FINAL REPORT

IMPROVING BUS OPERATIONS AND TRAFFIC (IBOT)

A REGIONAL APPROACH TO TRANSIT SIGNAL PRIORITY

Prepared for SANDAG
by IBI Group Version 3.3
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X. Executive Summary

Building upon the successful implementation of Transit Signal Priority (TSP) in the region, Improving Bus Operations and Traffic (IBOT) is a high-level planning study that sought to identify the top corridor locations to implement TSP on existing local bus routes. TSP is a way of reducing the amount of signal delay a bus experiences and increasing reliability by giving the bus more green time in the form of an early green or green extension.

IBI Group was scoped to develop methodology to identify these potential corridors and conduct a cost-benefit analysis for the top corridor locations. SANDAG, San Diego Metropolitan Transit System (MTS), North County Transit District (NCTD), as well as local jurisdictions and various planning committees were continually consulted throughout the planning process. The goal was to expand the region's TSP network of intersections, improve transit operations, reduce transit trip times, and enhance overall mobility. This study was funded primarily by a FY2014-15 California Department of Transportation (Caltrans) Transportation Planning Grant.

Region-wide analyses were first conducted for transit and traffic to determine a combined score for propensity for TSP, highlighting roadway segments that had high ridership, highest frequency, and greatest delay – situations where TSP can most ideally provide benefit to the most riders while not impacting traffic significantly. Responses from a survey of MTS and NCTD bus operators helped validate the regional analysis. A list of 23 corridors was identified from the region-wide analysis.

Of the top 23 corridors, the top 10 corridors were moved forward for further refinement. IBI Group developed a "hot spot" analysis to better understand what portions of the corridor would benefit from TSP the most rather than assuming TSP should be applied to all intersections along the corridor. A composite grade (A through F) for each segment on a corridor was determined. These segment composite grades were mapped for each of the 10 corridors and can be found in **Appendix B**.

Additional public outreach was done in the form of a factsheet about the IBOT project and TSP. Similar information was distributed to transit riders through the MTS newsletter and NCTD Rider Guide.

The top 10 corridors were costed out for capital as well as annual operations and maintenance costs. Cost estimates varied due to differences in the number of intersections, buses equipped, and type of traffic controller and TSP signal technology installed or available. The lowest priced corridor was Corridor 9 – Fairmount Ave. from Home Ave. to Orange Ave, located in the City of San Diego. The highest priced corridor was Corridor 4-Highland Ave. from 3rd St. to Main. St. via 3rd Ave. in National City and Chula Vista.

A second, more detailed transit and traffic modeling analysis was conducted for the three (3) of the top 10 corridors where intersection data was obtainable to assess the potential traffic impacts and transit benefits of TSP implementation on each of the three corridors: Corridor 2 in Oceanside, Corridor 4 in National City and Chula Vista, and Corridor 5 in El Cajon. Overall, TSP was estimated to provide more green time to buses while minimizing impacts to traffic. With TSP implemented, annual ridership and fare revenue were estimated to experience small increases. GHG emissions reductions are also estimated to occur with TSP implementation.

Potential funding opportunities have been identified in Section 7. Upon successful identification and receipt of funding, the next step would be to take one or more of the top 10 corridors into further detailed evaluation and design. This includes conceptual and detailed design of both the intersection level improvements, as well as the design for on-board vehicle installation and integration. Coordination with local agencies and transit providers will be essential to implementing TSP. Once implemented, TSP will require routine monitoring and maintenance to ensure the TSP system maximizes the benefit to transit while minimizing impacts to traffic. As future TSP corridors are implemented, they will continue to add value to the region's TSP network and contribute to the standards by which TSP is implemented.

1 Introduction

Building upon the successful implementation of Transit Signal Priority (TSP) in the region, Improving Bus Operations and Traffic (IBOT) is a high-level planning study that sought to identify the top corridor locations to implement TSP on existing local bus routes. IBI Group was scoped to develop methodology to identify these potential corridors and conduct a cost-benefit analysis for the top corridor locations. SANDAG, San Diego Metropolitan Transit System (MTS), North County Transit District (NCTD), as well as local jurisdictions and various planning committees were continually consulted throughout the planning process. The goal is to expand the region's TSP network of intersections, improve transit operations, reduce transit trip times, and enhance overall mobility. This study was funded primarily by a FY2014-15 California Department of Transportation (Caltrans) Transportation Planning Grant.

1.1 Currently Deployed TSP Corridors

Currently, five TSP corridors have been successfully deployed as part of the region's *Rapid* brand of buses that provide limited stops, upgraded stations and buses, and faster service. Studies have shown that the use of TSP on these routes has improved on-time performance and reduced travel times without greatly impacting traffic. These routes show reduced congestion at intersections with lower cross street traffic. An additional corridor, South Bay *Rapid*, a new bus rapid transit (BRT) route that will run from the Otay Mesa Port of Entry to downtown San Diego via eastern Chula Vista, will have TSP as part of its implementation. South Bay *Rapid* is currently under construction and is expected to begin service in 2018. The San Diego region is committed to utilizing technology that takes advantage of previous investments in transportation infrastructure. The region's TSP system capitalizes on the existing software and communications equipment onboard all buses in the region, as well as the previously deployed Emergency Vehicle Pre-emption (EVP) system that is active on nearly every intersection in the region. EVP is a high priority signal that can affect the signals at an intersection within seconds to accommodate emergency vehicles while TSP is a low priority signal that accommodates transit vehicles at certain points during a signal cycle. Current TSP status of corridors in the region can be seen in **Table 1-1**. A map of San Diego TSP deployments can been seen in **Figure 1-1** on the following page.

Table 1-1 - Summary Status of TSP Corridors

CORRIDOR AND ROUTE	NUMBER OF TSP INTERSECTIONS	STATUS
Escondido (NCTD Route 350, MTS Route 235)	19 Intersections	Deployed
University City (SuperLoop MTS Routes 201, 202, 204)	39 Intersections (4+ intersections possible in the future)	Deployed
Kearny Mesa (MTS Route 235)	5 Intersections	Deployed
Mira Mesa (MTS Route 237)	21 Intersections	Deployed
Mid-City (MTS Route 215)	33 Intersections	Deployed

1.2 Need for TSP

There is a need to improve bus reliability and overall transit time in the San Diego region. Travel time can be reduced by up to 10% during peak hours by reducing red light delays with TSP. TSP also allows buses that fall behind schedule the ability to recover some lost time to ensure passengers arrive at their destinations on time and are able to make their connections throughout the transit system. Time savings and increased reliability can improve the public's perception of the regional transit system, which may result in increased ridership.

Currently, TSP has been implemented only on regional *Rapid* bus routes. These initial investments have put the system in place to allow an expansion of TSP on existing local bus routes with comparatively lower startup costs.

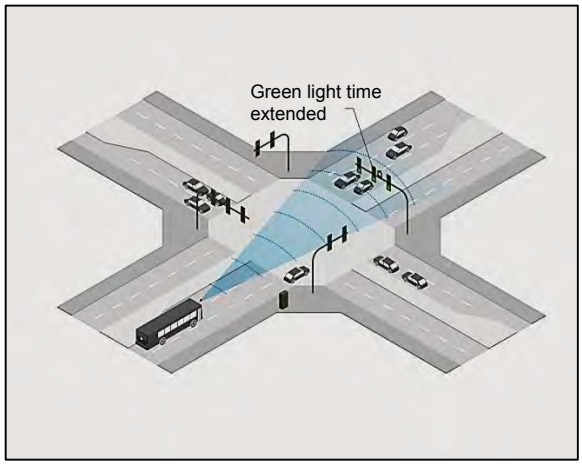
Figure 1-1 - Overview of San Diego TSP Deployments

1.3 How TSP Works

TSP is a method of adjusting signal timing at the intersection-level to provide more 'green time' for buses, resulting in fewer stops at traffic signals. It can help reduce delays by decreasing the probability of a bus stopping at a red signal. TSP can extend a green light in instances where a transit vehicle approaching an intersection might otherwise miss the green light. If a transit vehicle arrives at an intersection on a red light, TSP may serve an early green light in the signal cycle to shorten the waiting time for the transit vehicle and expediting transit travel. Once pre-emption is granted, the traffic controller will enter a "recovery" mode in which the controller takes one to several rounds of cycles to return to its normal cycle. Requests to grant TSP are "locked out" during recovery; not every transit vehicle crossing an intersection may be granted an explicit TSP request, however, other transit vehicles that arrive at the intersection close in time to the granted TSP request may also benefit. Local jurisdictions may also place limitations on how often TSP is granted. TSP is a lower priority signal than emergency vehicle pre-emption (EVP) whereas EVP can switch a traffic signal to green at any time.

TSP works by using onboard systems to measure the buses' exact GPS location and determine if it is running on schedule. When a bus falls behind schedule on a TSP-enabled route, the system activates an emitter onboard that sends continuous signals to the traffic signal receiver as the vehicle approaches a given intersection. Once the signal is received, the phase selector and controller inside the signal cabinet then determine whether to grant the request. If the request is granted, signal timing will be adjusted for additional green time if needed until the bus clears the intersection. TSP is only triggered when the bus is running behind schedule and the operation of the emitter would be seamless to the operator. Bus operators should generally notice a positive effect with respect to being stopped less at red lights. **Figure 1-2** depicts a bus approaching an intersection on a TSP-enabled route.

Figure 1-2 - San Diego TSP Intersection



1.4 IBOT Study Process

Under direction from SANDAG, IBI Group was competitively selected as the consultant to deliver the IBOT planning study. Planning work kicked off in September 2015 and was completed in late 2016. An IBOT Project Development Team (PDT) was formed which consisted of several SANDAG staff members, MTS planning staff, NCTD planning staff, and IBI Group. The PDT met 9 times throughout the planning phase of the project. The PDT reviewed all deliverables and provided direction to IBI Group. Additionally, SANDAG presented updates on the IBOT study to both the San Diego Regional Traffic Engineers Council (SANTEC) and Cities/County Transportation Advisory Committee (CTAC) at various stages of the project in order to engage and solicit feedback from the local jurisdictions. Meeting agendas, minutes, and presentations are included in **Appendix A**.

2 Region-wide TSP Evaluation

At the onset of the project, data was gathered to perform an assessment of the transit and arterial corridors within San Diego County to identify corridors where TSP could provide the greatest benefit. This was completed through a Geographic Information Systems (GIS) and algorithm coding exercise that included mapping all of the transit corridors in the County for ridership, frequency, arterial volumes, number of signals, and levels of service. The following sections detail the analysis conducted for each methodology input.

2.1 Data Collection

To first identify opportunity corridors where TSP could provide the greatest benefits based on the exiting transit network and operating characteristics, the following sources of data were collected in preparation for transit analysis as shown in **Table 2-1**.

Table 2-1 - Transit Analysis Data Sources

DATA	SOURCE
Automatic Vehicle Location (AVL)	MTS, NCTD
Automated Passenger Counts (APC)/Passenger RideCheck Data	SANDAG
Arterial network	SANDAG
Signalized intersections	Regional Arterial Management System (RAMS) – courtesy of SANDAG Modeling staff
Bus routes and stops	SANDAG
Existing and in-construction TSP corridors	IBI Group
General Transit Feed Specifications (GTFS) (headway, bus schedule)	Open source

2.2 Transit Analysis and Methodology

Using the data sets described in Section 2.1, the best potential corridors for TSP implementation were identified. The criteria used for the transit analysis was broken into two phases: 1) region-wide and 2) focused TSP corridors. The first phase of analysis included:

- RideCheck plus passenger data
- Headway data (GTFS)
- Bus Delay Data (GTFS) – normalized [off-peak – peak/peak]
- Arterial network – segment links of approximately 10 feet using GTFS data and road centerline shapefile

While APC data was collected, the dataset did not include all routes and was therefore not ideal for looking at ridership on a region-wide basis to develop the initial set of corridors to analyze. Passenger RideCheck data provided a snapshot of ridership in the region and therefore a smaller, easier dataset to work with. Therefore, it was used in place of APC data to represent ridership for the entire region. APC data was utilized for the second phase of analysis once a smaller subset of corridors was selected.

The data identified in Section 2.1 was analyzed in a GIS and assigned thresholds to the data giving it a “score” to easily identify roadway segments that have the highest ridership, highest

frequency, and greatest bus delay. The scores used are shown in **Tables 2-2 and 2-3**. Due to the varying transit characteristics between the MTS and NCTD transit systems, separate thresholds were developed to ensure more geographic equity.

Table 2-2 - Transit Analysis MTS Data Thresholds

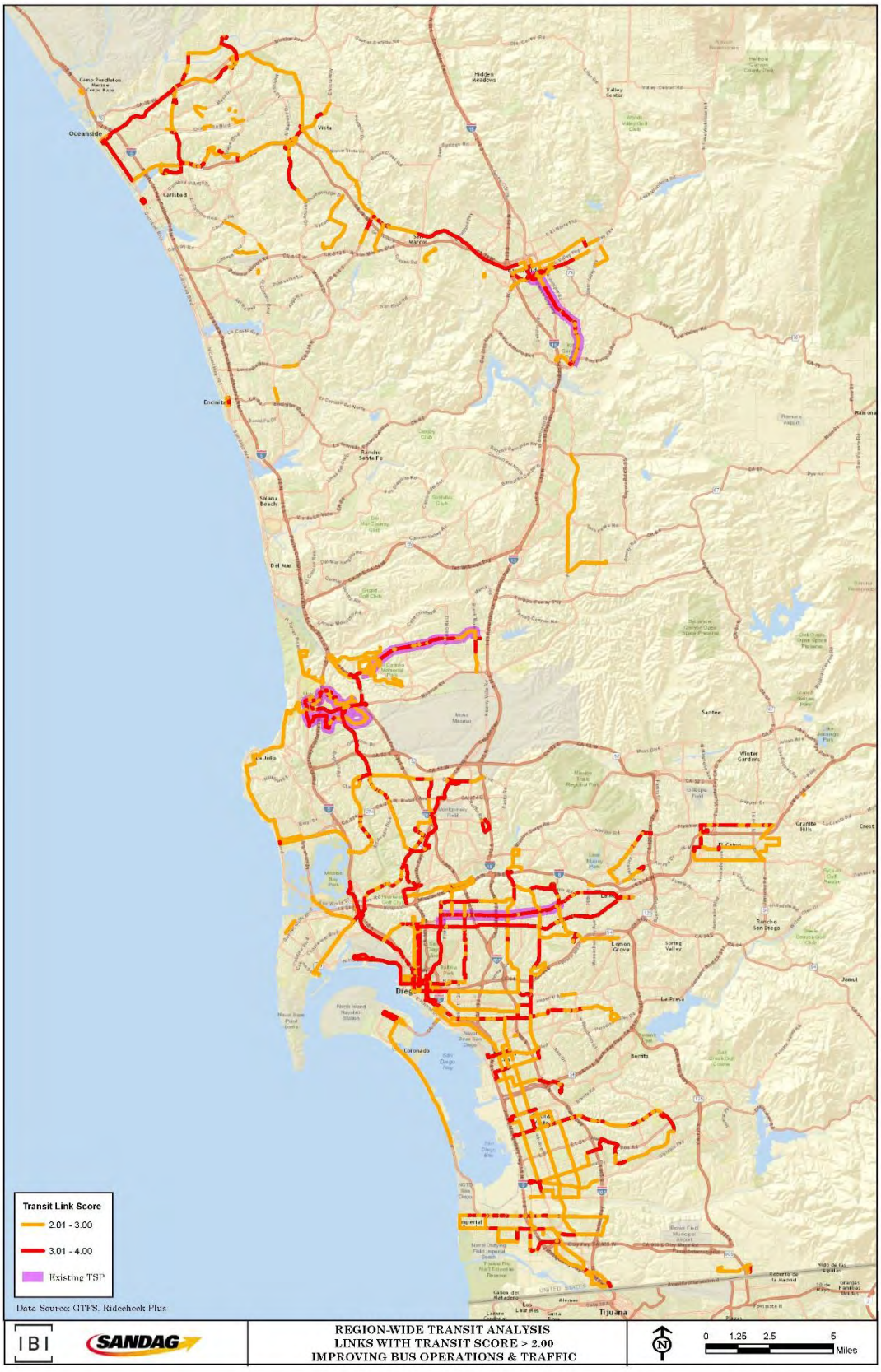
DAILY LOAD	SCORE
Less than 500 riders	1
501 – 1,500 riders	2
1,501 – 3,000 riders	3
More than 3,000 riders	4
PEAK HEADWAY	**SCORE**
Less than 10 minutes	4
11 – 15 minutes	3
16 – 20 minutes	2
More than 20 minutes	1
BUS DELAY (NORMALIZED)	**SCORE**
0.01 – 0.25	1
0.25 – 0.50	2
0.50 – 0.75	3
0.75 – 1.00	4

Table 2-3 - Transit Analysis NCTD Data Thresholds

DAILY LOAD	SCORE
Less than 250 riders	1
251 – 500 riders	2
501 – 750 riders	3
More than 750 riders	4
PEAK HEADWAY	**SCORE**
Less than 10 minutes	4
11 – 15 minutes	3
16 – 20 minutes	2
More than 20 minutes	1
BUS DELAY (NORMALIZED)	**SCORE**
0.01 – 0.25	1
0.25 – 0.50	2
0.50 – 0.75	3
0.75 – 1.00	4

Figure 2-1 shows the transit analysis conducted for the region using the composite scores tabulated from the rankings as shown in Tables 2-2 and 2-3 for all transit routes within the county.

Figure 2-1 - Region-wide Transit Analysis



2.3 Arterial Analysis and Methodology

Similar to the transit analysis, the arterial analysis was conducted in two phases: 1) region-wide and 2) top selected corridors. The first phase of arterial analysis considered:

- Level of service - based on annual average daily traffic volumes and roadway capacity
- Average signal cycle length
- Number of signals per segment

The arterial roadway network data collected in section 2.3 was analyzed in a GIS and assigned "scores" as shown in **Table 2-4**. The second half of the arterial analysis is used to further refine the top corridors, as described in Section 6.2.

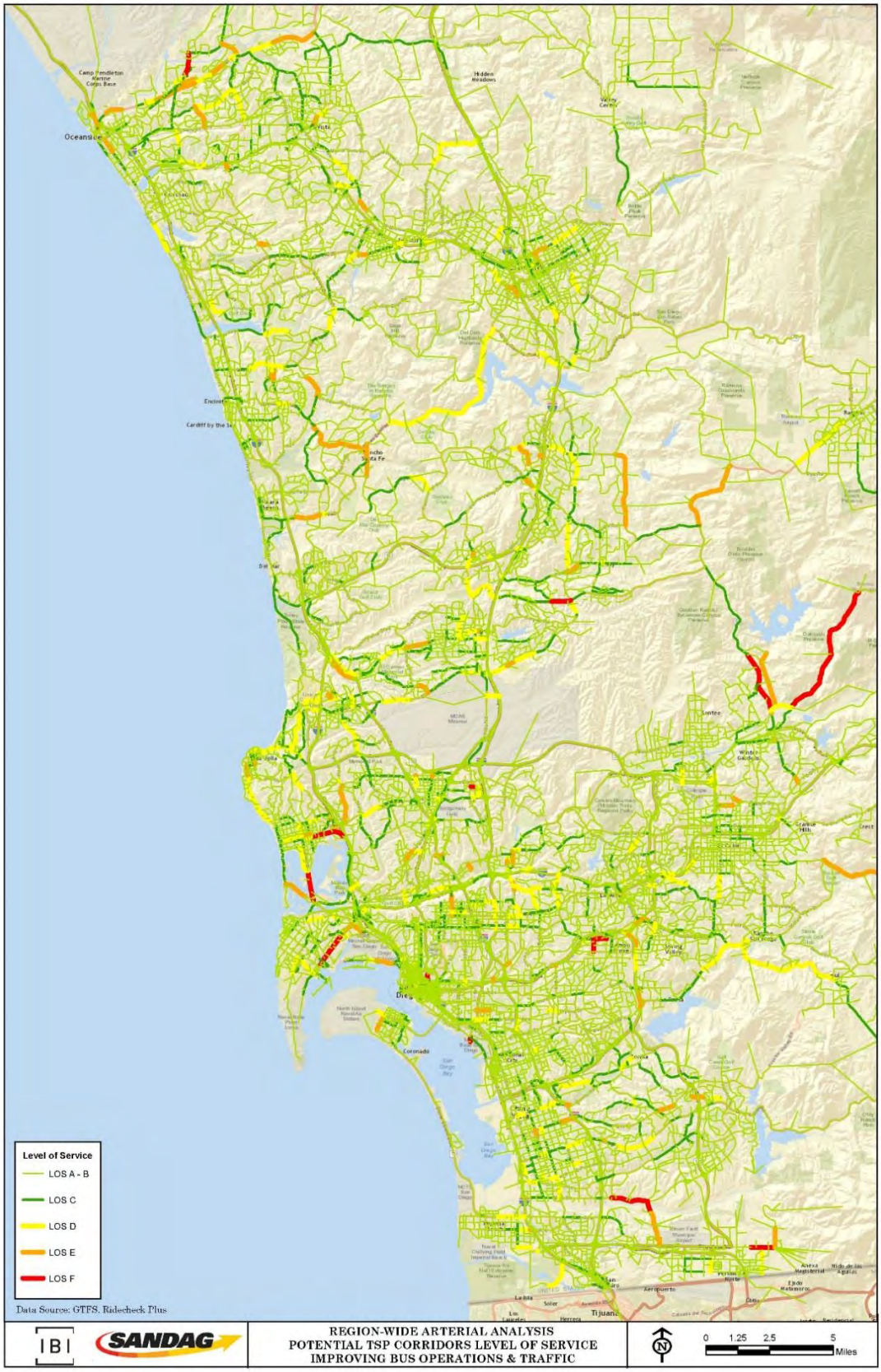
Table 2-4 - Arterial Analysis Data Thresholds

LEVEL OF SERVICE	SCORE
A – B	1
C	2
D	3
E – F	4
SIGNAL LENGTH	**SCORE**
0 – 79 seconds	0
80+ seconds	1
# SIGNALS PER SEGMENT	**SCORE**
0 – 5 signals	1
6 – 10 signals	2
11 – 15 signals	3
16+ signals	4

Note: Thresholds for arterial analysis were the same for MTS and NCTD service areas.

Figure 2-2 shows the arterial analysis conducted for the region using the composite scores tabulated from the rankings as shown in Table 2-3 for the arterial corridors within the county.

Figure 2-2 - Region-wide Arterial Analysis



2.4 Bus Operator Surveys

As part of the larger public outreach component of IBOT, TSP fact sheets and surveys were generated to receive input from bus operators about problematic or congested intersections and/or routes.

A total of 1,000 surveys were sent out to MTS and NCTD. 322 responses were received from both agencies, with 300 paper responses and 22 SurveyMonkey responses. A copy of the bus operator survey can be found in **Appendix C.** More information about this outreach effort can be found in Section 4: Public Outreach.

During the first phase of the transit and arterial analysis for identification of the top corridors, the number of responses and location of potential problematic intersections were incorporated into the output table with the composite transit and traffic score to serve as a simple mechanism of validation for the transit and traffic analysis.

2.5 Selection of Corridors

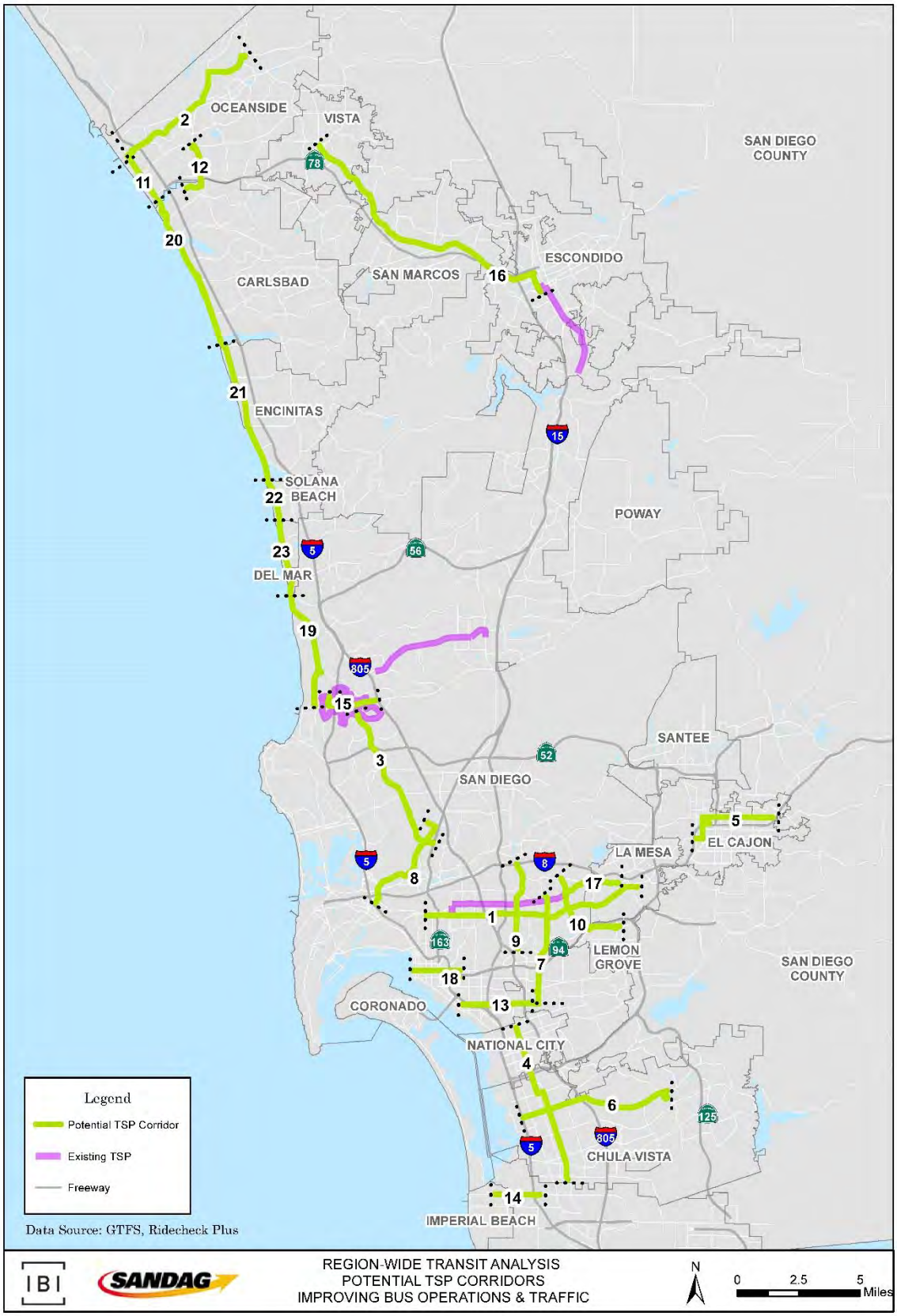
Based upon the first phase of analysis, there were twenty-three (23) corridors (see **Figure 2-3**) selected for further evaluation and discussion with the Project Development Team (PDT). These corridors were ones that showed potential to benefit from the implementation of TSP based on their quantitative transit score, arterial score, and/or combined score as well as qualitative considerations based on the bus driver surveys and NCTD and MTS operations and planning staff recommendations. A summary can be found in **Table 2-5** and the full list of these corridors and their scoring can be found in **Appendix B.** Note that expansions of currently deployed TSP corridors were not considered as part of this study, but that they may be worth revisiting in the next steps for implementation stage (Section 8) if funding opportunities become available and the fact that the foundational infrastructure for TSP may already be in place in the area. Planned TSP corridors outlined in SANDAG's 2050 Regional Transportation Plan were also not considered; only new unplanned corridors were ranked. As part of this analysis, some high scoring corridors were omitted due to existing unique signal timing (e.g. Downtown San Diego) and conflicting local projects (e.g. possible roundabouts on Coast Highway 101 in Oceanside).

Table 2-5 - Top 23 Corridors

CORRIDOR #	AGENCY	MAJOR STREETS	PRIMARY BUS ROUTE(S)	JURISDICTION
1	MTS	University Ave. between 1st Ave. and La Mesa Blvd.	1, 7, 10, 11, 83, 120	San Diego, La Mesa
2	NCTD	Mission Ave. between Oceanside Transit Center and San Luis Rey Transit Center (via Douglas Dr. & N. River Rd.)	303, 313	Oceanside
3	MTS	Genesee Ave. between SR-163 and Nobel Dr.	25, 41, 50, 105	San Diego
4	MTS	Highland Ave. between 3rd St. and Main St. (via 3rd Ave.)	929	National City, Chula Vista
5	MTS	Between El Cajon Transit Center and E. Main St. (via Main, Johnson, Broadway)	848, 864, 871, 872, 874, 875, 888, 892	El Cajon
6	MTS	H St. between Woodlawn Ave. and Southwestern College (via Otay Lakes Rd.)	709	Chula Vista

CORRIDOR #	AGENCY	MAJOR STREETS	PRIMARY BUS ROUTE(S)	JURISDICTION
7	MTS	54th St./Euclid Ave. between Logan Ave. and Monroe Ave.	3, 4, 13, 916, 917, 955	San Diego
8	MTS	Taylor St./Linda Vista Rd. between Old Town Transit Center and Armstrong St.	44, 88, 105	San Diego
9	MTS	Fairmount Ave. between Home Ave. and I-8	11,13	San Diego
10	MTS	College Ave. between SDSU and Lemon Grove Ave. (via Broadway)	215, 836, 936	San Diego, Lemon Grove
11	NCTD	Coast Hwy between Oceanside Transit Center and Vista Way	101, 302, 318	Oceanside
12	NCTD	El Camino Real between Plaza Camino Real and Oceanside Blvd.	302, 309, 325	Oceanside, Carlsbad
13	MTS	Palm Ave. between Hollister Ave. and 9th Ave.	933, 934	San Diego
14	MTS	National Ave. between 26th St. and Euclid Ave.	11	National City
15	MTS	La Jolla Village Dr. between I-805 and Gilman Dr. (via Villa La Jolla Dr.)	30, 41, 101, 150, 237, 921	San Diego
16	NCTD	Mission Blvd between Escondido Transit Center and Vista Transit Center	305, 347, 356	Escondido, San Marcos, Vista
17	MTS	El Cajon Blvd. between College Ave. and La Mesa Blvd.	1, 215	San Diego
18	MTS	Market St. between 16th Ave. and 25th St.	3, 5, 11	San Diego
19	NCTD	Torrey Pines Rd. between Del Mar Heights Rd. and Genesee Ave.	101	San Diego
20	NCTD	Carlsbad Blvd. between Eaton St. and La Costa Ave.	101	Carlsbad
21	NCTD	Coast Highway 101 between La Costa Ave. and just south of Chesterfield Dr.	101	Encinitas
22	NCTD	Highway 101 between just south of Chesterfield Dr. and Via De La Valle	101	Solana Beach
23	NCTD	Camino Del Mar between Via De La Valle and Del Mar Heights Rd.	101	Del Mar

Figure 2-3 - Top 23 IBOT Corridors



3 Focused TSP Evaluation

After the region-wide analysis of transit and arterial corridors, a second phase of analysis was performed on the top 23 corridors to further refine the list to 10 corridors for which a cost/benefit analysis was performed as described further in this report.

3.1 Top 10 Corridor Selection

The top 10 corridors were selected based on the criteria developed using the traffic and transit datasets and methodologies discussed in Section 2.0. In addition, detailed discussions were held with the PDT to identify the pros and cons associated with each corridor and relevant projects or corridor conditions that may not be readily apparent from just the datasets and analysis outcomes. This input in addition to feedback received from presentations made to the SANTEC and CTAC committees were utilized to select the top 10 corridors that warrant implementation of TSP, as shown in **Table 3-1** and **Figure 3-1**.

Table 3-1 - Top 10 Selected Corridors

CORRIDOR #	AGENCY	MAJOR STREETS	PRIMARY BUS ROUTE(S)	JURISDICTION
1	MTS	University Ave. between 1st Ave. and La Mesa Blvd.	1, 7, 10, 11, 83, 120	San Diego, La Mesa
2	NCTD	Mission Ave. between Oceanside Transit Center and San Luis Rey Transit Center (via Douglas Dr. & N. River Rd.)	303, 313	Oceanside
3	MTS	Genesee Ave. between SR-163 and Nobel Dr.	25, 41, 50, 105	San Diego
4	MTS	Highland Ave. between 3rd St. and Main St. (via 3rd Ave.)	929	National City, Chula Vista
5	MTS	Between El Cajon Transit Center and E. Main St. (via Main, Johnson, Broadway)	848, 864, 871, 872, 874, 875, 888, 892	El Cajon
6	MTS	H St. between Woodlawn Ave. and Southwestern College (via Otay Lakes Rd.)	709	Chula Vista
7	MTS	54th St./Euclid Ave. between Logan Ave. and Monroe Ave.	3, 4, 13, 916, 917, 955	San Diego
8	MTS	Taylor St./Linda Vista Rd. between Old Town Transit Center and Armstrong St.	44, 88, 105	San Diego
9	MTS	Fairmount Ave. between Home Ave. and I-8	11,13	San Diego
10	MTS	College Ave. between SDSU and Lemon Grove Ave. (via Broadway)	215, 836, 936	San Diego, Lemon Grove

3.2 Transit “Hot Spot” Analysis and Methodology

For the top 10 corridors, IBI Group developed a methodology to identify “hot spots” along the segments where buses experience significant delay and reliability challenges and where TSP is anticipated to provide the most improvement to bus service when implemented. This was done to

further refine the top 10 corridors and specify what portions of the corridor would benefit from TSP the most rather than assuming TSP should be applied to all intersections along the corridor. Per the methodology below, a composite grade (A through F) for each segment on a corridor was determined. These segment composite grades are mapped for each of the 10 corridors and can be found in **Appendix B**.

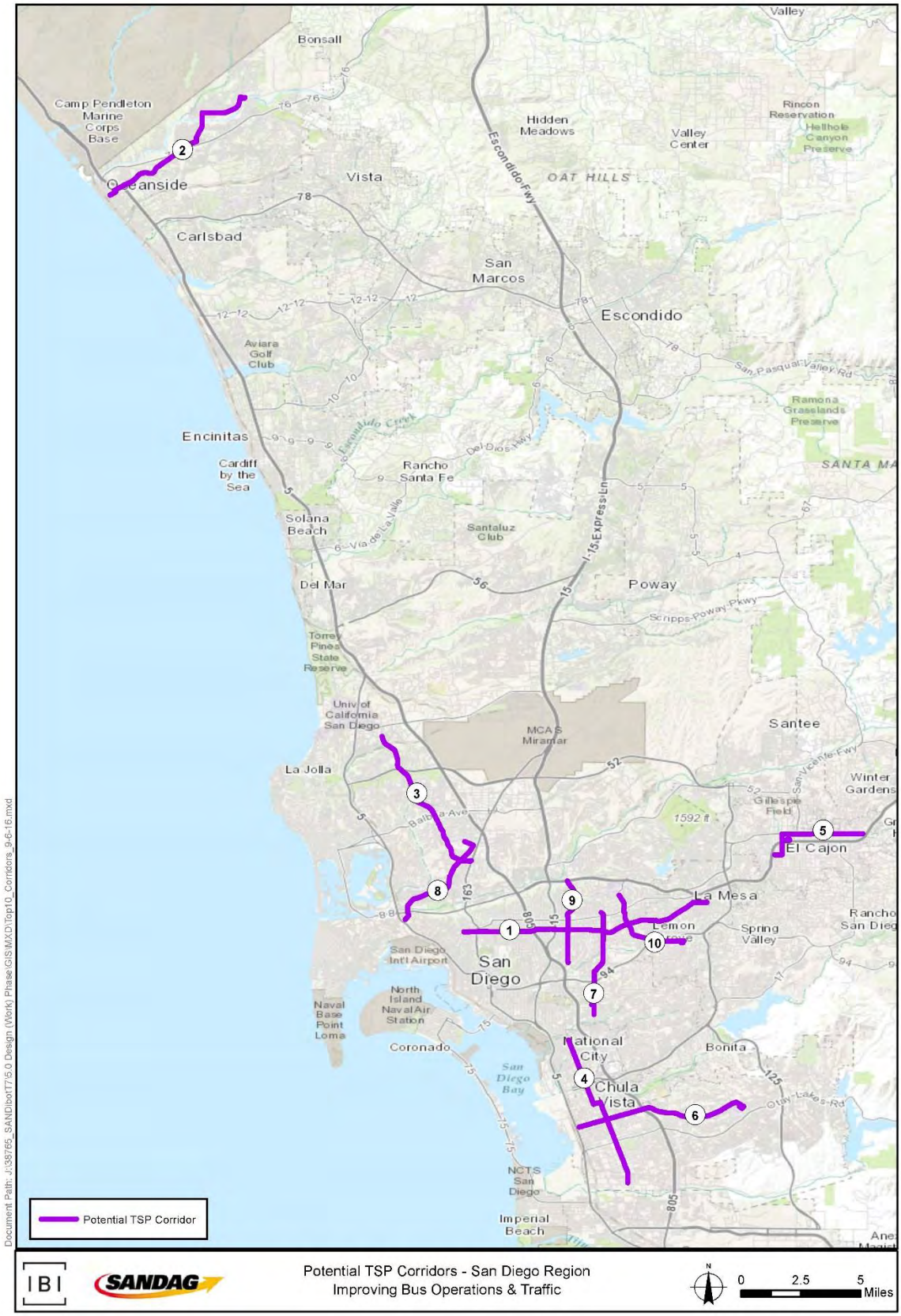
3.2.1 Data Source

The “hot spot” analysis uses data from MTS and NCTD’s Automatic Passenger Counters (APCs). These on-board devices count the number of passengers boarding and alighting at each stop, and also provide the travel time from the time the door closes at a stop to the time the door opens again at the next stop. The time from when the bus starts moving away from a stop to the time when the door opens at the next stop constitutes a stop-to-stop ‘segment’ in the analysis. The boarding and alighting information also allows calculation of the passenger load (i.e. the number of passengers in the bus) after each stop.

There was APC data for hundreds of trips for each day, providing a good dataset for bus performance. For each of the top 10 corridors, APC data from one or more routes that cover the length of the corridor entirely was used to analyze segment performance.

The following sections describe each of the measures of effectiveness (MOEs) for a segment, and how it was estimated. The MOEs are also combined into a composite grade for each segment.

Figure 3-1 – Top 10 Proposed TSP Corridors



3.2.2 Measures of Effectiveness

Three aspects of transit service quality were used to identify "hot spot" locations for TSP. These are bus travel time, passenger travel time, and reliability of service. To assess these, three MOEs were established:

- *Travel time LOS (TT_LOS)* captures the amount of delay for a bus. It is estimated as the ratio of the median bus travel time on a segment in a peak period to a minimum or reference travel time. This reference travel time is the amount of time it 'should' take a bus to travel a segment with no other delays. The reference travel time for each segment was established as the minimum of the following two values:
    - The median travel time observed in the early hours (between 4:00 AM and 7:00 AM)
    - The median travel time observed in the late evening hours (between 10:00 PM and midnight)[1]

$$\text{TT\_LOS} = \frac{\text{Median peak travel time}}{\text{Reference travel time}}$$

- *Excess passenger travel time (XPT)* captures the amount of delay for passengers. Although the TT_LOS measure captures vehicle delay, it does not fully account for the impact of these delays to the traveling public. Each passenger on a bus is affected by the excess running time, so the overall delay experienced by passengers is proportional to the number of passengers on the bus. In other words, the overall passenger delay is greater for a crowded bus, than for a relatively empty bus. To estimate XPT for a segment, the median passenger load on a segment is multiplied by the segment excess running time. The excess running time is the difference between the median travel time on a segment in a peak period and the reference running time (same as the one defined for the TT_LOS measure).

$$\text{XPT} = (\text{Median peak travel time - reference travel time}) \times \text{median passenger load}$$

- *Unreliability (SDTT)* is measured as the standard deviation of travel times of a segment. This measure captures the variability of bus service, with a lower value indicating less variation in the travel times. Both passengers and transit operators are negatively affected by variability in travel times. For the operator, high variability requires additional recovery time in the schedule to accommodate late buses, driving up operating costs. For passengers, high variability means that they may need to plan on longer travel times to be sure that they arrive on-time.

$$\text{SDTT} = \text{standard deviation of travel times}$$

All of the corridors were selected using both the AM and PM peak data. During the selection of the corridors, it was found that there was little difference resulting in the rank and extent of the corridors. Therefore, one peak period was chosen to calculate the MOEs. All three MOEs are measured for the AM peak (7 – 9 AM).

3.2.3 Rating of MOEs

For each MOE, ranges were established to map six general conditions (A to F), with excellent conditions (low delays and variability) receiving a score of A and failing conditions (high delays and variability) receiving a score of F. For each MOE, thresholds were established both by considering the typical observed range for each MOE in the dataset, and through IBI Group's

[1] In some cases, segments did not have data for the early AM and late evening peak, so the reference travel time for these segments was established as the median travel time observed in the midday time period (between 9:00 AM and 4:00 PM)

analysis of operational data from a number of transit systems in North America. The thresholds apply to the measure for each stop-to-stop segment. A summary of these ratings is shown in **Figure 3-2**.

3.2.4 Composite Grade

A composite grade for the three MOEs was developed so that segments can be described by a single letter grade. The composite grade was developed because a simple average of the grades for each MOE would allow an excellent grade to obscure a failing one. For the composite grade, a very poor performance on only one of the three MOEs would have a more than proportional effect. The composite grade is calculated as follows:

$$\text{Composite Grade} = \sqrt{\frac{(\text{TT\_LOS score})^2 + (\text{XPT score})^2 + (\text{SDTT score})^2}{3}}$$

The composite grade will have a value from A to F. Segment composite grades for each of the ten (10) corridors are shown on maps in **Appendix B**. An example composite grade map is shown in **Figure 3-3**.

Figure 3-2 - Ratings of MOE

Composite Grade	Travel Time LOS	Excess passenger travel time (person-minutes)	Unreliability (seconds) where T is the segment reference travel time in seconds
A	1.2	1.5	$0.056\ T + 0.967\ T^{0.5}$
B	1.3	4	$0.108\ T + 1.84\ T^{0.5}$
C	1.5	8	$0.147\ T + 2.87\ T^{0.5}$
D	1.7	16	$0.186\ T + 3.90\ T^{0.5}$
E	1.9	24	$0.225\ T + 6.88\ T^{0.5}$
F	>1.9	>24	$> 0.225\ T + 6.88\ T^{0.5}$

Using the segment composite grades for each corridor, the boundaries of the top ten (10) corridors were further refined to reflect existing conditions and account for existing TSP. The top ten (10) corridor maps are available in **Appendix B** with major and minor intersections distinguished, and exceptions noted.

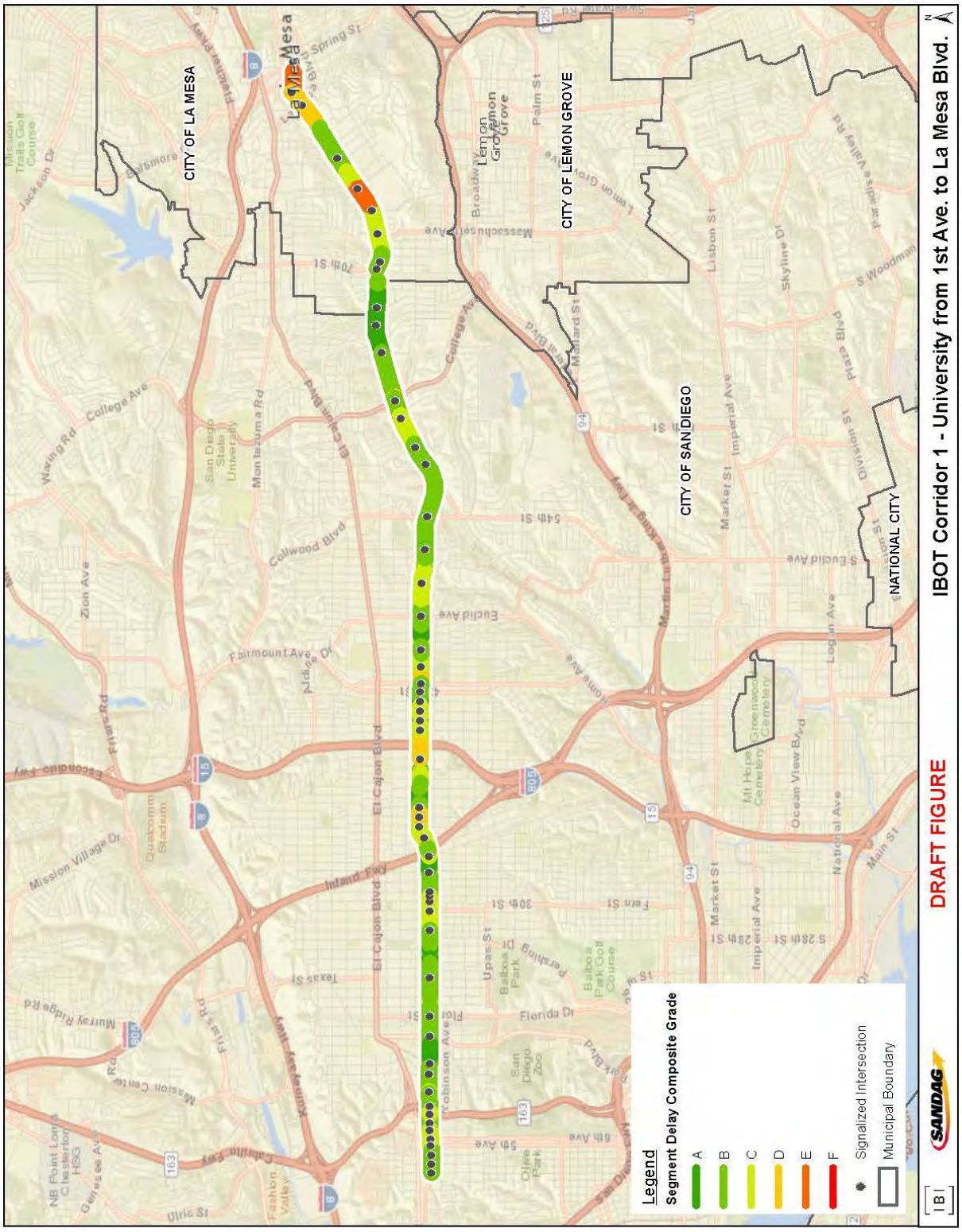


Figure 3-3 - Example Segment Composite Grade Map of Corridor 1

4 Public Outreach

The following section summarizes the public outreach that was done as part of IBOT. A detailed outreach plan was developed and implemented in accordance with SANDAG's Public Participation Plan. Outreach activities were coordinated with key activities in the project schedule.

The following messages about the study were communicated:

- TSP is an operational strategy that facilitates the movement of transit vehicles through traffic-signal controlled intersections. The TSP advantage is most commonly executed as an extended (or early) green light for a single transit vehicle approaching an intersection where a bus may otherwise be forced to wait at a red signal.

- TSP reduces the amount of time transit vehicles spend idle at intersections which helps improve on-time performance, reduce running times, and improve the overall quality of transit service.

- Through this study, SANDAG will identify opportunity corridors where TSP could be implemented to provide the greatest benefit to passengers and operations on existing bus routes. SANDAG will also develop cost estimates and identify potential funding sources for implementing TSP on the top-ranked corridors.

Three activities/deliverables were produced as part of the public outreach effort of this study:

- Bus Operator Surveys
- Fact Sheets
- Transit Rider Information

The detailed IBOT Public Outreach Plan can be found in **Appendix C**.

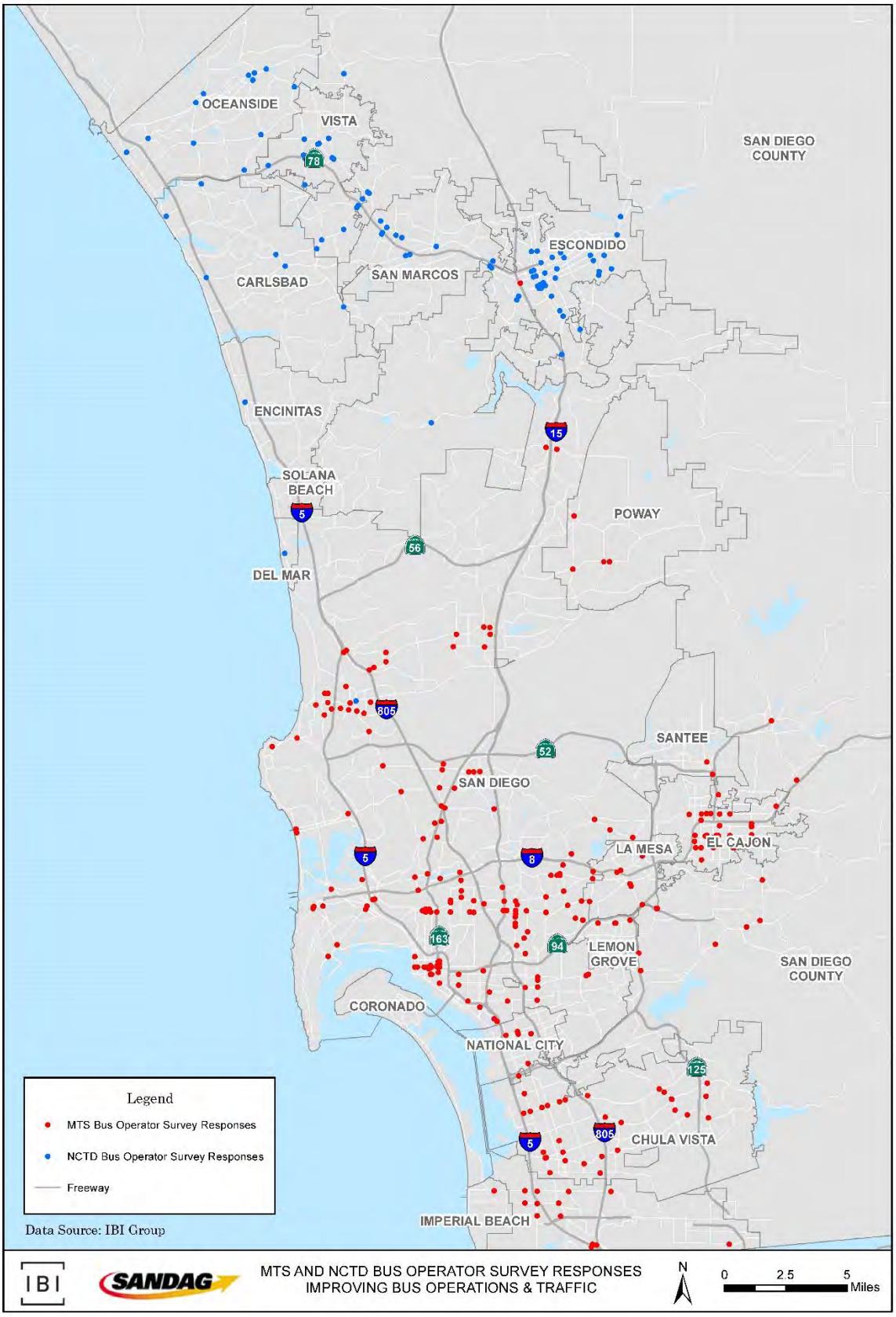
4.1 Bus Operator Surveys

This public outreach effort sought to simultaneously inform bus operators about TSP while seeking input from them on problem intersections and congested areas along bus routes to inform and validate the analysis. An IBOT and TSP fact sheet were attached to each survey. The fact sheet was also provided electronically.

A total of 1,000 surveys were sent out to MTS and NCTD operators with a 32.2% response rate. A total of 322 responses were received from both agencies; 300 paper responses and 22 SurveyMonkey responses. The responses covered a wide range of intersections and routes. The responses were incorporated into an Excel sheet comparison with the combined transit and traffic score to help validate the transit and traffic analysis and incorporated into a shapefile in GIS. A copy of MTS and NCTD survey packets, along with the combined survey response results, can be found in **Appendix C**.

Responses from the bus operator surveys helped to confirm the quantitative analysis, as shown in the snapshot of the bus operator survey responses shapefile in **Figure 4-1**.

Figure 4-1 - Bus Operator Survey Responses



4.2 IBOT and TSP Fact Sheet

The intent of the fact sheet was created to support initial efforts to educate key stakeholders about the study. An early version of the fact sheet was attached to the bus operator surveys that went out to MTS and NCTD. The fact sheet was later updated to reflect results of the IBOT study. A copy of both fact sheets can be found in **Appendix C**.

4.3 Transit Rider Information

Engaging the general public about TSP has challenges, however, the IBOT study includes an outreach program to educate transit riders about TSP and share the results of the IBOT study. A sample article about TSP and the IBOT study were prepared for the SANDAG rEgion, MTS Express, and NCTD News Center newsletters to educate the public about the purpose and results of the IBOT study as well as TSP itself. The sample article, as well as abridged versions for Facebook and Twitter, can be found in **Appendix C**.

5 TSP Corridor Cost Estimates

Capital costs and annual operations and maintenance costs were prepared for the top ten (10) corridors. The methodology and range of cost estimates are detailed in the following sections.

5.1 Capital Cost Estimate Assumptions and Methodology

Capital costs refer to non-reoccurring infrastructure and equipment costs. All potential pieces needed for TSP implementation have been included; however, if item(s) are determined to be no longer needed or relevant. Costs were prepared with the following considerations in mind:

- An intersection refers to an intersection with a traffic signal,
- Where intersections in recommended corridors cross intersections with existing TSP, higher importance arterial transit priority, incompatible traffic signal controllers, or heavy congestion may deem TSP unbeneficial, were noted on the accompanying maps (found in **Appendix B**),
- Intersection costs were based on use of existing controllers and technology at each intersection and typical operating conditions,
- Intersections are presumed to have already been equipped with emergency vehicle pre-emption (a high priority request),
- Backhaul communications systems (fiber recommended) costs are not included,
- Corridor improvement costs were developed in isolation (i.e. cost savings that could incur from improvement projects on the same corridor are not captured in these estimates),
- The cost of a GPS clock (which determines a moving vehicle's position and syncs the equipment's time to universal time for accurate data records) has been included in all capital cost estimates; if a server connection is existing or will be installed as part of a larger corridor improvement project, this cost may be zeroed out.
- Traffic control and traffic permits are included in all capital cost estimates and can be zeroed out if TSP is implemented on a corridor in conjunction with a larger BRT or corridor project,
- Costs for controllers have been included in all capital cost estimates, however, if controllers are existing or jurisdictions decide not to upgrade, costs for new controllers can be zeroed out.
- Given that this study considers implementing TSP on existing routes in the region, costs for equipping buses with TSP equipment assumes existing buses are retrofitted. New buses from the factory can be equipped with TSP equipment at a smaller cost per bus.
- "Spares" accounts for retrofitting spare buses and parts for routine maintenance of buses which remove them from regular rotation,
- Unit costs for equipping a bus are multiplied by the number of buses needed to run all routes on a selected corridor at peak operations to obtain a subtotal for retrofitting buses for TSP on that corridor. MTS and NCTD provided the number of buses needed to run each route at peak operations on each corridor. The 30% used for calculating spares was recommended by MTS to adequately estimate the cost of spares. In-vehicle equipment, in-vehicle installation, and spares costs were summed to obtain a total cost for equipping buses for TSP on a corridor. This total cost for equipping buses is also broken down by route in the case that funds are only available to equip selected routes with TSP,
- Management and Design, Contract Procurement, and Contingency category estimates were determined by taking a percentage of other costs. Management and Design costs are 10% of the intersections and buses subtotals per corridor. Contract Procurement

costs are also 10% of the intersections and buses subtotals per corridor. Contingency costs are 20% of all other capital costs, including intersections, buses, management and design, and contract procurement.

At a high level, capital costs for each corridor were divided into five (5) categories:

- Intersection sizes (Minor/Minor = 2/2 or 2/3 3 lanes, Minor/Major = 2/4 or 4/4 lanes, and Major/Major = 4/6 or 6/6 lanes)
- Buses
- Design
- Administration
- Contingency

Each of these categories was costed out for four (4) options. While much of the equipment needed for TSP implementation is the same, implementation and costs may vary due to differences in the following equipment technology that is already installed or will be installed:

- **Traffic Controller and Software**: The traffic controller (if not already installed) will be 170E (basic) or 2070ATC (advanced). 170E controllers are no longer in production but still work with TSP operations, however, once TSP is triggered, the controller will serve the full TSP cycle length even if the bus has already passed the intersection. The 2070ATC controller provides better functionality and less impacts to side streets because it will drop the TSP call as soon as the bus crosses the intersection, providing benefit to transit and regular traffic. Both controllers will go through a TSP recovery phase to get back to its normal signal cycle immediately following a signal cycle that serves TSP.
- **Communications technology**: Infrared (IR) or radio/GPS technology both serve as the route by which the bus communicates to the traffic controller located at each intersection to place a TSP call. Infrared technology can place a TSP call based on sensing a bus's physical closeness to the intersection. Radio frequency and GPS technology sends a bus's GPS coordinates via radio frequency to an intersection as a bus approaches an intersection and utilizes that method to determine when a bus passes a geographic threshold by which a TSP call can be placed.

The four (4) cost options per corridor are listed below and can be seen in the sample cost estimate summary in **Table 5-1**:

- 170E Traffic Controller with infrared emitter
- 2070ATC Traffic Controller with infrared emitter
- 170E Traffic Controller with Radio/GPS
- 2070ATC Traffic Controller with Radio/GPS

Table 5-1 - Sample Capital Cost Estimate Summary

Corridor 2 - Mission Blvd. from Oceanside TC to San Luis Rey TC				
	Option 1	Option 2	Option 3	Option 4
	Type A 170E + IR Emitter	Type B 2070ATC + IR Emitter	Type C 170E + Radio/GPS	Type D 2070ATC + Radio/GPS
Intersections	$507,350	$527,350	$373,625	$393,625
Buses	$157,500	$157,500	$189,000	$189,000
Management and Design	$67,985	$69,985	$51,363	$53,363
Contract Procurement	$67,985	$69,985	$51,363	$53,363
Contingency	$135,970	$139,970	$102,725	$106,725
Total Corridor Cost	**$951,790**	**$979,790**	**$719,075**	**$747,075**

The cost per category was summed up for each of the four (4) options for a total corridor cost, Each corridor has four (4) cost estimates that differ based on the technology used.

5.2 Range of Capital Cost Estimates

Capital cost estimates were created for the top ten (10) ranking IBOT corridors. Estimates ranged widely, largely dependent on the number and type of intersections within the corridor, from just over $300,000 on the low end to over $1.1 million on the high end. Variations in cost estimates are due to a number of factors. The number of intersections and size of intersections (minor/minor, minor/major, or major/major) present in a corridor greatly affect the cost, as seen in range of the top ten (10) corridors capital cost estimates in **Table 5-2**.

Table 5-2 - Top Ten (10) Corridor Capital Cost Estimates

CORRIDOR #	MAJOR STREETS	# OF INTERSECTIONS	# OF BUSES	COST RANGE
1	University Ave. between 1st Ave. and La Mesa Blvd.	26	42	$827,000 - $1,023,000
2	Mission Ave. between Oceanside Transit Center and San Luis Rey Transit Center (via Douglas Dr. & N. River Rd.)	26	46	$747,000 - $978,000
3	Genesee Ave. between SR-163 and Nobel Dr.	20	36	$662,000 - $814,000
4	Highland Ave. between 3rd St. and Main St. (via 3rd Ave.)	32	34	$925,000 - $1,182,000
5	Between El Cajon Transit Center and E. Main St. (via Main, Johnson, Broadway)	14	23	$488,000 - $611,000
6	H St. between Woodlawn Ave. and Southwestern College (via Otay Lakes Rd.)	21	21	$614,000 - $800,000
7	54th St./Euclid Ave. between Logan Ave. and Monroe Ave.	20	48	$759,000 - $903,000
8	Taylor St./Linda Vista Rd. between Old Town Transit Center and Armstrong St.	17	25	$549,000 - $706,000
9	Fairmount Ave. between Home Ave. and I-8	10	13	$305,000 - $391,000
10	College Ave. between SDSU and Lemon Grove Ave. (via Broadway)	12	17	$394,000 - $520,000

A summary table of capital cost estimates for the top ten (10) IBOT corridors plus detailed estimates per corridor can be found in **Appendix D**. Accompanying corridor maps can be found in **Appendix B.**

5.3 Annual Operations and Maintenance Cost Estimate Assumptions and Methodology

Annual operations and maintenance cost estimates were determined based on three (3) main categories with more detailed items under each:

- **TSP Signal Maintenance**: phase selector and add-on equipment maintenance and staff time required annually
- **TSP Vehicle Maintenance**: emitter and add-on on-board equipment maintenance and replacement and staff time required annually
- **Monitoring and Management**: staff time required annually to support TSP signals, TSP equipment on buses, and overall monitoring of the regional *Rapid* program

Unlike capital cost estimates, the annual operations and maintenance costs remained consistent regardless of traffic controller (170E or 2070ATC) and technology type (infrared or radio/GPS). Annual TSP signal maintenance costs per corridor consists of multiplying the total number of TSP intersections in a selected corridor by the annual subtotal per intersection (obtained from multiplying unit costs by estimated frequency per year). Once implemented, the costs to maintain an intersection is constant regardless of the size of the intersection. Annual TSP vehicle maintenance costs per corridor is the result of multiplying the sum of peak buses and spares by the annual subtotal per vehicle (unit costs multiplied by estimated frequency per year). A sample summary is shown in **Table 5-3**.

Table 5-3 - Sample Annual Operations and Maintenance and Cost Estimate Summary

Corridor 2 - Mission Blvd. from Oceanside TC to San Luis Rey TC					
Summary Costs Per Corridor		Summary Costs Per Corridor Breakdown by Agency			
Category	Subtotals	Category	Subtotals	Per	Annual Cost
TSP Signal Maintenance	$64,688	Local City/Traffic Agency	$71,888	Intersection	$2,876
TSP Vehicle Maintenance	$39,813	Transit Operator (NCTD)	$51,333	Vehicle	$1,128
Monitoring and Management	$79,200	Regional Program (SANDAG)	$60,480		
Annual Total	**$183,700**	**Annual Total**	$183,700		

TSP signal maintenance, TSP vehicle maintenance, and monitoring and management costs were summed to achieve a total cost per year to maintain a selected corridor. Based on previous experience with average equipment breakdown, costs for a certain number of equipment replacements per year have been factored in. Additionally, the total annual operations and maintenance cost per corridor was broken down by regional agency. The portion of operations and maintenance costs that the local city/traffic agency would be responsible for encompasses TSP signal maintenance and staff time for city traffic engineers. The transit operator (MTS or NCTD) could expect to be responsible for TSP vehicle maintenance costs as well as the staff time of a transit service analyst and transit scheduler. SANDAG may be responsible for monitoring the *Rapid* program, so staff time for managing the program comprises this cost. If more than one TSP corridor is implemented, economies of scale may apply and a 20% reduction in total staff time cost can be expected as more corridors are equipped with TSP.

5.4 Range of Annual Operations and Maintenance Cost Estimate

Annual operations and maintenance cost estimates were created for the top ten (10) ranking IBOT corridors. Estimates ranged from approximately $116,000 to $191,000 as seen in **Table 5-4**.

Table 5-4 - Top Ten (10) Corridor Annual Operations and Maintenance Cost Estimates

CORRIDOR #	MAJOR STREETS	# OF INTERSECTIONS	# OF BUSES	ANNUAL O + M COSTS
1	University Ave. between 1st Ave. and La Mesa Blvd.	26	42	**$183,000**
2	Mission Ave. between Oceanside Transit Center and San Luis Rey Transit Center (via Douglas Dr. & N. River Rd.)	26	46	**$184,000**
3	Genesee Ave. between SR-163 and Nobel Dr.	20	36	**$163,000**
4	Highland Ave. between 3rd St. and Main St. (via 3rd Ave.)	32	34	**$192,000**
5	Between El Cajon Transit Center and E. Main St. (via Main, Johnson, Broadway)	14	23	**$136,000**
6	H St. between Woodlawn Ave. and Southwestern College (via Otay Lakes Rd.)	21	21	**$152,000**
7	54th St./Euclid Ave. between Logan Ave. and Monroe Ave.	20	48	**$173,000**
8	Taylor St./Linda Vista Rd. between Old Town Transit Center and Armstrong St.	17	25	**$159,000**
9	Fairmount Ave. between Home Ave. and I-8	10	13	**$116,000**
10	College Ave. between SDSU and Lemon Grove Ave. (via Broadway)	12	17	**$125,000**

A summary table of annual operations and maintenance cost estimates for the top ten (10) IBOT corridors plus detailed estimates per corridor can be found in **Appendix D**. Accompanying corridor maps can be found in **Appendix B.**

5.5 Summary of Cost Estimates

Of the capital and annual operations and maintenance cost estimates conducted for the top ten (10) corridors, the lowest priced corridor was Corridor 9, located in the City of San Diego, running on Fairmount Ave. from Home Ave. to Orange Ave. It would cost $305,000 to implement and $116,000 a year to maintain the ten (10) intersections in the corridor and the thirteen (13) buses required to operate routes along the corridor.

The highest priced corridor overall was Corridor 4, which serves the Cities of National City and Chula Vista via Highland Ave and 3rd Ave. between 3rd St. and Main St. Corridor 4 would cost up

to $1,182,000 to implement and $192,000 a year to maintain thirty-two (32) intersections and thirty-four (34) buses that operate along the corridor.

The variability between the lowest and highest priced corridors is affected by the following factors:

- **Amount and Size of Intersections**: In general, the more intersections in a corridor, the more costly a corridor will be to implement. However, intersection costs also depend on the size of the intersection. Smaller intersections are cheaper to implement than larger intersections that require more equipment to be installed. A minor/minor intersection, defined as 2 lanes in one direction and 2 or 3 lanes in the other direction, can cost up to $20,000 to implement, A minor/major intersections, with 2 or 3 lanes in one direction and 4 in the other direction, can cost up to $22,600. A major/major intersection, which can consist of 4 or 6 lanes in both directions, implementation can cost up to $28,600. All intersections, regardless of size, costs about $2,600 a year to maintain. More details in regards to installation costs, traffic permit fees, and engineering support are available in **Appendix D**.
- **On-Board Bus Equipment**: The more buses that need to be equipped to operate routes along a corridor, the more costly it will be. It costs roughly $3,750 to equip a bus with infrared technology and $4,500 with radio/GPS technology.
- **Traffic Controllers**: As described earlier in Section 5.1, corridors may have 170E traffic controllers or 2070ATC controllers. 170E controllers cost $2,750 while 2070ATC controllers, with better functionality and operations for TSP, costs $3,550.
- **TSP Signal Technology**: Phase selector and add-on equipment at the intersection can either be infrared or radio/GPS technology. An infrared installation is $11,160 while a radio/GPS installation is $6,715.

Overall, it is understood during the cost estimation process for TSP that:

- Old signals require more investment upgrades than newer signals.
- Longer bus routes and higher frequency routes require more intersections and buses to be equipped.
- Larger intersections (with more lanes) are more expensive than smaller lanes to equip.

6 TSP Impacts and Benefits Analysis

An impacts/benefits analysis was conducted to assess the potential impacts to traffic and benefits to transit. This analysis included an estimation of decreased delay, increased ridership, increased firebox revenue, and decreased emissions.

6.1 TSP Impacts and Benefits Analysis Methodology

In order to assess potential impacts and benefits, data requests were made to the cities in which the top 5 corridors resided: Chula Vista, El Cajon, Oceanside, National City, and San Diego to provide existing turning movement counts and existing signal timing plans for pre-selected intersections.

Turning movement counts and signal timing were received from three cities: Chula Vista, El Cajon, and Oceanside, which corresponded to IBOT corridors 4, 5, and 2, respectively. A summary of intersection data received is available in **Table 6-1**. Intersection data available per corridor refers to the amount of data received in regards to the number of intersections along a corridor. Where intersection signal timing data was not available, Synchro optimization was employed. Synchro signal optimization automatically calculates the offsets for red, yellow and green time in the cycle allowing for optimal progression of traffic through the intersection.

Table 6-1 – Intersection Data Received Summary

JURISDICTION	IBOT CORRIDOR	INTERSECTION DATA AVAILABLE PER CORRIDOR
Chula Vista	#4 – Highland Ave and Main St	10/26 Intersections
El Cajon	#5 – Johnson Ave and Broadway	16/32 Intersections
Oceanside	Corridor 2 – Mission Blvd	14/14 Intersections

Traffic volumes and signal timing were modeled using Synchro, where two scenarios were generated for AM and PM peak periods:

- Without TSP (baseline)
- With TSP (20 seconds early green)

The “with TSP” scenario was set up to allow a maximum of a 20 second early green on TSP movements, while still serving all phases and preserving the overall cycle length. Where 20 seconds of early green time for TSP could not be “taken” without violating legal time minimums needed for red and yellow lights, and pedestrians, the next possible amount of green time was “taken,” either 15, 10, or 5 seconds.

The Synchro modeling analysis generated intersection delay and Level of Service (LOS) for each scenario.

6.2 TSP Traffic Impacts Results

Additional traffic analysis was conducted to assess the potential traffic impacts from adding TSP to the corridor. **Table 6-2** summarizes the traffic impacts by corridor. Detailed tables showing impacts by individual intersection can be found in **Appendix E.** *Average change in vehicle delay* is the average across all intersections for that corridor in the AM or PM peak period if TSP were implemented, displayed in seconds.

Table 6-2 - Summary of Traffic Impacts

City	TSP Intersections Analyzed	IMPACTS	
		Average Change in Vehicle Delay (sec)	
		AM	PM
Oceanside	10	11.6	17.2
Chula Vista	14	4.3	3.2
El Cajon	12	5.9	9.5

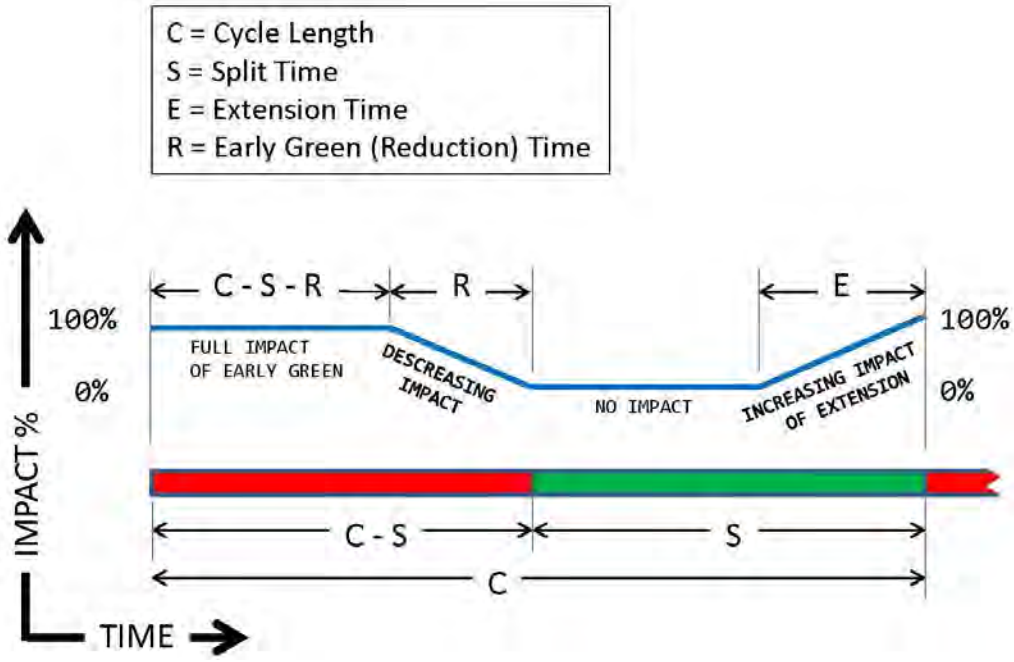
Corridor 2 - Oceanside: With TSP, the average increase in delay at an intersection averaged 11.6 seconds during the AM peak hour, and 17.2 seconds during the PM peak hour. The highest delays estimated were 34.5 seconds in the AM and 41.2 seconds in the PM.

Corridor 4 – Chula Vista: With TSP, the average increase in delay at an intersection averaged 4.3 seconds during the AM peak hour, and 3.2 seconds during the PM peak hour. The highest delays estimated were 15.5 seconds in the AM and 14.2 seconds in the PM.

Corridor 5 – El Cajon: With TSP, the average increase in delay at an intersection averaged 5.9 seconds during the AM peak hour, and 9.5 seconds during the PM peak hour. The highest delays estimated were 19.5 seconds in the AM and 45.7 seconds in the PM.

Most of the quantified impact is to the side streets (streets that are crossed by the main TSP corridor); the extra green time provided to buses on the main street (corridor implemented with TSP) also benefits cars. Overall, the impacts do not greatly impact traffic. The calculation method used is similar to previously used methodologies for calculating impacts, as shown visually in **Figure 6-1.** Figure 6-1 illustrates the experience of traffic impacts at any one point during a single cycle on a TSP equipped corridor. Time is across the x axis and percentage of impact to traffic in the corridor is shown on the y axis. Red bars indicate red lights and green bars indicate time allocated to green lights during the signal cycle. Depending on when and where a vehicle arrives at an intersection, it would receive more or less impact in accordance with TSP operations.

Figure 6-1 - Method to Quantify Traffic Impacts of TSP



This is true until the amount of early green granted to the bus exceeds the green time left for the side street. At that point, the impact can only be as long as the green time remaining, so the reduction to side street green is reduced linearly to having no impact. If the bus arrives at the beginning of the side street red (main street green) then there is no impact for the side street since the light would have been red during the bus passage regardless. At the end of the side street red comes closer, a bus priority call can now extend the main street green (leaving the side street red) which would result in delay to side street traffic. The amount of extra delay increases as it gets closer to the normal end of the side street green. Once the extension, if any, ends, the cycle repeats to the beginning point as just described.

6.3 TSP Transit Benefits Results

This additional traffic analysis assessed the potential transit benefits from adding TSP to the corridor. **Table 6-3** summarizes the transit benefits by corridor. Detailed tables showing benefits by individual intersection can be found in **Appendix E.** *Average delay reduced per bus* is the average number of seconds saved per bus run during the AM or PM peak period. *Hourly bus delay reduced* sums the seconds saved over the course of hour in the AM or PM peak period and is shown in minutes.

Table 6-3 - Summary of Transit Benefits

City	TSP Intersections Analyzed	BENEFITS			
		Avg delay reduced per bus (sec)		Hourly Bus Delay Reduced (Min)	
		AM	PM	AM	PM
Oceanside	10	149.8	157.0	25.0	23.5
Chula Vista	14	168.8	159.5	22.5	23.9
El Cajon	12	171.2	184.6	44.2	48.6
		Per bus run		All buses in an hour	

Corridor 2 - Oceanside: Average delay per bus reduced by 169 seconds in the AM peak and 160 seconds during the PM peak. For all the buses along the corridor, this saves a total of 25 minutes in the AM peak hour, and 23.5 minutes in the PM peak hour.

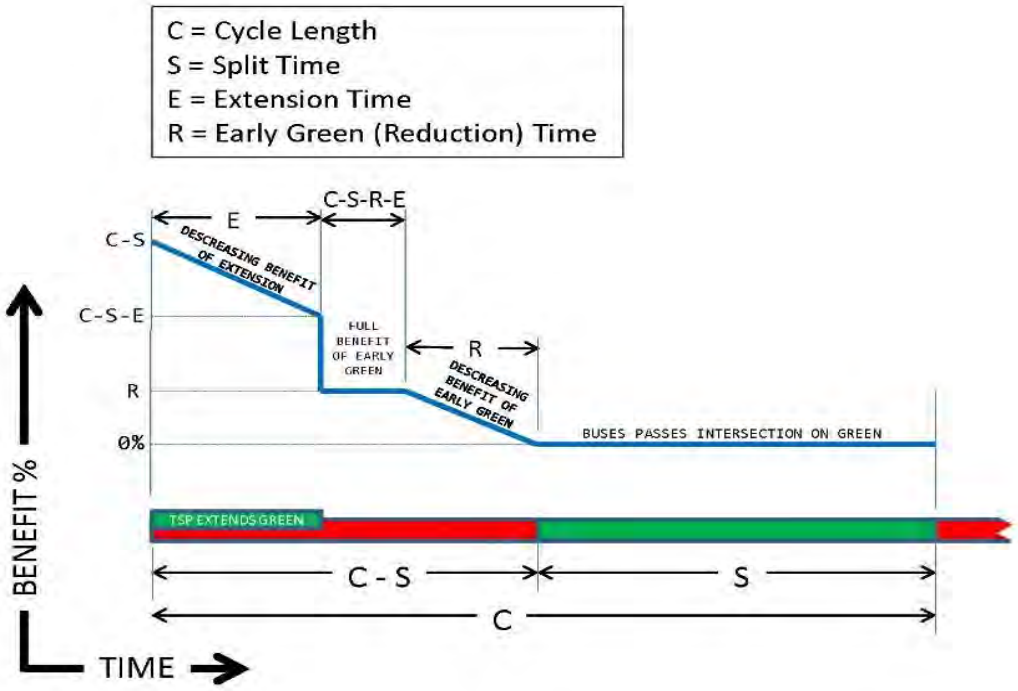
Corridor 4 – Chula Vista: Average delay per bus reduced by 150 seconds in the AM peak and 157 seconds during the PM peak. For all the buses along the corridor, this saves a total for 22 minutes in the AM peak hour, and 24 minutes in the PM peak hour.

Corridor 5 – El Cajon: Average delay per bus reduced by 171 seconds in the AM peak and 185 seconds during the PM peak. For all the buses along the corridor, this saves a total for 44 minutes in the AM peak hour, and 48 minutes in the PM peak hour.

When there is less delay, there is less benefit to be gained. The greatest benefits occur when the bus arrives at the intersection at the end of a red light and the beginning of a green light because that is where the longest green extension can occur. Typically, buses tend to gain more benefit from green extensions than early greens. Overall, the benefits are generally conservative. The calculation method used is similar to previously used methodologies for generating benefits, as shown visually in **Figure 6-2**.

The greatest benefit for the bus occurs if the bus crosses the intersection just at the end of the main street green. A bus receiving a green extension at that point saves the entire red time they would have otherwise had to wait through. A bus that receives the green extension, but would have arrived later in the main street red phase saves the amount of time remaining in the red. Thus the benefit to the bus reduces linearly until the point in time where the green extension is missed, and the bus instead gets an early main street green. The early green benefit is the amount of time that the bus saves by having the light change earlier, and thus is a steady value until the point in time where the amount of delay reduced is limited by the remaining red time. Once the normal beginning of main street green begins, the bus would have passed through the intersection on a green light without a priority call, thus there is no benefit gained by the bus for that period. When the normal green period ends, the cycle repeats as described above.

Figure 6-2 - Method to Quantify Transit Benefits to TSP



The greatest benefit for the bus occurs if the bus crosses the intersection just at the end of the main street green. A bus receiving a green extension at that point saves the entire red time they would have otherwise had to wait through. A bus that receives the green extension, but would have arrived later in the main street red phase saves the amount of time remaining in the red. Thus the benefit to the bus reduces linearly until the point in time where the green extension is missed, and the bus instead gets an early main street green. The early green benefit is the amount of time that the bus saves by having the light change earlier, and thus is a steady value until the point in time where the amount of delay reduced is limited by the remaining red time. Once the normal beginning of main street green begins, the bus would have passed through the intersection on a green light without a priority call, thus there is no benefit gained by the bus for that period. When the normal green period ends, the cycle repeats as just described.

Further, more detailed analysis per corridor would need to be conducted in order to determine whether or not transit operators would be able to save running a bus on a particular route.

6.4 Ridership and Farebox Revenue Benefits with TSP

The SANDAG model Series 13: 2050 Regional Growth Forecast was utilized to model differences in route ridership if TSP were to be implemented in the corridors described in this study. The model takes into account the demographic, economic, and housing trends expected through 2050 in the region. A SANDAG modeling Series 13 model run through 2020 was conducted in September 2016 which revealed increases in ridership for several routes on IBOT corridors. Given intersection information about delays, signal lengths, and timing, the model generated ridership for a “without TSP” scenario and a “with TSP implemented” scenario. The difference in ridership before and after TSP was annualized using a factor of 320 (number is typically used by SANDAG modeling for annualizing ridership). Average annual farebox revenue was obtained by multiplying annual ridership by the average revenue per boarding. For MTS routes, the average revenue per boarding was $1.04. For NCTD routes, the average revenue per boarding was $0.99.

For the purposes of evaluating ridership and farebox revenue, only routes that ran through at least five TSP intersections along a corridor were included in the projections. A detailed ridership and farebox revenue worksheet can be found in **Appendix E**.

Of the three routes analyzed for their traffic impacts, several routes were estimated to experience increased ridership and fares. Effects of TSP may be reflected in ridership across multiple routes that operate along a single corridor due in part to overlapping routes and changes in behavior because people may choose to ride the TSP-equipped route over a non-TSP equipped route.

IBOT Corridor 2 in Oceanside, **Table 6-4**, shows the estimated increase in ridership and fares if TSP were to be implemented on the corridor. It also shows that transit delay was reduced and reliability increased.

With TSP implemented, Corridor 2 is projected to experience increased annual ridership of 83,196 and an annual average farebox revenue of $82,342.76 collectively for all routes.

Table 6-4 - Corridor 2 Projected Increased Ridership and Farebox Revenue with TSP

ROUTE	INCREASED ANNUAL RIDERSHIP WITH TSP	% INCREASED ANNUAL RIDERSHIP WITH TSP	AVERAGE ANNUALFAREBOX REVENUE WITH TSP
303	48,213	3.1%	$47,730.37
309	-15,016	-1.3%	-$14,865.84
311	3,082	1.4%	$3,051.18
315	46,895	5.2%	$46,426.05
Corridor	**83,196**		**$82,342.76**

While 309 is a TSP equipped route, it shows a small drop in ridership due to the model's limited features for drilling down in granularity, such as ridership at the route level. The model was meant to show regional level trends. Only a portion of route 309 would be TSP equipped and a decrease in ridership may mean ridership shifts to other routes on the corridor. Overall, Corridor 2 experiences increased ridership and fare revenue.

Table 6-5 shows IBOT Corridor 4 in National City and Chula Vista with an estimated increase in ridership and fares, reduction in transit delay, and increase in reliability.

With TSP implemented, Corridor 4 is projected to experience increased annual ridership of 108,087 and an annual average farebox revenue of $112,504.08.

Table 6-5 - Corridor 4 Projected Increased Ridership and Farebox Revenue with TSP

ROUTE	INCREASED ANNUAL RIDERSHIP WITH TSP	% INCREASED ANNUAL RIDERSHIP WITH TSP	AVERAGE ANNUAL FAREBOX REVENUE WITH TSP
929	73,549	3%	$76,490.96
955	34,628	1.9%	$36,013.12
Corridor	**108,087**		**$112,504.08**

Lastly, IBOT Corridor 5 in El Cajon (**Table 6-6),** shows with TSP implemented that an increase in annual ridership of 36,950 and an annual average farebox revenue of $38,461.12 is estimated.

Table 6-6 - Corridor 5 Projected Increased Ridership and Farebox Revenue with TSP

ROUTE	INCREASED ANNUAL RIDERSHIP WITH TSP	% INCREASED ANNUAL RIDERSHIP WITH TSP	AVERAGE ANNUAL FAREBOX REVENUE WITH TSP
833	8,614	3.4%	$8,958.56
848	23,514	3.9%	$24,454.56
874/875	5,200	0.7%	$5048.00
Corridor	**36,950**		**$38,461.12**

It was consistently seen among all three corridors with TSP implemented that annual ridership and average weekday farebox revenue increased, as summarized in **Table 6-7**.

Table 6-7 - Summary of Corridors Projected Increased Ridership and Farebox Revenue with TSP

CORRIDOR	INCREASED ANNUAL RIDERSHIP WITH TSP	ANNUAL FAREBOX REVENUE WITH TSP
2 (Oceanside)	83,196	$82,342.76
4 (National City, Chula Vista)	108,087	$112,504.08
5 (El Cajon)	36,950	$38,461.12

6.5 Emissions Benefits with TSP

If implemented, TSP may increase the effectiveness of bus operations, schedule reliability, and public perception while reducing greenhouse gas (GHG) emissions. In some cases, TSP efficiency may be able to reduce operations by one bus during the peak hour while maintaining reliability and frequency of service. Utilizing the California Air Resources Board Greenhouse Gas Emissions quantification method, Vehicle Miles Traveled (VMT) Displaced and GHG Emission Reductions were calculated for each corridor. Quantification methodology and emissions benefits worksheets for each corridor can be found in **Appendix E**. Results are shown in **Table 6-8.**

Table 6-8 - Estimated VMT Displaced and GHG Emission Reductions with TSP

CORRIDOR	ANNUAL AVERAGE AUTO VMT DISPLACED	TOTAL ANNUAL GHG EMISSION REDUCTIONS (MTCO2E)
2 (Oceanside)	9,358,173	9,861
4 (National City, Chula Vista)	13,920,370	14,667
5 (El Cajon)	4,377,765	4,615

7 Potential Funding Sources and Opportunities

The funding opportunities that have been summarized into the following table are recommended for their relevance to the mission of IBOT. These opportunities were cleaved through a larger pot of potential funding opportunities and evaluated for relevance and potential for funding. Given the nature of this high-level planning study, further research and thought will be necessary to curate IBOT to specific grants. A simple breakdown of potential grants are shown in **Table 7-1** below. The table rates IBOT's relevance to a funding opportunity to prioritize research when applying for grants. A more detailed breakdown can be found in **Appendix F**.

Table 7-1 - IBOT Funding Sources and Opportunities

POTENTIAL	FUNDING OPPORTUNITY	SOURCE & TYPE
NON PROGRAMED FUNDING OPPORTUNITIES		
High	Advanced Transportation and Congestion Management Technologies Deployment Initiative (ATCMTD)	FHWA, Federal
High	Metropolitan & Statewide Planning - 5303, 5304, 5303	FTA, Federal
High	Mobility on Demand (MOD) Sandbox Demonstration Program - 5312	FTA, Federal
High	Transportation Investments Generating Economic Recovery (TIGER) Discretionary Grant Program	USDOT, Federal
High	Transit and Intercity Rail Capital Program (TIRCP)	Caltrans, State
Medium	Congestion Mitigation and Air Quality Program (CMAQ)	FHWA, Federal
Medium	Metropolitan Planning	FHWA, Federal
Medium	Urbanized Area Formula Grants - 5307	FTA, Federal
Medium	Affordable Housing and Sustainable Communities Program (AHSC)	California Department of Housing and Community Development, State
CAPITAL INVESTMENT GRANTS		
Medium	Core Capacity	FTA, Federal
Medium	New Starts	FTA, Federal
Medium	Small Starts	FTA, Federal
Low	Expedited Project Delivery for Capital Investment Grants Pilot	FTA, Federal
DISCRETIONARY GRANT PROGRAM		
High	Buses and Bus Facilities Discretionary Program - 5339	FTA, Federal
High	Low or No Emission Vehicle Program 5339	FTA, Federal
Medium	Pilot Program for Transit-Oriented Development Planning	FTA, Federal

Additional resources may be found in local Infrastructure Finance Districts or through Transit Benefit Assessment Districts (SB 142). Sponsorship/naming rights for transit lines or stations may also be employed for funding purposes.

8 Next Steps

The San Diego region has already shown willingness and adaptability to implementing TSP along *Rapid* corridors as part of larger projects. In an effort to continue to make transit a competitive mode choice for current and future users, improvement to transit reliability needs to continue beyond the high priority corridors slated for *Rapid* bus service. The IBOT study identified many corridors as viable candidates for which the implementation of TSP would result in benefits to the transit system and its patrons.

8.1 Identify Funding and Determine Agency Lead

Utilizing the set of funding sources identified under Section 7, potential funding sources should be further researched and aligned with the financial needs associated with each corridor for which TSP is recommended. Once the funding opportunities are identified, SANDAG working alongside the MTS or NCTD and the local jurisdiction should develop a memorandum of understanding (MOU) to determine the appropriate agency to take lead on the design and implementation of TSP along the corridor or specific aspects and phases of the project.

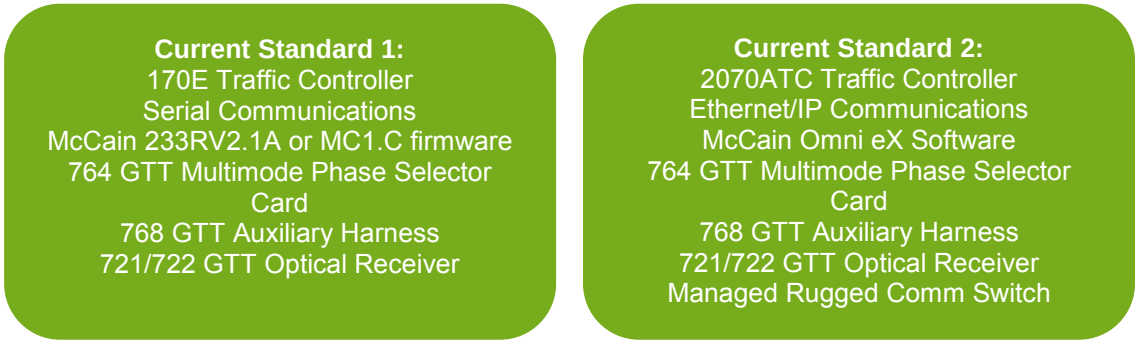
8.2 Project Selection and Design

Upon successful identification of the agency lead and receipt of funding, the next step would be to take one or more of the top 10 corridors into further detailed evaluation and design. This includes conceptual and detailed design of both the intersection level improvements, as well as the design for on-board vehicle installation and integration. While not explicitly addressed in this study, the number of pedestrian crossings is a finer grain detail and measure of mobility access that should be considered in future corridor selection and analysis. Measures of impacts and benefits should be considered more thoroughly to specifically highlight where savings can occur. This may be done as a design package and then separately for procurement for the installation or SANDAG may decide to proceed with an RFP package for design and implementation as a turnkey package. Any corridor identified in the IBOT study can proceed into implementation independently as funding becomes available. Some economies of scale can be achieved if using a shared bus fleet. While not evaluated as part of this study, expansions of current TSP corridors may serve as opportunities to extend the TSP network in San Diego County in areas where the foundational infrastructure and equipment for TSP may already be in place, thus reducing time and costs to implement.

8.3 Equipment Procurement Considerations

Local jurisdictions should consider upgrading intersections to TSP-compatible equipment for any identified corridors in this study, especially if jurisdictions have current or near-term plans to replace or upgrade equipment. Including TSP-compatible signal equipment as part of planned upgrades can save time and cost when implementing TSP corridors, such as traffic control costs. Current TSP-compatible equipment standards are displayed in **Figure 8-1** and are current as of 2017; future equipment and software upgrades may require further bench testing prior to implementation.

Figure 8-1 - Current Traffic Equipment Standards (2017)



Similarly, MTS and NCTD may want to consider including TSP emitters as standard specs on new bus procurements. The cost savings from having emitters installed at the factory versus retrofitting is approximately $2,200 for LED emitters per bus and approximately $3,000 for Radio/GPS per bus.

8.4 Implementation

Once the procurement process is complete for the selected corridor(s), SANDAG should coordinate with the city and transit service provider to work towards implementation. Implementation will involve three primary components:

- Signalized intersection TSP equipment installation
- Intersection signal timing modifications
- On-board vehicle installations

All of these three primary components have been performed on similar corridors within MTS and NCTD service areas managed by SANDAG staff.

8.5 Evaluation and Monitoring

Similar to TSP monitoring and evaluation currently being conducted on other TSP enabled corridors within the region, SANDAG should monitor and evaluate the corridor to ensure TSP is working and providing maximum benefits. Monitoring activities should:

- Collect performance data;
- Fine tune signal parameters, bus schedules, and TSP settings;
- Ensure ongoing maintenance of TSP systems continues beyond implementation phase;
- Consider regional standards for TSP for future bus procurements and new signal equipment installation.

As stated in Section 5.3, evaluation and monitoring requires staff time annually to support TSP signals, TSP equipment on buses, and overall monitoring of the regional program.

8.6 Future Corridors

If SANDAG and partner agencies determine that the TSP system should be expanded to other corridors based on the results of the selected corridor(s) and ongoing evaluation and monitoring, the priority matrix from the IBOT study should be used as a starting point to target corridors for implementation working with the respective jurisdictions. Similar analysis, evaluation and monitoring would need to be completed on any future corridors selected.

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Appendix A – Project Management

- PDT #1 Agenda and Notes
- PDT #2 Agenda and Notes
- PDT #3 Agenda and Notes
- PDT #4 Agenda and Notes
- PDT #5 Agenda and Notes
- PDT #6 Agenda and Notes
- PDT #7 Agenda and Notes
- PDT #8 Agenda and Notes
- PDT #9 Agenda and Notes
- SANTEC/CTAC Presentation Slides

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Improving Bus Operations and Traffic (IBOT): A Regional Approach to TSP

Thursday, August 13, 2015
11:00AM to 12:00 PM

SANDAG – Conference Room 8B

Agenda Items:		Minutes
1.	Introductions (Danny)	5
2.	Brief Overview of Scope, Schedule, and Budget (Danny)	5
3.	Data Collection Efforts to Date (Tuere)	5
4.	Proposed Methodology (Ritesh)	20
5.	Future PDT Meetings (Tuere)	10
	a. Reoccurring monthly PDT meetings	
	b. General schedule	
	c. Agency review period on deliverables	
6.	Open Discussion (All)	10

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Notes

To/Attention	Notes to File	**Date**	September 15, 2015
From	IBI Group	**Project No**	38765

Subject IBOT PDT Meeting #1 and Public Outreach Discussion
SANDAG Conference Room 8A
September 10, 2015, 1:00-2:30 PM

Present Pete Casellini (MTS), Kyle Phillips (SANDAG), April Petonak (SANDAG), Danielle Berger (IBI), Danny Veeh (SANDAG), Kristen Byrne (MJE), Tuere Fa'aola (IBI), Debbie Leung (IBI), Farah Machlab (IBI), Colleen Windsor (SANDAG),

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1. **PDT Meeting #1**
   - Met with Rick Curry, SANDAG Modeling, to discuss potential use of Dynamic Traffic Analysis (DTA) model for IBOT. DTA's development schedule does not correspond with project timeline, but there may be opportunities to run samples of data through DTA.
   - Preliminary Transit Routes Map – Farah: Shown for bidirectional routes, 7:30-8:30 AM weekday peak, accounts for overlapping routes. Farah will look at additional headway breakdown of 1-5 and 6-10 minutes. April requested that existing TSP corridors be shown on transit routes map, possibly signalized intersections too.
   - Next PDT Meeting set for Thursday, October 8 @ 1 PM

2. **Public Outreach Discussion**
   - Background: Public outreach task refers back to Caltrans grant requirement. Because of difficulty of TSP concepts, we will have to be sensitive to technical nature of project.
   - Discussed interviewing people at transit stops and asking which buses they take and which routes need help to be on time?
   - It was determined that people are currently workshopped and interviewed-out because of activity for new RTP
   - Kyle recommends surveying bus drivers for input since they drive their routes daily. Bus drivers meet every morning; survey can be announced then.
   - Danny will speak offline with Peter Thompson, SANDAG ITS, about outreach to SANTEC; the group has previously expressed interest in TSP projects
   - Danny is cautious about bringing the project to community groups; this is only a planning study. We may present the project to community groups to let them know this is in consideration and are looking for capital dollars for implementation.
   - Ideas to provide info to the public: Website, fact sheet, Take Ones on buses

- Data can be filtered for specific cities from regional database
- Colleen mentioned that Gary might like to share this data with the City Managers
- Data can inform problematic as well as better-performing intersections
- Danny pointed out that for MTS to even cut one bus from a route results in huge savings
- Data analysis and outreach will both wrap up by December 2015

3. Action Items

- **Danny** will connect Danielle with Stan Glowacki to get set up with ICMS
- **Debbie** will request full data set of regional transit routes from MTS and NCTD
- **Farah** will try analyzing splitting data view on map for routes with 1-5 minutes and 6-10 min headways to see if data is clearer than 1-10 minutes category
- **IBI** will provide input on survey questions to help MJE put together survey for bus drivers
- **Kristen** will take lead on creating bus driver survey
- Set up stakeholder meetings – ITE, SANTEC

Improving Bus Operations and Traffic (IBOT): A Regional Approach to TSP

PDT #2

Thursday, October 8, 2015
1:00 – 2:30 PM
SANDAG – Conference Room 8A

Conference Call Number: 1-888-363-4734
Participant Code: 691556

Agenda Items:		Minutes
1.	Introductions (Danny)	5
2.	Review PDT #1 Notes	5
3.	Data Collection Efforts to Date	20
4.	Outstanding Data Collection Issues, incl. SOAP UI	15
5.	Public Outreach	30
	a. Draft Bus Driver Survey	
	b. Draft TSP Fact Sheet	
	c. Outreach Timeline	
6.	Next Steps	15

Integrated Bus Operations and Traffic (IBOT) PDT #2

Place: SANDAG 8A

Date: 10/8/2015

Time: 1-2pm

Attendees: April Petonak (SANDAG), Kyle Phillips (SANDAG), Danny Veeh (SANDAG), Farah Machlab (IBI), Danielle Berger (IBI), Dan Pearce (IBI), Debbie Leung (IBI), Johnny Dunning (NCTD), Peter Thompson (SANDAG), Don Murphy (IBI), Kristen Byrne (MJE), Denis Desmond (MTS), Ritesh Warade (IBI)

Agenda Items

1) Review PDT Notes #1
2) Data Collection Efforts
3) Outstanding Data Collection Issues
4) Public Outreach
    a. Draft Bus Driver Survey
    b. Draft TSP Factsheet
    c. Outreach Timeline

2) Outstanding Data Collection Issues

- Farah request meeting to walk through SOAP UI
    - Does not map signal timing approach
    - 90-100% complete as of now (broad scale)
- Don – Biggest interest in cycle lengths
- Regional Arterial Management System (RAMS)
    - Pulled data from cities
    - Watch out for IDs (working with 3 sets of data)
    - Don – all this data feeds into scoring criteria

3) Public Outreach ***** *Up for discussion*

- Kristen – draft outreach plan
    - What are we doing with study?
    - How will it help you?
- Obtain input – Metropolitan Transit System (MTS), North County Transit District (NTCD), Communities
- Public information
- Outreach summary
- Implementation timeline
- Don -
    - Get feedback from MTS/NCTD (where to focus corridors? Also to reach out to bus drivers)
    - Online survey?
    - Coordinate with bus?
    - We need to be tech neutral with bus ad

- Denis – will arrange with operations

- Johnny – on-time performance, next Wednesday. We may not get good rate of return with Survey Monkey
- San Diego Regional Traffic Engineers Council (SANTEC) – Meeting Next Thursday
    - Peter – have 10 min conversation to put it on their radar/agenda
    - Danny – hi-level + generic
    - Peter – Next time (Jan/Feb) come with robust analysis
        - Have select set/good group to get opinions on
    - City/County Transportation Advisory Committee (CTAC), Transportation Working Group (TWG) City Manager (meet with these groups later?)

Fact Sheet:

- Generalize to – *"Smart Transit and Smart Intersections"*
- Danielle – own version of this. This can be attachment to project fact sheet
- Don – has some good photos of route 350 and TSP that can be used
- Danny – To check if threshold is met for translation into Spanish

Bus Driver Survey:

- Johnny – roll up into time points
- Danny – Ask follow questions on certain intersections (time, days of week)
- Peter – GTFS – IDs, major stops, present major stops in these questions
    - Limits stops, TSP, at least get segment
    - Include nearside and far side
- Don – we have stop and intersection data
- Ritesh – GTFS overlay
    - Everything together
    - If implement corridor – have four routes
    - Do I change lockouts i.e. am and pm by cycle lengths

<u>Action Items:</u>

- **Fact Sheet:**
    - Danielle and Kristen will work on this
    - Kristen will send Project Fact Sheet + TSP Fact Sheet
    - Danny will figure out if we need a translation
    - Colleen will work on strategy for fact sheets, webpage, translation
- **Bus Driver Survey:**
    - April – eliminate freeways as they will drop off when we apply the scoring
    - Dan – will revise bus driver survey
- **General:**
    - Danny and Danielle – Talk to Rick
    - Follow up meetings with MTS + NCTD for their input + bus driver surveys
    - IBI will take the lead in scheduling
    - Danny – will write a paragraph for Peter about the project
    - Debbie – Create a high level power point for SANTEC, just announce project
    - Danny will talk to Colleen

Improving Bus Operations and Traffic (IBOT): A Regional Approach to TSP

PDT #3

Thursday, November 12, 2015
1:00 – 2:30 PM
SANDAG – Conference Room 8A

Conference Call Number: 1-888-363-4734
Participant Code: 214 590

Agenda Items:	Minutes
1. Introductions	5
2. Public Outreach Update	15
a. Met with NCTD & MTS, distributed bus operator surveys	
b. Online survey for MTS	
3. Transit analysis update	10
a. Ridecheck figure & discussion (Farah)	
4. Traffic analysis update	5
5. Next steps	10
a. Availability for processing survey data	

IBOT: A Regional Approach to TSP – PDT#3

Location: SANDAG – Conference Room 8A
Date: Thursday, November12, 2015
Time: 1:00 – 2:30pm
Attendees: Johnny Dunning (NTCD), Denis Desmond (MTS), Farah Machlab (IBI), Kristen Byrne, Kyle Phillips, Danielle Berger (IBI), April Petonak (SANDAG), Danny Veeh (SANDAG), Peter Thompson (SANDAG), Ritesh Warade (IBI Group), Debbie Leung (IBI)

Agenda Items

1. Introductions
2. Public Outreach Update
    a. Met with NCTC & MTS, distributed bus operator surveys
    b. Online survey for MTS
3. Transit Analysis Update
    a. Ride check figure & discussion (Farah)
4. Traffic Analysis Update
5. Next Steps
    a. Availability for processing Survey data

2. Public Outreach Update

- East Division – 70-80 surveys
- West Division – 30 so far (expecting a few more than East Division)
- Kristen is working on the public fact sheet and webpage
- Need word document from Danny to keep template consistent
    - Kristen > Danny > Joy
- Reviewing Fact Sheet Comments
    - David Hicks is reviewing and will produce final format

3. Transit Analysis Update

- 929 not displayed on average daily loads map
- Difference in boardings and alightings shows aggregated load over all routes
- Feedback needed on high and low ridership corridors
- APC Data
    - Not available for al region
- GTFS Datasets
    - Send by January
    - Possibly better match. Unable to align January data.
    - Peter will work with Devin Braun

    - Ritesh will work with MTS / NCTD
    - Aggregated by route and direction. Seemed like there was schedule or routing changes

Data Collection Summary

- January GTFS Data – Farah and Ritesh
- Trip Level (ride check plus) data – Brian Lane
- Discussion around removing TSP rues from analysis
    - Considering taking away highway segments (no ramps) and proximity to TSP as evaluation criteria
- Change existing and planned TSP
    - Mira Mesa (next month)
    - Claremont Mesa Blvd. between SR-163 and I-15 (end of year)

4. Traffic Analysis Update

- GIS layer being created that integrate intersections and signals into major-major/major-minor
- Include 2070s for estimating costs
    - Lessons learned from current TSP projects

5. Next Steps

- Template is needed for processing survey data
    - Kyle, Dan and Kristen will process data
- Maps will be marked up by Danielle
- SANTAC (November) and CTAC (October)
    - Criteria will need to be reviewed. Assemble a good set of recommendations before bringing to SANTAC first and then CTAC again
- Danny wants criteria developed by next meeting (December)
    - SANTEC (third week of January)
    - CTAC (February)
    - Prepare criteria for next meeting for review
    - Farah will send drafts to group
    - Ask for methodology – rom Farah and Ritesh to understand map, replicate it (methodology write-up)
- Follow-up meeting on TSP effectiveness will/needs to be scheduled

Improving Bus Operations and Traffic (IBOT): A Regional Approach to TSP

PDT #4

Thursday, December 10, 2015
1:00 – 2:30 PM
SANDAG – Conference Room 8A

Conference Call Number: 1-888-363-4734
Participant Code: 214590

Agenda Items:	Minutes
1. Introductions	5
2. Update on Survey Data Input	5
3. Evaluation of Transit & Traffic Data Discussion	25
4. Next Steps / Schedule Update	5
5. Open Discussion/Other Items	10

GO-TO-MEETING LOGIN

1. Please join my meeting.

https://global.gotomeeting.com/join/177503797

2. Join the conference call:

Conference Call Number: 1-888-363-4734

Participant Code: 214590

IBOT: A Regional Approach to TSP – PDT #4

SANDAG – Conference Room 8A
Thursday, December 10, 2015
1:00 – 2:30pm

Attendees: Johnny Dunning (NTCD), Denis Desmond (MTS), Kyle Phillips (SANDAG), Danielle Berger (IBI), Don Murphy (IBI Group), Danny Veeh (SANDAG), Peter Thompson (SANDAG), Tuere Fa'aola (IBI Group), Dan Pearce (IBI Group)

Agenda Items

1. Introductions
2. Update on Survey Data Input
3. Evaluation of Transit & Traffic Data Discussion
4. Next Steps/Schedule Update
5. Open Discussion/Other Items

2. Public Outreach Update

- NCTD 81 survey responses (27% response rate)
- MTS 241 survey responses (24% response rate)
    - 221 paper, 20 electronic
- Survey data has been aggregated
    - Survey data will be finished by Thursday next week
    - Any potential other uses of the survey data in additional comments will be pass along to the respective transit agency
- GIS data being created
- Outreach work on hold until corridors have been selected

3. Evaluation of Transit & Traffic Data Discussion

- Analysis up until present shown via Google Earth

Data Used:

- Ridecheck Plus passenger data
    - APC data did not cover all routes

- Headway data (GTFS)
- Bus delay data (GTFS)
    - normalized [off-peak – peak/peak]
    - Will use AVL data once corridors are selected using
- ridership and headway criteria
- Segment links of approximately 10 feet were created using the GTFS data and road centerline shapefile.

Transit Analysis Data Thresholds:

Daily Load	Score
Less than 500 riders	1
501 - 2,000 riders	2
2,001 - 3,000 riders	3
More than 3,00 riders	4

Peak Headway	Score
Less than 5 minutes	4
6 - 10 minutes	3
11 - 20 mintues	2
More than 20 minutes	1

Bus Delay (normalized)	Score
0.00 - 0.25	1
0.25 - 0.50	2
0.50 - 0.75	3
0.75 - 1.00	4

- Peak Headway11-20 minute range could still be useful for consideration
- Consider aggregating data by route

Intersections Highlighted by analysis:

- Do we know if the intersection are live? This would determine if the intersections are being managed
- Currently working on creating combined segment shapefile with Head Way, Delay, and Daily Load
    - All currently separate
- The above threshold categories can be adjusted to tweak segments
    - They may need to be tweaked when we go through the data to reflect context
    - Initial adjustments have been made
- LOS Data – Series 12 Model

- Signalized Intersections – Phase 2
- Signal Length – Phase 2

LOS	Score
LOS A - C	1
LOS D	2
LOS E	3
LOS F	4

Signal Length	Score
0 - 79 seconds	0
80+ seconds	1

Signals per segment	Score
TBD	TBD

- If signal length below 80 seconds it is difficult to make up time
    - More purchase with TSP for longer signal lengths
- Scores will be even and applied weightings will be brought before the group
    - Don (IBI) has a preference for adjusting categories over weightings
- Question raised as to whether or not street profiles are being looked at in analysis i.e. pedestrian-centric street
    - This will be considered further down the line. Time and date will also come in at the ends of the analysis
- Freeways will be fade out of the analysis
    - Ramps will be kept

4. Next Steps

- Complete GIS data set will be put together
    - Input considered from group on threshold criteria
- Mapping will commence after GIS data is complete
- Tuere will revise schedule
- APC data will be incorporated
- Cost/Benefit Analysis will begin when the steps have been completed

- SANTEC Meeting (3rd week Jan) + CTAC (1st week Feb)
    - Ask for their input at these meetings once aggregate data is ready to be shared
    - Present methodology, data, ask for feedback, and explain what we will do with the data

Improving Bus Operations and Traffic (IBOT): A Regional Approach to TSP

PDT #5

Thursday, January 14, 2016
1:00 – 2:30 PM
SANDAG – Conference Room 9A

Conference Call Number: 1-888-363-4734
Participant Code: 214590

Agenda Items:	Minutes
1. Introductions	5
2. Brief Overview of Transit & Traffic Methodology	10
3. Top Recommended TSP Corridors	20
4. SANTEC/CTAC Meetings	10
5. Next Steps	5

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Meeting Notes

To/Attention	Notes to File	**Date**	February 5, 2016
From	IBI Group	**Project No**	38765

Subject IBOT PDT Meeting #5
SANDAG
January 14, 2016 1:00 PM

Present Charles Main (NCTD), Ryan Zatlin (NCTD) Denis Desmond (MTS), Kyle Phillips (SANDAG), Danielle Berger (IBI), Danny Veeh (SANDAG), Tuere Fa'aola (IBI Group), Dan Pearce (IBI Group), Farah Machlab (IBI), Ritesh Warade (IBI) Zachary Hernandez (SANDAG)

Distribution All

Agenda Items

1. Introductions
2. Brief Overview of Transit & Traffic Methodology
3. Top Recommended TSP Corridors
4. SANTEC/CTAC Meetings
5. Next Steps

2. Brief Overview of Transit & Traffic Methodology

- Analysis up until present shown via Google Earth

Data Used:

- Ridecheck Plus passenger data
    - APC data did not cover all routes
- Headway data (GTFS)
- Bus delay data (GTFS) - removed from phase 1
    - Normalized [off-peak – peak/peak]
    - Will use AVL data once corridors are selected to narrow down
- Ridership and headway criteria
- Segment links of approximately 10 feet were created using the GTFS data and road centerline shapefile.

Transit Analysis Data Thresholds MTS:

Daily Load	Score
Less than 500 riders	1
501 – 1,500 riders	2
1,501 – 3,000 riders	3
More than 3,000 riders	4

Peak Headway	Score
Less than 10 minutes	4
11 – 15 minutes	3
16 – 20 minutes	2
More than 20 minutes	1

Transit Analysis Data Thresholds NCTD:

Daily Load	Score
0 - 250 riders	1
250 – 500 riders	2
501 – 750 riders	3
More than 750 riders	4

Peak Headway	Score
Less than 10 minutes	4
11 – 15 minutes	3
16 – 20 minutes	2
More than 20 minutes	1

Data Used for Traffic Analysis:

- LOS data – Series 12 model
- Signalized intersections
- Signal length - Phase 2

Traffic Data Thresholds – MTS & NCTD

Number of Signals (corridor)	Score
0 – 5 signals	1
6 – 10 signals	2
11 – 15 signals	3
More than 15 signals	4

LOS (corridor)	Score
A - B	1
C	2
D	3
E – F	4

3. <u>Top Recommended TSP Corridors</u>

- A list of 10 Recommended TSP corridors was presented to participants accompanied by a Google Earth walk through of each corridor.
- List narrowed down from much longer list of corridors.
- A group discussion of more than 10 corridors was facilitated by IBI.

Corridor Analysis:

- SANDAG recommended that more corridors be shown when the work is presented outside of the PDT at CTAC/SANTEC meetings that reflects more cities in the region.

TOP 10 CORRIDORS

1) University Ave from 1st Ave to 70th St
    a. Extend to La Mesa, until it meets up with El Cajon Blvd. Gets into City of La Mesa boundaries.
2) Genesee Ave from Balboa Ave to Nobel Dr
    a. Take it all the way down to the 163 ideally.

3) Mission Ave from Oceanside Transit Center to Douglas Dr. (via Seagaze Dr.
    a.)Extend to Sal Luis Rey Transit Center would be nice, but Mission corridor is more of a priority.
4) Market St. from 2nd Ave to 25th St.
    a. Avoid downtown; cut to 16th to 25th
5) El Cajon Transit Center to E. Main St. (via Main, Johnson, and Broadway)
    a. Add Douglas and Main Street, note left turn on Marshall
6) Mission Blvd. from Escondido Transit Center to Twin Oaks Valley Road (via Quince)
    a. Maybe a little further west to Palomar College, NCTD is surprised that the segment on Mission and Santa Fe up to Vista Transit Center doesn't show up
7) H St. from Woodlawn Ave to Southwestern College (via Otay Lakes Rd.)
    a. Good. No comments.
8) College Blvd. from San Luis Rey Transit Center to Old Grove Rd.
    a. Issues from San Luis Rey Transit Center to Town Center North. NCTD will discuss with their team.
9) La Jolla Village Dr. from Genesee to Gilman (via Villa La Jolla Dr.)
    a. Extend east to I-805. Add route 237 to table.
10) 54th St/ Euclid Ave from Logan Ave. to University Ave.
    a. Extend to Monroe north of El Cajon Blvd.

OTHER CORRIDORS

11) Park Blvd from Broadway to University Ave.
    a. Will not consider – already under SANDAG consideration for TSP.
12) Taylor St./Linda Vista Rd from Old Town Transit Center to Armstrong St.
    a. Keep at 2nd tier, others are higher priority.
13) Coast Hwy from Oceanside Transit Center to Vista Way
    a. Currently under study to add roundabouts. Would like to extend south to Carlsbad station (right now, the bus has to go around the block through heavy traffic to access the transit station).
14) El Cajon Blvd. from College Ave. to 70th St.
    a. Extend El Cajon Blvd. to La Mesa (extension of route 215). Keep at 2nd tier.

MTS Suggested Corridors

- Routes 11 and 2 on 30th Street, note only a handful of signals for route 2
- National and Logan/I-5 to Euclid
- Fairmount from Home to Alvarado Canyon, lots of signals, 15 min headways, a number of bus drivers mentioned this corridor
- Imperial Beach: On Palm, from Hollister to 4th
- Imperial Beach: Imperial Beach Blvd. from Seacoast to Beyer
- Route 30: Torrey Pines Road to La Jolla Shores Drive to La Jolla Parkway
- Lemon Grove: College and University or College and Streamview to Lemon Grove Ave. and Skyline Dr.
- From SDSU down College Ave. to Broadway, then south down Lemon Grove Ave. and east to Skyline Dr.

NCTD Suggested Corridors

- Routes 302, 323, 323, 329: El Camino Real (lots of signals)
- Melrose (less priority than El Camino Real)

4. <u>Next Steps</u>

- Phase 2 Analysis
  - AVL/APC cycle length data will be used to go more in depth into corridor analysis
- Internal deadlines to be set by agencies to discuss and finalize 10 preferred TSP corridors

Maps and materials will be cleaned up by IBI for SANTEC/CTAC Meetings so that they reflect more TSP corridors

Improving Bus Operations and Traffic (IBOT): A Regional Approach to TSP

PDT #6

Thursday, February 11, 2016
1:00 – 2:30 PM
SANDAG – Conference Room 8A

Conference Call Number: 1-888-363-4734
Participant Code: 214590

Agenda Items:	Minutes
1. Introductions	5
2. Top 23 Corridors Discussion & Selection of Top 10	30
a. SANTEC & CTAC Comments	
b. Additional MTS & NCTD Comments	
3. Cost Benefit Analysis Discussion	20
a. Data Needs	
b. Costs to be Identified	
c. Quantifiable Benefits	
4. Next Steps	5

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Meeting Notes

To/Attention		**Date**	February 11, 2016
From	IBI Group	**Project No**	38765

Subject IBOT PDT Meeting #6
SANDAG

Present Tuere Fa'aola (IBI), Peter Thompson (SANDAG), Jonathan Levy (IBI), Dan Pearce (IBI), Charles Main (NCTD), Danny Veeh (SANDAG), Kyle Phillips (SANDAG), Zach Hernandez (SANDAG), Tom King (SANDAG), Denis Desmond (MTS), Danielle Berger (IBI), Rick Curry (SANDAG), Farah Machlab (IBI) - phone

Distribution All

Agenda Items

1. Introductions
2. Top 23 Corridors Discussion & Selection of Top 10
    a. SANTEC & CTAC Comments
    b. Additional MTS & NCTD
3. Cost Benefit Analysis Discussion
    a. Data Needs
    b. Costs to be Identified
    c. Quantifiable Benefits
4. Next Steps

2. Top 23 Corridors Discussion & Selection of Top 10

a) SANTEC & CTAC Comments
- 23 Corridors based on stakeholder input and scores were presented to SANTEC & CTAC
- Jurisdictions were overall supportive of the corridors with a few jurisdictions showing concerned due to overlap/conflict with other projects they are working on.

b) Additional MTS & NCTD Comments

- NCTD is fine with the scoring of corridors 19-23, but is happy to remove them from the list as candidates to move forward.
- Corridor 18 (Market Street) – MTS: This is a good corridor but can be removed because it's a short stretch.
- Need to think of geographic spread as the cost may knock corridors out of the running because of associated costs depending on contractor that operates the bus routes
- Corridor 11/Coast Highway 101 in Oceanside is undergoing a street redesign (road diet) and decisions won't be made on this corridor for a few months. It was agreed to remove 11 from the list
- All corridors on 101 taken off.
- Corridor 12 is a good corridor but there are few traffic lights.
- NCTD understands that there is greater need for more corridors for MTS and are fine with only one of their corridors making the top 10.
- Corridor 16 is not a priority at this moment.
- The final selected top 10 corridors were the 10 that ranked highest based on the scoring criteria. All parties were in agreement on the top 10 selected.

3. Cost Benefit Analysis

Approaches:

- John Levy gave an overview of the costs associated with each approach

Basic Installation

- Update traffic signal controller and software (170E)
- New Opticom phase selector and detectors

Advanced Installation

- Advanced traffic signal controller (2070)
- New Opticom phase selector and detectors
- Improved Communications (Fiber or Wireless)

a) Data Needs

Cost	Benefits
APC data, signal cycle	Rider benefits, value of time - $/hour
Bus emissions data (needed)	Possibly reduced emissions

"Intangibles"	More layover time for drivers

- Farah Machlab has received APC data to add additional layer to analysis. This will be useful for the cost to determine "hot spots" for delay along each corridor. Based on this information, the top 10 corridors might be further refined so that costs are not over estimated for portions of the corridor that would not benefit from TSP.

b) Costs to be Identified

- SANDAG would like a range prepare of the basic essentials to the package with additional capabilities

c) Quantifiable Benefits

- IBI interested in what data modelling team can provide for emissions
  - Emissions work is on a regional level so may not be applicable
  - This information is desirable for Cap & Trade funding.
- Peter mentioned the inclusion of connected vehicles into the methodology as an additional option for funding. He referenced a document with methodology that's not currently available for public distribution.
- SANDAG can model potential ridership benefits based on travel time savings along the corridor for transit only. IBI is to provide Tom with the travel time savings once calculated for the top 10 corridors.

4. <u>Next Steps</u>

- Do Title VI Analysis beforehand (outside of IBI scope but will look into LOE)
- IBI will send cost template

Improving Bus Operations and Traffic (IBOT): A Regional Approach to TSP

PDT #7

Wednesday, April 13, 2016
9:00 – 10:30 PM
IBI Group
701 B Street, Suite 1810, San Diego, CA 92101

GoToMeeting Login Information:
https://global.gotomeeting.com/join/361047013

Toll Free Dial: +1 (669) 224-3412
Access Code: 361-047-013

Agenda Items:	Minutes
1. Introductions	5
2. Top 10 Corridors Hot Spot Analysis Overview	20
a. Corridor Refinements	
3. Capital and Operating & Maintenance Cost Estimates	25
a. Costs	
b. Intersection Type Classifications	
4. Next Steps	5

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Meeting Notes

To/Attention	SANDAG	**Date**	April 13, 2016
From	IBI Group	**Project No**	38765
Subject	IBOT PDT Meeting #7		
Present	Tuere Fa'aola (IBI), Debbie Leung (IBI), Dan Pearce (IBI), Ryan Zatlin (NCTD), Danny Veeh (SANDAG), Denis Desmond (MTS), Danielle Berger (IBI)		
Distribution	All		

Agenda Items

1. Introductions
2. Top 10 Corridors Hot Spot Analysis Overview
    a. Corridor Refinements
3. Cost Estimate Determination
    a. Intersection Classifications
    b. Range of Cost Estimates
4. Next Steps

2. Top 10 Corridors Hot Spot Analysis

a) Corridor Refinements

- IBI provided an overview of analyses up to do date and explained how and why each of the Top 10 Corridors were refined.
    - MTS were surprised that there was not more delay along Corridors 1 and 9, and expected that Corridor 9 would be more congested than Corridor 7. Furthermore, MTS expected to see a lower level of service of on Corridor 10 in Lemon Grove.
    - IBI will check and confirm the data on those corridors.

- Jurisdictions were overall supportive of the corridor refinements made the following decisions and comments on each of the following corridors:
    - Corridor 1 – TSP recommended between I-15 and Spring St.
    - Corridor 2 – TSP recommended for the whole corridor.
    - Corridor 3 – TSP recommended for the whole corridor. It was decided that Corridor 3 would likely need additional physical improvements in order to reap the full benefits of TSP. MTS stated that on this corridor

TSP will bring benefits particularly at off-peak times and on the shoulders of peak times.

- Corridor 4 – TSP recommended for the whole corridor.
- Corridor 5 – TSP recommended between Marshall/Main St. to Broadway/Main St. it was agreed that past Broadway and Main St. commercial activity significantly drops off. This cuts three signals from this corridor.
- Corridor 6 – TSP recommended for the whole corridor. This would help maximize any potential deficiencies along the corridor. It was noted that this corridor is currently under study for adaptive traffic control.
- Corridor 7 – TSP recommended for the whole corridor. The signal at El Cajon & Collwood Ave. cannot be considered as it is fitted with TSP for Mid-City with East/West priority.
- Corridor 8 –TSP recommended for whole corridor. Two signals – one at Taylor St. and Morena Blvd., and one Linda Vista Rd. and Morena Blvd. are considered incompatible for TSP due to traffic conditions. These signals could maybe be improved with other measures.
- Corridor 9 – TSP recommended between Orange Ave. and Home Ave. Only three signals are north of those limits one of which (Fairmount & El Cajon) has existing Mid-City TSP with East/West priority.
- Corridor 10 – TSP recommended for two segments. Segment 1 is between Montezuma/College Ave. and Adelaide/College Ave. This segment consists of 5 signals, one of which (El Cajon & College Ave.) has existing Mid-City TSP with East/West priority. Segment 2 is between College/Federal Blvd. and Broadway/Lemon Grove Ave. It was decided that the discarded segment would not get much benefit out of TSP due to signal spacing and congestion at College Grove Marketplace.

3. <u>Cost Estimate Determination</u>

- Four cost options were determined divided by:
  - Controller type (170E or 2070)
  - Technology (infrared or radio)

- Costs are divided into five sub-categories:
  - Intersections
  - Buses
  - Maintenance
  - Procurement
  - Contingency

- Intersections - in each corridor were classified based on the number of travel lanes as:
    - Minor-Minor (2/2 or (2/3)
    - Minor-Major (2/4) or (3/4)
    - Major-Major (4/4) or (4/6)
- Costing for intersections was additionally based on real examples taken from IBI projects around the region.
- Unit costs for each intersection type were multiplied by the number of the number of that intersection type.

- Buses – Unit costs for equipping a bus were multiplied by the number of buses needed to run all routes on the corridor at peak times.

- Maintenance, procurement, and contingency subtotal costs were a percentage of the intersections and buses subtotals. The following percentages were assigned:
    - Maintenance: 10%
    - Procurement : 10%
    - Contingency: 20%
- Contingency is in place to capture any additionally costs.
    - SANDAG and MTS would like to see more buses added for spares in the costing.
    - At a minimum, MTS has 20% of their spare buses in use for training or maintenance. 30% will be used to calculate spares needed; IBI to make adjustments.

- Whether an intersection requires less work to make it TSP compatible was not taken into account at this level.

- Costs can be lowered depending on size of the project.

- IBI discussed several corridor costing examples based on each of the four cost options.

4. <u>Next Steps</u>

- IBI will adjust cost estimates based on MTS, NCTD, and SANDAG feedback.

Improving Bus Operations and Traffic (IBOT): A Regional Approach to TSP

PDT #8

Monday, July 18, 2016
1:00 – 2:30 PM
SANDAG 10A
401 B Street, Suite 800, San Diego, CA 92101

Conference Call & GoToMeeting Login Information:
Toll Free: 1 (872) 240-3412
Access Code: 946-196-949
https://global.gotomeeting.com/join/946196949

Agenda Items:	**Minutes**
1. Introductions	5
2. Project Review & Status Update	5
3. Revised Cost Estimates	10
4. Traffic Impacts & Transit Benefits Analysis Methodology	30
a. Methodology	
b. Impacts and Benefits	
5. Public Outreach	15
6. Next Steps	5

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Meeting Notes

To/Attention	SANDAG	**Date**	July 18, 2016
From	IBI Group	**Project No**	38765
Subject	IBOT PDT Meeting #8		
Present	Tuere Fa'aola (IBI), Debbie Leung (IBI), Jonathan Levy (IBI), Charles Main (NCTD), Danny Veeh (SANDAG), Denis Desmond (MTS), Zach Hernandez (SANDAG), Kristen Byrne (MJE), April Petonak (SANDAG)		
Distribution	All		

1. Introductions
2. Project Review & Status Update
   - IBI previously presented capital cost estimates for the top 10 corridors at the April PDT Meeting.
   - PDT meeting was to present an overview of the revised capital cost estimates and completed annual O+M cost estimates, as well as results of TSP impacts and benefits analysis.
   - Conclusion of the meeting will take the results of TSP impacts and benefits analysis through SANDAG modeling to produce ridership and/or fares as a result of TSP, and from there.
3. Revised Cost Estimates
   - IBI to change 30% for indicating spares to actual number of buses in capital cost estimates, rounding up or down.
   - IBI to confirm staff time costs and revise as necessary. IBI to also note if there is a cost savings for implementing multiple corridors and the breakdown between maintenance and staff time costs per agency.
4. Traffic Impacts & Transit Benefits Analysis Methodology
   a. Methodology
      - Analyzed top 3 out of 5 corridors from jurisdictions that provided signal timing and volume data for select intersections
      - Used Synchro to generate baseline intersection delay and LOS without TSP
      - Synchro calculates effects for a whole hour (including recovery).
   b. Impacts and Benefits
      - Note that impacts are mostly to the side streets; the extra green time provided for buses on the main street also benefits cars
      - When delay is less, there is less to improve (benefit)
      - These impacts and benefits are generally conservative but compares well to previously used methodologies for generating impacts and benefits.

- Greatest benefits occur when the traffic light is at the beginning of a red. Therefore, buses typically gain more benefit from green extensions than early greens.
- Zach would like to include the Impacts and Benefits diagrams in the TSP guidebook that IBI is developing

5. Public Outreach
    - Will include outreach on top 10 corridors
    - Danny to circle back with Colleen Windsor in early August to re-launch public outreach effort
6. Next Steps
    - Put time savings into SANDAG model to run ridership changes – can hopefully be put into a story to tell for grant funding opportunities i.e. TSP helps a route stay consistent/reliable
    - Danny to arrange meeting with Tom King (SANDAG modeling)
    - IBI to look into funding opportunities (Tracy has funding info from Peter Thompson)
    - SANDAG will aim to present to SANTEC, CCTAC, etc. in the fall with IBOT study results. IBI will help draft presentations.
    - IBI will aim to have a draft final report ready by early September to present to working groups. The agencies will take a few weeks to review and provide comments. The goals is to wrap the study in early to mid-October.

Improving Bus Operations and Traffic (IBOT): A Regional Approach to TSP

PDT #9

Thursday, October 13, 2016
1:00 – 2:30 PM
SANDAG 8A
401 B Street, Suite 800, San Diego, CA 92101

Conference Call & GoToMeeting Login Information:
Toll Free: 1 (312) 757-3119
Access Code: 873-039-565
https://global.gotomeeting.com/join/873039565

Agenda Items:	**Minutes**
1. Introductions	5
2. Project Overview Summary	30
a. Review administrative report	
b. PDT member comments to the report	
3. Public Outreach	10
a. Second Factsheet	
b. MTS Take Ones	
4. SANTEC & CTAC Meetings	5

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Meeting Notes

To/Attention	SANDAG	**Date**	October 13, 2016
From	IBI Group	**Project No**	38765
Subject	IBOT PDT Meeting #9		
Present	Tuere Fa'aola (IBI), Debbie Leung (IBI), Chris Duddy (IBI), Charles Main (NCTD), Danny Veeh (SANDAG), Denis Desmond (MTS), Zach Hernandez (SANDAG), April Petonak (SANDAG), Peter Thompson (SANDAG)		
Distribution	All		

1. Introductions
2. Project Overview Summary
    a. Review administrative report
        - Region-wide TSP Evaluation
            - MTS, SANDAG, NCTD provided data sources
            - Transit analysis utilized different thresholds of ridership for MTS & NCTD; generated map to show a road segment's propensity for TSP
            - KMZ files created with feedback from bus operator surveys, which aligned with and validated the quantifiable analysis – can provide to MTS and NCTD if needed
            - Arterial analysis was based on LOS and signal cycle length (if signal cycle length is less than 80 seconds, TSP benefits are potentially lessened). The more intersections in a corridor, the more potential benefit TSP can provide.
            - Figures will be modified to best show TSP evaluation.
        - Focused TSP Evaluation
            - Evaluated top 10 out of 23 corridors after discussions with MTS & NCTD, the majority of corridors are in San Diego
            - Developed and conducted a "hot spot" analysis to figure out which portions of corridors would be conducive to TSP, excluding existing TSP corridors or intersections that would need physical priority treatment to make TSP effective. A map for each of the top 10 corridors in available in the Appendix.
        - Cost Estimates
            - Add to final report whether fiber/interconnect is included in cost estimates, and if not, include why not. Fiber/interconnect may be beyond scope.
            - Revise to show 2070ATC controller and IR emitter as most expensive (rather than 170 controller and radio/GPS emitter)

        - IBI noted that contingency of 10% of subtotal has been included to account for any differences in
        - IBI to include Excel cost estimate sheets at final submittal of report
    - Impacts & Benefits Analysis
        - Utilized regional model to calculate ridership – bound to be some variability. Consider combining routes or refining how ridership is provided to show benefits e.g 874/875 are the same route yet have differences in ridership
        - IBI to revise and annualize average fare. Debbie will follow up with MTS/NCTD.
    - Funding Opportunities
        - More ITS and Smart Cities funding is becoming available; SANDAG will shoot for funding under these
    - Recommendations
        - IBI to provide a generalized schedule of implementation from NTP
  b. PDT member comments to the report
    - IBI to send comment matrix
    - SANDAG, MTS, and NCTD to each provide consolidated comments list
3. Public Outreach
    - Second Factsheet
        - Danny to provide comments
        - Idea is to provide perception that MTS/NCTD that as a region we are always working toward making their ride better – TSP education
    - MTS Take Ones
        - IBI is scoped to provide content for MTS Take Ones and NCTD Rider Guide, post November election
        - Denis to speak to MTS marketing folks on possibility for TSP education in MTS Take Ones.
        - Chris and Charles to check with their marketing department on including TSP education in Rider Guide.
4. SANTEC & CTAC Meetings
5. Action Items
    - Danny to provide comments on second factsheet
    - IBI to send comment matrix
    - MTS/NCTD to check with marketing departments on TSP education in Take Ones, Rider Guide
    - Debbie to follow up on average fare with MTS/NCTD

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Improving Bus Operations and Traffic (IBOT) Project Overview

SANTEC Meeting
Thursday October 15, 2015
SANDAG Conference Room, 7th Floor
9:30 – 11:30 a.m.

SANDAG Project Manager
Danny Veeh, Associate Planner
401 B Street, Suite 800
San Diego, CA 92101
619-699-7317

SANDAG

IBI

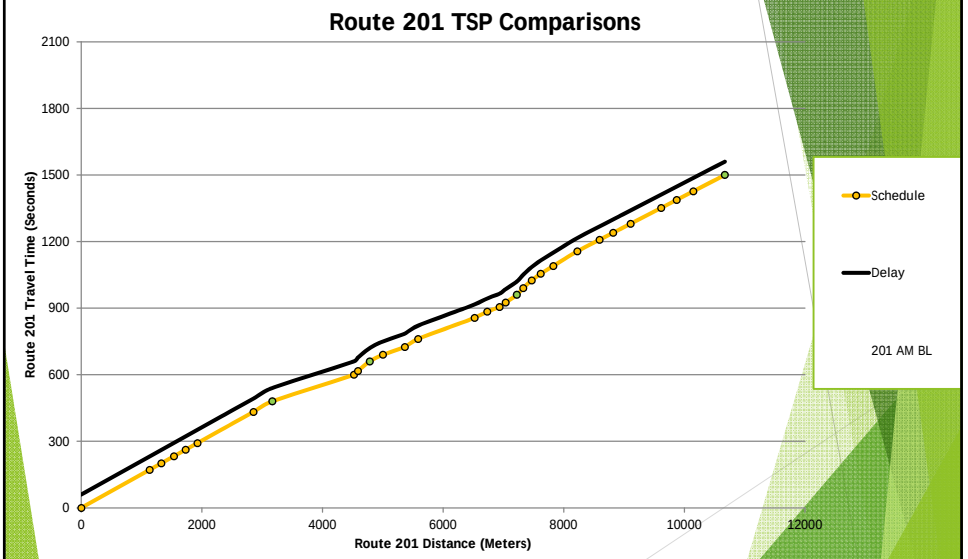
Transit Signal Priority (TSP) Overview

- TSP is a method of adjusting signal operations to provide more 'green time' for buses, resulting in fewer stops at traffic signals.
- Can reduce time delay up to 10% during peak hours.
- Decreases the probability of a bus experiencing a signal delay.
- Has a relatively low cost for implementation.
- Can improve overall LOS.

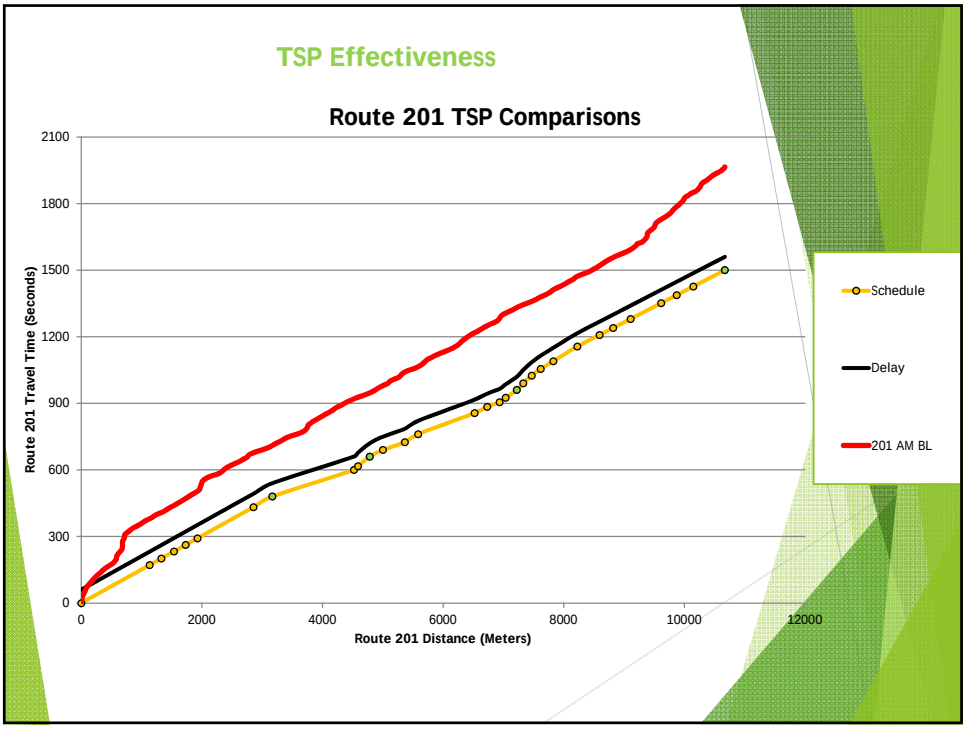
TSP in San Diego

- TSP is currently operational on the 350 Escondido BREEZE *Rapid* SuperLoop, 215 *Rapid,* 235 *Rapid* (Escondido), 280 *Rapid Express* (Escondido).
- TSP is under development on routes 235 *Rapid* (Clairemont Mesa Blvd.) 237 *Rapid* (Mira Mesa Blvd.), and South Bay *Rapid* (Chula Vista).

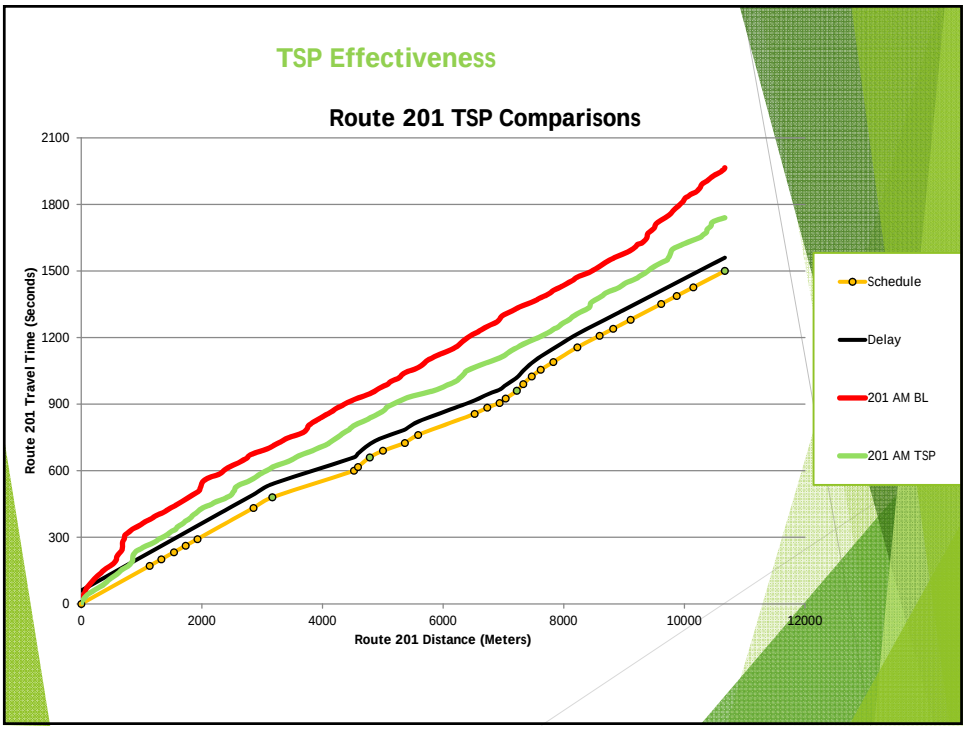
TSP Effectiveness



TSP Effectiveness



TSP Effectiveness

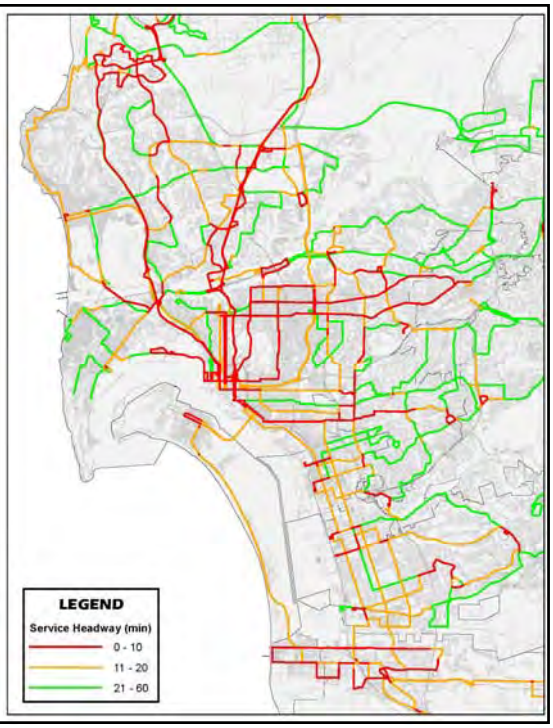


IBOT Study Overview & Purpose

1. Assess, evaluate, and prioritize corridors and intersections to expand TSP on existing bus services.
2. Develop cost estimates and quantify benefits to determine best locations to implement TSP.
3. Develop implementation strategies and recommendations.

Leveraging Investments

The IBOT project will leverage previous regional investments made on public transportation including the *Rapid* corridors, high-frequency bus routes, and intelligent transportation systems.



Public/Stakeholder Outreach

- Public outreach to existing and potential transit riders
- Coordination with local jurisdiction traffic engineers, city planners, and Caltrans District 11
- Coordination with transit operators
- TSP awareness and education

IBOT Project Schedule

Task	Timeline
Public/stakeholder outreach	October - November 2015, Early 2016, June 2016
Region-wide TSP evaluation	October – December 2015
TSP cost-benefit analysis	January – April 2016
Implementation/next steps	May – July 2016

Questions/Comments?

IBI

Appendix B – TSP Corridor Selection and Evaluation

- Top 23 Corridors Map
- Top 23 Corridors Scoring and Evaluation Worksheet
- Top 10 Segment Composite Grade Corridor Maps
- Top 10 Corridor Maps

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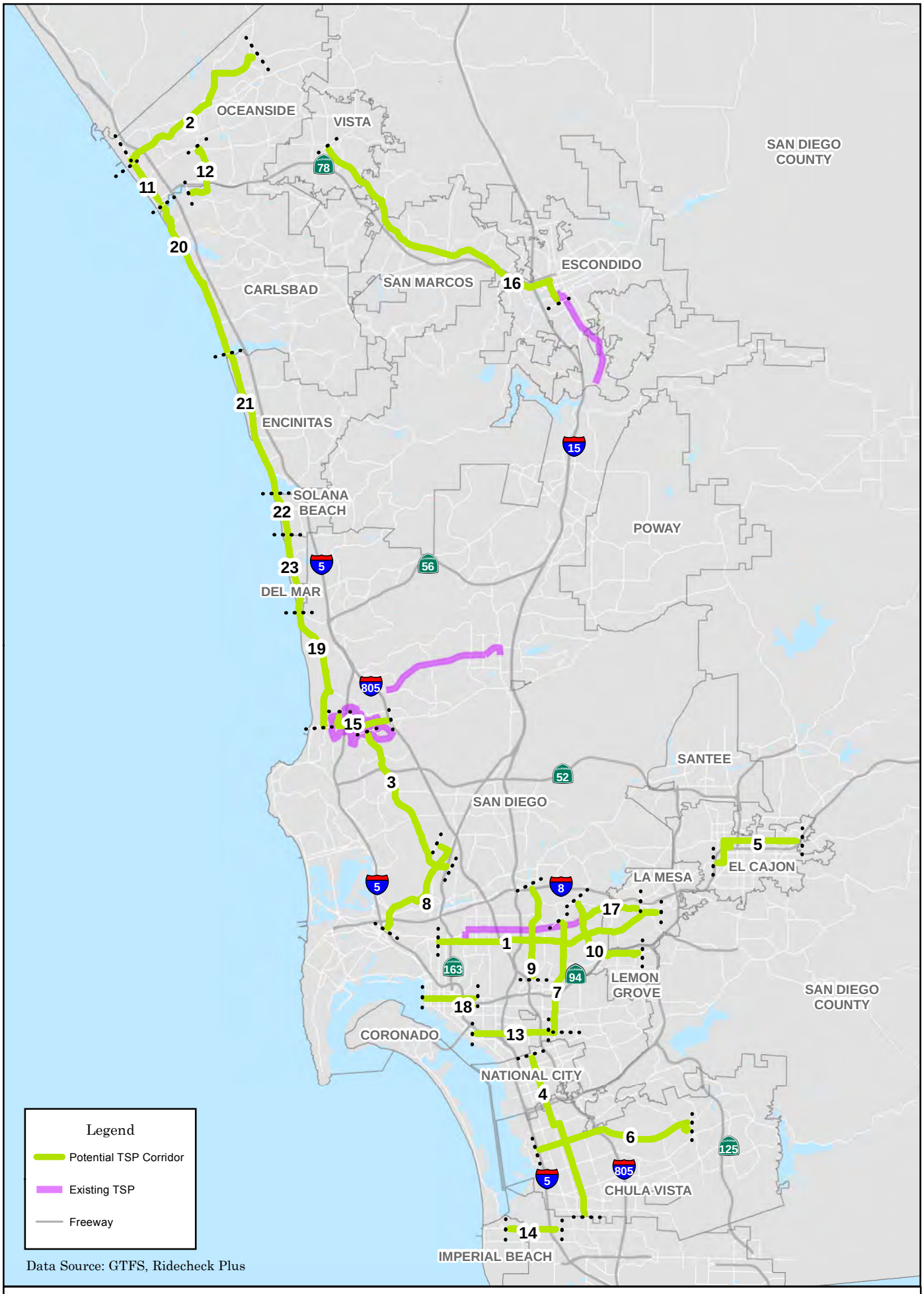
OCEANSIDE
VISTA
SAN DIEGO COUNTY
CARLSBAD
SAN MARCOS
ESCONDIDO
ENCINITAS
SOLANA BEACH
POWAY
DEL MAR
SANTEE
SAN DIEGO
EL CAJON
LA MESA
LEMON GROVE
SAN DIEGO COUNTY
CORONADO
NATIONAL CITY
CHULA VISTA
IMPERIAL BEACH
2
12
11
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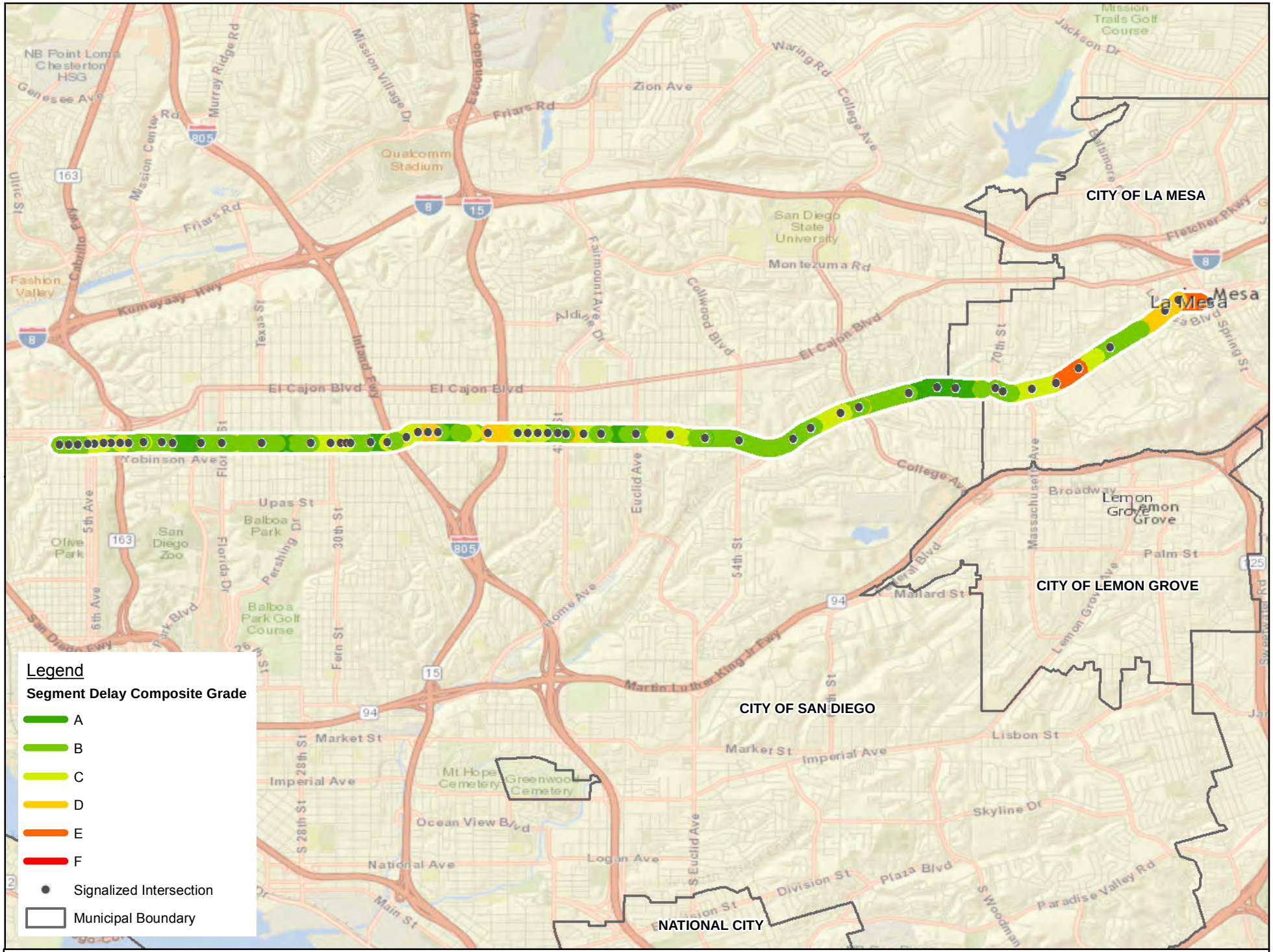
17
10
9
7
18
13
4
6
14
Legend
Potential TSP Corridor
Existing TSP
Freeway
Data Source: GTFS, Ridecheck Plus
IBI
SANDAG
REGION-WIDE TRANSIT ANALYSIS
POTENTIAL TSP CORRIDORS
IMPROVING BUS OPERATIONS & TRAFFIC
N
0
2.5
5
Miles

POTENTIAL TSP CORRIDORS

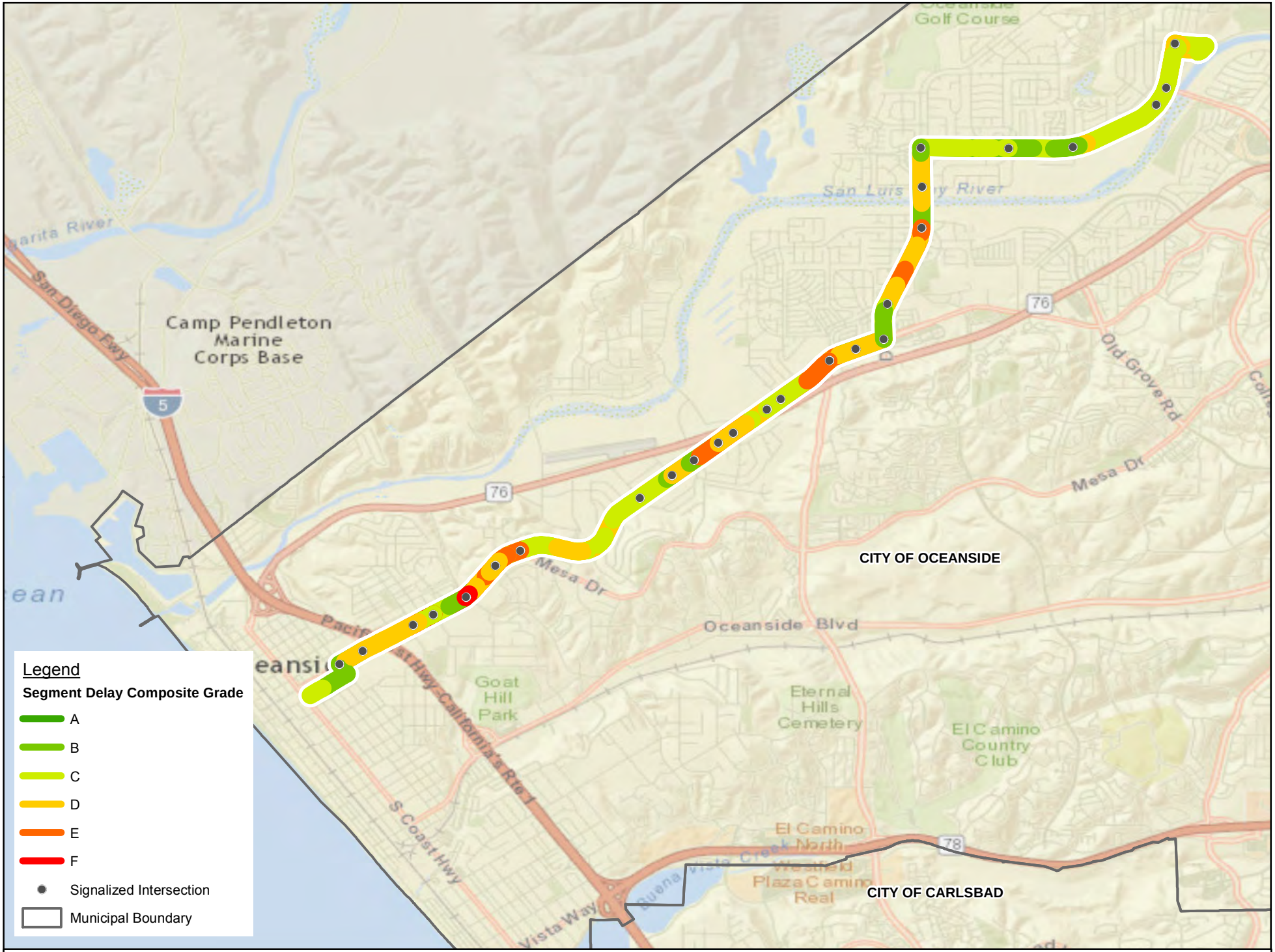
Segment values for headway, load, LOS, and signals are averaged over the entire corridor

CORRIDOR			TRANSIT				TRAFFIC			TSP PROPENSITY SCORE	BUS SURVEY	TRANSIT PRIORITY
ID	Agency	Corridor	Route(s)	Headway	Load	Transit Score	Signals	LOS	Traffic Score	Transit+Traffic	Responses	
1	MTS	University from 1st Ave. to La Mesa Blvd.	1, 7, 10, 11, 83, 120	6	3681	3.6	61	C	3.2	6.8	57	High
2	NCTD	Mission Ave. from Oceanside Transit Center to San Luis Rey Transit Center (via Douglas Dr. & N. River Rd.)	303, 313	13.2	879	3.3	28	C	3.2	6.5	13	High
3	MTS	Genessee from SR-163 to Nobel Dr.	25, 41, 50, 105	10	1533	3	20	C	3.2	6.2	13	High
4	MTS	Highland Ave. from 3rd St. to Main St. (via 3rd Ave.)	929	14	1084	2.6	29	C	3.2	6.1	12	High
5	MTS	El Cajon Transit Center to E. Main St. (via Main, Johnson, Broadway)	848, 864, 871, 872, 874, 875, 888, 892	8	944	3	17	B	2.9	5.9	23	High
6	MTS	H St. from Woodlawn Ave. to Southwestern College (via Otay Lakes Rd.)	709	11.8	3427	3	20	B	2.9	5.9	24	High
7	MTS	54th St./Euclid Ave. from Logan Ave. to Monroe Ave.	3, 4, 13, 916, 917, 955	10.4	1101	3	20	B	2.9	5.9	12	High
8	MTS	Taylor St./Linda Visa Rd. from Old Town Transit Center to Armstrong St.	44, 105, 88	9.7	1401	3	24	B	2.9	5.9	16	Medium
9	MTS	Fairmount Ave. from Home Ave. to I-8	11, 13	13	1065	2.7	12	C	2.5	5.7	32	Medium
10	MTS	College Ave. from SDSU to Lemon Grove Ave. (via Broadway)	215, 836, 936	13	686	2.6	14	C	2.5	5.6	42	Medium
11	NCTD	Coast Hwy. from Oceanside Transit Center to Vista Way	101, 302, 318	11	840	3.6	7	C	2.0	5.6	1	Medium
12	NCTD	Plaza Camino Real via Vista Way, Marron Rd, and El Camino Real	302, 309, 325	14	892	3.3	11	A	2.2	5.5	4	Medium
13	MTS	Palm Ave. from Hollister Ave. to 9th Ave.	933, 934	11	901	2.8	8	C	2.0	5.3	14	Medium
14	MTS	National Ave. from 26th St. to Euclid Ave.	11	9.8	1289	3	12	B	2.2	5.2	4	Medium
15	MTS	La Jolla Village Dr. from I-805 to Gilman Dr. (via Villa La Jolla Dr.)	30,41, 101, 150, 237, 921	5.4	2276	3.5	10	B	1.6	5.1	33	High
16	NCTD	Mission Blvd. from Escondido Transit Center to Vista Transit Center	305, 347, 356	25	562	2	38	B	2.9	4.9	35	High
17	MTS	El Cajon Blvd. from College Ave. to La Mesa Blvd.	1, 215	9.6	1635	3.19	10	B	1.6	4.6	5	Medium
18	MTS	Market St. from 16th Ave. to 25th St.	3, 5, 11	7.9	1887	3.5	5	A	1.0	4.5	5	High
19	NCTD	Torrey Pines Rd (San Diego)	101	29	406	1.6	13	C	2.5	4.1	1	Medium
20	NCTD	Carlsbad Blvd (Carlsbad)	101	28	403	1.6	13	B	2.2	3.8	2	Medium
21	NCTD	Coast Highway 101 (Encinitas)	101	31	362	1.6	11	B	2.2	3.8	1	Medium
22	NCTD	Highway 101 (Solana Beach)	101	37	341	1.6	6	C	2.0	3.6	1	Medium
23	NCTD	Camino Del Mar (Del Mar)	101	37	341	1.6	6	C	2.0	3.6	1	Medium



IBI SANDAG **DRAFT FIGURE**

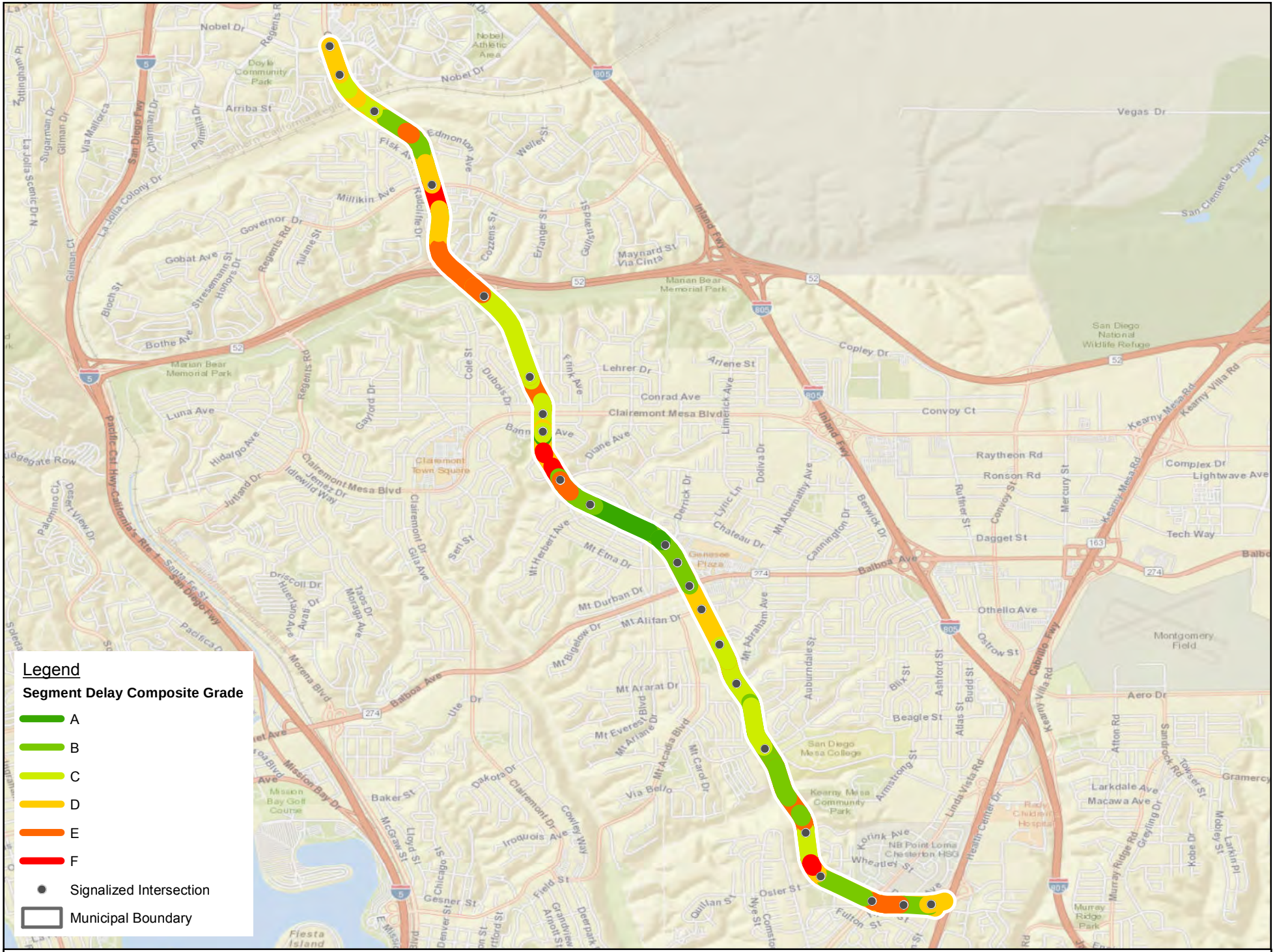
IBOT Corridor 1 - University from 1st Ave. to La Mesa Blvd.



IBI SANDAG **DRAFT FIGURE**

IBOT Corridor 2 - Mission Blvd. from Oceanside TC to San Luis Rey TC

N


Legend
Segment Delay Composite Grade
A
B
C
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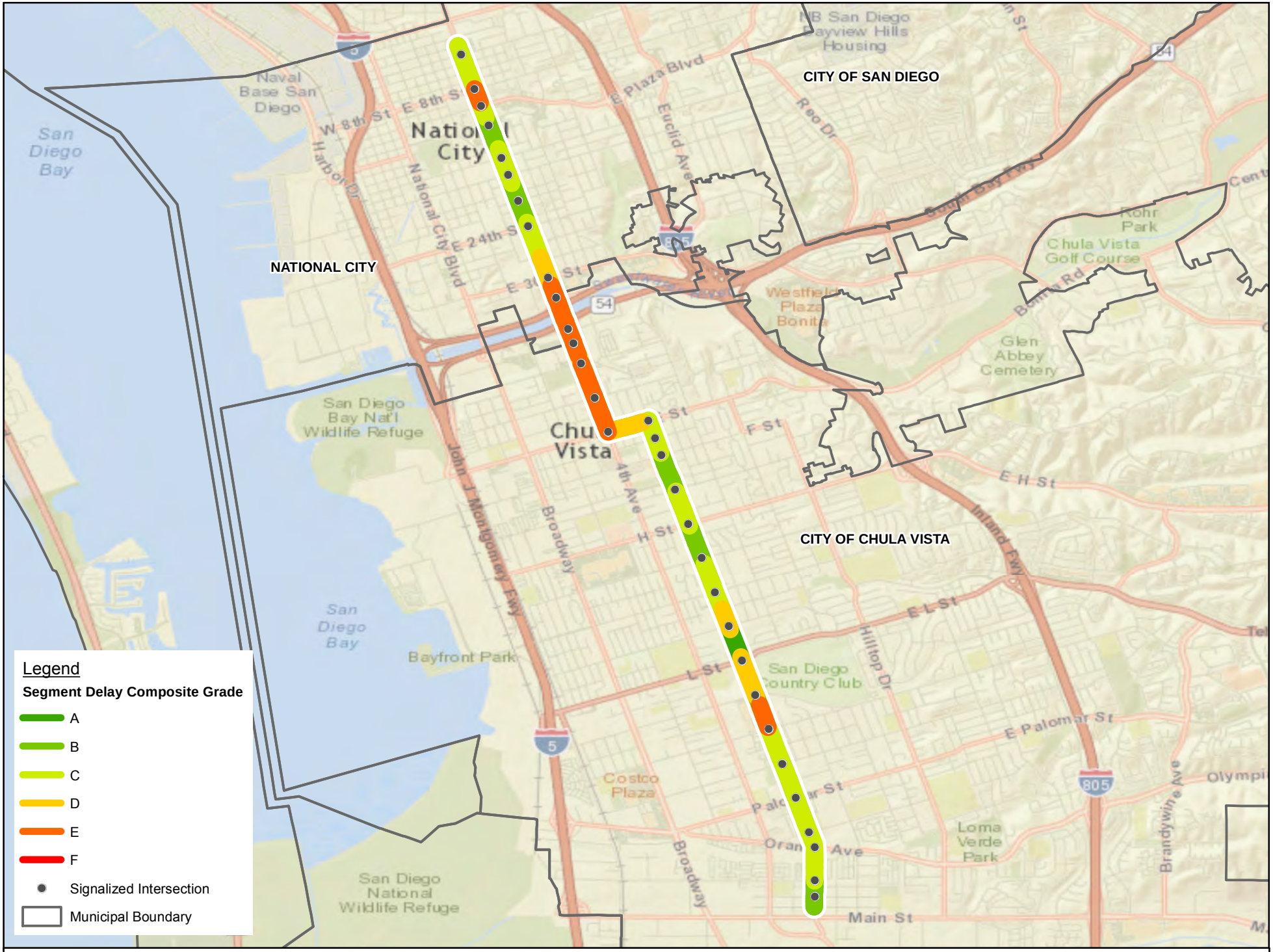
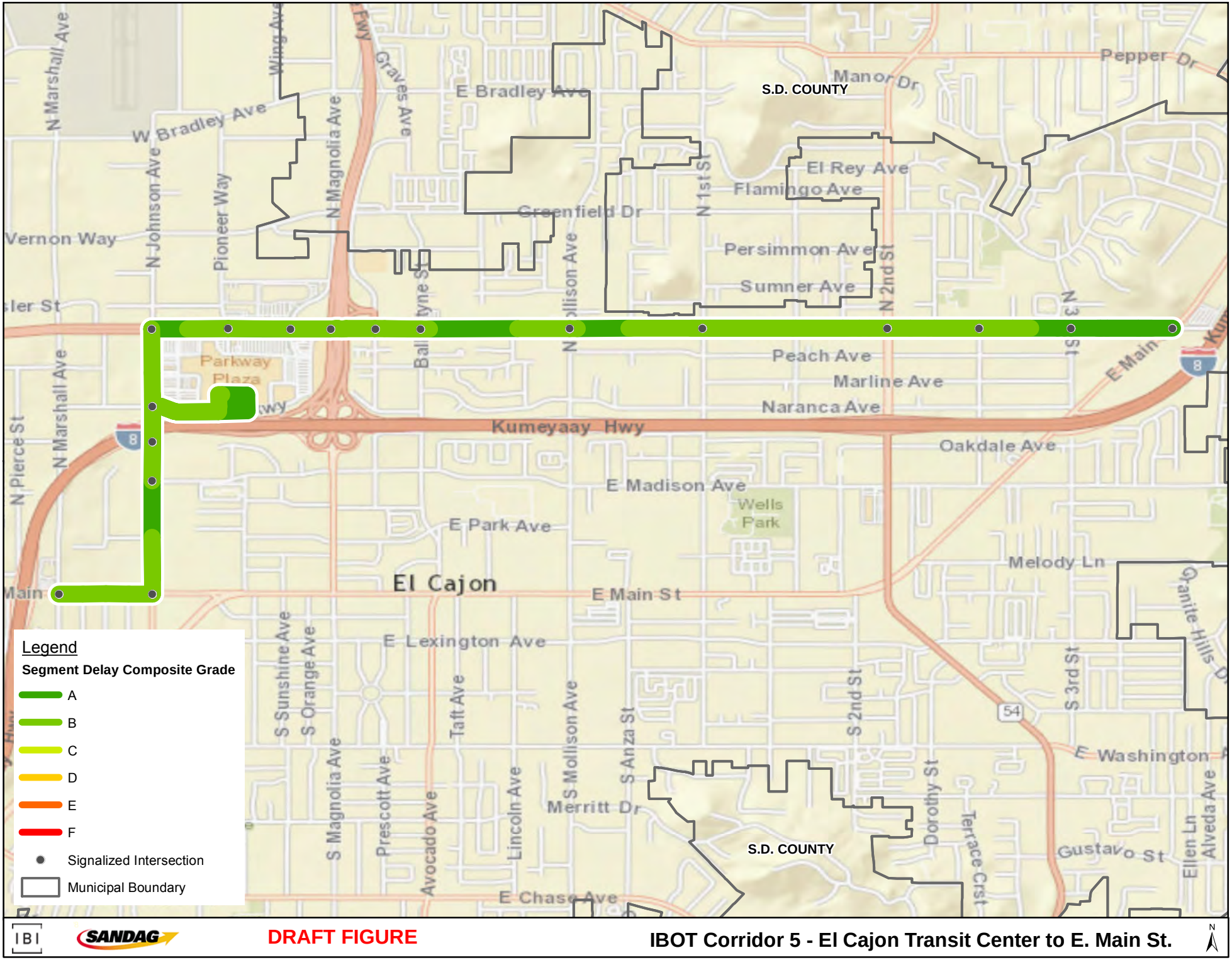
E
F
Signalized Intersection
Municipal Boundary
IBI
SANDAG
DRAFT FIGURE
IBOT Corridor 3 - Genesee Ave. from SR-163 to Nobel Dr.
N



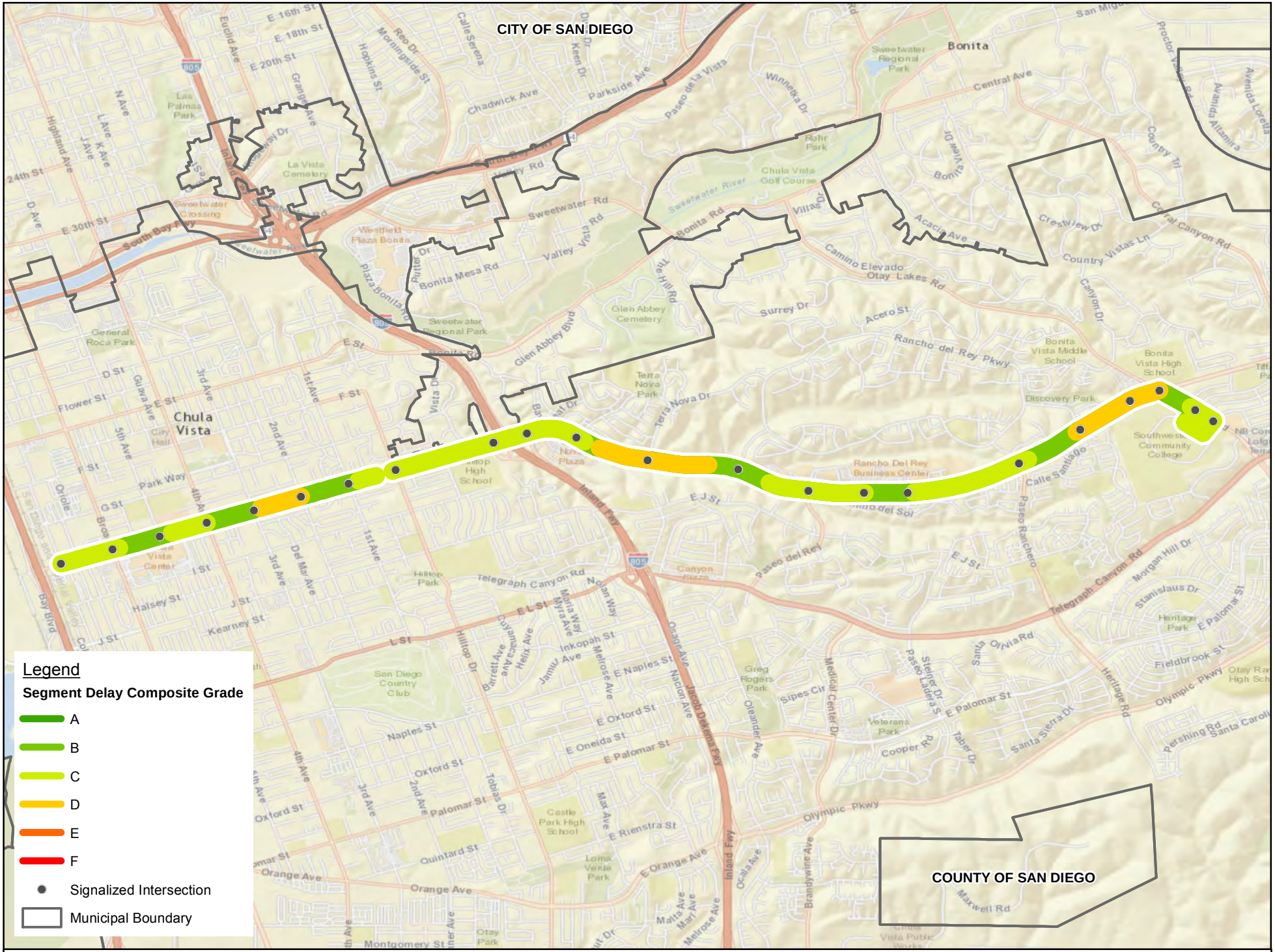
IBI SANDAG **DRAFT FIGURE** **IBOT Corridor 4 - Highland Ave. from 3rd St. to Main St. (via 3rd Ave.)**

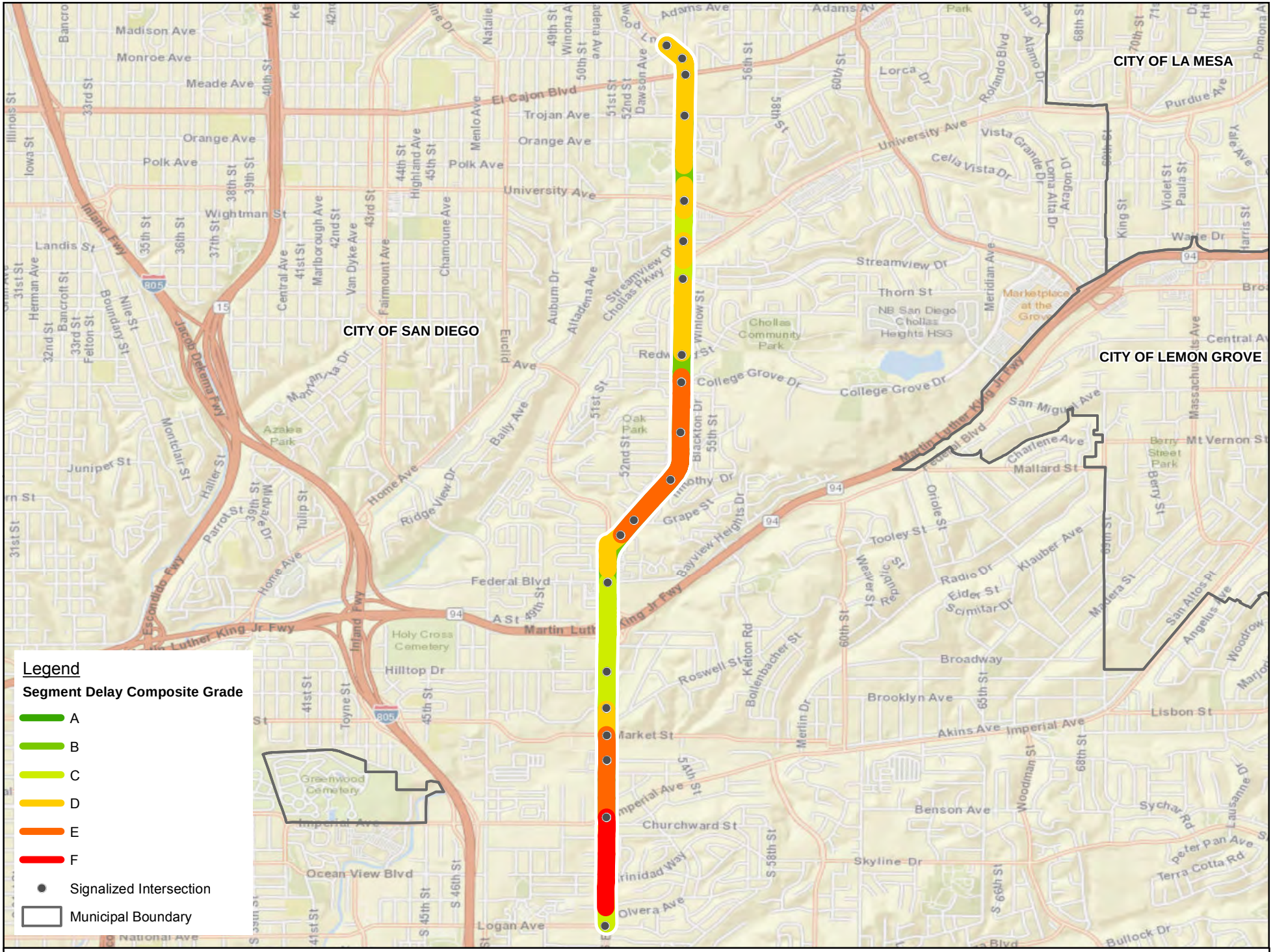


IBI SANDAG **DRAFT FIGURE**

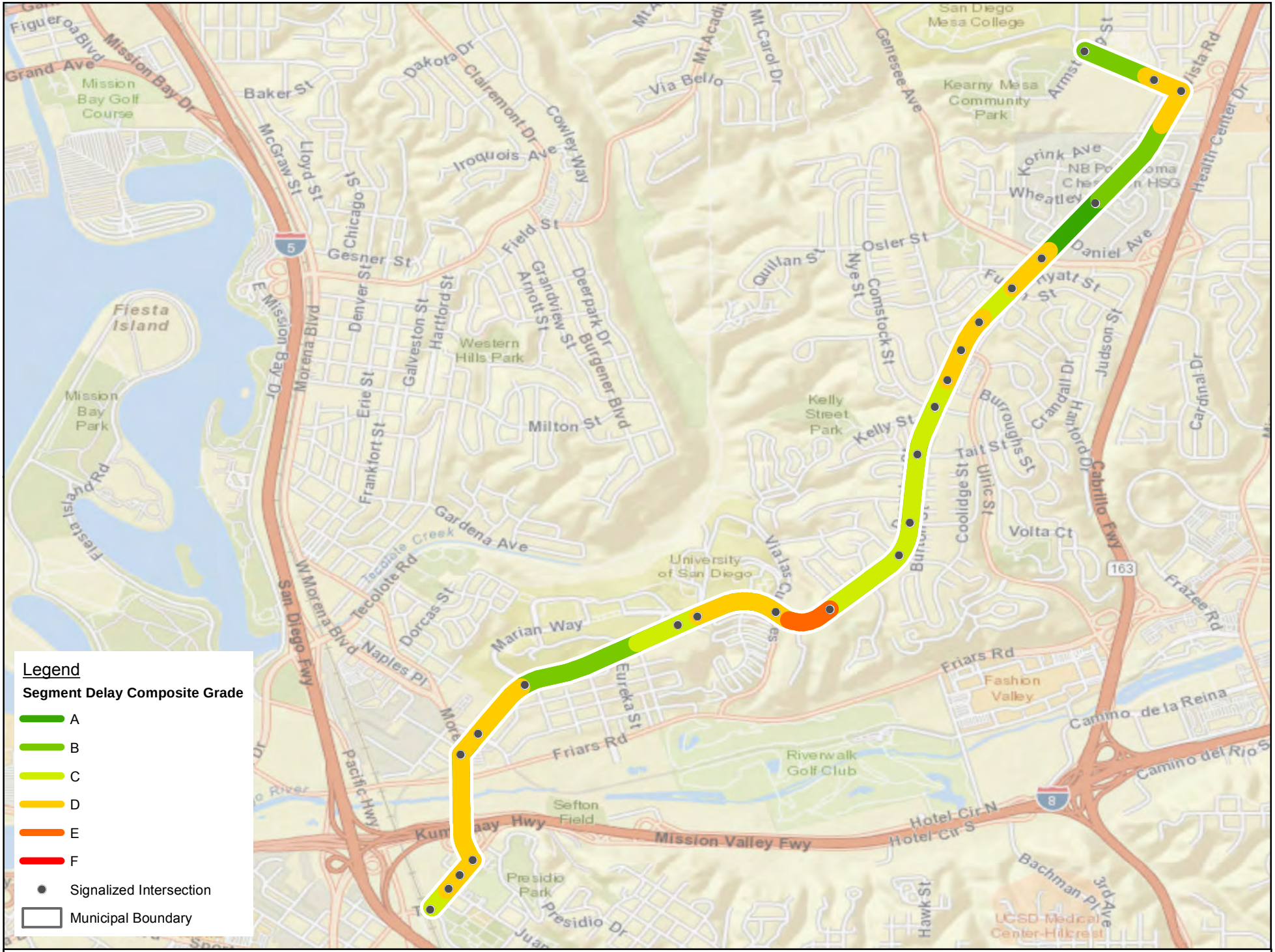
IBOT Corridor 5 - El Cajon Transit Center to E. Main St.

N

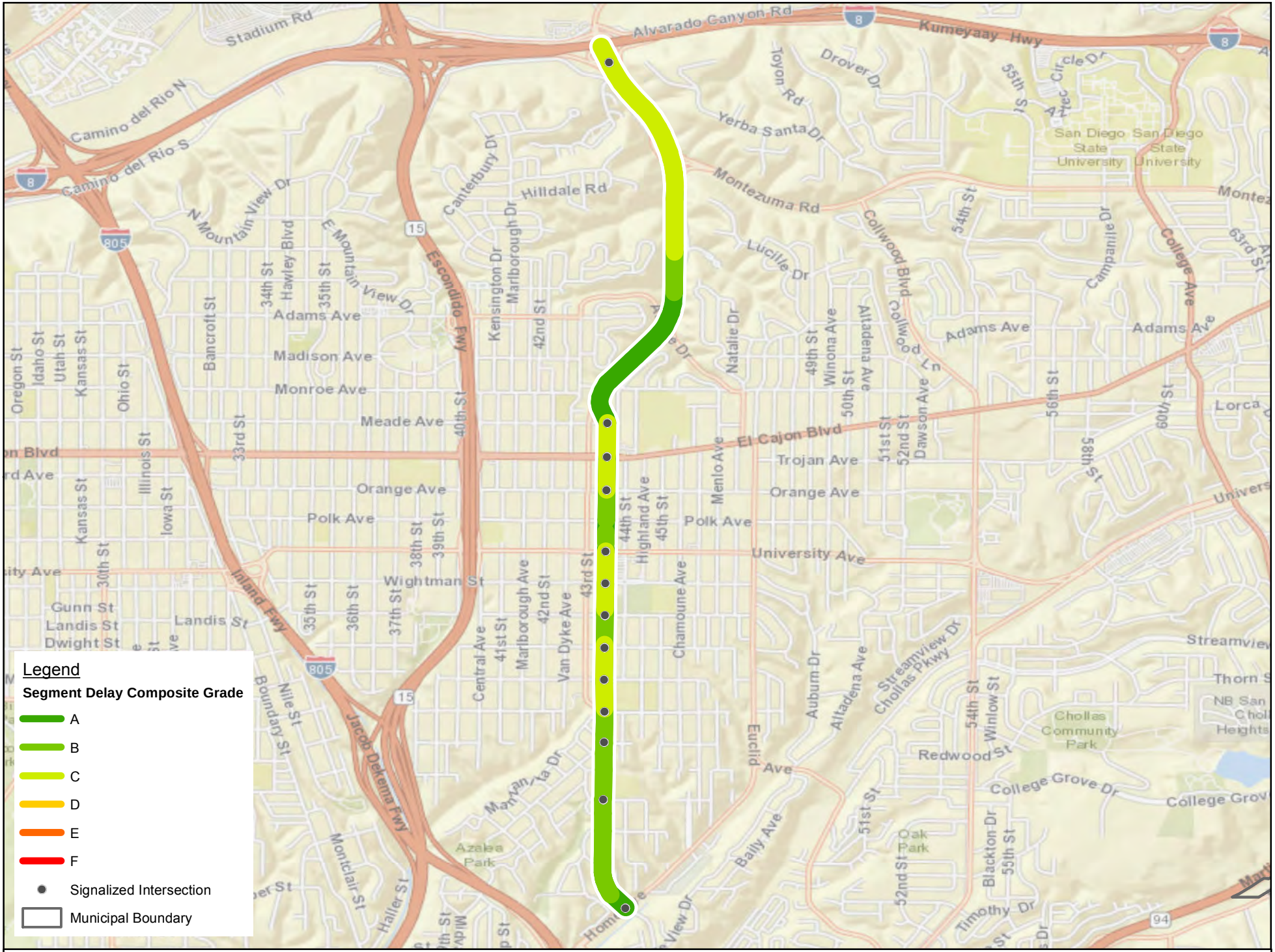

CITY OF SAN DIEGO
COUNTY OF SAN DIEGO
Legend
Segment Delay Composite Grade
A
B
C
D
E
F
Signalized Intersection
Municipal Boundary
IBI
SANDAG
DRAFT FIGURE
IBOT Corridor 6 - H St. from Woodlawn Ave. to Southwestern College
N



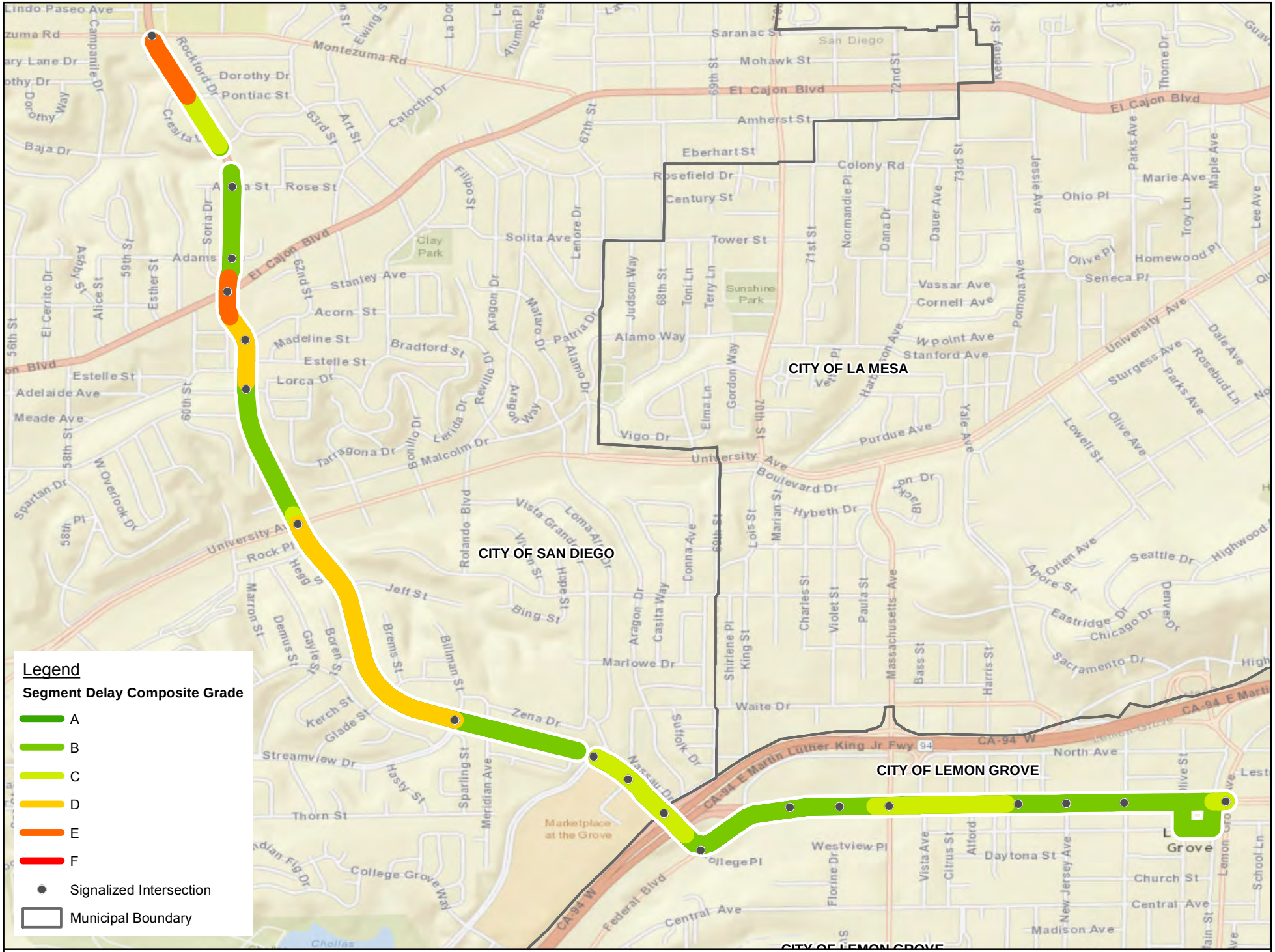
IBI SANDAG **DRAFT FIGURE** **IBOT Corridor 7 - 54th St./Euclid Ave. from Logan Ave. to Monroe Ave.**



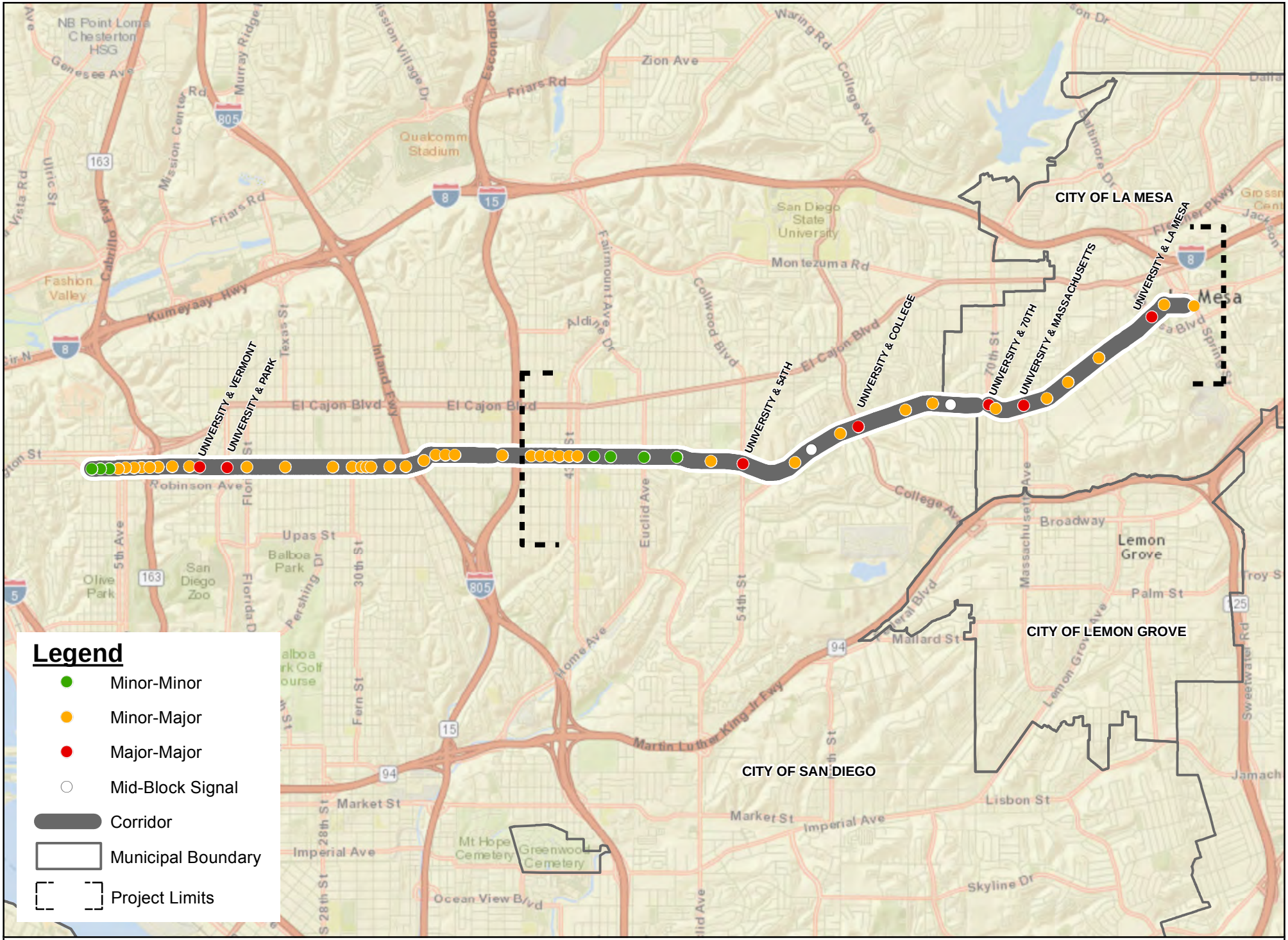
IBI SANDAG **DRAFT FIGURE** **IBOT Corridor 8 - Taylor St./Linda Visa Rd. from Old Town TC to Armstrong St.**



IBI SANDAG **DRAFT FIGURE** **IBOT Corridor 9 - Fairmount Ave. from Home Ave. to I-8**



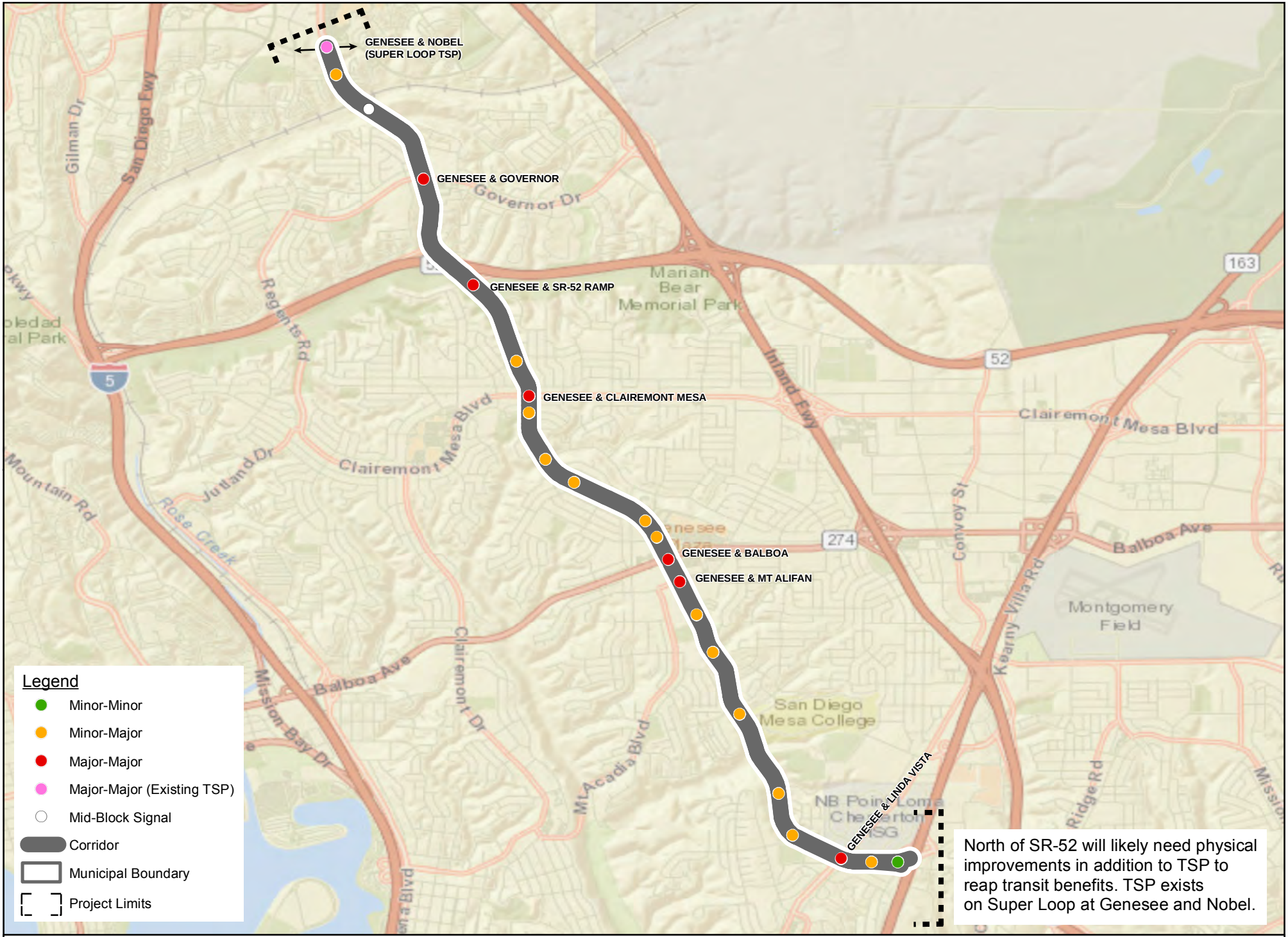
IBI SANDAG **DRAFT FIGURE** **IBOT Corridor 10 - College Ave. from SDSU to Lemon Grove Ave.** N



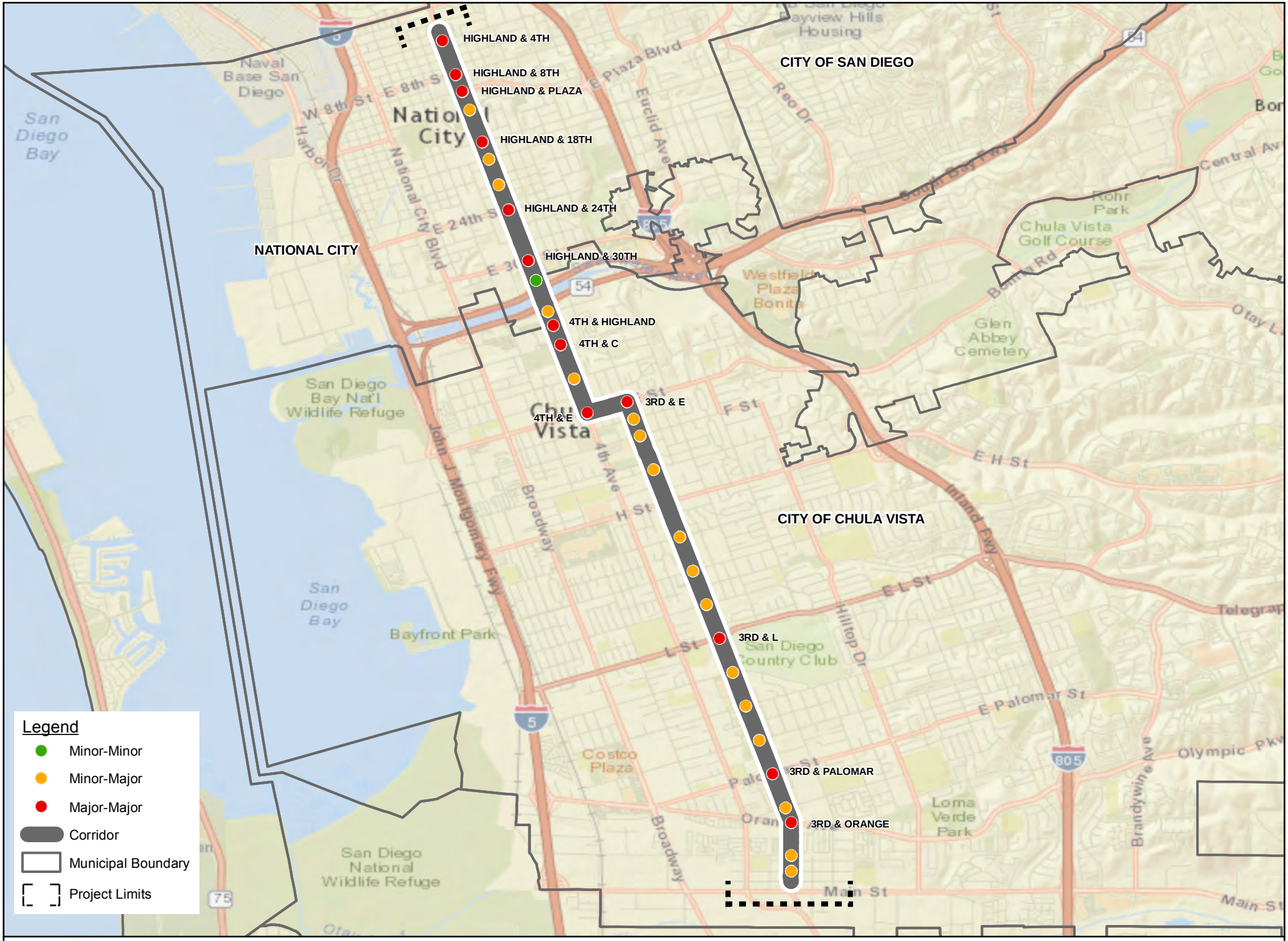
IBI SANDAG **DRAFT FIGURE**

IBOT Corridor 1 - University from 1st Ave. to La Mesa Blvd.

IBI SANDAG **DRAFT FIGURE** **IBOT Corridor 2 - Mission Blvd. from Oceanside TC to San Luis Rey TC** N



IBI SANDAG **DRAFT FIGURE** **IBOT Corridor 3 - Genesee Ave. from SR-163 to Nobel Dr.** N



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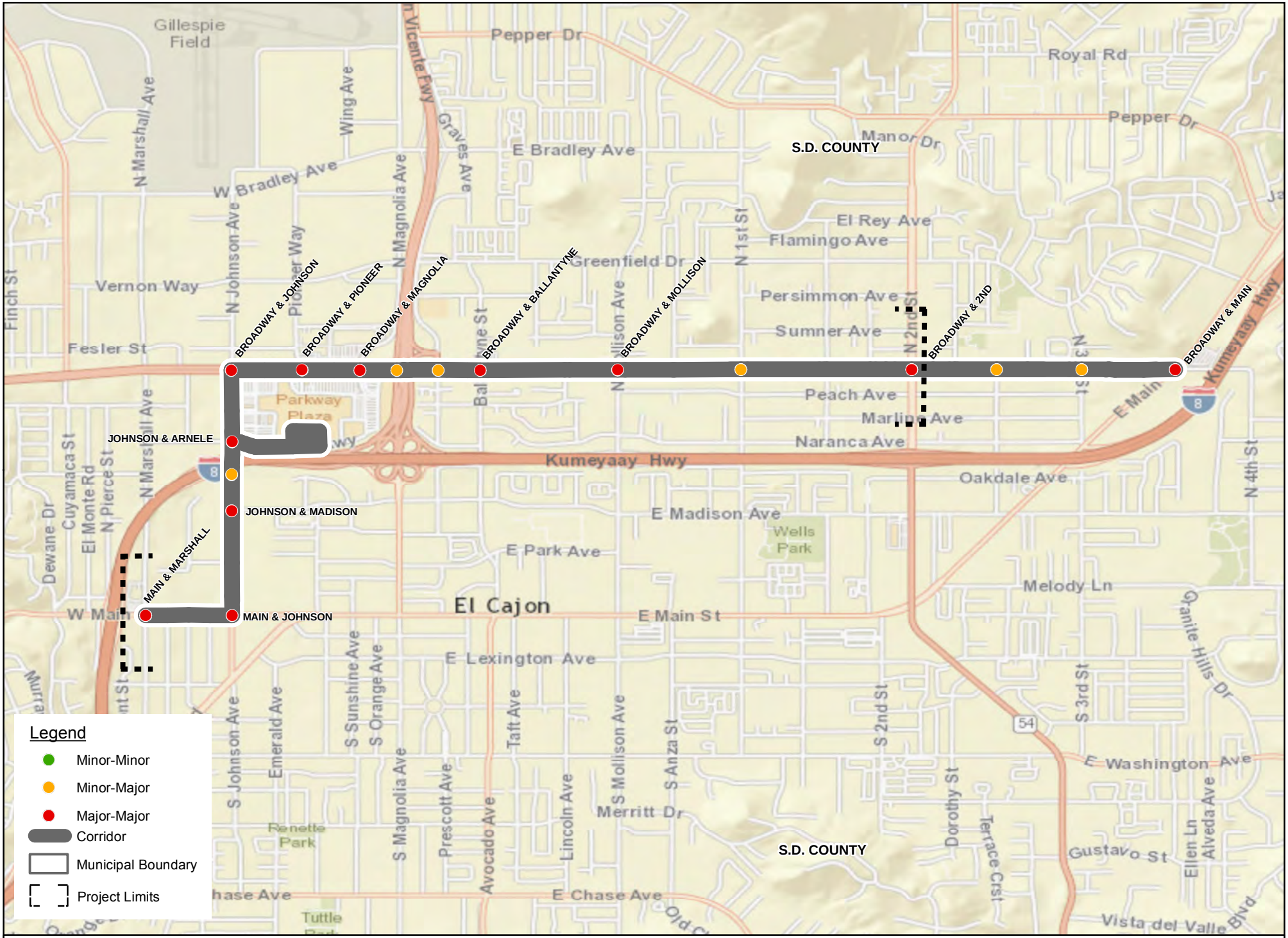
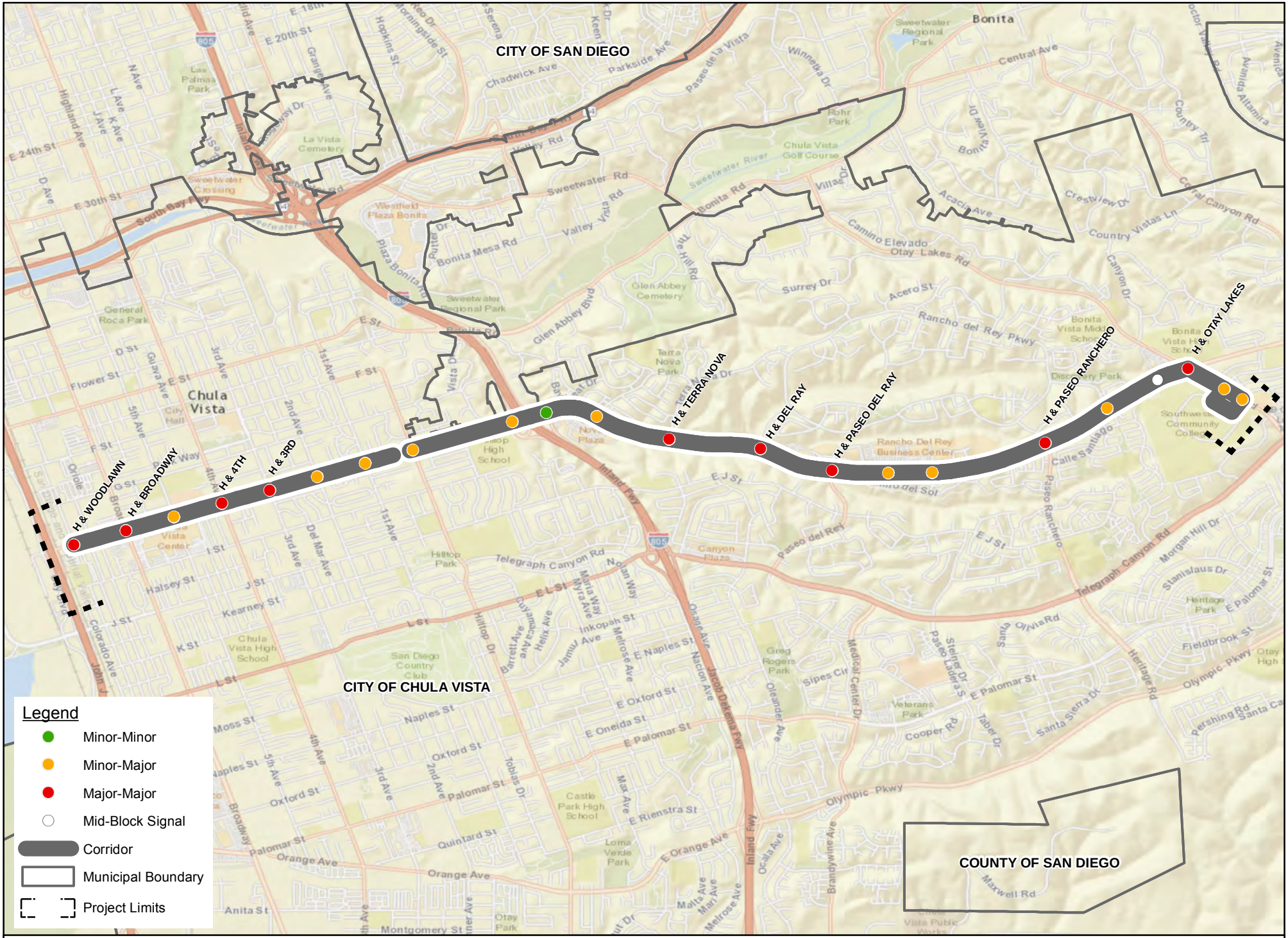
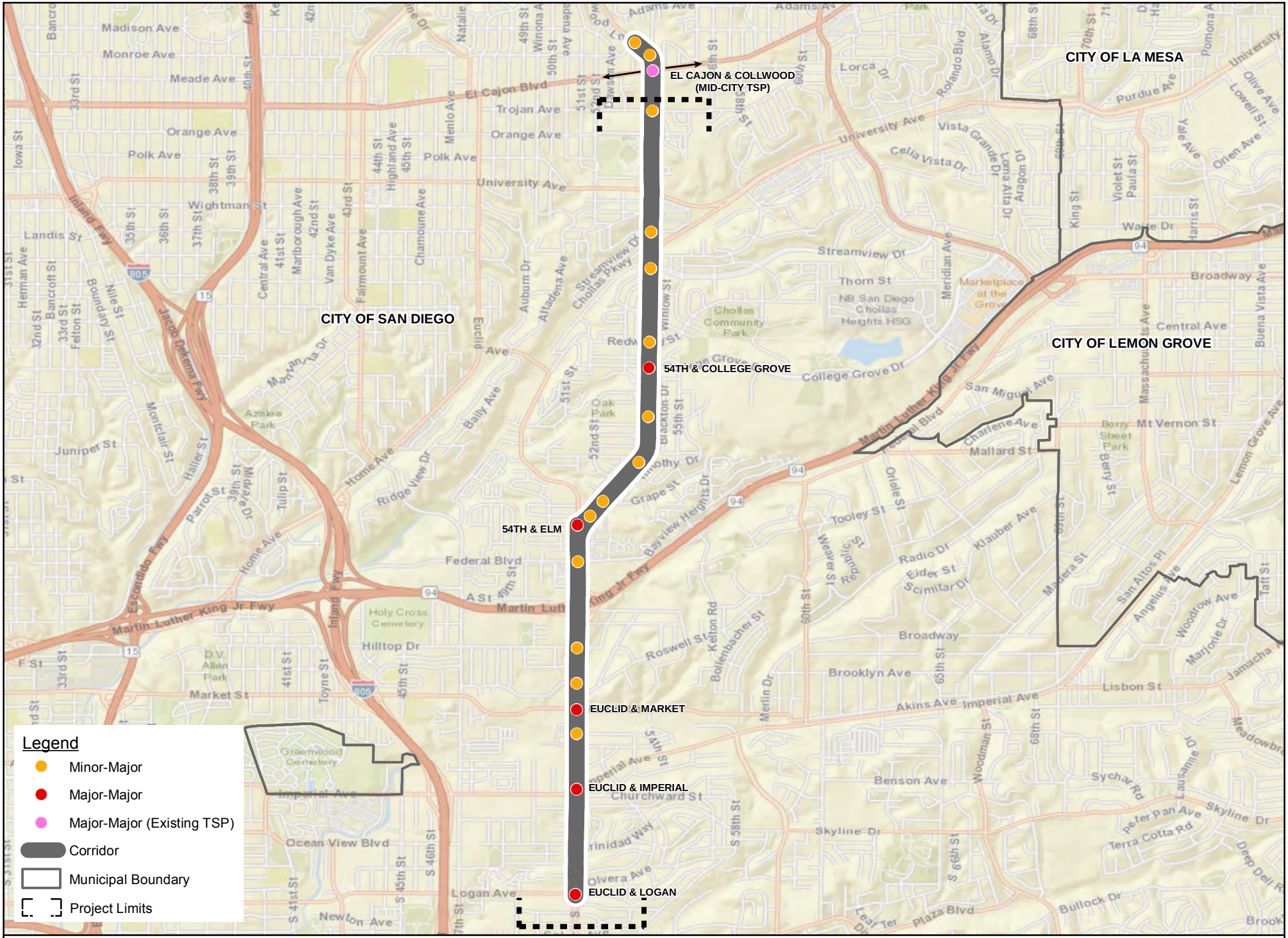


IBI SANDAG **DRAFT FIGURE**

IBOT Corridor 5 - El Cajon Transit Center to E. Main St.



IBI SANDAG **DRAFT FIGURE** **IBOT Corridor 6 - H St. from Woodlawn Ave. to Southwestern College** N



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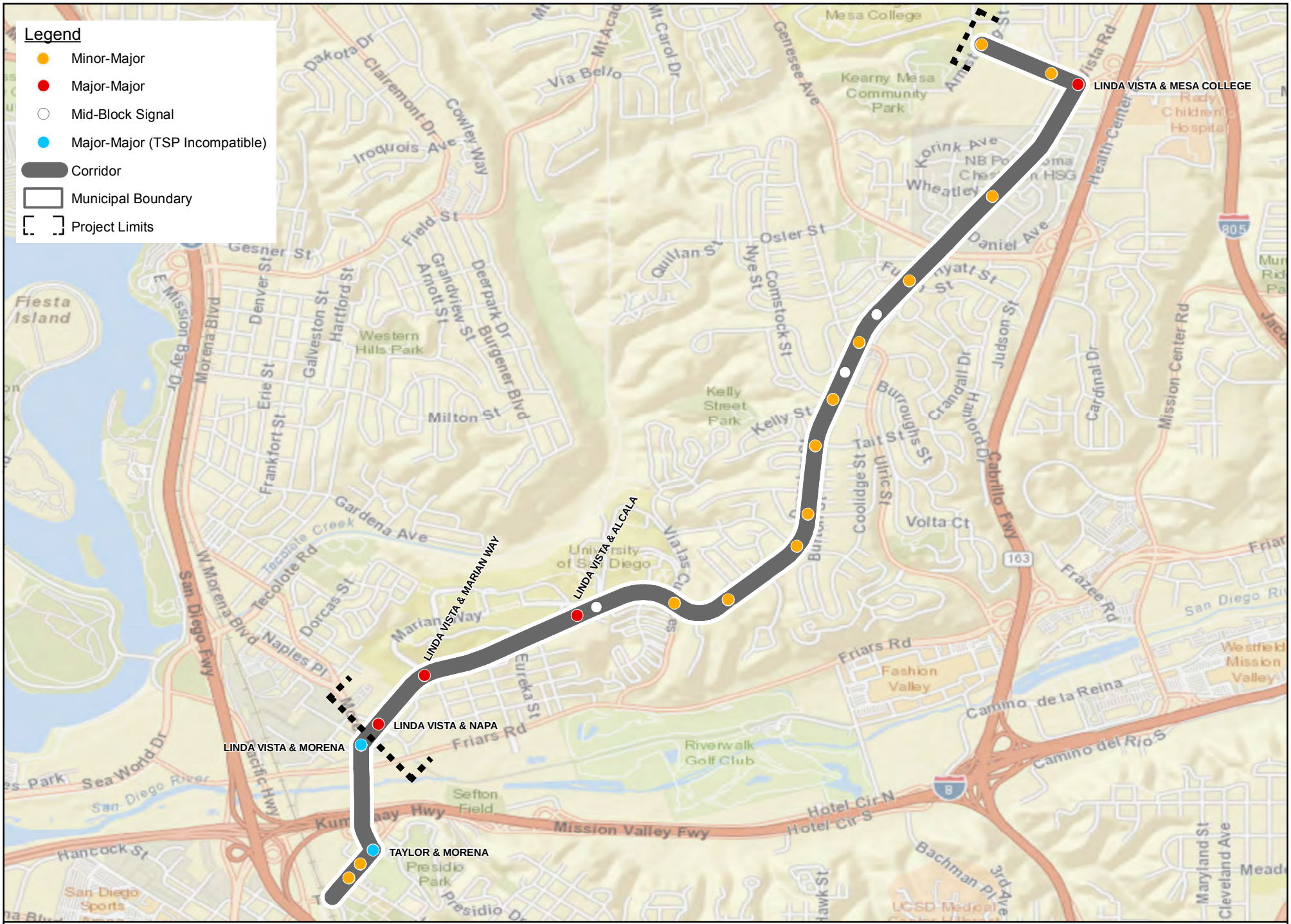
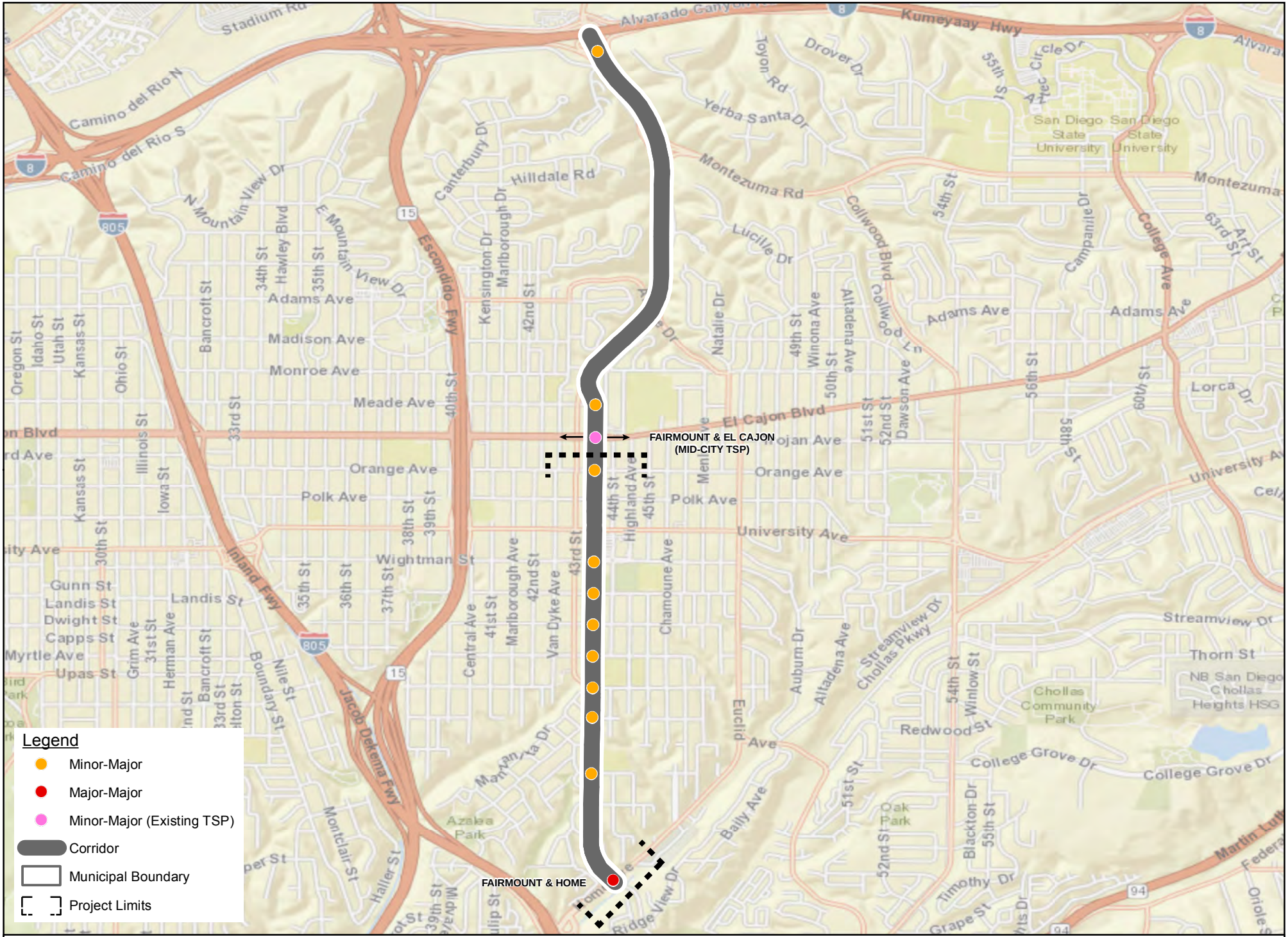
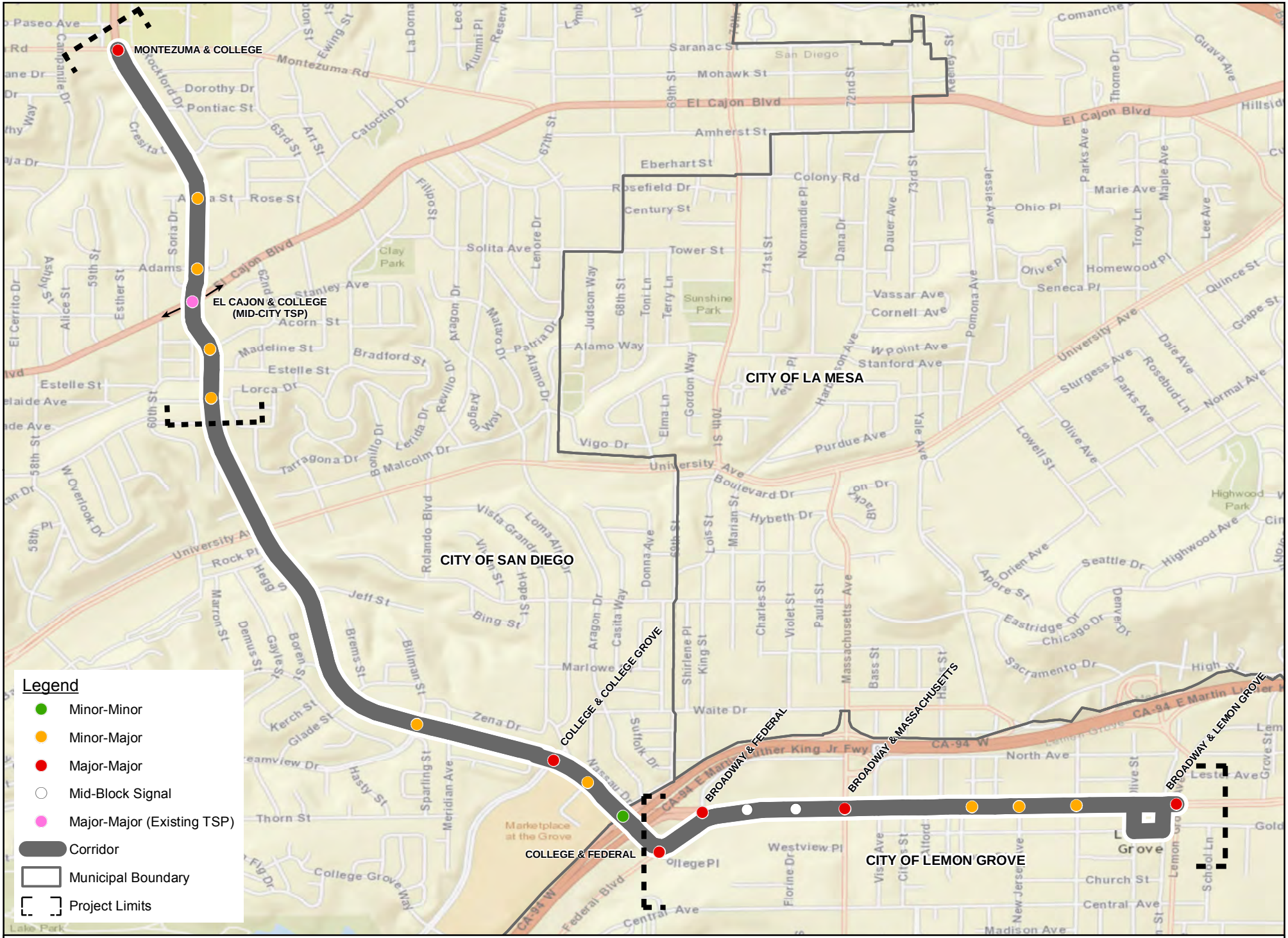


IBI SANDAG **DRAFT FIGURE** **IBOT Corridor 8 - Taylor St./Linda Vista Rd. from Old Town TC to Armstrong St.**



IBI SANDAG **DRAFT FIGURE** **IBOT Corridor 9 - Fairmount Ave. from Home Ave. to I-8**



IBI SANDAG

DRAFT FIGURE

IBOT Corridor 10 - College Ave. from SDSU to Lemon Grove Ave.

Appendix C – Public Outreach

- IBOT Public Outreach Plan
- MTS Bus Operator Survey Packet
- NCTD Bus Operator Survey Packet
- Bus Operator Survey Results
- IBOT and TSP Fact Sheet
- IBOT Fact Sheet #2
- Sample Articles for SANDAG rEgion, MTS Express, and NCTD News Center and Sample Social Media Posts

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IBI GROUP
701 B Street, Suite 1810
San Diego CA 92191 USA
tel 619 234 4410 fax 619 234 4109
ibigroup.com

Memorandum

To/Attention	SANDAG	**Date**	November 19, 2015
From	IBI Group	**Project No**	38765
Cc			
Subject	IBOT Outreach Plan		

The purpose of this memorandum is to describe the methodology for obtaining input from the public to determine the best locations to implement Transit Signal Priority.

Study Overview

SANDAG is conducting a planning study to identify the best locations throughout the region to implement Transit Signal Priority (TSP) on existing local bus routes. This study will develop a cost–benefit analysis to determine the best locations to implement TSP from a cost and operational standpoint.

Outreach Objectives

As part of the study process, the team will conduct public outreach to obtain useful input and share information with interested members of the public. The outreach activities will achieve the following objectives:

- Obtain input about routes that would benefit from TSP from stakeholders that have knowledge of transit operations.
- Share information about the benefits of TSP and potentially the results of the study with interested members of the public.

Messages

The following messages about the study will be communicated:

- TSP is an operational strategy that facilitates the movement of transit vehicles through traffic-signal controlled intersections. The TSP advantage is most commonly executed as an extended (or early) green light for a single transit vehicle approaching an intersection where a bus may otherwise be forced to wait in a queue.

- The technology reduces the amount of time transit vehicles spend idle at intersections which helps improve on-time performance, reduce running times, and improve the overall quality of transit service.

- Through this study, SANDAG will identify opportunity corridors where TSP could be implemented to provide the greatest benefit to passengers and operations on existing bus routes. SANDAG will also develop cost estimates and identify potential funding sources for implementing TSP on the top-ranked corridors.

Outreach Methods

The following methods will be employed to obtain input from key stakeholders, and communicate information to interested members of the public:

Obtaining Input

- Conduct meetings with transit agencies to gain input on high priority corridors within their services areas.

- Make presentations to CTAC, TWG, SANTEC, and the City Managers Committee to gain input about transit routes in local jurisdictions that may be good candidates for TSP.

- Develop a survey for bus drivers to complete which will provide information about individual routes and segments and/or intersections that may benefit from TSP.

Public Information

- Create a fact sheet with information about the study and/or TSP technology. This fact sheet will be used to support initial efforts to educate key stakeholders about the study, and will be updated as needed.

- Develop a web page with information about the IBOT study (to be hosted on sandag.org or sdforward.com website). This web page will be updated as needed throughout the study.

- Include information about TSP technology in existing publications and e-newsletters, including MTS' "Take One" handouts on transit vehicles and SANDAG's rEgion e-newsletter.

- Share relevant study results through SANDAG's social media channels.

- Offer presentations on the study and its results to select interested organizations (transit advocates, planning organizations, etc.).

Outreach Summary

A summary of input received and outreach efforts undertaken will be provided for inclusion in the final report.

Implementation Timeline

Outreach activities will be coordinated with key activities in the project schedule. In general, input will be obtained during the early stages of the project to ensure that contributions from transit agencies, committees and bus drivers are incorporated into the analysis and report, and public information will be disseminated in the later stages of the project once the top-ranked opportunity corridors have been identified and implementation recommendations are finalized. The table below outlines a timeline for implementation of outreach activities:

OUTREACH ACTIVITY	IMPLEMENTATION TIMELINE
Develop fact sheet	October 2015
Create web page	October 2015
Conduct meetings with transit agencies	By October 22, 2015
Make presentations to CTAC, TWG, SANTEC and City Managers meeting	October/November 2015
Develop and distribute a survey for bus drivers to provide input on specific routes	Final survey questions by October 16, 2015 Meet with bus drivers by October 29, 2015 Survey complete by November 12, 2015
Distribute information to the public (MTS "Take One," SANDAG's rEgion newsletter, SANDAG social media)	January – June 2016
Offer presentations to organizations with interest in transit issues (mobility advocates, planning organizations, etc.)	January – June 2016
Draft outreach summary for final report	June/July 2016

Improving Bus Operations and Traffic (IBOT): A Regional Approach to TSP

Fact Sheet

The Project

Building upon the successful launch of Transit Signal Priority (TSP) in the region, SANDAG is conducting the Improving Bus Operations and Traffic (IBOT) planning study to identify additional locations in the region to implement TSP. Working with transit operators and local jurisdictions, the IBOT project team will conduct a cost-benefit analysis to identify the corridors and bus routes that would most benefit from TSP. The goal is to expand the region's Smart Transit networks and increase the number of Smart Intersections to improve transit operations, reduce transit trip times, and improve overall mobility.

Currently, five bus routes are operating with TSP in San Diego County. Studies have shown that the use of TSP on these routes has improved on-time performance and reduced travel times without impacting traffic. These routes show reduced congestion at intersections with lower cross street traffic.

SANDAG was awarded an FY 2014-15 Caltrans Transportation Planning Grant, which is the primary funding source for the project. The study began in summer 2015 and it is expected to be complete in summer 2016.

The Need

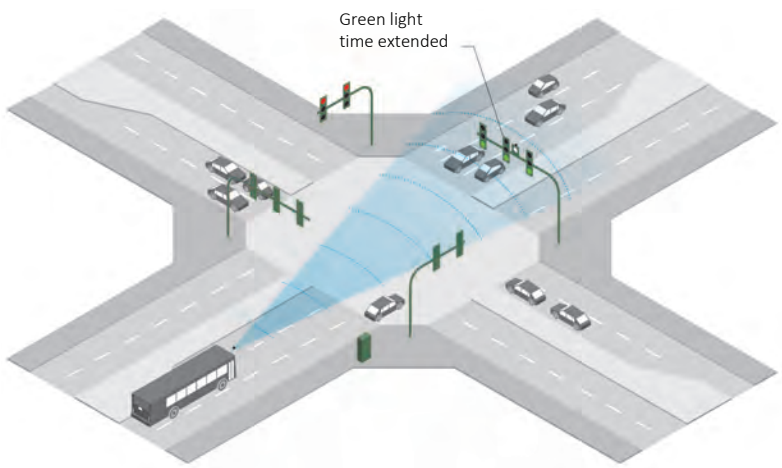
There is a need to improve bus reliability and overall transit travel time in the San Diego region. Travel time can be reduced by up to 10% during peak hours by reducing red light delays with TSP. TSP also allows buses that fall behind schedule an ability to recover lost time to ensure passengers arrive at their destinations on time and are able make connections throughout the transit system. Time savings and increased reliability can improve the public's perception of the regional transit system, which may result in increased ridership.

What is TSP?

TSP is a method of adjusting traffic signal timing to provide more 'green time' for buses, resulting in fewer stops at traffic signals. It can reduce delays by decreasing the probability of a bus stopping at a red signal. TSP can extend a green light by a few seconds to allow the bus to cross through an intersection or it can shorten a red light as bus approaches an intersection. TSP is a lower priority than emergency vehicle preemption, which can switch a traffic signal to green at any time.

How Does TSP Work?

Onboard systems measure a bus' exact location and can determine if it is running on schedule. When a bus falls behind schedule on a TSP-enabled route, the system will activate an emitter onboard the bus that is detected by the traffic signal as it approaches an intersection. Once a TSP request is detected at the intersection, signal timing will be adjusted for additional green time until the bus clears the intersection. TSP is only triggered if a bus is behind schedule and is typically unnoticeable to drivers. The figure below depicts a bus approaching an intersection on a TSP-enabled route.



SANDAG

FOR MORE INFORMATION CONTACT:

Danny Veeh, Associate Planner - Active Transportation and Rail
San Diego Association of Governments
401 B Street, Suite 800
San Diego, CA 92101
(619) 699-7317

Danny.Veeh@sandag.org

Smart Cities + Smart Intersections
MTS Bus Operator Survey

Please take a few moments to fill out this survey. Your input is appreciated.

1. List all the bus routes that you drive.

_____

_____

2. List the top five intersections in which delays are commonly experienced on your route(s) due to red lights. Please write the cross streets.

1) _____ 4) _____

2) _____ 5) _____

3) _____

3. Check all days in which delays typically occur.

☐ Monday ☐ Wednesday ☐ Friday ☐ Sunday

☐ Tuesday ☐ Thursday ☐ Saturday

4. Check all time periods where your route(s) experience delays and indicate the frequency of delays.

AM (before noon)

☐ Sporadic

☐ Peak Hours (6am-9am)

☐ All Hours

PM (after noon)

☐ Sporadic

☐ Peak Hours (3pm-6pm)

☐ All Hours

5. How severe would you rate typical delays?

☐ Not Severe ☐ Moderate ☐ Severe ☐ Very Severe

6. Are you aware of any other intersections where bus operators experience delays? If yes, please indicate those intersections below.

_____

_____

_____

7. Identify any stops along your route(s) that experience boarding/alighting delays.

_____

_____

_____

8. Additional comments:

_____

_____

_____

Improving Bus Operations and Traffic (IBOT): A Regional Approach to TSP

Fact Sheet

The Project

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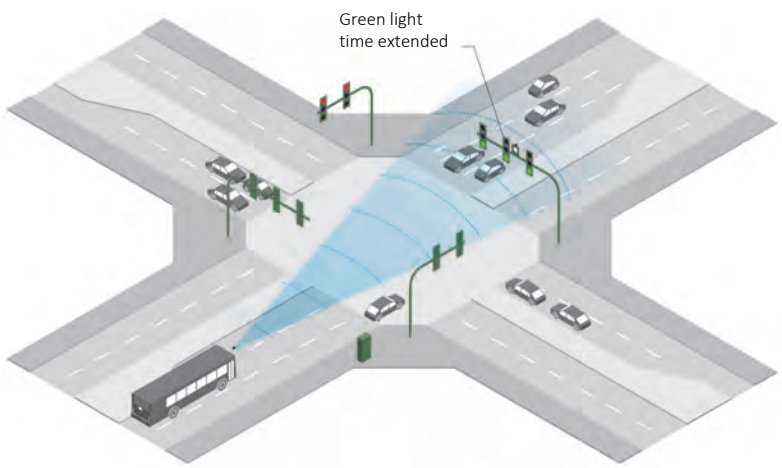

Smart Cities + Smart Intersections
NCTD Bus Operator Survey

NORTH COUNTY TRANSIT DISTRICT

Please take a few moments to fill out this survey. Your input is appreciated.

1. List all the bus routes that you drive.

_____

_____

2. List the top five intersections in which delays are commonly experienced on your route(s) due to red lights. Please write the cross streets.

1) _____ 4) _____

2) _____ 5) _____

3) _____

3. Check all days in which delays typically occur.

☐ Monday ☐ Wednesday ☐ Friday ☐ Sunday

☐ Tuesday ☐ Thursday ☐ Saturday

4. Check all time periods where your route(s) experience delays and indicate the frequency of delays.

AM (before noon)

☐ Sporadic

☐ Peak Hours (6am-9am)

☐ All Hours

PM (after noon)

☐ Sporadic

☐ Peak Hours (3pm-6pm)

☐ All Hours

5. How severe would you rate typical delays?

☐ Not Severe ☐ Moderate ☐ Severe ☐ Very Severe

6. Are you aware of any other intersections where bus operators experience delays? If yes, please indicate those intersections below.

_____

_____

_____

7. Identify any stops along your route(s) that experience boarding/alighting delays.

_____

_____

_____

8. Additional comments:

_____

_____

_____

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Bus Operator Survey Responses

Response	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
1	41						Genesee Ave & La Jolla Village Dr	Villa La Jolla Dr & Gilman Dr				x	x	x	x	x								x			x										
2	972	973	978	979			Sorrento Valley Rd & Sorrento Valley Blvd					x	x	x	x	x	x							x			x									Also experience delay at Sorrento Valley Coaster Station
3	944	833	115	832	872		Bradley Ave & Graves Ave	Poway Rd & Midland Rd	Magnolia Ave & Prospect Ave			x	x	x	x	x									x												
4	964	944	833	832	864		Gold Coast Dr & Black Mountain Rd	Bradley Ave & Graves Ave				x	x	x				x										x									
5	833	25					Bradley Ave & Graves Ave	Mesa College Dr & Health Center Dr	Magnolia Ave & Mission Gorge Rd	Clairemont Mesa Blvd & Complex Dr		x	x	x						x								x										
6	14	945					College Ave & Del Cerro Blvd	College Ave & Lindo Paseo	College Ave & Montezuma Rd	Rancho Bernardo Center Dr & Rancho Bernardo Rd	Poway Dr & Pomerado Rd	x	x	x	x	x				x	x					x	x												
7	972						Sorrento Valley Rd & Sorrento Valley Blvd	Vista Sorrento Pkwy & Sorrento Valley Blvd	Lusk Blvd & Mira Mesa Blvd	Barnes Canyon Rd & Pacific Heights Blvd	Vista Sorrento Pkwy & Mira Mesa Blvd		x	x	x					x				x				x										Known delays at Roselle entering and exiting I-5
8	25	833					Bradley Ave & Graves Ave					x	x	x	x	x			x	x		x					x		Osler St & Ulric St							Light at Bradley Ave and Graves Ave takes 2-3 lights to make a left turn. Sometimes wait up to 5 minutes. Need traffic light at Osler street and Ulric street because pedestrians are continually crossing at during Linda Vista Elementary school peak commute times
9	965						Home Ave & Menlo Ave					x	x	x					x							x										
10	83	88	851	965			Sweetwater Rd & Jamacha Rd	Home Ave & Euclid Ave				x	x	x	x	x					x			x		x			SR-94 & Spring St							Also an issue on SB spring street as SR-94/SR-125 split.
11	964	25	916	979	88	14	Ruffin Rd & Clairemont Mesa Blvd	Gold Coast Dr & Black Mountain Rd	Aero Dr & Murphy Canyon	Streamview Dr & College Ave	La Jolla Village Dr & Genesee	x	x	x	x	x				x			x			x			Madera St & Broadway							Route 917 is a bad route. Streets are uneven which causes a lot of shaking on the bus

Bus Operator Survey Responses

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12	851	945	115	832	921		Spring St & SR-94								x	x				x								x							
13	965	851	27	864	833		Home Ave & Fairmount Ave	University Ave & I-15							x	x				x								x								
14	965	25	88				Fairmount Ave & Wightman St	Complex Dr & Clairemont Mesa Blvd	Fashion Valley Rd & Friars Rd	Ulric St & Friars Rd		x	x	x	x	x			x				x				x	x							Fairmount Ave & Wightman St	Home Ave & Euclid St	University & I-15	Boarding and alighting delays mostly due to wheelchairs, carriages, infants, etc…
15	972	88	921	972	856	25	Sorrento Valley Rd & Sorrento Valley Blvd	Mira Mesa Blvd & Westview Pkwy	Fairmount Ave & University Ave	Broadway & Lemon Grove Ave	Oberlin Dr & Mira Mesa Blvd	x	x	x	x	x	x	x		x				x				x	Health Center Dr & Mesa College Dr	Sweetwater Rd & Troy St	Roselle St & Sorrento Valley Blvd	Fairmount Ave & Wightman St	Home Ave & Euclid St	Lemon Grove Ave & Broadway	Signals become longer later in the day on many routes/ Fixed routes need more time between timepoints to accomdate ADA issues.
16	851	83	965	88			Sweetwater Rd & Jamacha Rd	Spring St & La Mesa Blvd				x	x	x	x	x	x					x	x				x								
17	965	833	916				Home Ave & Fairmount Ave	Landis St & Fairmount Ave	Bradley Ave & Graves Ave	Fletcher Pkwy & Graves Ave	Myrtle Ave & Fairmount Ave	x	x	x	x	x			x				x				x										
18	921	944	833	832	964		Mira Mesa Blvd & Westview Pkwy	Mira Mesa Blvd & Camino Ruiz	Westview Pkwy & Hillery Dr	Bradley Ave & Graves Ave	La Jolla Village Dr & Villa La Jolla Dr	x			x	x	x	x				x	x				x	Health Center Dr & Mesa College Dr	Copley Park Pl & Copley Dr							
19	14	945					Alvarado Rd & 70th St	Alvarado Rd & College Ave	Rancho Bernardo Rd & West Bernardo Dr	Rancho Bernardo Center Dr & Rancho Bernardo Rd		x	x	x	x	x				x		x					x						Pomerado Rd & Colony Dr	Pomerado Rd & Glenoak Rd		Boarding and alighting delays due to large number of wheelchair passengers and big groups of passengers with special needs
20	25						Fryers Rd & Ulric St	Genesee Ave & Linda Vista Rd	Health Center Dr & Mesa College Dr	Clairemont Mesa Blvd & Ruffin Rd			x	x	x	x						x					x						Fashion Valley Transit Center	Aero Drive & Corporate Ct		
21	964	851	27	945	921	864	Mira Mesa Blvd & Camino Ruiz	Camino Ruiz & Gold Coast Dr	Black Mountain Rd & Gold Coast Dr	Sweetwater Rd & Blossom Ln		x	x		x	x				x			x				x						Miramar College Transit Station	El Cajon Transit Center	Mira Mesa & Camino Ruiz	
22	833	115	946	964	84	945	Mira Mesa Blvd & Camino Ruiz	Copley Park Pl & Convoy St	Mira Mesa Blvd & Westview Pkwy	Black Mountain Rd & Camino Ruiz	Camino Ruiz & Gold Coast Dr	x											x				x								
23	88						Taylor St & Congress St	Hotel Circle and Fashion Valley Rd				x			x				x							x			Taylor St & Congress St						

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24	142	88					El Cajon Blvd & 70th St	Montezuma Rd & College Ave				x	x	x							x		x				x	x								Route 25 needs to be loocked at, some bust stops need to be removed and or relocated.
25	14						Alvarado Rd & College Ave	El Cajon Blvd & 70th St	Alvarado Rd & 70th St	Montezuma Rd & College Ave		x	x	x	x	x							x			x										
26	944	84	864				Poway Rd & Community Rd	Poway Rd & Pomerado Rd	Rosecrans St & Canon St			x	x	x			x			x			x			x										Experience delays at transit stations.
27	945	83	854	965	88	18	Home Ave & Fairmount Ave	Mira Mesa Blvd & Black Mountain Rd	Kettner Blvd & Broadway	Twin Peaks Rd & Pomerado Rd	Rancho Bernardo Rd & Bernardo Center Dr	x	x	x	x	x	x			x			x				x				Fashion Valley Transit Center	America Plaza	University & I-15	Route 965 always 10-20 minutes behind schedule because of University Ave traffic. Never enough time to take a break to use the restroom.
28	921	944	945	833			Genesee Ave & La Jolla Village Dr	Poway Rd & Pomerado Rd	Bernardo Dr & Rancho Bernardo Rd						x	x	x	x		x														
29	18	14	921				Alvarado Rd & 70th St										x						x			x			Garnet Ave & Mission Bay Dr	Marbury Rd & Mira Mesa Blvd					Boarding and alighting at Marbury Rd and Greenford Drive is a challenge when traveling westbound due to traffic in curb lane. Also difficult to move over three lanes before stop at Westonhill.
30	964	115	872				Camino Ruiz & Gold Coast Dr	Johnson Ave & Chase Ave					x	x	x	x	x					x	x				x								
31	870	833	945	27	115	872	Poway Rd & Pomerado Rd																												
32	18	14					Alvarado Rd & 70th St	Alvarado Rd & I-8				x	x	x	x	x					x			x			x									
33	929	932	934				Main St & 32nd St	Highland Ave & 30th St	National City Blvd & 8th St	Saturn Blvd & Palm Ave			x	x	x					x			x				x			Palm Ave & Hollister St						Lots of students board/alight at Palm Ave and Hollister on 932 Route
34	701	704	705	707	709	712	Woodlawn Ave & H St	Broadway & H St	Otay Lakes Rd & La Media Rd	Telegraph Canyon Rd & Oleander Ave	Broadway & E St				x	x				x			x				x				Third Ave & H St			

Bus Operator Survey Responses

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35	955	932	901				Palm Ave & Saturn Blvd	Imperial Ave & 47th St	Euclid Ave & Naranja St	Broadway & Oxford St	National City Blvd & South Bay Fwy	x			x	x				x			x				x						Palm Ave & Saturn Blvd			
36	712	929	907	906	933	934	Palm Ave & Hollister St								x	x							x				x		Palm Ave & Hollister St						
37	901	967	992	28	929	905	El Cajon Blvd & Fairmount Ave					x		x												x									
38	955	923					Euclid Ave & Market St					x	x	x	x									x			x		University Ave & 4th Ave			C St & 5th Ave			
39	901	967	992	929	905	28	El Cajon Blvd & 54th St					x				x			x						x									
40	709						Broadway & H St	Woodlawn Ave & H St						x	x	x				x			x				x									
41	934	901	904				Saturn Blvd & Coranado Ave	Palm Ave & 9th St	Orange Ave & Third Ave	Orange Ave & 4th Ave		x			x	x							x					x				Palm Ave Trolley Station			
42	3	901					Market St & 25th St					x	x	x	x					x														Lots of wheelchairs and elderly passengers on route 3
43	3	916	5				Market St & 25th St	Imperial Ave & 47th St	Broadway & Palomar St	Palm Ave & Saturn Blvd	Highland Ave & 30th St	x	x	x	x	x				x			x				x									
44	704	712					Telegraph Canyon Rd & Oleander Ave	Palomar St & Third Ave				x				x				x							x									
45	704	712					Olympic Pkwy & Brandywine Ave	Palomar St & La Media Rd	Orange Ave & Hilltop Dr			x	x	x	x	x				x							x				Hilltop Dr & H St						
46	1	5	905	933	955	901	Palm Ave & Saturn Blvd	Palm Ave & Hollister St	Orange Ave & Third Ave	Market St & Euclid Ave	Imperial Ave & Euclid Ave					x	x			x	x		x					x	x	Rosecrans St & Midway Dr						
47	709	701	712	704			Olympic Pkwy & Palomar St	Olympic Pkwy & Eastlake Pkwy	Hilltop Dr & H St					x					x							x						Third Ave & H St				
48	916	3	929				Ocean View Blvd & 35th St	Commerical St & 25th St	Market St & 25th St	Market St & 5th Ave	Naranja St & Euclid Ave	x	x	x	x	x					x			x			x		x			Highland Ave & 30th St	Highland Ave & Plaza Blvd	National City Blvd & 8th St	Park & Market Trolley Station	C St & 5th Ave	Imperial & 12th Troley Station	
49	27	928	3	5	28		C St & 5th Ave	Rosecrans St & Midway Dr	University Ave & 5th Ave						x																			
50	905	950	955	933	934		Siempre Viva Rd & Drucker Ln	Hollister St & Iris Ave	Hollister St & Coronado Ave					x		x					x			x			x									
51	701	709					Woodlawn Ave & H St	Broadway & H St	Otay Lakes Rd & Telegraph Canyon Rd			x	x	x	x	x								x			x		Hilltop Dr & I St	Hilltop Dr & Palomar St						
52	923	936	929	933	28																													
53	5	3	1	929	933	905	Main St & Broadway					x		x		x	x			x			x				x				Imperial Ave & 12th Ave			Siempre Viva Rd			
54	907	929	955				Highland Ave & 30th St	National City Blvd & 8th St	Via De San Ysidro & Calle Primera	Yama St & Main St	Palm Ave & Beyer Way	x	x	x	x	x					x			x			x				Mira Mesa Blvd & Black Mountain Rd	Palm Ave & Saturn Blvd	Siempre Viva Rd & Drucker Ln	C St & 5th Ave	Hollister St & Palm Ave	Palm Ave & Saturn Blvd	
55	704	712	709				Olympic Pkway & Brandywine Ave	Otay Lakes Rd & Elmhurst St	Medical Center Dr & Telegraph Canyon Rd	Melrose Ave & Orange Ave	Orange Ave & Palomar St	x	x	x	x	x					x			x			x				Eastlake Pkwy & Olympic Pkwy	Eastlake Pkwy & Otay Lakes Rd	Eastlake Pkwy & Fenton St				

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56	916	3	962	963			Commercial St & 25th St	Plaza Blvd & Harbor Dr				x				x					x		x			x									
57	3	1	901	5			Market St & 25th St	Commerical St & 25th St				x	x	x	x	x	x	x			x				x										
58	3	5	916	962	63		Market St & 25th St	Commerical St & 25th St				x	x	x	x	x				x	x		x	x			x									
59	1						El Cajon Blvd & Park Blvd	University Ave & Park Blvd	Allison Ave & Spring St			x	x	x	x	x					x				x		x										
60	709	707	701				Eastlake Pkwy & Clubhouse Dr	H St & 1st Ave	Broadway & H St			x	x	x	x	x	x			x			x															
61	906	907	929				Highland Ave & 30th St	H St & 3rd Ave				x	x	x	x					x			x				x										
62	929	932	933	934	901	905	Broadway & Palomar St	Broadway & 11th Ave	F St & 3rd Ave			x				x	x	x		x		x	x				x						Palm Ave Trolley Station	Iris Ave & 27th St		
63	701	704	712				Olympic Pkway & Brandywine Ave	Hilltop Dr & H St	H St & 4th Ave	Broadway & E St		x	x	x	x	x	x			x			x				x										
64	921	962	963	907			Genesee Ave & La Jolla Village Dr	Broadway & 11th Ave				x	x	x	x	x	x	x		x			x				x					H St & 3rd Ave				
65	901	906	929	933	934	932	G St & 11th Ave	Palm Ave & Hollister St						x	x	x	x						x	x		x							12th St & Imperial Ave	City College		
66	704	709					Naples St & 3rd Ave	Hidden Vista Dr & H St	Eastlake Pkwy & Otay Lakes Rd			x	x	x									x			x	x					H St & 3rd Ave	Southwestern College	K St & 4th Ave	
67	933	907	910	929			Palm Ave & Saturn Blvd	Palm Ave & Dennery Rd	Main St & Vesta St	Orange Ave & 4th St		x	x	x	x				x			x	x			x									
68	905	910	923	933	907		Palm Ave & Saturn Blvd					x	x	x	x								x		x											
69	901	932	933	934	906	929	Palm Ave & Hollister St	College Ave & Montezuma Rd				x	x	x	x	x								x			x						Palm Ave & Hollister St			
70	709	904	929	901	906	992												x				x	x				x								
71	921	923					Mira Mesa Blvd & Black Mountain Rd	Rosecrans St & Nimitz Blvd				x	x	x	x	x											x										
72	929	901	3				Broadway & Main St					x	x	x	x	x	x	x					x			x										
73	923	3	27	928			Murphy Canyon Rd & Aero Dr					x	x	x	x	x			x				x			x	x		Orange Ave & 4th St	Orange Ave & 3rd St	Palm Ave & Saturn Blvd					
74	709						Broadway & H St	Otay Lakes Rd & H St	Woodlawn Ave & H St			x			x					x			x			x									
75	701	712	709				Hilltop Dr & H St						x		x					x						x						H St & 3rd Ave	Palomar St & 3rd Ave		
76	701	704	712	709	705		Olympic Pkwy & Brandywine Ave	Main St & Melrose Ave	Palomar St & La Media Rd			x	x	x	x						x						x									
77	929	901	906				Highland Ave & 8th St	Beyer Blvd & Coronado Ave	Beyer Blvd & San Ysidro Blvd	Willow Rd & San Ysidro Blvd	Orange Ave & 3rd St	x	x	x	x	x				x			x					x				F St & 3rd Ave	H St & 3rd Ave	12th St & Imperial Ave	
78	916	3					Ocean View Blvd & 35th St	Broadway & 5th Ave	Market St & 6th Ave	Washington St & 4th Ave	Washington St & 1st Ave	x	x	x	x	x				x						x					Imperial Ave & 47th St	Imperial Ave & 50th St	Collwood Blvd & Montezuma Rd	Broadway & 5th Ave	C St & 5th Ave		

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79	963	962	955				Plaza Blvd & Palm Ave					x			x	x			x	x		x	x			x									
80	709						Woodlawn Ave & H St	Otay Lakes Rd & H St	Otay Lakes Rd & Elmhurst St			x	x	x	x	x						x				x										
81	923	934	933	929	905	906	Highland Ave & 8th St	Iris Ave & Howard Ave	Plaza Blvd & Highland Ave	Voltaire St & Sunset Cliffs Blvd		x	x	x	x	x							x			x								Broadway & 1st Ave			Please put more stops after traffic lights, not before them.
82	709						Woodlawn Ave & H St	Otay Lakes Rd & H St				x	x	x	x	x							x				x							Otay Lakes Rd & H St	Southwestern College		
83	901	950	905	932	929	701	Palm Ave & Saturn Blvd					x	x	x	x	x					x			x			x								
84	955	961	962	28	35		Rosecrans St & Midway Dr	Point Loma Blvd & Nimitz Blvd	Point Loma Blvd & Sunset Cliffs Blvd	Imperial Ave & 47th St	Euclid Ave & Market St	x	x	x	x	x							x					x									
85	580	906	907				Via De San Ysidro & San Ysidro Blvd						x	x											x				x							
86	901	933	961	968								x	x	x	x	x					x				x									
87	905	906	907	933	1		Palm Ave & Saturn Blvd					x	x	x	x	x	x	x						x										Palm Ave Trolley Station			
88	709	712	704				Otay Lakes Rd & Elmhurst St	Otay Lakes Rd & Telegraph Canyon Rd	Orange Ave & Melrose Ave							x				x			x			x										
89	929	906	907	712	704	705	Main St & Vesta St					x	x	x	x	x				x								x							
90	992	901	929				Main St & Vesta St	Palm Ave & 9th St				x	x	x	x	x	x	x			x			x			x									
91	115	815	874	448	864		Main St & Marshall Ave					x	x	x	x	x				x			x			x										
92	280	856	936	832			Hale Ave & Tulip St					x	x							x							x							Lemon Grove Trolley Station			
93	848	874	875	872	815	115	Fletcher Pkwy & Pioneer Way	Fletcher Pkwy & Magnolia Ave	Broadway & Ballantyne St	Broadway & Mollison Ave		x	x	x	x	x						x	x			x				Broadway & Main St	Broadway & 2nd Ave		Broadway & Mollison Ave			
94	874	875	864	872	871	115	El Cajon Blvd & Douglas Ave	Fletcher Pkwy & Johnson Ave	Main St & Claydelle Ave	Broadway & Main St		x	x	x	x	x	x			x	x			x				x							
95	864	872	871	874	875	816	Main St & Claydelle Ave	Chase Ave & Johnson Ave				x		x					x	x			x			x					Washington Ave & Johnson Ave			Magnolia Ave & Douglas Ave			
96	848	115	815	874			Broadway & Main St	Main St & Claydelle Ave	El Cajon Blvd & Douglas Ave			x	x	x	x	x					x					x										
97	864	874	856				Main St & Marshall Ave	Highway 8 Business & Los Coches Rd				x	x			x	x		x			x				x							Lexington & Ivory Ave			
98	115	815	871	874	875	290	Lexington & Jamacha Rd	Main St & Broadway	Broadway & 4th Ave	Pacific Hwy & Cedar St	Pacific Hwy & Broadway	x	x	x	x	x				x			x			x								

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99	280	290	115	836	936	864	Broadway & Ballantyne St	Broadway & 2nd Ave	Washington Ave & Magnolia Ave	Arnele Ave & Johnson Ave	Broadway & Main St	x	x	x	x	x				x						x			Marshall Ave & Palm Ave			Broadway and Anza St			
100	874	875	848	936	856		Main St & Claydelle Ave	Main St & 2nd St					x				x			x				x				Marshall Ave & Main St	Broadway & Main St					
101							Madison Ave & 2nd St	Fletcher Pkwy & Grossmont Center Dr				x	x	x	x	x	x	x	x	x	x						x									
102	290	871	864				Madison Ave & 2nd St	Broadway & 2nd St	Hwy 8 Business & Los Coches Rd	El Cajon Blvd & Washington Ave	Washington Ave & Johnson Ave		x	x	x	x	x		x				x				x	x			Broadway & 1st St			2nd St & Madison Ave	2nd St & Marline Ave		
103	936	855	280	290			Campo Rd & Bancroft Dr	Campo Rd & Spring St	4th Ave & Broadway							x				x			x			x				Douglas Ave & El Cajon Blvd			College Ave & Adelaide Ave			
104	816	290	280				El Cajon Blvd & Main St	Main St & Marshall Ave	Main St & Mollison Ave	4th Ave & Broadway		x	x	x	x	x	x			x			x			x				4th Ave & Broadway						Traffic on Broadway and 4th causing gridlock at peak hours.
105	290	856	854				Main St & Marshall Ave					x			x					x			x			x									
106	864	871	872	280	290		Calavo Dr & Doubletree Rd	Jamacha Rd & Cuyamaca College Dr	Jamacha Rd & Main St	Magnolia Ave & Douglas Ave		x	x	x	x	x				x			x			x			4th Ave & Broadway	3rd Ave & Broadway	5th Ave & Broadway				Broadway Downtown should have lights turn green together and stay green longer.
107	815	816	290	115			Broadway & Main St	2nd St & Madison Ave	Claydelle Ave & Main St	4th Ave & Broadway	College Ave & Montezuma Rd	x	x		x					x			x			x				El Cajon Blvd & Douglas Ave	Magnolia Ave & Douglas Ave		Sabre Springs			
108	864	871	874	854	290		Broadway & 1st St	Claydelle Ave & Magnolia Ave	Fletcher Pkwy & Baltimore Dr	Washington Ave & Anza St	Washington Ave & Marshall Ave	x	x	x	x	x					x		x			x			Broadway & Main St						
109	280	290					Tulip St & Hale Ave					x	x	x					x							x			Magnolia Ave & Douglas Ave	Calavo Dr & Doubletree Rd	Claydelle Ave & Main St	Broadway & Mollison Ave			
110	848	816	815	864	856	936	Fletcher Pkwy & Johnson Ave	Broadway & Main St	Lexington Ave & Jamacha Rd			x	x	x	x	x	x			x				x										
111	856	936	848	871	872	115	Claydelle Ave & Main St	Magnolia Ave & Douglas Ave	College Ave & Montezuma Rd			x	x								x			x			x								
112	874	875	871	872	115	815	Fletcher Pkwy & Johnson Ave	Lexington Ave & Jamacha Rd	Broadway & Ballantyne St	Douglas Ave & El Cajon Blvd	Chase Ave & Johnson Ave	x	x	x	x	x	x			x			x			x			Broadway & Main St						
113	815	115					Jackson Dr & Navajo Rd	College Ave & Montezuma Rd				x				x				x			x				x		College Ave						
114	936	855	115	815			College Ave & Montezuma Rd	Broadway & Main St	College Ave & College Drove Dr			x	x	x	x	x					x			x				x	Johnson Ave & Arnele Ave	Broadway & Ballantyne St	Claydelle Ave & Main St	SDSU	Spring Street Trolley Station		We need the "T" lights.

Bus Operator Survey Responses

Response	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
115	874	871	872	115	815	816	Broadway & Ballantyne St	Magnolia Ave & Douglas Ave	Lexington Ave & Jamacha Rd	Douglas Ave & El Cajon Blvd		x	x	x	x	x				x						x										
116	856	115	815	864	874		Broadway & Ballantyne St	Ballantyne St & Madison Ave	Main St & Greenfield Dr	Jackson Dr & Lake Murray Blvd	College Ave & Montezuma Rd	x	x	x	x	x				x						x					Broadway & Main St						
117	115	815	871	875	874	888	Broadway & Main St	Claydelle Ave & Main St	College Ave & Montezuma Rd	Campanile Dr & Montezuma Rd		x	x	x	x	x	x	x						x							College Ave & Navajo Rd	College Ave & Montezuma Rd						
118	934	854	836				Broadway & Main St	Sweetwater Rd & Jamacha Rd	Main St & Jamacha Rd	College Ave & Montezuma Rd		x	x	x	x	x					x			x														
119	815	115	864				Main St & Mollison Ave	Madison Ave & 2nd St	2nd St & Oakdale Ln	College Ave & Montezuma Rd		x	x	x	x	x					x			x									Main St & 2nd St	Main St & Anza St		
120	816	856	936	864			Claydelle Ave & Main St						x	x							x			x							Grove St & Broadway			Grove St & Broadway			
121	856	936					College Ave & Montezuma Rd	College Ave & College Grove Dr				x	x	x	x	x				x			x				x							College Ave & El Cajon Blvd			
122	874	848	871	872	815	816	Lexington Ave & Jamacha Rd	Broadway & Ballantyne St	Douglas Ave & El Cajon Blvd	Chase Ave & Johnson Ave	Magnolia Ave & Douglas Ave	x	x	x	x	x				x			x			x										
123	856	3	855				College Ave & College Drove Dr					x	x	x	x	x					x		x										Broadway & Graves Ave			Broadway & Main St			
124	874	856	864	815	115		Claydelle Ave & Main St	Fletcher Pkwy & Cuyamaca St	Broadway & Main St			x	x	x	x	x				x				x				x					El Cajon Blvd & College Ave			
125	871	874	875	816	864	936	Jamacha Rd & Sweetwater Rd					x	x	x	x	x					x		x				x					Broadway & Main St			
126	864	871	872	874	875	815	Greenfield Dr & Main St	Fletcher Pkwy & Johnson Ave	Lexington Ave & Jamacha Rd			x	x	x	x	x				x			x				x									
127	848	874	875	872	115	815	Fletcher Pkwy & Pioneer Way	Broadway & Ballantyne St	Maine Ave & Mapleview St					x	x	x					x		x			x						Broadway & Mollison Ave	Broadway & Ballantyne St	Parkway Plaza	
128	816	280					Main St & Marshall Ave					x	x	x	x	x					x			x												
129	815	115					Claydelle Ave & Main St	Jackson Dr & Lake Shore Dr	College Ave & Montezuma Rd			x	x	x	x	x					x			x			x		Jamacha Rd & Cuyamaca College Dr			Grossmont College	College Ave & Lindo Paseo		Thanks for asking the driver's input.
130	936	964	834	854	871	872	Broadway & Lemon Grove Way	Claydelle Ave & Main St	College Ave & College Drove Dr	Fletcher Pkwy & Main St	Jamacha Rd & Cuyamaca College Dr	x	x	x	x	x				x			x				x									
131	854	848	815	874	115	856	Douglas Ave & El Cajon Blvd	Broadway & Main St	Calavo Dr & Jamacha Rd			x	x	x	x	x					x			x		x										
132	280	856	936	864	854	115	College Ave & Montezuma Rd	Sweetwater Rd & Jamacha Rd	College Ave & Streamview Dr	Broadway & Lemon Grove Way	Broadway & Massachusetts Ave	x	x	x	x	x	x	x			x			x		x					Broadway & Main St				I recommend a trial basis for high traffic areas.

Bus Operator Survey Responses

Response	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
133							Claydelle Ave & Main St	Jamacha Rd & Cuyamaca College Dr	Jamacha Rd & Willow Glen Dr	Jamacha Rd & Chase Ave		x	x	x	x	x					x			x			x										*Driver reported driving all routes. Need more lighting on the 864 inbound and out.
134	115	815	864				Claydelle Ave & Main St					x	x	x	x	x			x			x					x			Jamacha & Lexington Ave						
135	871	872	874	816			Magnolia Ave & Douglas Ave	Claydelle Ave & Main St				x	x	x	x	x				x				x		x									Wheelchairs cause a lot of delay.
136	875	115	815	290	280		Main St & Marshall Ave	Broadway & Main St	College Ave & University Ave			x	x	x	x	x			x			x					x									
137	816	815	115	290			Jamacha Rd & Cuyamaca College Dr	Broadway & Main St	Marshall Ave & Palm Ave	Douglas Ave & El Cajon Blvd	College Ave & Montezuma Rd	x	x	x	x	x					x			x				x										
138	816	815					Douglas Ave & El Cajon Blvd	Jamacha Rd & Cuyamaca College Dr				x	x	x	x	x					x			x					2nd St & Madison Ave							
139	864	871	872				Hwy 8 Business & Los Coches Rd					x	x	x	x	x				x			x			x			College Ave & Montezuma Rd							
140	115	848	815				Main St & Ballantyne St					x	x	x	x	x					x			x				x				Grossmont College			
141	848	864	815				Main St & Marshall Ave	Claydelle Ave & Main St				x	x	x	x	x			x								x								
142							Calavo Dr & Jamacha Rd	College Ave & Montezuma Rd	Broadway & Lemon Grove Way	Madison Ave & 2nd St	Sweetwater Rd & Jamacha Rd	x	x	x	x	x					x					x			Cuyamaca St & Mission Gorge Rd	Fletcher Pkwy & Cuyamaca St	Jamacha Rd & Campo Rd	Cuyamaca College Dr & Jamacha Rd	Jamacha Rd & Cuyamaca College	Jamacha Rd & Gillespie Dr	*Driver reported driving all routes.
143	11	4					National Ave & 28th St	Market St & 5th Ave	Montezuma Rd & 55th St			x	x	x	x	x							x											Heavy traffic along 55th St. Sometimes tripper does not show at 12th St & Imperial.
144	120	6					Mesa College Dr & Health Center Dr	Linda Vista Rd & Genesee Ave	Camino De La Reina & Mission Center Rd			x	x	x	x	x							x			x					University Ave & 5th Ave	5th Ave & C St	Linda Vista Plaza	
145							Genesee Ave & La Jolla Village Dr	Gilman Dr & Russell Ln	Mira Mesa Blvd & Black Mountain Rd	Clairemont Mesa Blvd & Convoy St		x	x	x			x	x			x					x						Gilman Dr & Myers Dr	Linda Vista Plaza		*Driver reported driving all routes.
146							Genesee Ave & La Jolla Village Dr	1st Ave & Broadway	Regents Rd & Nobel Dr			x	x	x	x	x								x								University Ave & 5th Ave		Fairmount Ave & University Ave	*Driver reported driving all routes.
147	13	235	41	6			Fairmount Ave & University Ave					x				x				x			x			x						Fairmount Ave & University Ave			Fairmount Rd southbound there is a tree hanging out 12 feet into lane 2.

Bus Operator Survey Responses

Response	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
148	20						Clairemont Mesa Blvd & Ruffin Rd					x	x	x	x	x				x							x									
149	41						Fairmount Ave & University Ave	La Jolla Village Dr & Villa La Jolla Dr				x	x	x	x	x	x				x							x						Fashion Valley	Mira Mesa College		
150	8	9	44	150	202	11	Sports Arena Blvd & Rosecrans St	Linda Vista Rd & Genesee Ave	Gilman Dr & Myers Dr	University Ave & 40th St		x	x	x	x	x	x	x				x					x						Old Town Transit Center	Gilman Dr & Myers Dr	12th St & Imperial Trolley Station	
151	41	201	204				Nobel Dr & Towne Centre Dr	Judicial Dr & Golden Haven Dr	Balboa Ave & Genesee Ave	Nobel Dr & La Jolla Village Square Driveway		x					x	x						x		x				1st Ave & Broadway			Gilman Dr & Myers Dr			Relief is often late, causing me to start late.
152	235						5th Ave & Broadway	6th Ave & Broadway	Kettner Blvd & Broadway					x	x					x			x				x				Highland Ave & 18th St			Fairmount Ave & University Ave			GPS/Radio issue says I'm late when I'm actually a minute early on University & El Cajon Blvd
153	41						Balboa Ave & Genesee Ave					x	x	x	x	x					x						x									
154	2	4	7	11	13	20	Genesee Ave & La Jolla Village Dr					x	x	x	x	x	x	x	x				x				x						Gilman Dr & Myers Dr			Passengers sually cause delay with fare issues and disputes.
155	2	31	105	8	9	13	University Ave & 30th St					x	x	x	x	x	x	x					x								El Cajon Blvd & 30th St	30th St & University Ave		City College			We need T lights at 30th St & University
156	44	120	2	110	237	30	Linda Vista Rd & Genesee Ave	Clairemont Mesa Blvd & Genesee Ave	Clairemont Mesa Blvd & Convoy St	Balboa Ave & Convoy St	Convoy St & Aero Dr				x	x	x	x		x				x				x				Fashion Valley Rd & Friars Rd	University Ave & 30th St					Need to trim fern trees on 30th St and Upas.
157	30	8	9	120	41	50	Genesee Ave & La Jolla Village Dr	Torrey Pines Rd & La Jolla Shores Dr	Nobel Dr & La Jolla Village Square Driveway	10th Ave & C St	Starling Dr & Health Center Dr	x	x		x	x	x	x					x					x						Old Town Transit Center	UTC	UCSD	
158	2	4	6	7	8	9	1st Ave & Broadway	Park Blvd & Broadway				x	x	x	x	x					x		x								La Jolla Village Dr & Executive Way			5th Ave & C St			For route 237, it would be great to have a shared bus/bike lane along Mira Mesa Blvd (or at least portions of it).
159							Genesee Ave & La Jolla Village Dr					x	x	x	x	x							x					x						2nd Ave & Elm St	City College		*Driver reported driving all routes.
160							12th Ave & Imperial Ave					x	x	x	x	x				x			x					x									*Driver reported driving all routes.

Bus Operator Survey Responses

	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
Response	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
161	44	30										x	x	x	x	x				x			x				x				Santa Fe Depot			*Driver reported driving all routes. Delays and dangerous conditions as people illegally park in front of the bus stop. Passenger pick up at Santa Fe is a problem.
162	201	8	9	30	150	50							x			x	x	x		x			x											Who ever makes the schedule doesn't realize there is traffic.
163	235	237					Mira Mesa Blvd & Black Mountain Rd	Mira Mesa Blvd & Scranton Rd	Genesee Ave & La Jolla Village Dr	La Jolla Village Dr & Villa La Jolla Dr		x	x	x	x	x				x							x										All stops along Clairemont Mesa Blvd are well spaced, however, there is a significant wait time at each light that makes the bus 5 or more minutes late. Turn signal is too short for the bus to make it across safely on Black Mountain Rd in Mira Mesa.
164	7						1st Ave & Broadway					x	x	x	x	x				x			x				x				University Ave & 30th St	University Ave & College Ave		Fairmount Ave & University Ave			
165	235	41					Friars Rd & Fashion Valley Rd					x	x	x	x	x							x				x									
166	13	7	20	30	150	235	1st Ave & Broadway	University Ave & 30th St	Clairemont Mesa Blvd & Convoy St	El Cajon Blvd & 30th St		x	x	x	x	x				x							x				Regents Rd & Nobel Dr	Fairmount Ave & University Ave		Smart Corner			
167							Park Blvd & Broadway	Genesee Ave & La Jolla Village Dr	Clairemont Mesa Blvd & Convoy St	1st Ave & Broadway		x	x	x	x	x								x			x								Mesa College	Gilman Dr & Myers Dr		*Driver reported driving all routes. At 1st and Broadway we need a walk light for pedestrians then a green for vehicles. The peds take up the entire green.

Bus Operator Survey Responses

Response	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
168	41						Genesee Ave & La Jolla Village Dr	Genesee Ave & Governor Dr	Balboa Ave & Genesee Ave	La Jolla Village Dr & Villa La Jolla Dr	Genesee Ave & Nobel Dr	x	x	x	x	x							x												Genesee Ave & Luigi Terrace	Friars Rd & Via De La Moda		On Veteran's Day I got my scheduled breaks noted on my schedule. On normal days I get no breaks.
169	44											x	x	x	x	x					x			x				x	Genesee Ave & La Jolla Village Dr			Mesa College			We need the T lights.
170	44	2	110	105								x	x	x				x		x		x					x					Limerick Ave			Cars don't let you merge over.
171							Genesee Ave & La Jolla Village Dr	Genesee Ave & Nobel Dr	Logan Ave & Euclid Ave			x	x	x	x	x	x	x			x			x			x							12th & Imperial			*Driver reported driving all routes.
172																					x			x										
173																					x			x										
174																					x			x										
175	235	201					Nobel Dr & La Jolla Village Square Driveway					x	x	x	x	x	x	x			x			x			x									Route 201 needs a T light at Nobel Dr and La Jolla Village Square
176	44	105	31				Genesee Ave & Nobel Dr	Genesee Ave & La Jolla Village Dr	Linda Vista Rd & Mesa College Dr			x	x	x	x	x				x			x			x							Old Town			
177							Garnet Ave & Mission Bay Dr	University Ave & Fairmount Ave					x	x	x						x			x			x							Old Town	University Ave & Fairmount Av		*Driver reported driving all routes.
178	202	41					Genesee Ave & La Jolla Village Dr					x	x	x	x	x					x						x									
179	201	235					Genesee Ave & La Jolla Village Dr	Voigt Dr & Campus Point Dr	Gilman Dr & Villa La Jolla Dr	Tulip St & Hale Ave		x	x	x	x	x					x			x					x		Balboa Ave & Genesee Ave	Clairemont Mesa Blvd & Genesee Ave	Black Mountain Rd & Genesee Ave	UCSD			I think this survery should be given out constantly to help make improvements.
180	235	44					Balboa Ave & Genesee Ave	Genesee Ave & La Jolla Village Dr	La Jolla Village Dr & Regents Rd			x	x	x	x	x				x			x			x			Park Ave & University Ave	1st Ave & Broadway		City College			T light needed at northbound Friars Rd after service stop.
181	235						Tulip St & Hale Ave	Broadway & Front St	Hillery Dr & Westview Pkwy	5th Ave & Broadway		x	x	x	x	x					x			x			x								EB Broadway doesn't get green until 1st Ave turns red. WB traffic gets green both at both lights.
182	2	20	120	4	7	11	Genesee Ave & Governor Dr	University Ave & 30th St	Park Ave & University Ave			x	x	x	x	x				x			x			x			Old Town	City College					
183	44	105										x	x	x	x	x	x	x		x			x			x		Genesee Ave & La Jolla Village Dr			Skyline Dr & Radio Rd	Skyline Dr & 61st St		Thanks for doing a survey.
184	150											x	x	x	x	x					x		x			x								

Bus Operator Survey Responses

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																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
185							Genesee Ave & La Jolla Village Dr					x	x	x						x			x			x				Broadway & Park Blvd			5th Ave & University Ave			Have turn signal lights stay green longer
186	7	20										x	x					x	x					x							City College			
187	50	235	41	20	30	13	Balboa Ave & Genesee Ave	Clairemont Mesa Blvd & Genesee Ave	Kettner Blvd & W Broadway			x	x	x	x	x					x			x					1st Ave & Broadway			City College	11th Ave & Broadway		
188	13	4					Fairmount Ave & El Cajon Blvd	Euclid Av & Unity Place Drwy	Fairmount Ave & Home Ave	Fairmount Ave & University Ave		x	x	x	x	x					x	x					x			University Ave & 5th Ave			Unity Place & Euclid Ave	Fairmount Ave & University Ave		
189	30	44					Pacific Hwy & Taylor St	Mission Bay Dr & Pacific Hwy	La Jolla Village Dr & Villa La Jolla Dr	Genesee Ave & La Jolla Village Dr		x	x	x	x	x					x			x				1st Ave & Broadway	Grand Ave & Ingraham St						
190	20	235	41				11th Ave and A St	Friars Rd & Fashion Valley Rd				x	x	x	x	x	x	x		x			x			x		University Ave & 30th Ave						Remove bus stop for route 20 at 11th and A st NB. T light at 11th and B st will make better merges into lanes.
191	215						Park Blvd & Broadway	11th Ave & C St				x	x	x	x	x					x			x			x				11th Ave & C St			
192	13						Fairmount Ave & Home Ave	University Ave & Fairmount Ave	Euclid Ave & Naranja St	Fairmount Ave & Thorn St		x	x	x	x	x	x	x			x			x			x				Fairmount Ave & University Ave			
193	215	4	11	30	10		Imperial Ave & Lisbon St					x	x	x	x	x	x	x			x			x			x							Regents Rd & Nobel Dr	Old Town		
194	10	7	11				1st Ave & Broadway	Fairmount Ave & University Ave	Park Ave & Broadway			x	x	x	x	x					x			x		x			Campanile Dr & Montezuma Rd			Fairmount Ave & University Ave	52nd St & University Ave		
195	6	150					Madison Ave & Texas St	Camino Del Rio & Texas St				x	x	x	x	x				x						x			Pacific Hwy & Taylor St			Gilman Dr & Myers Dr			
196	30	202					Genesee Ave & Nobel Dr	La Jolla Village Dr & Regents Rd				x	x	x			x				x		x			x			Genesee Ave & La Jolla Village Dr			VA Hospital	Gilman Dr & Myers Dr		
197							1st Ave & Broadway					x	x	x	x	x	x				x		x				x		Fairmount Ave & University Ave			Old Town	City College		*Driver reported driving all routes.
198	150	215					La Jolla Village Dr & Regents Rd	Park Ave & Broadway				x	x	x	x	x					x		x				x				La Jolla Village Dr & Regents Ave			
199	215						Park Blvd & University Ave	10th Ave & Broadway	Park Blvd & El Cajon Blvd			x	x	x						x		x				x						City College	SDSU	Park Blvd & University Ave	

Bus Operator Survey Responses

Response	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
200	4						Euclid Ave & Naranja St	47th St & Imperial Ave	68th St & Imperial Ave	Lisbon St & Imperial Ave		x	x	x	x	x				x			x					x	Euclid Ave & Naranja St			47th St & Imperial Ave			The trolley station is only 100 feet from the Euclid and Naranja bus stops, they should be eliminated.
201	10						University Ave & 30th St	University Ave & Broadway	University Ave & 47th St	Fairmount Ave & University Ave		x	x	x	x	x				x				x			x			1st Ave & Broadway	30th St & A St		Fairmount Ave & University Ave			
202	4											x	x	x	x	x					x			x				x	12th Ave & Imperial Ave						
203	150	7					Pacific Hwy & Rosecrans St	University Ave & 54th St	Mission Blvd & Grand Ave	Mission Blvd & Garnet Ave	Allison Ave & Spring St	x	x	x	x					x				x			x				City College	Fairmount Ave & University Ave	12th Ave & Imperial Ave	
204	110	8	9	2	11	20	Camino De La Reina & Qualcomm Way	Camino Del Rio S & Texas St				x	x	x	x	x					x			x				x	11th Ave & Broadway						Need to address no cash methods, it takes too much time.
205	120						4th Ave & E St								x					x					x						5th Ave & University Ave			
206	13	1					Fairmount Ave & Home Ave					x				x					x			x					Euclid Ave & Logan Ave			Fairmount Ave & University Ave			
207	12	7					College Ave & University Ave					x	x	x	x	x				x				x			x				11th Ave & C St			
208	7	215					Park Blvd & 12th Ave	11th Ave & Broadway				x	x	x	x	x								x			x					Fairmount Ave & University Ave	City College		
209	50	30					Pacific Hwy & Rosecrans St	Sea World Dr & Mission Bay Dr						x		x				x							x		Washington St & Pacific Hwy			Old Town	Mission Bay High School		
210	120	2	7				Kearny Villa Rd & Aero Dr	Aero Dr & Convoy St	Kearny Villa Rd & Balboa Ave	Starling Dr & Health Center Dr		x	x	x	x	x				x				x			x			Genesee Ave & La Jolla Village Dr			Park Ave & Broadway			
211							Fairmount Ave & 47th St					x	x	x	x	x				x				x			x					City College			
212	30						Herschel Ave & Silverado St	Torrey Pines Rd & La Jolla Shores Dr	Torrey Pines Rd & La Jolla Village Dr			x	x	x	x	x						x					x				Old Town	UCSD		
213							La Jolla Village Dr & Nobel Dr	Sports Arena Blvd & Rosecrans St				x				x							x				x				Gilman Dr & Myers Dr	Grantville Trolley Station		
214							Nobel Dr & Lebon Dr	University Ave & Albatross St				x	x	x	x	x							x	x							Old Town	UTC		
215							Broadway & 1st Ave	La Jolla Village Dr & Regents Rd	University Ave & 30th St	Genesee Ave & La Jolla Village Dr	Montezuma Rd & Campanile Dr	x	x	x	x	x				x	x			x	x		x				Broadway & 1st Ave			

Bus Operator Survey Responses

Response	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
216	30	10					Torrey Pines Rd & La Jolla Shores Dr					x	x	x	x	x							x				x			Mission Bay Dr & Grand Ave			Old Town	UCSD		
217	20	204	201	235			Clairemont Mesa Blvd & Overland Ave						x	x						x								x					City College	Fashion Valley		
218	4	7	11	13			Home Ave & Fairmount Ave	University Ave & Fairmount Ave				x	x	x	x	x				x							x			Imperial Ave & 16th St			National Ave & 38th St			
219	6											x	x	x	x	x	x	x			x			x										
220	309	311	315	446			El Camino Real & Marron Rd	El Camino Real & Camino Vida Roble					x	x	x					x						x										Answer to #6: Pretty much most intersections in Carlsbad, like Coast Hwy
221	313	318	101	309	303	315																												
222	311	332	302	306			Mission Ave & El Camino Real	Hwy 76 & Town Center Dr N	College Blvd & Hwy 76	El Camino Real & Oceanside Blvd		x	x	x	x	x	x	x			x			x				x	All of 101 & 309			N Santa Fe Ave & Bobier Dr			We need "TBS" system is best
223	303	302					Hwy 76 & Santa Fe Ave	Vista Village Dr & Santa Fe Ave	Town Center Dr & Hwy 76			x	x	x	x								x				x			Hwy 101 & Encinitas Blvd (SB)			Departing O'side Transit Center or departed loading zone, then courtesy pick-ups			
224	315	302	303				Emerald Dr & Vista Way	Olive Ave & Vista Way	El Camino Real & Vista Way			x	x	x	x	x								x				x						Oceanside Transit Center, Route 303			No time to connect with other buses
225	All of them						N Santa Fe Ave & Vista Village Dr	Hwy 76 & College Blvd	College Blvd & Oceanside Blvd	El Camino Real & Palomar Airport Rd	Carlsbad Blvd & Carlsbad Village Dr	x	x	x	x	x			x	x		x	x				x			Mission Ave & El Camino Real			Coast Hwy & Oceanside Blvd			
226							Hwy 76 & N Santa Fe Ave																													
227	302	303	315				Emerald Dr & N Vista Way	Vista Village Dr & Olive Ave	Douglas Dr & El Camino Real	College Blvd & Waring Rd/Barnard Ave	N Santa Fe Ave & Melrose Dr	x	x								x			x			x						Emerald Dr & N Vista Way			
228	118	203	303				Emerald Drive & Vista Way	Olve Ave & Vista Way	Mission Ave & El Camino Real	Canyon Dr & Mission Ave	Vista Way & Melrose Dr		x	x	x	x	x		x			x				x						Italia Way/Vista Way & Melrose Dr	Grapevine Rd & Vista Way		
229	305	308	354	351	352		Vista Rd & Sante Fe St	James Ave & Via de la Valle	Civic Center Dr & S Dante Fe Ave	Quince St & Mission Ave	Quince St & E Valley Pkwy	x	x	x	x	x	x	x			x			x		x			Escondido Blvd & E Valley Pkwy						
230	304	350					Quince St & Valley Pkwy	2nd Ave & Quince St	Center City Pkway & 2nd Ave	Melrose Dr & Rancho Santa Fe Rd	Palomar College - In & Out	x	x	x	x	x							x				x										

Bus Operator Survey Responses

Response	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
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231	Extra board, all in east, very few in west						Vista Transit Center RR xing	305 inbound to Escondido Transit Center Mission Ave/Quince St	305 East Palomar Transit Center	Exit Escondido Transit Center all		x	x	x	x	x	x			x			x			x											
232	354	352	351	350			Valley Pkwy & Quince St	Escondido Transit Center exit driveway				x	x	x	x	x				x			x			x					Fig St & Lincoln Ave	Mission Ave & Escondido Blvd	Washington Ave & Broadway	Beech St & Grand Ave (WB)	Date St & Grand Ave		Center City Pkwy to Escondido Transit Center, please put a dash line across Center City Pkwy to keep vehicles from drifting into dedicated bus lane
233	308	354	445	305			Bing Crosby Blvd WB					x	x	x												x								
234	388	305	350	351			2nd Ave & Escondido Blvd	Palomar College	Lake Wohlford Rd & Valley Center Rd						x	x	x						x			x						Vista Transit Center	North County Fair	Mary Lane	
235	305	354	332	351			Quince St & Mission Ave	Mission Ave & Ash St	Glenridge Rd & Bear Valley Pkwy	S Santa Fe Rd & Robelini Dr		x	x	x	x	x							x			x											
236	353	357					Palomar College	Mission Ave & Auto Pkwy				x	x	x	x	x							x			x										
237	355	354	305									x	x		x	x					x			x										
238	389																								x									
239	388	354	304	305			Palomar Airport Rd & Hwy 5	Rancho Santa Fe Rd & Hwy 78	Vista Transit Center	Citrus Ave & Glenridge Rd	Palomar College entrance		x	x	x	x	x				x			x			x			Right turn onto Washington Ave from Suince St	Broadway - Lincoln Ave						
240	334						Olive Ave	S Santa Fe Ave				x	x	x	x	x					x			x			x						W. Los Angeles Dr			On W. Los Angeles Dr most of the time there are cars parked in the bus stop and I can't pick up or drop off
241	350	356	351	352			Valley Pkwy & Center City Pkwy	Washington Ave & Center City Pkwy	Grand Ave & Valley Blvd	Escondido Blvd & Felicity Ave		x	x	x	x	x							x			x			Bear Valley Pkwy & Glenridge Rd						Keep Clear section at Escondido Transit Center
242	305	354	350	388			San Marcos Blvd & Mission Rd	Mission Rd & Palomar Transit Center	Center City Pkwy & Valley Pkwy	Santa Fe Ave & Buena Creek Station	Vista Transit Center & Santa Fe Ave	x	x	x	x	x			x	x		x	x				x											
243	389051	388051					Mission Ave & Center City Pkwy						x	x	x	x				x						x										

Bus Operator Survey Responses

Response	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
244	351	352	332				Quince St & Washington Ave (thru Ash St)	Sycamore Ave & La Mirada Dr (thru Thibodo Rd)	Melrose Dr & Park Center Dr (thru Live Oak Rd)	Melrose Dr & Sunset Dr (thru Hacienda Dr)	Vista Village Dr & Olive Ave	x	x	x	x	x						x	x				x			Mission Rd & Woodland Pkwy (thru San Marcos Blvd)	Vista Village Dr & S Santa Fe Ave		Washington Ave & Center City Pkwy	Washington Ave & Grape St	Washington Ave & Date St	Grand Ave & Valley Blvd and Grand Ave & Date St
245	308	350	352	351	356	305	Vista Village Dr & Santa Fe Ave	Hacienda Dr & Melrose Dr	Civic Center Dr & Vista Village Dr	College Blvd & Hwy 76	Sunset Dr & Bear Valley Pkwy	x	x	x	x	x				x			x				x						Civic Center Dr & Vista Village Dr			
246	332																																	
247	358051	352	351	354	302558	359	El Norte Pkwy (4 lights)	Washington Ave & Quince St (thru Broadway)	Auto Park Way & Mission Ave			x	x	x						x			x				x									
248	305061	350	308	305																															
249	350	354	351	352	356	305	Santa Fe Ave & Buena Creek Rd	Valley Pkwy & Quince St	Mission Rd & Palomar College			x	x	x	x	x					x			x				x									
250	305	302	350	356			Santa Fe Ave & Vista Village Dr, Vista, CA					x	x	x	x	x				x			x						x	Mission Ave & Ash St, Escondido, CA			Vista Village Dr & Santa Fe Ave, Vista, CA			
251	357	352	354	305	308	358	S Santa Fe Ave & Vista Way, Vista, CA	S Santa Fe Ave & Buena Creek Rd, Vista CA				x	x	x	x	x	x	x		x			x			x			Washington Ave & Quince St, Escondido, CA			Washington Ave & Grape St, Escondido, CA			
252	359																																	
253	All						All					x	x	x	x	x	x	x			x			x				x	All transit centers			All			
254	353						Quince St & Valley Pkwy, Escondido, CA	Auto Park way & Valley Pkwy, Escondido, CA	Nordahl Rd & Hwy 78 (EB ramps), San Marcos, CA	Nordahl Rd & Hwy 78 (WB ramps), San Marcos, CA	Mission Rd & Auto Park Way, Escondido, CA	x	x	x	x	x				x							x										
255	305	308	351	355	354		Valley Pkwy & El Norte Pkwy, Escondido, CA	El Norte Pkwy & Broadway, Escondido, CA	All Mission Road, Escondido, CA				x	x	x	x											x										
256	305	332	354	358	359		Vista Transit Center, Vista, CA	Buena Creek Rd, Vista, CA	Nordahl Rd, San Marcos, CA	Palomar College, San Marcos, CA		x	x	x	x	x					x			x			x	x		Escondido Transit Center, Escondido, CA	Vista Transit Center, Vista, CA	Palomar College, San Marcos, CA	All of them on route 305, especially school zones			
257	347	341	342				San Marcos Blvd & Bent Ave, San Marcos, CA					x	x	x	x	x									x										
258	350	304	351	305			Vista Transit Center, Vista, CA	2nd Ave & Center City Pkwy, Escondido, CA	Escondido Blvd & Sunset Dr, Escondido, CA	Valley Pkwy & Center City Pkwy, Escondido, CA	Mission Rd & Palomar College, San Marcos, CA			x	x	x				x			x				x										

Bus Operator Survey Responses

Response	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
259	All						Vista Village Dr & Olive Ave, Vista, CA	Bing Crosby Blvd & Del Dios Hwy	Buena Creek exit	Nordahl Rd & Mission Rd, Escondido, CA	Palomar College entrance, San Marcos, CA	x	x	x	x	x					x			x		x	x		Escondido Transit Center exit, Escondido, CA			347 - not enough time to load	305 - school kids cause major delays	305 - not enough time at Escondido Transit Center to unload/load	304 La Costa Canyon school trips
260	304	388	305				Santa Fe St & Vista Rd, Vista, CA	Mission Rd & Palomar College, San Marcos, CA				x						x					x			x								
261	332	347	345	305	308	350	Broadway & El Norte Pkwy, Escondido, CA	N Santa Fe Ave & Hwy 76, Oceanside, CA													x			x	x										
262	388	389	355	357	351	351																												
263	358	359	302	303	304	306																												
264	309																																	
265	356	325	352				Midway Dr & Valley Pkwy, Escondido, CA	Washington Ave & Quince St, Escondido, CA																	x						N Fig St & E Washington Ave, Escondido, CA				
266	351	352	305	354			Vista Transit Center & crossings, Vista, CA	Escondido Transit Center exit, Escondido, CA	Escondido Blvd & Valley Blvd, Escondido, CA	Washington Ave & Quince St, Escondido, CA	Center City Pkwy & Escondido Blvd, Escondido, CA	x	x	x	x	x							x	x			x									
267	305	351	352	347	308	355	N Ash St & E Lincoln Ave, Escondido, CA	E Valley Pkwy & El Norte Pkwy, Escondido, CA	N Santa Fe Ave & Vista Village Dr, Vista, CA	N Ash St & E Mission Ave, Escondido, CA	N Broadway & El Norte Pkwy, Escondido, CA		x	x	x	x				x			x				x			S Santa Fe Ave & Buena Creek Rd, Vista, CA	Via de la Valle & Paseo Delicias, Rancho Santa Fe, CA		E Washington Ave & Mills St, Escondido, CA	Washington Ave & Juniper St, Escondido, CA		Bushes and tree limbs block signs - hard to determine stops
268	354	358	359				Broadway & Hwy 78, Escondido, CA																												

Bus Operator Survey Responses

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																			AM (before noon)			PM (after noon)													
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269	350	351	352	356			Valley Blvd & Grand Ave, Escondido, CA					x	x	x	x	x							x			x			Center City Pkwy & E Valley Pkwy, Escondido, CA						Need improvement to 1st stop on Midway, south of Washington Ave (all dirt); long step down or up even when kneeled; How about a Keep Clear area on Quince St at Escondido Transit Center exit; sometimes it takes eight cycles to get on Quince
270	350	332	354	351	352	305	Quince St & Valley Pkwy, Escondido, CA	Washington Ave & Center City Pkwy, Escondido, CA	2nd Ave & Center City Pkwy, Escondido, CA	Quince St & 2nd Ave, Escondido, CA		x	x	x	x	x	x	x	x	x		x	x			x			N Santa Fe Ave & Vista village Dr, Vista, CA	Mission Rd & Knoll Rd, San Marcos, CA	Melrose Dr & Sycamore Ave, Vista, CA				
271	308																																	
272	305	308	350	351	352	353	N Santa Fe Ave & Vista Village Dr, Vista, CA	Mission Ave & Palomar College, San Marcos, CA	W Mission Rd & Nordahl Rd, Escondido, CA	Bear Valley Pkwy & Sunset Dr, Escondido, CA	Quince St & 2nd Ave, Escondido, CA	x	x	x	x	x	x	x			x			x		x						At high schools and middle schools			
273	354	355/357	356	358/359	388																													
274	308	305					W Mission Rd & Nordahl Rd, Escondido, CA	W Mission Rd & Palomar College, San Marcos, CA	N Santa Fe Ave & Vista Village Dr, Vista, CA			x	x	x	x	x							x					x									
275	388	354	304	445			Rancho Santa Fe Rd & Hwy 78	Palomar Airport Rd & I-5, Carlsbad, CA						x		x				x						x											
276	332	356	351				Sycamore Ave & Thibodo Rd, Vista, CA	Sycamore Ave & Shadowridge Dr, Vista, CA	Sycamore Ave & La Mirada Dr, Vista, CA	E Valley Pkwy & N Midway Dr, Escondido, Ca	N Broadway & E Washington Ave, Escondido, CA	x	x	x	x	x				x								x	Vista Village Dr & Vista Way, Vista, CA	Hacienda Dr & S Melrose Dr, Vista, CA	Park Cener Dr & S Melrose Dr, Vista, CA	Vista Transit Center	Escondido Transit Center		Most routes and trains in SD County don't connect with each other often enough
277	305	351	352	356			Santa Fe Dr & Vista Village Dr, Vista, CA	E Valley Pkwy & N Midway Dr, Escondido, CA	W Mission Rd & Auto Park Way, Escondido, CA	Grand Ave & Center City Pkwy, Escondido, CA	Valley Pkwy & Center City Pkwy, Escondido, CA	x	x	x	x	x				x							x			Vista Village Dr & Olive Ave, Vista, CA	Mission Rd & Palomar College, San Marcos, CA	Rancho Santa Fe Rd & San Marcos Blvd, San Marcos, CA				

Bus Operator Survey Responses

	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
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278	353	334					Valley Pkwy & Quince St, Escondido, CA	Valley Pkwy & Auto Park Way, Escondido, CA	Mission Rd & Auto Park Way, Escondido, CA	Nordahl Rd & Montiel Rd, San Marcos, CA	Vista Village Dr & Santa Fe Rd, Vista, CA	x	x	x						x						x							Nordahl Sprinter Station			The trash can outside Home Depot on 9th hasn't been cleaned out this entire bid. Passengers are complaining about the smell.
279	353						Valley Pkwy & Auto Park Way, Escondido, CA	Auto Park Way & Mission Rd, Escondido, CA	9th Ave & Valley Pkwy, Escondido, CA			x	x	x	x	x					x					x							9th Ave - Elderly with walkers	Escondido Transit Center		
280	301	302	303	306	311	318	Hwy 76 & College Blvd, Oceanside, CA	Hwy 101 southbound & northbound	Vista Village Dr intersection, Vista, CA	El Camino Real, Carlsbad, CA	La Jolla Village Dr, La Jolla, CA (VA/UTC)	x	x	x	x	x	x	x		x			x	x			x							Almost all of them			Nothing I or we could do anything about it. Just to be aware of surroundings and drive safely
281	325	392	395																															
282	309	303					Hwy 76 & College Blvd, Oceanside, CA	Hwy 76 & N. Santa Fe Ave, Oceanside, CA	Hwy 76 & Town Center Dr, Oceanside, CA			x	x	x	x	x				x			x	x				x							All delays are due to road construction
283	325																								x									
284	313001	309006	306005				309 - all of the lights								x	x										x									Detours on the 309; Detour 313 - having to pick up the 303 passengers
285	301	309	311	303	302		Emerald Dr & W Vista Way, Vista, CA	Encinitas Blvd & Hwy 101, Encinitas, CA				x	x	x	x	x	x						x			x	x						318 at Vista, route does not have enough break being the last stall and the bathroom is far away; no time			
286	302	315					Emerald Dr & W Vista Way, Vista, CA	Olive Ave & Vista Village Dr, Vista, CA	Oceanside Blvd & College Blvd, Oceanside, CA			x	x	x	x	x					x			x		x	x							Time point at Oceanside Blvd & Coast Hwy, Northbound blocking traffic
287	303	306	332				Melrose Dr & Olive Ave, Vista, CA																			x						Melrose Dr & Civic Center Dr, Vista, CA	Melrose Dr & Citrus Ave, Vista, CA	Sycamore Ave & Hibiscus Ave, Vista, CA	

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288	303	302	318				Mission Ave & Coast Hwy, Oceanside, CA	Oceanside Blvd, Oceanside, CA	College Blvd & Oceanside Blvd, Oceanside, CA	El Camino Real				x	x	x							x			x							El Camino Real			
289	303	302	101	309	306	332	El Camino Real & Marron Rd, Carlsbad, CA	Vista Transit Center & Village Drive, Vista, CA				x	x	x	x	x	x				x										W Vista Way & Vista Village Dr, Vista, CA			Mission Ave & El Camino Real, Oceanside, CA			
290	302	318	101	445	309	315	El Camino Real & Marron Rd, Carlsbad, CA	Genesee Ave & La Jolla Village Dr, La Jolla, CA	Faraday Ave & El Camino Real, Carlsbad, CA						x	x					x						x			Vista Transit Center & Village Dr, Vista, CA			309 NB El Camino Real & Mission Ave, Oceanside, CA			
291	303																																	
292	309	395	101	318	302	303	Vista Village Dr, Vista, CA	Camino Del Mar & 15th St, Del Mar, CA				x				x							x				x						309 La Costa Ave, La Costa, CA			
293	306																																	
294	311	315	302				Hwy 76 & Town Center Dr, Oceanside, CA	College Blvd & Town Center Dr, Oceanside, CA	Emerald Dr & W Vista Way, Vista, CA	El Camino Real	Vista Village Dr, Vista, CA	x	x										x				x				Emerald Dr & Vista Way, Vista, CA	El Camino Real & Vista Way, Vista, CA	Thunder Dr & Vista Way, Vista, CA	3 lights before crossing Emerald Dr stop	El Camino Real traffic heavy by hospital on Thunder Dr	Cyder stop on Vista Way, Vista, CA	Very busy - not just traffic, also human traffic. Lots of w/c's, slow seniors, lots of handicapped; lots of students. Very busy route, no breaks.
295																												Olive Ave & Vista Village Dr, Vista, CA	Vista Village Dr & Vista Way, Vista, CA	Miracosta College	Hwy 76 & Town Center Dr, Oceanside, CA (light won't change for a long time)			The lights early in the morning on College Blvd & Town Center Dr only lets one car through then it turns red; the light on Hwy 76 & Town Center Dr does not change unless a car pulls next to you
296	304	357					Hwy 78 & Rancho Santa Fe Rd, San Marcos, CA	S Santa Fe Rd & Descanso Ave, San Marcos, CA	Palomar College, San Marcos, CA						x	x					x					x									
297	325	356	352	351										x	x								x				x			E Valley Pkwy & N Midway Dr, Escondido, CA			Fig St & Washington Ave, Escondido, CA			
298	353052						Quince St & Valley Pkwy, Escondido, CA	Nordahl Rd & Hwy 78, San Marcos, CA				x	x	x	x	x				x						x										

Bus Operator Survey Responses

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																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
299	305	354	358	359	332		Vista Transit Center, Vista, CA	E Valley Pkwy & N Midway Dr, Escondido, CA	Las Posas Rd, San Marcos, CA	Buena Creek Rd, San Marcos, CA		x	x	x	x	x					x			x			x					Buena Creek Rd, San Marcos, CA	Vista Transit Center, Vista, CA		
300	354	352	351	350			Quince St & Valley Pkwy, Escondido, CA	Midway Dr & Bear Valley Pkwy, Escondido, CA	Midway Dr & Grand Ave, Escondido, CA			x	x	x	x	x			x			x			x										All boarding is slow because of old DCU and farebox. The only way to speed up the trip is to only count passengers.
301	Standby (all)						Quince St & Valley Pkwy, Escondido, CA	Escondido Blvd & Valley Pkwy, Escondido, CA	Mission Rd & Quince St, Escondido, CA	Palomar College, San Marcos, CA	Vista Transit Center, Vista, CA	x	x	x	x	x					x			x			x		Hwy 101 & Lomas Santa Fe Dr, Solana Beach, CA						
302	347	353					Las Posas Rd & Santa Fe Ave, San Marcos, CA					x	x	x	x	x							x						N Santa Fe Ave & Vista Village Dr, Vista, CA						
303	305	302	303	350	354	356	Vista Village Dr & Santa Fe Ave, Vista, CA	Nordahl Rd, Escondido, CA	San Pasqual Valley Rd, Escondido, CA	308 route		x	x	x	x	x				x			x				x	Vista Village Dr & Santa Fe Ave, Vista, CA			350 route			
304	351	352	332				Washington Ave & Quince St through Ash St, Escondido, CA	Sycamore Ave & University Dr, Vista, CA	Melrose Dr & Sycamore Ave thru Cannon Rd, Vista, CA	Melrose Dr & Sunset Dr through Hacienda Dr, Vista, CA	Vista Village Dr & Hwy 78 through Olive Ave, Vista, CA	x	x	x	x	x							x				x	Quince St & Washington Ave, Escondido, CA	Washington Ave & Center City Pkwy, Escondido, CA	Washington Ave & Broadway, Escondido, CA	Washington Ave & Grape St, Escondido, CA	Washington Ave & Valley Pkwy, Escondido, CA	Grand Ave & Valley Blvd, Escondido, CA	
305																												Washington Ave & Ash St, Escondido, CA						
306	305	308	303	301	318	351	Vista Village Dr & S Santa Fe Ave, Vista, CA	Washington Ave & Broadway, Escondido, CA	Quince St & Valley Pkwy, Escondido, CA	E Lincoln Ave & N Fig St, Escondido, CA	Robelini Dr & S Santa Fe Ave, Vista, CA	x	x	x	x	x				x			x				x		Mission Ave & El Camino Real, Oceanside, CA			Vista Village Dr & Civic Center Dr, Vista, CA	Mission Rd. & Palomar College, San Marcos, CA		
307	352	356																																
308	352	356	305	351			S Santa Fe Ave & Robelini Dr, Vista, CA	Mission Rd & Palomar College, San Marcos, CA	Valley Pkwy & Center City Pkwy, Escondido, CA	S Santa Fe Ave & Vista Village Dr, Vista, CA	S Santa Fe Ave & Civic Center Dr, Vista, CA	x	x	x	x	x				x			x			x										
309	308	305	445	354								x	x	x												x								For me, it isn't intersections, it's rush hour on Del Dios Hwy. 08:03 trip.

Bus Operator Survey Responses

Response	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
310	388	304	354				Washington Ave & Quince St, Escondido, CA										x				x								Mission Rd to and from Escondido Transit Center and Vista Transit Center						
311	351,52	354	308	358,59			Buena Creek Rd & Robelini Dr, Vista, CA	Vista Way & Olive Ave, Vista, CA	Broadway & El Norte Pkwy, Escondido, CA	Sunset Dr & Bear Valley Pkwy, Escondido, CA	N Ash St & E Lincoln Ave Escondido, CA	x	x	x	x	x	x		x	x		x	x				x			Quince St & Valley Pkwy, Escondido, CA	Quince St & Washington Ave, Escondido, CA		Grape St & Washington Ave, Escondido, CA	Buena Creek Rd & S Santa Fe Rd, Vista, CA	350 San Pasqual	
312																															354 Orange Glenn High School			
313	388	389	304				Vista Village Dr & Santa Fe Ave, Vista, CA	Valley Pkwy & Midway Dr, Escondido, CA				x	x	x	x	x				x						x										
314	350	351	352	356			W Valley Pkwy & Center City Pkwy, Escondido, CA	Washington Ave & Center City Pkwy, Escondido, CA	Escondido Blvd & 9th Ave, Escondido, CA			x	x	x	x	x					x			x				x									
315	358051	351	352	354	308	358	358 3 lights & I-5	Fig St & Washington Ave, Escondido, CA	Center City Pkwy & El Norte Pkwy, Escondido, CA			x	x	x	x	x							x				x			Sunset Dr & Bear Valley Pkwy, Escondido, CA						
316	359	305061	350	305																														
317	388	305	351	350			Midway Dr & Valley Pkwy, Escondido, CA	Vista Transit Center, Vista, CA	Valley View Casino							x	x			x						x										
318	395	303	302				Emerald Dr & Vista Way, Vista, CA	El Camino Real & Vista Way, Vista, CA	Hwy 76 & N Santa Fe Ave, Oceanside, CA	Vista Village Dr & Olive Ave, Vista, CA	Santa Fe Ave & Vista Village Dr, Vista, CA				x	x	x			x								x			Santa Fe Ave & Vista Village Dr, Vista, CA	Vista Village Dr & Olive Ave, Vista, CA					The light at Vista Village Dr & Olive Ave on 302 for the Vista Transit making left into Transit Center is awful; only lets 4-5 vehicles through; always makes me late.
319	305	351	352	355	354	358	Ash St & Mission Ave, Escondido, CA	Bear Valley Pkwy & S Citrus Ave, Escondido, CA	El Norte Pkwy & Broadway, Escondido, CA	S Santa Fe Ave & Vista Way, Vista, CA	S Santa Fe Ave & Buena Creek Rd, Vista, CA	x	x	x	x	x					x			x			x				I'm sure there are others; always have to take in the human aspect			Whenever someone or something pays with pennies			Pay us.
320	30	50	237	201	2	110	Sports Arena Boulevard & Rosecrans	Villa La Jolla Drive & La Jolla Village Drive							x	x	x				x			x			x					Gilman & Myers			

Bus Operator Survey Responses

	Q1						Q2					Q3							Q4						Q5				Q6			Q7			Q8
																			AM (before noon)			PM (after noon)													
Response	Route #	Route #	Route #	Route #	Route #	Route #	Intsec. 1	Intsec. 2	Intsec. 3	Intsec. 4	Intsec. 5	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Sporadic	Peak Hours	All Hours	Sporadic	Peak Hours	All Hours	Not Severe	Moderate	Severe	V. Severe	Intsect.	Intsect.	Intsect.	Stop 1	Stop 2	Stop 3	Additional Comments
321	235	237	215	7	11	13	University Ave and Fairmount Ave	Fairmount Ave and Home Ave				x	x	x	x	x				x	x			x				x			City College Trolley	5th and Broadway			
322	7						Fairmount and University	30th and university				x	x	x	x	x	x	x			x			x			x					30th University				

IMPROVING BUS OPERATIONS AND TRAFFIC (IBOT)

FACT SHEET

The Project

Building upon the successful launch of technology that helps transit vehicles stay on time while traveling on surface streets in the San Diego region, SANDAG has undertaken a study to determine the potential benefits of expanding the system. The effort, called the Improving Bus Operations and Traffic (IBOT) planning study, will identify additional locations in the region where implementation of transit signal priority (TSP) technology would boost the efficiency of the transit system.

Working with transit operators and local jurisdictions, the IBOT project team will conduct a cost-benefit analysis to identify the corridors and bus routes that would most benefit from TSP technology. The goal is to improve transit operations, reduce transit trip times, and improve overall mobility.

Currently, five Rapid routes are operating with TSP in San Diego County. Data show that the use of TSP on these routes has improved on-time performance and reduced travel times without negatively impacting the flow of traffic in these corridors. Overall, these routes show reduced congestion at intersections.

The Need

There is a need to improve bus reliability and overall transit travel time in the San Diego region. Transit travel times can be reduced by up to 10 percent during peak hours by improving efficiency at traffic signals with TSP technology. TSP allows buses that fall behind schedule to recover lost time, increasing the consistency of on-time arrival and improving connections throughout the transit system. This time savings and increased reliability improve the attractiveness of buses as a mobility option.

What is Transit Signal Priority?

TSP is a method of adjusting traffic signal timing to provide more "green time" for buses, resulting in fewer stops at traffic signals. It can reduce delays by decreasing the probability of a bus stopping at a red signal. TSP can extend a green light by a few

(Continued on reverse)

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seconds to allow the bus to cross through an intersection or it can shorten a red light as a bus approaches an intersection. TSP is a lower priority than emergency vehicle preemption, which can switch a signal to green at any time.

Systems onboard buses identify the exact location of the vehicle on the route and can determine if they are running on schedule. When a bus falls behind schedule on a TSP-enabled route, the system will activate an emitter onboard the bus that is detected by the traffic signal as it approaches an intersection. Once a TSP request is detected at the intersection, signal timing will be adjusted to allow for a few seconds of additional green time until the bus clears the intersection. The same is true at red lights, with the system slightly reducing the wait time. TSP is only triggered if a bus is behind schedule. Typically a TSP activation is unnoticeable to other drivers on the road.

Project Costs

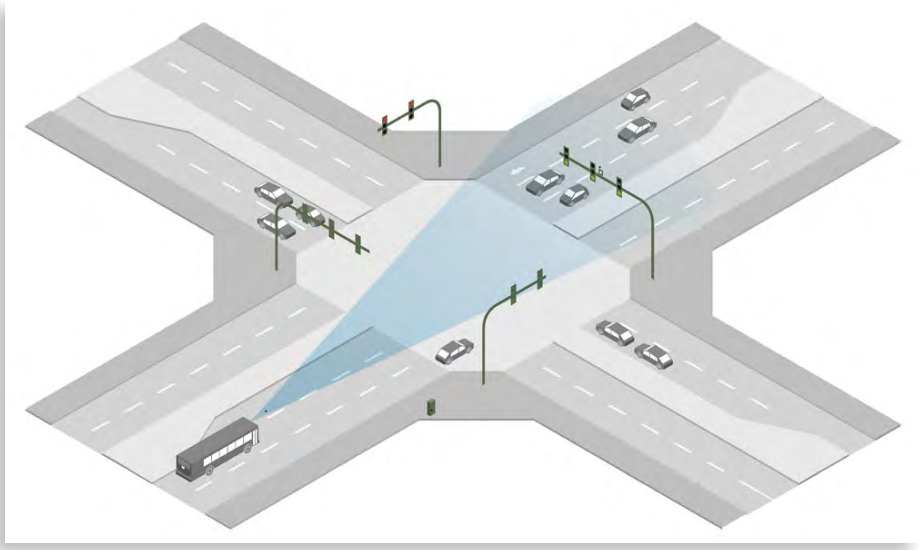
The project is expected to cost $230,000. The California Department of Transportation awarded SANDAG a Fiscal Year 2014-15 Transportation Planning Grant for approximately $204,000, providing the primary funding source. SANDAG will contribute the remaining funds. The completed study will include an evaluation of the costs and potential funding sources for implementation.

Status

The study began in summer 2015. It is expected to be complete in summer 2016.

For More Information

Contact Danny Veeh, Associate Planner – Active Transportation and Rail at
(619) 699-7317 or
Danny.Veeh@sandag.org



March 2016

3665

IMPROVING BUS OPERATIONS AND TRAFFIC (IBOT)

FACT SHEET

The Project

Building upon the successful launch of technology that helps transit vehicles stay on time while traveling on surface streets in the San Diego region, SANDAG conducted a study to determine the benefits of expanding the system. The effort, called the Improving Bus Operations and Traffic (IBOT) planning study, identified additional locations in the region where implementation of transit signal priority (TSP) technology would boost the efficiency of the transit system.

Currently, five *Rapid* routes in San Diego County use TSP. Data show that the use of TSP on these routes has improved on-time performance and reduced travel times without negatively impacting traffic flow in these corridors. Overall, these routes show reduced congestion at intersections.

Working with transit operators and local jurisdictions, the IBOT project team conducted a cost-benefit analysis to identify the top 10 additional corridors where bus routes would most benefit from TSP technology. The study found that implementing TSP on these corridors will improve transit operations, reduce transit trip times, and improve overall mobility.

The Need

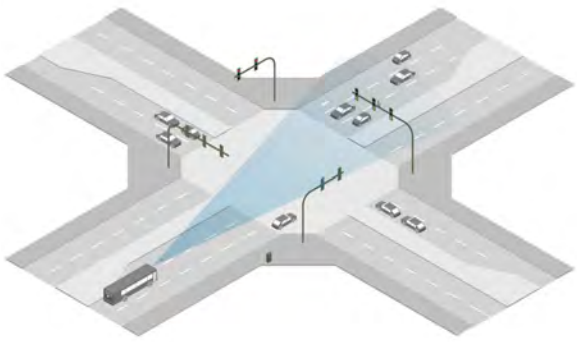
There is a need to improve bus reliability and overall transit travel time in the San Diego region. Transit travel times can be reduced by up to 10 percent during peak hours by improving efficiency at traffic signals with TSP technology. TSP allows buses that fall behind schedule to recover lost time, increasing the consistency of on-time arrival and improving connections throughout the transit system. This time savings and increased reliability improve the attractiveness of buses as a mobility choice.

What is Transit Signal Priority?

TSP is a method of adjusting traffic signal timing to provide more "green time" for buses, resulting in fewer stops at traffic signals. It can reduce delays by decreasing the probability of a bus stopping at a red signal. TSP can extend a green light by a few seconds to allow the bus to cross through an intersection or it can shorten a red light as a bus approaches an intersection. TSP is a lower priority than emergency vehicle preemption, which can switch a signal to green at any time.

TSP is only triggered if a bus is behind schedule. Typically, a TSP activation is unnoticeable to other drivers on the road.

(Continued on reverse)



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IBOT Study Findings

After a thorough technical review of bus corridors throughout the region, as well as a review of input received from transit operators about their experiences on their routes, the study identified the top ten corridors that would realize the most benefit from TSP implementation:

1. University Avenue (San Diego)
2. Mission Avenue (Oceanside)
3. Genesee Avenue (San Diego)
4. Highland Avenue (National City/ Chula Vista)
5. El Cajon Transit Center to E. Main Street (El Cajon)
6. H Street (Chula Vista)
7. 54th Street/Euclid Avenue (San Diego)
8. Linda Vista Road (San Diego)
9. Fairmount Avenue (San Diego)
10. College Avenue (San Diego/ Lemon Grove)

Implementing TSP on these corridors would result in time savings that will significantly increase on-time performance, and improve connections and service reliability for all bus routes on these corridors.

Project Costs

The budget for the IBOT study was $230,000, the majority of which was funded by a Transportation Planning Grant awarded to SANDAG by the California Department of Transportation in Fiscal Year 2014-15. SANDAG contributed the remaining funds. The study found that implementing IBOT on the recommended corridors would cost between $900,000 and $1.1 million per corridor.

Status

The study began in summer 2015 and concluded in fall 2016.

For More Information

Contact Danny Veeh, Associate Planner – Active Transportation and Rail, at (619) 699-7317 or danny.veeh@sandag.org.

November 2016

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IBOT ARTICLE AND SOCIAL MEDIA

NEWSLETTER ARTICLES: SANDAG rEgion, MTS Express, and NCTD News Center

Building upon the successful launch of technology that helps transit vehicles stay on time while traveling on surface streets, SANDAG recently completed a study to determine the potential benefits of expanding the system. The effort, called the Improving Bus Operations and Traffic (IBOT) planning study, identified ten corridors in the region where implementation of transit signal priority (TSP) technology would boost the efficiency of the transit system. TSP is a method of adjusting traffic signal timing to provide more "green time" for buses, resulting in fewer stops at traffic signals. The ten corridors identified in the study are:

1. University Avenue (San Diego/La Mesa)
2. Mission Avenue (Oceanside)
3. Genesee Avenue (San Diego)
4. Highland Avenue/3rd Avenue (National City/Chula Vista)
5. El Cajon Transit Center to E. Main Street (El Cajon)
6. H Street (Chula Vista)
7. 54th Street/Euclid Avenue (San Diego)
8. Linda Vista Road (San Diego)
9. Fairmount Avenue (San Diego)
10. College Avenue/Broadway (San Diego/Lemon Grove)

Implementing TSP on these corridors would result in time savings that will significantly increase on-time performance, improving connections and service reliability for all bus routes on these corridors. For more information about the study, contact Danny Veeh, Associate Planner at (619) 699-7317 or Danny.Veeh@sandag.org.

FACEBOOK POST

SANDAG recently completed the Improving Bus Operations and Traffic (IBOT) planning study, an effort to determine the benefits of expanding the Transit Signal Priority (TSP) system. TSP is a technology that helps transit vehicles stay on time while traveling on surface streets by allowing buses to adjust the "green time" on traffic signals. This results in fewer stops for buses, improving on-time performance and reliability. The study identified the top ten bus corridors in the region that would most benefit from implementing TSP. Read more at (*insert link to appropriate newsletter - if SANDAG posting, link to rEgion; if MTS posting, link to MTS Express; if NCTD posting, link to NCTD News Center*).

TWITTER POST

Study on improving bus ops ID'd top 10 corridors to implement TSP (lets buses extend "green time" at signals to reduce # of stops) (*insert link to appropriate newsletter - if SANDAG posting, link to rEgion; if MTS posting, link to MTS Express; if NCTD posting, link to NCTD News Center).*

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Appendix D – Cost Estimates

- Top 10 Corridors Capital Costs
- Top 10 Corridors Annual Operations & Maintenance Costs

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IBOT Capital Cost Estimates: Summary

Corridor 1 - University Ave. between I-15 and Spring St.

	Option 1 Type A 170E + IR Emitter	Option 2 Type B 2070ATC + IR Emitter	Option 3 Type C 170E + Radio/GPS	Option 4 Type D 2070ATC + Radio/GPS
Intersections	$531,910	$552,710	$385,590	$406,390
Buses	$157,500	$157,500	$189,000	$189,000
Management and Design	$68,941	$71,021	$57,459	$59,539
Contract Procurement	$68,941	$71,021	$57,459	$59,539
Contingency	$165,458	$170,450	$137,902	$142,894
Total Corridor Cost	**$992,750**	**$1,022,702**	**$827,410**	**$857,362**

Corridor 2 - Mission Blvd. between Oceanside TC and San Luis Rey TC

	Option 1 Type A 170E + IR Emitter	Option 2 Type B 2070ATC + IR Emitter	Option 3 Type C 170E + Radio/GPS	Option 4 Type D 2070ATC + Radio/GPS
Intersections	$507,350	$527,350	$373,625	$393,625
Buses	$157,500	$157,500	$189,000	$189,000
Management and Design	$67,985	$69,985	$51,363	$53,363
Contract Procurement	$67,985	$69,985	$51,363	$53,363
Contingency	$135,970	$139,970	$102,725	$106,725
Total Corridor Cost	**$951,790**	**$979,790**	**$719,075**	**$747,075**

Corridor 3 - Genesee Ave. between SR-163 and Nobel Dr.

	Option 1 Type A 170E + IR Emitter	Option 2 Type B 2070ATC + IR Emitter	Option 3 Type C 170E + Radio/GPS	Option 4 Type D 2070ATC + Radio/GPS
Intersections	$430,150	$446,150	$310,800	$326,800
Buses	$157,500	$157,500	$189,000	$189,000
Management and Design	$56,515	$58,115	$47,280	$48,880
Contract Procurement	$56,515	$58,115	$47,280	$48,880
Contingency	$113,030	$116,230	$94,560	$97,760
Total Corridor Cost	**$791,210**	**$813,610**	**$661,920**	**$684,320**

Corridor 4 - Highland Ave. between 3rd St. and Main St. (via 3rd Ave.)

	Option 1 Type A 170E + IR Emitter	Option 2 Type B 2070ATC + IR Emitter	Option 3 Type C 170E + Radio/GPS	Option 4 Type D 2070ATC + Radio/GPS
Intersections	$667,670	$693,270	$489,380	$514,980
Buses	$127,500	$127,500	$153,000	$153,000
Management and Design	$79,517	$82,077	$64,238	$66,798
Contract Procurement	$79,517	$82,077	$64,238	$66,798
Contingency	$190,841	$196,985	$154,171	$160,315
Total Corridor Cost	**$1,145,045**	**$1,181,909**	**$925,027**	**$961,891**

Corridor 5 - Between El Cajon Transit Center and 2nd St.

	Option 1 Type A 170E + IR Emitter	Option 2 Type B 2070ATC + IR Emitter	Option 3 Type C 170E + Radio/GPS	Option 4 Type D 2070ATC + Radio/GPS
Intersections	$326,740	$337,940	$235,510	$246,710
Buses	$172,500	$172,500	$140,000	$140,000
Management and Design	$41,299	$42,419	$33,901	$35,021
Contract Procurement	$41,299	$42,419	$33,901	$35,021
Contingency	$99,118	$101,806	$81,362	$84,050
Total Corridor Cost	**$594,706**	**$610,834**	**$488,174**	**$504,302**

Corridor 6 - H St. between Woodlawn Ave. and Southwestern College

	Option 1 Type A 170E + IR Emitter	Option 2 Type B 2070ATC + IR Emitter	Option 3 Type C 170E + Radio/GPS	Option 4 Type D 2070ATC + Radio/GPS
Intersections	$459,660	$476,460	$331,765	$348,565
Buses	$78,750	$78,750	$94,500	$94,500
Management and Design	$53,841	$55,521	$42,627	$44,307
Contract Procurement	$53,841	$55,521	$42,627	$44,307
Contingency	$129,218	$133,250	$102,304	$106,336
Total Corridor Cost	**$775,310**	**$799,502**	**$613,822**	**$638,014**

Corridor 7 - 54th St./Euclid Ave. between Logan Ave. and Monroe Ave.

	Option 1 Type A 170E + IR Emitter	Option 2 Type B 2070ATC + IR Emitter	Option 3 Type C 170E + Radio/GPS	Option 4 Type D 2070ATC + Radio/GPS
Intersections	$430,900	$446,900	$311,300	$327,300
Buses	$180,000	$180,000	$216,000	$216,000
Management and Design	$61,090	$62,690	$52,730	$54,330
Contract Procurement	$61,090	$62,690	$52,730	$54,330
Contingency	$146,616	$150,456	$126,552	$130,392
Total Corridor Cost	**$879,696**	**$902,736**	**$759,312**	**$782,352**

Corridor 8 - Linda Vista Rd. between Old Town TC and Armstrong St.

	Option 1 Type A 170E + IR Emitter	Option 2 Type B 2070ATC + IR Emitter	Option 3 Type C 170E + Radio/GPS	Option 4 Type D 2070ATC + Radio/GPS
Intersections	$383,020	$396,620	$268,405	$282,005
Buses	$93,750	$93,750	$112,500	$112,500
Management and Design	$47,677	$49,037	$38,091	$39,451
Contract Procurement	$47,677	$49,037	$38,091	$39,451
Contingency	$114,425	$117,689	$91,417	$94,681
Total Corridor Cost	**$686,549**	**$706,133**	**$548,503**	**$568,087**

Corridor 9 - Fairmount Ave. between Home Ave. and Orange Ave.

	Option 1 Type A 170E + IR Emitter	Option 2 Type B 2070ATC + IR Emitter	Option 3 Type C 170E + Radio/GPS	Option 4 Type D 2070ATC + Radio/GPS
Intersections	$214,550	$222,550	$153,150	$161,150
Buses	$48,750	$48,750	$58,500	$58,500
Management and Design	$26,330	$27,130	$21,165	$21,965
Contract Procurement	$26,330	$27,130	$21,165	$21,965
Contingency	$63,192	$65,112	$50,796	$52,716
Total Corridor Cost	**$379,152**	**$390,672**	**$304,776**	**$316,296**

Corridor 10 - College Ave. between Montezuma Rd. and Adelaide Ave & between Federal Blvd. and Lemon Grove Ave.

	Option 1 Type A 170E + IR Emitter	Option 2 Type B 2070ATC + IR Emitter	Option 3 Type C 170E + Radio/GPS	Option 4 Type D 2070ATC + Radio/GPS
Intersections	$287,670	$297,270	$197,080	$206,680
Buses	$63,750	$63,750	$76,500	$76,500
Management and Design	$35,142	$36,102	$27,358	$28,318
Contract Procurement	$35,142	$36,102	$27,358	$28,318
Contingency	$84,341	$86,645	$65,659	$67,963
Total Corridor Cost	**$506,045**	**$519,869**	**$393,955**	**$407,779**

IBOT Capital Cost Estimate: Corridor 1 - University Ave. between I-15 and Spring St.

Minor/Minor Intersection (2/2 or 2/3)		Option 1		Option 2		Option 3		Option 4	
		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$5,500	$0	$5,500	$0	$2,000	$0	$2,000	$0
6-15 Intersections	4	$3,500	$14,000	$3,500	$14,000	$1,500	$6,000	$1,500	$6,000
16-30 Intersections	0	$2,000	$0	$2,000	$0	$1,000	$0	$1,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	4	$1,000	$4,000	$1,000	$4,000	$800	$3,200	$800	$3,200
Integration, Configuration & Testing Services	4	$600	$2,400	$600	$2,400	$600	$2,400	$600	$2,400
Traffic Permits	4	$600	$2,400	$600	$2,400	$600	$2,400	$600	$2,400
Engineering Support	4	$1,000	$4,000	$1,000	$4,000	$1,000	$4,000	$1,000	$4,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	4	$3,000	$12,000	$3,000	$12,000	$3,000	$12,000	$3,000	$12,000
2 x IR Detectors	4	$1,200	$4,800	$1,200	$4,800	----	----	----	----
Detectors Wiring	4	$3,500	$14,000	$3,500	$14,000	----	----	----	----
Aux Panel & Green Sense Cable	4	$350	$1,400	$350	$1,400	$350	$1,400	$350	$1,400
Aux Panel Casing	4	$150	$600	$150	$600	$150	$600	$150	$600
GPS Clock (If no Server Connection)	4	$260	$1,040	$260	$1,040	$260	$1,040	$260	$1,040
RF/GPS Unit & Antenna Clamp	4	----	----	----	----	$2,805	$11,220	$2,805	$11,220
GPS Cable	4	----	----	----	----	$150	$600	$150	$600
170E Controller	4	$2,750	$11,000	----	----	$2,750	$11,000	----	----
2070 Advanced Traffic Controller w/ Omni EX	4	----	----	$3,550	$14,200	----	----	$3,550	$14,200
	Subtotal	----	$71,640	----	$74,840	----	$55,860	----	$59,060
Minor/Major Intersection (2/4 or 3/4)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$7,500	$0	$7,500	$0	$4,000	$0	$4,000	$0
6-15 Intersections	0	$5,500	$0	$5,500	$0	$2,500	$0	$2,500	$0
16-30 Intersections	17	$3,500	$59,500	$3,500	$59,500	$1,500	$25,500	$1,500	$25,500
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	17	$1,000	$17,000	$1,000	$17,000	$800	$13,600	$800	$13,600
Integration, Configuration & Testing Services	17	$600	$10,200	$600	$10,200	$600	$10,200	$600	$10,200
Traffic Permits	17	$600	$10,200	$600	$10,200	$600	$10,200	$600	$10,200
Engineering Support	17	$1,000	$17,000	$1,000	$17,000	$1,000	$17,000	$1,000	$17,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	17	$3,000	$51,000	$3,000	$51,000	$3,000	$51,000	$3,000	$51,000
2 x IR Detectors	17	$1,200	$20,400	$1,200	$20,400	----	----	----	----
Detectors Wiring	17	$4,250	$72,250	$4,250	$72,250	----	----	----	----
Aux Panel & Green Sense Cable	17	$350	$5,950	$350	$5,950	$350	$5,950	$350	$5,950
Aux Panel Casing	17	$150	$2,550	$150	$2,550	$150	$2,550	$150	$2,550
GPS Clock (If no Server Connection)	17	$260	$4,420	$260	$4,420	$260	$4,420	$260	$4,420
RF/GPS Unit & Antenna Clamp	17	----	----	----	----	$2,805	$47,685	$2,805	$47,685
GPS Cable	17	----	----	----	----	$150	$2,550	$150	$2,550
170E Controller	17	$2,750	$46,750	----	----	$2,750	$46,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	17	----	----	$3,550	$60,350	----	----	$3,550	$60,350
	Subtotal	----	$317,220	----	$330,820	----	$237,405	----	$251,005
Major/Major Intersection (4/4, 4/6 or 6/6)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	5	$11,500	$57,500	$11,500	$57,500	$6,000	$30,000	$6,000	$30,000
6-15 Intersections	0	$6,500	$0	$6,500	$0	$4,500	$0	$4,500	$0
16-30 Intersections	0	$4,000	$0	$4,000	$0	$3,000	$0	$3,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	5	$1,000	$5,000	$1,000	$5,000	$800	$4,000	$800	$4,000
Integration, Configuration & Testing Services	5	$600	$3,000	$600	$3,000	$600	$3,000	$600	$3,000
Traffic Permits	5	$600	$3,000	$600	$3,000	$600	$3,000	$600	$3,000
Engineering Support	5	$1,000	$5,000	$1,000	$5,000	$1,000	$5,000	$1,000	$5,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	5	$3,000	$15,000	$3,000	$15,000	$3,000	$15,000	$3,000	$15,000
2 x IR Detectors	5	$2,400	$12,000	$2,400	$12,000	----	----	----	----
Detectors Wiring	5	$5,000	$25,000	$5,000	$25,000	----	----	----	----
Aux Panel & Green Sense Cable	5	$350	$1,750	$350	$1,750	$350	$1,750	$350	$1,750
Aux Panel Casing	5	$150	$750	$150	$750	$150	$750	$150	$750
GPS Clock (If no Server Connection)	5	$260	$1,300	$260	$1,300	$260	$1,300	$260	$1,300
RF/GPS Unit & Antenna Clamp	5	----	----	----	----	$2,805	$14,025	$2,805	$14,025
GPS Cable	5	----	----	----	----	$150	$750	$150	$750
170E Controller	5	$2,750	$13,750	----	----	$2,750	$13,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	5	----	----	$3,550	$17,750	----	----	$3,550	$17,750
	Subtotal	----	$143,050	----	$147,050	----	$92,325	----	$96,325
	Intersections Subtotal	**$531,910**		**$552,710**		**$385,590**		**$406,390**	

Buses		Infrared Technology				Radio/GPS Technology			
In-Vehicle Equipment	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Multimode LED Emitter	32	$1,750	$56,000	$1,750	$56,000	----	----	----	----
Radio/GPS Vehicle Kit	32	----	----	----	----	$3,000	$96,000	$3,000	$96,000
In-Vehicle Installation	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Bus Installation	32	$1,500	$48,000	$1,500	$48,000	$1,000	$32,000	$1,000	$32,000
Engineering Support	32	$500	$16,000	$500	$16,000	$500	$16,000	$500	$16,000
Spares	10	----	$37,500	----	$37,500	----	$45,000	----	$45,000
	Buses Subtotal	$3,750	**$157,500**	$3,750	**$157,500**	$4,500	**$189,000**	$4,500	**$189,000**

Buses Subtotal Breakdown by Route	Quantity	Subtotal	Subtotal	Subtotal	Subtotal
Route 7 Subtotal*	22	$82,500	$82,500	$99,000	$99,000
Spares	7	$26,250	$26,250	$31,500	$31,500
Route 7 Total		$108,750	$108,750	$130,500	$130,500
Route 10 Subtotal*	10	$37,500	$37,500	$45,000	$45,000
Spares	3	$11,250	$11,250	$13,500	$13,500
Route 10 Total		$48,750	$48,750	$58,500	$58,500
Intersections and Buses Subtotal		$689,410	$710,210	$574,590	$595,390

Management and Design		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$68,941**	**$71,021**	**$57,459**	**$59,539**
Contract Procurement		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$68,941**	**$71,021**	**$57,459**	**$59,539**
Contingency		20% of All Previous Costs			
Subtotal	20%	**$165,458**	**$170,450**	**$137,902**	**$142,894**

Note: If TSP is part of a broader BRT project, traffic control and traffic permit costs can be zeroed out.
*The number of buses consists of the total buses needed to run peak operations for each route and **30% of the cost of retrofitting the peak number of buses on a route was used to account for spare buses.

	Option 1	Option 2	Option 3	Option 4
	Infrared Technology		Radio/GPS Technology	
	Type A 170E + IR Emitter	Type B 2070ATC + IR Emitter	Type C 170E + Radio/GPS	Type D 2070ATC + Radio/GPS
Total Corridor Cost	**$992,750**	**$1,022,702**	**$827,410**	**$857,362**

IBOT Capital Cost Estimate: Corridor 2 - Mission Blvd. between Oceanside TC and San Luis Rey TC

Minor/Minor Intersection (2/2 or 2/3)		Option 1 Infrared Technology Type A 170E + IR Emitter		Option 2 Infrared Technology Type B 2070ATC + IR Emitter		Option 3 Radio/GPS Technology Type C 170E + Radio/GPS		Option 4 Radio/GPS Technology Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	1	$5,500	$5,500	$5,500	$5,500	$2,000	$2,000	$2,000	$2,000
6-15 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
16-30 Intersections	0	$2,000	$0	$2,000	$0	$1,000	$0	$1,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	1	$1,000	$1,000	$1,000	$1,000	$800	$800	$800	$800
Integration, Configuration & Testing Services	1	$600	$600	$600	$600	$600	$600	$600	$600
Traffic Permits	1	$600	$600	$600	$600	$600	$600	$600	$600
Engineering Support	1	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	1	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
2 x IR Detectors	1	$1,200	$1,200	$1,200	$1,200	----	----	----	----
Detectors Wiring	1	$3,500	$3,500	$3,500	$3,500	----	----	----	----
Aux Panel & Green Sense Cable	1	$350	$350	$350	$350	$350	$350	$350	$350
Aux Panel Casing	1	$150	$150	$150	$150	$150	$150	$150	$150
GPS Clock (If no Server Connection)	1	$260	$260	$260	$260	$260	$260	$260	$260
RF/GPS Unit & Antenna Clamp	1	----	----	----	----	$2,805	$2,805	$2,805	$2,805
GPS Cable	1	----	----	----	----	$150	$150	$150	$150
170E Controller	1	$2,750	$2,750	----	----	$2,750	$2,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	1	----	----	$3,550	$3,550	----	----	$3,550	$3,550
	Subtotal	----	$19,910	----	$20,710	----	$14,465	----	$15,265
Minor/Major Intersection (2/4 or 3/4)		**Infrared Technology Type A 170E + IR Emitter**		**Type B 2070ATC + IR Emitter**		**Radio/GPS Technology Type C 170E + Radio/GPS**		**Type D 2070ATC + Radio/GPS**	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$7,500	$0	$7,500	$0	$4,000	$0	$4,000	$0
6-15 Intersections	0	$5,500	$0	$5,500	$0	$2,500	$0	$2,500	$0
16-30 Intersections	16	$3,500	$56,000	$3,500	$56,000	$1,500	$24,000	$1,500	$24,000
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	16	$1,000	$16,000	$1,000	$16,000	$800	$12,800	$800	$12,800
Integration, Configuration & Testing Services	16	$600	$9,600	$600	$9,600	$600	$9,600	$600	$9,600
Traffic Permits	16	$600	$9,600	$600	$9,600	$600	$9,600	$600	$9,600
Engineering Support	16	$1,000	$16,000	$1,000	$16,000	$1,000	$16,000	$1,000	$16,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	16	$3,000	$48,000	$3,000	$48,000	$3,000	$48,000	$3,000	$48,000
2 x IR Detectors	16	$1,200	$19,200	$1,200	$19,200	----	----	----	----
Detectors Wiring	16	$4,250	$68,000	$4,250	$68,000	----	----	----	----
Aux Panel & Green Sense Cable	16	$350	$5,600	$350	$5,600	$350	$5,600	$350	$5,600
Aux Panel Casing	16	$150	$2,400	$150	$2,400	$150	$2,400	$150	$2,400
GPS Clock (If no Server Connection)	16	$260	$4,160	$260	$4,160	$260	$4,160	$260	$4,160
RF/GPS Unit & Antenna Clamp	16	----	----	----	----	$2,805	$44,880	$2,805	$44,880
GPS Cable	16	----	----	----	----	$150	$2,400	$150	$2,400
170E Controller	16	$2,750	$44,000	----	----	$2,750	$44,000	----	----
2070 Advanced Traffic Controller w/ Omni EX	16	----	----	$3,550	$56,800	----	----	$3,550	$56,800
	Subtotal	----	$298,560	----	$311,360	----	$223,440	----	$236,240
Major/Major Intersection (4/4, 4/6 or 6/6)		**Infrared Technology Type A 170E + IR Emitter**		**Type B 2070ATC + IR Emitter**		**Radio/GPS Technology Type C 170E + Radio/GPS**		**Type D 2070ATC + Radio/GPS**	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$11,500	$0	$11,500	$0	$6,000	$0	$6,000	$0
6-15 Intersections	8	$6,500	$52,000	$6,500	$52,000	$4,500	$36,000	$4,500	$36,000
16-30 Intersections	0	$4,000	$0	$4,000	$0	$3,000	$0	$3,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	8	$1,000	$8,000	$1,000	$8,000	$800	$6,400	$800	$6,400
Integration, Configuration & Testing Services	8	$600	$4,800	$600	$4,800	$600	$4,800	$600	$4,800
Traffic Permits	8	$600	$4,800	$600	$4,800	$600	$4,800	$600	$4,800
Engineering Support	8	$1,000	$8,000	$1,000	$8,000	$1,000	$8,000	$1,000	$8,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	8	$3,000	$24,000	$3,000	$24,000	$3,000	$24,000	$3,000	$24,000
2 x IR Detectors	8	$2,400	$19,200	$2,400	$19,200	----	----	----	----
Detectors Wiring	8	$5,000	$40,000	$5,000	$40,000	----	----	----	----
Aux Panel & Green Sense Cable	8	$350	$2,800	$350	$2,800	$350	$2,800	$350	$2,800
Aux Panel Casing	8	$150	$1,200	$150	$1,200	$150	$1,200	$150	$1,200
GPS Clock (If no Server Connection)	8	$260	$2,080	$260	$2,080	$260	$2,080	$260	$2,080
RF/GPS Unit & Antenna Clamp	8	----	----	----	----	$2,805	$22,440	$2,805	$22,440
GPS Cable	8	----	----	----	----	$150	$1,200	$150	$1,200
170E Controller	8	$2,750	$22,000	----	----	$2,750	$22,000	----	----
2070 Advanced Traffic Controller w/ Omni EX	8	----	----	$3,550	$28,400	----	----	$3,550	$28,400
	Subtotal	----	$188,880	----	$195,280	----	$135,720	----	$142,120
	Intersections Subtotal	**$507,350**		**$527,350**		**$373,625**		**$393,625**	

Buses		Infrared Technology				Radio/GPS Technology			
In-Vehicle Equipment	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Multimode LED Emitter	35	$1,750	$61,250	$1,750	$61,250	----	----	----	----
Radio/GPS Vehicle Kit	35	----	----	----	----	$3,000	$105,000	$3,000	$105,000
In-Vehicle Installation	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Bus Installation	35	$1,500	$52,500	$1,500	$52,500	$1,000	$35,000	$1,000	$35,000
Engineering Support	35	$500	$17,500	$500	$17,500	$500	$17,500	$500	$17,500
Spares	11	----	$41,250	----	$41,250	----	$49,500	----	$49,500
	Buses Subtotal	$3,750	**$172,500**	$3,750	**$172,500**	$4,500	**$140,000**	$4,500	**$140,000**

Buses Subtotal Breakdown by Route	Quantity	Subtotal	Subtotal	Subtotal	Subtotal
Route 303 Subtotal*	14	$52,500	$52,500	$63,000	$63,000
Spares	4	$15,000	$15,000	$18,000	$18,000
Route 303 Total		$67,500	$67,500	$81,000	$81,000
Route 309 Subtotal*	10	$37,500	$37,500	$45,000	$45,000
Spares	3	$11,250	$11,250	$13,500	$13,500
Route 309 Total		$48,750	$48,750	$58,500	$58,500
Route 311 Subtotal*	4	$15,000	$15,000	$18,000	$18,000
Spares	1	$3,750	$3,750	$4,500	$4,500
Route 311 Total		$18,750	$18,750	$22,500	$22,500
Route 313 Subtotal*	2	$7,500	$7,500	$9,000	$9,000
Spares	1	$3,750	$3,750	$4,500	$4,500
Route 313 Total		$11,250	$11,250	$13,500	$13,500
Route 315 Subtotal*	5	$18,750	$18,750	$22,500	$22,500
Spares	2	$7,500	$7,500	$9,000	$9,000
Route 315 Total		$26,250	$26,250	$31,500	$31,500
Intersections and Buses Subtotal		$679,850	$699,850	$513,625	$533,625

Management and Design		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$67,985**	**$69,985**	**$51,363**	**$53,363**
Contract Procurement		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$67,985**	**$69,985**	**$51,363**	**$53,363**
Contingency					
Subtotal	20%	**$135,970**	**$139,970**	**$102,725**	**$106,725**

Note: If TSP is part of a broader BRT project, traffic control and traffic permit costs can be zeroed out.
*The number of buses consists of the total buses needed to run peak operations for each route and **30% of the cost of retrofitting the peak number of buses on a route was used to account for spare buses.

	Option 1	Option 2	Option 3	Option 4
	Infrared Technology		Radio/GPS Technology	
	Type A 170E + IR Emitter	Type B 2070ATC + IR Emitter	Type C 170E + Radio/GPS	Type D 2070ATC + Radio/GPS
Total Corridor Cost	**$951,790**	**$979,790**	**$719,075**	**$747,075**

IBOT Capital Cost Estimate: Corridor 3 - Genesee Ave. between SR-163 and Nobel Dr.

Minor/Minor Intersection (2/2 or 2/3)		Option 1 Infrared Technology Type A 170E + IR Emitter		Option 2 Infrared Technology Type B 2070ATC + IR Emitter		Option 3 Radio/GPS Technology Type C 170E + Radio/GPS		Option 4 Radio/GPS Technology Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	1	$5,500	$5,500	$5,500	$5,500	$2,000	$2,000	$2,000	$2,000
6-15 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
16-30 Intersections	0	$2,000	$0	$2,000	$0	$1,000	$0	$1,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	1	$1,000	$1,000	$1,000	$1,000	$800	$800	$800	$800
Integration, Configuration & Testing Services	1	$600	$600	$600	$600	$600	$600	$600	$600
Traffic Permits	1	$600	$600	$600	$600	$600	$600	$600	$600
Engineering Support	1	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	1	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
2 x IR Detectors	1	$1,200	$1,200	$1,200	$1,200	----	----	----	----
Detectors Wiring	1	$3,500	$3,500	$3,500	$3,500	----	----	----	----
Aux Panel & Green Sense Cable	1	$350	$350	$350	$350	$350	$350	$350	$350
Aux Panel Casing	1	$150	$150	$150	$150	$150	$150	$150	$150
GPS Clock (If no Server Connection)	1	$260	$260	$260	$260	$260	$260	$260	$260
RF/GPS Unit & Antenna Clamp	1	----	----	----	----	$2,805	$2,805	$2,805	$2,805
GPS Cable	1	----	----	----	----	$150	$150	$150	$150
170E Controller	1	$2,750	$2,750	----	----	$2,750	$2,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	1	----	----	$3,550	$3,550	----	----	$3,550	$3,550
	Subtotal	----	$19,910	----	$20,710	----	$14,465	----	$15,265
Minor/Major Intersection (2/4 or 3/4)		**Infrared Technology Type A 170E + IR Emitter**		**Type B 2070ATC + IR Emitter**		**Radio/GPS Technology Type C 170E + Radio/GPS**		**Type D 2070ATC + Radio/GPS**	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$7,500	$0	$7,500	$0	$4,000	$0	$4,000	$0
6-15 Intersections	13	$5,500	$71,500	$5,500	$71,500	$2,500	$32,500	$2,500	$32,500
16-30 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	13	$1,000	$13,000	$1,000	$13,000	$800	$10,400	$800	$10,400
Integration, Configuration & Testing Services	13	$600	$7,800	$600	$7,800	$600	$7,800	$600	$7,800
Traffic Permits	13	$600	$7,800	$600	$7,800	$600	$7,800	$600	$7,800
Engineering Support	13	$1,000	$13,000	$1,000	$13,000	$1,000	$13,000	$1,000	$13,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	13	$3,000	$39,000	$3,000	$39,000	$3,000	$39,000	$3,000	$39,000
2 x IR Detectors	13	$1,200	$15,600	$1,200	$15,600	----	----	----	----
Detectors Wiring	13	$4,250	$55,250	$4,250	$55,250	----	----	----	----
Aux Panel & Green Sense Cable	13	$350	$4,550	$350	$4,550	$350	$4,550	$350	$4,550
Aux Panel Casing	13	$150	$1,950	$150	$1,950	$150	$1,950	$150	$1,950
GPS Clock (If no Server Connection)	13	$260	$3,380	$260	$3,380	$260	$3,380	$260	$3,380
RF/GPS Unit & Antenna Clamp	13	----	----	----	----	$2,805	$36,465	$2,805	$36,465
GPS Cable	13	----	----	----	----	$150	$1,950	$150	$1,950
170E Controller	13	$2,750	$35,750	----	----	$2,750	$35,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	13	----	----	$3,550	$46,150	----	----	$3,550	$46,150
	Subtotal	----	$268,580	----	$278,980	----	$194,545	----	$204,945
Major/Major Intersection (4/4, 4/6 or 6/6)		**Infrared Technology Type A 170E + IR Emitter**		**Type B 2070ATC + IR Emitter**		**Radio/GPS Technology Type C 170E + Radio/GPS**		**Type D 2070ATC + Radio/GPS**	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$11,500	$0	$11,500	$0	$6,000	$0	$6,000	$0
6-15 Intersections	6	$6,500	$39,000	$6,500	$39,000	$4,500	$27,000	$4,500	$27,000
16-30 Intersections	0	$4,000	$0	$4,000	$0	$3,000	$0	$3,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	6	$1,000	$6,000	$1,000	$6,000	$800	$4,800	$800	$4,800
Integration, Configuration & Testing Services	6	$600	$3,600	$600	$3,600	$600	$3,600	$600	$3,600
Traffic Permits	6	$600	$3,600	$600	$3,600	$600	$3,600	$600	$3,600
Engineering Support	6	$1,000	$6,000	$1,000	$6,000	$1,000	$6,000	$1,000	$6,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	6	$3,000	$18,000	$3,000	$18,000	$3,000	$18,000	$3,000	$18,000
2 x IR Detectors	6	$2,400	$14,400	$2,400	$14,400	----	----	----	----
Detectors Wiring	6	$5,000	$30,000	$5,000	$30,000	----	----	----	----
Aux Panel & Green Sense Cable	6	$350	$2,100	$350	$2,100	$350	$2,100	$350	$2,100
Aux Panel Casing	6	$150	$900	$150	$900	$150	$900	$150	$900
GPS Clock (If no Server Connection)	6	$260	$1,560	$260	$1,560	$260	$1,560	$260	$1,560
RF/GPS Unit & Antenna Clamp	6	----	----	----	----	$2,805	$16,830	$2,805	$16,830
GPS Cable	6	----	----	----	----	$150	$900	$150	$900
170E Controller	6	$2,750	$16,500	----	----	$2,750	$16,500	----	----
2070 Advanced Traffic Controller w/ Omni EX	6	----	----	$3,550	$21,300	----	----	$3,550	$21,300
	Subtotal	----	$141,660	----	$146,460	----	$101,790	----	$106,590
	Intersections Subtotal	**$430,150**		**$446,150**		**$310,800**		**$326,800**	

Buses		Infrared Technology				Radio/GPS Technology			
In-Vehicle Equipment	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Multimode LED Emitter	28	$1,750	$49,000	$1,750	$49,000	----	----	----	----
Radio/GPS Vehicle Kit	28	----	----	----	----	$3,000	$84,000	$3,000	$84,000
In-Vehicle Installation	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Bus Installation	28	$1,500	$42,000	$1,500	$42,000	$1,000	$28,000	$1,000	$28,000
Engineering Support	28	$500	$14,000	$500	$14,000	$500	$14,000	$500	$14,000
Spares	8	----	$30,000	----	$30,000	----	$36,000	----	$36,000
	Buses Subtotal	$3,750	**$135,000**	$3,750	**$135,000**	$4,500	**$162,000**	$4,500	**$162,000**

Buses Subtotal Breakdown by Route	Quantity	Subtotal	Subtotal	Subtotal	Subtotal
Route 25 Subtotal*	2	$7,500	$7,500	$9,000	$9,000
Spares	1	$3,750	$3,750	$4,500	$4,500
Route 25 Total		$11,250	$11,250	$13,500	$13,500
Route 41 Subtotal*	12	$45,000	$45,000	$54,000	$54,000
Spares	4	$15,000	$15,000	$18,000	$18,000
Route 41 Total		$60,000	$60,000	$72,000	$72,000
Route 50 Subtotal*	4	$15,000	$15,000	$18,000	$18,000
Spares	1	$3,750	$3,750	$4,500	$4,500
Route 50 Total		$18,750	$18,750	$22,500	$22,500
Route 105 Subtotal*	4	$15,000	$15,000	$18,000	$18,000
Spares	1	$3,750	$3,750	$4,500	$4,500
Route 105 Total		$18,750	$18,750	$22,500	$22,500
Route 120 Subtotal*	6	$22,500	$22,500	$27,000	$27,000
Spares	2	$7,500	$7,500	$9,000	$9,000
Route 120 Total		$30,000	$30,000	$36,000	$36,000
Intersections and Buses Subtotal		$565,150	$581,150	$472,800	$488,800

Management and Design		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$56,515**	**$58,115**	**$47,280**	**$48,880**
Contract Procurement		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$56,515**	**$58,115**	**$47,280**	**$48,880**
Contingency					
Subtotal	20%	**$113,030**	**$116,230**	**$94,560**	**$97,760**

Note: If TSP is part of a broader BRT project, traffic control and traffic permit costs can be zeroed out.
*The number of buses consists of the total buses needed to run peak operations for each route and **30% of the cost of retrofitting the peak number of buses on a route was used to account for spare buses.

	Option 1	Option 2	Option 3	Option 4
	Infrared Technology		Radio/GPS Technology	
	Type A 170E + IR Emitter	Type B 2070ATC + IR Emitter	Type C 170E + Radio/GPS	Type D 2070ATC + Radio/GPS
Total Corridor Cost	**$791,210**	**$813,610**	**$661,920**	**$684,320**

IBOT Capital Cost Estimate: Corridor 4 - Highland Ave. between 3rd St. and Main St. (via 3rd Ave.)

Minor/Minor Intersection (2/2 or 2/3)		Option 1		Option 2		Option 3		Option 4	
		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	1	$5,500	$5,500	$5,500	$5,500	$2,000	$2,000	$2,000	$2,000
6-15 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
16-30 Intersections	0	$2,000	$0	$2,000	$0	$1,000	$0	$1,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	1	$1,000	$1,000	$1,000	$1,000	$800	$800	$800	$800
Integration, Configuration & Testing Services	1	$600	$600	$600	$600	$600	$600	$600	$600
Traffic Permits	1	$600	$600	$600	$600	$600	$600	$600	$600
Engineering Support	1	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	1	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
2 x IR Detectors	1	$1,200	$1,200	$1,200	$1,200	----	----	----	----
Detectors Wiring	1	$3,500	$3,500	$3,500	$3,500	----	----	----	----
Aux Panel & Green Sense Cable	1	$350	$350	$350	$350	$350	$350	$350	$350
Aux Panel Casing	1	$150	$150	$150	$150	$150	$150	$150	$150
GPS Clock (If no Server Connection)	1	$260	$260	$260	$260	$260	$260	$260	$260
RF/GPS Unit & Antenna Clamp	1	----	----	----	----	$2,805	$2,805	$2,805	$2,805
GPS Cable	1	----	----	----	----	$150	$150	$150	$150
170E Controller	1	$2,750	$2,750	----	----	$2,750	$2,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	1	----	----	$3,550	$3,550	----	----	$3,550	$3,550
	Subtotal	----	$19,910	----	$20,710	----	$14,465	----	$15,265
Minor/Major Intersection (2/4 or 3/4)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$7,500	$0	$7,500	$0	$4,000	$0	$4,000	$0
6-15 Intersections	0	$5,500	$0	$5,500	$0	$2,500	$0	$2,500	$0
16-30 Intersections	17	$3,500	$59,500	$3,500	$59,500	$1,500	$25,500	$1,500	$25,500
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	17	$1,000	$17,000	$1,000	$17,000	$800	$13,600	$800	$13,600
Integration, Configuration & Testing Services	17	$600	$10,200	$600	$10,200	$600	$10,200	$600	$10,200
Traffic Permits	17	$600	$10,200	$600	$10,200	$600	$10,200	$600	$10,200
Engineering Support	17	$1,000	$17,000	$1,000	$17,000	$1,000	$17,000	$1,000	$17,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	17	$3,000	$51,000	$3,000	$51,000	$3,000	$51,000	$3,000	$51,000
2 x IR Detectors	17	$1,200	$20,400	$1,200	$20,400	----	----	----	----
Detectors Wiring	17	$4,250	$72,250	$4,250	$72,250	----	----	----	----
Aux Panel & Green Sense Cable	17	$350	$5,950	$350	$5,950	$350	$5,950	$350	$5,950
Aux Panel Casing	17	$150	$2,550	$150	$2,550	$150	$2,550	$150	$2,550
GPS Clock (If no Server Connection)	17	$260	$4,420	$260	$4,420	$260	$4,420	$260	$4,420
RF/GPS Unit & Antenna Clamp	17	----	----	----	----	$2,805	$47,685	$2,805	$47,685
GPS Cable	17	----	----	----	----	$150	$2,550	$150	$2,550
170E Controller	17	$2,750	$46,750	----	----	$2,750	$46,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	17	----	----	$3,550	$60,350	----	----	$3,550	$60,350
	Subtotal	----	$317,220	----	$330,820	----	$237,405	----	$251,005
Major/Major Intersection (4/4, 4/6 or 6/6)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$11,500	$0	$11,500	$0	$6,000	$0	$6,000	$0
6-15 Intersections	14	$6,500	$91,000	$6,500	$91,000	$4,500	$63,000	$4,500	$63,000
16-30 Intersections	0	$4,000	$0	$4,000	$0	$3,000	$0	$3,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	14	$1,000	$14,000	$1,000	$14,000	$800	$11,200	$800	$11,200
Integration, Configuration & Testing Services	14	$600	$8,400	$600	$8,400	$600	$8,400	$600	$8,400
Traffic Permits	14	$600	$8,400	$600	$8,400	$600	$8,400	$600	$8,400
Engineering Support	14	$1,000	$14,000	$1,000	$14,000	$1,000	$14,000	$1,000	$14,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	14	$3,000	$42,000	$3,000	$42,000	$3,000	$42,000	$3,000	$42,000
2 x IR Detectors	14	$2,400	$33,600	$2,400	$33,600	----	----	----	----
Detectors Wiring	14	$5,000	$70,000	$5,000	$70,000	----	----	----	----
Aux Panel & Green Sense Cable	14	$350	$4,900	$350	$4,900	$350	$4,900	$350	$4,900
Aux Panel Casing	14	$150	$2,100	$150	$2,100	$150	$2,100	$150	$2,100
GPS Clock (If no Server Connection)	14	$260	$3,640	$260	$3,640	$260	$3,640	$260	$3,640
RF/GPS Unit & Antenna Clamp	14	----	----	----	----	$2,805	$39,270	$2,805	$39,270
GPS Cable	14	----	----	----	----	$150	$2,100	$150	$2,100
170E Controller	14	$2,750	$38,500	----	----	$2,750	$38,500	----	----
2070 Advanced Traffic Controller w/ Omni EX	14	----	----	$3,550	$49,700	----	----	$3,550	$49,700
	Subtotal	----	$330,540	----	$341,740	----	$237,510	----	$248,710
	Intersections Subtotal	**$667,670**		**$693,270**		**$489,380**		**$514,980**	

Buses		Infrared Technology				Radio/GPS Technology			
In-Vehicle Equipment	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Multimode LED Emitter	26	$1,750	$45,500	$1,750	$45,500	----	----	----	----
Radio/GPS Vehicle Kit	26	----	----	----	----	$3,000	$78,000	$3,000	$78,000
In-Vehicle Installation	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Bus Installation	26	$1,500	$39,000	$1,500	$39,000	$1,000	$26,000	$1,000	$26,000
Engineering Support	26	$500	$13,000	$500	$13,000	$500	$13,000	$500	$13,000
Spares	8	----	$30,000	----	$30,000	----	$36,000	----	$36,000
	Buses Subtotal	$3,750	**$127,500**	$3,750	**$127,500**	$4,500	**$153,000**	$4,500	**$153,000**

Buses Subtotal Breakdown by Route	Quantity	Subtotal	Subtotal	Subtotal	Subtotal
Route 929 Subtotal*	17	$63,750	$63,750	$76,500	$76,500
Spares	5	$18,750	$18,750	$22,500	$22,500
Route 929 Total		$82,500	$82,500	$99,000	$99,000
Route 955 Subtotal*	9	$33,750	$33,750	$40,500	$40,500
Spares	3	$11,250	$11,250	$13,500	$13,500
Route 955 Total		$45,000	$45,000	$54,000	$54,000
Intersections and Buses Subtotal		$795,170	$820,770	$642,380	$667,980

Management and Design		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$79,517**	**$82,077**	**$64,238**	**$66,798**
Contract Procurement		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$79,517**	**$82,077**	**$64,238**	**$66,798**
Contingency		20% of All Previous Costs			
Subtotal	20%	**$190,841**	**$196,985**	**$154,171**	**$160,315**

Note: If TSP is part of a broader BRT project, traffic control and traffic permit costs can be zeroed out.
*The number of buses consists of the total buses needed to run peak operations for each route and **30% of the cost of retrofitting the peak number of buses on a route was used to account for spare buses.

	Option 1	Option 2	Option 3	Option 4
	Infrared Technology		Radio/GPS Technology	
	Type A 170E + IR Emitter	Type B 2070ATC + IR Emitter	Type C 170E + Radio/GPS	Type D 2070ATC + Radio/GPS
Total Corridor Cost	**$1,145,045**	**$1,181,909**	**$925,027**	**$961,891**

IBOT Capital Cost Estimate: Corridor 5 - Between El Cajon Transit Center and 2nd St.

		Option 1		Option 2		Option 3		Option 4	
Minor/Minor Intersection (2/2 or 2/3)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$5,500	$0	$5,500	$0	$2,000	$0	$2,000	$0
6-15 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
16-30 Intersections	0	$2,000	$0	$2,000	$0	$1,000	$0	$1,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	0	$1,000	$0	$1,000	$0	$800	$0	$800	$0
Integration, Configuration & Testing Services	0	$600	$0	$600	$0	$600	$0	$600	$0
Traffic Permits	0	$600	$0	$600	$0	$600	$0	$600	$0
Engineering Support	0	$1,000	$0	$1,000	$0	$1,000	$0	$1,000	$0
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	0	$3,000	$0	$3,000	$0	$3,000	$0	$3,000	$0
2 x IR Detectors	0	$1,200	$0	$1,200	$0	----	----	----	----
Detectors Wiring	0	$3,500	$0	$3,500	$0	----	----	----	----
Aux Panel & Green Sense Cable	0	$350	$0	$350	$0	$350	$0	$350	$0
Aux Panel Casing	0	$150	$0	$150	$0	$150	$0	$150	$0
GPS Clock (If no Server Connection)	0	$260	$0	$260	$0	$260	$0	$260	$0
RF/GPS Unit & Antenna Clamp	0	----	----	----	----	$2,805	$0	$2,805	$0
GPS Cable	0	----	----	----	----	$150	$0	$150	$0
170E Controller	0	$2,750	$0	----	----	$2,750	$0	----	----
2070 Advanced Traffic Controller w/ Omni EX	0	----	----	$3,550	$0	----	----	$3,550	$0
	Subtotal	----	$0	----	$0	----	$0	----	$0
Minor/Major Intersection (2/4 or 3/4)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	4	$7,500	$30,000	$7,500	$30,000	$4,000	$16,000	$4,000	$16,000
6-15 Intersections	0	$5,500	$0	$5,500	$0	$2,500	$0	$2,500	$0
16-30 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	4	$1,000	$4,000	$1,000	$4,000	$800	$3,200	$800	$3,200
Integration, Configuration & Testing Services	4	$600	$2,400	$600	$2,400	$600	$2,400	$600	$2,400
Traffic Permits	4	$600	$2,400	$600	$2,400	$600	$2,400	$600	$2,400
Engineering Support	4	$1,000	$4,000	$1,000	$4,000	$1,000	$4,000	$1,000	$4,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	4	$3,000	$12,000	$3,000	$12,000	$3,000	$12,000	$3,000	$12,000
2 x IR Detectors	4	$1,200	$4,800	$1,200	$4,800	----	----	----	----
Detectors Wiring	4	$4,250	$17,000	$4,250	$17,000	----	----	----	----
Aux Panel & Green Sense Cable	4	$350	$1,400	$350	$1,400	$350	$1,400	$350	$1,400
Aux Panel Casing	4	$150	$600	$150	$600	$150	$600	$150	$600
GPS Clock (If no Server Connection)	4	$260	$1,040	$260	$1,040	$260	$1,040	$260	$1,040
RF/GPS Unit & Antenna Clamp	4	----	----	----	----	$2,805	$11,220	$2,805	$11,220
GPS Cable	4	----	----	----	----	$150	$600	$150	$600
170E Controller	4	$2,750	$11,000	----	----	$2,750	$11,000	----	----
2070 Advanced Traffic Controller w/ Omni EX	4	----	----	$3,550	$14,200	----	----	$3,550	$14,200
	Subtotal	----	$90,640	----	$93,840	----	$65,860	----	$69,060
Major/Major Intersection (4/4, 4/6 or 6/6)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$11,500	$0	$11,500	$0	$6,000	$0	$6,000	$0
6-15 Intersections	10	$6,500	$65,000	$6,500	$65,000	$4,500	$45,000	$4,500	$45,000
16-30 Intersections	0	$4,000	$0	$4,000	$0	$3,000	$0	$3,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	10	$1,000	$10,000	$1,000	$10,000	$800	$8,000	$800	$8,000
Integration, Configuration & Testing Services	10	$600	$6,000	$600	$6,000	$600	$6,000	$600	$6,000
Traffic Permits	10	$600	$6,000	$600	$6,000	$600	$6,000	$600	$6,000
Engineering Support	10	$1,000	$10,000	$1,000	$10,000	$1,000	$10,000	$1,000	$10,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	10	$3,000	$30,000	$3,000	$30,000	$3,000	$30,000	$3,000	$30,000
2 x IR Detectors	10	$2,400	$24,000	$2,400	$24,000	----	----	----	----
Detectors Wiring	10	$5,000	$50,000	$5,000	$50,000	----	----	----	----
Aux Panel & Green Sense Cable	10	$350	$3,500	$350	$3,500	$350	$3,500	$350	$3,500
Aux Panel Casing	10	$150	$1,500	$150	$1,500	$150	$1,500	$150	$1,500
GPS Clock (If no Server Connection)	10	$260	$2,600	$260	$2,600	$260	$2,600	$260	$2,600
RF/GPS Unit & Antenna Clamp	10	----	----	----	----	$2,805	$28,050	$2,805	$28,050
GPS Cable	10	----	----	----	----	$150	$1,500	$150	$1,500
170E Controller	10	$2,750	$27,500	----	----	$2,750	$27,500	----	----
2070 Advanced Traffic Controller w/ Omni EX	10	----	----	$3,550	$35,500	----	----	$3,550	$35,500
	Subtotal	----	$236,100	----	$244,100	----	$169,650	----	$177,650
	Intersections Subtotal	**$326,740**		**$337,940**		**$235,510**		**$246,710**	

Buses		Infrared Technology				Radio/GPS Technology			
In-Vehicle Equipment	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Multimode LED Emitter	18	$1,750	$31,500	$1,750	$31,500	----	----	----	----
Radio/GPS Vehicle Kit	18	----	----	----	----	$3,000	$54,000	$3,000	$54,000
In-Vehicle Installation	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Bus Installation	18	$1,500	$27,000	$1,500	$27,000	$1,000	$18,000	$1,000	$18,000
Engineering Support	18	$500	$9,000	$500	$9,000	$500	$9,000	$500	$9,000
Spares	5	----	$18,750	----	$18,750	----	$22,500	----	$22,500
	Buses Subtotal	$3,750	**$86,250**	$3,750	**$86,250**	$4,500	**$103,500**	$4,500	**$103,500**

Buses Subtotal Breakdown by Route	Quantity	Subtotal	Subtotal	Subtotal	Subtotal
Route 815 Subtotal*	2	$7,500	$7,500	$9,000	$9,000
Spares	1	$3,750	$3,750	$4,500	$4,500
Route 815 Total		$11,250	$11,250	$13,500	$13,500
Route 816 Subtotal*	3	$11,250	$11,250	$13,500	$13,500
Spares	1	$3,750	$3,750	$4,500	$4,500
Route 816 Total		$15,000	$15,000	$18,000	$18,000
Route 833 Subtotal*	2	$7,500	$7,500	$9,000	$9,000
Spares	1	$3,750	$3,750	$4,500	$4,500
Route 833 Total		$11,250	$11,250	$13,500	$13,500
Route 848 Subtotal*	3	$11,250	$11,250	$13,500	$13,500
Spares	1	$3,750	$3,750	$4,500	$4,500
Route 848 Total		$15,000	$15,000	$18,000	$18,000
Route 871, 872, 874, 875 (interlined) Subtotal*	7	$26,250	$26,250	$31,500	$31,500
Spares	2	$7,500	$7,500	$9,000	$9,000
Route 871, 872, 874, 875 Total		$33,750	$33,750	$40,500	$40,500
Route 894 Subtotal*	1	$3,750	$3,750	$4,500	$4,500
Spares	0	$0	$0	$0	$0
Route 894 Total		$3,750	$3,750	$4,500	$4,500
Intersections and Buses Subtotal		$412,990	$424,190	$339,010	$350,210

Management and Design		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$41,299**	**$42,419**	**$33,901**	**$35,021**
Contract Procurement					
Subtotal	10%	**$41,299**	**$42,419**	**$33,901**	**$35,021**
Contingency		20% of All Previous Costs			
Subtotal	20%	**$99,118**	**$101,806**	**$81,362**	**$84,050**

Note: If TSP is part of a broader BRT project, traffic control and traffic permit costs can be zeroed out.
*The number of buses consists of the total buses needed to run peak operations for each route and **30% of the cost of retrofitting the peak number of buses on a route was used to account for spare buses.

	Option 1	Option 2	Option 3	Option 4
	Infrared Technology		Radio/GPS Technology	
	Type A 170E + IR Emitter	Type B 2070ATC + IR Emitter	Type C 170E + Radio/GPS	Type D 2070ATC + Radio/GPS
Total Corridor Cost	**$594,706**	**$610,834**	**$488,174**	**$504,302**

IBOT Capital Cost Estimate: Corridor 6 - H St. between Woodlawn Ave. and Southwestern College

Minor/Minor Intersection (2/2 or 2/3)		Option 1		Option 2		Option 3		Option 4	
		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	1	$5,500	$5,500	$5,500	$5,500	$2,000	$2,000	$2,000	$2,000
6-15 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
16-30 Intersections	0	$2,000	$0	$2,000	$0	$1,000	$0	$1,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	1	$1,000	$1,000	$1,000	$1,000	$800	$800	$800	$800
Integration, Configuration & Testing Services	1	$600	$600	$600	$600	$600	$600	$600	$600
Traffic Permits	1	$600	$600	$600	$600	$600	$600	$600	$600
Engineering Support	1	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	1	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
2 x IR Detectors	1	$1,200	$1,200	$1,200	$1,200	----	----	----	----
Detectors Wiring	1	$3,500	$3,500	$3,500	$3,500	----	----	----	----
Aux Panel & Green Sense Cable	1	$350	$350	$350	$350	$350	$350	$350	$350
Aux Panel Casing	1	$150	$150	$150	$150	$150	$150	$150	$150
GPS Clock (If no Server Connection)	1	$260	$260	$260	$260	$260	$260	$260	$260
RF/GPS Unit & Antenna Clamp	1	----	----	----	----	$2,805	$2,805	$2,805	$2,805
GPS Cable	1	----	----	----	----	$150	$150	$150	$150
170E Controller	1	$2,750	$2,750	----	----	$2,750	$2,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	1	----	----	$3,550	$3,550	----	----	$3,550	$3,550
	Subtotal	----	$19,910	----	$20,710	----	$14,465	----	$15,265
Minor/Major Intersection (2/4 or 3/4)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$7,500	$0	$7,500	$0	$4,000	$0	$4,000	$0
6-15 Intersections	11	$5,500	$60,500	$5,500	$60,500	$2,500	$27,500	$2,500	$27,500
16-30 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	11	$1,000	$11,000	$1,000	$11,000	$800	$8,800	$800	$8,800
Integration, Configuration & Testing Services	11	$600	$6,600	$600	$6,600	$600	$6,600	$600	$6,600
Traffic Permits	11	$600	$6,600	$600	$6,600	$600	$6,600	$600	$6,600
Engineering Support	11	$1,000	$11,000	$1,000	$11,000	$1,000	$11,000	$1,000	$11,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	11	$3,000	$33,000	$3,000	$33,000	$3,000	$33,000	$3,000	$33,000
2 x IR Detectors	11	$1,200	$13,200	$1,200	$13,200	----	----	----	----
Detectors Wiring	11	$4,250	$46,750	$4,250	$46,750	----	----	----	----
Aux Panel & Green Sense Cable	11	$350	$3,850	$350	$3,850	$350	$3,850	$350	$3,850
Aux Panel Casing	11	$150	$1,650	$150	$1,650	$150	$1,650	$150	$1,650
GPS Clock (If no Server Connection)	11	$260	$2,860	$260	$2,860	$260	$2,860	$260	$2,860
RF/GPS Unit & Antenna Clamp	11	----	----	----	----	$2,805	$30,855	$2,805	$30,855
GPS Cable	11	----	----	----	----	$150	$1,650	$150	$1,650
170E Controller	11	$2,750	$30,250	----	----	$2,750	$30,250	----	----
2070 Advanced Traffic Controller w/ Omni EX	11	----	----	$3,550	$39,050	----	----	$3,550	$39,050
	Subtotal	----	$227,260	----	$236,060	----	$164,615	----	$173,415
Major/Major Intersection (4/4, 4/6 or 6/6)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$11,500	$0	$11,500	$0	$6,000	$0	$6,000	$0
6-15 Intersections	9	$6,500	$58,500	$6,500	$58,500	$4,500	$40,500	$4,500	$40,500
16-30 Intersections	0	$4,000	$0	$4,000	$0	$3,000	$0	$3,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	9	$1,000	$9,000	$1,000	$9,000	$800	$7,200	$800	$7,200
Integration, Configuration & Testing Services	9	$600	$5,400	$600	$5,400	$600	$5,400	$600	$5,400
Traffic Permits	9	$600	$5,400	$600	$5,400	$600	$5,400	$600	$5,400
Engineering Support	9	$1,000	$9,000	$1,000	$9,000	$1,000	$9,000	$1,000	$9,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	9	$3,000	$27,000	$3,000	$27,000	$3,000	$27,000	$3,000	$27,000
2 x IR Detectors	9	$2,400	$21,600	$2,400	$21,600	----	----	----	----
Detectors Wiring	9	$5,000	$45,000	$5,000	$45,000	----	----	----	----
Aux Panel & Green Sense Cable	9	$350	$3,150	$350	$3,150	$350	$3,150	$350	$3,150
Aux Panel Casing	9	$150	$1,350	$150	$1,350	$150	$1,350	$150	$1,350
GPS Clock (If no Server Connection)	9	$260	$2,340	$260	$2,340	$260	$2,340	$260	$2,340
RF/GPS Unit & Antenna Clamp	9	----	----	----	----	$2,805	$25,245	$2,805	$25,245
GPS Cable	9	----	----	----	----	$150	$1,350	$150	$1,350
170E Controller	9	$2,750	$24,750	----	----	$2,750	$24,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	9	----	----	$3,550	$31,950	----	----	$3,550	$31,950
	Subtotal	----	$212,490	----	$219,690	----	$152,685	----	$159,885
	Intersections Subtotal	**$459,660**		**$476,460**		**$331,765**		**$348,565**	

Buses		Infrared Technology				Radio/GPS Technology			
In-Vehicle Equipment	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Multimode LED Emitter	16	$1,750	$28,000	$1,750	$28,000	----	----	----	----
Radio/GPS Vehicle Kit	16	----	----	----	----	$3,000	$48,000	$3,000	$48,000
In-Vehicle Installation	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Bus Installation	16	$1,500	$24,000	$1,500	$24,000	$1,000	$16,000	$1,000	$16,000
Engineering Support	16	$500	$8,000	$500	$8,000	$500	$8,000	$500	$8,000
Spares	5	----	$18,750	----	$18,750	----	$22,500	----	$22,500
Buses Subtotal		$3,750	**$78,750**	$3,750	**$78,750**	$4,500	**$94,500**	$4,500	**$94,500**

Buses Subtotal Breakdown by Route	Quantity	Subtotal	Subtotal	Subtotal	Subtotal
Route 701 Subtotal*	7	$26,250	$26,250	$31,500	$31,500
Spares	2	$7,500	$7,500	$9,000	$9,000
Route 701 Total		$33,750	$33,750	$40,500	$40,500
Route 709 Subtotal*	9	$33,750	$33,750	$40,500	$40,500
Spares	3	$11,250	$11,250	$13,500	$13,500
Route 709 Total		$45,000	$45,000	$54,000	$54,000
Intersections and Buses Subtotal		$538,410	$555,210	$426,265	$443,065

Management and Design		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$53,841**	**$55,521**	**$42,627**	**$44,307**
Contract Procurement		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$53,841**	**$55,521**	**$42,627**	**$44,307**
Contingency		20% of All Previous Costs			
Subtotal	20%	**$129,218**	**$133,250**	**$102,304**	**$106,336**

Note: If TSP is part of a broader BRT project, traffic control and traffic permit costs can be zeroed out.
*The number of buses consists of the total buses needed to run peak operations for each route and **30% of the cost of retrofitting the peak number of buses on a route was used to account for spare buses.

	Option 1	Option 2	Option 3	Option 4
	Infrared Technology		Radio/GPS Technology	
	Type A 170E + IR Emitter	Type B 2070ATC + IR Emitter	Type C 170E + Radio/GPS	Type D 2070ATC + Radio/GPS
Total Corridor Cost	**$775,310**	**$799,502**	**$613,822**	**$638,014**

IBOT Capital Cost Estimate: Corridor 7 - 54th St./Euclid Ave. between Logan Ave. and Monroe Ave.

		Option 1		Option 2		Option 3		Option 4	
Minor/Minor Intersection (2/2 or 2/3)		**Infrared Technology**				**Radio/GPS Technology**			
		Type A 170E + IR Emitter		**Type B 2070ATC + IR Emitter**		**Type C 170E + Radio/GPS**		**Type D 2070ATC + Radio/GPS**	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$5,500	$0	$5,500	$0	$2,000	$0	$2,000	$0
6-15 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
16-30 Intersections	0	$2,000	$0	$2,000	$0	$1,000	$0	$1,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	0	$1,000	$0	$1,000	$0	$800	$0	$800	$0
Integration, Configuration & Testing Services	0	$600	$0	$600	$0	$600	$0	$600	$0
Traffic Permits	0	$600	$0	$600	$0	$600	$0	$600	$0
Engineering Support	0	$1,000	$0	$1,000	$0	$1,000	$0	$1,000	$0
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	0	$3,000	$0	$3,000	$0	$3,000	$0	$3,000	$0
2 x IR Detectors	0	$1,200	$0	$1,200	$0	----	----	----	----
Detectors Wiring	0	$3,500	$0	$3,500	$0	----	----	----	----
Aux Panel & Green Sense Cable	0	$350	$0	$350	$0	$350	$0	$350	$0
Aux Panel Casing	0	$150	$0	$150	$0	$150	$0	$150	$0
GPS Clock (If no Server Connection)	0	$260	$0	$260	$0	$260	$0	$260	$0
RF/GPS Unit & Antenna Clamp	0	----	----	----	----	$2,805	$0	$2,805	$0
GPS Cable	0	----	----	----	----	$150	$0	$150	$0
170E Controller	0	$2,750	$0	----	----	$2,750	$0	----	----
2070 Advanced Traffic Controller w/ Omni EX	0	----	----	$3,550	$0	----	----	$3,550	$0
	Subtotal	----	$0	----	$0	----	$0	----	$0
Minor/Major Intersection (2/4 or 3/4)		**Infrared Technology**				**Radio/GPS Technology**			
		Type A 170E + IR Emitter		**Type B 2070ATC + IR Emitter**		**Type C 170E + Radio/GPS**		**Type D 2070ATC + Radio/GPS**	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$7,500	$0	$7,500	$0	$4,000	$0	$4,000	$0
6-15 Intersections	14	$5,500	$77,000	$5,500	$77,000	$2,500	$35,000	$2,500	$35,000
16-30 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	14	$1,000	$14,000	$1,000	$14,000	$800	$11,200	$800	$11,200
Integration, Configuration & Testing Services	14	$600	$8,400	$600	$8,400	$600	$8,400	$600	$8,400
Traffic Permits	14	$600	$8,400	$600	$8,400	$600	$8,400	$600	$8,400
Engineering Support	14	$1,000	$14,000	$1,000	$14,000	$1,000	$14,000	$1,000	$14,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	14	$3,000	$42,000	$3,000	$42,000	$3,000	$42,000	$3,000	$42,000
2 x IR Detectors	14	$1,200	$16,800	$1,200	$16,800	----	----	----	----
Detectors Wiring	14	$4,250	$59,500	$4,250	$59,500	----	----	----	----
Aux Panel & Green Sense Cable	14	$350	$4,900	$350	$4,900	$350	$4,900	$350	$4,900
Aux Panel Casing	14	$150	$2,100	$150	$2,100	$150	$2,100	$150	$2,100
GPS Clock (If no Server Connection)	14	$260	$3,640	$260	$3,640	$260	$3,640	$260	$3,640
RF/GPS Unit & Antenna Clamp	14	----	----	----	----	$2,805	$39,270	$2,805	$39,270
GPS Cable	14	----	----	----	----	$150	$2,100	$150	$2,100
170E Controller	14	$2,750	$38,500	----	----	$2,750	$38,500	----	----
2070 Advanced Traffic Controller w/ Omni EX	14	----	----	$3,550	$49,700	----	----	$3,550	$49,700
	Subtotal	----	$289,240	----	$300,440	----	$209,510	----	$220,710
Major/Major Intersection (4/4, 4/6 or 6/6)		**Infrared Technology**				**Radio/GPS Technology**			
		Type A 170E + IR Emitter		**Type B 2070ATC + IR Emitter**		**Type C 170E + Radio/GPS**		**Type D 2070ATC + Radio/GPS**	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$11,500	$0	$11,500	$0	$6,000	$0	$6,000	$0
6-15 Intersections	6	$6,500	$39,000	$6,500	$39,000	$4,500	$27,000	$4,500	$27,000
16-30 Intersections	0	$4,000	$0	$4,000	$0	$3,000	$0	$3,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	6	$1,000	$6,000	$1,000	$6,000	$800	$4,800	$800	$4,800
Integration, Configuration & Testing Services	6	$600	$3,600	$600	$3,600	$600	$3,600	$600	$3,600
Traffic Permits	6	$600	$3,600	$600	$3,600	$600	$3,600	$600	$3,600
Engineering Support	6	$1,000	$6,000	$1,000	$6,000	$1,000	$6,000	$1,000	$6,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	6	$3,000	$18,000	$3,000	$18,000	$3,000	$18,000	$3,000	$18,000
2 x IR Detectors	6	$2,400	$14,400	$2,400	$14,400	----	----	----	----
Detectors Wiring	6	$5,000	$30,000	$5,000	$30,000	----	----	----	----
Aux Panel & Green Sense Cable	6	$350	$2,100	$350	$2,100	$350	$2,100	$350	$2,100
Aux Panel Casing	6	$150	$900	$150	$900	$150	$900	$150	$900
GPS Clock (If no Server Connection)	6	$260	$1,560	$260	$1,560	$260	$1,560	$260	$1,560
RF/GPS Unit & Antenna Clamp	6	----	----	----	----	$2,805	$16,830	$2,805	$16,830
GPS Cable	6	----	----	----	----	$150	$900	$150	$900
170E Controller	6	$2,750	$16,500	----	----	$2,750	$16,500	----	----
2070 Advanced Traffic Controller w/ Omni EX	6	----	----	$3,550	$21,300	----	----	$3,550	$21,300
	Subtotal	----	$141,660	----	$146,460	----	$101,790	----	$106,590
	Intersections Subtotal	**$430,900**		**$446,900**		**$311,300**		**$327,300**	

Buses		**Infrared Technology**				**Radio/GPS Technology**			
In-Vehicle Equipment	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Multimode LED Emitter	37	$1,750	$64,750	$1,750	$64,750	----	----	----	----
Radio/GPS Vehicle Kit	37	----	----	----	----	$3,000	$111,000	$3,000	$111,000
In-Vehicle Installation	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Bus Installation	37	$1,500	$55,500	$1,500	$55,500	$1,000	$37,000	$1,000	$37,000
Engineering Support	37	$500	$18,500	$500	$18,500	$500	$18,500	$500	$18,500
Spares	11	----	$41,250	----	$41,250	----	$49,500	----	$49,500
	Buses Subtotal	$3,750	**$180,000**	$3,750	**$180,000**	$4,500	**$216,000**	$4,500	**$216,000**

Buses Subtotal Breakdown by Route	Quantity	Subtotal	Subtotal	Subtotal	Subtotal
Route 3 Subtotal*	11	$41,250	$41,250	$49,500	$49,500
Spares	3	$11,250	$11,250	$13,500	$13,500
Route 3 Total		$52,500	$52,500	$63,000	$63,000
Route 4 Subtotal*	4	$15,000	$15,000	$18,000	$18,000
Spares	1	$3,750	$3,750	$4,500	$4,500
Route 4 Total		$18,750	$18,750	$22,500	$22,500
Route 10 Subtotal*	10	$37,500	$37,500	$45,000	$45,000
Spares	3	$11,250	$11,250	$13,500	$13,500
Route 13 Total		$48,750	$48,750	$58,500	$58,500
Route 916 Subtotal*	2	$7,500	$7,500	$9,000	$9,000
Spares	1	$3,750	$3,750	$4,500	$4,500
Route 916 Total		$11,250	$11,250	$13,500	$13,500
Route 917 Subtotal*	1	$3,750	$3,750	$4,500	$4,500
Spares	0	$0	$0	$0	$0
Route 917 Total		$3,750	$3,750	$4,500	$4,500
Route 955 Subtotal*	9	$33,750	$33,750	$40,500	$40,500
Spares	3	$11,250	$11,250	$13,500	$13,500
Route 955 Total		$45,000	$45,000	$54,000	$54,000
Intersections and Buses Subtotal		$610,900	$626,900	$527,300	$543,300

Management and Design		**10% of Intersections and Buses Subtotal**			
Subtotal	10%	**$61,090**	**$62,690**	**$52,730**	**$54,330**
Contract Procurement					
Subtotal	10%	**$61,090**	**$62,690**	**$52,730**	**$54,330**
Contingency		**20% of All Previous Costs**			
Subtotal	20%	**$146,616**	**$150,456**	**$126,552**	**$130,392**

Note: If TSP is part of a broader BRT project, traffic control and traffic permit costs can be zeroed out.
*The number of buses consists of the total buses needed to run peak operations for each route and **30% of the cost of retrofitting the peak number of buses on a route was used to account for spare buses.

	Option 1	Option 2	Option 3	Option 4
	Infrared Technology		**Radio/GPS Technology**	
	Type A 170E + IR Emitter	**Type B 2070ATC + IR Emitter**	**Type C 170E + Radio/GPS**	**Type D 2070ATC + Radio/GPS**
Total Corridor Cost	**$879,696**	**$902,736**	**$759,312**	**$782,352**

IBOT Capital Cost Estimate: Corridor 8 - Linda Vista Rd. between Old Town TC and Armstrong St.

Minor/Minor Intersection (2/2 or 2/3)		Option 1		Option 2		Option 3		Option 4	
		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$5,500	$0	$5,500	$0	$2,000	$0	$2,000	$0
6-15 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
16-30 Intersections	0	$2,000	$0	$2,000	$0	$1,000	$0	$1,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	0	$1,000	$0	$1,000	$0	$800	$0	$800	$0
Integration, Configuration & Testing Services	0	$600	$0	$600	$0	$600	$0	$600	$0
Traffic Permits	0	$600	$0	$600	$0	$600	$0	$600	$0
Engineering Support	0	$1,000	$0	$1,000	$0	$1,000	$0	$1,000	$0
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	0	$3,000	$0	$3,000	$0	$3,000	$0	$3,000	$0
2 x IR Detectors	0	$1,200	$0	$1,200	$0	----	----	----	----
Detectors Wiring	0	$3,500	$0	$3,500	$0	----	----	----	----
Aux Panel & Green Sense Cable	0	$350	$0	$350	$0	$350	$0	$350	$0
Aux Panel Casing	0	$150	$0	$150	$0	$150	$0	$150	$0
GPS Clock (If no Server Connection)	0	$260	$0	$260	$0	$260	$0	$260	$0
RF/GPS Unit & Antenna Clamp	0	----	----	----	----	$2,805	$0	$2,805	$0
GPS Cable	0	----	----	----	----	$150	$0	$150	$0
170E Controller	0	$2,750	$0	----	----	$2,750	$0	----	----
2070 Advanced Traffic Controller w/ Omni EX	0	----	----	$3,550	$0	----	----	$3,550	$0
Subtotal		----	$0	----	$0	----	$0	----	$0

Minor/Major Intersection (2/4 or 3/4)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$7,500	$0	$7,500	$0	$4,000	$0	$4,000	$0
6-15 Intersections	13	$5,500	$71,500	$5,500	$71,500	$2,500	$32,500	$2,500	$32,500
16-30 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	13	$1,000	$13,000	$1,000	$13,000	$800	$10,400	$800	$10,400
Integration, Configuration & Testing Services	13	$600	$7,800	$600	$7,800	$600	$7,800	$600	$7,800
Traffic Permits	13	$600	$7,800	$600	$7,800	$600	$7,800	$600	$7,800
Engineering Support	13	$1,000	$13,000	$1,000	$13,000	$1,000	$13,000	$1,000	$13,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	13	$3,000	$39,000	$3,000	$39,000	$3,000	$39,000	$3,000	$39,000
2 x IR Detectors	13	$1,200	$15,600	$1,200	$15,600	----	----	----	----
Detectors Wiring	13	$4,250	$55,250	$4,250	$55,250	----	----	----	----
Aux Panel & Green Sense Cable	13	$350	$4,550	$350	$4,550	$350	$4,550	$350	$4,550
Aux Panel Casing	13	$150	$1,950	$150	$1,950	$150	$1,950	$150	$1,950
GPS Clock (If no Server Connection)	13	$260	$3,380	$260	$3,380	$260	$3,380	$260	$3,380
RF/GPS Unit & Antenna Clamp	13	----	----	----	----	$2,805	$36,465	$2,805	$36,465
GPS Cable	13	----	----	----	----	$150	$1,950	$150	$1,950
170E Controller	13	$2,750	$35,750	----	----	$2,750	$35,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	13	----	----	$3,550	$46,150	----	----	$3,550	$46,150
Subtotal		----	$268,580	----	$278,980	----	$194,545	----	$204,945

Major/Major Intersection (4/4, 4/6 or 6/6)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	4	$11,500	$46,000	$11,500	$46,000	$6,000	$24,000	$6,000	$24,000
6-15 Intersections	0	$6,500	$0	$6,500	$0	$4,500	$0	$4,500	$0
16-30 Intersections	0	$4,000	$0	$4,000	$0	$3,000	$0	$3,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	4	$1,000	$4,000	$1,000	$4,000	$800	$3,200	$800	$3,200
Integration, Configuration & Testing Services	4	$600	$2,400	$600	$2,400	$600	$2,400	$600	$2,400
Traffic Permits	4	$600	$2,400	$600	$2,400	$600	$2,400	$600	$2,400
Engineering Support	4	$1,000	$4,000	$1,000	$4,000	$1,000	$4,000	$1,000	$4,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	4	$3,000	$12,000	$3,000	$12,000	$3,000	$12,000	$3,000	$12,000
2 x IR Detectors	4	$2,400	$9,600	$2,400	$9,600	----	----	----	----
Detectors Wiring	4	$5,000	$20,000	$5,000	$20,000	----	----	----	----
Aux Panel & Green Sense Cable	4	$350	$1,400	$350	$1,400	$350	$1,400	$350	$1,400
Aux Panel Casing	4	$150	$600	$150	$600	$150	$600	$150	$600
GPS Clock (If no Server Connection)	4	$260	$1,040	$260	$1,040	$260	$1,040	$260	$1,040
RF/GPS Unit & Antenna Clamp	4	----	----	----	----	$2,805	$11,220	$2,805	$11,220
GPS Cable	4	----	----	----	----	$150	$600	$150	$600
170E Controller	4	$2,750	$11,000	----	----	$2,750	$11,000	----	----
2070 Advanced Traffic Controller w/ Omni EX	4	----	----	$3,550	$14,200	----	----	$3,550	$14,200
Subtotal		----	$114,440	----	$117,640	----	$73,860	----	$77,060
Intersections Subtotal		**$383,020**		**$396,620**		**$268,405**		**$282,005**	

Buses		Infrared Technology				Radio/GPS Technology			
In-Vehicle Equipment	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Multimode LED Emitter	19	$1,750	$33,250	$1,750	$33,250	----	----	----	----
Radio/GPS Vehicle Kit	19	----	----	----	----	$3,000	$57,000	$3,000	$57,000
In-Vehicle Installation	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Bus Installation	19	$1,500	$28,500	$1,500	$28,500	$1,000	$19,000	$1,000	$19,000
Engineering Support	19	$500	$9,500	$500	$9,500	$500	$9,500	$500	$9,500
Spares	6	----	$22,500	----	$22,500	----	$27,000	----	$27,000
Buses Subtotal		$3,750	**$93,750**	$3,750	**$93,750**	$4,500	**$112,500**	$4,500	**$112,500**

Buses Subtotal Breakdown by Route	Quantity	Subtotal	Subtotal	Subtotal	Subtotal
Route 44 Subtotal*	13	$48,750	$48,750	$58,500	$58,500
Spares	4	$15,000	$15,000	$18,000	$18,000
Route 44 Total		$63,750	$63,750	$76,500	$76,500
Route 120 Subtotal*	6	$22,500	$22,500	$27,000	$27,000
Spares	2	$7,500	$7,500	$9,000	$9,000
Route 120 Total		$30,000	$30,000	$36,000	$36,000
Intersections and Buses Subtotal		$476,770	$490,370	$380,905	$394,505

Management and Design		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$47,677**	**$49,037**	**$38,091**	**$39,451**
Contract Procurement		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$47,677**	**$49,037**	**$38,091**	**$39,451**
Contingency		20% of All Previous Costs			
Subtotal	20%	**$114,425**	**$117,689**	**$91,417**	**$94,681**

Note: If TSP is part of a broader BRT project, traffic control and traffic permit costs can be zeroed out.
*The number of buses consists of the total buses needed to run peak operations for each route and **30% of the cost of retrofitting the peak number of buses on a route was used to account for spare buses.

	Option 1	Option 2	Option 3	Option 4
	Infrared Technology		Radio/GPS Technology	
	Type A 170E + IR Emitter	Type B 2070ATC + IR Emitter	Type C 170E + Radio/GPS	Type D 2070ATC + Radio/GPS
Total Corridor Cost	**$686,549**	**$706,133**	**$548,503**	**$568,087**

IBOT Capital Cost Estimate: Corridor 9 - Fairmount Ave. between Home Ave. and Orange Ave.

Minor/Minor Intersection (2/2 or 2/3)		Option 1		Option 2		Option 3		Option 4	
		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$5,500	$0	$5,500	$0	$2,000	$0	$2,000	$0
6-15 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
16-30 Intersections	0	$2,000	$0	$2,000	$0	$1,000	$0	$1,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	0	$1,000	$0	$1,000	$0	$800	$0	$800	$0
Integration, Configuration & Testing Services	0	$600	$0	$600	$0	$600	$0	$600	$0
Traffic Permits	0	$600	$0	$600	$0	$600	$0	$600	$0
Engineering Support	0	$1,000	$0	$1,000	$0	$1,000	$0	$1,000	$0
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	0	$3,000	$0	$3,000	$0	$3,000	$0	$3,000	$0
2 x IR Detectors	0	$1,200	$0	$1,200	$0	----	----	----	----
Detectors Wiring	0	$3,500	$0	$3,500	$0	----	----	----	----
Aux Panel & Green Sense Cable	0	$350	$0	$350	$0	$350	$0	$350	$0
Aux Panel Casing	0	$150	$0	$150	$0	$150	$0	$150	$0
GPS Clock (If no Server Connection)	0	$260	$0	$260	$0	$260	$0	$260	$0
RF/GPS Unit & Antenna Clamp	0	----	----	----	----	$2,805	$0	$2,805	$0
GPS Cable	0	----	----	----	----	$150	$0	$150	$0
170E Controller	0	$2,750	$0	----	----	$2,750	$0	----	----
2070 Advanced Traffic Controller w/ Omni EX	0	----	----	$3,550	$0	----	----	$3,550	$0
	Subtotal	----	$0	----	$0	----	$0	----	$0

Minor/Major Intersection (2/4 or 3/4)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$7,500	$0	$7,500	$0	$4,000	$0	$4,000	$0
6-15 Intersections	9	$5,500	$49,500	$5,500	$49,500	$2,500	$22,500	$2,500	$22,500
16-30 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	9	$1,000	$9,000	$1,000	$9,000	$800	$7,200	$800	$7,200
Integration, Configuration & Testing Services	9	$600	$5,400	$600	$5,400	$600	$5,400	$600	$5,400
Traffic Permits	9	$600	$5,400	$600	$5,400	$600	$5,400	$600	$5,400
Engineering Support	9	$1,000	$9,000	$1,000	$9,000	$1,000	$9,000	$1,000	$9,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	9	$3,000	$27,000	$3,000	$27,000	$3,000	$27,000	$3,000	$27,000
2 x IR Detectors	9	$1,200	$10,800	$1,200	$10,800	----	----	----	----
Detectors Wiring	9	$4,250	$38,250	$4,250	$38,250	----	----	----	----
Aux Panel & Green Sense Cable	9	$350	$3,150	$350	$3,150	$350	$3,150	$350	$3,150
Aux Panel Casing	9	$150	$1,350	$150	$1,350	$150	$1,350	$150	$1,350
GPS Clock (If no Server Connection)	9	$260	$2,340	$260	$2,340	$260	$2,340	$260	$2,340
RF/GPS Unit & Antenna Clamp	9	----	----	----	----	$2,805	$25,245	$2,805	$25,245
GPS Cable	9	----	----	----	----	$150	$1,350	$150	$1,350
170E Controller	9	$2,750	$24,750	----	----	$2,750	$24,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	9	----	----	$3,550	$31,950	----	----	$3,550	$31,950
	Subtotal	----	$185,940	----	$193,140	----	$134,685	----	$141,885

Major/Major Intersection (4/4, 4/6 or 6/6)		Infrared Technology				Radio/GPS Technology			
		Type A 170E + IR Emitter		Type B 2070ATC + IR Emitter		Type C 170E + Radio/GPS		Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	1	$11,500	$11,500	$11,500	$11,500	$6,000	$6,000	$6,000	$6,000
6-15 Intersections	0	$6,500	$0	$6,500	$0	$4,500	$0	$4,500	$0
16-30 Intersections	0	$4,000	$0	$4,000	$0	$3,000	$0	$3,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	1	$1,000	$1,000	$1,000	$1,000	$800	$800	$800	$800
Integration, Configuration & Testing Services	1	$600	$600	$600	$600	$600	$600	$600	$600
Traffic Permits	1	$600	$600	$600	$600	$600	$600	$600	$600
Engineering Support	1	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	1	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
2 x IR Detectors	1	$2,400	$2,400	$2,400	$2,400	----	----	----	----
Detectors Wiring	1	$5,000	$5,000	$5,000	$5,000	----	----	----	----
Aux Panel & Green Sense Cable	1	$350	$350	$350	$350	$350	$350	$350	$350
Aux Panel Casing	1	$150	$150	$150	$150	$150	$150	$150	$150
GPS Clock (If no Server Connection)	1	$260	$260	$260	$260	$260	$260	$260	$260
RF/GPS Unit & Antenna Clamp	1	----	----	----	----	$2,805	$2,805	$2,805	$2,805
GPS Cable	1	----	----	----	----	$150	$150	$150	$150
170E Controller	1	$2,750	$2,750	----	----	$2,750	$2,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	1	----	----	$3,550	$3,550	----	----	$3,550	$3,550
	Subtotal	----	$28,610	----	$29,410	----	$18,465	----	$19,265
	Intersections Subtotal	**$214,550**		**$222,550**		**$153,150**		**$161,150**	

Buses		Infrared Technology				Radio/GPS Technology			
In-Vehicle Equipment	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Multimode LED Emitter	10	$1,750	$17,500	$1,750	$17,500	----	----	----	----
Radio/GPS Vehicle Kit	10	----	----	----	----	$3,000	$30,000	$3,000	$30,000
In-Vehicle Installation	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Bus Installation	10	$1,500	$15,000	$1,500	$15,000	$1,000	$10,000	$1,000	$10,000
Engineering Support	10	$500	$5,000	$500	$5,000	$500	$5,000	$500	$5,000
Spares	3	----	$11,250	----	$11,250	----	$13,500	----	$13,500
	Buses Subtotal	$3,750	**$48,750**	$3,750	**$48,750**	$4,500	**$58,500**	$4,500	**$58,500**

Buses Subtotal Breakdown by Route	Quantity	Subtotal	Subtotal	Subtotal	Subtotal
Route 13 Subtotal*	10	$37,500	$37,500	$45,000	$45,000
Spares	3	$11,250	$11,250	$13,500	$13,500
Route 13 Total		$48,750	$48,750	$58,500	$58,500
Intersections and Buses Subtotal		$263,300	$271,300	$211,650	$219,650

Management and Design		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$26,330**	**$27,130**	**$21,165**	**$21,965**
Contract Procurement		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$26,330**	**$27,130**	**$21,165**	**$21,965**
Contingency		20% of All Previous Costs			
Subtotal	20%	**$63,192**	**$65,112**	**$50,796**	**$52,716**

Note: If TSP is part of a broader BRT project, traffic control and traffic permit costs can be zeroed out.
*The number of buses consists of the total buses needed to run peak operations for each route and **30% of the cost of retrofitting the peak number of buses on a route was used to account for spare buses.

	Option 1	Option 2	Option 3	Option 4
	Infrared Technology		Radio/GPS Technology	
	Type A 170E + IR Emitter	Type B 2070ATC + IR Emitter	Type C 170E + Radio/GPS	Type D 2070ATC + Radio/GPS
Total Corridor Cost	**$379,152**	**$390,672**	**$304,776**	**$316,296**

IBOT Capital Cost Estimate: Corridor 10 - College Ave. between Montezuma Rd. and Adelaide Ave & between Federal Blvd. and Lemon Grove Ave.

Minor/Minor Intersection (2/2 or 2/3)		Option 1 Infrared Technology Type A 170E + IR Emitter		Option 2 Infrared Technology Type B 2070ATC + IR Emitter		Option 3 Radio/GPS Technology Type C 170E + Radio/GPS		Option 4 Radio/GPS Technology Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$5,500	$0	$5,500	$0	$2,000	$0	$2,000	$0
6-15 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
16-30 Intersections	0	$2,000	$0	$2,000	$0	$1,000	$0	$1,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	0	$1,000	$0	$1,000	$0	$800	$0	$800	$0
Integration, Configuration & Testing Services	0	$600	$0	$600	$0	$600	$0	$600	$0
Traffic Permits	0	$600	$0	$600	$0	$600	$0	$600	$0
Engineering Support	0	$1,000	$0	$1,000	$0	$1,000	$0	$1,000	$0
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	0	$3,000	$0	$3,000	$0	$3,000	$0	$3,000	$0
2 x IR Detectors	0	$1,200	$0	$1,200	$0	----	----	----	----
Detectors Wiring	0	$3,500	$0	$3,500	$0	----	----	----	----
Aux Panel & Green Sense Cable	0	$350	$0	$350	$0	$350	$0	$350	$0
Aux Panel Casing	0	$150	$0	$150	$0	$150	$0	$150	$0
GPS Clock (If no Server Connection)	0	$260	$0	$260	$0	$260	$0	$260	$0
RF/GPS Unit & Antenna Clamp	0	----	----	----	----	$2,805	$0	$2,805	$0
GPS Cable	0	----	----	----	----	$150	$0	$150	$0
170E Controller	0	$2,750	$0	----	----	$2,750	$0	----	----
2070 Advanced Traffic Controller w/ Omni EX	0	----	----	$3,550	$0	----	----	$3,550	$0
Subtotal		----	$0	----	$0	----	$0	----	$0

Minor/Major Intersection (2/4 or 3/4)		Option 1 Infrared Technology Type A 170E + IR Emitter		Option 2 Infrared Technology Type B 2070ATC + IR Emitter		Option 3 Radio/GPS Technology Type C 170E + Radio/GPS		Option 4 Radio/GPS Technology Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	0	$7,500	$0	$7,500	$0	$4,000	$0	$4,000	$0
6-15 Intersections	7	$5,500	$38,500	$5,500	$38,500	$2,500	$17,500	$2,500	$17,500
16-30 Intersections	0	$3,500	$0	$3,500	$0	$1,500	$0	$1,500	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	7	$1,000	$7,000	$1,000	$7,000	$800	$5,600	$800	$5,600
Integration, Configuration & Testing Services	7	$600	$4,200	$600	$4,200	$600	$4,200	$600	$4,200
Traffic Permits	7	$600	$4,200	$600	$4,200	$600	$4,200	$600	$4,200
Engineering Support	7	$1,000	$7,000	$1,000	$7,000	$1,000	$7,000	$1,000	$7,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	7	$3,000	$21,000	$3,000	$21,000	$3,000	$21,000	$3,000	$21,000
2 x IR Detectors	7	$1,200	$8,400	$1,200	$8,400	----	----	----	----
Detectors Wiring	7	$4,250	$29,750	$4,250	$29,750	----	----	----	----
Aux Panel & Green Sense Cable	7	$350	$2,450	$350	$2,450	$350	$2,450	$350	$2,450
Aux Panel Casing	7	$150	$1,050	$150	$1,050	$150	$1,050	$150	$1,050
GPS Clock (If no Server Connection)	7	$260	$1,820	$260	$1,820	$260	$1,820	$260	$1,820
RF/GPS Unit & Antenna Clamp	7	----	----	----	----	$2,805	$19,635	$2,805	$19,635
GPS Cable	7	----	----	----	----	$150	$1,050	$150	$1,050
170E Controller	7	$2,750	$19,250	----	----	$2,750	$19,250	----	----
2070 Advanced Traffic Controller w/ Omni EX	7	----	----	$3,550	$24,850	----	----	$3,550	$24,850
Subtotal		----	$144,620	----	$150,220	----	$104,755	----	$110,355

Major/Major Intersection (4/4, 4/6 or 6/6)		Infrared Technology Type A 170E + IR Emitter		Infrared Technology Type B 2070ATC + IR Emitter		Radio/GPS Technology Type C 170E + Radio/GPS		Radio/GPS Technology Type D 2070ATC + Radio/GPS	
Traffic Control	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
0-5 Intersections	5	$11,500	$57,500	$11,500	$57,500	$6,000	$30,000	$6,000	$30,000
6-15 Intersections	0	$6,500	$0	$6,500	$0	$4,500	$0	$4,500	$0
16-30 Intersections	0	$4,000	$0	$4,000	$0	$3,000	$0	$3,000	$0
TSP Installation & Integration	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
TSP Installation	5	$1,000	$5,000	$1,000	$5,000	$800	$4,000	$800	$4,000
Integration, Configuration & Testing Services	5	$600	$3,000	$600	$3,000	$600	$3,000	$600	$3,000
Traffic Permits	5	$600	$3,000	$600	$3,000	$600	$3,000	$600	$3,000
Engineering Support	5	$1,000	$5,000	$1,000	$5,000	$1,000	$5,000	$1,000	$5,000
On-Site Equipment	Quantity	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal	Cost/Int.	Subtotal
Multimode Phase Selector (4 Channel)	5	$3,000	$15,000	$3,000	$15,000	$3,000	$15,000	$3,000	$15,000
2 x IR Detectors	5	$2,400	$12,000	$2,400	$12,000	----	----	----	----
Detectors Wiring	5	$5,000	$25,000	$5,000	$25,000	----	----	----	----
Aux Panel & Green Sense Cable	5	$350	$1,750	$350	$1,750	$350	$1,750	$350	$1,750
Aux Panel Casing	5	$150	$750	$150	$750	$150	$750	$150	$750
GPS Clock (If no Server Connection)	5	$260	$1,300	$260	$1,300	$260	$1,300	$260	$1,300
RF/GPS Unit & Antenna Clamp	5	----	----	----	----	$2,805	$14,025	$2,805	$14,025
GPS Cable	5	----	----	----	----	$150	$750	$150	$750
170E Controller	5	$2,750	$13,750	----	----	$2,750	$13,750	----	----
2070 Advanced Traffic Controller w/ Omni EX	5	----	----	$3,550	$17,750	----	----	$3,550	$17,750
Subtotal		----	$143,050	----	$147,050	----	$92,325	----	$96,325
Intersections Subtotal		**$287,670**		**$297,270**		**$197,080**		**$206,680**	

Management and Design		Infrared Technology				Radio/GPS Technology			
In-Vehicle Equipment	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Multimode LED Emitter	13	$1,750	$22,750	$1,750	$22,750	----	----	----	----
Radio/GPS Vehicle Kit	13	----	----	----	----	$3,000	$39,000	$3,000	$39,000
In-Vehicle Installation	Quantity	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal	Cost/Vehicle	Subtotal
Bus Installation	13	$1,500	$19,500	$1,500	$19,500	$1,000	$13,000	$1,000	$13,000
Engineering Support	13	$500	$6,500	$500	$6,500	$500	$6,500	$500	$6,500
Spares	4	----	$15,000	----	$15,000	----	$18,000	----	$18,000
Buses Subtotal		$3,750	**$63,750**	$3,750	**$63,750**	$4,500	**$76,500**	$4,500	**$76,500**

Buses Subtotal Breakdown by Route	Quantity	Subtotal	Subtotal	Subtotal	Subtotal
Route 856 Subtotal*	6	$22,500	$22,500	$27,000	$27,000
Spares	2	$7,500	$7,500	$9,000	$9,000
Route 856 Total		$30,000	$30,000	$36,000	$36,000
Route 916 Subtotal*	2	$7,500	$7,500	$9,000	$9,000
Spares	0	$0	$0	$0	$0
Route 916 Total		$7,500	$7,500	$9,000	$9,000
Route 917 Subtotal*	1	$3,750	$3,750	$4,500	$4,500
Spares	0	$0	$0	$0	$0
Route 917 Total		$3,750	$3,750	$4,500	$4,500
Route 936 Subtotal*	4	$15,000	$15,000	$18,000	$18,000
Spares	0	$0	$4,500	$5,400	$5,400
Route 936 Total		$15,000	$19,500	$23,400	$23,400
Intersections and Buses Subtotal		$351,420	$361,020	$273,580	$283,180

Management and Design		10% of Intersections and Buses Subtotal			
Subtotal	10%	**$35,142**	**$36,102**	**$27,358**	**$28,318**
Contract Procurement		**10% of Intersections and Buses Subtotal**			
Subtotal	10%	**$35,142**	**$36,102**	**$27,358**	**$28,318**
Contingency		**20% of All Previous Costs**			
Subtotal	20%	**$84,341**	**$86,645**	**$65,659**	**$67,963**

Note: If TSP is part of a broader BRT project, traffic control and traffic permit costs can be zeroed out.
*The number of buses consists of the total buses needed to run peak operations for each route and **30% of the cost of retrofitting the peak number of buses on a route was used to account for spare buses.

	Option 1 Infrared Technology Type A 170E + IR Emitter	Option 2 Infrared Technology Type B 2070ATC + IR Emitter	Option 3 Radio/GPS Technology Type C 170E + Radio/GPS	Option 4 Radio/GPS Technology Type D 2070ATC + Radio/GPS
Total Corridor Cost	**$506,045**	**$519,869**	**$393,955**	**$407,779**

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IBOT Annual Operations and Maintenance Cost Estimates: Summary

Corridor 1 - University Ave. between I-15 and Spring St.

Summary Costs Per Corridor		Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Category**	**Subtotals**	**Per**	**Annual Cost**
TSP Signal Maintenance	$67,275	Cities of San Diego, La Mesa	$74,475	Intersection	$2,864
TSP Vehicle Maintenance	$36,400	Transit Operator (MTS)	$47,920	Vehicle	$1,152
Monitoring and Management	$79,200	Regional Program (SANDAG)	$60,480		
Annual Total	**$182,875**	**Annual Total**	$182,875		

Corridor 2 - Mission Blvd. between Oceanside TC and San Luis Rey TC

Summary Costs Per Corridor		Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Category**	**Subtotals**	**Per**	**Annual Cost**
TSP Signal Maintenance	$64,688	City of Oceanside	$71,888	Intersection	$2,876
TSP Vehicle Maintenance	$39,813	Transit Operator (NCTD)	$51,333	Vehicle	$1,128
Monitoring and Management	$79,200	Regional Program (SANDAG)	$60,480		
Annual Total	**$183,700**	**Annual Total**	$183,700		

Corridor 3 - Genesee Ave. between SR-163 and Nobel Dr.

Summary Costs Per Corridor		Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Category**	**Subtotals**	**Per**	**Annual Cost**
TSP Signal Maintenance	$51,750	City of San Diego	$58,950	Intersection	$2,948
TSP Vehicle Maintenance	$31,850	Transit Operator (MTS)	$43,370	Vehicle	$1,191
Monitoring and Management	$79,200	Regional Program (SANDAG)	$60,480		
Annual Total	**$162,800**	**Annual Total**	$162,800		

Corridor 4 - Highland Ave. between 3rd St. and Main St. (via 3rd Ave.)

Summary Costs Per Corridor		Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Category**	**Subtotals**	**Per**	**Annual Cost**
TSP Signal Maintenance	$82,800	Cities of National City, Chula Vista	$90,000	Intersection	$2,813
TSP Vehicle Maintenance	$29,575	Transit Operator (MTS)	$41,095	Vehicle	$1,216
Monitoring and Management	$79,200	Regional Program (SANDAG)	$60,480		
Annual Total	**$191,575**	**Annual Total**	$191,575		

Corridor 5 - Between El Cajon Transit Center and 2nd St.

Summary Costs Per Corridor		Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Category**	**Subtotals**	**Per**	**Annual Cost**
TSP Signal Maintenance	$36,225	City of El Cajon	$43,425	Intersection	$3,102
TSP Vehicle Maintenance	$20,475	Transit Operator (MTS)	$31,995	Vehicle	$1,367
Monitoring and Management	$79,200	Regional Program (SANDAG)	$60,480		
Annual Total	**$135,900**	**Annual Total**	$135,900		

Corridor 6 - H St. between Woodlawn Ave. and Southwestern College

Summary Costs Per Corridor		Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Category**	**Subtotals**	**Per**	**Annual Cost**
TSP Signal Maintenance	$54,338	City of Chula Vista	$61,538	Intersection	$2,930
TSP Vehicle Maintenance	$18,200	Transit Operator (MTS)	$29,720	Vehicle	$1,429
Monitoring and Management	$79,200	Regional Program (SANDAG)	$60,480		
Annual Total	**$151,738**	**Annual Total**	$151,738		

Corridor 7 - 54th St./Euclid Ave. between Logan Ave. and Monroe Ave.

Summary Costs Per Corridor		Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Category**	**Subtotals**	**Per**	**Annual Cost**
TSP Signal Maintenance	$51,750	City of San Diego	$58,950	Intersection	$2,948
TSP Vehicle Maintenance	$42,088	Transit Operator (MTS)	$53,608	Vehicle	$1,115
Monitoring and Management	$79,200	Regional Program (SANDAG)	$60,480		
Annual Total	**$173,038**	**Annual Total**	$173,038		

Corridor 8 - Linda Vista Rd. between Old Town TC and Armstrong St.

Summary Costs Per Corridor		Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Category**	**Subtotals**	**Per**	**Annual Cost**
TSP Signal Maintenance	$43,988	City of San Diego	$51,188	Intersection	$3,011
TSP Vehicle Maintenance	$21,613	Transit Operator (MTS)	$33,133	Vehicle	$1,341
Monitoring and Management	$79,200	Regional Program (SANDAG)	$60,480		
Annual Total	**$159,200**	**Annual Total**	$144,800		

Corridor 9 - Fairmount Ave. between Home Ave. and Orange Ave.

Summary Costs Per Corridor		Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Category**	**Subtotals**	**Per**	**Annual Cost**
TSP Signal Maintenance	$25,875	City of San Diego	$33,075	Intersection	$3,308
TSP Vehicle Maintenance	$11,375	Transit Operator (MTS)	$22,895	Vehicle	$1,761
Monitoring and Management	$79,200	Regional Program (SANDAG)	$60,480		
Annual Total	**$116,450**	**Annual Total**	$116,450		

Corridor 10 - College Ave. between Montezuma Rd. and Adelaide Ave & between Federal Blvd. and Lemon Grove

Summary Costs Per Corridor		Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Category**	**Subtotals**	**Per**	**Annual Cost**
TSP Signal Maintenance	$31,050	Cities of San Diego, Lemon Grove	$38,250	Intersection	$3,188
TSP Vehicle Maintenance	$14,788	Transit Operator (MTS)	$26,308	Vehicle	$1,557
Monitoring and Management	$79,200	Regional Program (SANDAG)	$60,480		
Annual Total	**$125,038**	**Annual Total**	$125,038		

IBOT Annual O + M Cost Estimate: Corridor 1 - University Ave. between I-15 and Spring St.

TSP Signal Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Lead Signal Technician/Electrical	1 hr	$120	2	$240	2	0.5	**2.5**	$600
Support Signal Technician/Electrical	1 hr	$85	2	$170	2	0.5	**2.5**	$425
Support Vehicle/Bucket Truck	1 hr	$250	2.5	$625	2	0.5	**2.5**	$1,563
		Subtotal Per Intersection Per Occurrence		$1,035		Annual Subtotal Per Intersection		$2,588
							Corridor Subtotal	**$67,275**

TSP Vehicle Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Vehicle Electrician/Tech System Check	1 hr	$100	2	$200	2	1	**3**	$600
Equipment Emitter Replacement	1 ea	$2,000	1	$2,000	0.1	0.025	**0.125**	$250
Equipment Replacement Vehicle Tech	1 hr	$100	2	$200	0.1	0.025	**0.125**	$25
Misc Vehicle Fixes - Vehicle Electrician*	1 hr	$120	4	$480				
		Subtotal Per Vehicle Per Occurrence		$2,880		Annual Subtotal Per Vehicle		$875
							Corridor Subtotal	**$36,400**

Monitoring and Management**					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Traffic Engineer - Reporting	1 hr	$150	1	$150	12	4	**16**	$2,400
Traffic Engineer - Review/Refinement	1 hr	$150	8	$1,200	3	1	**4**	$4,800
Transit Service Analyst	1 hr	$120	4	$480	12	2	**14**	$6,720
Transit Scheduler	1 hr	$150	8	$1,200	3	1	**4**	$4,800
BRT Program Monitoring Staff Senior	1 hr	$150	6	$900	12	4	**16**	$14,400
BRT Program Monitoring Staff Junior	1 hr	$90	32	$2,880	12	4	**16**	$46,080
		Subtotal Per Review Per Occurrence		$6,810			**Corridor Subtotal**	**$79,200**

* Not included in subtotal or breakdown costs below.

**Monitoring and Management costs are per corridor. Transit Operator and BRT Program staff time costs include employee benefits.

***If implementing more than one TSP corridor, a 20% reduction in total staff time cost can be expected.

Corridor Description	
Category	Qty
Number of TSP Intersections	26
Number of Peak Buses	32
Number of Spares	10

Summary Costs Per Corridor	
Category	Subtotals
TSP Signal Maintenance	$67,275
TSP Vehicle Maintenance	$36,400
Monitoring and Management	$79,200
Annual Total	**$182,875**

Summary Costs Per Corridor Breakdown by Agency			
Category	Subtotals	Per	Annual Cost
Cities of San Diego, La Mesa[1]	$74,475	Intersection	$2,864
Transit Operator (MTS)[2]	$47,920	Vehicle	$1,152
Regional Program (SANDAG)[3]	$60,480		
Annual Total	$182,875		

Annual costs based on number of TSP intersections and total buses equipped.

[1]Includes TSP signal maintenance and staff time for traffic engineers.

[2] Includes costs for vehicle maintenance for TSP and staff time for a transit service analyst and

[3]Includes costs for BRT Program Monitoring staff time.

IBOT Annual O + M Cost Estimate: Corridor 2 - Mission Blvd. between Oceanside TC and San Luis Rey TC

TSP Signal Maintenance					Maintenance Cycle			
Cost Category	**Unit**	**Unit Cost**	**Qty/Int.**	**Cost/Int.**	**Planned Freq./Year**	**Unplanned Freq./Year**	**Subtotal Occurrences**	**Subtotal Costs**
Lead Signal Technician/Electrical	1 hr	$120	2	$240	2	0.5	**2.5**	$600
Support Signal Technician/Electrical	1 hr	$85	2	$170	2	0.5	**2.5**	$425
Support Vehicle/Bucket Truck	1 hr	$250	2.5	$625	2	0.5	**2.5**	$1,563
			Subtotal Per Intersection Per Occurrence	$1,035			Annual Subtotal Per Intersection	$2,588
							Corridor Subtotal	**$64,688**

TSP Vehicle Maintenance					Maintenance Cycle			
Cost Category	**Unit**	**Unit Cost**	**Qty/Int.**	**Cost/Int.**	**Planned Freq./Year**	**Unplanned Freq./Year**	**Subtotal Occurrences**	**Subtotal Costs**
Vehicle Electrician/Tech System Check	1 hr	$100	2	$200	2	1	**3**	$600
Equipment Emitter Replacement	1 ea	$2,000	1	$2,000	0.1	0.025	**0.125**	$250
Equipment Replacement Vehicle Tech	1 hr	$100	2	$200	0.1	0.025	**0.125**	$25
Misc Vehicle Fixes - Vehicle Electrician*	1 hr	$120	4	$480				
			Subtotal Per Vehicle Per Occurrence	$2,880			Annual Subtotal Per Vehicle	$875
							Corridor Subtotal	**$39,813**

Monitoring and Management**					Maintenance Cycle			
Cost Category	**Unit**	**Unit Cost**	**Qty/Int.**	**Cost/Int.**	**Planned Freq./Year**	**Unplanned Freq./Year**	**Subtotal Occurrences**	**Subtotal Costs**
Traffic Engineer - Reporting	1 hr	$150	1	$150	12	4	**16**	$2,400
Traffic Engineer - Review/Refinement	1 hr	$150	8	$1,200	3	1	**4**	$4,800
Transit Service Analyst	1 hr	$120	4	$480	12	2	**14**	$6,720
Transit Scheduler	1 hr	$150	8	$1,200	3	1	**4**	$4,800
BRT Program Monitoring Staff Senior	1 hr	$150	6	$900	12	4	**16**	$14,400
BRT Program Monitoring Staff Junior	1 hr	$90	32	$2,880	12	4	**16**	$46,080
			Subtotal Per Review Per Occurrence	$6,810			**Corridor Subtotal**	**$79,200**

* Not included in subtotal or breakdown costs below.

**Monitoring and Management costs are per corridor. Transit Operator and BRT Program staff time costs include employee benefits.

***If implementing more than one TSP corridor, a 20% reduction in total staff time cost can be expected.

Corridor Description	
Category	**Qty**
Number of TSP Intersections	25
Number of Peak Buses	35
Number of Spares	11

Summary Costs Per Corridor	
Category	**Subtotals**
TSP Signal Maintenance	$64,688
TSP Vehicle Maintenance	$39,813
Monitoring and Management	$79,200
Annual Total	**$183,700**

Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Per**	**Annual Cost**
City of Oceanside[1]	$71,888	Intersection	$2,876
Transit Operator (MTS)[2]	$51,333	Vehicle	$1,128
Regional Program (SANDAG)[3]	$60,480		
Annual Total	$183,700		

Annual costs based on number of TSP intersections and total buses equipped.

[1]Includes TSP signal maintenance and staff time for traffic engineers.

[2] Includes costs for vehicle maintenance for TSP and staff time for a transit service analyst and

[3]Includes costs for BRT Program Monitoring staff time.

IBOT Annual O + M Cost Estimate: Corridor 3 - Genesee Ave. between SR-163 and Nobel Dr.

TSP Signal Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Lead Signal Technician/Electrical	1 hr	$120	2	$240	2	0.5	**2.5**	$600
Support Signal Technician/Electrical	1 hr	$85	2	$170	2	0.5	**2.5**	$425
Support Vehicle/Bucket Truck	1 hr	$250	2.5	$625	2	0.5	**2.5**	$1,563
			Subtotal Per Intersection Per Occurrence	$1,035			Annual Subtotal Per Intersection	$2,588
							Corridor Subtotal	**$51,750**

TSP Vehicle Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Vehicle Electrician/Tech System Check	1 hr	$100	2	$200	2	1	**3**	$600
Equipment Emitter Replacement	1 ea	$2,000	1	$2,000	0.1	0.025	**0.125**	$250
Equipment Replacement Vehicle Tech	1 hr	$100	2	$200	0.1	0.025	**0.125**	$25
Misc Vehicle Fixes - Vehicle Electrician*	1 hr	$120	4	$480				
			Subtotal Per Vehicle Per Occurrence	$2,880			Annual Subtotal Per Vehicle	$875
							Corridor Subtotal	**$31,850**

Monitoring and Management**					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Traffic Engineer - Reporting	1 hr	$150	1	$150	12	4	**16**	$2,400
Traffic Engineer - Review/Refinement	1 hr	$150	8	$1,200	3	1	**4**	$4,800
Transit Service Analyst	1 hr	$120	4	$480	12	2	**14**	$6,720
Transit Scheduler	1 hr	$150	8	$1,200	3	1	**4**	$4,800
BRT Program Monitoring Staff Senior	1 hr	$150	6	$900	12	4	**16**	$14,400
BRT Program Monitoring Staff Junior	1 hr	$90	32	$2,880	12	4	**16**	$46,080
			Subtotal Per Review Per Occurrence	$6,810			**Corridor Subtotal**	**$79,200**

* Not included in subtotal or breakdown costs below.

**Monitoring and Management costs are per corridor. Transit Operator and BRT Program staff time costs include employee benefits.

***If implementing more than one TSP corridor, a 20% reduction in total staff time cost can be expected.

Corridor Description	
Category	Qty
Number of TSP Intersections	20
Number of Peak Buses	28
Number of Spares	8

Summary Costs Per Corridor	
Category	Subtotals
TSP Signal Maintenance	$51,750
TSP Vehicle Maintenance	$31,850
Monitoring and Management	$79,200
Annual Total	**$162,800**

Summary Costs Per Corridor Breakdown by Agency			
Category	Subtotals	Per	Annual Cost
City of San Diego[1]	$58,950	Intersection	$2,948
Transit Operator (MTS)[2]	$43,370	Vehicle	$1,191
Regional Program (SANDAG)[3]	$60,480		
Annual Total	$162,800		

Annual costs based on number of TSP intersections and total buses equipped.

[1]Includes TSP signal maintenance and staff time for traffic engineers.

[2] Includes costs for vehicle maintenance for TSP and staff time for a transit service analyst and

[3]Includes costs for BRT Program Monitoring staff time.

IBOT Annual O + M Cost Estimate: Corridor 4 - Highland Ave. between 3rd St. and Main St. (via 3rd Ave.)

TSP Signal Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Lead Signal Technician/Electrical	1 hr	$120	2	$240	2	0.5	**2.5**	$600
Support Signal Technician/Electrical	1 hr	$85	2	$170	2	0.5	**2.5**	$425
Support Vehicle/Bucket Truck	1 hr	$250	2.5	$625	2	0.5	**2.5**	$1,563
			Subtotal Per Intersection Per Occurrence	$1,035			Annual Subtotal Per Intersection	$2,588
							Corridor Subtotal	**$82,800**

TSP Vehicle Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Vehicle Electrician/Tech System Check	1 hr	$100	2	$200	2	1	**3**	$600
Equipment Emitter Replacement	1 ea	$2,000	1	$2,000	0.1	0.025	**0.125**	$250
Equipment Replacement Vehicle Tech	1 hr	$100	2	$200	0.1	0.025	**0.125**	$25
Misc Vehicle Fixes - Vehicle Electrician*	1 hr	$120	4	$480				
			Subtotal Per Vehicle Per Occurrence	$2,880			Annual Subtotal Per Vehicle	$875
							Corridor Subtotal	**$29,575**

Monitoring and Management**					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Traffic Engineer - Reporting	1 hr	$150	1	$150	12	4	**16**	$2,400
Traffic Engineer - Review/Refinement	1 hr	$150	8	$1,200	3	1	**4**	$4,800
Transit Service Analyst	1 hr	$120	4	$480	12	2	**14**	$6,720
Transit Scheduler	1 hr	$150	8	$1,200	3	1	**4**	$4,800
BRT Program Monitoring Staff Senior	1 hr	$150	6	$900	12	4	**16**	$14,400
BRT Program Monitoring Staff Junior	1 hr	$90	32	$2,880	12	4	**16**	$46,080
			Subtotal Per Review Per Occurrence	$6,810			**Corridor Subtotal**	**$79,200**

* Not included in subtotal or breakdown costs below.

**Monitoring and Management costs are per corridor. Transit Operator and BRT Program staff time costs include employee benefits.

***If implementing more than one TSP corridor, a 20% reduction in total staff time cost can be expected.

Corridor Description	
Category	Qty
Number of TSP Intersections	32
Number of Peak Buses	26
Number of Spares	8

Summary Costs Per Corridor	
Category	Subtotals
TSP Signal Maintenance	$82,800
TSP Vehicle Maintenance	$29,575
Monitoring and Management	$79,200
Annual Total	**$191,575**

Summary Costs Per Corridor Breakdown by Agency			
Category	Subtotals	Per	Annual Cost
Cities of National City, Chula Vista[1]	$90,000	Intersection	$2,813
Transit Operator (MTS)[2]	$41,095	Vehicle	$1,216
Regional Program (SANDAG)[3]	$60,480		
Annual Total	$191,575		

Annual costs based on number of TSP intersections and total buses equipped.

[1]Includes TSP signal maintenance and staff time for traffic engineers.

[2] Includes costs for vehicle maintenance for TSP and staff time for a transit service analyst and

[3]Includes costs for BRT Program Monitoring staff time.

IBOT Annual O + M Cost Estimate: Corridor 5 - Between El Cajon Transit Center and 2nd St.

TSP Signal Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Lead Signal Technician/Electrical	1 hr	$120	2	$240	2	0.5	**2.5**	$600
Support Signal Technician/Electrical	1 hr	$85	2	$170	2	0.5	**2.5**	$425
Support Vehicle/Bucket Truck	1 hr	$250	2.5	$625	2	0.5	**2.5**	$1,563
			Subtotal Per Intersection Per Occurrence	$1,035			Annual Subtotal Per Intersection	$2,588
							Corridor Subtotal	**$36,225**

TSP Vehicle Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Vehicle Electrician/Tech System Check	1 hr	$100	2	$200	2	1	**3**	$600
Equipment Emitter Replacement	1 ea	$2,000	1	$2,000	0.1	0.025	**0.125**	$250
Equipment Replacement Vehicle Tech	1 hr	$100	2	$200	0.1	0.025	**0.125**	$25
Misc Vehicle Fixes - Vehicle Electrician*	1 hr	$120	4	$480				
			Subtotal Per Vehicle Per Occurrence	$2,880			Annual Subtotal Per Vehicle	$875
							Corridor Subtotal	**$20,475**

Monitoring and Management**					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Traffic Engineer - Reporting	1 hr	$150	1	$150	12	4	**16**	$2,400
Traffic Engineer - Review/Refinement	1 hr	$150	8	$1,200	3	1	**4**	$4,800
Transit Service Analyst	1 hr	$120	4	$480	12	2	**14**	$6,720
Transit Scheduler	1 hr	$150	8	$1,200	3	1	**4**	$4,800
BRT Program Monitoring Staff Senior	1 hr	$150	6	$900	12	4	**16**	$14,400
BRT Program Monitoring Staff Junior	1 hr	$90	32	$2,880	12	4	**16**	$46,080
			Subtotal Per Review Per Occurrence	$6,810			**Corridor Subtotal**	**$79,200**

* Not included in subtotal or breakdown costs below.

**Monitoring and Management costs are per corridor. Transit Operator and BRT Program staff time costs include employee benefits.

***If implementing more than one TSP corridor, a 20% reduction in total staff time cost can be expected.

Corridor Description	
Category	Qty
Number of TSP Intersections	14
Number of Peak Buses	18
Number of Spares	5

Summary Costs Per Corridor	
Category	Subtotals
TSP Signal Maintenance	$36,225
TSP Vehicle Maintenance	$20,475
Monitoring and Management	$79,200
Annual Total	**$135,900**

Summary Costs Per Corridor Breakdown by Agency			
Category	Subtotals	Per	Annual Cost
City of El Cajon[1]	$43,425	Intersection	$3,102
Transit Operator (MTS)[2]	$31,995	Vehicle	$1,367
Regional Program (SANDAG)[3]	$60,480		
Annual Total	$135,900		

Annual costs based on number of TSP intersections and total buses equipped.

[1]Includes TSP signal maintenance and staff time for traffic engineers.

[2] Includes costs for vehicle maintenance for TSP and staff time for a transit service analyst and

[3]Includes costs for BRT Program Monitoring staff time.

IBOT Annual O + M Cost Estimate: Corridor 6 - H St. between Woodlawn Ave. and Southwestern College

TSP Signal Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Lead Signal Technician/Electrical	1 hr	$120	2	$240	2	0.5	**2.5**	$600
Support Signal Technician/Electrical	1 hr	$85	2	$170	2	0.5	**2.5**	$425
Support Vehicle/Bucket Truck	1 hr	$250	2.5	$625	2	0.5	**2.5**	$1,563
			Subtotal Per Intersection Per Occurrence	$1,035			Annual Subtotal Per Intersection	$2,588
							Corridor Subtotal	**$54,338**

TSP Vehicle Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Vehicle Electrician/Tech System Check	1 hr	$100	2	$200	2	1	**3**	$600
Equipment Emitter Replacement	1 ea	$2,000	1	$2,000	0.1	0.025	**0.125**	$250
Equipment Replacement Vehicle Tech	1 hr	$100	2	$200	0.1	0.025	**0.125**	$25
Misc Vehicle Fixes - Vehicle Electrician*	1 hr	$120	4	$480				
			Subtotal Per Vehicle Per Occurrence	$2,880			Annual Subtotal Per Vehicle	$875
							Corridor Subtotal	**$18,200**

Monitoring and Management**					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Traffic Engineer - Reporting	1 hr	$150	1	$150	12	4	**16**	$2,400
Traffic Engineer - Review/Refinement	1 hr	$150	8	$1,200	3	1	**4**	$4,800
Transit Service Analyst	1 hr	$120	4	$480	12	2	**14**	$6,720
Transit Scheduler	1 hr	$150	8	$1,200	3	1	**4**	$4,800
BRT Program Monitoring Staff Senior	1 hr	$150	6	$900	12	4	**16**	$14,400
BRT Program Monitoring Staff Junior	1 hr	$90	32	$2,880	12	4	**16**	$46,080
			Subtotal Per Review Per Occurrence	$6,810			**Corridor Subtotal**	**$79,200**

* Not included in subtotal or breakdown costs below.

**Monitoring and Management costs are per corridor. Transit Operator and BRT Program staff time costs include employee benefits.

***If implementing more than one TSP corridor, a 20% reduction in total staff time cost can be expected.

Corridor Description	
Category	Qty
Number of TSP Intersections	21
Number of Peak Buses	16
Number of Spares	5

Summary Costs Per Corridor	
Category	Subtotals
TSP Signal Maintenance	$54,338
TSP Vehicle Maintenance	$18,200
Monitoring and Management	$79,200
Annual Total	**$151,738**

Summary Costs Per Corridor Breakdown by Agency			
Category	Subtotals	Per	Annual Cost
City of Chula Vista[1]	$61,538	Intersection	$2,930
Transit Operator (MTS)[2]	$29,720	Vehicle	$1,429
Regional Program (SANDAG)[3]	$60,480		
Annual Total	$151,738		

Annual costs based on number of TSP intersections and total buses equipped.

[1]Includes TSP signal maintenance and staff time for traffic engineers.

[2] Includes costs for vehicle maintenance for TSP and staff time for a transit service analyst and

[3]Includes costs for BRT Program Monitoring staff time.

IBOT Annual O + M Cost Estimate: Corridor 7 - 54th St./Euclid Ave. between Logan Ave. and Monroe Ave.

TSP Signal Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Lead Signal Technician/Electrical	1 hr	$120	2	$240	2	0.5	**2.5**	$600
Support Signal Technician/Electrical	1 hr	$85	2	$170	2	0.5	**2.5**	$425
Support Vehicle/Bucket Truck	1 hr	$250	2.5	$625	2	0.5	**2.5**	$1,563
		Subtotal Per Intersection Per Occurrence		$1,035		Annual Subtotal Per Intersection		$2,588
							Corridor Subtotal	**$51,750**

TSP Vehicle Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Vehicle Electrician/Tech System Check	1 hr	$100	2	$200	2	1	**3**	$600
Equipment Emitter Replacement	1 ea	$2,000	1	$2,000	0.1	0.025	**0.125**	$250
Equipment Replacement Vehicle Tech	1 hr	$100	2	$200	0.1	0.025	**0.125**	$25
Misc Vehicle Fixes - Vehicle Electrician*	1 hr	$120	4	$480				
		Subtotal Per Vehicle Per Occurrence		$2,880		Annual Subtotal Per Vehicle		$875
							Corridor Subtotal	**$42,088**

Monitoring and Management**					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Traffic Engineer - Reporting	1 hr	$150	1	$150	12	4	**16**	$2,400
Traffic Engineer - Review/Refinement	1 hr	$150	8	$1,200	3	1	**4**	$4,800
Transit Service Analyst	1 hr	$120	4	$480	12	2	**14**	$6,720
Transit Scheduler	1 hr	$150	8	$1,200	3	1	**4**	$4,800
BRT Program Monitoring Staff Senior	1 hr	$150	6	$900	12	4	**16**	$14,400
BRT Program Monitoring Staff Junior	1 hr	$90	32	$2,880	12	4	**16**	$46,080
		Subtotal Per Review Per Occurrence		$6,810			**Corridor Subtotal**	**$79,200**

* Not included in subtotal or breakdown costs below.

**Monitoring and Management costs are per corridor. Transit Operator and BRT Program staff time costs include employee benefits.

***If implementing more than one TSP corridor, a 20% reduction in total staff time cost can be expected.

Corridor Description	
Category	Qty
Number of TSP Intersections	20
Number of Peak Buses	37
Number of Spares	11

Summary Costs Per Corridor	
Category	Subtotals
TSP Signal Maintenance	$51,750
TSP Vehicle Maintenance	$42,088
Monitoring and Management	$79,200
Annual Total	**$173,038**

Summary Costs Per Corridor Breakdown by Agency			
Category	Subtotals	Per	Annual Cost
City of San Diego[1]	$58,950	Intersection	$2,948
Transit Operator (MTS)[2]	$53,608	Vehicle	$1,115
Regional Program (SANDAG)[3]	$60,480		
Annual Total	$173,038		

Annual costs based on number of TSP intersections and total buses equipped.

[1]Includes TSP signal maintenance and staff time for traffic engineers.

[2] Includes costs for vehicle maintenance for TSP and staff time for a transit service analyst and

[3]Includes costs for BRT Program Monitoring staff time.

IBOT Annual O + M Cost Estimate: Corridor 8 - Linda Vista Rd. between Old Town TC and Armstrong St.

TSP Signal Maintenance					Maintenance Cycle			
Cost Category	**Unit**	**Unit Cost**	**Qty/Int.**	**Cost/Int.**	**Planned Freq./Year**	**Unplanned Freq./Year**	**Subtotal Occurrences**	**Subtotal Costs**
Lead Signal Technician/Electrical	1 hr	$120	2	$240	2	0.5	**2.5**	$600
Support Signal Technician/Electrical	1 hr	$85	2	$170	2	0.5	**2.5**	$425
Support Vehicle/Bucket Truck	1 hr	$250	2.5	$625	2	0.5	**2.5**	$1,563
			Subtotal Per Intersection Per Occurrence	$1,035			Annual Subtotal Per Intersection	$2,588
							Corridor Subtotal	**$43,988**

TSP Vehicle Maintenance					Maintenance Cycle			
Cost Category	**Unit**	**Unit Cost**	**Qty/Int.**	**Cost/Int.**	**Planned Freq./Year**	**Unplanned Freq./Year**	**Subtotal Occurrences**	**Subtotal Costs**
Vehicle Electrician/Tech System Check	1 hr	$100	2	$200	2	1	**3**	$600
Equipment Emitter Replacement	1 ea	$2,000	1	$2,000	0.1	0.025	**0.125**	$250
Equipment Replacement Vehicle Tech	1 hr	$100	2	$200	0.1	0.025	**0.125**	$25
Misc Vehicle Fixes - Vehicle Electrician*	1 hr	$120	4	$480				
			Subtotal Per Vehicle Per Occurrence	$2,880			Annual Subtotal Per Vehicle	$875
							Corridor Subtotal	**$21,613**

Monitoring and Management**					Maintenance Cycle			
Cost Category	**Unit**	**Unit Cost**	**Qty/Int.**	**Cost/Int.**	**Planned Freq./Year**	**Unplanned Freq./Year**	**Subtotal Occurrences**	**Subtotal Costs**
Traffic Engineer - Reporting	1 hr	$150	1	$150	12	4	**16**	$2,400
Traffic Engineer - Review/Refinement	1 hr	$150	8	$1,200	3	1	**4**	$4,800
Transit Service Analyst	1 hr	$120	4	$480	12	2	**14**	$6,720
Transit Scheduler	1 hr	$150	8	$1,200	3	1	**4**	$4,800
BRT Program Monitoring Staff Senior	1 hr	$150	6	$900	12	4	**16**	$14,400
BRT Program Monitoring Staff Junior	1 hr	$90	32	$2,880	12	4	**16**	$46,080
			Subtotal Per Review Per Occurrence	$6,810			**Corridor Subtotal**	**$79,200**

* Not included in subtotal or breakdown costs below.

**Monitoring and Management costs are per corridor. Transit Operator and BRT Program staff time costs include employee benefits.

***If implementing more than one TSP corridor, a 20% reduction in total staff time cost can be expected.

Corridor Description	
Category	**Qty**
Number of TSP Intersections	17
Number of Peak Buses	19
Number of Spares	6

Summary Costs Per Corridor	
Category	**Subtotals**
TSP Signal Maintenance	$43,988
TSP Vehicle Maintenance	$21,613
Monitoring and Management	$79,200
Annual Total	**$144,800**

Summary Costs Per Corridor Breakdown by Agency			
Category	**Subtotals**	**Per**	**Annual Cost**
City of San Diego[1]	$51,188	Intersection	$3,011
Transit Operator (MTS)[2]	$33,133	Vehicle	$1,341
Regional Program (SANDAG)[3]	$60,480		
Annual Total	$144,800		

Annual costs based on number of TSP intersections and total buses equipped.

[1]Includes TSP signal maintenance and staff time for traffic engineers.

[2] Includes costs for vehicle maintenance for TSP and staff time for a transit service analyst and

[3]Includes costs for BRT Program Monitoring staff time.

IBOT Annual O + M Cost Estimate: Corridor 9 - Fairmount Ave. between Home Ave. and Orange Ave.

TSP Signal Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Lead Signal Technician/Electrical	1 hr	$120	2	$240	2	0.5	**2.5**	$600
Support Signal Technician/Electrical	1 hr	$85	2	$170	2	0.5	**2.5**	$425
Support Vehicle/Bucket Truck	1 hr	$250	2.5	$625	2	0.5	**2.5**	$1,563
			Subtotal Per Intersection Per Occurrence	$1,035			Annual Subtotal Per Intersection	$2,588
							Corridor Subtotal	**$25,875**

TSP Vehicle Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Vehicle Electrician/Tech System Check	1 hr	$100	2	$200	2	1	**3**	$600
Equipment Emitter Replacement	1 ea	$2,000	1	$2,000	0.1	0.025	**0.125**	$250
Equipment Replacement Vehicle Tech	1 hr	$100	2	$200	0.1	0.025	**0.125**	$25
Misc Vehicle Fixes - Vehicle Electrician*	1 hr	$120	4	$480				
			Subtotal Per Vehicle Per Occurrence	$2,880			Annual Subtotal Per Vehicle	$875
							Corridor Subtotal	**$11,375**

Monitoring and Management**					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Traffic Engineer - Reporting	1 hr	$150	1	$150	12	4	**16**	$2,400
Traffic Engineer - Review/Refinement	1 hr	$150	8	$1,200	3	1	**4**	$4,800
Transit Service Analyst	1 hr	$120	4	$480	12	2	**14**	$6,720
Transit Scheduler	1 hr	$150	8	$1,200	3	1	**4**	$4,800
BRT Program Monitoring Staff Senior	1 hr	$150	6	$900	12	4	**16**	$14,400
BRT Program Monitoring Staff Junior	1 hr	$90	32	$2,880	12	4	**16**	$46,080
			Subtotal Per Review Per Occurrence	$6,810			**Corridor Subtotal**	**$79,200**

* Not included in subtotal or breakdown costs below.

**Monitoring and Management costs are per corridor. Transit Operator and BRT Program staff time costs include employee benefits.

***If implementing more than one TSP corridor, a 20% reduction in total staff time cost can be expected.

Corridor Description	
Category	Qty
Number of TSP Intersections	10
Number of Peak Buses	10
Number of Spares	3

Summary Costs Per Corridor	
Category	Subtotals
TSP Signal Maintenance	$25,875
TSP Vehicle Maintenance	$11,375
Monitoring and Management	$79,200
Annual Total	**$116,450**

Summary Costs Per Corridor Breakdown by Agency			
Category	Subtotals	Per	Annual Cost
City of San Diego[1]	$33,075	Intersection	$3,308
Transit Operator (MTS)[2]	$22,895	Vehicle	$1,761
Regional Program (SANDAG)[3]	$60,480		
Annual Total	$116,450		

Annual costs based on number of TSP intersections and total buses equipped.

[1]Includes TSP signal maintenance and staff time for traffic engineers.

[2] Includes costs for vehicle maintenance for TSP and staff time for a transit service analyst and

[3]Includes costs for BRT Program Monitoring staff time.

IBOT Annual O + M Cost Estimate: Corridor 10 - College Ave. between Montezuma Rd. and Adelaide Ave & between Federal Blvd. and Lemon Grove Ave

TSP Signal Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Lead Signal Technician/Electrical	1 hr	$120	2	$240	2	0.5	**2.5**	$600
Support Signal Technician/Electrical	1 hr	$85	2	$170	2	0.5	**2.5**	$425
Support Vehicle/Bucket Truck	1 hr	$250	2.5	$625	2	0.5	**2.5**	$1,563
		Subtotal Per Intersection Per Occurrence		$1,035		Annual Subtotal Per Intersection		$2,588
							Corridor Subtotal	**$31,050**

TSP Vehicle Maintenance					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Vehicle Electrician/Tech System Check	1 hr	$100	2	$200	2	1	**3**	$600
Equipment Emitter Replacement	1 ea	$2,000	1	$2,000	0.1	0.025	**0.125**	$250
Equipment Replacement Vehicle Tech	1 hr	$100	2	$200	0.1	0.025	**0.125**	$25
Misc Vehicle Fixes - Vehicle Electrician*	1 hr	$120	4	$480				
		Subtotal Per Vehicle Per Occurrence		$2,880		Annual Subtotal Per Vehicle		$875
							Corridor Subtotal	**$14,788**

Monitoring and Management**					Maintenance Cycle			
Cost Category	Unit	Unit Cost	Qty/Int.	Cost/Int.	Planned Freq./Year	Unplanned Freq./Year	Subtotal Occurrences	Subtotal Costs
Traffic Engineer - Reporting	1 hr	$150	1	$150	12	4	**16**	$2,400
Traffic Engineer - Review/Refinement	1 hr	$150	8	$1,200	3	1	**4**	$4,800
Transit Service Analyst	1 hr	$120	4	$480	12	2	**14**	$6,720
Transit Scheduler	1 hr	$150	8	$1,200	3	1	**4**	$4,800
BRT Program Monitoring Staff Senior	1 hr	$150	6	$900	12	4	**16**	$14,400
BRT Program Monitoring Staff Junior	1 hr	$90	32	$2,880	12	4	**16**	$46,080
		Subtotal Per Review Per Occurrence		$6,810			**Corridor Subtotal**	**$79,200**

* Not included in subtotal or breakdown costs below.

**Monitoring and Management costs are per corridor. Transit Operator and BRT Program staff time costs include employee benefits.

***If implementing more than one TSP corridor, a 20% reduction in total staff time cost can be expected.

Corridor Description	
Category	Qty
Number of TSP Intersections	12
Number of Peak Buses	13
Number of Spares	4

Summary Costs Per Corridor	
Category	Subtotals
TSP Signal Maintenance	$31,050
TSP Vehicle Maintenance	$14,788
Monitoring and Management	$79,200
Annual Total	**$125,038**

Summary Costs Per Corridor Breakdown by Agency			
Category	Subtotals	Per	Annual Cost
Cities of San Diego, Lemon Grove[1]	$38,250	Intersection	$3,188
Transit Operator (MTS)[2]	$26,308	Vehicle	$1,557
Regional Program (SANDAG)[3]	$60,480		
Annual Total	$125,038		

Annual costs based on number of TSP intersections and total buses equipped.

[1]Includes TSP signal maintenance and staff time for traffic engineers.

[2] Includes costs for vehicle maintenance for TSP and staff time for a transit service analyst and

[3]Includes costs for BRT Program Monitoring staff time.

Appendix E – TSP Impacts/Benefits Analysis

- Sample Intersection Data Request
- Top 3 Corridors Impacts/Benefits Worksheet
- Top 3 Corridors Ridership Worksheet
- California Air Resources Board (CARB) Greenhouse Gases Quantification Methodology
- Top 3 Corridors Emissions Worksheet

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Memorandum

To/Attention	City of Chula Vista	**Date**	May 9, 2016
From	IBI Group	**Project No**	38765
Subject	IBOT Intersection Data Collection		

As part of the IBOT Regional Approach to Transit Signal Priority project, IBI Group will be analyzing the operations for a large number of intersections throughout the San Diego region. IBI Group will perform a high level traffic study to evaluate the potential TSP traffic impacts or benefits for the top five ranked TSP corridors.

In order to identify potential traffic impacts or benefits from implementing TSP, IBI Group is requesting *turning movement counts* and *signal timing* for the following intersections in the City of Chula Vista for the most recent time period available. We ask that the data be provided by **Friday, May 20** in order to move forward with next steps to analyze the data to quantify the impacts or benefits of implementing TSP at certain intersections. Any available information is useful even if data is not available for the full list of intersections requested. Please forward any data or questions you may have to Dan Pearce at dan.pearce@ibigroup.com.

Turning Movement Counts:

Intersections
Highland Ave. & Ramp SR-54 EB
4th Ave. & Brisbane St.
4th Ave. & C St.
4th Ave. & D St.
4th Ave. & E St.
4th Ave. & E St.
3rd Ave. & Davidson St.
3rd Ave. & F St.
3rd Ave. & G St.
3rd Ave. & H St.
3rd Ave. & I St.
3rd Ave. & J St.
3rd Ave. & K St.
3rd Ave. & L St.
3rd Ave. & Moss St.
3rd Ave. & Naples St.
3rd Ave. & Oxford St.
3rd Ave. & Palomar St.
3rd Ave. & Quintard St.

Intersections
3rd Ave. & Orange Ave.
3rd Ave. & Anita St.
3rd Ave. & Montgomery St.

Signal Timing Data:

Intersections
Highland Ave. & Ramp SR-54 EB
4th Ave. & Brisbane St.
4th Ave. & C St.
4th Ave. & D St.
4th Ave. & E St.
4th Ave. & E St.
3rd Ave. & Davidson St.
3rd Ave. & F St.
3rd Ave. & G St.
3rd Ave. & H St.
3rd Ave. & I St.
3rd Ave. & J St.
3rd Ave. & K St.
3rd Ave. & L St.
3rd Ave. & Moss St.
3rd Ave. & Naples St.
3rd Ave. & Oxford St.
3rd Ave. & Palomar St.
3rd Ave. & Quintard St.
3rd Ave. & Orange Ave.
3rd Ave. & Anita St.
3rd Ave. & Montgomery St.

TSP IMPACTS / BENEFITS

PROJECT: IBOT - Chula Vista

AM PEAK Intersection	Cycle Length	Main St Split	Extension	Reduction	Base Delay	TSP Delay	# Buses / hr	% of Cycles w/ Buses	Probable Impact of TSP %	Predicted Delay	**IMPACTS** **Change in Vehicle Delay***	**BENEFITS** **Avg delay reduced per bus (sec)**	**Hourly Bus Delay Reduced**
Highland Ave. / SR-54 WB	45	22.5	0	0	11.0	11.0	8	10%	50%	11.00	**0.00**	**0.00**	**0.0 Mins**
4th Ave. / Ramp SR-54 EB	60	30.2	0	0	15.7	15.7	8	13%	50%	15.70	**0.00**	**0.00**	**0.0 Mins**
4th Ave. / Brisbane St.	80	25.6	10	10	29.3	157.2	8	18%	68%	44.78	**15.48**	**11.11**	**1.5 Mins**
4th Ave. / C St.	80	34.0	20	20	22.8	48.8	8	18%	58%	25.46	**2.66**	**13.00**	**1.7 Mins**
4th Ave. / D St.	50	25.0	19	19	6.1	118.4	8	11%	50%	12.34	**6.24**	**4.56**	**0.6 Mins**
4th Ave. / E St.	110	30.4	20	20	25.8	23.5	8	24%	72%	25.39	**-0.41**	**21.69**	**2.9 Mins**
3rd Ave. / E St.	65	16.0	10	10	24.9	22.7	8	14%	75%	24.66	**-0.24**	**12.00**	**1.6 Mins**
3rd Ave. / Davidson St.	60	37.0	15	15	3.5	3.9	8	13%	38%	3.52	**0.02**	**4.00**	**0.5 Mins**
3rd Ave. / F St.	80	31.8	15	15	24.4	37.3	8	18%	60%	25.78	**1.38**	**12.47**	**1.7 Mins**
3rd Ave. / G St.	65	28.0	15	15	19.3	109.9	8	14%	57%	26.75	**7.45**	**10.15**	**1.4 Mins**
3rd Ave. / H St.	85	26.9	20	20	26.9	91.4	8	19%	68%	35.23	**8.33**	**17.93**	**2.4 Mins**
3rd Ave. / I St.	55	28.0	15	15	9.4	28.2	8	12%	49%	10.53	**1.13**	**6.55**	**0.9 Mins**
3rd Ave. / J St.	75	28.9	20	20	23.7	67.6	8	17%	62%	28.20	**4.50**	**13.95**	**1.9 Mins**
3rd Ave. & K St.	75	31.1	20	20	22.2	56.4	8	17%	59%	25.54	**3.34**	**12.75**	**1.7 Mins**
3rd Ave. & L St.	75	26.9	20	20	28.0	113	8	17%	64%	37.09	**9.09**	**14.99**	**2.0 Mins**
3rd Ave. & Naples St.	65	22.8	20	20	26.8	38.8	8	14%	65%	27.93	**1.13**	**13.69**	**1.8 Mins**
											4.3	**168.8**	**22.5 Mins**
											Average	**Per bus run**	**All buses in an hour**

* Change in average delay per vehicle

TSP IMPACTS / BENEFITS

PROJECT: IBOT - Chula Vista

PM PEAK Intersection	Cycle Length	Main St Split	Extension	Reduction	Base Delay	TSP Delay	# Buses / hr	% of Cycles w/ Buses	Probable Impact of TSP %	Predicted Delay	IMPACTS Change in Vehicle Delay*	BENEFITS Avg delay reduced per bus (sec)	Hourly Bus Delay Reduced
Highland Ave. / SR-54 WB	45	22.5	0	0	19.5	19.5	9	11%	50%	19.50	**0.00**	**0.00**	**0.0 Mins**
4th Ave. / Ramp SR-54 EB	60	30.2	0	0	57.0	57	9	15%	50%	57.00	**0.00**	**0.00**	**0.0 Mins**
4th Ave. / Brisbane St.	80	25.6	10	10	41.9	146.3	9	20%	68%	56.11	**14.21**	**11.11**	**1.7 Mins**
4th Ave. / C St.	80	34.0	20	20	33.5	78.2	9	20%	58%	38.64	**5.14**	**13.00**	**2.0 Mins**
4th Ave. / D St.	50	25.0	10	10	17.3	85.4	9	13%	50%	21.56	**4.26**	**6.00**	**0.9 Mins**
4th Ave. / E St.	110	27.8	20	20	31.1	28.4	9	28%	75%	30.54	**-0.56**	**22.64**	**3.4 Mins**
3rd Ave. / E St.	65	16.0	10	10	33.5	32.3	9	16%	75%	33.35	**-0.15**	**12.00**	**1.8 Mins**
3rd Ave. / Davidson St.	60	37.0	19	19	5.4	7.8	9	15%	38%	5.54	**0.14**	**2.53**	**0.4 Mins**
3rd Ave. / F St.	80	31.8	15	15	23.4	42.1	9	20%	60%	25.66	**2.26**	**12.47**	**1.9 Mins**
3rd Ave. / G St.	65	28.0	15	15	16.4	45.6	9	16%	57%	19.10	**2.70**	**10.15**	**1.5 Mins**
3rd Ave. / H St.	85	26.9	15	15	37.2	67.4	9	21%	68%	41.59	**4.39**	**15.21**	**2.3 Mins**
3rd Ave. / I St.	55	28.0	15	15	9.3	25	9	14%	49%	10.36	**1.06**	**6.55**	**1.0 Mins**
3rd Ave. / J St.	75	28.9	15	15	32.5	73.7	9	19%	62%	37.25	**4.75**	**12.46**	**1.9 Mins**
3rd Ave. & K St.	75	31.1	15	15	35.5	58.5	9	19%	59%	38.02	**2.52**	**11.56**	**1.7 Mins**
3rd Ave. & L St.	75	26.9	10	10	75.2	86.9	9	19%	64%	76.61	**1.41**	**10.16**	**1.5 Mins**
3rd Ave. & Naples St.	65	22.8	20	20	30.7	53.7	9	16%	65%	33.13	**2.43**	**13.69**	**2.1 Mins**
											3.2	**159.5**	**23.9 Mins**
											Average	**Per bus run**	**All buses in an hour**

* Change in average delay per vehicle

TSP IMPACTS / BENEFITS

PROJECT: IBOT - El Cajon

AM PEAK Intersection	Cycle Length	Main St Split	Extension	Reduction	Base Delay	TSP Delay	# Buses / hr	% of Cycles w/ Buses	Probable Impact of TSP %	Predicted Delay	**IMPACTS** **Change in Vehicle Delay***	**BENEFITS** **Avg delay reduced per bus (sec)**	**Hourly Bus Delay Reduced**
Main St. & Marshall Ave.	75	27.3	10	10	65.0	79.9	15.5	32%	64%	68.06	**3.06**	**10.07**	**2.6 Mins**
Main St. & Johnson Ave.	65	10.0	10	10	24.4	105.1	15.5	28%	85%	43.51	**19.11**	**13.85**	**3.6 Mins**
Johnson Ave. & Madison Ave.	91.5	30.0	20	20	19.2	26.3	15.5	39%	67%	21.08	**1.88**	**18.14**	**4.7 Mins**
Johnson Ave. & Ramp I-8 EB	45	22.5	0	0	11.4	11.4	15.5	19%	50%	11.40	**0.00**	**0.00**	**0.0 Mins**
Johnson Ave. & Arnele Ave.	122	40.0	20	20	13.7	15.8	15.5	53%	67%	14.44	**0.74**	**20.33**	**5.3 Mins**
Fletcher Parkway & Johnson Ave.	65	16.5	5	5	22.3	24.2	15.5	28%	75%	22.70	**0.40**	**6.69**	**1.7 Mins**
Fletcher Parkway & Pioneer Way	65	22.9	20	20	20.2	31.2	15.5	28%	65%	22.20	**2.00**	**13.63**	**3.5 Mins**
Flectcher Parkway & Magonolia Ave.	80	23.0	20	20	24.6	22.8	15.5	34%	71%	24.16	**-0.44**	**18.53**	**4.8 Mins**
Fletcher Parkway & Ramp SR-67 SB	60	30.0	0	0	13.9	13.9	15.5	26%	50%	13.90	**0.00**	**0.00**	**0.0 Mins**
Broadway & Graves Ave.	80	23.4	20	20	23.1	22.6	15.5	34%	71%	22.98	**-0.12**	**18.30**	**4.7 Mins**
Broadway & Ballantyne St.	70	22.5	10	10	30.5	55.6	15.5	30%	68%	35.63	**5.13**	**10.71**	**2.8 Mins**
Broadway & Mollison St.	70	24.3	15	15	26.7	95.9	15.5	30%	65%	40.33	**13.63**	**13.18**	**3.4 Mins**
Broadway & 1st St.	65	22.5	15	15	32.2	61.1	15.5	28%	65%	37.49	**5.29**	**12.69**	**3.3 Mins**
Broadway & 2st St.	70	23.6	20	20	27.3	125.1	15.5	30%	66%	46.84	**19.54**	**15.09**	**3.9 Mins**
											5.9	**171.2**	**44.2 Mins**
											Average	**Per bus run**	**All buses in an hour**

* Change in average delay per vehicle

TSP IMPACTS / BENEFITS

PROJECT: IBOT - El Cajon

PM PEAK Intersection	Cycle Length	Main St Split	Extension	Reduction	Base Delay	TSP Delay	# Buses / hr	% of Cycles w/ Buses	Probable Impact of TSP %	Predicted Delay	IMPACTS Change in Vehicle Delay*	BENEFITS Avg delay reduced per bus (sec)	Hourly Bus Delay Reduced
Main St. & Marshall Ave.	80	26.7	10	10	49.2	83	15.8	35%	67%	57.11	**7.91**	**10.83**	**2.9 Mins**
Main St. & Johnson Ave.	70	12.0	10	10	28.0	66.5	15.8	31%	83%	37.80	**9.80**	**13.71**	**3.6 Mins**
Johnson Ave. & Madison Ave.	91.5	30.0	20	20	19.2	26.3	15.8	40%	67%	21.12	**1.92**	**18.14**	**4.8 Mins**
Johnson Ave. & Ramp I-8 EB	45	22.5	0	0	2.6	2.6	15.8	20%	50%	2.60	**0.00**	**0.00**	**0.0 Mins**
Johnson Ave. & Arnele Ave.	122	29.5	20	20	23.2	29.5	15.8	54%	76%	25.76	**2.56**	**23.77**	**6.3 Mins**
Fletcher Parkway & Johnson Ave.	70	16.0	5	5	24.2	91.3	15.8	31%	77%	40.10	**15.90**	**7.00**	**1.8 Mins**
Fletcher Parkway & Pioneer Way	65	22.5	20	20	26.0	270.9	15.8	29%	65%	71.68	**45.68**	**13.85**	**3.6 Mins**
Flectcher Parkway & Magonolia Ave.	80	22.8	20	20	33.8	40.2	15.8	35%	72%	35.41	**1.61**	**18.63**	**4.9 Mins**
Fletcher Parkway & Ramp SR-67 SB	60	29.0	0	0	16.6	116.3	15.8	26%	52%	30.16	**13.56**	**0.00**	**0.0 Mins**
Broadway & Graves Ave.	80	23.9	20	20	28.9	27.8	15.8	35%	70%	28.63	**-0.27**	**18.08**	**4.8 Mins**
Broadway & Ballantyne St.	80	25.0	15	15	35.7	54.8	15.8	35%	69%	40.31	**4.61**	**15.02**	**4.0 Mins**
Broadway & Mollison St.	90	31.8	15	15	34.4	38.5	15.8	40%	65%	35.45	**1.05**	**14.42**	**3.8 Mins**
Broadway & 1st St.	65	22.5	15	15	30.7	87.5	15.8	29%	65%	41.29	**10.59**	**12.69**	**3.3 Mins**
Broadway & 2st St.	80	23.0	20	20	31.2	65.4	15.8	35%	71%	39.76	**8.56**	**18.50**	**4.9 Mins**
											9.5	**184.6**	**48.6 Mins**
											Average	**Per bus run**	**All buses in an hour**

* Change in average delay per vehicle

TSP Impacts / Benefits

PROJECT: IBOT - Oceanside

AM PEAK Intersection	Cycle Length	Main St Split	Extension	Reduction	Base Delay	TSP Delay	# Buses / hr	% of Cycles w/ Buses	Probable Impact of TSP %	Predicted Delay	**IMPACTS** **Change in Vehicle Delay***	**BENEFITS** **Avg delay reduced per bus (sec)**	**Hourly Bus Delay Reduced**
Mission Ave. & Horne St.	80.0	23.3	20	20	26.8	44.7	10	22%	71%	29.62	**2.82**	**18.38 Secs**	**3.1 Mins**
Mission Ave. & Ramp I-5 SB	70.0	30.0	0	0	28.2	28.2	10	19%	57%	28.20	**0.00**	**0.00 Secs**	**0.0 Mins**
Mission Ave. & Canyon Dr.	70.0	24.1	20	20	31.9	141	10	19%	66%	45.83	**13.93**	**14.83 Secs**	**2.5 Mins**
Mission Ave. & El Camino Real	180.5	50.0	20	20	39.6	101.3	10	50%	72%	61.97	**22.37**	**24.49 Secs**	**4.1 Mins**
Mission Ave. & Douglas Dr.	90.0	24.8	10	10	35.2	72.3	10	25%	72%	41.92	**6.72**	**12.27 Secs**	**2.0 Mins**
Douglas Dr. & El Camino Real	150.0	61.9	20	20	59.5	136.1	10	42%	59%	78.26	**18.76**	**18.17 Secs**	**3.0 Mins**
Douglas Dr. & N. River Rd.	110.0	32.8	20	20	32.5	36.8	10	31%	70%	33.42	**0.92**	**20.80 Secs**	**3.5 Mins**
N. River Rd. & Calle Montecito	55.0	22.8	15	15	17.1	17	10	15%	59%	17.09	**-0.01**	**9.41 Secs**	**1.6 Mins**
N. River Rd. & Redondo Dr.	55.0	22.5	15	15	16.3	137	10	15%	59%	27.20	**10.90**	**9.55 Secs**	**1.6 Mins**
N. River Rd. & College Blvd.	120.0	44.2	15	15	31.4	195	10	33%	63%	65.87	**34.47**	**15.21 Secs**	**2.5 Mins**
Vandergrift Blvd. & N. River Rd.	65.0	16.5	5	5	21.0	59.5	10	18%	75%	26.19	**5.19**	**6.69 Secs**	**1.1 Mins**
											11.6	**149.8 Secs**	**25.0 Mins**
											Average	**Per bus run**	**All buses in an hour**

* Change in average delay per vehicle

TSP Impacts / Benefits

PROJECT: IBOT - Oceanside

PM PEAK Intersection	Cycle Length	Main St Split	Extension	Reduction	Base Delay	TSP Delay	# Buses / hr	% of Cycles w/ Buses	Probable Impact of TSP %	Predicted Delay	**IMPACTS** Change in Vehicle Delay*	**BENEFITS** Avg delay reduced per bus (sec)	**BENEFITS** Hourly Bus Delay Reduced
Mission Ave. & Horne St.	90	24.4	15	15	42.2	115	9	23%	73%	54.14	**11.94**	**16.87**	**2.5 Mins**
Mission Ave. & Ramp I-5 SB	90	49.5	0	0	30.4	30.4	9	23%	45%	30.40	**0.00**	**0.00**	**0.0 Mins**
Mission Ave. & Canyon Dr.	90	35.8	20	20	36.1	56.3	9	23%	60%	38.84	**2.74**	**15.20**	**2.3 Mins**
Mission Ave. & El Camino Real	180.5	50.0	20	20	59.4	158.6	9	45%	72%	91.76	**32.36**	**24.49**	**3.7 Mins**
Mission Ave. & Douglas Dr.	70	17.0	10	10	27.3	27.8	9	18%	76%	27.37	**0.07**	**12.30**	**1.8 Mins**
Douglas Dr. & El Camino Real	90	28.9	20	20	36.5	183.9	9	23%	68%	59.03	**22.53**	**18.29**	**2.7 Mins**
Douglas Dr. & N. River Rd.	90	22.5	10	10	27.8	27.8	9	23%	75%	27.80	**0.00**	**12.78**	**1.9 Mins**
N. River Rd. & Calle Montecito	60	24.8	15	15	18.5	18.4	9	15%	59%	18.49	**-0.01**	**10.13**	**1.5 Mins**
N. River Rd. & Redondo Dr.	55	22.5	15	15	21.0	527.9	9	14%	59%	62.19	**41.19**	**9.55**	**1.4 Mins**
N. River Rd. & College Blvd.	150	50.8	20	20	100.0	261.4	9	38%	66%	140.05	**40.05**	**21.13**	**3.2 Mins**
Vandergrift Blvd. & N. River Rd.	100	30.8	15	15	32.7	54	9	25%	69%	36.38	**3.68**	**16.26**	**2.4 Mins**
											17.2	**157.0 Secs**	**23.5 Mins**
											Average	**Per bus run**	**All buses in an hour**

* Change in average delay per vehicle

RIDERSHIP WORKSHEET

CORRIDOR 2					
Route	Ridership without TSP	Ridership with TSP	Ridership Difference	Ridership Difference (%)	Annualized Ridership
303	4,932	5,082	151	3.1%	48,213
309	3,694	3,647	(47)	-1.3%	-15,016
311	689	699	10	1.4%	3,082
313	587	587	0	0.0%	21
315	2,837	2,983	147	5.2%	46,895
					83,196

CORRIDOR 4					
Route	Ridership without TSP	Ridership with TSP	Ridership Difference	Ridership Difference (%)	Annualized Ridership
929	7,735	7,964	230	3.0%	73,459
955	5,576	5,685	108	1.9%	34,628
					108,087

CORRIDOR 5					
Route	Ridership without TSP	Ridership with TSP	Ridership Difference	Ridership Difference (%)	Annualized Ridership
833	786	813	27	3.4%	8,614
848	1,835	1,907	72	3.9%	23,154
871	239	239	(0)	-0.2%	-118
874	2,584	2,637	54	2.1%	17,165
875	2,646	2,609	(37)	-1.4%	-11,865
					36,950

Source: SANDAG Series 13 Regional Transportation Model, September 2016

California Air Resources Board

Greenhouse Gas Quantification Methodology for the California State Transportation Agency Transit and Intercity Rail Capital Program

Greenhouse Gas Reduction Fund

February 9, 2015

A. Introduction

The California Air Resources Board (ARB) is responsible for providing the quantification methodology to estimate greenhouse gas (GHG) emission reductions from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). For the California State Transportation Agency's (CalSTA) Transit and Intercity Rail Capital Program (TIRCP), ARB staff developed the GHG emission reduction quantification methodology to be used by grant applicants to estimate proposed project GHG emission reductions for the first solicitation of TIRCP.

Project applicants will use available project-level data to the extent possible for estimated ridership increases and corresponding vehicle miles traveled (VMT) changes. This methodology relies on applicant provided data, specific components of the "Methods to Find the Cost-Effectiveness of Funding Air Quality Projects for Evaluating Motor Vehicle Registration Fee Projects and Congestion Mitigation and Air Quality Improvement Projects" (CMAQ Methods), on-road vehicle GHG emission factors from the ARB Mobile-Source Emission Factor model (EMFAC2011), as well as ARB developed calculations and emission factors to estimate the GHG emission reductions from proposed TIRCP projects.

Methodology Development

For the first solicitation of the program, ARB and CalSTA staff followed a set of principles to guide the development of the quantification methodology. These principles ensure that the methodology for TIRCP projects would:

- Apply at the project-level
- Align with the project types proposed for funding with TIRCP
- Provide uniform methodologies that can be applied statewide, and be accessible by all applicants
- Use existing and proven tools or methodologies
- Use project-level data when available for estimated ridership increases and corresponding vehicle miles traveled (VMT) reductions

TIRCP Project Types

TIRCP will fund capital improvements and operational investments that will modernize California's transit systems and intercity, commuter, and urban rail systems to reduce GHG emissions; improve/expand service and increase ridership; integrate existing bus and rail operations with each other and with high-speed rail; and improve safety. For GHG quantification purposes, eligible TIRCP projects fall into the three activity types described in Table 1 below. Some projects may include more than one activity, such as those that provide operational improvements that reduce travel time (generating ridership gains) and also deploy new, lower-emitting vehicles that replace current vehicles.

Table 1: Description of TIRCP GHG Reduction Activities

GHG Reduction Activity	Description
New Service (Bus/Train)	Expansion of bus or train service through new service or additional routes.
Cleaner Vehicles/Technology/Fuels (Bus/Train)	Use of cleaner vehicles, technologies, or fuels that result in GHG emission reductions.
System and Efficiency Improvements that Result in Increased Ridership (Bus/Train)	Any system or efficiency improvements that result in increased ridership for existing routes, including projects that increase service levels, reliability, or decrease travel times.

GHG Emission Reductions

This methodology estimates the GHG emission reductions of a proposed TIRCP project. Applicants will estimate the total GHG emission[1] reductions from the proposed project over the project life, as defined in the methodology.

For TIRCP Program application evaluation purposes, the applicant will report results as:

$$\frac{Metric\ tons\ (MT)\ of\ CO2\ over\ the\ project\ life}{GGRF\ Funds\ Requested\ (\$)}$$

The following sections describe the calculations needed to estimate the GHG emission reductions for proposed projects under the first solicitation of the TIRCP Program.

[1] This methodology results in estimated CO_2 reductions only. For the purposes of this quantification methodology and the TIRCP application, the applicant will report CO_2 reductions as GHG reductions.

B. Quantification Methodology

In consultation with CalSTA, quantification methods are provided for the three activity types described in Table 1. The following is a summary of the three steps TIRCP applicants will follow to estimate the GHG emission reductions for a proposed project. Detailed instructions for each step are provided on subsequent pages.

Step 1[2] Calculate trip and VMT reductions, if not available from existing project analyses: The applicant will calculate expected auto and/or bus trip and VMT reductions or use project specific trip or VMT reduction data.

Step 2 Calculate annual GHG emission reductions: The applicant will use the trip data and VMT determined in Step 1, in conjunction with specified CO_2 emission factors from EMFAC 2011 to calculate the initial year and final year GHG emission reductions.[3] Detailed instructions for obtaining the EMFAC 2011 emission factors needed to estimate the GHG emissions are included.

Note: Steps 1 and 2 will each need to be done twice to calculate both the first operational year (Yr1) and the final operational year (YrF) emission reductions of the project. This will require trip and VMT reductions for both the first operational year and the final operational year.

Step 3 Calculate the GHG reductions over the project life: The applicant will calculate the GHG reductions over the project life using results from Steps 1 and 2.

[2] Step 1 applies only to New Service and System/Efficiency Improvement projects with car displacement.
[3] When using a new vehicle type not contained in EMFAC2011, document the emissions factor recommended for use and submit to the TIRCP program email account for CARB and CalSTA review. See contact instructions at the end of this document.

Step 1: Calculate trip and VMT reductions

AutoTrips = $Annual\ Auto\ Trips\ Reduced\ (in\ trips\ per\ year)\ =$

$$[(\boldsymbol{D}) * (\boldsymbol{R}) * (\boldsymbol{A})] * [1 - (\boldsymbol{AA})]$$

or

Annual auto trip reduction value determined by applicant's method[4]

AutoVMT = $Annual\ Auto\ VMT\ Reduced\ (in\ miles\ per\ year)\ =$

$$[(\boldsymbol{D}) * (\boldsymbol{R}) * (\boldsymbol{A})] * [(\boldsymbol{L}) - (\boldsymbol{AA}) * (\boldsymbol{LL})]$$

or

Annual auto VMT reduction value determined by applicant's method[4]

Where:

D = Days of operation per year

R = Average daily ridership.
Use: expected average daily increased ridership based on project data.

A = Adjustment factor to account for transit dependency
Use: documented project specific data or system average developed from a recent, statistically valid survey.

L = Length (miles) of average auto trip reduced.
Use: value based on specific project or system average reported to the National Transit Database.

AA = Adjustment factor to account for auto trips used to access transit service.
Use value based on project specific data or system average developed from a recent, statistically valid survey.

LL = Length (miles) of average trip for auto access to transit.
Use: value based on specific project data.

Note: Applicant must provide detailed supporting documentation for calculations and variables used in Step 1. ARB has developed recommended default values[5] for certain service types that may be used if project specific data does not exist, which include:

A = Adjustment factor to account for transit dependency
Use: 0.5 for local bus service or 0.83 for long distance commuter service

AA = Adjustment factor to account for auto trips used to access transit service.
Use: 0.1 for local bus service or 0.8 for long distance commuter service

LL = Length of average trip for auto access to transit.
Use: 2 miles for local bus or 5 miles for long distance commuter service.

[4] Applicant specified methods are subject to CalSTA and ARB approval. The applicant must provide supporting documenting demonstrating how the auto trip and VMT reduction values were derived.
[5] "Methods to Find the Cost-Effectiveness of Funding Air Quality Projects for Evaluating Motor Vehicle Registration Fee Projects and Congestion Mitigation and Air Quality Improvement Projects"

Step 2: Calculate GHG emission reductions

Table 2 below lists the specific calculations applicants will use to estimate the GHG emission reductions based on their project type.

Table 2: TIRCP Project GHG Emission Reduction Calculations

Activity		GHG Emission Reduction Calculations (in $MTCO_2$ / year)
New Service	Bus	GHGs of Displaced Autos – GHGs of New Bus
	Train	[GHGs of Displaced Autos + GHGs of Displaced Buses] – GHGs of New Train
Cleaner Vehicles/ Technology/ Fuels	Bus	GHGs of Old Bus – GHGs of New Bus
	Train	GHGs of Old Train – GHGs of New Train
System and Efficiency Improvements (that result in increased ridership)	Bus	GHGs of Displaced Autos
	Train	GHGs of Displaced Autos + GHGs Displaced Bus

Where:

GHGs of Displaced Autos

$$= \frac{[(\boldsymbol{AutoTrips}) * (\boldsymbol{ATSEF}) + (\boldsymbol{AutoVMT}) * (\boldsymbol{AREF})]}{1{,}000{,}000}$$

GHG Bus (Displaced, New, or Old)

$$= \frac{[(\boldsymbol{BusVMT}) * (\boldsymbol{BREF})]}{1{,}000{,}000}$$

GHG Train (New or Old)

$$= \frac{[(\boldsymbol{TrainVMT}) * (\boldsymbol{TREF})]}{1{,}000{,}000}$$

Where:
AutoTrips = Annual Auto Trips Reduced from Step 1
AutoVMT = Annual Auto VMT Reduced value from Step 1
Bus VMT = Annual Bus VMT based on project data
TrainVMT = Annual Train VMT based on project data
ATSEF = Auto Trip Start Emission Factor in grams/trip from EMFAC2011
AREF = Auto Running Emission Factor in grams/mile from EMFAC2011
BREF = Bus Running Emission Factor in grams/mile from EMFAC2011, specific to old or new engine
TREF (Diesel)= 19,600 grams CO_2/mile[6]

Note: The current methodology calculates only tailpipe emissions. For projects that incorporate zero emission technologies or zero emission miles (i.e. electric train), the new technology emission factor is 0 grams CO_2/mile.

Reminder: each GHG emission reduction calculation will need to be done two times to calculate both the first year (Yr1) and the final year (YrF) emission reductions of the project. Yr1 is the first operational year of the project and YrF is the final operational year of the project, as determined by the Project Life[7] in Step Three. Once the Yr1 and YrF GHG reductions have been calculated, the Total GHG Reductions over the Project Life can be calculated according to Step Three.

[6] This train emission factor (TREF) represents the average CO_2 emission rate of 124 diesel powered passenger trains in California over the course of a full year (2010) incorporating total fuel usage and miles traveled based on best available data.
[7] Project Life, or PL, is the reported lifetime of the equipment, the useful lifetime of the equipment, 20 years, or 2035, whichever comes first.

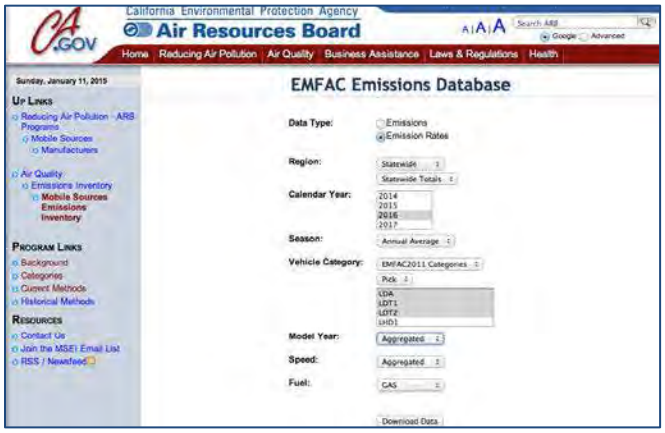
EMFAC2011 Emission Factors

CO_2 emission factors must be obtained from EMFAC2011. ARB provides a web-based EMFAC2011 tool (available at http://www.arb.ca.gov/emfac/) to determine vehicle emission factors based on region, calendar year, season, vehicle category, model year, speed, and fuel. The tool provides specified emission factor data in a comma separated values (CSV) output file that can be opened in most spreadsheet software.

Complete the following steps for both calendar years: Yr1 and YrF[8].

Step 2a. Generate the Output File

Figure 1. EMFAC Emissions Database



On the EMFAC Emissions Database screen, select the following parameters:

Data Type:	Emission Rates
Region:	County
Calendar year:	Obtain output files for both Yr1 and YrF
Season:	Annual Average
Vehicle category:	EMFAC2011 Categories
	Autos: LDA, LDT1, LDT2, and MDV
	Bus: UBUS or project specific vehicle category
Model year:	Aggregated for autos or existing buses
	Model year specific for new bus projects
Speed:	Aggregated
Fuel:	Gas for autos; Diesel for buses

[8] EMAC2011 emission factors are only available through 2035. Use 2035 as a proxy for any final year beyond 2035.

For the remaining steps, you will only need the following columns from the output file:

- VMT
- CO2_RUNEX (Pavley I+LCFS)
- CO2_STREX (Pavley I+LCFS)

Step 2b. Calculate VMT-weighted Auto Trip Start and Running Emission Factors

Auto Trip Start Emission Factor (ATSEF)

Auto fleet average Start Factor in grams/vehicle/day divided by trips per vehicle per day)

$$= \frac{\begin{array}{c}(\text{VMT} * \text{CO2\_STREX(Pavley I + LCFS)})_{LDA} + (\text{VMT} * \text{CO2\_STREX(Pavley I + LCFS)})_{LDT1} \\ +(\text{VMT} * \text{CO2\_STREX(Pavley I + LCFS)})_{LDT2} + (\text{VMT} * \text{CO2\_STREX(Pavley I + LCFS)})_{MDV}\end{array}}{Sum\ (VMT)}$$

The Auto Trip Start Factor in grams/trip is calculated by dividing the Auto Start Factor by 6 trips/vehicle/day[9] as follows:

$$\text{ATSEF} = \left(\frac{Auto\ Start\ Factor}{6}\right)$$

Auto Running Emission Factor (AREF)

Auto fleet average Running Factor in grams/vehicle/day

$$= \frac{\begin{array}{c}(\text{VMT} * \text{CO2\_RUNEX(Pavley I + LCFS)})_{LDA} + (\text{VMT} * \text{CO2\_RUNEX(Pavley I + LCFS)})_{LDT1} \\ +(\text{VMT} * \text{CO2\_RUNEX(Pavley I + LCFS)})_{LDT2} + (\text{VMT} * \text{CO2\_RUNEX(Pavley I + LCFS)})_{MDV}\end{array}}{Sum\ (VMT)}$$

Bus Running Emission Factor (BREF)

For each calendar year, the Running Factor can be taken directly from the CSV file:

$$Running\ Factor = \text{CO2\_RUNEX(Pavley I + LCFS)}$$

[9] The number of trips per vehicle per day was estimated by dividing the average number of trips per day by the number of vehicles for each vehicle category (LDA, LDT1, LDT2, and MDV) from the EMFAC web-based tool.

Step 3: Calculate the GHG Reductions Over the Project Life

Project Life (GHG Reductions) =

$$\left(\frac{Yr1\ GHG\ Reductions\ +\ YrF\ GHG\ Reductions}{2}\right)\ *\ PL$$

Where:
PL = Project Life, or the reported lifetime of the equipment, the useful lifetime of the equipment, 20 years, or 2035, whichever comes first.

C. Reporting and Documentation

For TIRCP application evaluation purposes, the applicant will report results as:

$$\frac{Metric\ tons\ (MT)\ of\ CO2\ over\ the\ project\ life}{GGRF\ Funds\ Requested\ (\$)}$$

Applicants are required to provide electronic documentation that is complete, and sufficient enough to allow the quantification calculations to be reviewed and replicated. Paper copies of any materials must be available upon request by CalSTA or ARB staff.

Documentation will include such things as:

- Contact information for the person who can answer project specific questions from staff reviewers on the quantification calculations
- Project description, including excerpts or specific references to the location in the main TIRCP application of the project information necessary to complete the applicable portions of the quantification methodology
- Project data support, including:
    - Documentation of the project specific data used in Section B
    - References to public documents that are the source of the project specific data used in Section B.
    - Documentation of calculations (spreadsheets, EMFAC2011 reports, etc.)
- Summary page with, at minimum, the following information
    - The Activity Types from Table 2 that are applicable to the GHG estimates identified.
    - GHG emission reductions for Yr1, YrF, and Total over the project life
    - GGRF funds requested for the project
    - Total Project GHG emission reductions per GGRF funds requested

For more information on ARB's efforts to support implementation of GGRF investments, see: www.arb.ca.gov/auctionproceeds. Questions on this document should be forwarded to GGRFProgram@arb.ca.gov. Questions on the TIRCP program should be forwarded to tircpcomments@dot.ca.gov.

EMISSIONS WORKSHEET

Corridor 2

Project Inputs				Displaced Autos Inputs								Net GHG Benefits
Project Type	Transit Service Type	Year 1 (Yr1)	Year F (YrF)	County	Yr1 Days of Operation (D)	Yr1 Average Unlinked Daily Ridership (R)	YrF Days of Operation (D)	YrF Average Unlinked Daily Ridership (R)	Adjustment (A)	Length (L)	Annual Average Auto VMT Displaced	Total GHG Emission Reductions (MTCO2e)
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	4,932	365	5,082	0.50	5.00	4,568,887.50	4813.68
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	3,694	365	3,647	0.50	4.00	2,679,465.00	2824.86
System and Efficiency Improvements	Bus	2016	2018	San Diego	260	689	260	699	0.50	4.00	360,880.00	380.30
System and Efficiency Improvements	Bus	2016	2018	San Diego	260	587	260	587	0.50	9.00	686,790.00	723.92
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	2,837	365	2,983	0.50	2.00	1,062,150.00	1118.71

Corridor 4

Project Inputs				Displaced Autos Inputs								Net GHG Benefits
Project Type	Transit Service Type	Year 1 (Yr1)	Year F (YrF)	County	Yr1 Days of Operation (D)	Yr1 Average Unlinked Daily Ridership (R)	YrF Days of Operation (D)	YrF Average Unlinked Daily Ridership (R)	Adjustment (A)	Length (L)	Annual Average Auto VMT Displaced	Total GHG Emission Reductions (MTCO2e)
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	7,735	365	7,964	0.50	9.00	12,892,803.75	13583.73
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	5,576	365	5,685	0.50	1.00	1,027,566.25	1082.80

Corridor 5

Project Inputs				Displaced Autos Inputs								Net GHG Benefits
Project Type	Transit Service Type	Year 1 (Yr1)	Year F (YrF)	County	Yr1 Days of Operation (D)	Yr1 Average Unlinked Daily Ridership (R)	YrF Days of Operation (D)	YrF Average Unlinked Daily Ridership (R)	Adjustment (A)	Length (L)	Annual Average Auto VMT Displaced	Total GHG Emission Reductions (MTCO2e)
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	2,499	365	2,411	0.50	3.00	1,024,372.50	1079.12
System and Efficiency Improvements	Bus	2016	2018	San Diego	260	2,705	260	2,708	0.50	3.00	382,976.25	403.92
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	786	365	813	0.50		65,426.25	68.96
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	1,835	365	1,907	0.50	3.00	27,375.00	28.95
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	2,140	365	2,057	0.50	1.00	238,208.13	251.01
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	239	365	239	0.50	1.50	239,759.38	252.77
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	111	365	89	0.50	1.50	-	
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	2,584	365	2,637	0.50	0.50	-	
System and Efficiency Improvements	Bus	2016	2018	San Diego	365	2,646	365	2,609	0.50	0.50	-	

Source: California Air Resources Board Greenhouse Gas Quantification Methodology

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Appendix F – Funding

- IBOT Funding Opportunities Matrix

Note: Funding opportunities were selected based on relevance to IBOT's scope of work. Criteria for grants were reviewed to determine if IBOT would fit into each grant's criteria. Only grants that IBOT is eligible for were listed in the matrix in this appendix. A majority of the grants relate to smart cities, smart technology procurement, and enhancing infrastructure to improve quality of life and health. More general, all-encompassing transportation grants were also included.

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IBOT Funding Opportunities

POTENTIAL	FUNDING SOURCE	SOURCE & TYPE	ELIGIBLE ACTIVITIES	AVAILABLE FUNDING	FUNDING AVAILABILITY	DEADLINE	COST SHARE	FY16 AWARDEES	RANGE OF AWARD AMOUNT (FY16)	LINK	NOTES
High	Advanced Transportation and Congestion Management Technologies Deployment Initiative (ATCMTD)	FHWA, Federal	To develop model deployment sites for large scale installation and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment.	$60 million/year (Up to $12 million/project) Will award 5-10 projects.	FY16-20	Typically June of each year	Cost sharing or matching is required; maximum possible federal share is 50% with minimum non-federal cost share at 50%	FY16 is the first award year; no past recipients	N/A	https://www.fhwa.dot.gov/fastact/factsheets/advtranscongmgmtfs.cfm	
Low	Clean Fuels Grant Program - 5308	FTA, Federal	(1) Purchasing or leasing clean fuel buses, including buses that employ a lightweight composite primary structure and vans for use in revenue service. The purchase or lease of non-revenue vehicles is not an eligible project. (2) Constructing or leasing clean fuel bus facilities or electrical recharging facilities and related equipment. Facilities and related equipment for clean diesel buses are not eligible. (3) Projects relating to clean fuel, biodiesel, hybrid electric, or zero emissions technology buses that exhibit equivalent or superior emissions reductions to existing clean fuel or hybrid electric technologies. Funds made available under this program cannot be used to fund operating expenses or preventive maintenance.	Discretionary basis	Funds are available the year appropriated plus two years	N/A	Maximum 90% federal share	N/A	N/A	https://www.transit.dot.gov/funding/grants/clean-fuels-grant-program-5308	
Medium	Congestion Mitigation and Air Quality Program (CMAQ)	FHWA, Federal	Funding is available to reduce congestion and improve air quality for areas that do not meet the National Ambient Air Quality Standards for ozone, carbon monoxide, or particulate matter (nonattainment areas) and for former nonattainment areas that are now in compliance (maintenance areas).	$2.3-2.5 billion, dependent on MAP-21 approach to distribution formula	FY16-20, funds are available for (3) years after the last day of the fiscal year in which the funds were authorized	Annually	Generally 80% federal share	N/A	N/A	https://www.fhwa.dot.gov/map21/guidance/guidecmaq.cfm	
Medium	Metropolitan Planning	FHWA, Federal	Encompasses all MPO responsibilities and requirements	N/A, varies for state. Allocated by state to MPOs.	N/A	N/A	N/A	$3,6-3.8 million for SANDAG	N/A		

POTENTIAL	FUNDING SOURCE	SOURCE & TYPE	ELIGIBLE ACTIVITIES	AVAILABLE FUNDING	FUNDING AVAILABILITY	DEADLINE	COST SHARE	FY16 AWARDEES	RANGE OF AWARD AMOUNT (FY16)	LINK	NOTES
High	Metropolitan & Statewide Planning - 5303, 5304, 5303	FTA, Federal	Funds are available for planning activities that (A) support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency; (B) increase the safety of the transportation system for motorized and nonmotorized users; (C) increase the security of the transportation system for motorized and nonmotorized users; (D) increase the accessibility and mobility of people and for freight; (E) protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development patterns; (F) enhance the integration and connectivity of the transportation system, across and between modes, for people and freight; (G) promote efficient system management and operation; and (H) emphasize the preservation of the existing transportation system. Major new fixed guideway projects, or extension to existing systems financed with New Starts funds, typically receive these funds through a full funding grant agreement that defines the scope of the project and specifies the total multi-year Federal commitment to the project.	N/A, varies for state. Allocated by state to MPOs.	Available for 4 years once allocated	N/A	Maximum 80% federsal share of the cost of projects funded under the program.	$1.3-1.4 million for SANDAG	N/A	https://www.transit.dot.gov/funding/grants/grant-programs/metropolitan-statewide-planning-5303-5304-5305	
High	Mobility on Demand (MOD) Sandbox Demonstration Program - 5312	FTA, Federal	Eligible activities include all activities leading to the demonstration of the innovative MOD and transit integration concept, such as planning and developing business models, obtaining equipment and service, acquiring/developing software and hardware interfaces to implement the project, and operating the demonstration.	$8 million	N/A	$42,552.00	Maximum federal share is 80%, proposers may request less. Local share must be in the form of cash or in-kind donation.	FY16 is the first award year; no past recipients	N/A	https://www.transit.dot.gov/research-innovation/mobility-demand-mod-sandbox-program.html	
High	Transportation Investments Generating Economic Recovery (TIGER) Discretionary Grant Program	USDOT, Federal	innovative projects, including multi-modal and multi-jurisdictional projects, which are difficult to fund through traditional federal programs. This year's awards focus on capital projects that generate economic development and improve access to reliable, safe and affordable transportation for communities, both urban and rural.	Varies annually	Annually	Annually, typically in April	Varies	https://www.transportation.gov/sites/dot.gov/files/docs/TIGER%20Fact%20Sheets%20-%207-28.pdf	$5 -25 million	https://www.transportation.gov/tiger	

POTENTIAL	FUNDING SOURCE	SOURCE & TYPE	ELIGIBLE ACTIVITIES	AVAILABLE FUNDING	FUNDING AVAILABILITY	DEADLINE	COST SHARE	FY16 AWARDEES	RANGE OF AWARD AMOUNT (FY16)	LINK	NOTES
Medium	Urbanized Area Formula Grants - 5307	FTA, Federal	planning, engineering, design and evaluation of transit projects and other technical transportation-related studies; capital investments in bus and bus-related activities such as replacement, overhaul and rebuilding of buses, crime prevention and security equipment and construction of maintenance and passenger facilities; and capital investments in new and existing fixed guideway systems including rolling stock, overhaul and rebuilding of vehicles, track, signals, communications, and computer hardware and software. In addition, associated transit improvements and certain expenses associated with mobility management programs are eligible under the program. All preventive maintenance and some Americans with Disabilities Act complementary paratransit service costs are considered capital costs.	$4.5 billion. Funding is apportioned on the basis of legislative formulas.	Funds are available the year appropriated plus five years.	N/A	Maximum federal share is 80% of net project cost for capital expenditures. May be 90% for cost of vehicle-related equipment attributable to compliance with ADA and CAA. May not exceed 50% of net project cost of operating assistance.	N/A	N/A	https://www.transit.dot.gov/funding/grants/urbanized-area-formula-grants-5307	
High	Transit and Intercity Rail Capital Program (TIRCP)	Caltrans, State	Provides grants from the Greenhouse Gas Reduction Fund to fund transformative capital improvements that will modernize California's intercity, commuter, and urban rail systems, and bus and ferry transit systems to reduce emissions of greenhouse gases by reducing congestion and vehicle miles traveled throughout California. The goal of the TIRCP is to provide monies to fund transformative capital improvements that modernize California's intercity rail, bus, ferry and rail transit systems to achieve the following objectives: Reduction in greenhouse gas emissions; Expand and improve rail service to increase ridership; Integrate the rail service of the state's various rail operations, including integration with the high-speed rail system; and Improve safety	Varies annually	Funds availabe up to 36 months after award of contract	Annually, typically in April	N/A	http://www.dot.ca.gov/hq/MassTrans/Docs-Pdfs/Cap&Trade/tircp.2016.awards.pdf	$5-89 million	http://www.dot.ca.gov/hq/MassTrans/tircp.html	

POTENTIAL	FUNDING SOURCE	SOURCE & TYPE	ELIGIBLE ACTIVITIES	AVAILABLE FUNDING	FUNDING AVAILABILITY	DEADLINE	COST SHARE	FY16 AWARDEES	RANGE OF AWARD AMOUNT (FY16)	LINK	NOTES
Medium	Affordable Housing and Sustainable Communities Prorgam (AHSC)	California Department of Housing and Community Development, State	The purpose of the AHSC Program is to reduce greenhouse gas (GHG) emissions through projects that implement land-use, housing, transportation, and agricultural land preservation practices to support infill and compact development, and that support related and coordinated public policy objectives, including the following: (1) reducing air pollution; (2) improving conditions in disadvantaged communities; (3) supporting or improving public health and other co-benefits as defined in Section 39712 of the Health and Safety Code; (4) improving connectivity and accessibility to jobs, housing, and services; (5) increasing options for mobility, including the implementation of the Active Transportation Program established pursuant to Section 2380 of the Streets and Highway Code; (6) increasing transit ridership; (7) preserving and developing affordable housing for lower income households, as defined in Section 50079.5 of the Health and Safety Code; and (8) protecting agricultural lands to support infill development. The AHSC Program includes three eligible Project Area types as defined below: (1) Transit Oriented Development (TOD) Project Areas, (2) Integrated Connectivity Project (ICP) Project Areas, and (3) Rural Innovation Project Areas (RIPA).	$320 million (FY2016) 50% of funds for Affordable Housing Developments, 50% of funds for projects benefitting Disadvantaged Communities. Maximum award is $20 million.	Funds available for three years after disbursement	Annually, typically in March	N/A	http://sgc.ca.gov/pdf/Attachment_B_Summary_of_AHSC_Recommendations.pdf	$1-10 million	http://www.hcd.ca.gov/financial-assistance/affordable-housing-and-sustainable-communities/	
	CAPITAL INVESTMENT GRANTS										
Meidum	Core Capacity	FTA, Federal	Substantial corridor-based investment in existing fixed guideway system Project must: Be located in a corridor that is at or over capactiy or will be in five years Increase capacity by 10% "not include project elements designated to maintain a state of good repair" Should justify: mobility, environmental benefits, congestion relief, economic development, capacity needs of the corridor, cost effectiveness (cost per trip)	N/A$2.3 billion annually across Core Capacity, New Starts, and Small Starts	Once allocated, funds are available for up to (5) years	Eligibility requires completing a set of steps over several years	Acceptable degree of local financial commitment including evidence of stable and dependable financing sources	N/A	N/A	https://www.transit.dot.gov/funding/grant-programs/capital-investments/about-program	Must go through 3 phases: Project Development, Engineering, and Construction (Full Funding Grant Agreement)

POTENTIAL	FUNDING SOURCE	SOURCE & TYPE	ELIGIBLE ACTIVITIES	AVAILABLE FUNDING	FUNDING AVAILABILITY	DEADLINE	COST SHARE	FY16 AWARDEES	RANGE OF AWARD AMOUNT (FY16)	LINK	NOTES
Low	Expedited Project Delivery for Capital Investment Grants Pilot	FTA, Federal	Design and construction of New Starts, Small Starts, or Core Capacity Projects must be supported through a public-private partnership and demonstrate local financial commitment, technical capacity, and a certification that the existing transit system is in a state of good repair, operated and maintained by employees of an existing provider of public transportation.	N/A	Allocated funds for up to 8 projects	$42,583.00	Maximum federal share 25%	N/A	N/A	https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/3005(b)_Expedited_Project_Delivery_Fact_Sheet.pdf	
Medium	New Starts	FTA, Federal	Total project cost is equal to or greater than $300 million or total New Starts funding sought equals or exceeds $100 million New fixed guideway system (light rail, commuter rail etc.) Extension to existing system Fixed guideway BRT system Should justify: mobility, environmental benefits, congestion relief, economic development, land use, cost effectiveness (cost per trip)	N/A$2.3 billion across Core Capacity, New Starts, and Small Starts	Once allocated, funds are available for up to (5) years	Eligibility requires completing a set of steps over several years	Acceptable degree of local financial commitment including evidence of stable and dependable financing sources	https://www.transit.dot.gov/sites/fta.dot.gov/files/FY16_Annual_Report_on_Funding_Recommendations.pdf	$6.5 - 75 million	https://www.transit.dot.gov/funding/grant-programs/capital-investments/about-program	Must go through 3 phases: Project Development, Engineering, and Construction (Full Funding Grant Agreement)
Medium	Small Starts	FTA, Federal	Total project cost is less than $300 million and total Small Starts funding sought is less than $100 million New fixed guideway systems (light rail, commuter rail etc.) Extension to existing system Fixed guideway BRT system Corridor-based BRT system Should justify: mobility, environmental benefits, congestion relief, economic development, land use, cost effectiveness (cost per trip)	N/A$2.3 billion across Core Capacity, New Starts, and Small Starts	Once allocated, funds are available for up to (5) years	Eligibility requires completing a set of steps over several years	Acceptable degree of local financial commitment including evidence of stable and dependable financing sources	https://www.transit.dot.gov/sites/fta.dot.gov/files/FY16_Annual_Report_on_Funding_Recommendations.pdf	$92-265 million	https://www.transit.dot.gov/funding/grant-programs/capital-investments/about-program	Must go through 2 phases: Project Development and Construction Grant Agreement SANDAG's Mid-Coast Trolley Project is funded by Small Starts.
	DISCRETIONARY GRANT PROGRAM										

POTENTIAL	FUNDING SOURCE	SOURCE & TYPE	ELIGIBLE ACTIVITIES	AVAILABLE FUNDING	FUNDING AVAILABILITY	DEADLINE	COST SHARE	FY16 AWARDEES	RANGE OF AWARD AMOUNT (FY16)	LINK	NOTES
High	Buses and Bus Facilities Discretionary Program - 5339	FTA, Federal	Capital projects to replace, rehabilitate and purchase buses, vans, and related equipment, and to construct bus-related facilities, including technological changes or innovations to modify low or no emission vehicles or facilities.	$211 million (FY2016),	Funds remain available for obligation for three fiscal years. This includes the fiscal year in which the amount is made available or appropriated plus two additional years.	Annually, typically in May	Federal share is 80%, may exceed 80% with certain projects related to ADD, the Clean Air Act (CAA), and bicycle projects	https://www.transit.dot.gov/funding/grants/fiscal-year-2016-bus-and-bus-facilities-projects	$26,400 - $12,800,000	https://www.transit.dot.gov/funding/grants/buses-and-bus-facilities-grants-program-5339	
High	Low or No Emission Vehicle Program 5339	FTA, Federal	Purchasing or leasing low- or no-emission buses -acquiring low- or no-emission buses with a leased power source -constructing or leasing facilities and related equipment (including intelligent technology and software) for low- or no-emission buses -constructing new public transportation facilities to accommodate low- or no-emission buses -rehabilitating or improving existing public transportation facilities to accommodate low- or no-emission buses	$55 million (FY2016)	FY16-20, funds are available the year appropriated plus three years	Annually, typically in May	Maximum possible federal share is 85% for vehicles and 90% for facilities	https://www.transit.dot.gov/funding/grants/fiscal-year-2016-low-or-no-emission-low-no-bus-program-projects	$0.5 - 4 million	https://www.transit.dot.gov/funding/grants/low-or-no-emission-vehicle-program-5339c	
Medium	Pilot Program for Transit-Oriented Development Planning	FTA, Federal	The Pilot Program for TOD Planning helps support FTA's mission of improving public transportation for America's communities by providing funding to local communities to integrate land use and transportation planning with a New Starts, Core Capacity or fixed-guideway Small Starts project that is seeking or has recently received funding through the CIG Program.	$20.49 million (FY2016) Award amounts may range from $200,000-250,000	FY16-20	Annually, typicaly in June	Maximum possible federal share is 80%	https://www.gpo.gov/fdsys/pkg/FR-2015-09-15/pdf/2015-23154.pdf	$0.25 - 2 million	https://www.transit.dot.gov/TODPilot	SANDAG 's Mid-Coast Corridor Mobility Hub Implementation Strategy was funded for $429,635 in FY2015.

Additional resources may be found in local Infrastructure Finance Districts or through Transit Benefit Assessment Districts (SB 142). Sponsorship/naming rights for transit lines or stations may also be employed for funding purposes.