Redlands Passenger Rail Project

Model Application and Ridership Forecasts – Updated for Phase 1

draft technical

memorandum

prepared for

San Bernardino Associated Governments

prepared by

Cambridge Systematics, Inc.

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date

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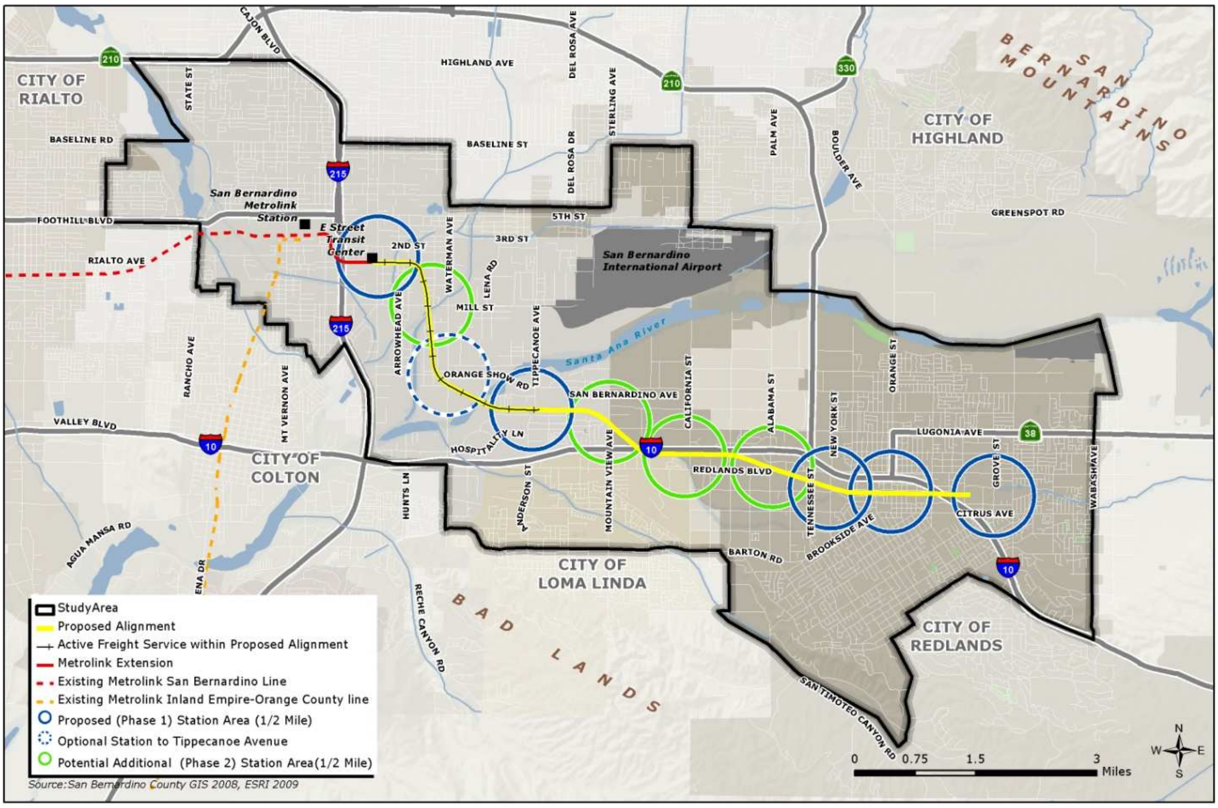
1.0 Overview

The original purpose of the Redlands Passenger Rail Project was to evaluate alternatives for the introduction of passenger rail services along the Redlands Corridor (see Figure 1.1), and to identify a locally preferred alternative that best serves local transportation needs.

Figure 1.1 Redlands Corridor Study Area Map



The Redlands Corridor is a nine-mile corridor running between downtown San Bernardino and the University of Redlands. Metrolink, the regional commuter railway that provides passenger transport service from the Santa Fe Depot (on the west side of I-215) is planning the extension of commuter rail service to the planned downtown San Bernardino Transit Center at E Street and Rialto Avenue (on the east side of I-215) . The study area for the Redlands Passenger Rail Project represents a varied mixture of land uses, from dense urban centers with residential and retail or office commercial establishments to low-density highway commercial and light industrial uses. A mixture of transportation facilities, including highways, bus transit networks, freight railroads, and the San Bernardino International Airport, serves the San Bernardino Valley.

The approach used by San Bernardino Associated Governments (SANBAG) and the HDR consulting team for studying the Redlands Passenger Rail Project has evolved since the initiation of the project, and each change in approach has required revisions to the approach for model application and ridership forecasts. The original approach assumed that the project would pursue the Federal Transit Administration (FTA) New Starts/Small Starts funding, using the traditional alternatives analysis process to identify a locally preferred alternative.

The Alternatives Analysis approach for the Redland Passenger Rail Project was initiated in 2010. This Alternatives Analysis studied two baseline alternatives and four build alternatives. The alternatives under consideration in the Alternatives Analysis were a No-Build Baseline, a Transportation Systems Management (TSM) Baseline, and four Build alternatives. The four build alternatives included Diesel Multiple Unit (DMU), Light-Rail Transit (LRT), Commuter Rail (extension of Metrolink service), and Bus Rapid Transit (BRT). The four proposed build alternatives would all utilize the railroad right-of-way owned by SANBAG, which is sufficient to accommodate the proposed guideway and station platforms. The alternatives and the operating plans are described in greater detail in the Draft Environmental Impact Statement and Environmental Impact Report (EIS/EIR) for the Redlands Passenger Rail Project (scheduled for publication in June 2013).

Preliminary results of the Alternatives Analysis showed that the project was unlikely to qualify for FTA Section 5309 New Starts/Small Starts funding under any of the alternatives identified for study. Based on this preliminary assessment and recent changes in funding requirements with the adoption of MAP-21, the approach for the project changed from an alternative analysis to a strategic planning process to develop the passenger rail service in the Redlands Corridor in phases, with different funding sources identified to complete each phase of the strategic plan. Phase 1 of the strategic planning process would connect the San Bernardino Transit Center at E Street to Redlands University using passenger rail vehicles on a single-track alignment with three intermediate stations. The Phase 1 operations are similar, though not identical, to the definition of the Commuter Rail Alternative of the Alternatives Analysis. Phase 1 operations would more closely resemble a local transit service, which would operate back and forth between the station platforms with express train service during the peak commute hours.

Phase 2 of the strategic planning process upgrades the rail service in Phase 1 to LRT, with double tracking and five additional stations. Phase 3 of the strategic planning process extends the passenger rail alignment to create a loop that connects the Redlands Corridor to San Bernardino International Airport and the City of Highland.

Throughout the strategic planning process, the engineering team has provided SANBAG with alternatives analyses and ridership forecasts for a wide range of variables, including alternative modes of transportation, service levels, and station locations. Concurrent with the change in approach from the alternative analysis to the strategic plan, the engineering team has engaged in a process of educating and engaging local governments to reevaluate their land use plans and to concentrate transit-oriented development in the Redlands Corridor station areas. The results of the updated land use plans have been used to prepare alternate land use scenarios and socioeconomic data input for application in the travel demand model.

The purpose of this model application and ridership report is to describe the application of the travel demand model, and to summarize the resulting ridership forecasts for Phase 1 of the Strategic Plan. **Section 2.0** of this technical memorandum summarizes the basic procedures for application of the San Bernardino Valley Focus Model (SBVFM).

Section 3.0 of this technical memorandum presents a summary of the input assumptions and summarizes the ridership forecasting results for Phase 1 of the strategic plan process.

Section 4.0 of this technical memorandum presents summaries of the impacts of several input assumptions, and provides estimates of elasticity values that can be used to assess the range of ridership forecasting results that could occur in the future.

2.0 Travel Demand Model Application

The forecasting tool employed for the Redlands Passenger Rail Project is the San Bernardino Valley Focus Model (SBVFM), which is a focused model derived from the Southern California Association of Governments (SCAG) regional model. Elements of the SCAG model are documented in *2003 SCAG Model Validation and Summary – Regional Transportation Model* (January 2008).

The SBVFM uses the basic structure of the SCAG model, with the mode choice model derived from the Orange County Transportation Authority Model (OCTAM) – customized for use in the San Bernardino Valley – with a focused definition of the networks and zone system within the San Bernardino Valley.

The SBVFM employs the traditional 4-step modeling process used in the SCAG model. Special features of the SBVFM include the following:

- All person trips are modeled (including nonmotorized);
- Auto-ownership is tied to transit accessibility;
- Person trip data is split into peak and off-peak trips before application of distribution models;
- Feedback loops are used for highway and transit skims;
- Logsums are used to estimate composite impedance for application within trip distribution models for the home-based work trip purpose;
- Vehicle trip data is split into four time periods and converted to origin-destination format using time-of-day models; and
- Transit trip data is assigned to peak (AM) and off-peak (midday) time periods in production-attraction format.

The travel demand model methodology and validation are described in greater detail in *Redlands Passenger Rail Project Travel Demand Model Methodology and Validation draft technical memorandum* (August 2011). That technical memorandum summarizes modeling methodology and model validation for the Redlands Passenger Rail Project, using the SBVFM.

Following validation of the SBVFM, this model was used to produce travel forecasts and user benefits for future year conditions to assess future year transit ridership sensitivity for several combinations of transit alternatives for the Redlands Corridor.

Application of the SBVFM is performed in two steps: creation of baseline person trip tables; and mode choice and assignment for transit alternatives. This two-step process has been utilized in order to satisfy the FTA requirement for New Starts projects that requires alternatives analyses to use common person trip tables and common highway skim data.

The SBVFM could, hypothetically, be applied in a single step process whereby each transit scenario is run through the complete model stream. This approach would allow the model to recognize the incremental effects that the transit scenarios have on the highway skims and trip distribution (e.g., if a transit scenario attracted significant ridership from auto modes, traffic volumes for that scenario would be lower and highway speeds would be faster). These faster highway speeds would result in changes to the highway and transit skims, the trip distribution, as well as the mode choice results.

Under the two-step application process, the baseline person trip tables are created by preparing the input data for the baseline alternative (socioeconomic data files and highway and transit networks) and running the model stream through three full feedback loops to bring the skims and trip distribution models into a state of equilibrium.

A new database is then built for each future transit scenario using a transit network coded to represent the operations of that transit scenario. The baseline person trip tables and highway skims are then used to build transit skims for each transit scenario, and the mode choice model is used to create a final set of highway and transit trip tables. The transit trip tables are assigned to the transit networks and the results are analyzed to compare the transit scenarios.

3.0 RPRP – Phase 1 Ridership Forecasts

Subsequent to the strategic planning process, SANBAG has continued to study options for a Phase 1 project, including station platform locations and operating plans. The remainder of this chapter is used to document the Phase 1 alternative and ridership results for opening year 2018 and horizon year 2038.

3.1 Description of Alternatives

No Project Alternative

The No Project Alternative includes existing and committed infrastructure, facilities, and services contained in the SCAG Federally-approved transportation plan, the Federal Statewide Transportation Improvement Program (FSTIP). A No Project Alternative provides an essential benchmark to test whether project alternatives improve future transit service compared to improvements planned to be implemented without the proposed project. The No Project Alternative includes existing transit services in the Cities of San Bernardino, Loma Linda, and Redlands (consisting of 12 local bus routes and one express bus route operated by Omnitrans, and two bus routes serving the mountain areas of Big Bear and Lake Arrowhead operated by Mountain Area Transit Authority). The No Project Alternative also includes the E Street Corridor sbX (BRT) project and the one-mile extension of Metrolink service to the new San Bernardino Transit Station at Rialto and E Streets in downtown San Bernardino. Of the transit services listed above, five local Omnitrans bus routes provide transit service within the Redlands Corridor, while the other transit routes provide transfer opportunities at the San Bernardino Transit Station.

Phase 1 Alternative – Passenger Rail

The first phase of the Redlands Passenger Rail Project Strategic Plan supports the development of a passenger rail service operating between the San Bernardino Transit Center and the University of Redlands. The proposed Phase 1 alternative begins at the future San Bernardino Transit Center, and extends east eight blocks before turning southward, passing to the southwest of Waterman Avenue and Orange Show Road. The right-of-way then crosses the Santa Ana River and turns east until reaching Richardson Street, where the corridor turns southeast until passing under I-10 near Bryn Mawr Avenue. The corridor then turns to the east, paralleling I-10 to Nevada Street until turning southeast again, running parallel to Redlands Boulevard to Texas Street. It then turns east, passing under

I-10 again near Church Street, and ending at the south end of the University of Redlands.

Passenger rail technology was selected for Phase 1 because it allows for quicker and less expensive implementation. Passenger rail vehicles (engines and cab cars) are readily available through Metrolink and would require only minimal rehabilitation to go from storage to operation. The Phase 1 service is proposed to operate on 30-minute headways in the peak periods and 1-hour headways in the off-peak periods.

The five stations proposed would be located at the San Bernardino Transit Center, Tippecanoe Avenue or Waterman Avenue, New York Street, Downtown Redlands, and University of Redlands. The Phase 1 alignment is illustrated in Figure 3.1.

Operating Plans

Operating plans for Phase 1 in both future years are displayed in Table 3.1. The operating assumptions include service frequency, vehicle capacity and station-to-station run time estimates for the Phase 1 alternatives.

For the purposes of estimating ridership forecasts for Phases 1 and 2 of the RPRP Strategic Plan, the horizon year (2038) and operating plans are based on the same assumptions used for the RPRP Alternatives Analysis.

Table 3.1 Operating Plans for RPRP Phase 1 (Opening and Horizon Years)

Variable	Value
Number of Stations	5
Length (miles)	8.95
Travel Time - Tippecanoe (min:sec)	15:55
Travel Time – Waterman Option (min:sec)	16:15
Capacity (seated)	132
Peak Headway	30
Off-peak Headway	60
Weekend Headway	60

The Phase 1 train sets shuttling between the University of Redlands station and the San Bernardino Transit Center would not interline with Metrolink and would be composed of a locomotive and a cab car—much shorter than the standard Metrolink train sets. The exception to this would be two express (Metrolink) trains that would operate in the AM and PM peak hours. Heavy maintenance activities would be completed at a Metrolink facility, saving the cost of constructing a maintenance facility.

Figure 3.1 Phase 1 – Passenger Rail Alignment

If future phases of this project result in a change in technology to LRT, passenger rail platform heights are compatible with LRT, thus reducing the costs to retrofit stations and platforms. That potential cost savings for LRT would have to be balanced against the cost of an electrified traction power system and the lower vehicle costs of DMUs in the analysis and selection of a mode to replace passenger rail in the future.

Phase 1 would require removal and replacement of the existing track and addition of an approximately 1-mile-long passing track near the halfway point of the proposed corridor. Also, as a part of Phase 1, safety improvements would be made at 24 grade crossings. The grade crossings will include crossing gates. Phase 1 will replace the rail bridge over the Santa Ana River, as well as rehabilitate/reconstruct four other drainage crossings.

The annual operations and maintenance costs for Phase 1 are $8 million (2012 dollars). The capital cost for Phase 1 is estimated to cost up to $200 million. Phase 1 would be funded using a combination of regional, state, and Federal sources.

The Phase 1 track alignment will be designed to the extent feasible so that in later phases of the project the corridor can be expanded to become double tracked, and so that rail technology such as LRT or DMU can replace the passenger rail technology at minimal costs.

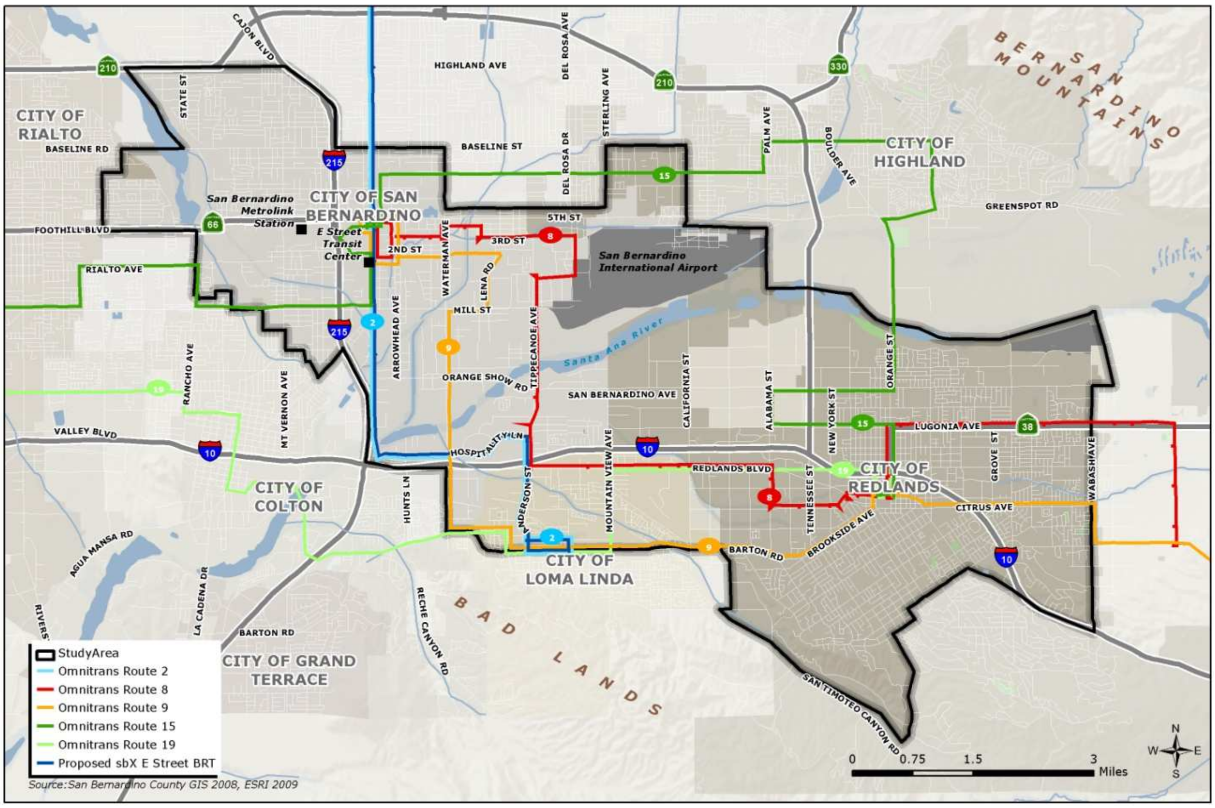
Interface with Other Existing and Planned Transit Services

Both No Project and Phase 1 alternatives assume that Metrolink will be extended from the existing Santa Fe Depot to the new E Street Transit Center, and that the E Street sbX, currently under construction, will be in operation. The Phase 1 Passenger Rail alternatives would require a transfer at the E Street Transit Center to access Metrolink Commuter Rail service to Downtown Los Angeles and Riverside, E Street sbX service, and local bus services. Two Metrolink lines currently run all day service into the existing Santa Fe Depot and terminate west of the I-215 freeway and downtown San Bernardino. The Inland Empire-Orange County Line operates 14 trains daily, and extends from Oceanside in San Diego County north through Anaheim and Riverside into San Bernardino. The San Bernardino Line has Metrolink's most frequent service with 42 weekday trains, as well as weekend service into downtown Los Angeles.

Existing transit service in the study area includes five fixed-route bus routes (Omnitrans Routes 2, 8, 9, 15, and 19), which are operated by Omnitrans in the Redlands Corridor. The baseline and build alternatives assume that the existing Omnitrans local bus routes and the proposed sbX E Street BRT route will be operated in the Redlands Corridor. Alignments for these routes are assumed to be maintained with only minor alignment variations to serve the new San Bernardino Transit Station at E Street.

Figure 3.2 shows the existing bus service that will interface with the proposed for the Redlands corridor.

Figure 3.2 Bus Services in Redlands Corridor Alternatives



Source: HDR, Inc., 2011.

Service Frequency

Service frequencies for transit routes in both the No Project and RPRP Phase 1 alternatives are assumed the same for both analysis years. Service frequencies for Route 2 and the E Street sbX are consistent with short-range and long-range plans for the sbX system. Table 3.2 summarizes the assumed service frequencies for Omnitrans bus routes in the No Project and Phase 1 alternatives.

Table 3.2 Peak Headways for Transit Routes Phase in Redlands Corridor

Route	Opening Year 2018	Horizon Year 2038
Omnitrans Route 2	30	20
Omnitrans Route 8	60	60
Omnitrans Route 9	60	60
Omnitrans Route 15	30	30
Omnitrans Route 19	30	30
Omnitrans sbX E Street BRT	10	5

3.2 TRANSIT RIDERSHIP FORECASTS

The ridership forecasts for the No Project and RPRP Phase 1 alternatives documented in this section were prepared for opening year 2018 and for horizon year 2038 using socioeconomic data derived from SCAG RTP 2008. SCAG RTP 2012 socioeconomic data were not available for this analysis. However, subsequent comparison of the socioeconomic data in the 2008 and 2012 datasets confirms that there is minimal difference in the long-range data in the Phase 1 station area.

The ridership forecasts are based on the operating plans for the alternatives, as described above.

Linked Transit Trips – New Transit Trips

The total numbers of daily linked transit trips associated with the No Project and RPRP Phase 1 alternatives are summarized in Table 3.3. The estimated numbers of transit trips are shown for both San Bernardino County and the Redlands Corridor study area.

Table 3.3 Daily Linked Transit Trips for Phase 1 Alternatives – Years 2018 and 2038

	Opening Year 2018		Horizon Year 2038	
Area/Statistic	No Project	Phase 1	No Project	Phase 1
San Bernardino County	56,730	56,940	102,390	102,560
New Trips	–	210	–	170
Corridor Study Area	21,950	22,190	27,990	28,180
New Trips	–	240	–	190

This table shows that the Phase 1 improvements are forecast to attract approximately 200 new transit trips in both opening year 2018 and horizon year 2038, as compared to the No Project Baseline.

Unlinked Transit Trips – Transit Ridership by Route

The Phase 1 ridership forecasts are based on a five station passenger rail alignment that includes four stations at San Bernardino Transit Center, New York Street, Downtown Redlands and University of Redlands, plus one additional station that will be located at either Tippecanoe Avenue or Waterman Avenue. In both future year model runs the alignment with the Tippecanoe Avenue Station is forecast to attract more passengers than the alignment with the Waterman Avenue Station. The tabulated ridership forecasts for each future year presents a range of values wherein the higher value is associated with the Tippecanoe Avenue station location and the lower value is associated with the Waterman Avenue station location.

The daily unlinked transit ridership forecasts for the transit routes serving the Redlands Corridor study area in the No Project and RPRP Phase 1 alternatives are summarized in Table 3.4. This table shows that the Redlands Rail route is forecast to carry between 720 and 820 daily riders in opening year 2018 (depending on the Tippecanoe/Waterman station location) and between 1,120 and 1,340 daily riders in horizon year 2038.

Table 3.4 Daily Transit Trips (Boardings) for Redlands Corridor Routes

Route	Opening Year 2018		Horizon Year 2038	
	No Project	Phase 1[a]	No Project	Phase 1[a]
Redlands Rail	–	720/820	–	1,120/1,340
Omnitrans Route 2	1,550	1,540	2,170	2,160/2,170
Omnitrans Route 8	1,590	1,520	1,810	1,830/1,840
Omnitrans Route 9	1,950	1,860/1,870	2,190	2,080
Omnitrans Route 15	4,320	4,420	4,840	4,830
Omnitrans Route 19	3,950	3,880	4,490	4,340
Omnitrans sbX E Street	6,210	6,130/6,030	9,670	9,370/9,160
Other Omnitrans Routes[b]	20,000	20,050	28,770	28,790
San Bernardino Metrolink	10,910	10,930	20,640	20,670
IE-OC Metrolink Line	6,250	6,260	8,720	8,760
All Study Area Routes	**56,730**	**57,310/57,320**	**83,300**	**83,950/83,980**
	Additional Transit Boardings			
vs. No Project Alternative	–	580/590	–	650/680

[a] Multiple values reflect differences in ridership forecasts for alternate station options (Waterman/Tippecanoe).

[b] Other routes serving San Bernardino Station include Omnitrans Routes 1, 3, 4, 5, 7, 10, and 14.

Comparison of these ridership forecasts to the new trips presented in Table 3.3 shows that the model assumes that the majority of passengers riding the Redlands Rail route will be existing transit riders, who alter their transit paths to include the Redlands Rail route. In opening year 2018, approximately 30 percent of the passengers on the Redlands Rail route are assumed to be new transit riders, and the remaining 70 percent existing riders. In horizon year 2038, approximately 15 percent of the Redlands Rail passengers are new transit riders.

The transit routes serving the Redlands Corridor study area in opening year 2018 are forecast to accommodate 56,700 (No Project) and 57,300 (Phase 1) total daily boardings, a net increase of approximately 600 boardings for the Phase 1 alternative over the No Project Baseline Alternative. Similarly, the transit routes serving the Redlands Corridor study area in 2038 are forecast to accommodate 83,300 (No Project) and 83,950(Phase 1) total daily boardings, a net increase of approximately 650 boardings for the Phase 1 alternative over the No Project Baseline.

Since there are approximately 200 new transit trips forecast for each of the future years (Table 3.3), this data implies that the transfer rates for trips associated with the Redlands Rail route are higher than the transfer rate for transit routes that currently operate in the Redlands corridor (the current transfer rate equates to approximately 1.4 boardings per transit trip). The increased transfer rates imply that the travel time savings provided by the Redlands Rail route will make multi-seat transit paths more attractive than in the current transit system. For example, with the Redlands Rail route, Metrolink riders from Redlands who currently drive to the Metrolink station in San Bernardino are likely to change their behavior and use the Redlands Rail route to get from Redlands to the Metrolink station, thereby, adding a transfer to their transit path.

Most Omnitrans bus routes within the Redlands Corridor study area (Omnitrans Routes 2, 8, 9, 19, and sbX) are forecast to experience minor ridership losses with the Phase 1 Alternative, as compared to the No Project Baseline, due to competition between the local routes and the Redlands Rail route. Other Omnitrans bus routes that operate outside the Redlands Corridor study area but interface with Redlands Rail at the San Bernardino Transit Center are forecast to experience minor ridership gains with the Phase 1 Alternative, as compared to the No Project Baseline, due to the improved mobility and travel times offered by the Redlands Rail route. Similarly, ridership on the Metrolink routes that serve the San Bernardino Transit Center – the San Bernardino and Inland Empire-Orange County Metrolink Lines – is forecast to increase with the Phase 1 Alternative due to the improved connectivity offered by the Redlands Rail route.

Ridership Activity at Stations

The daily station activity forecasts for Phase 1 Redlands Rail route in 2018 and 2038 are summarized in Table 3.5. This table shows the number of daily boardings (and alightings) forecast for the stations in each future year.

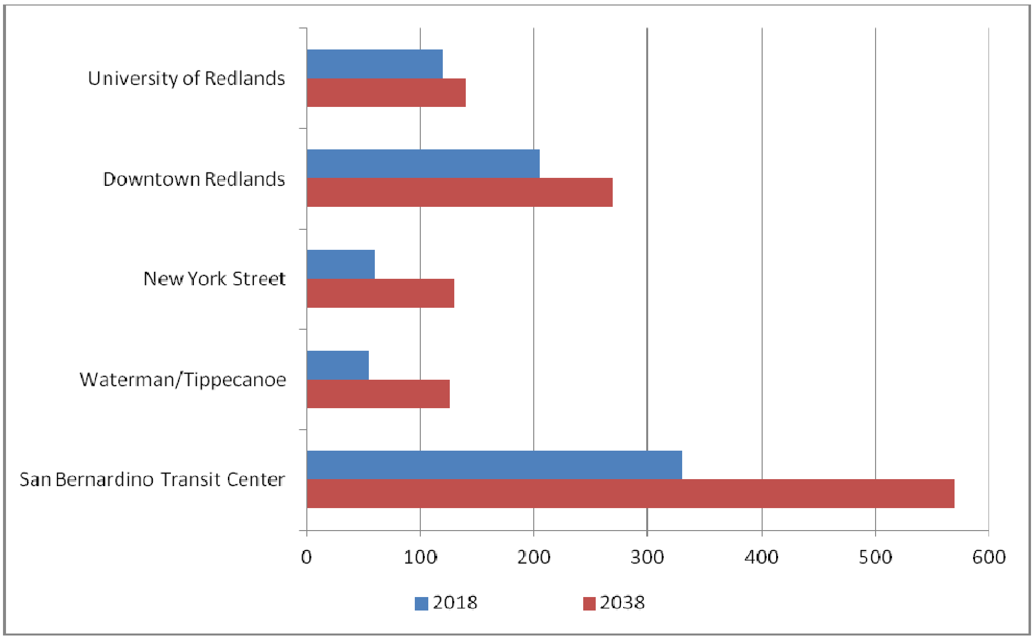
Table 3.5 Daily Transit Boardings at Redlands Rail Stations

Station	Opening Year 2018[a]	Horizon Year 2038[a]
San Bernardino Transit Center	310/350	520/610
Waterman Avenue/Tippecanoe Avenue	30/80	70/180
New York Street	60	130
Downtown Redlands	200/210	260/280
University of Redlands	120	140
Total	**720/820**	**1,120/1,340**

[a] Multiple values reflect differences in ridership forecasts for alternate station options (Waterman/Tippecanoe).

The San Bernardino Transit Center is forecast to serve the greatest passenger volume in both future years, followed by the Downtown Redlands Station. The data in Table 3.5 is displayed graphically in Figure 3.3.

Figure 3.3 Daily Transit Boardings at Redlands Rail Stations



Access Modes

Table 3.6 displays the access mode shares forecast for each station, and aggregated for the entire system, for year 2018 and 2038 operations of the Phases 1 Redlands Rail route. In both forecast years, walk access is more popular than transfer access as the most common access mode. Walk access is the predominant access mode at most of the stations except Downtown Redlands, where transfer access is the predominant access mode, and San Bernardino, where walk and transfer access are almost equal. It is possible to transfer from other transit routes at only three of the five stations in the Phase 1 alternatives. Auto access accounts for only three percent of the total station access forecast for the Phase 1 Redlands Rail alignment for both future years.

Table 3.6 Transit Access Shares at Redlands Rail Stations

	Opening Year 2018			Horizon Year 2038		
Station	**Walk**	**Auto**	**Transfer**	**Walk**	**Auto**	**Transfer**
San Bernardino Transit Center	50%	1%	49%	48%	1%	51%
Waterman Avenue/ Tippecanoe Avenue	57%	0%	43%	82%	0%	18%
New York Street	99%	1%	0%	100%	0%	0%
Downtown Redlands	32%	0%	68%	24%	6%	70%
University of Redlands	84%	16%	0%	95%	5%	0%
Total	**56%**	**3%**	**41%**	**51%**	**3%**	**46%**

Transit Loads

Transit loads are the number of passengers on transit vehicles at any point on the transit route. Transit *loads* differ from transit *activity*, which represents the number of passengers boarding and alighting at each station. Transit loads are compared to vehicle capacity in order to assess the ability of the planned operations to serve the forecast demand. Daily transit loads are tabulated for year 2018 and 2038 operations of the Phase 1 Redlands Rail route in Table 3.7.

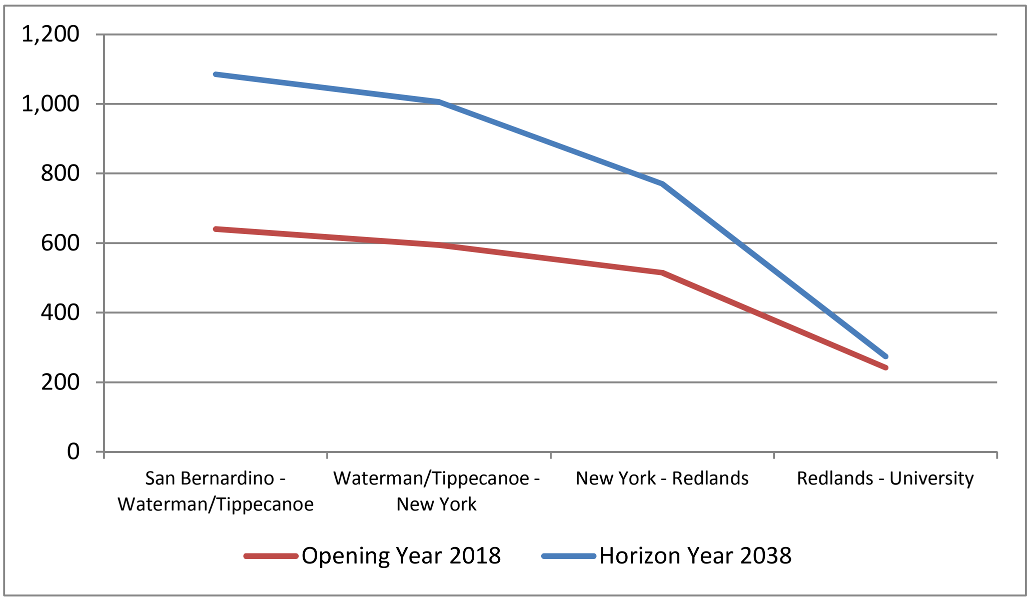
Table 3.7 Daily Transit Loads between Redlands Rail Stations

Stations	**Opening Year 2018[a]**	**Horizon Year 2038[a]**
San Bernardino – Waterman/Tippecanoe	620/660	1,050/1,230
Tippecanoe/Waterman – New York	590/600	990/1,020
New York – Redlands	510/520	760/790
Redlands – University	240	270/280

[a] Multiple values reflect differences in ridership forecasts for alternate station options (Waterman/Tippecanoe).

The data in Table 3.7 is displayed graphically in Figure 3.4. The peak loads for Phase 1 are forecast to be over 600 riders per day in opening year 2018 and over 1,000 riders per day in horizon year 2038. These exhibits show that the peak loads for both future years are in the western end of the corridor, in the City of San Bernardino.

Figure 3.4 Daily Transit Loads between Phase 1 Redlands Rail Stations



Peak-Hour Ridership

Peak-hour ridership forecasts can be used to plan such design elements as station design, platform length and fleet requirements. Peak-hour boarding forecasts at transit stations for year 2018 and 2038 operations of the Phase 1 Redlands Rail route are tabulated in Table 3.8. This table shows that, for both future years, in the AM peak hour the San Bernardino Transit Center and Downtown Redlands stations will have the greatest demand for transit boardings. In the PM peak hour the San Bernardino Transit Center is forecast to have, by far, the greatest demand for transit boardings.

Table 3.8 AM and PM Peak-Hour Transit Boardings at Rail Stations

	Opening Year 2018[a]		Horizon Year 2038[a]	
Station	**AM Peak Hour**	**PM Peak Hour**	**AM Peak Hour**	**PM Peak Hour**
San Bernardino Transit Center	35/46	46/49	58/74	75/80
Waterman Avenue/ Tippecanoe Avenue	4/10	3/8	4/12	11/29
New York Street	8	9	19	13
Downtown Redlands	32/33	19	43/44	21
University of Redlands	20	14	25	12
Total	**99/117**	**90/99**	**148/174**	**132/155**

[a] Multiple values reflect differences in ridership forecasts for alternate station options (Waterman/Tippecanoe).

Peak-hour transit loads are tabulated for year 2018 and 2038 operations of the Phase 1 Redlands Rail route in Table 3.9. The peak-hour loads forecast for both directions of travel are tabulated separately to allow computation of transit demand to seating capacity ratios on the system. The transit load data in this table are displayed graphically in Figures 3.5 and 3.6 for the AM and PM peak hours, respectively.

These exhibits show that the peak loads for both future years are found in the western end of the corridor, in the City of San Bernardino. For both future years, the peak transit loads are forecast for the westbound direction during the AM peak hour, and for the eastbound direction during the PM peak hour.

Table 3.9 Peak-Hour Transit Loads between Rail Stations

	Opening Year 2018[a]		Horizon Year 2038[a]	
Stations	**Eastbound**	**Westbound**	**Eastbound**	**Westbound**
AM Peak Hour				
San Bernardino – Waterman/Tippecanoe	35/46	50/54	58/74	81/88
Waterman/Tippecanoe – New York	34	48/49	49	81/83
New York – Redlands	27	44/45	36	64/66
Redlands – University	15	20	15	25
PM Peak Hour				
San Bernardino – Waterman/Tippecanoe	46/49	33/42	75/80	53/67
Waterman/Tippecanoe – New York	44/45	31	74/76	45
New York – Redlands	40/41	25	59/61	33
Redlands – University	18	14	23	13/14

[a] Multiple values reflect differences in ridership forecasts for alternate station options (Waterman/Tippecanoe).

The peak-hour transit loads can be used to assess the ability of the planned operations to serve the forecast demand. Table 3.10 presents a tabulation of the demand-to-capacity ratio for year 2018 and 2038 operations of the Phase 1 Redlands Rail route. The number of peak-hour vehicles and seating capacities are derived from the operating assumptions for the two future years. Operations for both future years assume single-car consists. The highest peak load on a single vehicle operating during the peak hour is estimated assuming a peak-hour factor of 1.25 (i.e., the peak vehicle is assumed to carry 25 percent more passengers than the average peak hour vehicle).

Figure 3.5 AM Peak-Hour Transit Loads for Phase 1 Redlands Rail Stations

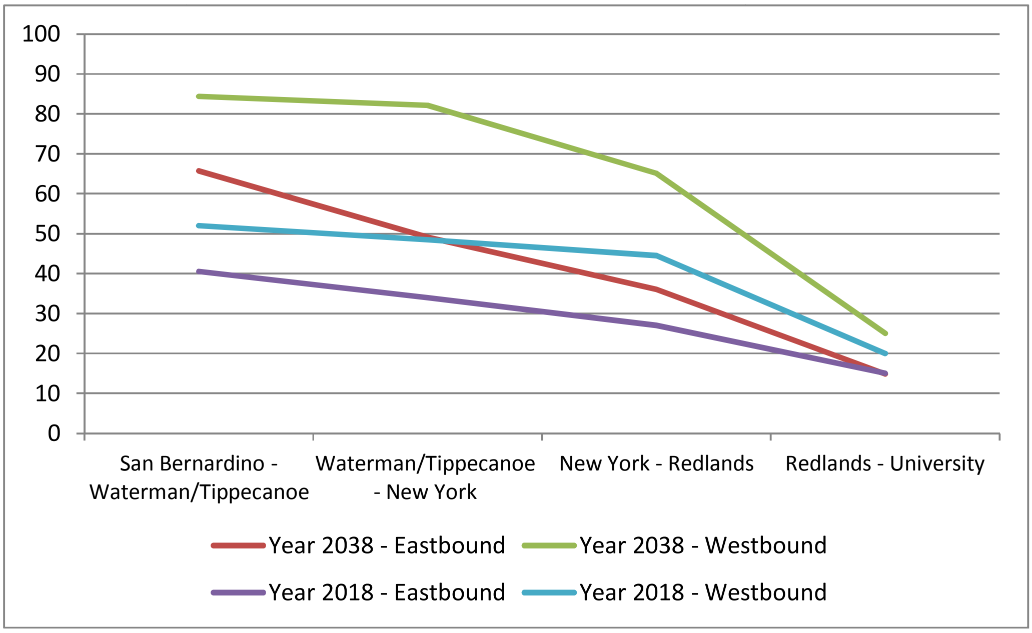
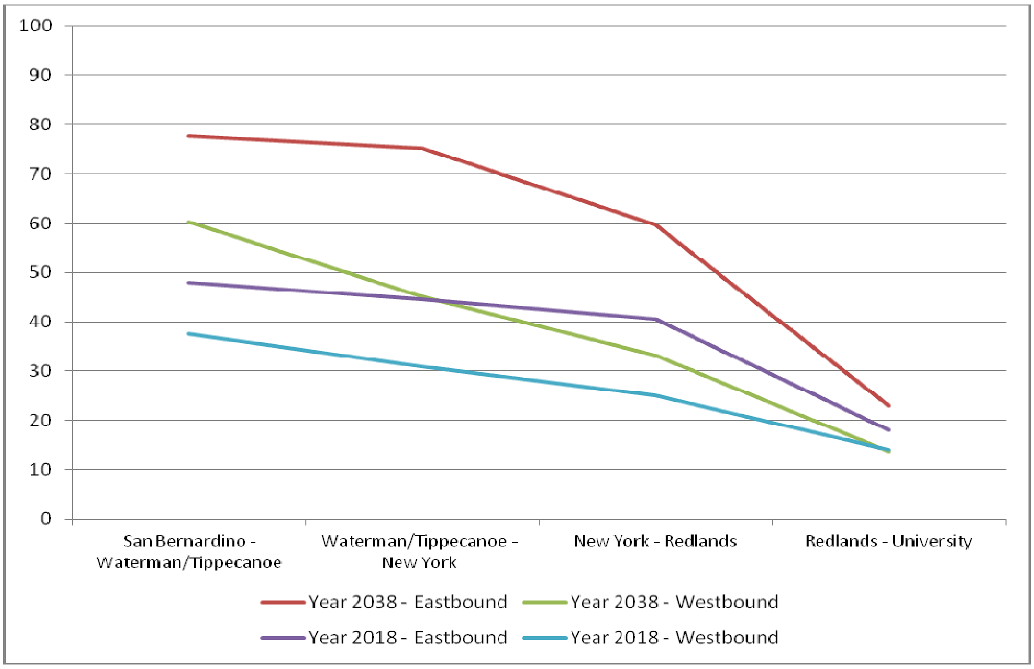


Figure 3.6 PM Peak-Hour Transit Loads for Phase 1 Redlands Rail Stations



The demand-to-capacity ratios calculated for both future years demonstrate that the operating plans and vehicle seating capacities will easily supply sufficient seating for all passenger demand on the peak vehicles. Peak vehicle demands on the Phase 1 system are forecast to consume approximately 25 percent of total capacity in opening year 2018, and 40 percent of capacity in horizon year 2038.

Table 3.10 Demand-to-Capacity Ratios

Variable	Opening Year 2018[a]	Horizon Year 2038[a]
Vehicles during Peak Hour	2	2
Vehicle Seating Capacity	132	132
Vehicle Total Capacity	132	132
Peak Passenger Load (Peak Hour)	50/54	81/88
Peak Passenger Load (Peak Vehicle)	31/34	51/55
Peak Vehicle Load/Capacity Ratio	24%/26%	38%/42%

[a] Multiple values reflect differences in ridership forecasts for alternate station options (Waterman/Tippecanoe).

3.3 Intersection Turning Movement Counts

The traffic forecast methodology applies a post-processing procedure to estimate future intersection turning movement volumes. Existing turning movement counts are used as the seed data, and the model-generated traffic assignment volumes are used to calculate and apply traffic growth factors for each intersection approach leg. The post-processing methodology estimates future year background traffic for each approach of intersections being analyzed by comparing future year No Project traffic assignments to validation year traffic assignments. This methodology uses the assignment volume comparisons to calculate annual growth rates for each intersection approach leg, separately for AM and PM peak periods. The future growth for the background traffic is calculated by applying growth factors for the appropriate number of years to grow from observed traffic counts (in year 2011) to the two future years: opening year 2018 (seven years of compounded growth) and horizon year 2038 (27 years of compounded growth).

For estimating the impacts of project related traffic in future years, the post-processing methodology applies a direct adjustment to the background traffic counts. First, future year No Project traffic assignments are compared to future year with Phase 1 traffic assignments to calculate the assignment differences, and then the raw difference in assigned traffic volumes is added to the background traffic counts to estimate the Phase 1 traffic volumes.

Intersection volumes for observed traffic counts and for future alternatives are tabulated in Appendix A.

4.0 Sensitivity Analysis

The transit ridership forecasts presented in Section 3.0 of this memorandum are based on a conservative set of assumptions regarding the socioeconomic characteristics and other variables input to the travel demand model. Such conservative assumptions are necessary when producing ridership forecasts that will be subject to review by agencies, such as the Federal Transit Authority (FTA) that insist that forecasts conform to regionally accepted transportation plans.

However, throughout the planning process for the Redlands Passenger Rail Project, the engineering team has also provided SANBAG with alternatives analyses and ridership forecasts for a wide range of variables, including alternative modes of transportation, service levels and station locations. Concurrently with the change in approach from the alternative analysis to the strategic plan, the engineering team has engaged in a process of educating and engaging local governments to reevaluate their land use plans and to concentrate transit-oriented development in the Redlands Corridor station areas. The results of the updated land use plans have been used to prepare alternate land use scenarios and socioeconomic data input for application in the travel demand model.

This sensitivity analysis documents the impacts of several input assumptions and provides estimates of elasticity values that can be used to assess the range of ridership forecasting results that could occur in the future under a range of conditions. Specific variables subject to analysis include:

- Land use in RPRP corridor and station areas (ranging from current RTP forecast to full TOD build-out plans);
- Number of stations;
- Service characteristics (e.g., service frequency and operating speeds); and
- Travel mode.

Land Use

Of all variables studied, the variable with the greatest potential impact to attract additional transit ridership to the Redlands Corridor is land use density. This is primarily due to the fact that the existing development density along most of the corridor is very low, and increases in the development density to modest levels will have a profound impact on the transit ridership demand on the Redlands Rail route.

The measure of development density chosen for application is the composite of population and employment density in the station areas in the corridor. Comparison of the ridership results of the preferred land use scenarios to the composite development density in the RTP showsthat the ridership forecasts have an elasticity of approximately 0.63. In other words, a 40-percent increase in the average development density in the station areas will results in a 25-percent increase in the ridership demand on the Redlands Corridor route.

Number of Transit Stations

The number of transit stations served along a transit alignment has both positive and negative impacts on transit ridership on the corridor route. The addition of new stations necessarily reduces the operating speed of the corridor route, due to additional acceleration/deceleration time and dwell time, which reduces transit ridership demand. On the other hand, the addition of stations has a positive impact on transit ridership if the new stations are located within access of trip origins and destinations. In most cases, the positive impacts of the additional coverage area easily outweigh the negative impacts of the additional travel time.

However, this relationship has limitations, and the return on investment in additional stations reaches a point of diminishing returns when stations are spaced too close together. This is due to the fact that most transit riders are willing to walk a reasonable distance to access transit, and spacing stations close together doesn't always increase the catchment area, it merely improves the access time for riders who would use the system regardless of the new stations.

It is difficult to quantify the ridership impact of additional stations because each potential station location is unique, especially in terms of the land use and development density associated with the station location. However, if we assume that development density of the new station location is similar to the development density for other station locations in the corridor, we have found that the ridership impact is almost directly related to the percent increase in the number of stations (i.e., the elasticity of the number of stations is approximately 0.90).

Similarly, if we assume that development density of the new station location is a fraction of the average development density for the other station locations in the corridor, we have found that the ridership impact is then related to the percent increase in the number of stations times the relative development density of the new station area(s).

For example, if we start with an alignment that includes five stations, and add an intermediate station in a location that has a development density that is one-half the development density of the stations along the original alignment, we can calculate that the new six-station alignment will attract 9 percent more ridership than the original route (20 percent increase in number of stations × 0.90 elasticity × 0.50 ratio of development densities = 9 percent).

Service Characteristics

The quantifiable service characteristics of the transit alternatives have a direct and quantifiable impact on the transit ridership. Comparison of operating speeds and ridership forecasts for the alternatives analysis allow us to quantify the relationship between transit operating speeds and ridership on the Redlands Rail route. For example, data from the alternatives analysis can be used to estimate that the elasticity for average travel speed on the corridor alignment is approximately 0.40 (i.e., a 10-percent improvement in the average travel speed will result in a 4-percent increase in the ridership on the corridor route).

Similarly, we can calculate the ridership effect of improvements in the service frequency on the corridor route. The elasticity for service frequency on the corridor alignment is approximately 0.80 (i.e., a 25-percent improvement in the service frequency (headway) will result in a 20-percent increase in the ridership on the corridor route. The measure of service frequency is transit headway, which has values that are inversely related to the service frequency. Therefore the elasticity for service frequency is expressed as a negative value (-0.80).

Premium Travel Mode

The premium travel mode chosen to serve the Redlands Corridor has very limited impact on the ridership forecasts. The alternatives analysis was able to identify minor ridership variations for the different travel modes (BRT, LRT, DMU, and commuter rail), but most of the ridership impacts were due to the service characteristics of the alternative modes.

For example, the LRT mode provided the fastest operating speeds of the alternatives tested in the alternatives analysis, and this is the primary reason that LRT achieved the highest ridership forecast. On the other hand, the analysis performed for the Redlands Corridor strategic plan compared the Phase 1 alternative using passenger rail mode, to the Phase 2 alternative using LRT. In this analysis, the Phase 2 alternative was forecast to attract more than twice the ridership of the Phase 1 alternative, even though the operating speeds of the passenger rail route in Phase 1 were much faster than the LRT route in Phase 2. This was because the other operating characteristics for Phase 2 were superior, including service frequency and the number of stations served.

Summary and Combined Effects

The transit ridership elasticities estimated for the premium transit service in the Redlands Corridor are summarized in Table 4.1.

Table 4.1 Summary of Elasticity Values

Variable	Elasticity Value
Land Use Development Density	0.63
Number of Stations	0.90
Operating Speed	0.40
Service Frequency	-0.80

As an example exercise, Table 4.2 presents the results of using elasticity values to estimate the cumulative effects of several changes to the future environment. When estimating the ridership impacts of a combination of variables, it is important to take care to avoid double-counting effects of dependent variables.

Table 4.2 first shows that composite land use density growth is calculated to increase from 17 per acre to 54 per acre, and the elasticity value of 0.63 is applied to calculate that ridership demand will increase from 1,330 daily trips to 2,620 daily trips as a result of the development density in the stations areas. Subsequent rows of Table 4.2 show the effects of changing the number of stations along the alignment (from 5 to 10), the average operating speed (from 34 mph to 30 mph) and the peak service frequency (from 30 minutes to 15 minutes). The cumulative effects of these variables are calculated and applied sequentially to estimate that the total transit demand on the RPRP alignment will increase to a total of 6,100 daily trips.

Table 4.2 Combined Effects of Ridership Impacts

Variable	Base Value	Alternate Value	Variable Change[a]	Elasticity Value	Ridership Change[a]	Cumulative Ridership
Baseline Value (Year 2038 Phase 1 with Tippecanoe)						1,330
Composite Land Use Density (population plus employment/acre)	17	54	104%	0.63	65%	2,620
Number of Stations	5	10	67%	0.52[b]	34%	3,710
Operating Speed (mph)	34	30	-13%	0.40	-5%	3,530
Service Frequency (minutes)	30	15	-67%	-0.80	53%	6,100

[a] When applying arc elasticity procedures, both the variable change and the ridership change are calculated from the mid-point of the Base and Alternative values.

[b] The base elasticity value for number of stations (0.90) is factored by the relative density of the new station areas to the original station areas (0.62) to calculate the applied elasticity value (0.52).

A. Intersection Turning Movement Count Volumes

Figure A.1 Year 2011 Intersection Count Volumes

			South Approach			North Approach			West Approach			East Approach			
NB Street	SB Street	Peak Hour	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Total
Sierra	Mill	AM	0	0	0	80	0	68	54	391	0	0	316	28	937
		PM	0	0	0	98	0	142	67	543	0	0	566	34	1,450
Waterman	9th	AM	42	410	49	61	608	39	42	167	44	78	201	51	1,792
		PM	90	854	140	67	735	77	121	279	63	122	240	75	2,863
Waterman	Mill	AM	71	452	76	73	551	59	79	267	110	102	196	57	2,093
		PM	128	801	94	102	750	125	133	299	168	134	295	97	3,126
Waterman	Orange Show	AM	65	529	40	46	563	68	109	253	181	80	215	43	2,192
		PM	182	702	120	123	825	133	155	429	148	116	383	59	3,375
Waterman	Dumas	AM	4	637	0	0	827	3	4	0	3	0	0	0	1,478
		PM	18	1,011	0	0	1,119	3	2	0	6	0	0	0	2,159
Waterman	Washington	AM	2	2	1	428	9	177	496	983	2	11	504	344	2,959
		PM	4	7	4	302	7	604	385	620	5	5	990	521	3,454
Tippecanoe	Victoria	AM	0	464	16	18	756	2	1	0	1	56	1	29	1,344
		PM	1	882	40	38	848	0	2	0	2	45	0	23	1,881
Tippecanoe	Hospitality	AM	168	452	20	51	501	60	58	25	60	50	113	60	1,618
		PM	443	562	57	55	794	132	231	147	333	61	71	30	2,916
Tippecanoe	I-10 WB Ramps	AM	297	565	0	0	431	308	0	0	0	484	10	297	2,392
		PM	468	763	0	0	1,014	560	0	0	0	254	16	420	3,495
Tippecanoe	I-10 EB Ramps	AM	0	538	183	100	755	0	321	0	276	0	0	0	2,173
		PM	0	735	308	370	849	0	513	12	292	0	0	0	3,079
Anderson	Academy	AM	172	429	15	25	962	364	264	136	217	81	235	39	2,939
		PM	59	786	53	66	589	123	108	46	56	43	56	30	2,015
California	I-10 WB Ramps	AM	433	593	0	1	152	141	0	0	0	373	15	318	2,026
		PM	525	391	1	0	574	549	0	0	0	337	3	95	2,475
California	I-10 EB Ramps	AM	1	605	276	52	477	0	399	1	393	0	0	0	2,204
		PM	0	723	463	239	597	0	205	7	469	0	0	0	2,703
California	Wal-Mart	AM	1	731	16	165	607	0	0	0	0	1	0	69	1,590
		PM	0	1,040	38	281	726	0	0	0	0	2	0	141	2,228
California	Redlands	AM	94	352	12	271	280	72	90	183	133	41	260	283	2,071
		PM	39	344	34	291	289	95	156	455	129	95	413	439	2,779
Alabama	I-10 WB Ramps	AM	342	436	0	0	334	130	0	0	0	243	303	193	1,981
		PM	378	1,045	0	0	788	385	0	0	0	164	307	217	3,284
Alabama	I-10 EB Ramps	AM	0	590	120	49	540	0	229	2	374	0	0	0	1,904
		PM	0	1,048	287	217	745	0	380	7	481	0	0	0	3,165
Alabama	Industrial	AM	19	590	24	68	726	105	49	10	28	16	16	46	1,697
		PM	49	921	83	285	795	122	102	61	38	63	56	315	2,890
Alabama	Redlands	AM	78	388	47	73	454	172	131	217	40	64	262	82	2,008
		PM	112	577	92	140	517	175	264	640	75	109	386	214	3,301
Tennessee	Redlands	AM	47	553	19	125	532	17	12	101	28	34	190	62	1,720
		PM	63	513	44	102	511	27	261	634	78	40	272	183	2,728
Texas	Stuart	AM	56	272	19	26	381	82	23	4	26	15	27	12	943
		PM	16	454	24	16	276	12	3	10	52	20	15	18	916
Texas	Oriental	AM	2	487	14	4	335	3	6	3	5	20	1	11	891
		PM	1	460	10	5	277	0	4	1	3	16	1	9	787
Eureka	Pearl	AM	0	31	63	4	40	0	82	434	490	38	0	9	1,191
		PM	0	123	230	15	44	0	169	608	462	36	0	16	1,703
Eureka	Stuart	AM	8	77	4	22	492	47	14	14	2	7	7	3	697
		PM	15	294	91	38	462	28	13	21	10	38	21	6	1,037
Eureka	Oriental	AM	5	85	1	8	454	43	5	2	5	0	0	0	608
		PM	7	363	22	30	501	19	14	1	12	5	3	18	995
Eureka	Redlands	AM	12	83	17	57	275	83	9	149	10	11	335	16	1,057
		PM	28	223	55	121	344	38	66	662	50	45	351	53	2,036
Orange	Colton	AM	13	186	33	76	544	58	50	117	63	197	235	82	1,654
		PM	63	300	94	85	451	43	154	395	158	148	234	106	2,231
Orange	Pearl	AM	2	662	11	9	276	15	169	268	105	16	40	232	1,805
		PM	20	879	74	25	383	8	260	378	217	47	42	232	2,565
Orange	Stuart	AM	5	630	50	3	323	6	8	6	17	34	9	26	1,117
		PM	8	736	143	50	507	10	72	77	44	127	47	71	1,892
Orange	Oriental	AM	1	666	0	0	366	1	3	0	1	0	0	0	1,038
		PM	10	830	0	0	645	30	42	0	20	0	0	0	1,577
Orange	Redlands	AM	32	524	16	44	261	39	42	103	37	15	194	108	1,415
		PM	63	431	43	147	379	94	183	527	85	51	307	245	2,555
6th	WB Off Ramp	AM	0	147	0	0	283	0	0	0	0	181	17	188	816
		PM	0	316	0	0	387	0	0	0	0	197	10	166	1,076
6th	Pearl	AM	195	85	30	120	262	94	65	34	169	0	0	1	1,055
		PM	189	168	119	234	246	107	127	205	175	0	0	0	1,570
6th	Stuart	AM	9	239	6	75	320	12	5	7	13	15	7	59	767
		PM	60	464	20	36	325	35	23	17	46	18	9	55	1,108
Redlands	Citrus	AM	164	376	34	120	170	29	18	216	91	54	299	230	1,801
		PM	71	265	54	155	462	101	125	290	183	48	187	115	2,056
Church	Stuart	AM	36	256	0	0	278	49	22	0	34	0	0	0	675
		PM	11	295	0	0	261	18	63	0	29	0	0	0	677
University	I-10 WB Ramps	AM	424	376	20	6	131	876	0	0	1	0	7	25	1,866
		PM	307	601	42	10	180	426	0	0	0	2	22	16	1,606
University	I-10 EB Ramps	AM	0	616	0	0	133	0	274	0	423	0	0	0	1,446
		PM	0	505	0	0	196	0	447	1	576	0	0	0	1,725

Figure A.2 Year 2018 Intersection Count Forecasts – No Project

			Northbound			Southbound			Eastbound			Westbound			
NB Street	SB Street	Period	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Total
Sierra	Mill	AM	0	0	0	86	0	73	58	419	0	0	339	30	1,005
		PM	0	0	0	134	0	195	72	582	0	0	611	37	1,631
Waterman	9th	AM	45	440	53	74	739	47	45	179	47	89	230	58	2,046
		PM	99	936	153	73	800	84	130	299	68	135	266	83	3,125
Waterman	Mill	AM	88	563	95	78	591	63	85	286	118	153	295	86	2,501
		PM	137	859	101	109	804	134	143	321	180	201	444	146	3,578
Waterman	Orange Show	AM	70	567	43	67	823	99	164	380	272	86	231	46	2,848
		PM	215	830	142	132	885	143	193	535	185	151	499	77	3,987
Waterman	Dumas	AM	4	683	0	0	1,005	4	4	0	3	0	0	0	1,704
		PM	21	1,198	0	0	1,321	4	2	0	6	0	0	0	2,553
Waterman	Washington	AM	2	2	1	459	10	190	532	1,054	2	12	540	360	3,172
		PM	4	7	4	324	8	648	413	665	5	3	1,061	559	3,702
Tippecanoe	Victoria	AM	0	497	17	22	921	2	1	0	1	69	1	36	1,567
		PM	1	946	43	44	980	0	2	0	2	48	0	25	2,090
Tippecanoe	Hospitality	AM	180	485	21	61	601	72	82	35	85	56	126	67	1,873
		PM	475	603	61	62	898	149	347	221	501	92	107	45	3,560
Tippecanoe	I-10 WB Ramps	AM	318	606	0	0	514	367	0	0	0	538	11	330	2,684
		PM	502	818	0	0	1,220	674	0	0	0	305	19	504	4,041
Tippecanoe	I-10 EB Ramps	AM	0	627	213	111	836	0	344	0	296	0	0	0	2,427
		PM	0	826	346	494	1,134	0	550	13	313	0	0	0	3,676
Anderson	Academy	AM	184	460	16	28	1,082	410	283	146	233	87	252	42	3,222
		PM	63	843	57	71	631	132	116	49	60	50	65	35	2,171
California	I-10 WB Ramps	AM	485	664	0	2	229	212	0	0	0	437	18	373	2,417
		PM	627	467	1	0	728	697	0	0	0	396	4	112	3,031
California	I-10 EB Ramps	AM	1	649	296	76	697	0	434	1	429	0	0	0	2,582
		PM	0	929	595	260	671	0	242	8	553	0	0	0	3,266
California	Wal-Mart	AM	1	794	17	184	675	0	0	0	0	1	0	74	1,736
		PM	0	1,402	51	357	922	0	0	0	0	1	0	151	2,886
California	Redlands	AM	141	529	18	306	316	81	125	254	185	44	279	303	2,582
		PM	59	517	51	385	382	126	198	577	163	123	533	567	3,679
Alabama	I-10 WB Ramps	AM	405	517	0	0	379	148	0	0	0	318	396	252	2,415
		PM	405	1,120	0	0	905	442	0	0	0	176	329	233	3,611
Alabama	I-10 EB Ramps	AM	0	770	157	57	627	0	246	2	401	0	0	0	2,260
		PM	0	1,124	308	264	908	0	407	8	516	0	0	0	3,534
Alabama	Industrial	AM	27	848	34	74	787	114	61	12	35	19	19	55	2,085
		PM	53	987	89	330	922	141	153	92	57	71	64	357	3,317
Alabama	Redlands	AM	85	423	51	80	499	189	182	302	56	74	301	94	2,338
		PM	127	655	104	184	678	230	298	723	85	117	414	229	3,843
Tennessee	Redlands	AM	50	593	20	134	570	18	13	108	30	37	205	67	1,846
		PM	72	590	51	109	548	29	333	808	99	44	297	200	3,179
Texas	Stuart	AM	60	292	20	31	454	98	25	4	29	16	29	13	1,071
		PM	19	541	29	17	296	13	3	11	56	21	16	19	1,042
Texas	Oriental	AM	2	522	15	5	441	4	6	3	5	21	1	12	1,037
		PM	1	555	12	5	297	0	4	1	3	17	1	10	907
Eureka	Pearl	AM	0	33	68	6	60	0	88	465	525	57	0	14	1,316
		PM	0	134	250	18	53	0	181	652	495	40	0	18	1,841
Eureka	Stuart	AM	9	83	4	24	527	50	15	15	2	8	8	3	747
		PM	16	318	98	41	495	30	14	23	11	41	23	6	1,116
Eureka	Oriental	AM	6	94	1	9	487	46	5	2	5	0	0	0	655
		PM	8	392	24	32	537	20	15	1	13	5	3	18	1,068
Eureka	Redlands	AM	13	91	19	61	295	89	10	166	11	12	375	18	1,160
		PM	30	239	59	130	369	41	73	735	56	48	376	57	2,213
Orange	Colton	AM	14	202	36	83	598	63	62	144	78	222	265	92	1,855
		PM	68	322	101	91	484	46	170	437	175	159	251	114	2,417
Orange	Pearl	AM	2	710	12	10	296	16	181	287	113	18	44	254	1,942
		PM	21	942	79	27	412	9	298	434	249	50	45	249	2,817
Orange	Stuart	AM	5	675	54	3	346	6	9	6	18	36	10	28	1,198
		PM	8	789	153	54	544	11	77	83	47	136	50	76	2,028
Orange	Oriental	AM	1	714	0	0	392	1	3	0	1	0	0	0	1,113
		PM	11	890	0	0	692	32	45	0	21	0	0	0	1,691
Orange	Redlands	AM	35	576	18	47	280	42	45	110	40	17	219	122	1,550
		PM	68	462	46	158	406	101	196	565	91	55	329	263	2,739
6th	WB Off Ramp	AM	0	187	0	0	303	0	0	0	0	272	26	283	1,071
		PM	0	352	0	0	506	0	0	0	0	211	11	178	1,258
6th	Pearl	AM	214	93	33	129	281	101	70	36	181	0	0	1	1,140
		PM	203	180	128	258	271	118	144	232	198	0	0	0	1,731
6th	Stuart	AM	10	256	6	80	343	13	5	7	13	23	12	89	855
		PM	64	497	21	39	348	38	23	17	46	22	11	68	1,196
Redlands	Citrus	AM	180	412	37	130	184	31	19	232	98	54	299	230	1,905
		PM	76	294	58	166	495	108	134	311	196	48	187	115	2,179
Church	Stuart	AM	41	293	0	0	352	62	26	0	40	0	0	0	814
		PM	13	356	0	0	280	19	68	0	31	0	0	0	767
University	I-10 WB Ramps	AM	474	420	22	6	140	939	0	0	1	0	8	27	2,038
		PM	329	644	45	11	193	457	0	0	0	2	24	17	1,722
University	I-10 EB Ramps	AM	0	675	0	0	143	0	294	0	454	0	0	0	1,565
		PM	0	549	0	0	212	0	479	1	618	0	0	0	1,858

Figure A.3 Year 2018 Intersection Count Forecasts – Phase 1

			South Approach			North Approach			West Approach			East Approach			
NB Street	SB Street	Period	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Total
Sierra	Mill	AM	0	0	0	71	0	61	55	396	0	0	314	28	924
		PM	0	0	0	86	0	125	59	478	0	0	501	30	1,280
Waterman	9th	AM	45	440	53	74	739	47	45	179	47	89	231	59	2,049
		PM	99	939	154	73	803	84	131	301	68	136	268	84	3,140
Waterman	Mill	AM	90	571	96	80	600	64	87	293	121	157	301	88	2,547
		PM	153	957	112	123	901	150	171	383	215	234	514	169	4,082
Waterman	Orange Show	AM	70	567	43	67	823	99	164	380	272	86	230	46	2,846
		PM	215	830	142	132	885	143	194	536	185	151	500	77	3,989
Waterman	Dumas	AM	4	683	0	0	1,005	4	4	0	3	0	0	0	1,703
		PM	21	1,183	0	0	1,305	3	0	0	0	0	0	0	2,512
Waterman	Washington	AM	1	1	1	458	10	189	531	1,053	2	12	539	368	3,165
		PM	5	9	5	325	8	550	414	667	5	5	1,064	560	3,716
Tippecanoe	Victoria	AM	0	492	17	22	915	2	0	0	0	65	1	34	1,547
		PM	1	950	43	44	984	0	4	0	4	51	0	36	2,109
Tippecanoe	Hospitality	AM	179	482	21	61	598	72	81	35	84	55	124	66	1,857
		PM	477	605	61	62	902	150	349	222	503	93	109	46	3,579
Tippecanoe	I-10 WB Ramps	AM	319	606	0	0	514	367	0	0	0	538	11	330	2,685
		PM	505	823	0	0	1,225	677	0	0	0	308	19	509	4,066
Tippecanoe	I-10 EB Ramps	AM	0	626	213	111	835	0	344	0	296	0	0	0	2,425
		PM	0	831	348	496	1,139	0	555	13	316	0	0	0	3,697
Anderson	Academy	AM	184	459	16	28	1,081	409	282	145	232	86	251	42	3,215
		PM	63	846	57	71	634	132	118	50	61	51	66	36	2,185
California	I-10 WB Ramps	AM	485	665	0	3	229	213	0	0	0	437	18	373	2,421
		PM	633	471	1	0	734	702	0	0	0	405	4	114	3,064
California	I-10 EB Ramps	AM	1	645	294	76	693	0	432	1	425	0	0	0	2,567
		PM	0	934	598	271	677	0	244	8	559	0	0	0	3,291
California	Wal-Mart	AM	1	775	17	182	668	0	0	0	0	1	0	65	1,709
		PM	0	1,396	51	355	917	0	0	0	0	2	0	145	2,865
California	Redlands	AM	138	518	18	299	309	80	122	247	180	43	272	296	2,522
		PM	58	511	50	381	378	124	196	572	562	122	530	563	3,647
Alabama	I-10 WB Ramps	AM	406	517	0	0	379	148	0	0	0	318	396	252	2,416
		PM	406	1,122	0	0	906	443	0	0	0	175	330	233	3,616
Alabama	I-10 EB Ramps	AM	0	773	157	57	630	0	247	2	403	0	0	0	2,270
		PM	0	1,129	309	266	913	0	411	8	520	0	0	0	3,556
Alabama	Industrial	AM	27	846	34	74	785	114	60	12	34	19	19	54	2,078
		PM	53	989	89	331	923	142	154	92	57	72	64	359	3,324
Alabama	Redlands	AM	85	421	51	80	498	189	182	301	55	73	295	94	2,327
		PM	127	655	104	184	678	230	298	723	85	117	414	229	3,844
Tennessee	Redlands	AM	50	589	20	133	567	18	12	105	29	36	202	66	1,828
		PM	73	592	51	110	549	29	333	809	100	44	298	200	3,186
Texas	Stuart	AM	60	291	20	31	454	98	25	4	29	16	29	13	1,070
		PM	19	538	28	17	293	13	3	10	53	20	15	18	1,028
Texas	Oriental	AM	2	587	17	6	506	5	35	17	29	63	3	35	1,305
		PM	1	616	13	6	358	0	35	9	26	55	3	31	1,155
Eureka	Pearl	AM	0	34	68	6	61	0	88	466	526	58	0	14	1,322
		PM	0	134	250	18	53	0	181	652	495	41	0	18	1,842
Eureka	Stuart	AM	9	86	4	24	531	51	17	17	2	9	9	4	763
		PM	16	320	99	41	498	30	15	25	12	43	24	7	1,130
Eureka	Oriental	AM	6	95	1	9	487	46	6	2	6	0	0	0	657
		PM	8	396	24	32	541	21	17	1	15	5	4	21	1,086
Eureka	Redlands	AM	13	92	19	61	296	89	10	167	11	12	377	18	1,165
		PM	31	243	60	131	373	41	74	740	56	49	381	57	2,235
Orange	Colton	AM	14	200	35	83	592	63	61	143	77	221	264	92	1,844
		PM	67	321	101	91	484	46	170	436	174	159	251	114	2,415
Orange	Pearl	AM	2	710	12	10	296	16	181	287	113	18	44	254	1,942
		PM	21	943	79	27	413	9	299	434	249	51	45	249	2,820
Orange	Stuart	AM	5	677	54	3	348	6	9	7	19	38	10	29	1,206
		PM	9	788	153	53	542	11	77	82	47	135	50	76	2,021
Orange	Oriental	AM	1	714	0	0	392	1	3	0	1	0	0	0	1,113
		PM	11	890	0	0	692	32	45	0	21	0	0	0	1,691
Orange	Redlands	AM	35	574	18	47	278	42	44	109	39	17	217	121	1,541
		PM	68	464	46	158	408	101	197	567	91	55	331	264	2,751
6th	WB Off Ramp	AM	0	188	0	0	304	0	0	0	0	273	26	283	1,074
		PM	0	352	0	0	506	0	0	0	0	211	11	178	1,258
6th	Pearl	AM	216	94	33	129	282	101	70	37	183	0	0	3	1,149
		PM	203	180	128	258	271	118	144	233	199	0	0	0	1,734
6th	Stuart	AM	10	254	6	80	341	13	4	6	12	22	10	87	845
		PM	63	490	21	38	341	37	21	15	41	20	10	62	1,160
Redlands	Citrus	AM	179	411	37	129	183	31	19	231	97	54	298	230	1,900
		PM	76	282	57	166	493	108	133	309	195	48	185	114	2,167
Church	Stuart	AM	41	295	0	0	354	62	26	0	41	0	0	0	820
		PM	14	362	0	0	286	20	72	0	33	0	0	0	786
University	I-10 WB Ramps	AM	472	419	22	6	140	937	0	0	0	0	7	25	2,029
		PM	328	643	45	11	192	455	0	0	0	2	22	16	1,716
University	I-10 EB Ramps	AM	0	673	0	0	142	0	293	0	453	0	0	0	1,560
		PM	0	548	0	0	211	0	479	1	617	0	0	0	1,857

Figure A.4 Year 2038 Intersection Count Forecasts – No Project

			Northbound			Southbound			Eastbound			Westbound			
NB Street	SB Street	Period	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Total
Sierra	Mill	AM	0	0	0	217	0	184	67	484	0	0	381	34	1,367
		PM	0	0	0	156	0	226	88	714	0	0	892	54	2,130
Waterman	9th	AM	48	469	56	82	817	52	101	402	106	169	435	110	2,848
		PM	116	1,101	181	84	926	97	209	483	109	180	354	111	3,951
Waterman	Mill	AM	99	631	106	85	643	69	96	325	134	294	565	164	3,213
		PM	157	980	115	123	904	151	177	397	223	283	623	205	4,336
Waterman	Orange Show	AM	125	1,021	77	70	862	104	207	480	343	229	617	123	4,258
		PM	312	1,203	206	164	1,101	178	271	749	259	304	1,004	155	5,906
Waterman	Dumas	AM	8	1,239	0	0	1,213	4	5	0	3	0	0	0	2,472
		PM	31	1,761	0	0	1,787	5	6	0	17	0	0	0	3,608
Waterman	Washington	AM	2	2	1	536	11	222	645	1,279	3	18	841	574	4,133
		PM	4	7	4	375	9	749	641	1,032	8	7	1,315	692	4,843
Tippecanoe	Victoria	AM	0	1,259	43	27	1,136	3	1	0	1	64	1	33	2,568
		PM	2	1,498	68	71	1,593	0	2	0	2	55	0	28	3,319
Tippecanoe	Hospitality	AM	484	1,303	58	75	735	88	137	59	142	87	196	104	3,466
		PM	769	975	99	99	1,426	237	590	375	850	176	205	87	5,887
Tippecanoe	I-10 WB Ramps	AM	535	1,018	0	0	956	683	0	0	0	554	11	340	4,097
		PM	729	1,189	0	0	2,379	1,314	0	0	0	291	18	481	6,400
Tippecanoe	I-10 EB Ramps	AM	0	634	216	114	864	0	719	0	618	0	0	0	3,166
		PM	0	1,100	461	761	1,746	0	957	22	545	0	0	0	5,592
Anderson	Academy	AM	197	491	17	29	1,101	416	536	276	440	93	269	45	3,908
		PM	68	899	61	88	783	164	311	133	161	93	121	65	2,946
California	I-10 WB Ramps	AM	783	1,072	0	2	361	335	0	0	0	1,075	43	917	4,589
		PM	1,035	771	2	0	1,261	1,206	0	0	0	868	8	245	5,394
California	I-10 EB Ramps	AM	2	1,059	483	150	1,375	0	779	2	767	0	0	0	4,618
		PM	0	1,554	995	558	1,393	0	293	10	670	0	0	0	5,472
California	Wal-Mart	AM	2	1,305	29	352	1,295	0	0	0	0	1	0	79	3,063
		PM	0	2,497	91	470	1,213	0	0	0	0	2	0	161	4,435
California	Redlands	AM	271	1,015	35	636	657	169	151	308	224	70	442	481	4,457
		PM	112	992	98	514	510	168	365	1,064	302	155	675	717	5,671
Alabama	I-10 WB Ramps	AM	501	639	0	0	382	149	0	0	0	521	650	414	3,256
		PM	432	1,196	0	0	1,271	621	0	0	0	237	443	313	4,513
Alabama	I-10 EB Ramps	AM	0	675	137	58	634	0	357	3	583	0	0	0	2,447
		PM	0	1,199	328	384	1,319	0	585	11	741	0	0	0	4,568
Alabama	Industrial	AM	24	742	30	78	831	120	68	14	39	28	28	79	2,080
		PM	56	1,054	95	460	1,283	197	294	176	110	72	64	360	4,220
Alabama	Redlands	AM	92	458	55	84	519	197	150	248	46	98	402	126	2,474
		PM	128	660	105	274	1,013	343	402	974	114	125	442	245	4,826
Tennessee	Redlands	AM	57	666	23	143	609	19	14	116	32	53	296	96	2,123
		PM	76	620	53	117	585	31	522	1,269	156	46	311	209	3,995
Texas	Stuart	AM	64	311	22	30	436	94	26	5	30	43	78	35	1,173
		PM	20	577	31	18	316	14	3	11	59	57	43	51	1,201
Texas	Oriental	AM	2	557	16	5	383	3	6	3	5	24	1	13	1,019
		PM	1	601	13	7	362	0	4	1	3	18	1	10	1,021
Eureka	Pearl	AM	0	35	72	5	46	0	107	569	642	110	0	26	1,612
		PM	0	141	263	23	67	0	251	902	686	104	0	46	2,482
Eureka	Stuart	AM	9	88	5	25	563	54	16	16	2	12	12	5	807
		PM	17	336	104	43	529	32	25	41	19	43	24	7	1,222
Eureka	Oriental	AM	6	97	1	9	519	49	6	2	6	0	0	0	696
		PM	8	415	25	34	573	22	16	1	14	5	3	18	1,135
Eureka	Redlands	AM	14	95	19	65	315	95	10	170	11	19	589	28	1,432
		PM	32	255	63	138	394	43	87	877	66	51	402	61	2,470
Orange	Colton	AM	15	213	38	87	624	67	144	337	182	278	332	116	2,432
		PM	135	644	202	98	518	49	235	604	241	169	268	121	3,285
Orange	Pearl	AM	2	757	13	10	316	17	318	504	198	18	46	265	2,465
		PM	23	1,006	85	41	626	13	582	847	486	54	48	265	4,075
Orange	Stuart	AM	6	721	57	6	690	13	9	7	19	39	10	30	1,608
		PM	9	842	164	130	1,319	26	118	126	72	145	54	81	3,086
Orange	Oriental	AM	1	762	0	0	722	2	3	0	1	0	0	0	1,491
		PM	11	950	0	0	1,547	72	48	0	23	0	0	0	2,651
Orange	Redlands	AM	37	600	18	100	594	89	48	118	42	23	301	167	2,137
		PM	72	493	49	351	905	224	209	603	97	58	351	280	3,694
6th	WB Off Ramp	AM	0	168	0	0	327	0	0	0	0	522	49	542	1,608
		PM	0	362	0	0	805	0	0	0	0	346	18	291	1,821
6th	Pearl	AM	223	97	34	156	340	122	122	64	317	0	0	1	1,476
		PM	216	192	136	466	490	213	186	300	256	0	0	0	2,457
6th	Stuart	AM	10	273	7	135	576	22	5	7	13	19	9	75	1,151
		PM	69	531	23	41	372	40	23	17	46	21	10	63	1,255
Redlands	Citrus	AM	188	430	39	143	202	34	29	345	145	54	299	230	2,138
		PM	81	303	62	177	529	116	150	347	219	48	187	115	2,334
Church	Stuart	AM	43	308	0	0	318	56	25	0	39	0	0	0	789
		PM	13	338	0	0	381	26	72	0	33	0	0	0	862
University	I-10 WB Ramps	AM	556	493	26	7	150	1,002	0	0	1	0	8	29	2,272
		PM	417	817	57	11	206	487	0	0	0	2	25	18	2,042
University	I-10 EB Ramps	AM	0	826	0	0	180	0	313	0	484	0	0	0	1,803
		PM	0	623	0	0	264	0	626	1	807	0	0	0	2,322

Figure A.5 Year 2038 Intersection Count Forecasts – Phase 1

			South Approach			North Approach			West Approach			East Approach			
NB Street	SB Street	Period	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Total
Sierra	Mill	AM	0	0	0	175	0	148	57	415	0	0	310	27	1,133
		PM	0	0	0	126	0	182	80	648	0	0	823	49	1,908
Waterman	9th	AM	48	468	56	82	815	52	101	401	106	169	434	110	2,841
		PM	116	1,101	180	84	925	97	209	483	109	180	354	111	3,949
Waterman	Mill	AM	108	684	115	93	700	75	108	367	151	314	604	176	3,494
		PM	170	1,063	125	134	985	164	200	450	253	310	682	224	4,760
Waterman	Orange Show	AM	126	1,024	77	71	866	105	208	482	345	230	619	124	4,276
		PM	311	1,200	205	164	1,099	177	270	747	258	303	1,002	154	5,891
Waterman	Dumas	AM	8	1,231	0	0	1,205	4	0	0	0	0	0	0	2,448
		PM	30	1,697	0	0	1,722	5	0	0	0	0	0	0	3,454
Waterman	Washington	AM	0	0	0	530	11	219	643	1,274	3	18	836	571	4,105
		PM	5	8	5	376	9	751	642	1,034	8	7	1,317	695	4,855
Tippecanoe	Victoria	AM	0	1,254	43	27	1,131	3	0	0	0	61	1	32	2,553
		PM	2	1,484	67	71	1,580	0	0	0	0	46	0	23	3,273
Tippecanoe	Hospitality	AM	483	1,301	58	74	732	88	135	58	140	86	194	103	3,451
		PM	762	967	98	98	1,413	235	585	372	843	170	198	84	5,824
Tippecanoe	I-10 WB Ramps	AM	539	1,025	0	0	962	688	0	0	0	560	12	344	4,129
		PM	726	1,183	0	0	2,374	1,311	0	0	0	288	18	475	6,375
Tippecanoe	I-10 EB Ramps	AM	0	639	217	115	869	0	722	0	621	0	0	0	3,183
		PM	0	1,102	462	762	1,748	0	959	22	546	0	0	0	5,601
Anderson	Academy	AM	197	451	17	29	1,101	417	536	276	440	93	269	45	3,910
		PM	68	905	61	88	788	165	315	134	163	95	124	66	2,974
California	I-10 WB Ramps	AM	786	1,077	0	2	365	339	0	0	0	1,080	43	921	4,613
		PM	1,037	772	2	0	1,263	1,208	0	0	0	871	8	246	5,407
California	I-10 EB Ramps	AM	2	1,047	477	148	1,359	0	770	2	758	0	0	0	4,563
		PM	0	1,553	995	558	1,393	0	292	10	669	0	0	0	5,470
California	Wal-Mart	AM	2	1,287	28	348	1,281	0	0	0	0	1	0	61	3,008
		PM	0	2,489	91	467	1,208	0	0	0	0	2	0	153	4,411
California	Redlands	AM	267	1,001	34	628	649	167	147	300	218	68	434	472	4,385
		PM	112	988	98	512	508	167	364	1,060	301	155	672	715	5,650
Alabama	I-10 WB Ramps	AM	501	639	0	0	382	149	0	0	0	521	650	414	3,257
		PM	433	1,197	0	0	1,272	622	0	0	0	237	444	314	4,518
Alabama	I-10 EB Ramps	AM	0	680	138	58	639	0	359	3	587	0	0	0	2,465
		PM	0	1,200	329	384	1,320	0	586	11	742	0	0	0	4,571
Alabama	Industrial	AM	24	746	30	78	834	121	71	14	41	29	29	82	2,099
		PM	57	1,065	96	463	1,291	198	300	180	112	74	66	369	4,270
Alabama	Redlands	AM	93	461	56	84	523	198	152	251	46	99	405	127	2,495
		PM	130	667	106	276	1,020	345	404	981	115	126	447	248	4,865
Tennessee	Redlands	AM	57	669	23	144	611	20	14	118	33	53	298	97	2,136
		PM	76	621	53	117	586	31	523	1,270	156	46	312	210	4,003
Texas	Stuart	AM	64	312	22	30	436	94	27	5	30	43	78	35	1,175
		PM	20	577	31	18	316	14	3	11	59	57	43	51	1,200
Texas	Oriental	AM	3	621	18	5	448	4	34	17	29	65	3	36	1,283
		PM	1	676	15	8	437	0	42	11	32	65	4	37	1,327
Eureka	Pearl	AM	0	36	72	5	46	0	107	569	642	110	0	26	1,613
		PM	0	141	264	23	68	0	251	903	686	105	0	47	2,488
Eureka	Stuart	AM	9	91	5	25	566	54	18	18	3	13	13	6	820
		PM	17	341	105	44	534	32	27	44	21	47	26	7	1,245
Eureka	Oriental	AM	6	98	1	9	520	49	6	2	6	0	0	0	698
		PM	8	419	25	35	577	22	18	1	16	6	4	21	1,153
Eureka	Redlands	AM	14	95	20	65	315	95	10	171	11	19	589	28	1,433
		PM	32	258	64	139	396	44	88	880	66	52	405	61	2,487
Orange	Colton	AM	15	212	38	87	624	66	144	337	181	278	331	116	2,428
		PM	135	644	202	98	519	49	235	604	242	170	268	121	3,288
Orange	Pearl	AM	2	757	13	10	315	17	318	504	197	18	46	265	2,463
		PM	23	1,009	85	41	629	13	583	848	487	54	49	268	4,089
Orange	Stuart	AM	6	717	57	6	686	13	8	6	17	37	10	28	1,591
		PM	9	847	165	131	1,324	26	120	128	73	148	55	83	3,110
Orange	Oriental	AM	1	755	0	0	714	2	0	0	0	0	0	0	1,472
		PM	12	955	0	0	1,552	72	52	0	25	0	0	0	2,668
Orange	Redlands	AM	36	593	18	99	589	88	47	114	41	23	297	165	2,111
		PM	72	493	49	351	905	224	209	603	97	58	351	280	3,695
6th	WB Off Ramp	AM	0	173	0	0	331	0	0	0	0	524	49	544	1,622
		PM	0	361	0	0	804	0	0	0	0	345	18	291	1,819
6th	Pearl	AM	228	100	35	158	344	124	124	65	323	0	0	9	1,510
		PM	213	190	134	463	487	212	184	297	254	0	0	0	2,435
6th	Stuart	AM	10	273	7	135	575	22	5	7	12	19	9	74	1,147
		PM	67	520	22	40	362	39	20	15	39	18	5	54	1,205
Redlands	Citrus	AM	186	427	39	141	199	34	28	341	144	53	296	228	2,117
		PM	81	303	62	177	528	116	150	347	219	48	187	115	2,333
Church	Stuart	AM	43	305	0	0	316	56	24	0	37	0	0	0	781
		PM	12	324	0	0	368	25	63	0	29	0	0	0	821
University	I-10 WB Ramps	AM	554	491	26	7	149	999	0	0	0	0	7	25	2,258
		PM	416	815	57	11	205	485	0	0	0	2	33	17	2,031
University	I-10 EB Ramps	AM	0	824	0	0	178	0	313	0	483	0	0	0	1,797
		PM	0	622	0	0	264	0	626	1	807	0	0	0	2,320