Rendering shows an illustration of vehicle type only, set in Riverside. Not intended to indicate exact placement of tracks.

Riverside Streetcar System Feasibility Study Report

May 15, 2022

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The City of Riverside, California

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Modern Street Railways

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Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic (counts)
AEP	Association of Environmental Professionals
AEP	Association of Environmental Professionals
APU	Auxiliary Power Unit
APTA	American Public Transportation Association
ATC	Average Traffic Count
AW	Added Weight
BCA	Benefit/Cost Analysis
BID	Business Improvement District
BNSF	Burlington Northern and Santa Fe Railway
BRT	Bus Rapid Transit
CAPEX	Capital Expense
CARB	California Air Resources Board
CBD	Central Business District
CBU	California Baptist University
CE-CERT	(The Bourns) College of Engineering, Center for Environmental Research and Technology at UCR
CEQA	California Environmental Quality Act
CIP	Capital Improvement Program
COTS	Customer Oriented Transit Service
CPUC	California Public Utilities Commission
DAMS	Driver Alertness Monitoring System
DOT	Department of Transportation
EIR	Environmental Impact Report
ESS	Energy Storage System
FF&E	Fixtures, Furniture, and Equipment
FGT	Fixed Guideway Transit
FPM	Feet Per Minute
FRA	Federal Railroad Administration

FTA	Federal Transit Administration
GO	General Order (CPUC)
GHG	Greenhouse Gases
kg	Kilogram
KGSF	1,000 Gross Square Feet
LLC	Limited Liability Company
LRT	Light Rail Transit
LRV	Light Rail Vehicle
LTAA	Local Travel Analysis Area
MFC	McDonald Financial Corporation
MRE	Millennium Reign Energy
MRV	Modern Rail Vehicle
NAIC	National Association of Insurance Commissioners
NEPA	National Environmental Policy Act
NTD	National Trust Database
OCS	Overhead Contact (Catenary) System
O&M	Operations and Maintenance
OPEX	Operating Expense
P&R	Park-and-Ride
PE	Pacific Electric Railway
PM	Particulate Matter
PPH	Passengers Per Hour
PPD	Passengers Per Day
PPP or P3	Public-Private Partnership
R&A	Riverside and Arlington Railway
RCC	Riverside Community College
RCTC	Riverside County Transportation Commission
RDP	Riverside Downtown Partnership
ROM	Rough Order of Magnitude
RPU	Riverside Public Utilities

RRC	Riverside Railroad Company
RTA	Riverside Transit Association
RTP	Residential Travel Population
SCAG	Southern California Association of Governments
SCP	Safety Certification Plan (CPUC)
SGR	State of Good Repair
SSI	Self-Sufficient Investment
STOPS	Simplified Trips-on-Project Software (FTA)
TAD	Transit-Adjacent Development
TAZ	Transit Analysis Zone(s)
TBD	To Be Determined
TCRP	Transportation Cooperative Research Program (TRB)
TIRCP	Transit and Intercity Rail Capital Program (Caltrans)
TOD	Transit-Oriented Development
TMP	Travel Modeling Group
TMV	Track Maintenance Vehicle
TPR	Total Projected Ridership
TRB	Transportation Research Board
TUMF	Transportation Uniform Mitigation Fee
UCR	University of California at Riverside
VMT	Vehicle Miles Traveled
VTDS	Virtual Tram Detection System(s)
WRCOG	Western Riverside Council of Governments

Definitions and Railway Terms

Accessibility	The ease of reaching a destination, transit mode, or activities.
AW-0	Simulates a ready-to-drive streetcar empty of passengers
AW-1	Simulates a load with seated passengers only
AW-2	Simulates a load with seated passengers as well as passengers standing at 4 persons per square meter

AW-3	Simulates a load with seated passengers as well as passengers standing at 6 persons per square meter
AW-4	Simulates a load with seated passengers as well as passengers standing at 8 persons per square meter. This is considered “crush load” because very close contact with other persons is impossible to avoid.
Alignment	The horizontal and vertical design of a railway track, described by curved track, tangent track, vertical radius, and gradient.
Average Operating Speed	The operational speed of a streetcar averaged over acceleration/deceleration, traffic, and other delays.
Battery/Hybrid	A vehicle power generation/storage/supply system combining batteries and some form of on-board generator to provide all traction and ancillary power needs.
Cant	The angle of an individual rail relative to vertical (e.g., around curves).
Catenary	A power supply arrangement incorporating an overhead electrical contact wire. The term catenary refers to the shape of the curve adopted by a suspended chain or wire.
Catchment or catchment area	In human geography, a catchment area is the area from which a city, service, or institution attracts a population that uses its services. In this study, it refers to proximity to streetcar and multi-modal transit stations.
Clearance Corridor	A corridor centered on the alignment comprising the Dynamic Corridor plus clearance of 1m (minimum) on both sides.
Consist	A group of vehicles not separated during normal operation.
Continuously Reinforced Concrete	A concrete rail slab that does not incorporate discreet reinforced plates separated by contraction joints.
Depot	A common U.K. term for a streetcar stabling and maintenance facility.
Driver Alertness Monitoring System (DAMS)	A system installed to monitor the requisite vigilance of the streetcar driver. If a driver becomes considerably distracted or incapacitated, the system is designed to send a signal to the vehicle’s computer control unit that initiates the emergency stop system.
Dynamic Corridor	The corridor associated with a rail alignment that defines the full excursion of a moving vehicle (widening in curves due to cantilevers), usually marked to alert pedestrians to areas to avoid during vehicle passage.
Expansion Joint	Rail special work that allows longitudinal movement of the track due to thermal expansion/contraction and/or sub-structure movement.
Fleet	The vehicles on hand to provide service for a transit operation.
Gauge	The width between the inner faces of the track rails.
Gauge-Side / Field-Side of Track	The "gauge side" is the area between two parallel tracks; "field-side" describes the area outside two parallel tracks.
Gradient	The ratio of elevation change to horizontal track length.
Headway	The distance or time between trams on the alignment

Horizontal Design	The proposed track alignment considering only horizontal component.
Kinematic Envelope	The outline of the space occupied by a rail vehicle when in motion, including the effects of tilt, sway, cant, etc.
Light Rail	Electrified passenger rail normally running on dedicated track.
Maintenance Facility	A shop with space and equipment for the daily maintenance and inspection of rail vehicles.
Maintenance of Way	Operations for the purpose of maintaining the alignment, condition, and good working order of the track, power supply system, special-work, and signalization equipment along the Right-Of-Way.
Maximum Operating Speed	The highest safe operating speed for a vehicle determined by its engine, weight, bogie, and wheel/rail interface characteristics.
Micro-mobility	Transportation over short distances using of small, lightweight vehicles (typically single-person) that operate at speeds usually below 25 mph, including bicycles, electric scooters, electric skateboards, and electric pedal-assisted bicycles.
Minimum Radius	The smallest turning circle that can be negotiated by a vehicle, determined by the configuration of its wheels and its wheel/rail interface.
Mobility	The ability to travel
Mobility Hub	A multi-modal transportation center that includes transit service(s), and pick-up and drop-off areas, and often bicycle parking and storage facilities.
MRV	Modern Rail Vehicle
Opportunity Charging	System installed either above or in-ground that recharges onboard batteries while a streetcar is dwelling at a station. This type of charging can increase dwell times up to several minutes.
Public-Private Partnership (P3)	A cooperative financing arrangement between two or more public and private sectors, typically of a long-term nature.
Revenue Alignment	Rail or track that conducts vehicles or rail cars with paying customers and/or freight between destinations. This excludes maintenance yards and depot alignments (including pits) and the like.
Revenue Speed	The speed of a streetcar averaged over acceleration/deceleration, station stops, traffic stops, and other delays. Used in calculations to ascertain the revenue generating capability of a system.
Rolling Resistance	The force retarding forward progress of a rolling wheel due to deformation at the contact point. This force is minimized in a steel wheel on a rail.
Single-Point Failure	A part of a system that, if it fails, will stop the entire system from working.
Special Work	Track hardware that performs duties other than the basic trackwork, e.g., switches, crossings, sensors, signals, and so forth.

Spur	A non-continuous stub track that diverges from main or other tracks providing access to a maintenance and storage area, usually culminating in a vertical buffer stop
Stabling Yard	An area to store rail vehicles not immediately in service.
State of Good Repair	FTA grant program that supports well-maintained, reliable transit infrastructure.
Station	An area to stop rail vehicle to pick up or drop off passengers or freight.
Streetcar	A rail vehicle that operates on city streets with the intention to convey passengers. Typically operating in concert with pedestrians and other vehicle types. Also referred to as “tram”.
Structure Gauge	The clear space associated with a track alignment necessary for the safe passage of all rolling stock, i.e. rail vehicles, intended to operate on the alignment.
Sustainability	The capacity to endure in a relatively ongoing way across various domains of life, including social, economic, and environmental domains
Switch	A generic term for a turnout (see Turnout).
Tangent track	Straight track.
Tram	Streetcar
Transit-Adjacent Development	Urban development near high-quality transit but not ‘oriented’ towards the transit.
Transit-Oriented Development	Urban development that maximizes the amount of residential, business and leisure space within walking distance of public transport. It promotes a symbiotic relationship between dense, compact urban form and public transport use.
Turnout (switch)	A track section including switch points, closure and transition rails, frog, and points setting hardware used to divert a rail borne vehicle from one alignment to another.
Value capture	A type of public financing that recovers some or all of the value that public infrastructure generates for private landowners.
Vertical Design	The alignment design concerned with the changes in elevation of a track design.
Wayside Power	Any form of power distribution system along the railway Right-of-Way used to provide traction and ancillary power to moving rail vehicles. Typical examples would be Overhead Catenary System (OCS), Opportunity Charging, and third-rail.
Wheel / Rail Interface	The contact between rail and wheel in motion is the complex and essential factor of rail transport. Careful attention to design and maintenance of this interface is critical to safe and efficient rail operations.
Axle Load	The load carried by one axle.
Wye	A triangular intersection of three tracks with a railroad turnout (switch) at each convergence.

Section 1:
Feasibility Study Executive Summary

1 Feasibility Study Executive Summary

60,000 more people in Riverside by 2040.[1]

This forecast presents several city-planning and management challenges. It also inspires imagination and engenders innovation. Where and how will residents be housed? How will commercial, industrial, and education centers need to be built or expanded to attract, incubate, and propel productive social and economic growth? How can central business districts foster a sense of neighborhood, civic pride, and a vibrant welcoming spirit? How will Riverside's residents, employees, and visitors be encouraged to participate in environmental justice? How will the city integrate an attractive public transportation system to facilitate easy conveyance that unifies its constituents with its essentials and conveniences?

Old-school city planning, which assumed limitless available land acquisition, as well as post-WWII suburban sprawl, enabled optimistic and rapid expansion. But population proliferation within limited perimeters has resulted in urban transportation inflammation. Expeditious growth had unfavorable consequences. Multiple-passenger trolleys and busses were replaced with predominantly single-passenger autos. As populations multiplied, so multiplied cars. Intersections are now often gridlocked; streets and freeways, congested; air, polluted.

Riverside is now approaching its growth strategy with keen and enterprising foresight. In its Envision Riverside Strategic Plan 2025, infrastructure, mobility, and connectivity hold equal stature to—and assume amalgamation with—its other priorities of social, cultural, economic, environmental, and governance goals. Facilitating connection between people, place, and information which is built upon safe and reliable infrastructure is listed as a key objective.[2]

The city has for several years been attracting high-tech businesses, while creating an environment that will draw to it more business, cultural, and educational opportunities as well as pioneering technical talent and expertise. Riverside's renovated Convention Center now boasts more than 65,000 square feet of useable indoor meeting space that can accommodate 10 to 3,000, and a 20,000 square foot outdoor meeting and relaxing area. The University of California at Riverside plans to expand its campus and housing, expecting to increase its staff and student body considerably in the next two decades. The California Air Research Board (CARB) is already installing a facility in Riverside.

For nearly two decades, Riverside has been investing in a renaissance. These investments have certainly paid off, writes Grace Lee of Public CEO. Lee reports that Riverside was rated eighth America's Coolest Cities in 2014 by Forbes. The ranking gave each city an index for arts and culture, recreation, diversity, local eats, population age 20-34, and 2010-2013 net migration. Riverside is also increasingly attracting more young professionals through the growth of businesses and opportunities for high-paying jobs, as well as the growth of entertainment and culture in the city. As a result, Forbes rated Riverside the sixth Happiest Place in the Nation for Young Professionals in 2013. It was based on the results of an analysis of young professionals with less than 10 years of work experience, evaluating ten factors that influenced workplace happiness, including work environment and job resources.[3]

Imagine, then: entrepreneurship, employment, entertainment, and housing, all in one place. This is the vision for Riverside's Innovation District, a district in development intended to attract and retain institutions and businesses that focus on technology and environmental research, remediation, and product innovation. The initiative is to develop the 3-square-mile area into a home for clean tech jobs, new dining and entertainment options, and more.

In order to provide the City of Riverside with enough information to be able to continue a productive relationship with TIG/m towards installing and operating a fleet of streetcars on a multi-line network—envisioned to connect several areas of the City of Riverside to the Riverside Metrolink Station—along with a stabling and maintenance depot, with an option for a vehicle manufacturing facility, TIG/m will, in this Feasibility Study Report:

- Establish the viability of TIG/m's proposed streetcar solution in the City of Riverside
- Present comprehensive considerations for the implementation of the system including coordination required with project stakeholders such as the City, RTA, Caltrans, etc.
- Forecast costs associated with implementing, operating, and maintaining the proposed system
- Outline the roles and responsibilities of project partners and stakeholders in a public-private delivery method

This report will present the findings of a study to determine the economic and practical feasibility of a streetcar network in the City of Riverside. It will include rationale for a shift from a preponderance of automobile use to a vibrant multimodal transit system in which streetcars complement and enhance the city's existing public transportation systems.

The study reflected in this report represents the first step in the process of planning, designing, installing, and implementing a self-powered streetcar system, and focuses on the development of the first phase of a streetcar network which will include an initial curb-running track alignment with streetcar priority traffic signalization, virtual streetcar detection with real-time arrival displays, and a depot. The study will briefly present further development of subsequent lines as well as the installation of a TIG/m design/manufacture facility in Riverside.

1.1 Background

Championed by Mayor William "Rusty" Bailey in 2013 and endorsed by the Riverside City Council, Riverside began discussing the possibility of reintroducing a streetcar system to round out its vision of a renaissance. The project, called "Riverside Reconnects", was originally conceived to provide a connection between the city's universities and college, through the central business district.

The City of Riverside intends to leverage the existing transportation network in a sustainable manner through the provision of emission friendly rail circulation that will reduce VMT in the densest portions of Riverside. The project will be an incubator for innovative technology that is currently not deployed in the United States. A streetcar network, as part of a multi-modal public transit system with an array of options that supplies participants to a vibrant, pedestrian-friendly *walkable* city, would constitute a strong link in the chain of connection throughout Riverside.

TIG/m has been engaged by the City of Riverside to study the feasibility of building its state-of-the-art self-powered electric/hydrogen streetcar system and establishing a world headquarters for innovative transportation technology research and development, with an associated manufacturing facility. TIG/m is a turnkey design/build company that will assess the feasibility of using our revolutionary self-powered streetcar systems for the purposes intended on the Riverside Streetcar. TIG/m systems require no wayside power infrastructure thereby dramatically reducing the visual, technical, and economic impacts to the community. TIG/m is also a full-service engineering firm with independent design groups that work autonomously and have the capability of performing unbiased feasibility and demand analysis for alternative options.

The City of Riverside's mission statement for planning and development is that its "Planning Division commits to creative urban planning and design solutions that allows Riverside to be a livable, high-quality location of choice for businesses and residents." Committed to "urban planning and design that results in a livable, high-quality of place – where people can live, work and play. By focusing on creative solutions for our customers, and in developing our long-range plans, Riverside is poised to become the location of choice for residents and businesses." [4]

1.1.1 A Vision for Riverside

Developing and building a high-value fixed guideway transportation system like the Riverside Streetcar will require vision, commitment, and the buy-in and participation of all the major stakeholders in the city government, business community, and transportation agencies. In order to realize the level of ridership that will need to be developed to make the system profitable and to maximize the benefits to the population served, the current public transportation picture will need to be modified to focus all other modes of transportation on delivering trips to the central streetcar system.

We cannot just add a streetcar to the current transportation services and expect to be successful. Rather, our vision should be more ambitious and seek to improve the lives of all residents by delivering a multi-modal transportation network that can not only increase pride-of-place but reduce automobile traffic, improve air quality, serve accessibility and social equity, and create a truly walkable city.

At the heart of a walkable Riverside is a silent, smooth running, zero-emission streetcar service with a reliable nine-minute headway and a passenger capacity of about 800 PPH (Passengers Per Hour). Streetcar stops will be located at five-minute walking intervals along the streets served. In this scenario the streetcar will be the only public transportation vehicle running on the indicated alignment. At each stop, at many locations within an eight-minute micro-mobility catchment zone (one mile wide and centered on the streetcar alignment), and throughout the high-density residential areas of the city are micro-mobility solutions (Citi-bikes, e-scooters) available to the public using the same fare platform (smart card) as the streetcar and buses. Every third passenger station along the streetcar alignment will be a multi-modal station where passengers may board or alight buses which will provide access to and from all of greater Riverside and Western Riverside County.

Overall, the goal is to reduce automobile usage along with the public and private disadvantages that it entails, capture that value, and redirect it to more advantageous uses for the individual and the society as a whole. Redefining public transportation in Riverside as an integrated multi-modal network will increase the ridership in all modes of the public transportation system. By capturing the full potential revenue generating capacity of the system and utilizing a privately funded city corporation to build and operate the streetcar we can keep the project off-books and avoid impacting the city bonding capacity or bank lines of credit.

By focusing local trips generated in the immediate catchment zone on the streetcar by providing a regular, efficient, attractive, short-headway service; and by focusing the greater Riverside automobile traffic on the bus system as a feeder service to the Streetcar, TIG/m is confident that we will be able to realize a substantial ridership on the Riverside Streetcar by the first year of operation in 2025.

1.1.2 Benefits

The number one goal of any public transportation system is to provide a baseline transportation solution for those who do not have the private means to effectively reach their required travel destinations. An elevated goal of public transportation is to get people out of their private automobiles by giving them a complete end-to-end solution for their travels; creating a communal sense of place that is a connected,

walkable, exciting place to be. Bus systems, serving the wide sub-urban areas, in conjunction with streetcars, serving the denser urban core, has been shown to be able to serve both of these goals. This is done by connecting all of the alternate modes of travel into a seamless whole. In the case of the Riverside Streetcar System, this means making as many stops as possible multi-modal stops for buses, streetcars, RapidLink, bicycles and pedestrians. These modes support each other; when we give motorists a viable opportunity to leave their cars at home or let them go altogether, all of these modes of travel will see an increase. When properly configured, these modes do not compete with the other, they complement the other, creating an integrated "hub-to-home" transport system that also completes the "first/last mile" gap between train stations/parking centers and several key locations in the city.

It is the empirical experience of this study team is that there is an unusually large percentage of un- and under-developed land, relative to its importance as a main thoroughfare, along University Avenue. As evidence from the Portland Streetcar in the Pearl District of Portland, OR, South Lake Union Streetcar in Seattle, WA, the Kansas City Streetcar, and other streetcar systems around the US show, a high-frequency, reliable, fixed-guideway streetcar system brings a permanence to the flow of potential customers that encourages development of available real estate along the alignment which leads to new jobs, increased land values, and generally increased prosperity to the community served. Just the plans alone for an extension of the Kansas City Streetcar has brought $413MM in new private investment to development along the proposed alignment.

A new streetcar system will itself create jobs. TIG/m, as a lead contractor, always seeks to use local contractors for the majority of civil works. A major construction project such as the 9 miles of track installation included in our Study will allow local contractors to increase employment by as many as 100 positions during the 3-year construction period indicated in our schedule. There may be many follow-on jobs resulting from City improvements generated by the streetcar project. O&M Facility for the Riverside Streetcar system with create 20 new jobs for administrators, technicians, and laborers. The proposed Manufacturing Facility and R&D center will create up to 200 administrative, engineering, technical, and medium to low skill jobs.

RTA has identified--and described well—the advantages of a successful public transit system:

"Public transit saves the U.S. the equivalent of 4.2 billion gallons of gasoline annually. If an individual switches a 20-mile round-trip commute to public transit, his or her annual CO2 emissions will decrease by 4,800 pounds per year, equal to a 10 percent reduction in a two-car household's carbon footprint. And an individual can achieve an average annual savings of more than $10,000 by taking public transit instead of driving and by living with one less car." [5]

Energy-efficient, zero-emission, rail-borne streetcars take these metrics to an even healthier level. Additional benefits are examined and described in ***Section 12.7: Community Benefits.***

1.2 Existing Conditions

This section details existing conditions in the study area corridor that would affect the planning and implementation of a streetcar system, including but not limited to existing infrastructure (bridges and underpasses), utilities, right-of-way constraints (if any), parking, land use, and current traffic and public transit options. A careful survey of existing conditions, combined with the results of stakeholder workshops and surveys, will reveal factors that influence the cost and overall feasibility of the alignment for the Riverside Streetcar System.

At an early stage in this study, it was decided that the most effective first phase of a wide ranging fixed-guideway system for Riverside would be a circulatory pinched loop with easily defined destinations at each end. The most economically feasible area for this type of configuration is the East side, with Downtown at one end and UCR at the other. For this reason, the existing conditions review is limited to the area of Downtown and the East side.

Structural features of the exiting roadway network on which the proposed Streetcar system would operate were examined. None were found to violate the streetcar vehicles “structure gauge”. That is, the physical dimension (vertical and horizontal) which is required for the vehicle to safely operate, including the “degraded mode structure gauge” (for example: due to the failure of a suspension system component, the vehicle is leaning in such a way as to extend beyond the normal physical limits of the “structure gauge”)

Traveling east from Downtown on University Avenue to UCR, a potential streetcar alignment would pass under seven (7) underpasses:

- SR 91 (two individual bridges)
- Vine St.
- Santa Fe Ave
- Railway crossing (two individual bridges)
- Commerce St.
- A pedestrian overpass
- SR60 and US 215

None of the underpasses poses a difficulty for a streetcar system design.

In order to access the Vine Street Metrolink Station and proposed Vine Street Mobility Hub a streetcar alignment will need to utilize the 14th Street SR-91 Overpass. While this bridge is designed for loads far greater than the proposed streetcar, the application of the track structure to the existing bridge surface will require close coordination between the Track engineers and Caltrans.

The current at-grade Rail Crossing at 3rd Street is the site for the new 3rd Street Grade Separation project. A proposed Streetcar system would pass under the proposed railroad bridge, in the same manner as the underpasses identified above. No structure gauge issues are anticipated. What will be a required subject of study, if the Riverside Streetcar project goes forward, is the scheduling aspects of design and implementation of the 3rd Street Grade Separation. Design, and construction will need to be closely coordinated as the proposed Operation and Maintenance Facility for the Streetcar would require use of this new underpass.

Land Use in the study are for the Riverside Streetcar is mixed throughout with single family, multiple family, and commercial use in all areas of the City including the Downtown. This is ideal for the walking-oriented built environment required to support streetcar.

Of the streets under consideration for the Phase 1 Streetcar alignment only Lemon, 3rd Street and Market Street currently allow On-Street Automobile Parking. Changes to the current street parking allowances will be a top-priority design collaboration between all affected stakeholders, the City, and TIG/m track engineers, should the project go forward. No on-street parking is currently allowed on University Avenue or on the southwest-bound curb lane of Vine Street.

Current Public Transit Options

- Riverside Transit Agency (RTA) Busses
- RapidLink: Riverside Transit Agency (RTA) Gold Line service between UCR and Corona Transit Center serves 14 bus stops, reserved exclusively for Gold Line buses. Currently, RapidLink's stops that are closest to the Downtown Riverside Metrolink Station are at University/Lemon, Market/11th (westbound), and Market/12th (eastbound).
- Riverside Transit Agency (RTA) Special Transportation for Seniors and Disabled: a paratransit bus service that provides disabled residents and seniors rides to the mall, doctor's appointments, group events, senior centers or to visit friends.
- Metrolink Heavy Passenger Rail.

Automobile Traffic

Currently the automobile is the predominant mode of transportation in Riverside with eastside aggregate daily ADT counts at several intersections along University Avenue registering above 20,000 vehicles. A street-running railway will need to work within this existing environment and will benefit from streetcar priority signalization.

Bus Service

The Riverside Transit Agency (RTA) is the main transit agency for western Riverside County, California, United States. RTA provides both local and regional services throughout the region with 39 fixed-routes (including RapidLink Gold Line), nine (9) CommuterLink routes, and Dial-A-Ride services using a fleet of 339 vehicles. In the cities of Corona, Beaumont and Banning, RTA coordinates regional services with municipal transit systems. In Riverside, RTA coordinates with the city's Riverside Special Services, which provides ADA complementary service to RTA's fixed-route services.

Existing Bus System Ridership

14 RTA bus lines serve the downtown area of the City of Riverside. Aggregate total for these bus lines for the years 2019 and 2019 were 3,419,887 and 3224,107 respectively.

RapidLink

RTA operates the RapidLink Gold Line service between UCR and Corona Transit Center, which includes the Corona Metrolink Station, serves 14 bus stops, operating Monday – Friday, morning peak hours between 6:30-8:30 AM and afternoon hours between 1:30-5:30 PM. Busses are scheduled to arrive at each station every 15 minutes. RapidLink stations nearest to the Downtown Riverside Metrolink Station are located at:

- University and Lemon
- Market at 11th and 12th [6]

Metrolink

Metrolink maintains three train station/platforms in the Riverside area:

- Downtown Riverside, located on Vine Street, south of University Avenue and north of 14th Street
- Hunter Park / UCR Station, located on Marlborough Avenue, east of Iowa Avenue and west of Northgate Street
- La Sierra Station, located on Indiana Avenue at Grande Vista Parkway

Currently, three Metrolink lines travel through and stop at the Downtown Riverside Station, which is located on Vine Street, south of University Avenue and north of 14th Street.

- Metrolink 91 Line: Union Station – Riverside-Perris (via Fullerton)
- Metrolink Riverside Line: Union Station – Riverside – San Bernardino
- Inland Empire - Orange County Line.

Bicycle Facilities (Lanes)

Several bicycle lanes and bicycle-friendly roads (without delineated bike-dedicated lanes) exist on the roadways in Riverside. Another top priority in design development for a streetcar infrastructure is co-development of bicycle lanes and bicycle facilities with all effected stakeholders and City Staff.

Utilities

This section describes existing sub-grade utilities and relevant access points along the conceptual Phase 1 alignment. Sub-grade utilities include:

- Sub-Grade Vaults
- Electrical
- Fiber Optic
- Water
- Gas
- Sewer
- Storm Drains

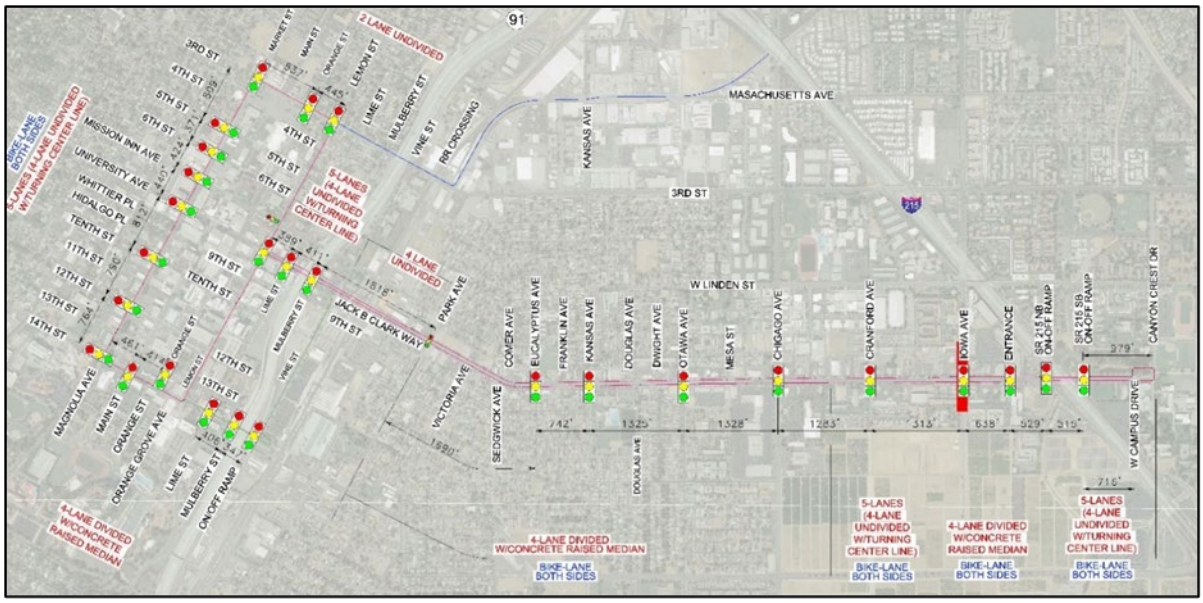
A detailed study of available city documents relative to sub-grade in-street utilities was undertaken to determine where utilities are placed in the streets in relation to the proposed streetcar alignment. Where active utilities run parallel to, and underneath, the proposed streetcar track slab, an estimate was produced for relocating those utilities.

Where utilities are not directly beneath the proposed track slab or are running beneath the track slab at oblique to 90° angles, the TIG/m panelized trackform may be employed if deemed necessary during design development review of the utilities in coordination with City Staff and RPU.

Traffic Signalization

Traffic signals in the area designated for study of the Phase 1 Streetcar alignments are shown in the following figure:

Figure 1-1, *Traffic Signalization in Conceptual Phase 1 Alignment*



Source: City of Riverside

1.3 Travel Market Analysis

Toward the goal of identifying a potential optimal configuration for a streetcar network in Riverside, we have been engaged to provide a Ridership Analysis. To do this we are utilizing data supplied by the city, gathered from residents and nonresidents who travel within and to the city, and also captured from external sources. Our aim is to develop a picture of the *local travel market* within Riverside and then specify a streetcar circulator network which will efficiently serve that travel market. Using land use diagrams and spreadsheets identifying the demographic distribution of current populations, we have collated and then subjected this data to a simplified four-step method with the ultimate goal of forecasting a passenger demand on the streetcar circulator network projected forward to a multimodal transportation system.

As part of our data-gathering efforts we distributed invitations to participate in a Travel Survey through zoom meetings, a webpage, and physical Survey Stations placed at five locations in Riverside.

During the course of our ongoing survey, to date we have gathered and collated over 1,000 individual responses—from every area of the City—to a number of questions concerning preferred modes of transportation and daily travel habits. Questions in the Travel Survey were carefully composed to gather information regarding each respondent's current travel habits for 5 basic daily activity types; work, school, shopping, entertainment, and other. They were also asked where these trips originated and terminated, and what mode of transportation was used for each trip. Finally, they were asked whether they would be inclined to use a new mode (streetcar) if were to serve an existing trip in their daily travel routine. These real-world responses from current Riverside residents are used as factors in our analysis.

TIG/m began by creating map dividing the City of Riverside into 12 Transit Analysis Zones for the purpose of defining trip generation and destination areas (see ***Figure 1-2****)*.

Figure 1-2, *Map of Transit Analysis Zones*

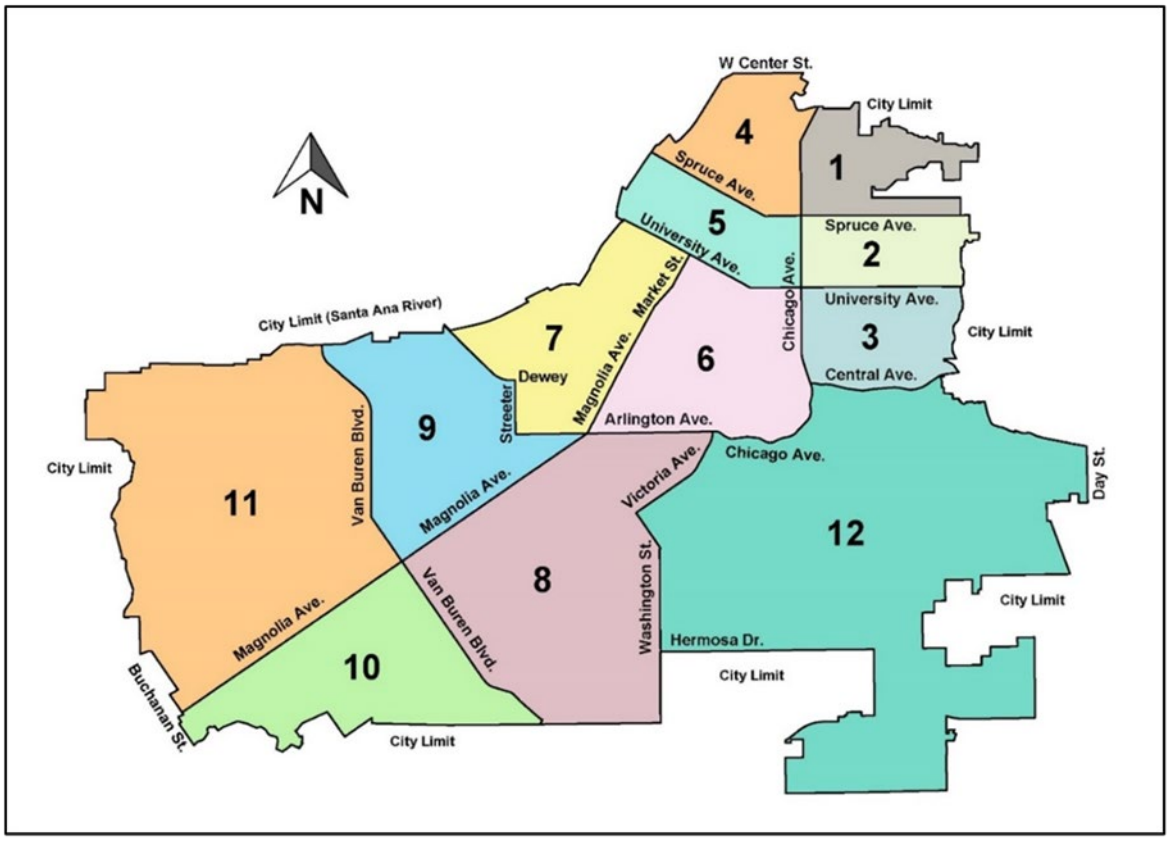
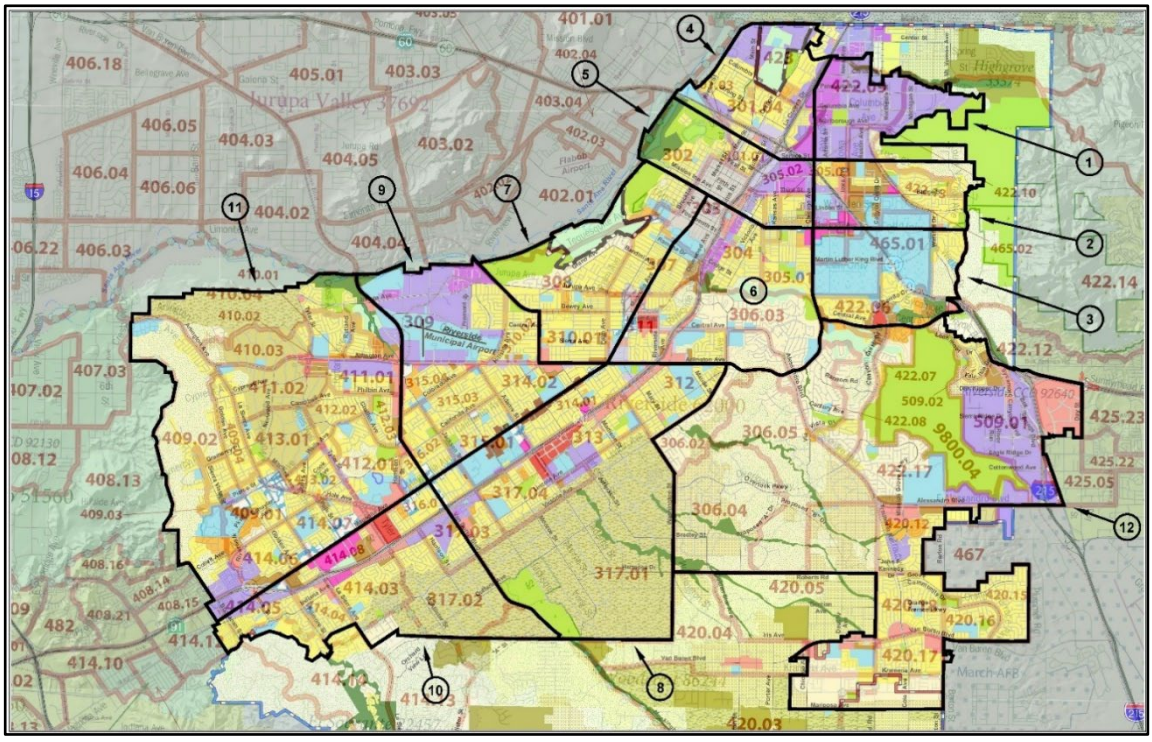


Figure 1-3, *Map of TAZ with Land Use and Census Tracts*



Adapted from map source: U.S. Census 2019

According to the U.S. Census, the City of Riverside had a population of over 331,360 in 2019, with an average density of 4,083 people per square mile. However, the population density of the area within a 5-minute walk of the conceptual Phase 1 alignment (the 5-minute pedestrian catchment zone) was 14,596 (or 7,409 per square mile). The rate of population increases between 2010 and 2019 was 9% (or 1% per year). Using these factors, we can project that in 2025 (the year the Riverside Streetcar System is projected to begin operations in this study) the population of Riverside will be approximately 350,000 with an average density of 4,311 people per square mile with a population density in the 5-minute pedestrian catchment zone of approximately 24,845 (or 12,612 per square mile).

Examples of successful streetcar systems in cities of this size (and smaller) with similar population densities around the world are abundant, especially in northern Europe where there are over 40 cities with successful tram systems serving populations under 100,000.[7]

It is therefore considered likely that a similarly successful streetcar system within the City of Riverside can be feasible. The challenge is to design a project that has a sufficiently low CAPEX and OPEX and a sufficiently high potential ridership to make the Cost Model attractive to the Riverside City leadership.

A transportation mode that helped shape the thoroughfares and population centers of Riverside was the Electrified Railway (Streetcar). The Riverside Railroad Company (RRC) began operating horse powered streetcars on Main Street and 8th Street in 1886. The Riverside & Arlington Railway Company (R&A) was incorporated in 1887 and bought the RRC in 1895. In 1900 the R&A electrified all of its streetcar operations and Frank Miller, its manager, operated approximately 14 miles of streetcar lines until 1911 when it was incorporated into the Pacific Electric Railway (PE) of Henry Huntington. The PE operated all of the streetcars and interurban systems in the Inland Empire until about 1943 when the proliferation of automobiles, buses, and trucks overtook the ability of electrified rail lines to modernize, and the systems were unfortunately abandoned.[8]

Figure 1-4, *Old Hand-Drawn Route Map, Pacific Electric Railway Riverside-Corona Line*

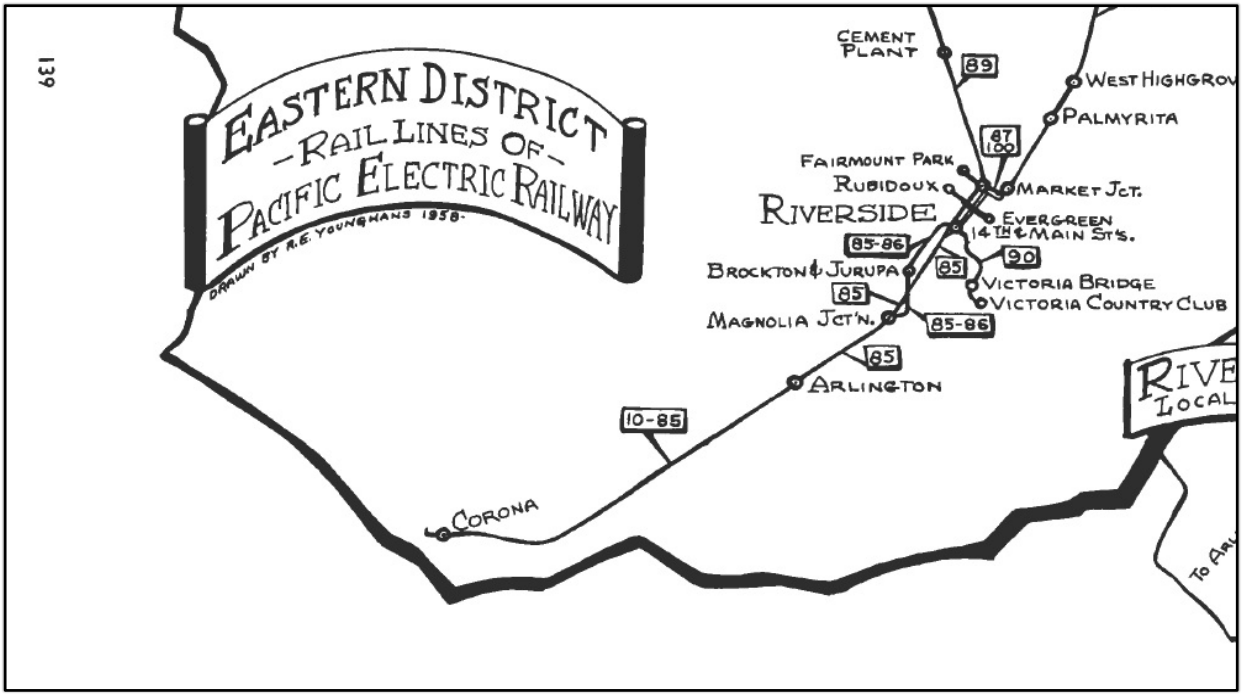


Figure 1-5, *Old Postcard of a Trolley on Magnolia Avenue*

Source: Press Enterprise. 2011. [9]

Magnolia Avenue, which became the main line of the R&A and originally carried passengers between Downtown and Frank Miller's Chemewa Park near Arlington, has always been the prominent thoroughfare on the west side of Riverside and continuing all the way to neighboring Corona. When UCR opened in 1954 and University Avenue became the major eastside thoroughfare, the "L" shaped transit corridor was well established and remains the most viable route for a high-value fixed guideway transportation system today. Currently the RTA Rapid Link (Route 1) serves this corridor.

When establishing new streetcar lines, the guiding principle is to establish them along corridors with the highest bus ridership. The bus lines on these corridors, being easily movable, should be rearranged to intersect with the new streetcar corridor to function as feeder lines for the newly established fixed guideway transportation system.

This is what we are proposing in Riverside. Although there are several current bus lines that will need to continue to function, as part of their overall route, along part of the proposed streetcar alignment, it should clear these two modes (bus and streetcar) in competition for ridership along the same end-to-end route would be counterproductive. When bus and streetcar are systems are planned correctly and work together to provide a comprehensive travel package, both modes will see increased ridership by modal shift from automobile trips.

By providing a locally circulating higher frequency service in a quieter, smoother riding vehicle, it is proven by the experience of other streetcar systems that a modal shift from automobile ridership to streetcar ridership can be achieved. In fact, it has been established by passenger survey that many new streetcar systems (called tram systems in Europe and the UK) attribute up to 20% of their ridership to modal shift from automobile use.

What we will be showing in our ridership projection is that between the:

- Increase in population by the year 2025
- Reallocation of the bus ridership to the streetcar along the routes served
- Automobile to Streetcar Modal Shift (we will use a conservative 10% modal shift)

…we will be able to plausibly predict a ridership that will be within the current experience of peer cities of similar size and population density and be sufficient to support the operation and maintenance costs of the system through farebox revenues, advertising, and sponsorships after a period of time during which the system becomes established.

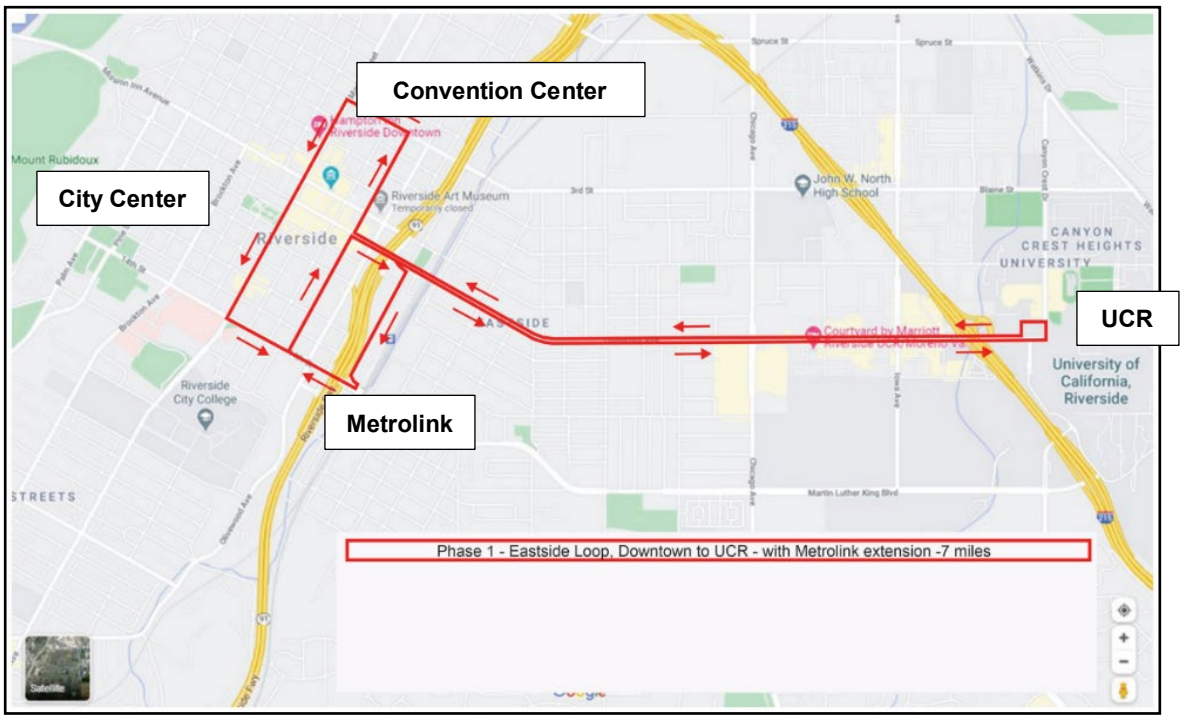
1.4 Conceptual Alignment Design

Working in conjunction with City Staff and interested groups in design charrettes, TIG/m developed a phase-able alignment concept incorporating 5 phases serving the north, west, and east Riverside areas. For a complete explanation of the overall concept please refer to ***Appendix R.*** TIG/m civil engineers brought the Phase 1 concept alignment up to the level of schematic design (geometrically able to support engineered track) in order to assess the buildability of the trackwork in the existing streets and to provide a basis for accurate estimation of construction costs using current unit quantities from our suppliers. Close liaison with City Managers, Planners, and Engineers has informed this design process with all available current data relative to rights of way, traffic controls, as well as at-grade and sub-grade utilities.

If the project moves forward, TIG/m along with the City and stakeholders including RTA will closely examine locations where the alignment is proposed to effect on-street parking, the configuration of bike lanes, existing bus stops, and where the alignment makes lane changes, turning movements, or pulls into or out of proposed stop locations. Much of the detailed design of entering and exiting the right-hand lane of traffic and the all-important consideration of safely accommodating the bicycle lane will need to be addressed during design development, but none of these considerations are show-stoppers.

As envisioned for this study, the Riverside Streetcar system will operate as a curb-running streetcar circulator line between Downtown Riverside and UCR which will benefit from a Tram Priority Signalization system along all tracks and will not have posted schedules but will operate using a Real-Time Arrival system which will post streaming data on-board each vehicle, on PDA apps, and at each station identifying the number of minutes and seconds until the next arrival. The benefits of this system for the patrons are shorter travel times due to the “green wave” through traffic lights and easier choice-making supported by next-vehicle-arrival information.

Figure 1-6, *Phase 1 Alignment Concept*



Map source: Google Maps

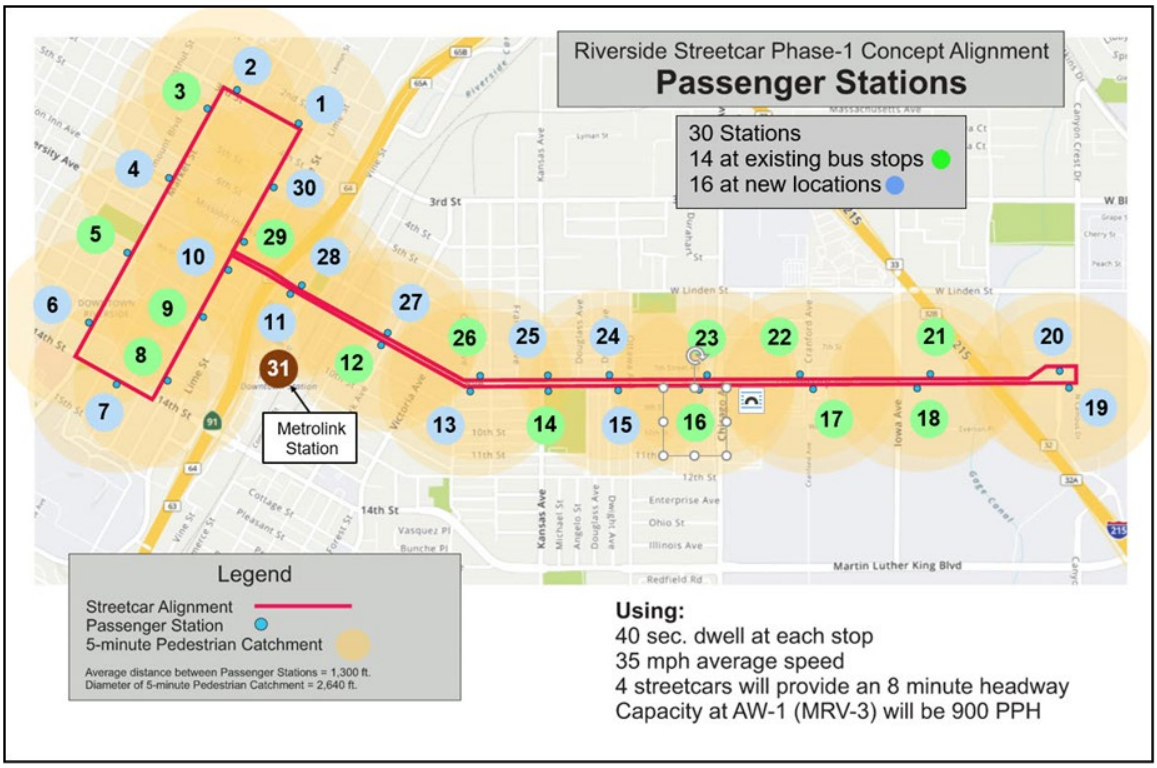
A concept for incorporating the required Operations & Maintenance facility with a manufacturing center and test track was undertaken with input from Public Works Department regarding currently available real estate of the appropriate acreage within the necessary proximity of the streetcar alignment. The resulting preliminary O&M track alignment looks like this:

Figure 1-7, *Phase 1 Operations Alignment with Depot Access Spur and Test Track*

Map source: Google Maps

The low floor of the TIG/m tram allows for level-boarding at 11-inch raised curb platforms at each passenger station.

Figure 1-8*, Station Location Concept, Phase 1*



Map source: Google Maps

Figure 1-9, *Typical Station Stop with Ramped Level Boarding Platform*

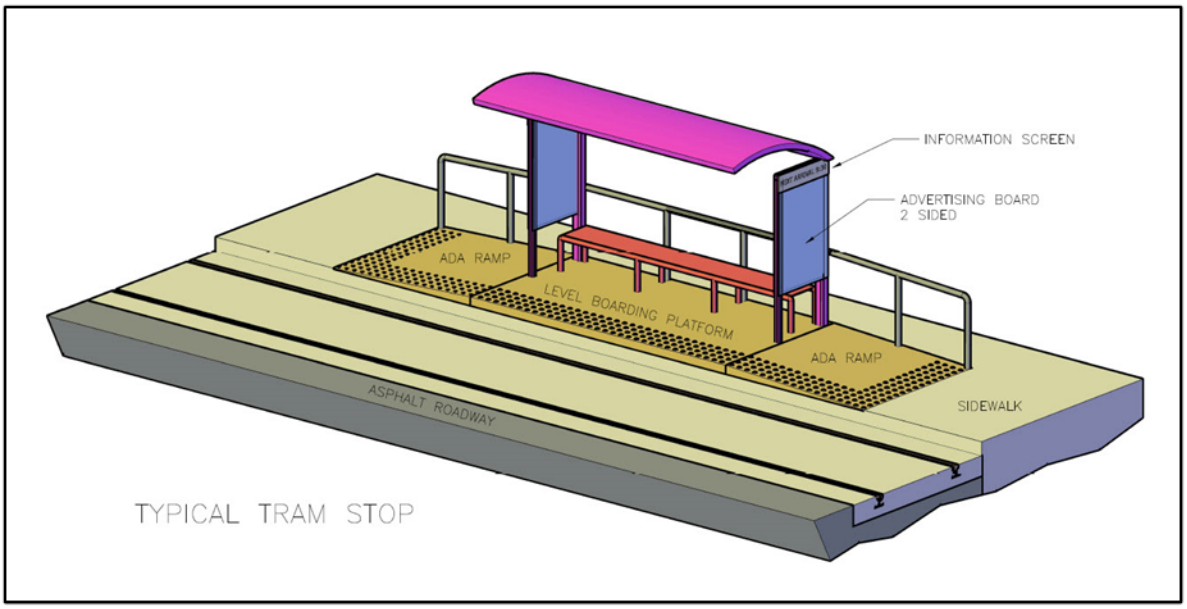


Table 1-1, *Conceptual Station Locations*

	Location	Travel Direction	New Station Location or at Existing Bus Stop
1	3rd Street at Lemon Street	NW	New
2	3rd Street at Market Street	NW	New
3	Market Street at 4th Street	SW	Existing
4	Market Street at Mission Inn Avenue	SW	New
5	Market Street at 10th Street	SW	Existing
6	Market Street at 13th Street	SW	New
7	14th Street at Orange Street	SE	New
8	Lemon Street at 13th Street	NE	Existing
9	Lemon Street at 9th Street	NE	Existing
10	Lemon Street at University Avenue	NE	New
11	University Avenue at Vine Street	SE	New
12	University Avenue at Park Avenue	SE	Existing
13	University Avenue at Comer Avenue	E	New
14	University Avenue at Kansas Avenue	E	Existing
15	University Avenue at Dwight Avenue	E	New
16	University Avenue at Chicago Avenue	E	Existing
17	University Avenue at Cranford Avenue	E	Existing
18	University Avenue at Iowa Avenue	E	Existing

	Location	Travel Direction	New Station Location or at Existing Bus Stop
19	University Avenue at N. Canyon Drive	E	New
20	University Avenue at N. Canyon Drive	W	New
21	University Avenue at Iowa Avenue	W	Existing
22	University Avenue at Cranford Avenue	W	Existing
23	University Avenue at Chicago Avenue	W	Existing
24	University Avenue at Dwight Avenue	W	New
25	University Avenue at Kansas Avenue	W	New
26	University Avenue at Comer Avenue	W	Existing
27	University Avenue at Park Avenue	NW	New
28	University Avenue at Lemon Street	NW	New
29	Lemon Street at Mission Inn Drive	NE	Existing
30	Lemon Street at 5th Street	NE	New
31	Vine Street Metrolink Station	SW	New

1.5 Operations Plan

This section will examine theoretical capacity calculations and scheduling options considered for the Phase 1, as presented in ***Section 6*****,** followed by suggested staffing requirements for Phase 1 system operations and maintenance. We assume that these recommendations will change according to actual requirements, determined during design development of Phase 1, as it is explored and developed over time. For the sake of simplifying the duty-cycle calculation, the intermittent Metrolink service (three times per day) is not included in the following work. However, the track and infrastructure for that service is included in the CAPEX and Cost Model.

Passenger service would commence at Station 1, the first station after exiting the depot alignment and proceed in a counterclockwise direction around the alignment (see ***Figure 1-6***).

Using the TIG/m MRV-3A vehicle as the rolling stock for this operation we can calculate the theoretical capacity of the system at various loading conditions using a set of assumptions and factors derived from those assumptions:

Duty Cycle Calculations and Theoretical Capacity

Terms

AW-1 = 32 passengers, seated only
AW-2 = 80 passengers, seated and standing @ four (4) per square meter (p/m^2)
AW-3 = 110 passengers, seated and standing @ six p/m²
PPH: passengers per hour
PPD: passengers per day
PPY: passengers per year
FPM: feet per minute

Assumptions

- 30 passenger stations
- 7 miles of revenue alignment
- 40 second dwell at passenger stations
- 25 mph average speed (between stops)
- Average passenger trip length, 8 stops

30 station stops →	@ 40 second dwell time 30 x 40 ÷ 60 = 20 minutes	
25 mph average travel speed →	@ 2,200 FMP 7 mi. x 5280' ÷ 2,200	= 16.8 minutes
	1 cycle	= 36.8 minutes
	60 min. ÷ 36.8 min.	= 1.63 cycles per hour
9-minute headway →	36.8 min. cycle ÷ 9 min. headway	= 4 peak vehicles
16-hour passenger service day →	16 hours x 1.63 hourly cycles	= 26 cycles per day
14-hour passenger service day →	14 hours x 1.63 hourly cycles	= 22.82 cycles per day
12-hour passenger service day →	12 hours x 1.63 hourly cycles	= 19.56 cycles per day
Average trip = 8 station stops →	30 stops ÷ 8 stops per trip	= 3.75 trips/seats/cycle

Factors

- 36.8-minute full cycle
- 1.63 cycles per hour
- 4 peak vehicles (with 1 spare)
- 26 cycles per day (16 hours, weekdays)
- 22.82 cycles per day (14 hours, Saturdays)
- 19.56 cycles per hour (12 hours, Sundays)
- 3.75 trips/seat/cycle
- 365 operational days/year

Using these factors, we can calculate the capacity of the streetcar fleet during each day of the week. This then allows us to find the average capacity for the year, which is used in the Cost Model, where the yearly ridership projection is expressed as a percentage of capacity at AW-1.

AW-1 (32 passengers, seated only) Weekdays

4 cars x 1.63 cycles/hour x 32 passengers x 3.75 trips/seat/cycle	=	782 PPH
4 cars x 26 cycles/day x 32 passengers x 3.75 trips/seat/cycle	=	12,480 PPD

AW-1 (32 passengers, seated only) Saturdays

4 cars x 1.63 cycles/hour x 32 passengers x 3.75 trips/seat/cycle	=	782 PPH
4 cars x 22.82 cycles/day x 32 passengers x 3.75 trips/seat/cycle	=	10,954 PPD

AW-1 (32 passengers, seated only) Sundays

4 cars x 1.635 cycles/hour x 32 passengers x 3.75 trips/seat/cycle	=	782 PPH
4 cars x 19.56 cycles/day x 32 passengers x 3.75 trips/seat/cycle	=	9,389 PPD

AW-1 Yearly

Weekdays (260 x 12,480)	= 3,244,800
Saturdays (52 x 10,954)	= 569,608
Sundays (52 x 9,389)	= 488,228

4,302,636 PPY ÷ 365 = 11,788 PPD Avg.

Operations and Maintenance Staffing Requirements

The following draft organization chart is based on our experience with actual O&M organizations at our projects elsewhere around the world. The numbers of staff included may change when we receive confirmation of daily hours of operation for the Riverside Streetcar System. Please note as well that projected personnel numbers may require additional adjusting during the development of Operations and Maintenance Plans, when contracted.

The O&M organization chart (***Figure 1-10***) and staffing recommendations table (***Table 1-2***) are based on two full shifts of drivers—with one driver for each vehicle—and maintenance personnel. Assume for these recommendations that full operations during Phase 1 will be:

- 16-hour passenger service day (Monday through Friday)
- 14-hour passenger service day (Saturday)
- 12-hour passenger service day (Sunday)

Until we have a confirmed daily schedule of hours, we will not be able to value engineer the personnel configuration. However, it should be noted that most maintenance functions are performed at night and a small maintenance staff is required to be present throughout the day to respond to any issues that may arise during passenger service operations. This fact always requires that two shifts of maintenance personnel are always required.

Figure 1-10, *Recommended O&M Organization Chart, Phase 1*

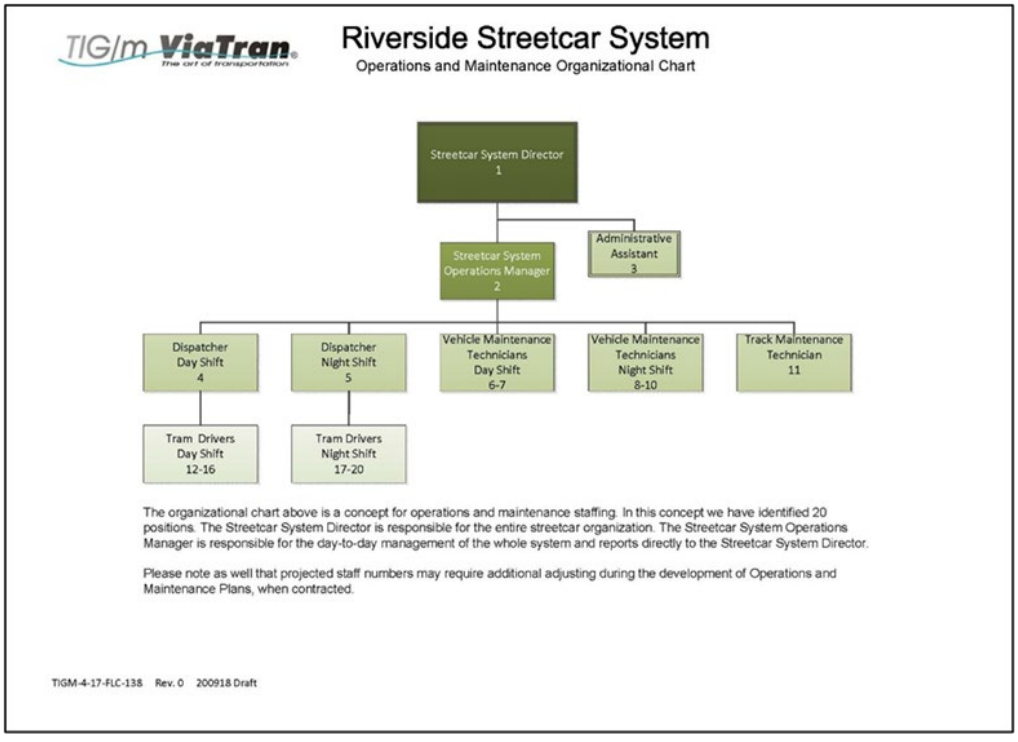


Table 1-2, *O&M Staffing Recommendations, Phase 1*

STAFFING RECOMMENDATIONS Two 8-hour shifts per 16-hour day (Monday through Friday) Two 7-hour shifts per 14-hour day (Saturday) Two 6-hour shifts per 12-hour day (Sunday)	
Personnel	**Per # of Cars in Service**
	4
Office staff	
O&M Director	**1**
Administration Manager	**1**
Administration Assistant	**1**
Dispatcher	**2**
Rolling Stock Operators	
Drivers	**9**
Conductor	**0**
Maintenance staff	
Maintenance/Mechanics	**5**
Maintenance/Welder/Track	**1**
	20
Max. Total Staff per Shift 10	

The above duty cycle results in:

- 55,124 annual man hours
- 22,048 annual vehicle revenue hours.

These numbers are used to calculate annual O&M expense in ***Section 1.9.***

1.6 Ridership Projections

For this Report, TIG/m has investigated the history and current trends in local journey making in the city of Riverside and have taken a very close look at the local travel market in the Downtown to east side area; this area we call the Limited Travel Analysis Area (LTAA). To do this, we have gathered existing data concerning populations, land use, automobile and public transportation volumes and patterns, and the existing conditions on the roadways deemed most suitable for a future Streetcar System. We have also generated our own data through a general Public Survey questionnaire carried out on-line, through five on-site paper survey stations, and several in-person public outreach events. Over 1,000 individual questionnaires have been collected to date.

For our ridership study, we divided the city into 12 Travel Analysis Zones and correlated all the data gathered from outside sources with these zones. We then gathered data from residents in each of the 12 zones through our Travel Survey and collated this date in a series of graphics and tables.

Figure 1-11, *Travel Analysis Zones (TAZs)*

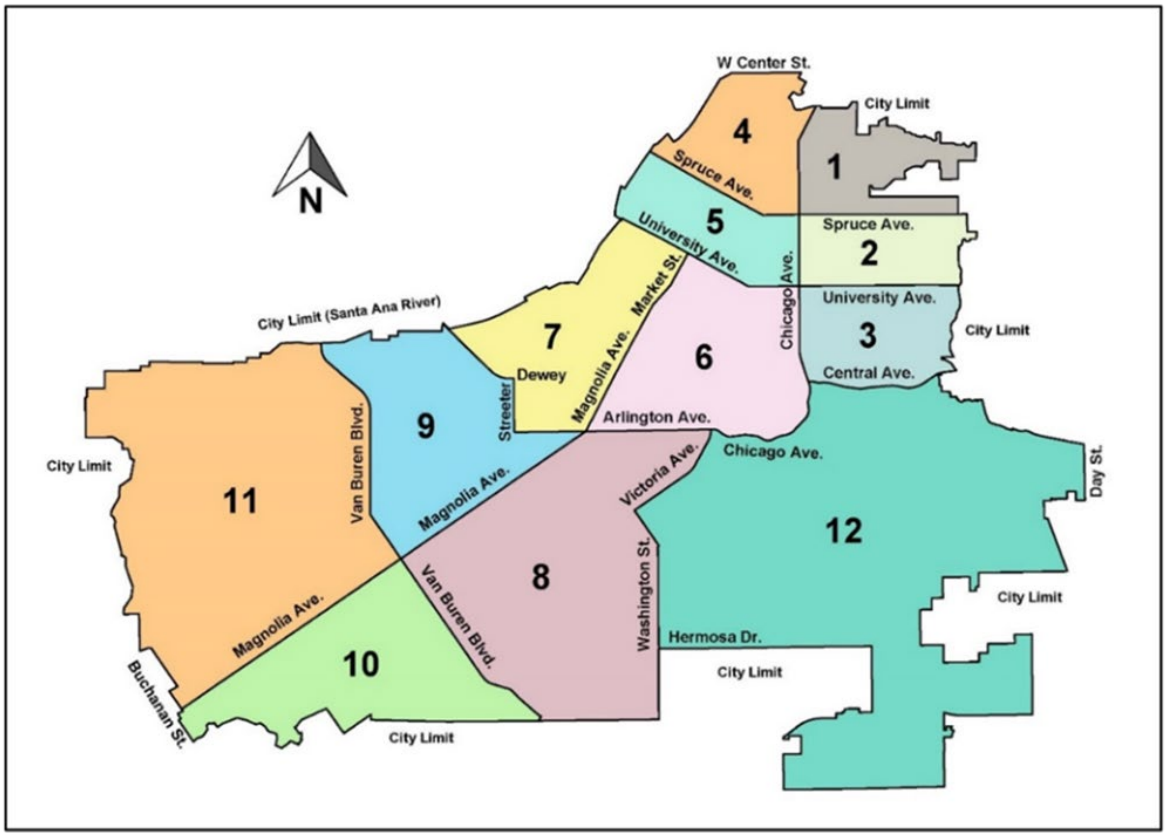
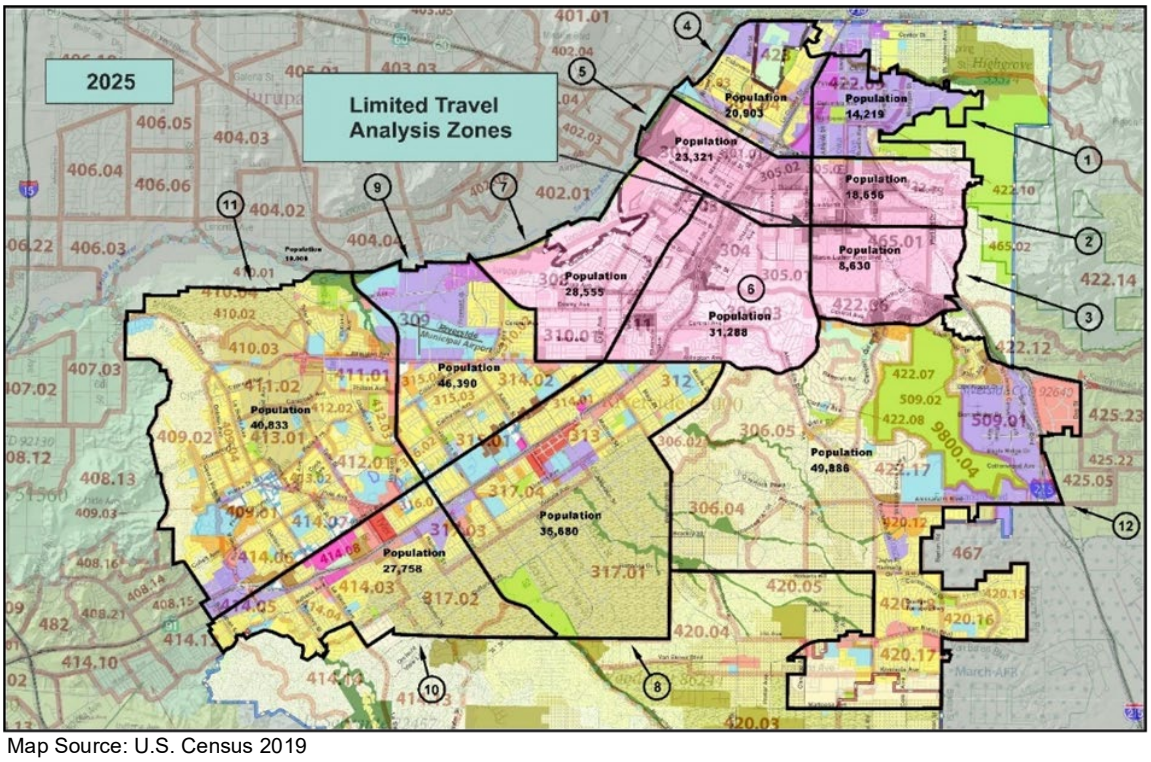


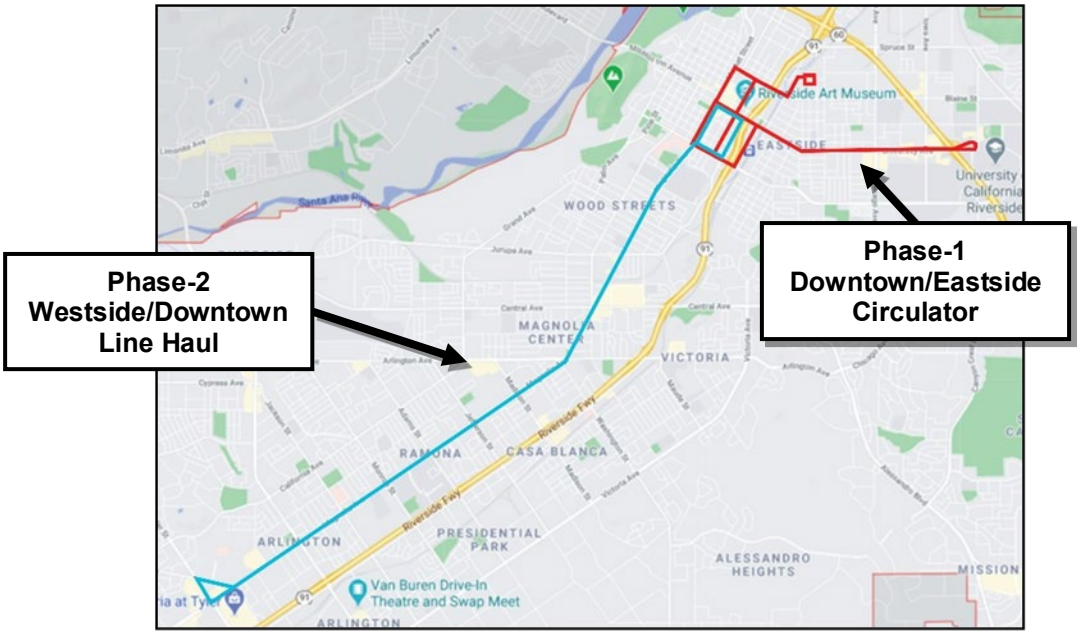
Figure 1-12, *Populations Within TAZs, 2025 Projections*



Map Source: U.S. Census 2019

The results are compelling and strongly support the basic design thrust of the TIG/m concept:
A Phase 1 circulator in the downtown to eastside corridor, and a Phase 2 line-haul from the southwest side to downtown (see ***Figure 1-13***).

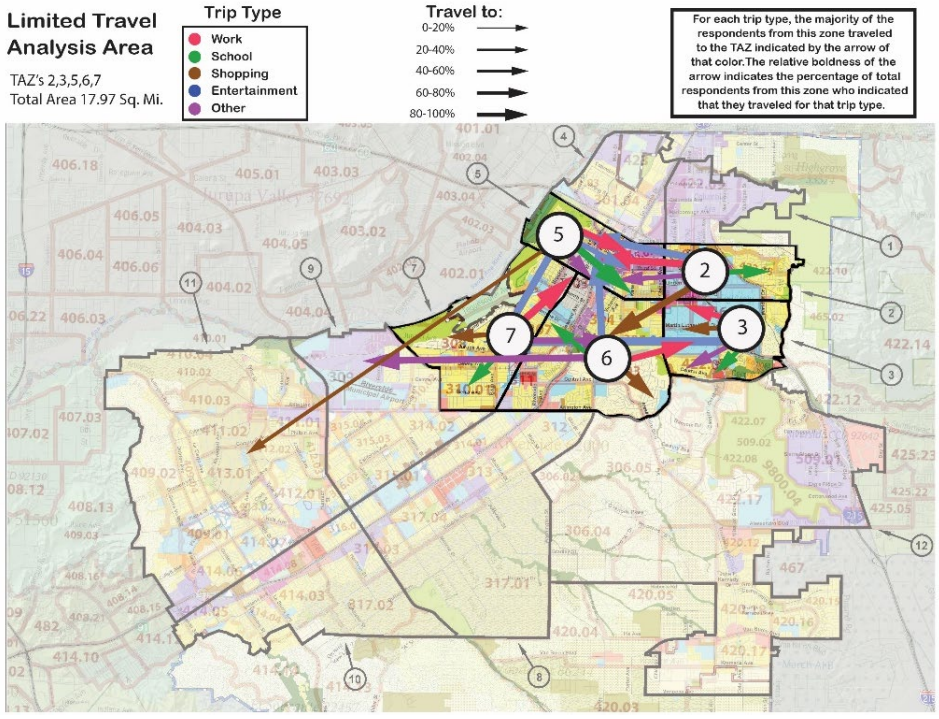
Figure 1-13, *Conceptual Phase 1 Circulator and Phase 2 Line-Haul*



Map source: Google Maps

The graphic overview of the Travel Survey questionnaire results clearly show that the residents of the downtown/eastside area (LTAA) rarely make journeys outside of the area and would logically benefit from a high-frequency circulator:

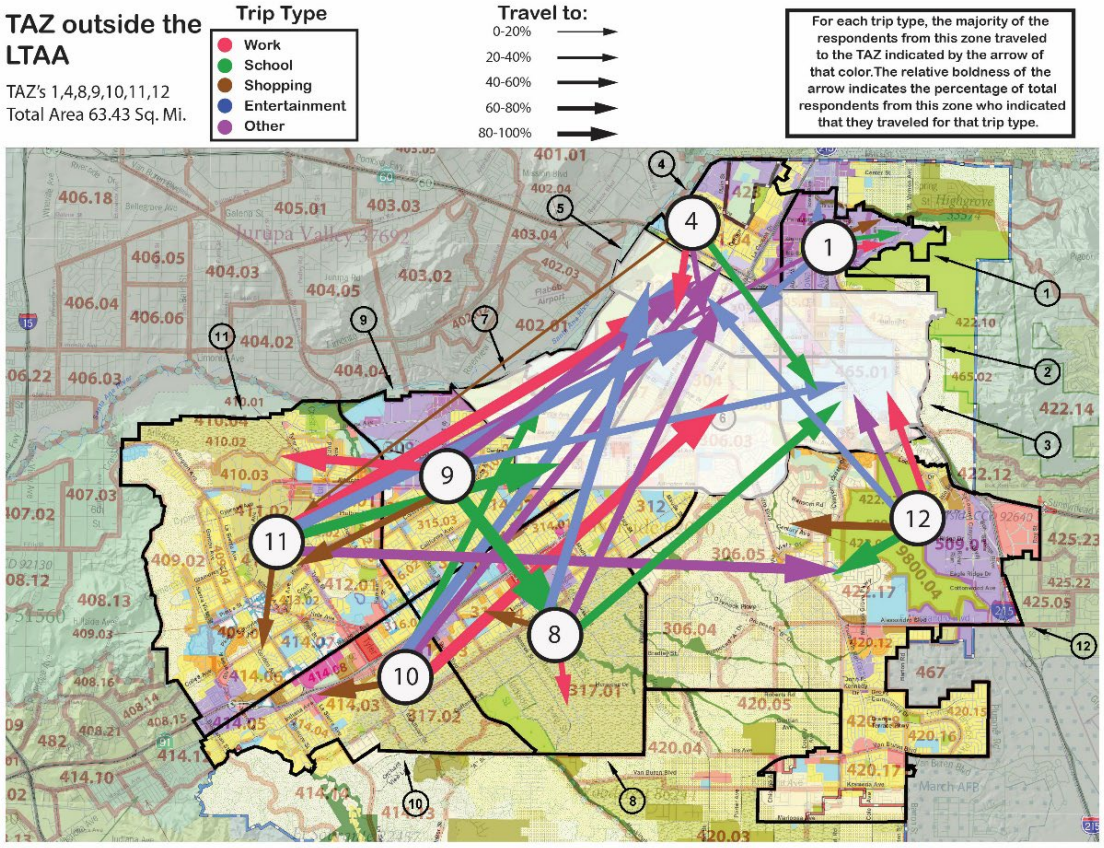
Figure 1-14, *Trips Originating Within the LTAA*



Map Source: U.S. Census 2019

While the residents of the westside and other TAZs travel predominantly into the LTAA and would logically benefit from a high-frequency line-haul system along Magnolia from the Westside into the LTAA:

Figure 1-15, *Trips into the LTAA, Originating Outside the LTAA*



Map Source: U.S. Census 2019

The Travel Survey questionnaires showed that a significant majority of the respondents would shift their mode of transportation to the Streetcar if they had the opportunity and it served to facilitate their journey.

Question #9:
If an electric streetcar were to provide service on the routes of the normal trips you have identified in this survey, how likely would it be that you would switch from or your current mode of transportation or add the new streetcar system to it? (please check only one)

Response:
Somewhat to Highly Likely = 79.3%, Somewhat to Highly Unlikely = 20.7%

This modal shift, although hard to quantify, is empirically shown to favor the installation of new streetcar and tram lines around the world and continues to be a driving factor in the acceptance of street-running railways over bus systems and BRT.

Our demand analysis produced a ridership projection through a simplified four-step model:

Step 1: Trip Generation

Using resident and non-resident daily populations in the City of Riverside and applying Home-Based and Site-Based trip generation methods, we calculated 2,247,690 daily trips.

Step 2: Trip Distribution

Based on information provided the Riverside residents who responded to our Travel Survey questionnaire we concluded that a significant number of the 596,5795 trips generated in the LTAA are completed in that area and will be best served by a high-frequency circulator.

Step 3: Modal Split

The responses from our Travel Survey showed an unusually high reporting of public transportation mode use so we performed a comparison of automobile and bus trip volumes at key locations around the city and found the resulting percentage to be 5.25% very close to the national average of 5%. We have determined to use this 5% figure for our modal split resulting in 30,059 daily public transportation trips within the LTAA.

Step 4: Trip Assignment

The Trips generated in LTAA and identified as public transportation mode trips through the mode split are then assigned to a particular route through per capita distribution to patrons who are within a 5-minute walking distance of a public transportation service passenger station. It is assumed that the higher frequency service, shorter travel times, and increased comfort and convenience of a streetcar system will favor that system and per capita patrons who fall within the identified 5-minute streetcar pedestrian catchment are assigned to the streetcar. This results in a streetcar ridership projection of **4,521 passengers per day**.

This ridership is used in the Project Cost Model in ***Section 1.10*** and represents 33% of the streetcar capacity at AW-1 (32 seated passengers only) or an average of 11 passengers on each streetcar at any given time.

A comparison analysis carried out using the FTA's STOPS ridership projection software confirmed the TIG/m manual analysis by estimating a base ridership within 8% of the TIG/m figure. After running an identical Cost Model for the two sets of ridership projections, the resulting cost to the public sector differed by only 4% for the first year. This cost differential dwindles year to 0% at year 8. The two projections both go profitable after year 15 and enjoy the same profit at year 30.

Our aspirational vision for the City includes the addition of an extensive Park and Ride system which can increase ridership in both the bus and streetcar modes. This system could be added in the future. We also feel that the inclusion of a Modal Shift factor is sensible. This phenomenon has been shown to be significant as streetcar lines become established and automobile drivers shift to streetcar use for trips where it is convenient for their travel needs. The work we have done in these areas can be reviewed in ***Appendix J.***

1.7 TIG/m Vehicles

TIG/m, LLC manufactures several different types of rail vehicles, all falling within the category of electric streetcar or tram vehicle. By far the unique defining characteristic that sets TIG/m vehicles apart from its competition is that all TIG/m vehicles are self-powered, requiring no wayside power systems of any kind.

All power for a full day of passenger service is carried onboard each vehicle. TIG/m is the only company that has achieved this in an all-electric streetcar. Current independently verified performance data from our Msheireb Downtown Doha Tramway Transportation system shows that under the specific operating parameters of that tramway, TIG/m vehicles are capable of continuous air-conditioned operation for over 30 hours before requiring battery recharging.

The propulsion technology can most accurately be described as a battery-dominant hydrogen/ electric system. Approximately 60% of the daily energy budget is carried on-board in the energy storage system (ESS) batteries, with 20% in carried in the gaseous hydrogen fuel (H2) for the hydrogen fuel cell auxiliary power unit (APU), and the final 20% being produced in passenger service by regenerative braking. Fleet fueling of the H2 APU is accomplished by on-site hydrogen production through the electrolysis of water. Because the daily consumption of hydrogen per vehicle is so low (approximately 20% of daily energy budget, or 2 Kg), the H2 production plant is relatively small and affordable.

The TIG/m vehicle used in this study is the MRV-3A shown below.

Figure 1-16, *TIG/m 100-Passenger MRV-3A*

By performing a simple Google search for “Hydrogen Rail” you will find that this is the hottest area of research and development in the railway industry. Utilizing TIG/m advanced streetcar technology for this project will put the Riverside Streetcar System at least a decade ahead of the industry curve. We have been researching, developing, and delivering battery dominant/hydrogen fuel cell vehicles for the public transportation market for over 10 years and have had rail vehicles utilizing this technology in public passenger service operations since 2014.

In Oct. 2021 TIG/m performed the first public operation of hydrogen/electric passenger rail vehicle in North America as a successful demonstration in Santa Cruz California. The operation was inspected and approved by CPUC and FRA.

Examples of ambitious current attempts—but still years away from completion, approval by governing bodies, and operation—being made by other rolling stock manufacturers are:

- The San Bernardino hydrogen project (DMU to HEMU conversion)
- GM and Wabtec, in June 2021, announced a joint venture to start development for exactly such a system in the heavy rail industry.[10]

TIG/m's curb-running streetcars operate independently of any fixed power system and can deliver over 30 hours of continuous passenger service without creating any pollutants at the vehicle.

1.8 Capital Cost Estimates

TIG/m designed a conceptual streetcar system for the City of Riverside based on a series of phases to be built out over time. The Phase 1 of this concept was then taken to a *schematic level of track and infrastructure design* and is used as the basis for all of the detailed analysis in this study. This allows us to apply unit costs to each component of the design. Our experience in construction of turnkey streetcar systems allows us to use the actual unit costs from our construction partners and material suppliers from current and previous projects. This method does not require TIG/m to include large contingencies for each line item as we have included all materials, components, and labor in our estimates. Other construction costs such as civil works were derived from U.S. averages reported in *Gordian, Heavy Construction Cost with RS Means Data, 35th Edition, 2021*.[11] Streetcar and other rolling stock costs come from the application of the TIG/m vehicle technology as it applies to the fleet design for the Phase 1 alignment. Resulting detailed capital costs are provided on the following page in ***Table 1-3***, For detailed description of each of the included line items please go to ***Section 9*** of this Report.

Exclusions from the following CAPEX, which are considered the responsibility of the City, include:

- EIR Studies (if required pursuant to SB 288)
- Roadway re-paving outside of the 8-10ft wide track corridor
- Remediation of existing ageing or sub-code street surfaces and structures
- Costs associated with Independent Safety Certification and Assessment which must, by definition, remain independent from the delivery team.

***Table 1-3**, Capital Cost Estimate*

RIVERSIDE STREETCAR FEASIBILITY STUDY

CAPITAL COST ESTIMATE ($MM)

LINE	SCOPE	UNITS	UNIT COST	QUANTITY	EXTENDED COST	ALLOCATED CONTINGENCY	TOTAL	PERECENTAGE OF PROJECT
1	**Track and Special Work**							
1.1	Cast-in-place trackform (Line 1)	Miles	5.226	7.12	37.20912		37.209	
1.2	Cast-in-place trackform (Line 2)	Miles	5.226	0.772	4.034472		4.034	
1.3	Turnouts	Assy.	0.0975	9	0.8775		0.878	
1.4	Expansion joints	Assy.	0.0273	41	1.1193		1.119	
1.5	Panelized Trackform	14' panel	0.0124		0	1	1.000	
1.6	O&M Spur (embedded and open)	Miles	4.2	1.2	5.04		5.040	
	Sub-Total						**49.280**	**37.1%**
2	**Passenger Stations**							
2.1	Repurposed Bus Stops	1 Station	0.055	14	0.77		0.770	
2.2	New Streetcar stops	1 Station	0.15	16	2.4		2.400	
2.3	Multimodal Upgrades	1 Station	0.06	10	0.6		0.600	
	Sub-Total						**3.770**	**2.8%**
3	**Operations and Maintenance Yard**							
3.1	Property Lease	Plot	5 yrs.			1.2	1.200	
3.2	Switch Yard Track (open)	Miles	3.6	0.45	1.62		1.620	
3.3	Switch Yard Turnouts	Assy.	0.0975	8	0.78		0.780	
3.4	Switch Yard Expansion joints	Assy.	0.0273	6	0.1638		0.164	
3.5	O&M Facility	Sq. Ft.	0.000246	22,000	5.412		5.412	
	Sub-Total						**9.176**	**6.9%**
4	**Civil Works, General Conditions**							
4.1	Demolition, Earthworks	Miles	0.063	9	0.567		0.567	
4.2	Hauling / Disposal or Recycling	Ton			0	0.518	0.518	
4.3	Utilities Relocation				3.62	5.88	9.500	
4.4	Traffic Management	Day	0.001	915	0.915		0.915	
4.5	Safety Management	Day	0.001	915	0.915		0.915	
4.6	Temporary structures				0	0.5	0.500	
	Sub-Total						**12.915**	**9.7%**
5	**Support Systems**							
5.1	Existing Traffic Signal Interface	Kit	0.0154	29	0.4466		0.447	
5.2	New traffic signals	Install	0.225	5	1.125		1.125	
5.3	Streetcar Priority Signalization	System	0.64	1	0.64		0.640	
5.4	Virtual Tram Location	System	In 5.2	N/A	N/A			
5.5	Next Vehicle Arrival Station Signs	Kit	0.0135	30	0.405		0.405	
5.6	Fare Collection	Per vehicle	0.06	5	0.3	0.3	0.300	
	Sub-Total						**2.917**	**2.2%**
6	**Rolling Stock**							
6.1	Streetcars	MRV-3	2.87	5	14.35		14.350	
6.2	Tug	MB	0.23	1	0.23		0.230	
6.3	Track Maintenance Vehicle	TMV-2	0.16	1	0.16		0.160	
6.4	Spare Parts 1 year (5% cost)	Lot	0.15	5	0.75		0.750	
	Sub-Total						**15.490**	**11.7%**
7	**Project Services**							
7.1	Design-Alignments	Project	1.4	1	1.4		1.400	
7.2	Track Engineering	Project	2.2	1	2.2		2.200	
7.3	Design-O&M Facilities	Project	0.45	1	0.45		0.450	
7.4	Design-Vehicles	Project	0.15	1	0.15		0.150	
7.5	Liaise - Safety Case Manager	Project	0.34	1	0.34		0.340	
7.6	Liaise - ISA	Project	0.075	1	0.075		0.075	
7.7	Contruction Management	Project	8.5	1	8.5		8.500	
7.8	FAT, SAT, SIT, Certification	Project	0.35	1	0.35		0.350	
7.9	Project Insurance	Project	2.17	1	2.17		2.170	
	Sub-Total						**15.635**	**11.8%**
8	**Documentation**							
8.1	Construction Documents	Project	0.26	1	0.26		0.260	
8.2	Safety Certification Documents	Project	0.505	1	0.505		0.505	
8.3	Manuals, Catalogs, SOP's	Project	0.206	1	0.206		0.206	
8.4	As-Built Drawings - Civil	Project	0.112	1	0.112		0.112	
8.5	As-Built Drawings-Vehicle	Project	0.065	1	0.065		0.065	
	Sub-Total						**1.148**	**0.9%**
9	**Project Total**							
9.1	Subtotal (lines 1.1 - 8.5)						110.331	83.1%
9.2	Unalloctated Contingency						10.000	7.5%
9.3	Finance Charges 3 YEARS (4%)						12.511	9.4%
9.4	**TOTAL CAPEX**						**132.842**	100%

1.9 O&M Cost Estimates

The following tables list projected operating costs for the first year of operations and projected yearly operating costs for the subsequent four years of operations.

Figure 1-17, *Initial Operating Costs (First Year of Operation)*

First-Year Operating Costs Two 8-hour shifts per 16-hour day (Monday through Friday) Two 7-hour shifts per 14-hour day (Saturday) Two 6-hour shifts per 12-hour day (Sunday)			
Cost Model Factor	Unit Cost	Initial # of Units from Operating Plan	Total Cost
Man-Hours Labor	$62.00	55,120	$3,417,440.00
Revenue mi	$2.25	306,600	$689,850.00
Peak Vehicles	$64,600.00	4	$258,400.00
Track mi	$35,750.00	7	$250,250.00
Subtotal			$4,615,940.00
One Time Start-up Cost	10.00%		$461,594.00
TOTAL			$5,067,534.00

Figure 1-18, *Yearly Operating Costs (Years 2-5)*

Yearly Operating Costs (Years 2 Through 5) **Two 8-hour shifts per 16-hour day (Monday through Friday)** **Two 7-hour shifts per 14-hour day (Saturday)** **Two 6-hour shifts per 12-hour day (Sunday)**			
Cost Model Factor	**Unit Cost**	**Initial # of Units from Operating Plan**	**Total Cost**
Man-Hours Labor	**$62.00**	**55,120**	**$3,417,440.00**
Revenue mi	**$2.25**	**306,600**	**$689,850.00**
Peak Vehicles	**$64,600.00**	**4**	**$258,400.00**
Track mi	**$35,750.00**	**7**	**$250,250.00**
TOTAL			**$4,615,940.00**

For a detailed description of how the O&M Model is developed, please refer to ***Section 10.***

1.10 Cost Model

Having developed the capital cost of the project (CAPEX) in the capital cost spreadsheet and operating and maintenances costs (OPEX) through the O&M cost model, we will now bring these expenses together into a project cost model which will show the project expenditures and revenues over three years of construction and 30 years of operations.

The CAPEX includes the costs to construct the project plus 8% contingency and three years of prepaid interest at 4% on a private sector loan. The CAPEX is exhausted over three years of construction and operations begin in 2025.

The ridership projection is developed in ***Section 4 Travel Market Analysis*** and is shown as a percentage of fleet capacity (at AW-1 seated passengers only [32 passengers per vehicle]) increasing over time at a rate of 2% per year for the first 10 years, and 3% per year thereafter.

The Revenue section of the Cost model show three sources of income:

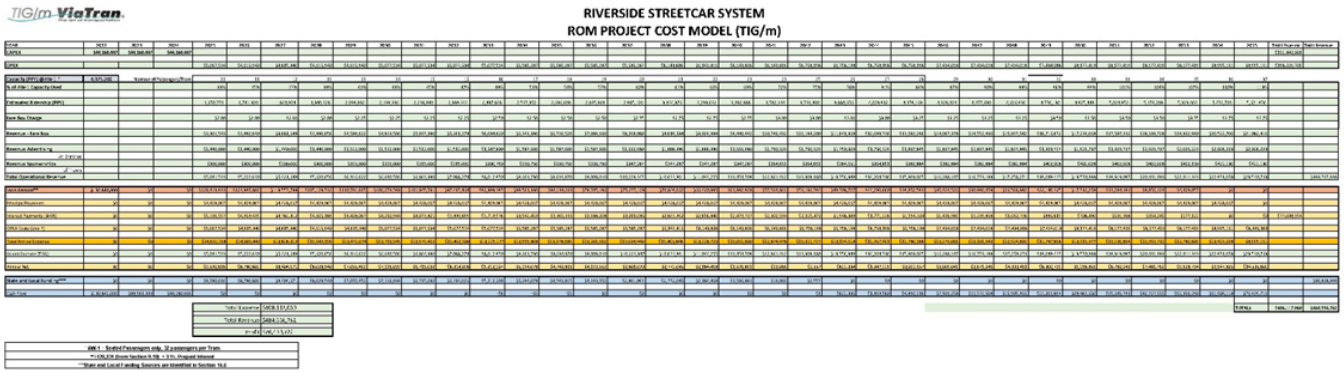
- Farebox revenue beginning at the projected 2025 RTA rate ($2) and increasing at the industry average of 25 cents every fifth year
- Advertising at stations as four lighted boards at each station ($1K/mo./station). This cost is derived from current Riverside advertisers
- Sponsorships of Trams in the form of full-body advertising wraps ($5/mo./tram). This cost is derived from current Riverside advertisers.

Advertising and sponsorship income increases by 5% every 5th year.

The bottom half of the spreadsheet represents the cash flow: Yearly payments on the loan principal, an annual interest payment at 4%, and the annual O&M cost make up the yearly expense. This is offset by the total annual operating revenue, yielding the annual net.

For the first 15 years of operations the annual net is negative (year 1 = $9.5MM, decreasing yearly thereafter) and will require public sector funding from greenhouse gas reduction grant programs. At year 16 the operation breaks even and becomes increasingly profitable thereafter.

Table 1-4, *ROM Project Cost Model (See Appendix O for Larger Format)*


RIVERSIDE STREETCAR SYSTEM
ROM PROJECT COST MODEL (TIG/m)

1.11 Next Steps

Should the City of Riverside opt to move ahead with the Riverside Streetcar Project along the lines presented in this Report, TIG/m will propose a DFBOM Agreement which would be negotiated during an Exclusive Negotiating Period. Major considerations to be defined within this period are: final budget parameters (with fixed costs coming after design development and value engineering), the form of the agreement, the definition and formation of the Joint Development Partners to act for the public and private sectors (Riverside Streetcar, Inc., Streetcar O&M Partners LLC, etc.), and the building of agreements between the City of Riverside, the RTA, and the RCTC relative to the implementation of the project.

Funding the project through an Institutional Private Placement with the private sector financial corporation that TIG/m brings to the Joint Development team.

Application for Exemption from CEQA pursuant to SB 288.
“In addition to supporting public transit agencies, SB 288 can also create opportunities for new public-private partnerships. The private sector has shown increasing interest in investing in proposed streetcar, light rail, and bus transit projects over the past several years. The new exemptions may help fast-track new transportation projects by eliminating CEQA review and thereby reducing one of the most time-consuming and risky elements of project development. Transportation agencies and private developers should carefully evaluate proposed projects to determine if they can take advantage of the new exemption over the next two years.”[12]

Within the P3 structure developed for the Riverside Streetcar project delivery, institute a Grant Funding Committee. This Committee will be tasked with formulating the permanent strategy for the grant funding requirement identified in the Cost Model and potential shortfall recovery. No grant funding will be required during the three years of project construction which is funded by the private sector loan but will need to be in place for the first year of Operations.

Coordinated work with the CPUC (Railway Authority) to determine the structure of the Safety Certification program for the project and appointment of a Safety Case Manager and ISA (Independent Safety Assessor).

Coordinated work with Caltrans to determine the way forward with design of the crossings of Caltrans properties at the 14th Street overpass at SR 91, and the new 3rd Street Railroad Grade Separation.

Proceed with Schematic Design, Design Development, Final Design, Construction Documents, Construction, Manufacturing, Testing and Commissioning.

Section 2:
Introduction

2 Introduction

Streetcars are just one of many transportation services that may be offered in an urban community. Compared to other transit modes, streetcars typically are intended for local, short-distance circulation, and are effective at providing a sense of permanence, identity, and involvement within a corridor.

During the golden era of Electric Railway Transit (1895 through 1930), before the advent of affordable mass-produced rubber-tired vehicles, a complete and logical system of electric railway transit evolved within and around major urban centers worldwide. This system consisted of two parts: Interurban rail lines, complimented by street railway circulators. There was some overlap between the two systems, but essentially the interurban line operated as line-haul transit on mainly tangent, mostly dedicated, rights-of-way between towns in urbanized areas; while the street railways operated as local circulators on the city streets, delivering people to within a short walk of their final destination, and often right to their doorstep.

These electrified railway systems were fantastically successful and spread rapidly around the world from their point of origin in Richmond, Virginia. The circulators shared the city streets which were congested with the vehicles of the day: horse and buggy rigs, the stagecoach, and the omnibus. After the turn of the twentieth century, the automobile increasingly replaced animal powered vehicles, and streetcars operated successfully with the automobile in mixed traffic for decades. Eventually, due to a convergence of market forces, the electric railway itself was supplanted by the automobile as suburban development spread rapidly beyond the limits of the fixed railway systems. As the urban cores emptied out, the dwindling fare generation of the railways could not support the cost of maintaining the tracks and wayside power systems.

Today, many cities around the world and in the U.S. are seeking to reinstate the electric railway systems that were routinely decommissioned and removed after WWII. Toward this goal they tend to install LRT systems, which are essentially the equivalent of the interurban railway component defined above, but they fail (especially in the U.S.) to develop true local street railway circulators which constituted the necessary second element of the logical electric railway system. This has led to the “last mile problem” in which a substantial percentage of potential transit passengers do not
ride light rail systems because at the end of the line they have no way to traverse the “last mile”. In other words, the system is not fine-grained enough.

TIG/m’s mission is to provide the “last mile solution”: true street railway circulators in a system of Customer Oriented Transit Service (COTS).

The City of Riverside is of the right scale to warrant a local circulator network. The city has for some time identified its aspiration to provide an environment conducive to walking and the most fitting form of transportation for the walkable urban community is the streetcar. When this type of system is correctly interfaced with the existing transit modes, it will provide the residents, commuters, and visitors with a full-service multi-modal transit system. This system will encourage walking within the area and will not only reduce the need for automotive trips within Riverside but will reduce the necessity of automotive trips with origins and destinations outside the city.

With the installation of a fixed-guideway street rail network on which zero-emission streetcars circulate thousands of passengers each day, Riverside would be among the first cities in the United States to emulate the global “smart cities’” paradigm of reducing vehicle miles traveled (VMT), regenerating healthy walking districts, and substantially reducing noise and air pollution.
Automobile drivers could drive to and leave their cars at Park-and-Ride facilities on the outskirts of the city or simply leave their cars at home. Existing bus service, Metrolink trains, and a circulating streetcar

system, supported by micro-mobility solutions available at many of the passenger stations, would function in concert as an interconnected and egalitarian service for residents and visitors alike.

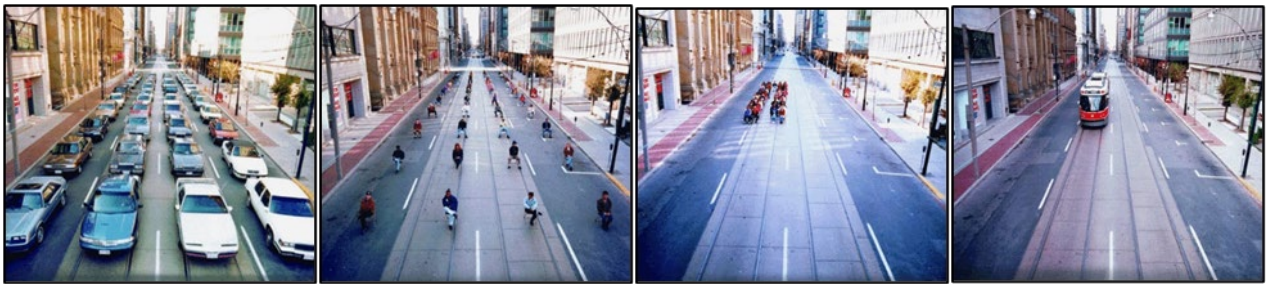
Benefits of operating a local circulator street railway system within the City of Riverside include:

1. It will reduce the need for automotive travel, reducing VMT.
   Quality-of-life benefits:
   - Creates quieter, safer, streets and neighborhoods. A single quiet electric streetcar replaces, on average, 30-50 automobiles on the same street.
   - Encourages non-motorized travel (walking, bicycling) within the development.
   - Promotes greater interpersonal interaction and sense of community.
   - Improves air quality.

2. Through well designed interfaces with established existing transit systems, it will reduce the need for automotive travel to, from, and around the City of Riverside.
   Benefits:
   - Reduction in the quantity of required parking infrastructure.
   - Reduction of the number of automotive trips burdening the ambient neighborhood.
   - Improves air quality.

3. It will provide a signature attraction which will bring additional visitors and potential retail customers to Riverside.
   Benefits:
   - Increased retail exposure and resulting revenues.
   - Increased entertainment venue exposure and resulting revenues.
   - Increased attendance at heritage sites, museums, and other important cultural events and venues.

***Figure 2-1**, Vehicle Number Reduction Facilitated by a Single Streetcar*



2.1 Lessons Learned from European Tramway Systems

Based on our experience and supported by the most successful tramway programs in Europe, the following are TIG/m's Six Steps to successfully deliver a streetcar system:

1. Create strong political will and leadership to support the project.
2. Dedicate private sector funding: P3 can reduce delivery time and increase quality.
3. Implement the system in corridors with the strongest existing bus ridership.
4. Restructure bus lines to support, rather than compete with, a streetcar network. A true multi-modal transportation system will increase ridership in both modes due to modal shift from automobile traffic.

5. Design corridors for mixed traffic with tram priority signalization.
6. Project a powerful image of the beauty and benefits of Streetcars to create public support.[13]

2.2 Study Area

The entire City of Riverside was included in our initial research of available data on land use, populations, travel and transit modes and preferences, traffic volumes and other data sets pertinent to our study.

An initial concept of five interlocking pinched-loop streetcar circulators serving much of the relatively densely populated areas of Riverside was envisioned and simulated. Please refer to ***Appendix R: Phase Concept.***

As the input from Stakeholders was incorporated into our Study, the study area became focused on a Phase 1 streetcar circulator on the Eastside between Downtown and UCR. This focus led to the creation of a Limited Travel Analysis Area (LTAA) based on the 5 Travel Analysis Zones (TAZ) that border on the proposed alignment.

2.3 Brief History of the Streetcar in Riverside

A transportation mode that helped shape the thoroughfares and population centers of Riverside was the Electrified Railway (Streetcar). The Riverside Railroad Company (RRC) began operating horse powered streetcars on Main Street and 8th Street in 1886. The Riverside & Arlington Railway Company (R&A) was incorporated in 1887 and bought the RRC in 1895. In 1900 the R&A electrified all of its streetcar operations and Frank Miller, its manager, operated approximately 14 miles of streetcar lines until 1911 when it was incorporated into the Pacific Electric Railway (PE) of Henry Huntington. Riverside itself was specifically served by the Riverside-(Arlington)-Corona Line until early 1943. The PE operated all of the streetcars and interurban systems in the Inland Empire until about 1943 when the proliferation of automobiles, buses, and trucks overtook the ability of electrified rail lines to modernize, and the systems were unfortunately abandoned. [14]

Figure 2-2, *Old Hand-Drawn Route Map, Pacific Electric Railway Riverside-Corona Line*

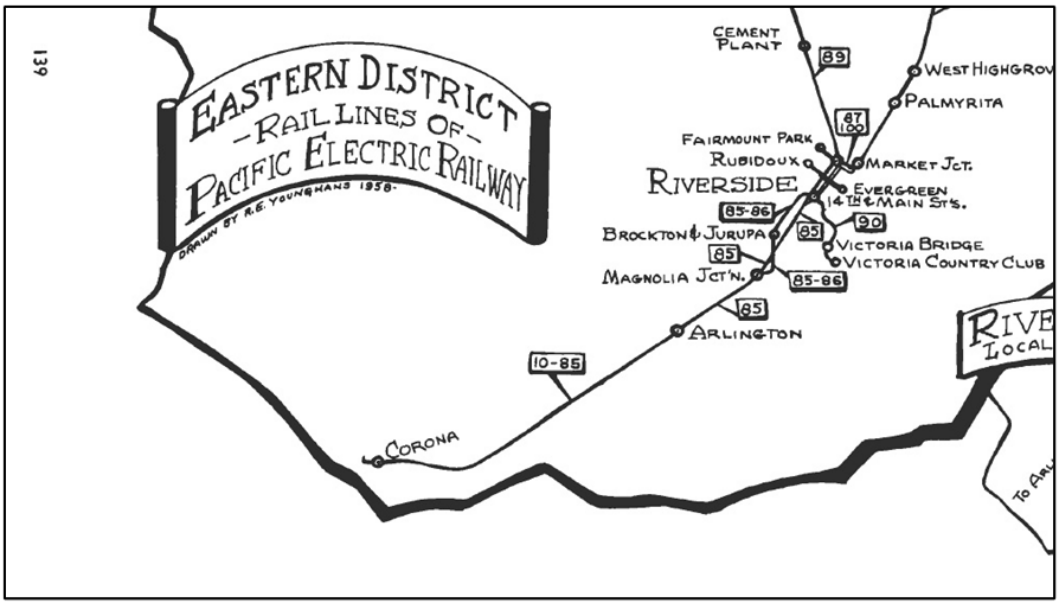


Figure 2-3, *Old Postcard of a Trolley on Magnolia Avenue*

Source: Press Enterprise. 2011. [15]

Magnolia Avenue, which became the main line of the R&A and originally carried passengers between Downtown and Frank Miller's Chemewa Park near Arlington, has always been the prominent thoroughfare on the west side of Riverside and continuing all the way to neighboring Corona. When UCR opened in 1954 and University Avenue became the major eastside thoroughfare, the "L" shaped transit corridor was well established and remains the most viable route for a high-value fixed guideway transportation system today. Currently the RTA Rapid Link (Route 1) serves this corridor.

2.4 Riverside's Motivation to Reintroduce Streetcars

Riverside is one of several communities that were served by the famed Pacific Electric streetcar network and is among those seeking to revive rail-borne streetcar services, including Santa Ana (in construction), Anaheim, and Corona, which entirely vanished from Southern California by 1961. Until the preponderance of automobile use, Riverside's downtown—as were all city centers—were more vibrant pedestrian concourses.

A native of Riverside, Mayor William "Rusty" Baily, whose terms in office spanned from 2012 to 2020, championed the concept of reviving the streetcar in Downtown Riverside. "Riverside Reconnects" envisions a streetcar corridor from UC Riverside to the western city limits via downtown Riverside, utilizing University Avenue and Magnolia Avenue, two major transportation corridors within the city.

The Riverside Reconnects name is a reference to fact that Riverside once was among the cities across Southern California served by the Pacific Electric Railway's Red Car line. Installing a streetcar network would "reconnect" residents, commuters, and visitors to business, educational, recreational, residential, and devotional canters throughout the Downtown Riverside area, and would provide a first-and-last-mile solution from Riverside's Metrolink stations.

2.5 Considerations of Riverside's Strategic Plan 2025

Riverside has identified goals and aspirations for advancing the city's economy by expanding and/or attracting research and development organizations, both public and private, whose focus is on environmental stewardship and innovative arts and technologies. The potential introduction of a streetcar network is included in its overall strategic plan.

Streetcars are just one of many transportation options that may be offered in an urban community. Streetcars typically are intended for local circulation and reciprocation, are effective at enhancing a sense of permanence and community identity within the corridors through which run. They are proven to promote walkability and livability within communities, encouraging "park and walk" behaviors.

While streetcars have historically enjoyed popular sentiment among residents of and visitors to numerous municipalities, smart-growth land use policies, multi-modal transit policies, and development partnerships can greatly affect the ridership and ultimate success of all local public transit types. Typically, this is referred to as transit-oriented development (TOD).

This section addresses the goals and priorities described in *Envision Riverside 2025, City of Riverside Strategic Plan (2020 Edition)*, to present how a sustainable self-powered zero-emission streetcar system can contribute to Riverside's aspirations to meet or exceed applicable "cross-cutting thread" goals of its strategic priorities.[16]

Figure 2-4, *Envision Riverside 2025: Priorities & Cross-Cutting Threads*

Source: Envision Riverside 2025, City of Riverside Strategic Plan (2020 Edition)[17]

2.5.1 Community Well-Being

(**Goal # 2.3**) The City of Riverside strives to "strengthen neighborhood identities and improve community health and the physical environment through amenities and programs that foster an increased sense of community and enhanced feelings of pride and belonging citywide."[18]

Worldwide, a renaissance of streetcar systems is enhancing or engendering the appeal of numerous cities as cultural destinations for residents and visitors alike, transforming car-clogged thoroughfares into thriving transit-oriented communities.

The streetcar as public transport has an impact on people's mental health and wellbeing. It allows people to connect and maintain relationships with others, access work opportunities, education, or leisure activities outside their homes, and to be more autonomous. It enables older people to keep active lifestyles and to be involved in their communities. Furthermore, it has been shown that shorter travel time, provided by many fixed guideway transit systems, improves wellbeing, while commutes lasting between 60 and 90

minutes (an all-to-often experience in single rider automobiles) have the biggest negative impact on wellbeing.[19]

2.5.2 Economic Opportunity

(**Goal # 3.2**) "Work with key partners in implementing workforce development programs and initiatives that connect local workers with high quality employment opportunities and provide access to education and training in Riverside."

Urban street rail investment can help regenerate and invigorate central business districts (CBDs) and boost employment and property prices.[20]

Additionally, towards Riverside's goal to "work with key partners in implementing workforce development programs and initiatives that connect local workers with high quality employment opportunities and provide access to education and training in Riverside," the installation of a streetcar system and a fabrication facility would provide up to 250-300 employment opportunities in research, design, engineering, administrative, manufacturing, craftworking, operations, and maintenance within the rapidly growing green transportation industry.[21]

A streetcar system can act as an economic stimulus, encouraging investors to spend. More residents and visitors are inclined to leave their cars behind. Foot traffic increases along streetcar routes and is naturally attracted to local businesses—more people with money in their pockets, many of whom are likely to spend at local businesses. When these local businesses start to flourish, more investors will recognize the area as having potential, and will endeavor to join the community, offering a wide variety of new businesses and amenities, attracting more customers, and so on. The result of this chain reaction is economic development and prosperity along the streetcar route.[22]

Adding new transportation modes to existing built-up urban areas can also increase aggregate economic activity simply by making congested areas less congested.[23]

Riverside is already poised for a boost in economic opportunity and technology excellence, with a high profile in environmental guardianship. The California Air Quality Resources Board (CARB) is nearing completion of one of the largest and most advanced vehicle emissions testing and research facilities in the world, near the campus of UC Riverside.[24]

Riverside is in the planning stages of creating innovation districts across the city, with the first such district located roughly between downtown and UC Riverside. The districts may feature start-up businesses—many in environmental and/or technical specialties—readily available multi-modal transportation options (including a potential streetcar network), art and artists, ethnic foods and markets, a variety of public spaces, and performance opportunities. The City Council agreed to pursue the city's first innovation district in a 3 square-mile area that includes part of downtown Riverside, portions of North Main Street, an industrial area north of Third Street near the 60/91/215 interchange, the packinghouses just east of downtown, the Eastside neighborhood, and UC Riverside.[25]

Providing potential sustenance to these thriving specialties, the Bourns College of Engineering, Center for Environmental Research and Technology at UC Riverside (CERT) currently attracts an abundance of environmental and technical enthusiasts. Riverside will be ready to retain much of its finest talent, along with graduates from other nearby colleges and universities, who would become an integral part of the city's burgeoning economy.[26]

2.5.3 Environmental Stewardship

(**Goal # 4.1)** Riverside is endeavoring to "rapidly decrease [its] carbon footprint by acting urgently to reach a zero-carbon electric grid with the goal of reaching 100% renewable energy production by 2040 while continuing to ensure safe, reliable and affordable energy for all residents."[27]

A streetcar system with vehicles that are self-powered and zero-emission, with the potential to consume 100% of their energy requirements from renewable solar and/or wind generated powers sources, would contribute substantially to a truly green and sustainable public transit system.

With the addition of the new CARB headquarters and the extant CE-CERT at UCR, the inclusion of a zero-emission streetcar system would make Riverside a beacon and an inspiration in the advancement of environmental, economic, and social sustainability.

2.5.4 Infrastructure, Mobility, and Connectivity

(**Goal # 6.1**) The City of Riverside is broadening its efforts to "provide, expand, and ensure equitable access to sustainable modes of transportation that connect people to opportunities such as employment, education, healthcare, and community amenities".[28]

High quality transport services and infrastructure enhance internal and external urban connectivity. Research shows that a "modal shift from private cars to public transportation is often presented as one of the pillars of sustainable mobility in cities", indicating that high quality transport services and infrastructure enhance internal and external connectivity, which can:

- Unlock previously hard to reach sites for development
- Trigger fresh growth through elimination of significant transport constraints
- Stimulate inward investment
- Extend labor market catchment areas
- Reorganize production, distribution, and land use
- Enhance land and property value increase and value capture.[29]

Urban streetcar circulators, each with station/stops adjacent or within a five-minute walk to the Riverside Metrolink train station would fulfill the "first/last mile" requirement to convey passengers within the city limits and beyond.

2.6 Characteristics and Benefits of a Streetcar System

The number one goal of any public transportation system is to get people out of their private automobiles by giving them a complete end-to-end solution for their travels; creating a communal sense of place that is a connected, walkable, exciting place to be. This is done by connecting all of the alternate modes of travel into a seamless whole. In the case of the Riverside Streetcar System, this means making as many stops as possible multi-modal stops for buses, streetcars, RapidLink, bicycles and pedestrians. These modes support each other, when we give motorists a viable opportunity to leave their cars at home or at Park-and-Ride facilities (or let them go altogether), all of these modes of travel will see an increase. These modes do not compete with the other, they complement the other, creating an integrated "hub-to-home" transport system that also completes the "first/last mile" gap between train stations/parking centers and several key locations in the city.

RTA has identified--and described well—the advantages of a successful public transit system:

"Public transit saves the U.S. the equivalent of 4.2 billion gallons of gasoline annually. If an individual switches a 20-mile round-trip commute to public transit, his or her annual CO2 emissions will decrease by 4,800 pounds per year, equal to a 10 percent reduction in a two-car household's carbon footprint. And an individual can achieve an average annual savings of more than $10,000 by taking public transit instead of driving and by living with one less car." [30]

Energy-efficient, zero-emission, rail-borne streetcars take these metrics to an even healthier level. Additional benefits are examined and described in ***Section 12.7: Community Benefits.***

2.6.1 Features

While the value of busses will never be dismissed, electric and self-powered streetcars are found to be a more desirable mode of transport. They offer:

- ***Permanence****:* a bus route can be easily altered or removed on a whim by the transport authority or operating company, whereas doing the same to a tram route requires much more careful consideration (and expense). This also means that tram networks have to be carefully planned before they are created. This permanence generally inspires confidence, both in residents and in businesses that may be looking to set up in a particular neighborhood.
- ***Urban renewal:*** in Portland, Seattle, Kansas City, Dallas, and other U.S. cities, wherever streetcar has been implemented, this permanence has inspired the redevelopment of streets and neighborhoods by increasing land values and encouraging higher private sector investment . It also tends to boost businesses along the route once the tram line is operational.
- ***Image:*** linked to the above point is the positive impact that tram networks can have in terms of a city's image, particularly as modern trams can be customized in many ways and so can become a distinctive and highly visible symbol for the city in which they operate. Raising the city's profile in this way may, in turn, boost the local economy.
- ***Rapidity:*** trams with detection systems ensure they have priority at traffic lights, roundabouts, and level crossings (where they exist).
- ***Reliability:*** electric drive (trams) requires a small fraction of the maintenance of internal combustion engines (most buses), leading to greater reliability and a better overall level of service. [Additionally, in systems that rely on a unified wayside power supply such as overhead catenary wires, if the power supply should fail, the entire streetcar network would come to a complete standstill. With self-powered streetcars, this could not happen.]
- ***Access and comfort:*** trams [with wider doorways] offer better access for persons with reduced mobility—persons in wheelchairs, parents with [strollers], persons with heavy luggage, etc., as the station platforms are designed so that they are at exactly the same level as the tram floors. Buses, even low-floor models, rarely offer the same level of comfort and convenience. Furthermore, most modern trams have significantly wider aisles than buses, further facilitating access and comfortable circulation within the vehicle. The extra space, combined with the greater length of trams compared to buses, also allows for higher passenger capacities.
- ***"Greenness"****:* [self-powered battery dominant / hydrogen hybrid] trams produce no emissions in situ and therefore do not contribute to air pollution in the city. Trams are also generally much quieter than diesel buses, and therefore generate less in the way of noise pollution. Steel wheel / steel rail vehicles

create only 15% of the rolling resistance of tire-borne vehicles, substantially less energy is required for propulsion.

- ***Safety:*** running on rails [combined with driver alertness monitoring system (DAMS) controls] makes for a safer mode of transport compared to buses.[31]

The Community Streetcar Coalition conducted a study in 2015, describes multiple benefits of streetcars, including:

- New, short-distance trips that did not require a car
- Enhanced pedestrian mobility and increased pedestrian activity
- Connectivity with the regional transport network and
- Robust private investments in walkable urban development along streetcar routes.

Also asserted in their study report is the need to consider the streetcar as:

…an element of the local transport network, it is not a stand- alone infrastructure decision. There is a broader context where people-moving and place-making potential should be optimized, with the assistance of the streetcar. Communities should look broadly to define a streetcar district that is appropriately scaled with the following factors:

- Definable, manageable boundaries
- Route visibility and clarity
- Stop spacing for efficient operations and easy access for riders
- Multiple options for internal connectivity and links to the larger transport network
- A mix of pedestrian attractors and producers with a supporting sidewalk network
- Appropriate land use and zoning provisions to allow intense and dense mixed uses
- Require appropriate orientation toward sidewalks, and, where possible, direct integration with the streetcar
- Walkable sub-areas
- Opportunities for redevelopment and joint development
- Potential implementation by public-private partnerships.

The combination of these features and elements allows the streetcar to help complete the ‘last mile of longer transit trips’ and also to avoid short auto trips that can be completely avoided because of a well-designed walking environment and transit – the so-called “trip not taken.” These twin mobility benefits are integral features of a more walkable, livable downtown or streetcar district, and the streetcar’s urban integration and frequent access points are essential to delivering its economic development benefits. A complementary result is making a meaningful dent in auto traffic congestion.[32]

2.6.2 Economic Development Benefits

Economic development refers to progress toward a community’s economic goals such as increased employment, income, productivity, property values, and tax revenues. Economic development can be

affected in various ways by transport policy and planning decisions, including some that are indirect and long-term.[33]

Transport plays a critical role in facilitating competitiveness in post-industrial economies. High quality transport services and infrastructure enhance internal and external connectivity. Streetcar [urban light rail] investment can help regenerate Central Business Districts and boost employment and property prices.

- Light rail can have positive economic impacts on cities, but location matters.
- Light rail systems improve accessibility, and usually increase land and property values.
- Economic impacts of light rail are enhanced if coordinated with land use planning.
- Light rail can help cities attract inward investment.[34]

See *Section 12* for further details regarding how the addition of a streetcar network will benefit Riverside communities.

From *The Suburban City* web site:

> Portland's streetcar illustrated the impact that investing in urban cores with reliable, comfortable, safe public transportation can do. In 2007, The New York Times reported that the Portland Streetcar "has helped sweep in $2.4 billion in new commercial and housing development, with 7,248 new housing units," a huge return on the original $100 million dollar investment raised through local taxes to build it. Since then, dozens of cities across America have constructed or are in the planning stages for streetcars and light-rail, hoping to reap similar benefits. Streetcars, such as the Portland Streetcar, spur denser development in urban areas, often as in-fill development that makes use of abandoned or dilapidated spaces within developed urban areas. This development results in jobs created in the surrounding area, increases property values, and increases ridership of all other means of public transportation as well. Cities are also using streetcars and improved public transportation systems to attract young adults; "young creatives," "Millennials," "Gen-Y's," or whatever else the newest generation to enter the workforce is being referred to have the lowest number of licensed drivers, lowest rates of driving, and are the largest group of increased public transit ridership. [35]

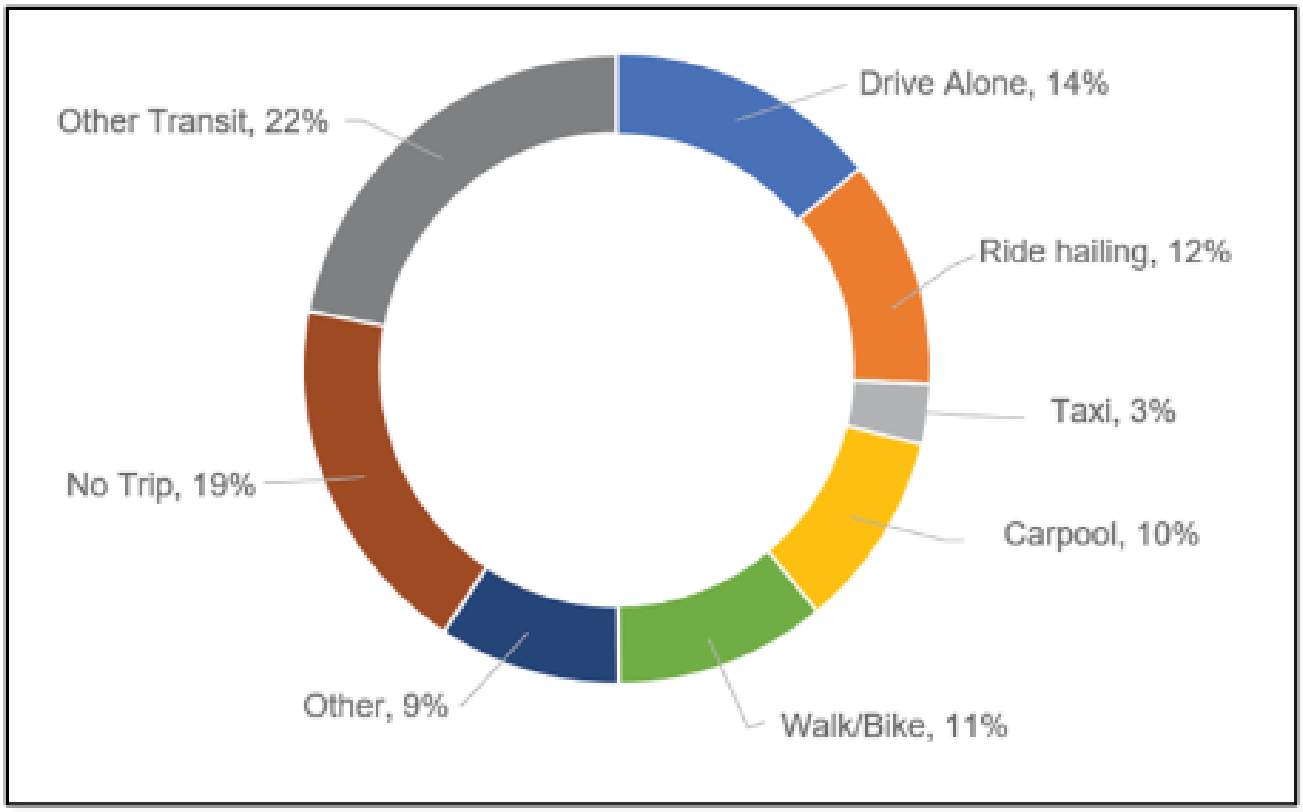
2.6.3 Environmental Benefits

A shift from single passenger automobile traffic to multi-modal public transit options means a considerable reduction in traffic. VMT reduction leads to:

- Reduced gasoline and diesel consumption
- Reduced airborne pollution from tailpipe emissions and tire wear
- Reduced audio pollution: fewer cars on the roads leads to less car noise.
- Installing and implementing a self-powered, battery dominant, hydrogen-supplement and zero-emission vehicle fleet would:
- Eliminate visual pollution from overhead wires and/or opportunity charging power structures inherent in streetcar systems that are wayside power dependent.
- Reduce overall power consumption required to operate the fleet.

See ***Section 12.7.3*** for additional details of pollution reduction as a community benefit.

Figure 2-5, *U.S. Transit Survey Mode Shift Profile, 2020*



Source: *TCRP—An Update on Public Transportation's Impacts on Greenhouse Gas Emissions.*[36]

In its Alstom-sponsored study comparing the CO_2 emissions of BRT and Tramway systems over a 30-year lifecycle, Carbone 4, an independent consulting firm in Paris, France, shows that:

- A diesel BRT's lifetime emissions are more than twice than those of a tramway system
- A plug-in hybrid BRT's emission totals are approximately 30% higher than those of a tramway system, also using more electricity than a tramway with similar capacity [see note regarding rolling resistance, below]
- A fully-electric BRT system's emissions are 17% higher than those of a tramway system, due to fleet size requirements being greater to accommodate demand.[37]

Non-Tailpipe Pollution Reduction

Non-exhaust emission—that from tire, brake, and road surface wear—is recognized as significant source of ambient concentrations of toxic airborne particulate matter. [38]

Emissions Analytics, an independent global testing and data specialist for the scientific measurement of real-world emissions for passenger and commercial vehicles as well as non-road mobile machinery, finds that pollution from tire wear, which is still unregulated, can be 1,000 times worse than exhaust emissions.[39]

Energy Consumption Reduction

Rail-borne streetcar wheels have 15% of the rolling resistance of tires, greatly reducing friction during propulsion, which translates to a proportional reduction in energy consumption.

2.6.4 Community Benefits

Transport Equity: Social Inclusion Rather than Social Exclusion

The impact of transport on wellbeing is also connected to the impact of transport on equality. Public transport is an integral component of the wider picture of socio-economic equality and egalitarianism. The main way that streetcar public transport and equality are linked is through providing affordable, comfortable, and pleasant access to a wide range of destination opportunities. These not only include access to education, training, and employment opportunities, but also family and social networks, housing, recreation and amenities, community engagement activities, and key goods and services. Transport policy can perhaps have the most potential for benefit when it is incorporated into a wider equality, cohesion, and regeneration strategy.[40]

2.7 Potential Markets Served by a Streetcar System

Toward the goal of encouraging change in the accustomed mode of single passenger automobile travel to a successful multi-modal transit system, it helps to review the potential markets that could be well served by a streetcar network in Riverside. Among them are:

- Commuters who live within Riverside and outside the city can make good use of a streetcar network to commute to and from their workplaces. Residents who live within the ten-minute pedestrian catchment will have the option to leave their cars at home (adding significant savings in car fuel and maintenance costs) and hop on a comfortable streetcar to go to work and come home. Multiple vehicles with a reliable 8-minute headway means the high level of predictability of how to schedule when to leave the house in order to catch a streetcar.
- Those who come into Riverside on the Metrolink could hop on a streetcar, which will be scheduled to meet them when their train arrives at the station, and either take streetcars directly to their workplace or transfer to one of many busses onto which they could board at a station from which they alight the streetcar.
- Commuters driving into the city can park on the outskirts, leave their car in a Park-and-Ride (P&R) lot, and have the freedom from searching for and paying for parking within the city.
- Both residential and non-residential students of UCR, Riverside City College, Central Middle School on Magnolia, and other educational institutions within Riverside.
- Retail businesses and shoppers along University Avenue, in the Downtown District, the Galleria at Tyler, as wells as all other retail business within a five- or ten-minute walk from any transit stop along the conceptual alignments.
- Riverside Downtown Business Improvement District, with its objective to create an environment to support downtown Riverside as a regional destination for economic, arts, cultural, and residential uses.
- Technology Innovation District, a district in development intended to attract and retain institutions and businesses that focus on technology and environmental research, remediation, and product innovation. The California Air Research Board is already installing a facility in Riverside.
- Hospitals and medical offices, including but not limited to Kaiser Permanente on Magnolia, Parkview Community Hospital Medical Center on Magnolia, Pacific Grove Hospital on Brockton and Maplewood, Riverside Community Hospital 14th and Market, Riverside Family Physicians on Orange Street at 13th Street.

- Riverside Convention Center would benefit from a streetcar that stops at the convention center, which could easily transport visitors around the city to shops and other points of interest. Additionally, a streetcar could transport visitors to and from the Metrolink station. The cluster of hotels in its vicinity including the historic Mission Inn Hotel would all be within a five-minute walk from the streetcar station. Visitors and tourists could avail themselves of the convenience and comfort of a streetcar, boarding and alighting at stations near places of interest all along the finalized network from UCR to Downtown to the Galleria at Tyler.

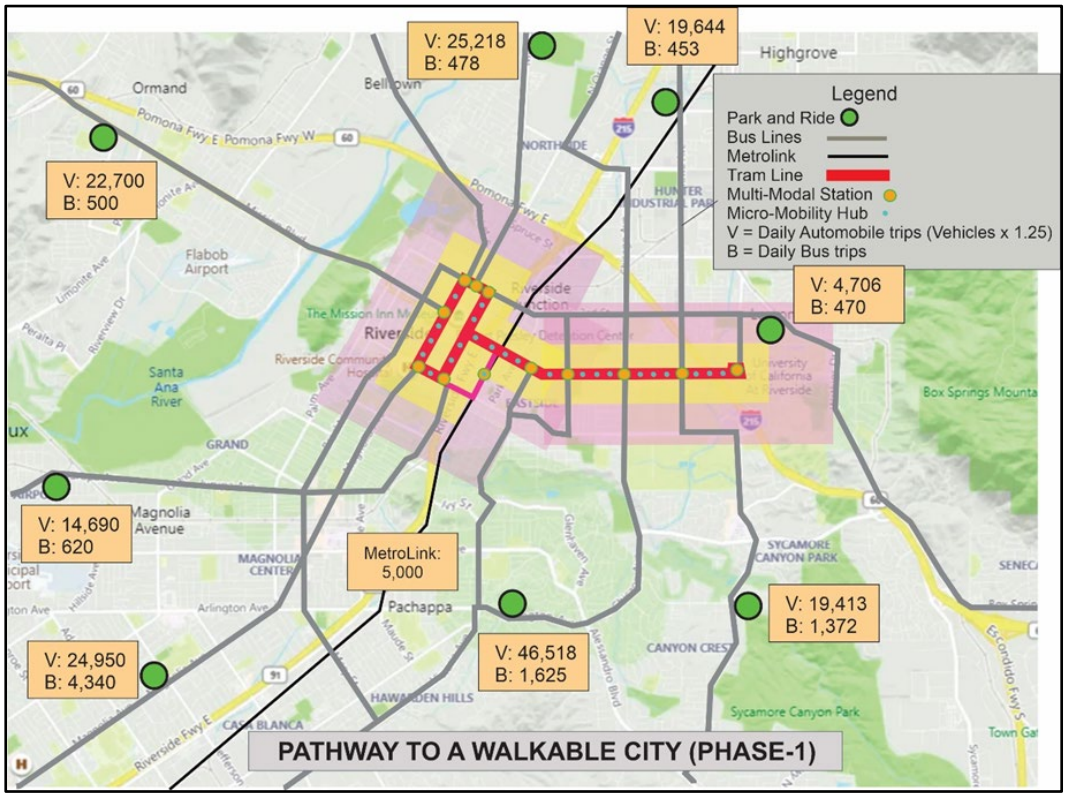
2.8 Sustainable Multi-Modal Transit: A Pathway to a Walkable City

Sustainability is defined as the capacity to endure in a relatively ongoing way across various domains of life, including social, economic, and environmental domains.[41]

A city's walkability improves with easy access to active multi-modal public transit. The wider the variety of available transit opportunities, the likelier it is that people will start and/or finish their trips around a city on foot. These local trips may originate from Riverside homes, from available parking facilities on the city's perimeter, or via incoming Metrolink passenger rail. All of these options, when utilized, reduce the number of vehicles and VMT.

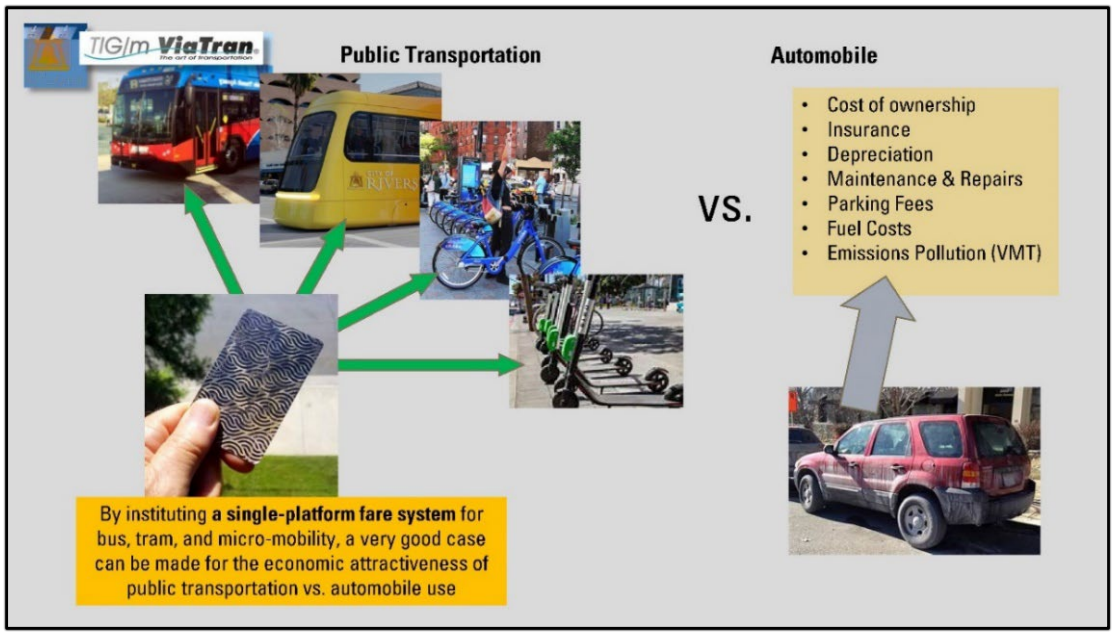
Figure 2-6, below, shows a map of Riverside with TIG/m's conceptual Phase 1 streetcar alignment, five-minute pedestrian catchment within an eight-minute micro-mobility catchment to transit stops (all placed 1,300 feet apart). This, in addition to the streetcar stops at Metrolink stations, solves the "first and last mile" problem.

***Figure 2-6**, Riverside: Pathway to a Walkable City, Phase 1*



Single-Platform Fare System

Figure 2-7, *Public Transportation vs. Personal Automobile*



2.9 Study Methodology

The subject of this study is a street-running electric railway system (commonly known as a streetcar system) to be considered for the Downtown area of Riverside, California. The project has been dubbed the Riverside Streetcar System for the purposes of this conceptual effort.

The study requires a certain level of conceptual design in order to quantify the project in units that can be used to provide insight into the technical and economic feasibility of the project.

As applicable to Riverside's growth plans and strategies, a study was a necessary component in determining the economic and practical feasibility of:

- Adding a TIG/m designed and built streetcar network as well as a depot/maintenance facility within the City of Riverside
- Incorporating a streetcar network into a well-functioning and serviceable multi-modal and more sustainable city-wide transit system

2.9.1 Study Report Scope and Structure

This report is organized as follows, which will summarize the scope of the study as contracted:

- ***Section 1, Feasibility Study Executive Summary*****:** a concise summary of each section presented in the Report.
- ***Section 2, Introduction****:* describes a brief overview of the study and lists key participants and stakeholders, funding for the study documented in this report, and repot deliverables

- ***Section 3, Existing Conditions:*** describes the existing conditions in the study area corridor that would affect the planning and the implementation of a streetcar system
- ***Section 4, Travel Market Analysis***: presents a discussion of current and historic travel behaviors in Riverside
- ***Section 5, Conceptual Alignment Design:*** defines components of the installation of streetcar infrastructure in five phases, conceptualized to be implemented over time
- ***Section 6, Operations Plan:*** provides an example of an operations plan with duty cycle calculations and theoretical capacity, as well as recommended vehicle fleet size and scalability, scheduling, personnel requirements.
- ***Section 7, Ridership Forecast:*** projects ridership estimates for the streetcar network
- ***Section 8, TIG/m ViaTran® Streetcar Vehicles****:* describes TIG/m streetcar vehicles that are suitable for the project, per ongoing discussion with Riverside's City Planning and Manager's Offices.
- ***Section 9, Capital Cost Estimates:*** provides an order-of-magnitude estimate of the initial capital costs for the streetcar project, focusing on the Phase 1 estimates
- ***Section 10, Operations and Maintenance Cost Estimates:*** provides an order-of-magnitude estimate of the operations and maintenance costs for the streetcar project, focusing on Phase 1 estimates
- ***Section 11, Project Cost Model:*** shows the project expenditures and revenues over three years of construction and 20 years of operations.
- ***Section 12: Cost / Benefit:*** examines qualitative benefits as well as those quantifiable, such as value capture and value added, and compares the costs of self-powered system to those of wayside power-dependent streetcar systems.
- ***Section 13: Next Steps:*** discusses future activities, as well as project funding sources and strategies***.***
- ***Section 14: Endnotes and Bibliographical/Web Site References***

Appendix A: U.S. Census Quick Facts for Riverside, California
Appendix B: Maps: Land Use by TAZ
Appendix C: Traffic Counts
Appendix D: Community Survey Questionnaire
Appendix E: Civil Engineering Schematic Drawings
Appendix F: Track Construction Quantities
Appendix G: Turnouts and Crossings
Appendix H: Utilities Relocation
Appendix I: Estimated Cost Savings
Appendix J: Park and Ride Concept
Appendix K: Average Ridership Comparisons
Appendix L: Trip Distribution Graphics
Appendix M: STOPS Model

Appendix N: Modified Trackforms: Removable Panelized Track Sections

Appendix O: Project Cost Model

Appendix P: Riverside Streetcar Project Conceptual Schedule

Appendix Q: MFC Statement

Appendix R: Phase Concept

Appendix S: TIG/m Projects and References

2.9.2 Project History: Initial Introduction, Presentations, and Discussions

TIG/m was introduced to Riverside City Management in 2016. In 2019, TIG/m made a presentation to Riverside's City Council. After driving the main streets of Riverside with Previous Mayor Rusty Bailey, TIG/m started with sketches on large print-outs of East and West Riverside. These initial ideas were presented to the stakeholders, through on-line presentations to generate and consider comments. Each iteration of design, in response to comments, was incorporated into a new presentation, until we reached a consensus among stakeholders. The result of this iterative process was a concept in five phases. The cost models included in this report will concentrate on Phase 1 of this concept. Please refer to ***Appendix R*** which includes detailed descriptions of different route options established with the initial conceptual Phase 1 alignment and those to be built in each successive phase.

Working in conjunction with City Staff and interested groups in design charrettes, TIG/m developed a phase-able alignment concept. TIG/m civil engineers brought the entire alignment up to the level of schematic design (geometrically able to support engineered track) in order to assess the buildability of the trackwork in the existing streets and to provide a basis for accurate estimation of construction costs using unit quantities. Close liaison with City Managers, Planners, and Engineers informs this design process with all available current data relative to rights of way, traffic controls, as well as at-grade and sub-grade utilities.

2.9.3 Study Funding and Guidance

Following the submission of ***TIG/m, LLC's The Riverside Streetcar: Proposal for Feasibility Study with Conceptual Design (RMV-0-10-PPL-160)*** in December 2020, the City of Riverside contracted TIG/m, funding the study as proposed.

During the study TIG/m met (mostly via online meetings) with key representatives Riverside County and City government and transportation agencies, the Railway Safety Division of the California Public Utilities Commission, as well as with local stakeholders, as listed in *Section 2.10.*

The purpose of these meetings was to:

- Introduce TIG/m to the stakeholders
- Describe the scope, objectives, and structure of the feasibility study
- Present design and operations concepts
- Receive feedback and guidance from agencies and other stakeholders to redefine potential streetcar network phases and track alignments
- Organize public outreach programs and survey questionnaires
- Develop a study report that addresses stakeholder's concerns.

2.10 Involved Parties and Stakeholders

TIG/m has been engaged by the City of Riverside to study the feasibility of building its state-of-the-art self-powered electric/hydrogen streetcar system and establishing a world headquarters for transportation technology research and development, with an associated manufacturing facility.

In order to establish feasibility of installing and operating a fleet of streetcars on a multi-line network—envisioned to connect several areas of the City of Riverside to the Riverside Metrolink Station—along with a stabling and maintenance depot, with an option for a vehicle manufacturing facility, TIG/m will, in this Feasibility Study Report:

- Describe and summarize results of analysis and evaluations conducted
- Propose a detailed overview of a solution and/or alternative solutions
- Present conclusions and recommendations.

This study report is intended to lead to broader and also more specific discussions with stakeholders. If the City of Riverside advances to a design phase, several meetings would be conducted with interface between designers, public works and planning officials, transportation agencies, etc., to reach an agreed-upon approach to the satisfaction of the stakeholders.

In addition to TIG/m, LLC, as Feasibility Study Report preparer as well as prospective vehicle supplier and local manufacturer, the following entities provided a wealth of necessary and valuable input to the study and this report:

2.10.1 City, County, and State Government Agencies

- **Riverside County Transportation Commission (RCTC)** improves highways and public transportation in Riverside County with strategic projects. It also provides funds for city transit in Corona and Riverside and is one of Metrolink's five governing agencies.[42]
- **Riverside Transit Agency (RTA)** is the Consolidated Transportation Service Agency for western Riverside County and is responsible for coordinating bus and shuttle services throughout an approximate 2,500 square mile service area covering several cities in the county.[43]
- **City of Riverside Transportation Board (RTB),** within the Riverside City Clerk Office, comprises nine permanent members who act in an advisory capacity to the Mayor and City Council in matters pertaining to public parking and the operation and management of the City streets systems and recommend traffic regulations.[44]
- **California Public Utilities Commission (CPUC)** is the statewide safety regulatory body for all rail systems.[45] General orders establish minimum standards for design elements and considerations, such as:
  - Right-of-way clearances
  - Guideway and track systems
  - Power systems
  - Signage and signaling
  - Emergency safeguards and
  - Vehicular and pedestrian crossings, where applicable.

2.10.2 Chambers of Commerce

- Greater Riverside Chamber of Commerce
- Greater Riverside Hispanic Chamber of Commerce
- Riverside County Black Chamber of Commerce

2.10.3 Education & Research Institutions, Community Groups, and Associations

- Arlington South Neighborhood Group
- Center for Environmental Research & Technology at UCR (CE-CERT)
- City Neighborhood Team
- Community Settlement Association
- Downtown Area Neighborhood Alliance (DANA)
- Eastside Neighborhood Forum / Lincoln Park Community Group
- La Sierra Arlanza Neighborhood Association
- Latino Network
- Magnolia Area Neighborhood Alliance (MANA)
- Neighbor to Neighbor
- Neighbors Better Together
- Neighbors of the Wood Streets (NOWS)
- Northside Improvement Association
- Riverside Community College (RCC)
- Riverside Community Health Foundation
- Riverside Community Hospital
- Riverside Convention Center
- Riverside Downtown Partnership (Business Improvement District)
- Riverside Neighborhood Partnership
- The Group / African American Historical Association
- Transportation Now (T-Now)
- University of California Riverside (UCR)
- University Neighborhood Association / Friends of Riverside's Hills
- Western Riverside Council of Governments (WRCOG).

2.10.4 TIG/m Personnel

The following TIG/m personnel contributed to this study and report:

- Brad Read — Senior Infrastructure and Rolling Stock Designer
- David Hall — Chief Financial Officer
- Polly Chellew — Project Manager
- Julia Wahnsiedler — Lead Technical Writer

- Dalia Cordoba — Civil Engineer
- Thomas Martinez — Infrastructure Designer
- Brent Lottman — Technical Draftsperson
- Mauricio Lopez — Graphic Illustrator
- Martin Villa — Survey Coordinator

2.11 Community and Stakeholder Outreach

Socially-distanced community outreach was initiated in early 2021 as a series of online meetings with representatives of stakeholder groups, as well as community survey questionnaires that were made available online at https://www.riversideca.gov/streetcar, as well as printed copies that respondents could fill out.

A survey questionnaire was developed by TIG/m and reviewed with suggestions by representatives of the Public Works and City Manager's offices, then edited accordingly.

Riverside is hosting a web page https://www.riversideca.gov/streetcar, which redirects visitors to a TIG/m-managed page that includes the interactive survey in both English and Spanish, with an invitation to submit contact information should visitors wish to participate in charettes. A note suggesting a revisit to the site for study updates is included. Stakeholders were urged to forward the link and/or alert members of their communities to visit the site and participate in the survey.

An information table was set at the Main Street Mall to provide in-person information about the study and to disseminate survey questionnaires.

Outside the Main Street Mall

Printed versions of the surveys were placed in several commercial locations around the City of Riverside that are frequented by residents and visitors.

The photos shown left and right are of a survey kiosk and display set up inside Back to the Grind coffeehouse at 3575 University Avenue.

Additional survey kiosks were placed in the following locations:

- Starbucks: 3311 Market Street
- Coffee Bean & Tea Leaf: 3712 Mission Inn Avenue
- City Hall Cafeteria/Lobby: 3900 Main Street
- Starbucks: 1303 University Avenue

2.11.1 Public Feedback from Survey Questionnaires

Data gathered from survey questionnaires is described in ***Section 7: Ridership Forecast*** and the questionnaire in both English and Spanish are shown in ***Appendix D: Community Survey Questionnaire.***

2.11.1 Stakeholder Feedback

During the feasibility study, initial outreach Zoom meetings with stakeholders consisted of PowerPoint presentations with narration by Brad Read, President, followed by Q&A sessions. TIG/m. Responses were predominantly positive, with a general inclination towards anticipation of the city adding a high-tech transit system. information pertaining to this study, making note of stakeholders' concerns and suggestions, and updating conceptual design strategies where applicable and workable.

Councilmember Erin Edwards (Ward 1) inquired into the possibility of extending the alignment to include of the Riverside Convention Center. Discussions resulted in an adjustment in TIG/m's original preliminary alignment conceptual design to run adjacent to and serve the west and north-facing sides of the campus (Market and 3rd Streets). The Phase 1 alignment concept map was adjusted and now reflects this suggestion.

A representative City of Riverside Public Works Office identified lemon a better NS route as opposed to Lime, because it fronts municipal offices. The Phase 1 alignment concept map was adjusted and now reflects this suggestion.

2.12 Conclusions

Drawn from data examined and preliminary design exercises, conclusions were made as to the economic and constructable feasibility of a streetcar installation in Riverside. Recommendations, founded on TIG/m's experience and expertise, are offered to support informed decisions to be made by the city with regards to a project of this description.

2.13 Attributions

Several publications and web sites were researched and are referred to and quoted in this study. Quotes, citations, references, and attributions included in this study are not, unless otherwise specified, intended as endorsements for TIG/m's products or for-profit services, but rather are posited to substantiate assertions in its disquisition.

Section 3:
Existing Conditions

3 Existing Conditions

This section details existing conditions in the study area corridor that would affect the planning and implementation of a streetcar system, including but not limited to existing infrastructure (bridges and underpasses), utilities, right-of-way constraints (if any), parking, land use, and current traffic and public transit options. A careful survey of existing conditions, combined with the results of stakeholder workshops and surveys, will reveal factors that influence the cost and overall feasibility of the alignment for the Riverside Streetcar System.

At an early stage in this study, it was decided that the most effective first phase of a wide ranging fixed-guideway system for Riverside would be a circulatory pinched loop with easily defined destinations at each end. The most economically feasible area for this type of configuration is the East side, with Downtown at one end and UCR at the other. For this reason, the existing conditions review is limited to the area of Downtown and the East side.

3.1 Underpasses / Overpasses / Level Rail Crossings

For the purposes of this study, details of the conceptual Phase 1 alignment are examined. Structural features of the exiting roadway network on which the proposed Streetcar system would operate were examined. None were found to violate the streetcar vehicles “structure gauge”. That is, the physical dimension (vertical and horizontal) which is required for the vehicle to safely operate, including the “degraded mode structure gauge” (for example: due to the failure of a suspension system component, the vehicle is leaning in such a way as to extend beyond the normal physical limits of the “structure gauge”).

3.1.1 Underpasses

Extant highway and railway underpasses to be utilized on a portion of the conceptual streetcar alignments are described below.

On the west end of Downtown Riverside:

1. University Avenue, between Lime Street and Park Avenue, passes under:
   - Vine Street (City of Riverside)
   - Commerce Street. (City of Riverside)
   - Southern Pacific/Metrolink heavy rail (BNSF Railroad)
   - Santa Fe Avenue (City of Riverside
   - US-91 (Riverside Freeway) (Caltrans)

Figure 3-1, *University Avenue / SR-91 Underpasses, Arial View*

Source: Google Maps

Figure 3-2, *University Avenue / Retired Southern Pacific Underpass (WB)*

Source: Google Maps

Figure 3-3, *University Avenue / Commerce Street Underpass (WB)*

Source: Google Maps

Figure 3-4*, University Avenue / Railway Underpasses (WB)*

Source: Google Maps

Figure 3-5, *University Avenue / Santa Fe Street Overpass (WB)*

Source: Google Maps

Figure 3-6, *University Avenue / Vine Street Underpass (WB)*

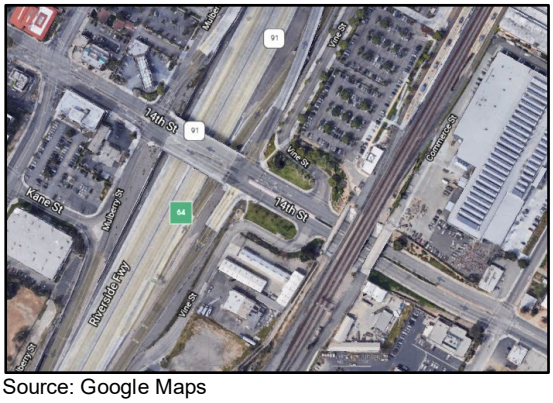
Source: Google Maps

Figure 3-7, *University Avenue / SR-91 Underpass (WB)*

Source: Google Maps

2. 14th Street, between Vine Street and Howard Avenue, passes under:
   - Commerce Street
   - BNSF heavy rail / Metrolink rail bridge.

Figure 3-8, *14th Street / SR-91 Overpass, Arial View*



Source: Google Maps

3. 3rd Street passes under SR-91

Figure 3-9, *3rd Street Underpass at SR-91 (WB)*

Source: Google Maps

On the east end of Riverside, near UCR:
University Avenue, between Iowa Avenue and West Campus Drive, passes under:

- I-215 / SR-60, with northbound exit off-ramp 32.

Figure 3-10, *University Ave / I-215 & SR-60 Underpass, Arial View*

Source: Google Maps

Figure 3-11, *University Avenue/ I-215 & SR-60 Underpass*

Source: Google Maps

3.1.2 Overpasses

In order to access the Vine Street Metrolink Station and proposed Vine Street Mobility Hub a streetcar alignment will need to utilize the 14th Street SR-91 Overpass. While this bridge is designed for loads far greater than the proposed streetcar, the application of the track structure to the existing bridge surface will require close coordination between the Track engineers and Caltrans.

1. On the west end of the Downtown Riverside, (Phase 1) 14th Street overpasses Highway SR-91, and the northbound exits 64 offramp to University Avenue.

***Figure 3-12,** 14th Street / SR-91 Overpass, Arial View*

Source: Google Maps

***Figure 3-13**, 14th Street / SR-91 Overpass*

WB on 14th Street

Source: Google Maps

NB View of 14th Street Overpass on SR-91

Source: Google Maps

3.1.3 Pedestrian Bridges

The conceptual streetcar alignments do not at this time pass under pedestrian bridges.

3.1.4 At-Grade Rail Crossing

The current at-grade Rail Crossing at 3rd Street is the site for the new 3rd Street Grade Separation project. A proposed Streetcar system would pass under the proposed railroad bridge, in the same manner as the underpasses identified above. No structure gauge issues are anticipated. What will be a required subject of study, if the Riverside Streetcar project goes forward, is the scheduling aspects of design and implementation of the 3rd Street Grade Separation. Design, and construction will need to be closely

coordinated as the proposed Operation and Maintenance Facility for the Streetcar would require use of this new underpass.

At the time of this study, 3rd Street, between Commerce Street and Vine Street crosses at grade the BNSF heavy-rail tracks used for Metrolink. 3rd Street is a major east/west arterial roadway in Riverside, comprising one through lane in each direction east of Market Street, which falls into the Phase 1 depot-access alignment in this study.

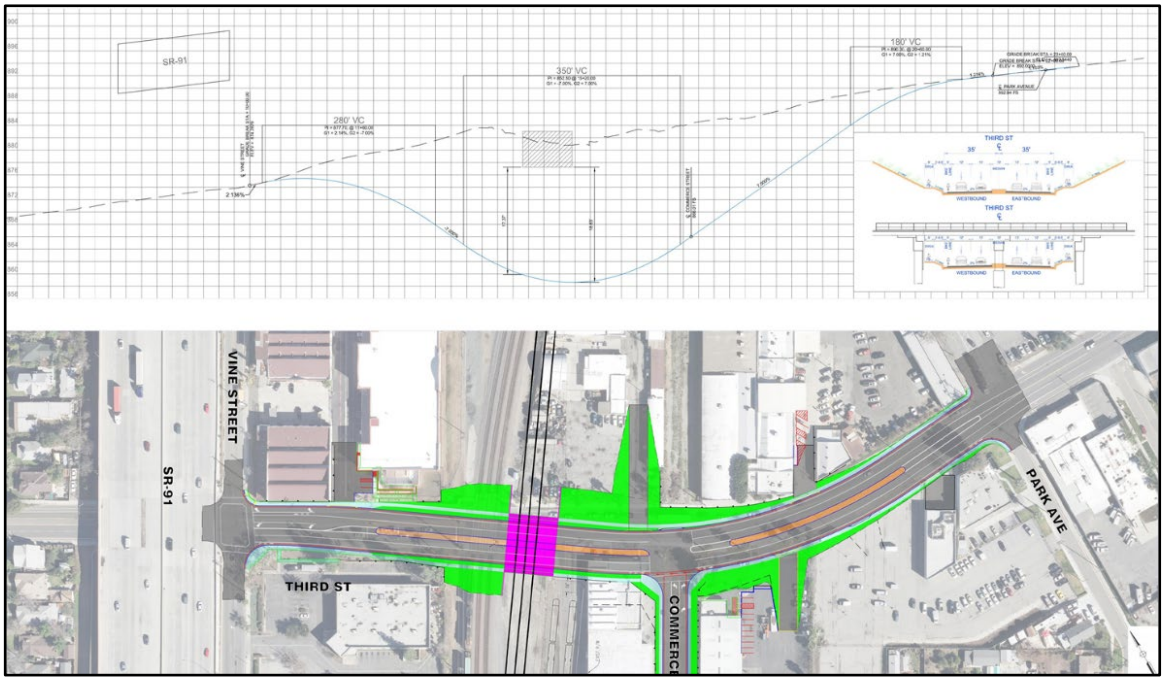
***Figure 3-14,** 3rd Street at BNSF Railway Line, Looking Southward*

Source: City of Riverside, Public Works Department. Third Street Grade Separation Project PPT.

The City of Riverside, in cooperation with BNSF, is proposing to replace the existing at-grade crossing with a grade separation 400' east of the intersection of Vine Street/3rd Street and the SR-91 Riverside Freeway. The Third Street Grade Separation project proposes to construct a railroad underpass at Third Street and the BNSF railroad tracks. Third Street will be lowered from about Vine Street to Park Avenue and a bridge will be constructed to convey rail traffic. The project will require the realignment of Commerce Street, construction of slopes, retaining walls, storm water pump station, and relocation of wet and dry utilities. While design concepts are not finalized, construction is anticipated to begin mid-2022 and last approximately 18 months. This would put the construction of the proposed Riverside Streetcar track in the right window for concurrent construction.[46]

Figure 3-15 shows a conceptual rail realignment and 3rd Street grade separation.

***Figure 3-15**, Future Realignment of BNSF Rail & 3rd Street Grade Separation*



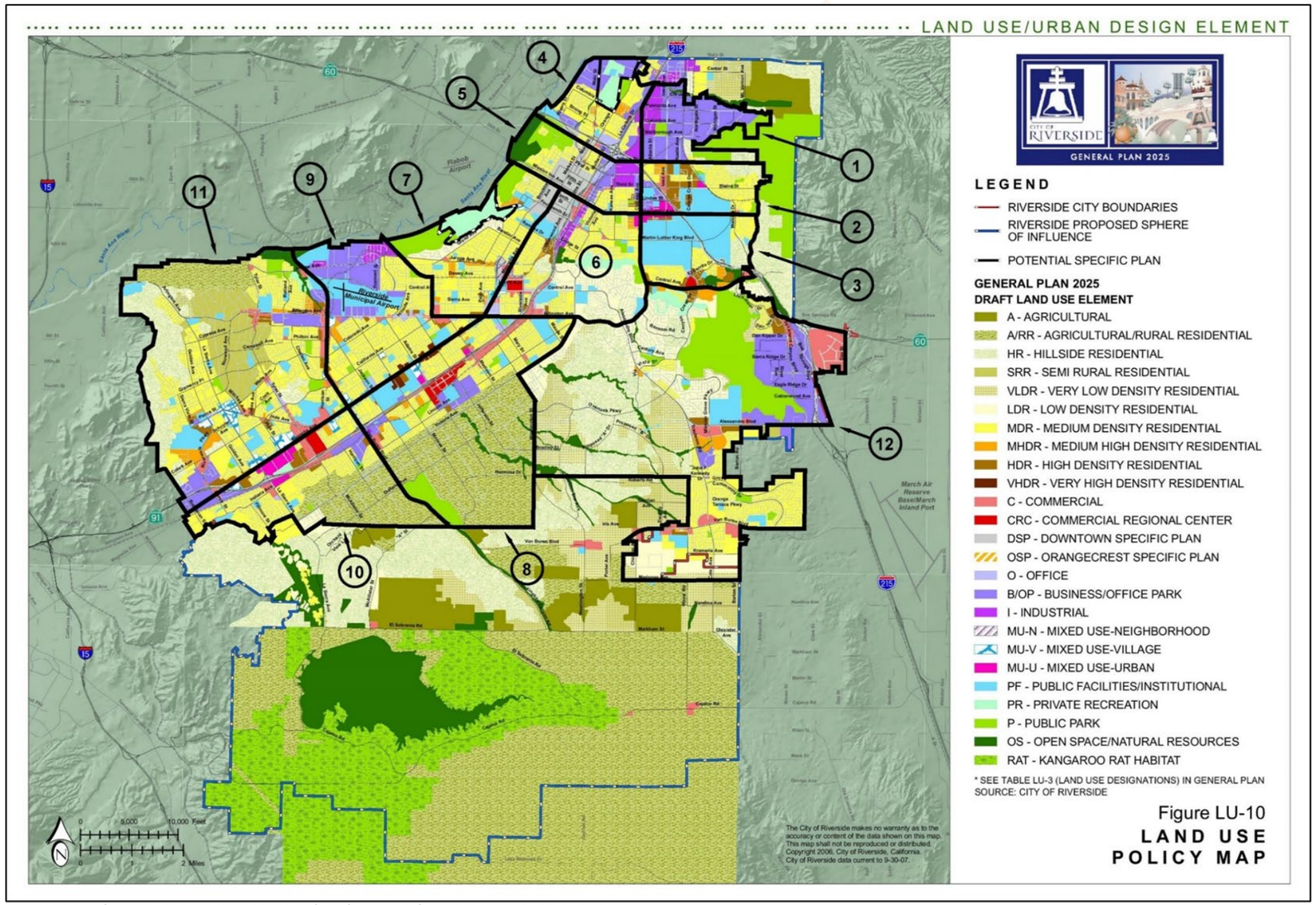
Source: City of Riverside, Public Works Department. Third Street Grade Separation Project PPT.

3.2 Land Use

Land Use in the study area for the Riverside Streetcar is mixed throughout with single family, multiple family, and commercial use in all areas of the City including the Downtown. This is ideal for the walking -oriented built environment required to support streetcar.

Figure 3-16 shows current land use in the Riverside area with transit analysis zones, assigned by TIG/m for this study, delineated. See also ***Appendix B: Land Use By TAZ*** for additional details.

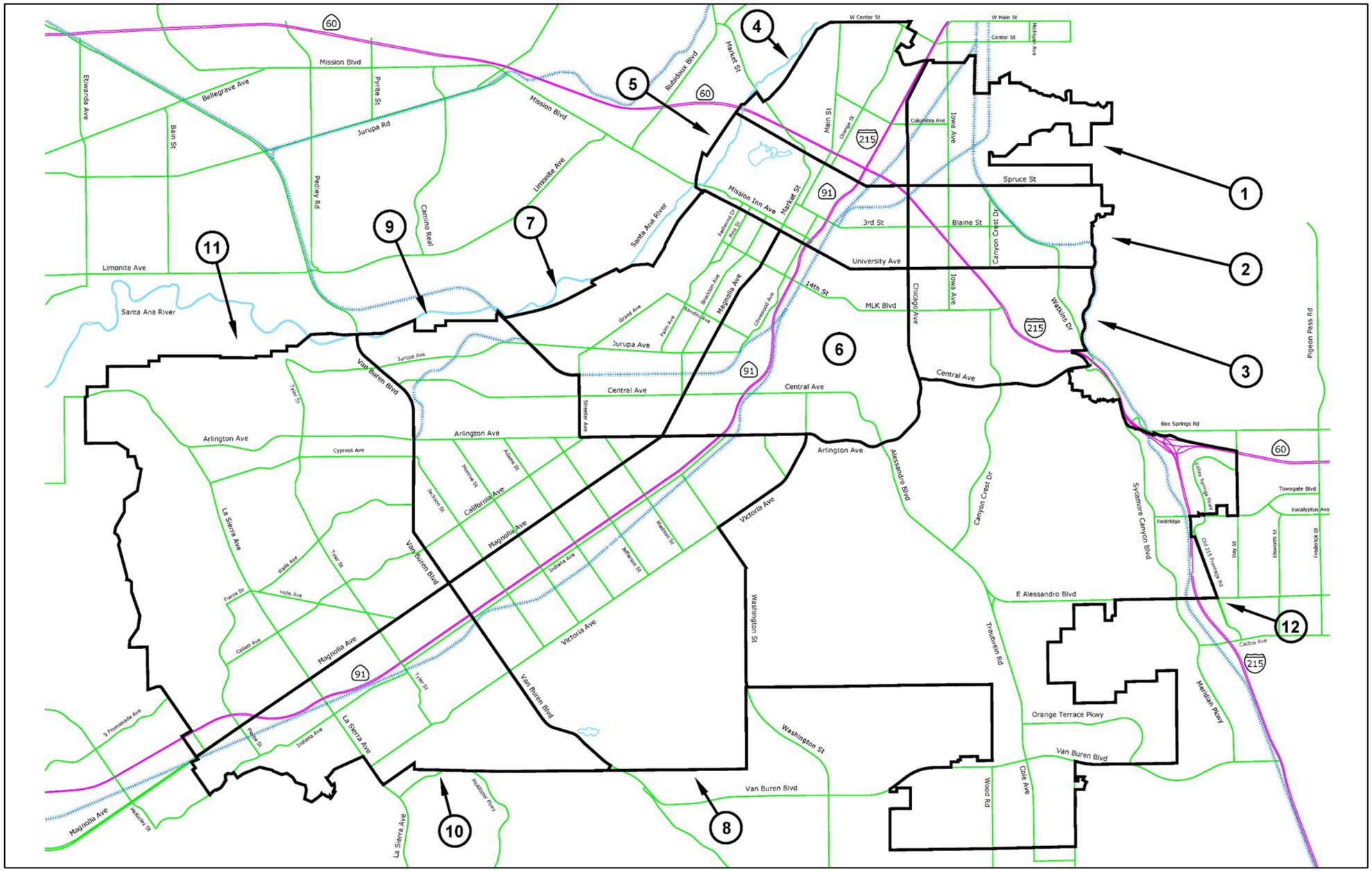
Figure 3-16, *Current Land Use in Riverside and Feasibility Study TAZs*



Land Use Map Source: Envision Riverside 2025. City of Riverside Strategic Plan – 2020 Edition. 47

Figure 3-17 shows the transit analysis zones overlaid on a street map of Riverside.

Figure 3-17, *TAZs: Map of Major Streets*



Source: Google Maps

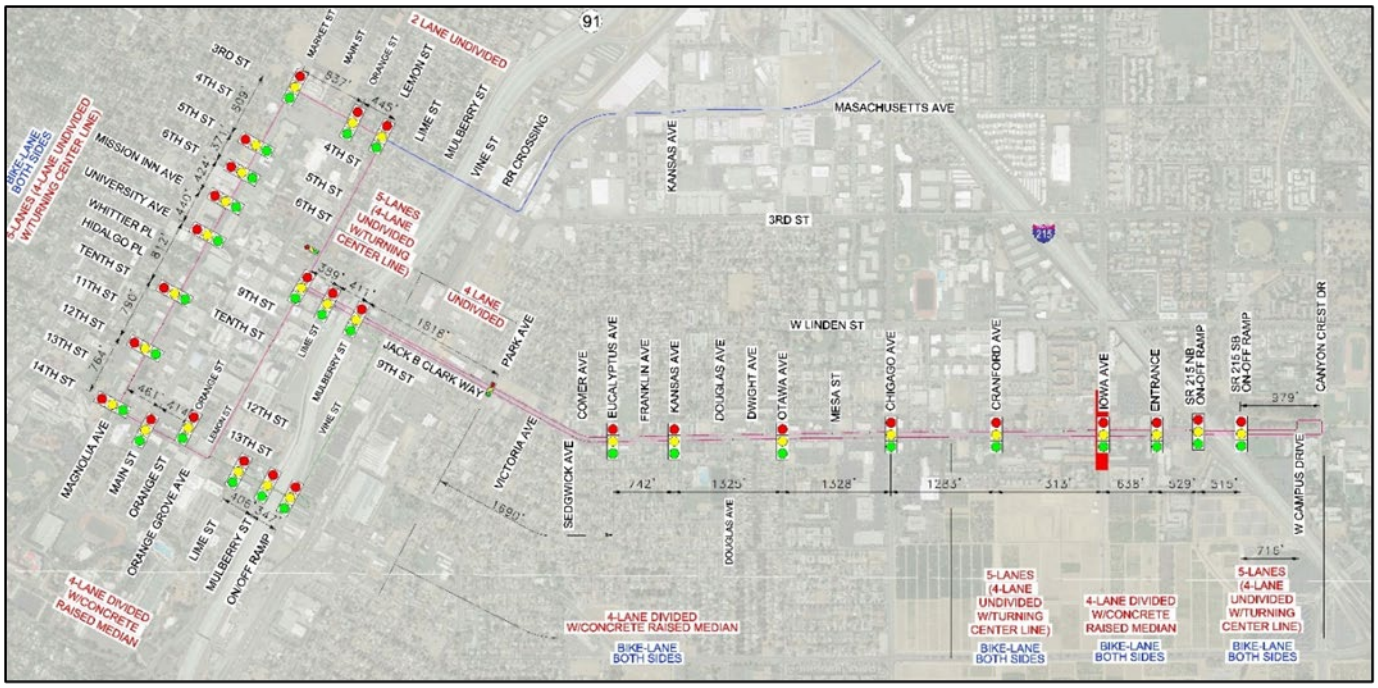
3.3 Traffic Operations

Currently the automobile is the predominant mode of transportation in Riverside with eastside aggregate daily ADT counts at several intersections along University Avenue registering above 20,000 vehicles. A street-running railway will need to work within this existing environment and will benefit from streetcar priority signalization. To view traffic ADT Tables and vehicle counts by TAZ map, please refer to ***Appendix C.***

3.3.1 Traffic Signals

Figure 3-18 shows known traffic signal locations along the conceptual Phase 1 alignment. Because the Riverside Streetcar System would be street running and share the roadway with other vehicular traffic, streetcar drivers would be required to follow the existing rules of the road as regards traffic signalization. A description of traffic signal priority pre-emption, as well as a discussion the benefits of the resulting "green wave", are found in ***Section 5*** of this report.

Figure 3-18, *Existing Traffic Signalization, Phase 1 Alignment*



3.3.2 On-Street Parking

Of the streets under consideration for the Phase 1 Streetcar alignment only Lemon, 3rd Street and Market Street currently allow On-Street Automobile Parking. Changes to the current street parking allowances will be a top-priority design collaboration between all affected stakeholders, the City, and TIG/m track engineers, should the project go forward. No on-street parking is currently allowed on University Avenue or on the southwest-bound curb lane of Vine Street.

- Lemon Street, between 6th Street and 3rd Street
- 3rd Street, between Lemon Street and Market Street
- Market Street, between 3rd Street and 14th Street.

Elimination of on-street parking, or its incorporation with the streetcar track alignment is to be considered during the design development stage of Phase 1.

No on-street parking is currently allowed on University Avenue or on the southwest-bound curb lane of Vine Street.

3.4 Current Transit Options

- Riverside Transit Agency (RTA) Busses
- RapidLink: Riverside Transit Agency (RTA) Gold Line service between UCR and Corona Transit Center serves 14 bus stops, reserved exclusively for Gold Line buses. Currently, RapidLink's stops that are closest to the Downtown Riverside Metrolink Station are at University/Lemon, Market/11th (westbound), and Market/12th (eastbound).
- Riverside Transit Agency (RTA) Special Transportation for Seniors and Disabled: a paratransit bus service that provides disabled residents and seniors rides to the mall, doctor's appointments, group events, senior centers or to visit friends.
- Metrolink & Amtrak Heavy Passenger Rail

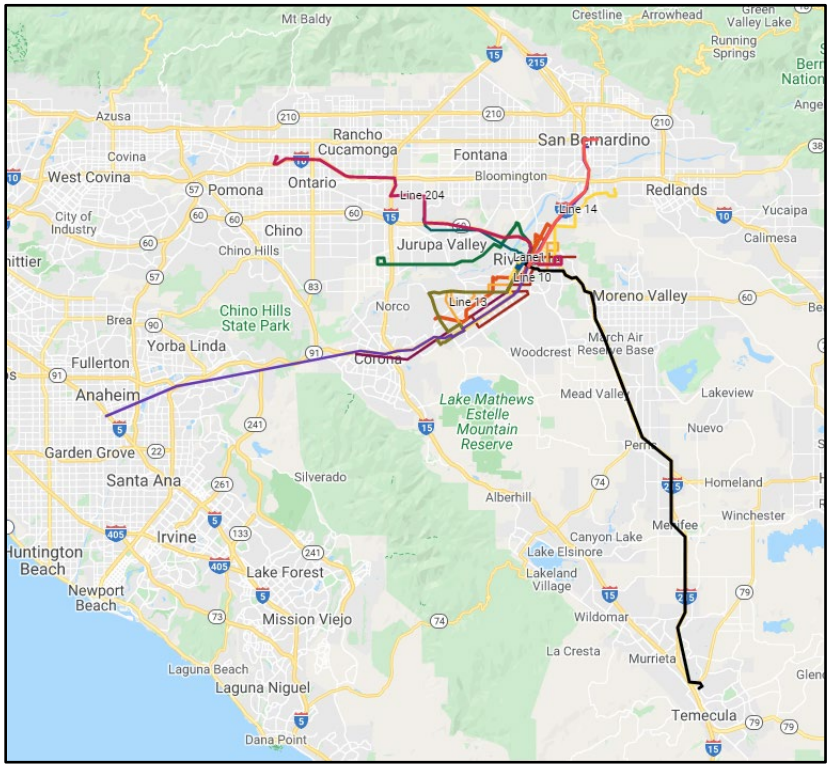
3.4.1 Bus Service

Current RTA bus lines circulating through downtown Riverside area are listed in ***Table 3-1.***

Table 3-1, *Current Bus Lines*

Line	Area Served
001	Corona/Downtown Riverside/Magnolia/UCR
010	Big Springs & Watkins to Galleria
012	La Cadena & Stephens to Merced & Magnolia
013	Hunter Park Metrolink/Galleria at Tyler
014	Galleria at Tyler/Indiana/VA Hospital
015	Downtown Riverside/Galleria at Tyler
029	Downtown Riverside/Hamner & Limonite
049	Country Village/Downtown Riverside
050	Downtown Riverside Jury Trolley
200	SB/Riverside/Orange County
204	Riverside/Country Village/Ontario/Montclair
208	Temecula/Murrieta/Sun City/Perris/Mo Valley/Riverside
215	Riverside/San Bernardino, via I-215

Figure 3-19, *Existing Riverside Bus Service Lines, Map*



Source: Google Maps

3.4.2 Existing Bus System Ridership

Table 3-2, *Riverside RTA Bus Ridership Summaries 2018 and 2019*

Year 2018

Line	Area Served	January	February	March	April	May	June	July/August	September	October	November	December	Year Totals
001	Corona/Magnolia/Downtown Riverside/UCR	151,110	152,465	162,442	156,314	163,912	143,840	133,504	156,290	190,605	160,873	135,846	1,707,201
010	Big Springs & Watkins to Galleria	12,461	13,154	14,227	13,058	14,858	12,949	10,537	14,575	16,063	13,656	12,562	148,100
012	La Cadena & Stephens to Merced & Magnolia	15,993	15,245	16,795	16,477	16,783	16,229	16,135	17,845	18,970	17,101	15,906	183,479
013	Hunter Park Metrolink/Galleria at Tyler	17,143	17,186	19,649	18,039	18,836	17,184	16,550	19,078	20,891	18,025	15,863	198,444
014	Galleria at Tyler/Indiana/VA Hospital	16,607	16,365	17,594	17,083	18,087	16,958	15,310	16,474	18,541	15,704	14,852	183,575
015	Downtown Riverside/Galleria at Tyler	36,282	36,107	41,165	38,676	41,309	35,330	33,483	42,813	48,072	40,618	34,905	428,760
029	Downtown Riverside/Hamner & Limonite	10,708	10,552	11,563	11,756	12,596	12,107	11,645	12,834	14,233	12,200	11,394	131,588
049	Country Village/Downtown Riverside	17,249	18,759	19,984	19,945	20,269	18,958	18,313	20,590	22,078	19,404	18,022	213,571
050	Downtown Riverside Jury Trolley	219	183	190	133	109	268	170	258	102	142	210	1,984
200	SB/Riverside/Orange County	6,745	11,388	13,329	13,904	14,727	15,112	14,430	15,617	17,805	16,740	15,232	155,029
204	Riverside/Country Village/Ontario/Montclair	3,504	3,595	3,542	3,934	4,037	3,183	2,539	2,903	4,758	3,958	2,688	38,641
208	Temecula/Murrieta/Sun City/Perris/Mo Valley/Riverside	2,995	2,996	3,019	3,281	2,280	2,416	2,215	2,037	3,549	2,857	1,870	29,515
215	Riverside/San Bernardino (via I-215) No Data												
	Monthly Totals	291,016	297,995	323,499	312,600	327,803	294,534	274,831	321,314	375,667	321,278	279,350	3,419,887

Year 2019

Line	Area Served	January	February	March	April	May	June	July/August	September	October	November	December	Year Totals
001	Corona/Magnolia/Downtown Riverside/UCR	149,988	142,819	155,086	163,649	163,081	137,028	134,269	152,840	182,791	151,885	52,106	1,585,542
010	Big Springs & Watkins to Galleria	13,892	12,358	13,590	14,905	14,193	11,699	10,097	13,881	15,209	12,577	2,942	135,343
012	La Cadena & Stephens to Merced & Magnolia	15,733	14,863	16,615	16,910	16,913	15,357	15,487	16,765	19,728	17,674	8,524	174,569
013	Hunter Park Metrolink/Galleria at Tyler	16,690	15,820	18,314	17,997	18,151	16,176	16,700	18,916	21,521	17,640	5,987	183,912
014	Galleria at Tyler/Indiana/VA Hospital	15,857	14,220	15,738	16,499	16,062	14,490	15,034	16,259	19,379	16,125	5,765	165,428
015	Downtown Riverside/Galleria at Tyler	36,647	35,129	40,564	40,467	41,711	35,116	34,727	40,668	43,004	34,635	11,188	393,856
029	Downtown Riverside/Hamner & Limonite	10,986	10,074	11,728	12,795	13,601	12,953	13,154	12,781	14,262	12,321	5,377	130,032
049	Country Village/Downtown Riverside	18,117	16,806	19,524	20,391	20,055	18,639	19,301	20,219	22,046	18,383	6,124	199,605
050	Downtown Riverside Jury Trolley	245	229	198	185	220	126	94	218	282	204	10	2,011
200	SB/Riverside/Orange County	16,050	15,168	17,623	18,374	19,020	18,120	17,898	18,303	20,732	18,212	4,017	183,517
204	Riverside/Country Village/Ontario/Montclair	3,674	3,320	3,182	3,948	4,109	2,756	2,935	2,766	4,643	3,741	988	36,062
208	Temecula/Murrieta/Sun City/Perris/Mo Valley/Riverside	3,393	3,479	3,100	3,712	3,665	2,451	2,752	2,872	4,738	3,635	433	34,230
215	Riverside/San Bernardino (via I-215) No Data												
	Monthly Totals	301,272	284,285	315,262	329,832	330,781	284,911	282,448	316,488	368,335	307,032	103,461	3,224,107

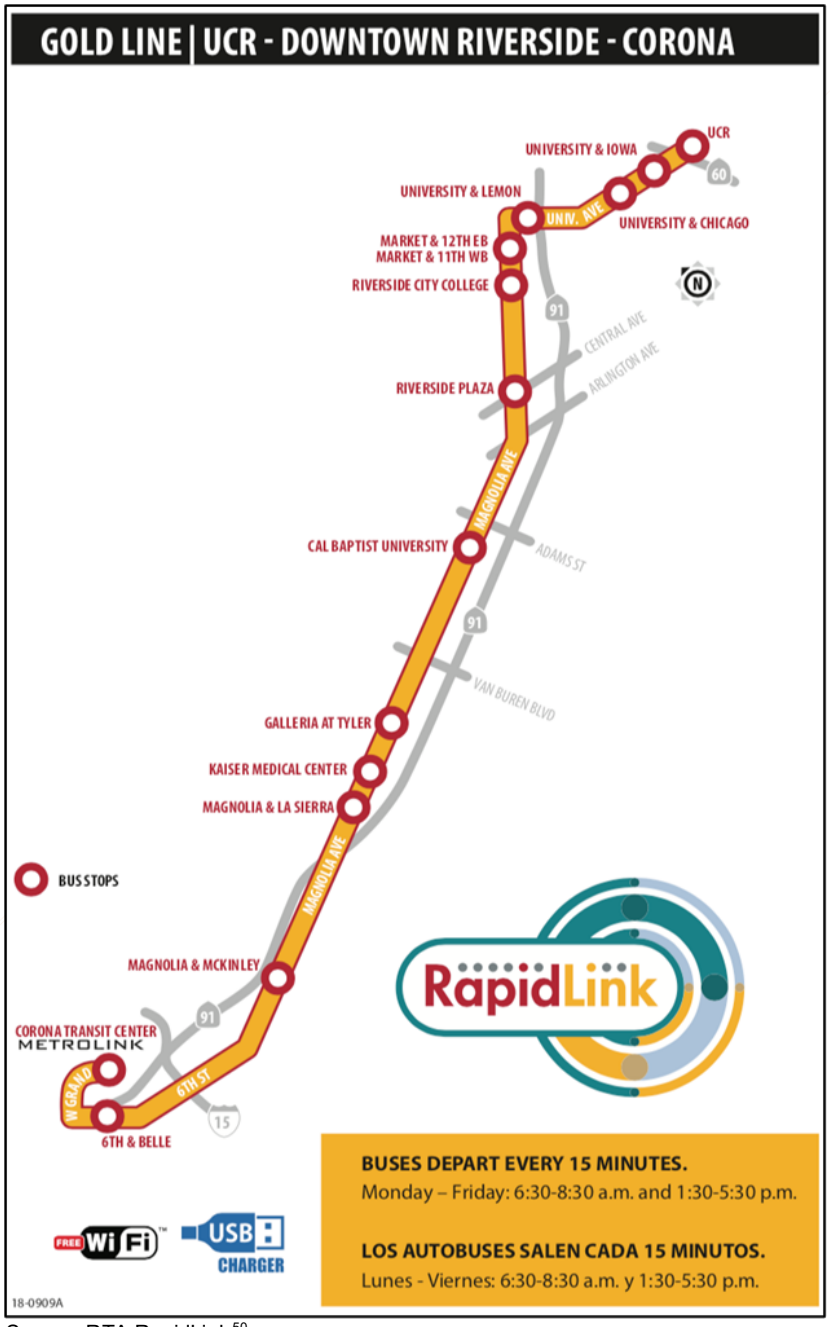
Source: Riverside Transit Agency, Month-End Ridership Summaries, 2018-2019 [48]

3.4.3 RapidLink

RTA operates the RapidLink Gold Line service between UCR and Corona Transit Center, which includes the Corona Metrolink Station, serves 14 bus stops, operating Monday – Friday, morning peak hours between 6:30-8:30 AM and afternoon hours between 1:30-5:30 PM. Busses are scheduled to arrive at each station every 15 minutes. RapidLink stations nearest to the Downtown Riverside Metrolink Station are located at:

- University and Lemon
- Market at 11th and 12th [49]

Figure 3-20, *RapidLink Route*



Source: RTA RapidLink [50]

3.4.4 Metrolink

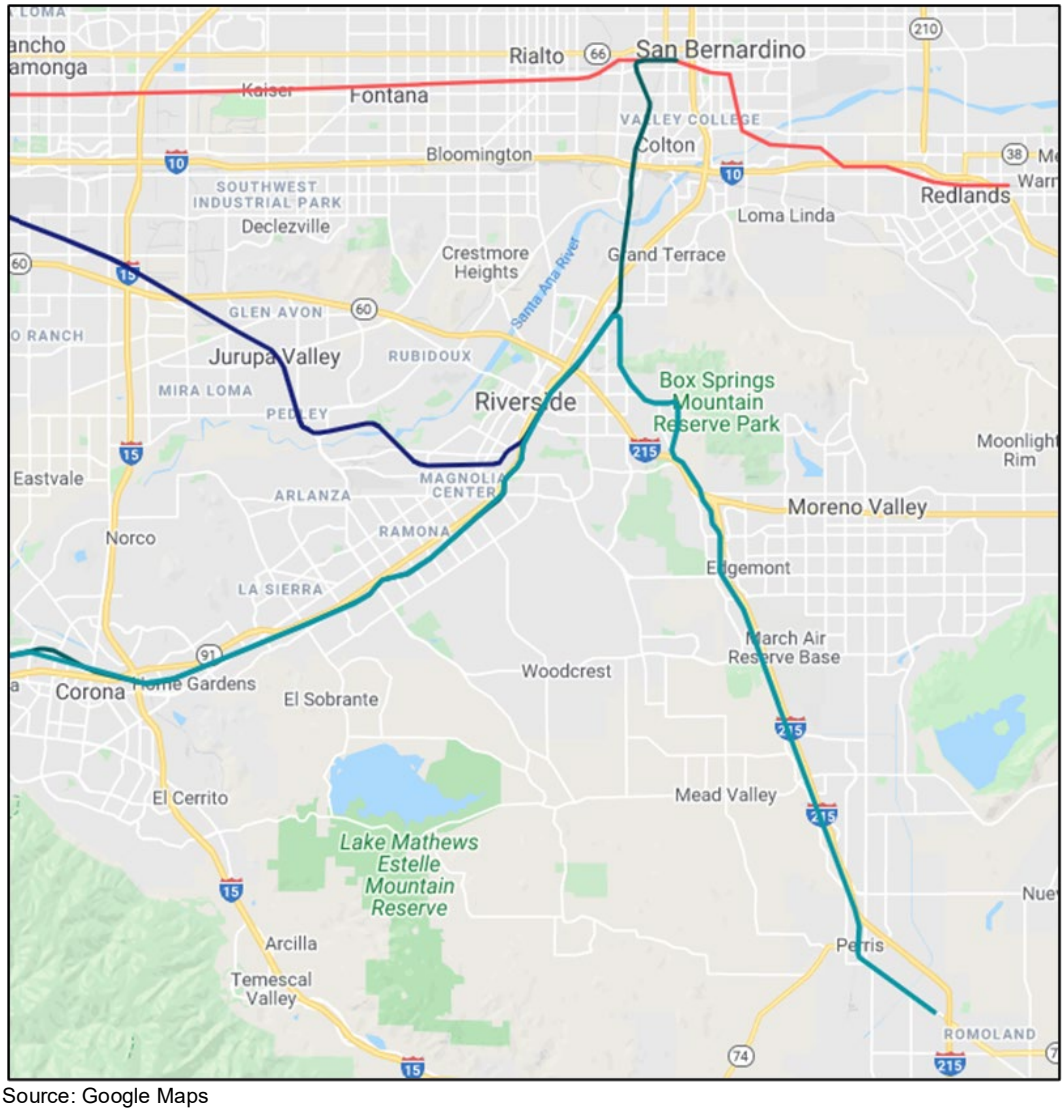
Metrolink maintains three train station/platforms in the Riverside area:

- Downtown Riverside, located on Vine Street, south of University Avenue and north of 14th Street
- Hunter Park / UCR Station, located on Marlborough Avenue, east of Iowa Avenue and west of Northgate Street
- La Sierra Station, located on Indiana Avenue at Grande Vista Parkway

Currently, three Metrolink lines travel through and stop at the Downtown Riverside Station, which is located on Vine Street, south of University Avenue and north of 14th Street (see ***Figure 3-21***).

- Metrolink 91 Line: Union Station – Riverside-Perris (via Fullerton)
- Metrolink Riverside Line: Union Station – Riverside – San Bernardino
- Inland Empire - Orange County Line.

Figure 3-21, *Metrolink Lines Through Riverside*



Source: Google Maps

Table 3-3, below, shows the train schedules for each line, indicating which line stop at the Downtown station.

Table 3-3, *Metrolink Schedule, To and From Riverside*

	Riverside Line	Perris Valley Line	Inland Empire-Orange County		Riverside Line	Perris Valley Line	Inland Empire-Orange County
	Downtown						
Days	Time Out				Time In		
M-F	4:35 AM	5:14 AM	4:53 AM		6:27 PM	7:15 AM	9:44 AM
	5:35 AM	5:54 AM	5:40 AM		6:58 PM	5:03 PM	10:29 AM
	6:35 AM	6:32 AM	6:16 AM		7:25 PM	5:48 PM	4:57 PM
	8:10 AM	7:14 AM	6:59 AM			6:28 PM	5:17 PM
			7:28 AM			6:58 PM	6:06 PM
			12:40 PM			8:25 PM	6:37 PM
			3:01 PM				8:05 PM
S&S		7:50 AM				4:42 PM	
		9:00 AM				8:39 PM	
	Hunter Park / UCR						
Days	Time Out					Time In	
M-F		5:02 AM				5:15 PM	
		5:42 AM				5:57 PM	
		6:20 AM				6:37 PM	
		7:14 AM				7:07 PM	
S&S		7:41 AM				4:59 PM	
		8:51 AM				8:57 PM	
	La Sierra						
Days	Time Out					Time In	
M-F		5:24 AM	5:06 AM			6:59 AM	9:21 AM
		6:02 AM	5:50 AM			4:50 PM	10:17 AM
		6:42 AM	6:27 AM			5:34 PM	4:35 PM
		7:24 AM	7:10 AM			6:14 PM	5:06 PM
			7:40 AM			6:44 PM	5:54 PM
			12:52 PM			8:04 PM	6:25 PM
			3:14 PM				7:44 PM
S&S		8:00 AM				4:29 PM	
		9:00 AM				8:26 PM	

3.5 Bicycle Facilities

The three types of bikeways identified by Caltrans in Chapter 1000 of the Highway Design Manual are as follows.

Class I Bikeway

Typically called a "bike path," a Class I bikeway provides bicycle travel on a paved right-of-way completely separated from any street or highway.

Class II Bikeway

Often referred to as a "bike lane," a Class II bikeway provides a striped and stenciled lane for one-way travel on a street or highway.

Class III Bikeway

Generally referred to as a "bike route", a Class III bikeway provides for shared use with motor vehicle traffic and is identified only by signage.

Class IV Bikeway

Class IV separated bikeways are on-street facilities reserved for use by bicyclists, with physical separation between the bikeway and vehicular travel lanes. Separated bikeways can be one-way facilities on both sides of the street or two-way facilities on one side of the street. Physical separation can include concrete curbs, landscaping, parking lanes, bollards, or other vertical elements. (There are no planned Class IV [on-street] protected bike facilities at present.)

3.5.1 Existing Bicycle Facilities

Currently, bicycles are permitted on all roads in the State of California and in Riverside (with the exception of access-controlled freeways). As such, Riverside's entire street network is effectively the city's bicycle network, regardless of whether or not a bikeway stripe, stencil, or sign is present on a given street. The designation of certain roads as Class II or III bicycle facilities is not intended to imply that these are the only roadways intended for bicycle use, or that bicyclists should not be riding on other streets. Rather, the designation of a network of Class II and III on-street bikeways recognizes that certain roadways are optimal bicycle routes, for reasons such as directness or access to significant destinations and allows the City of Riverside to then focus resources on building out this primary network.[51]

3.5.1.1 Bicycle Lanes

Several bicycle lanes and bicycle-friendly roads (without delineated bike-dedicated lanes) exist on the roadways in Riverside. Discussions of incorporating a streetcar network with bicycle lanes are appropriate to a design phase of project development. Several existing bike lanes will need to be coordinated with the streetcar guideway:

- University Avenue Class II Bike Lanes
- Market Street Class II Bike Lanes
- 3rd Street Class II Bike Lanes

3.5.1.2 Bicycle Support Facilities: Racks and Lockers

Riverside Municipal Code requires that, when parked, bicycles be locked and secured in a bicycle rack or receptacle for parking. [52]

3.6 Utilities

This section describes existing sub-grade utilities and relevant access points along the conceptual Phase 1 alignment. Sub-grade utilities include:

- Storm Drains
- Electrical (underground and overhead)
- Fiber Optic (underground and overhead)
- Water
- Gas
- Sewer

A detailed study of available city documents relative to sub-grade in-street utilities was undertaken to determine where utilities are placed in the streets in relation to the proposed streetcar alignment. Where active utilities run parallel to, and underneath, the proposed streetcar track slab, an estimate was produced for relocating those utilities. Additional coordination is required to identify the limits of all proposed utility relocations. Refer to ***Appendix H: Utilities Relocation*** for large-size Figures 3-22 to 24.

Where utilities are not directly beneath the proposed track slab or are running beneath the track slab at oblique angles, the TIG/m panelized trackform may be employed if deemed necessary during design development review of the utilities in coordination with City Staff and RPU.

Figure 3-22, *Utilities Identification - Downtown*

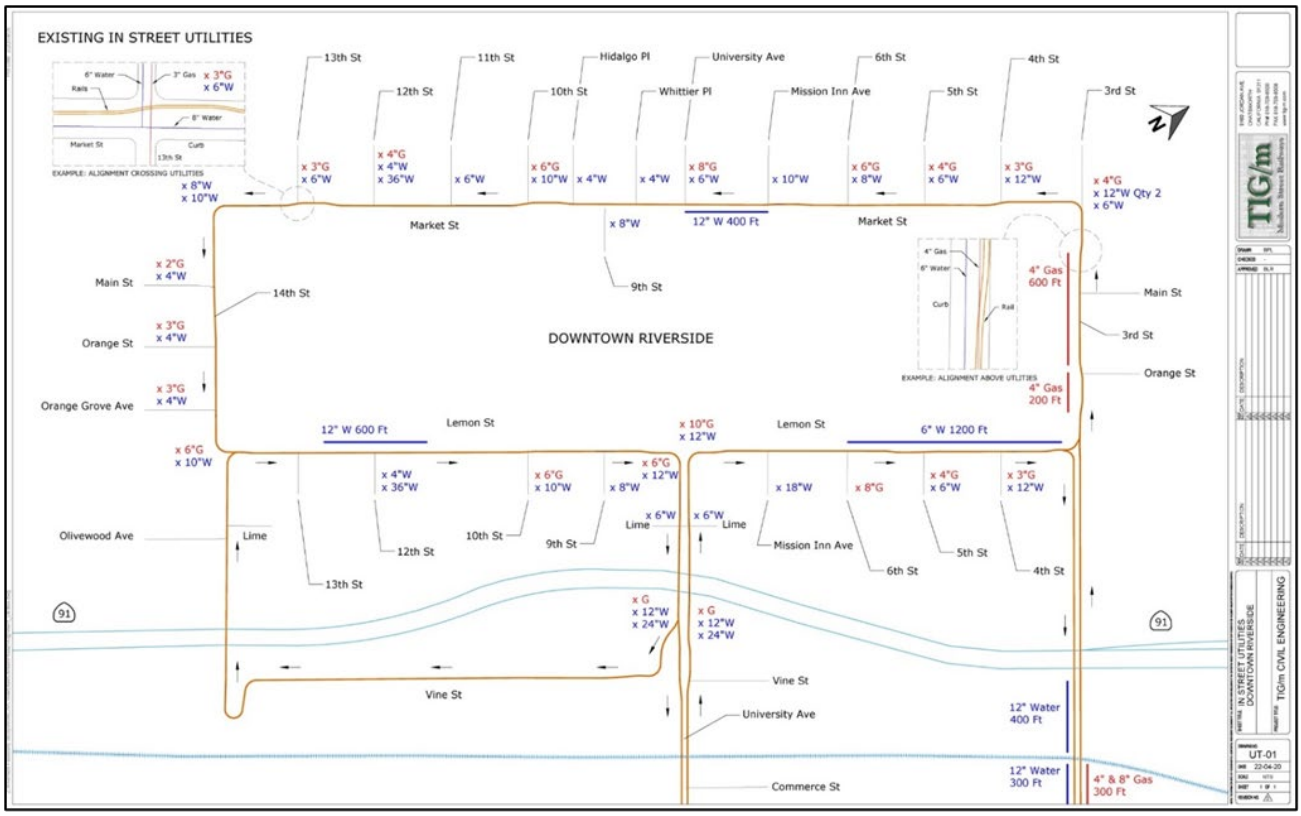


Figure 3-23, *Utilities Identification – Eastside*

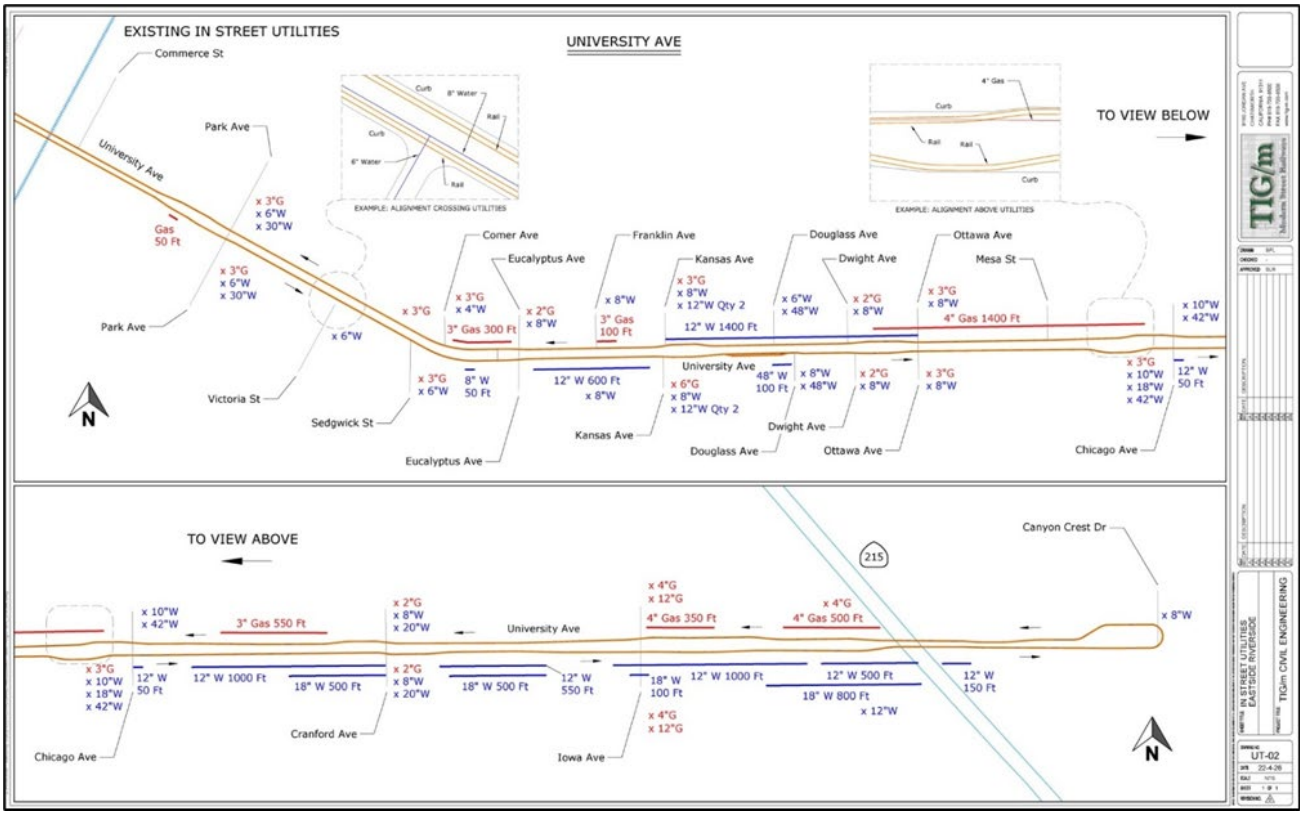


Figure 3-24, *Utilities Identification – 3rd Street*

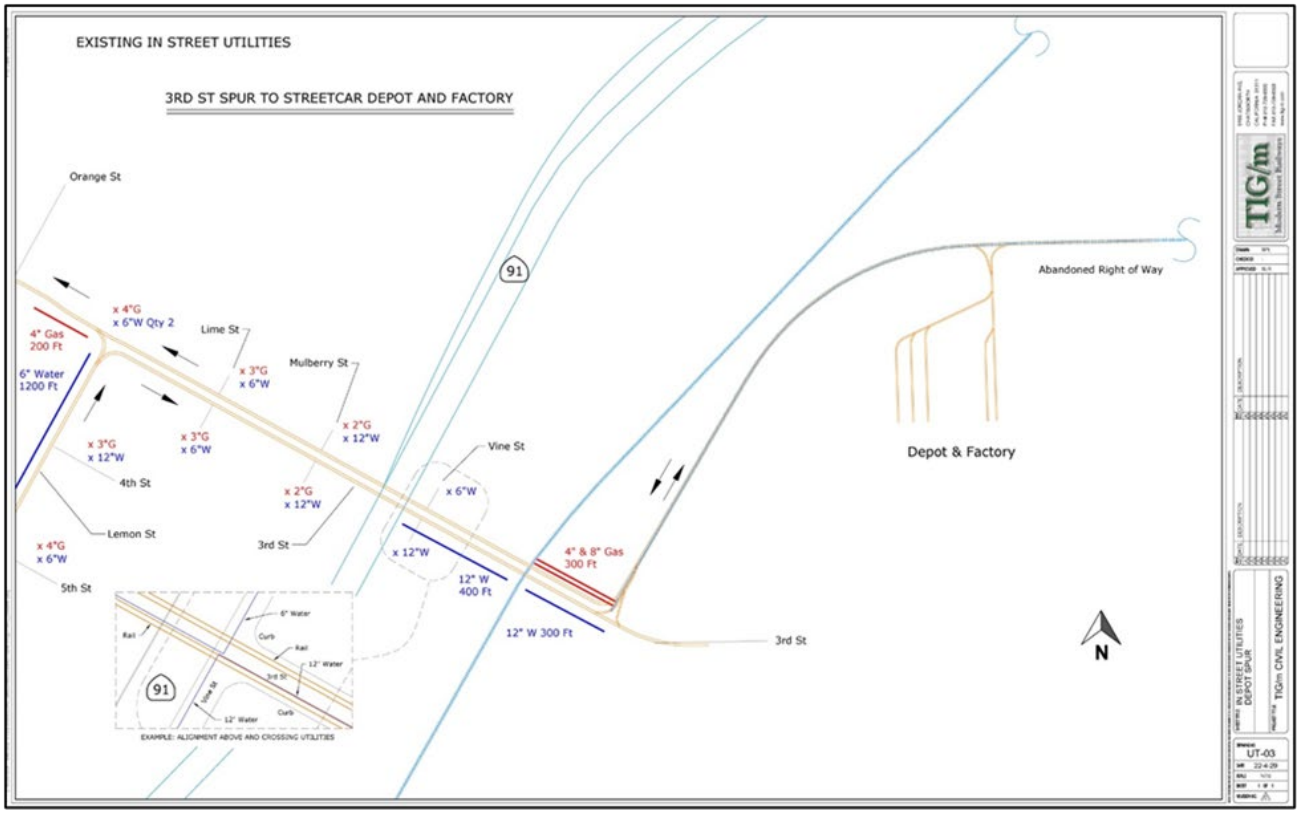
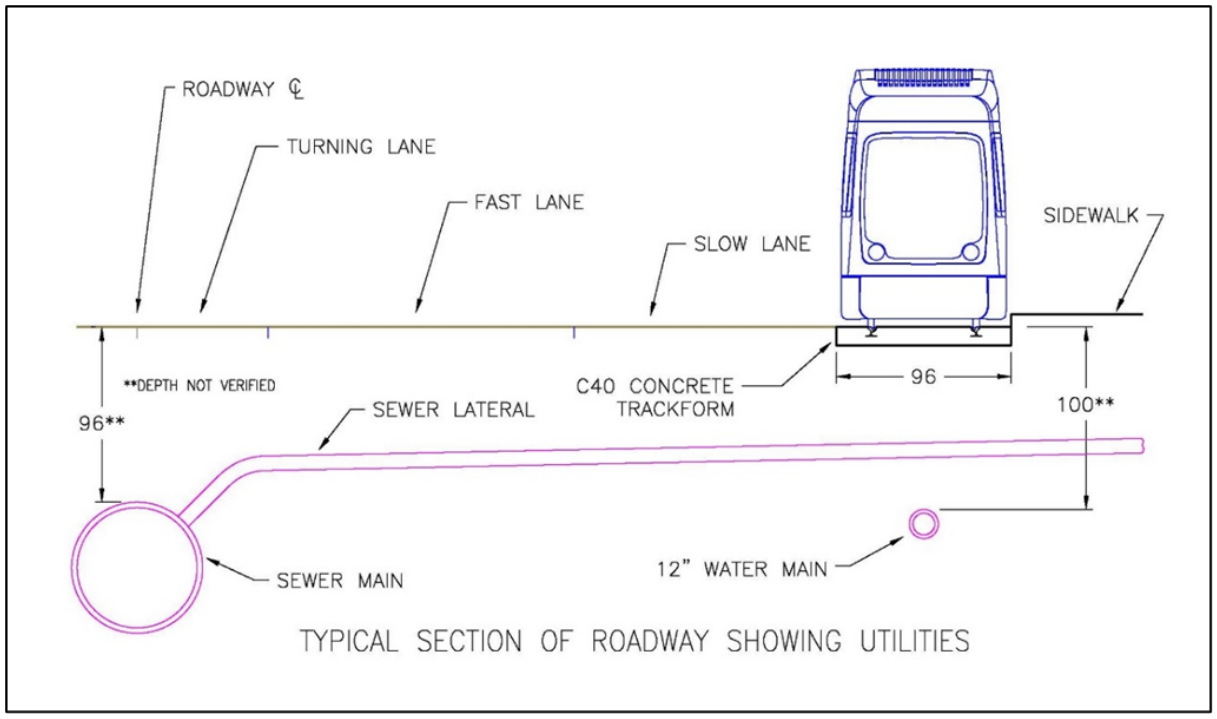


Figure 3-25, *Typical Section of Roadway Showing Utilities, Profile*



To avoid considerable underground utilities relocation costs, TIG/m offers low-impact cast panelized sections of concrete embedded standard-gauge railway track, to bridge over at-grade utility access and installed underground utilities. These panelized sections are 10” deep and 12’-14’ long and can be removed to access sub-grade utilities.

Figure 3-26, *Panelized Trackform Section*

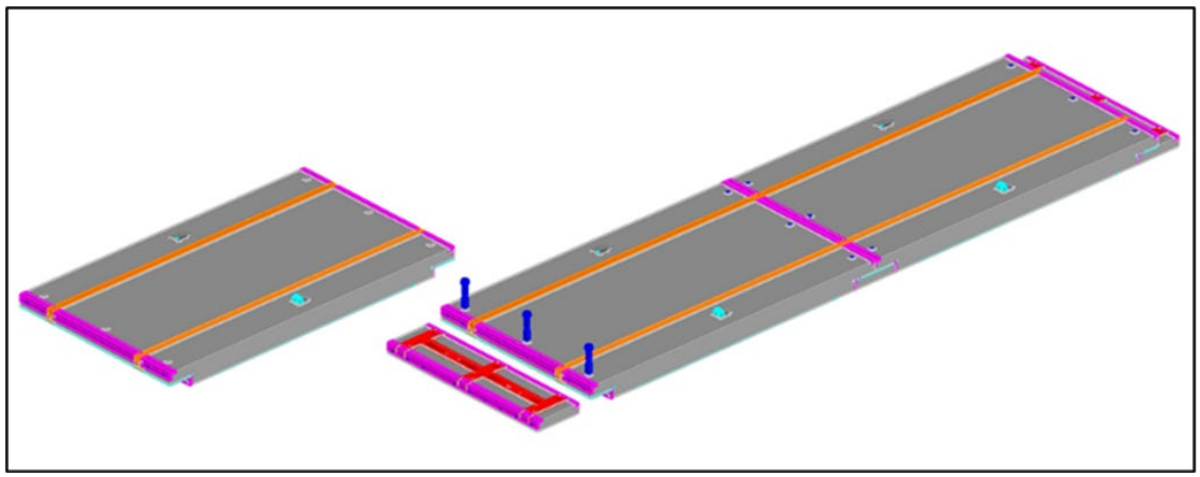
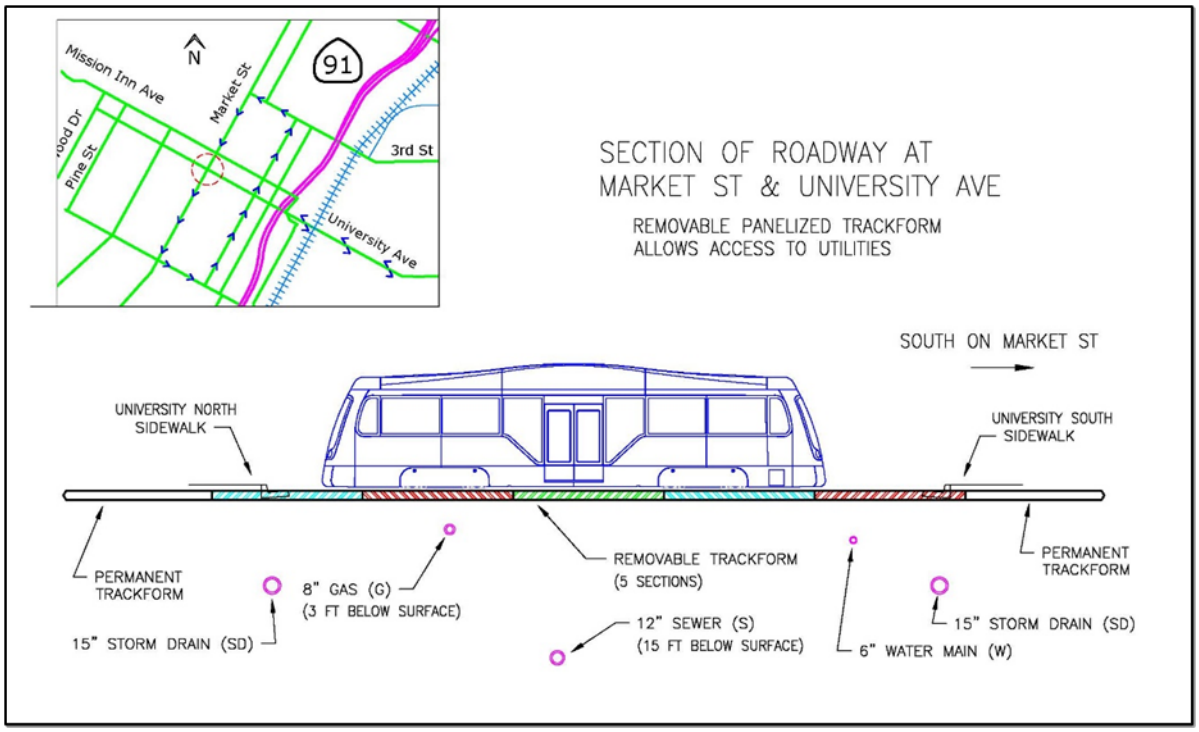


Figure 3-27, *Removable Trackform Over Utilities Access*



3.7 Planned Future Facilities

In addition to the existing conditions in the study area, some future facilities are already planned that must be considered when evaluating the Riverside Streetcar. These are not limited simply to transportation facilities, but also include development plans for the various properties and institutions in close proximity to the conceptual alignment. Relevant known plans are described below.

Vine Street Mobility Hub

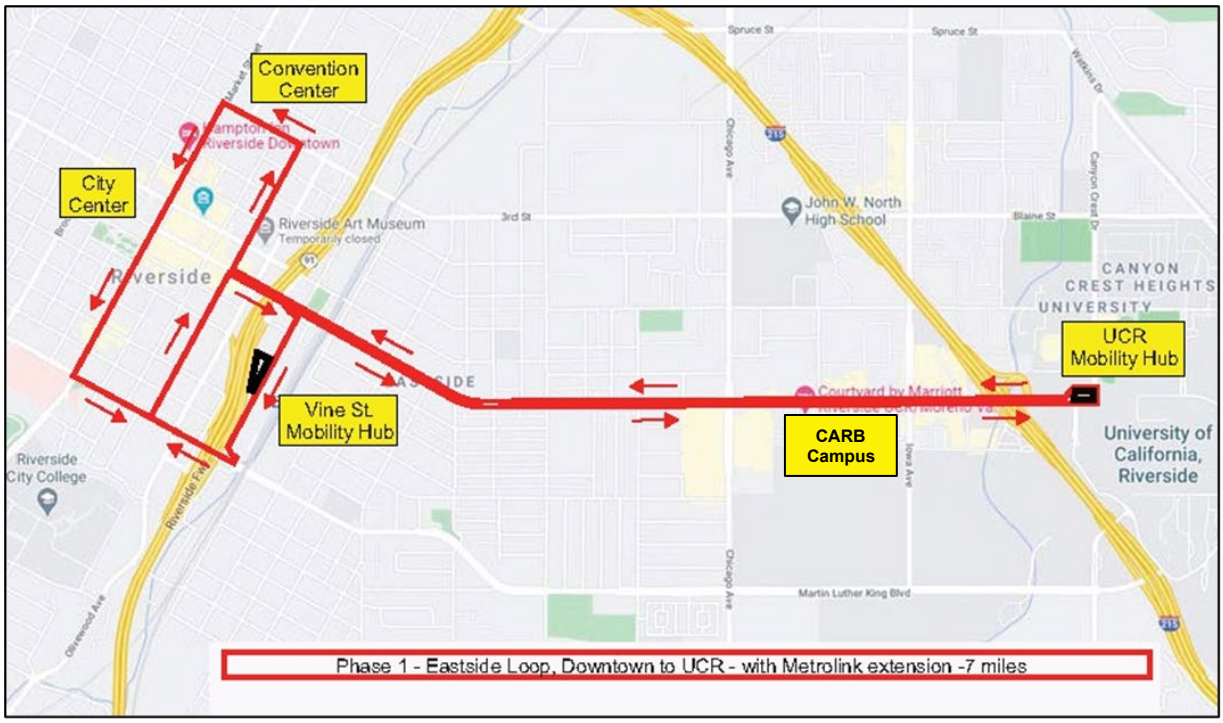
RTA, in partnership with the City of Riverside, is proposing a new Mobility Hub for the area south of SR-91 along Vine Street across from the Metrolink Station. TIG/m's view of this plan is that it presents an ideal opportunity to include a streetcar station as part of the multi-modal transit hub.

"Vine Street has been identified as the preferred location for a new Mobility Hub due to its proximity to the Metrolink station, major employment centers, county and city government centers, University of California Riverside (UCR), Riverside Community College (RCC), Riverside Convention Center, multiple entertainment venues, and urban housing complexes within the downtown core area. The Mobility Hub will function as a multi-modal transportation hub that supports connectivity and expands transportation."[53]

University Gateway Mobility Hub

UCR in partnership with RTA has, in the past, proposed a Mobility Hub for the area around the intersection of University Ave and Canyon Crest. This is the ideal time to revisit these ideas and propose new solutions including automobile parking, bus stop, tram stop, bicycle and pedestrian facilities, and micromobility solutions.

Figure 3-28, Mobility Hubs



Riverside Alive! Expansion of the Riverside Convention Center

The Riverside Convention Center will at least double in size and downtown Riverside will see an amphitheater and 376 more hotel rooms along with housing, offices and a five-level parking structure — all by early 2023.

CARB Lab and Campus

The California Air Resources Board (CARB) and its partners dedicated a new state-of-the-art Southern California Headquarters in Riverside designed to carry CARB's acclaimed research and vehicle emissions testing into the future. The new structure, designed to house research and testing of next-generation vehicles, continues a more than 50-year legacy of CARB's previous labs where CARB set groundbreaking pollution standards for cars and trucks.

Details of other plans and concepts, additional to those pertaining to transit development, can be found at https://www.riversideca.gov/cedd/planning.

Section 4:
Travel Market Analysis

4 Travel Market Analysis

Toward the goal of identifying a potential optimal configuration a streetcar network in Riverside, we have been engaged to provide a Ridership Analysis. To do this we are utilizing data supplied by the city, gathered from residents and nonresidents who travel to and within the city, and also captured from external sources. Our aim is to develop a picture of the *local travel market* within Riverside and then specify a streetcar circulator network which will efficiently serve that travel market. Using land use diagrams and spreadsheets identifying the demographic distribution of current populations, we have collated and then subjected this data to a simplified four-step method with the ultimate goal of forecasting a maximum demand on the streetcar circulator network projected forward to a multimodal transportation system.

As part of our data-gathering efforts we distributed invitations to participate in a Travel Survey through zoom meetings, a webpage, and physical Survey Stations placed at five locations in Riverside.

During the course of our ongoing survey, to date we have gathered and collated over 800 individual responses to a number of questions concerning preferred modes of transportation and daily travel habits. These real-world responses from current Riverside residents are used as factors in our analysis.

TIG/m began by creating map dividing the City of Riverside into 12 Transit Analysis Zones for the purpose of defining trip generation and destination areas (see ***Figure 4-1***).

Figure 4-1, *Map of Transit Analysis Zones (TAZ)*

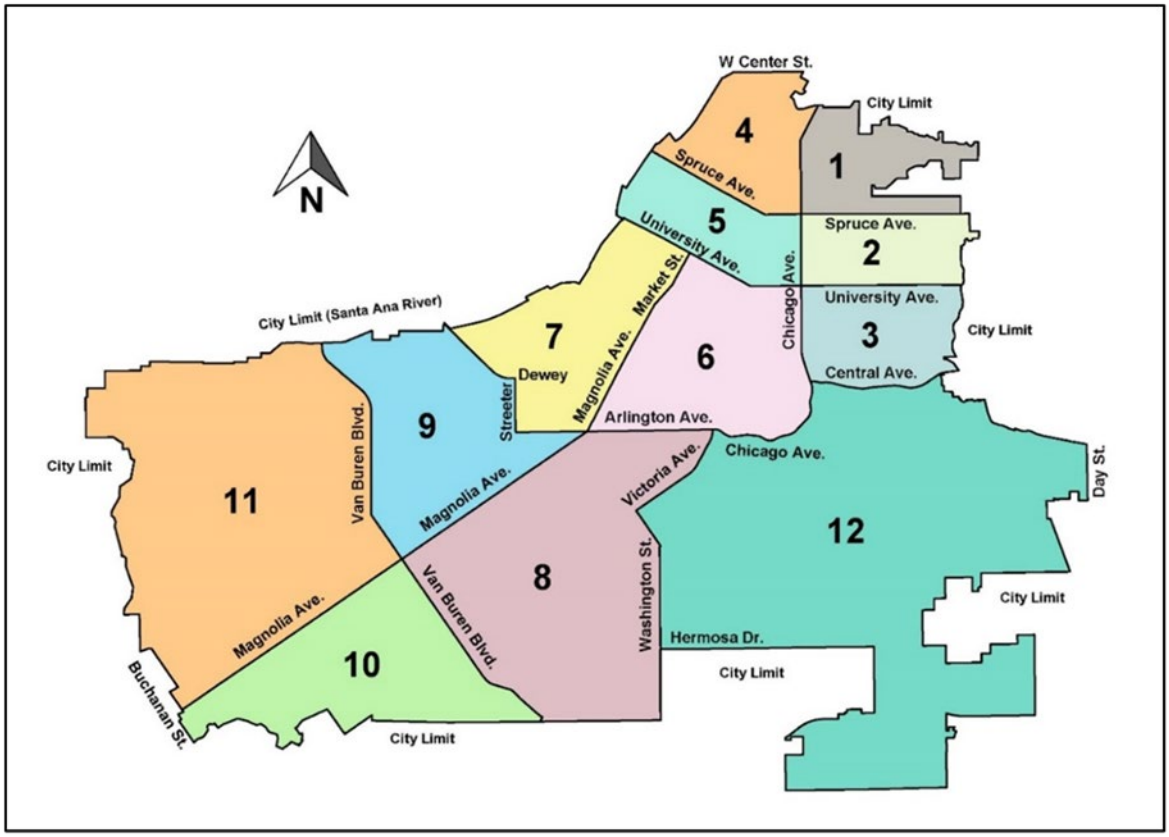
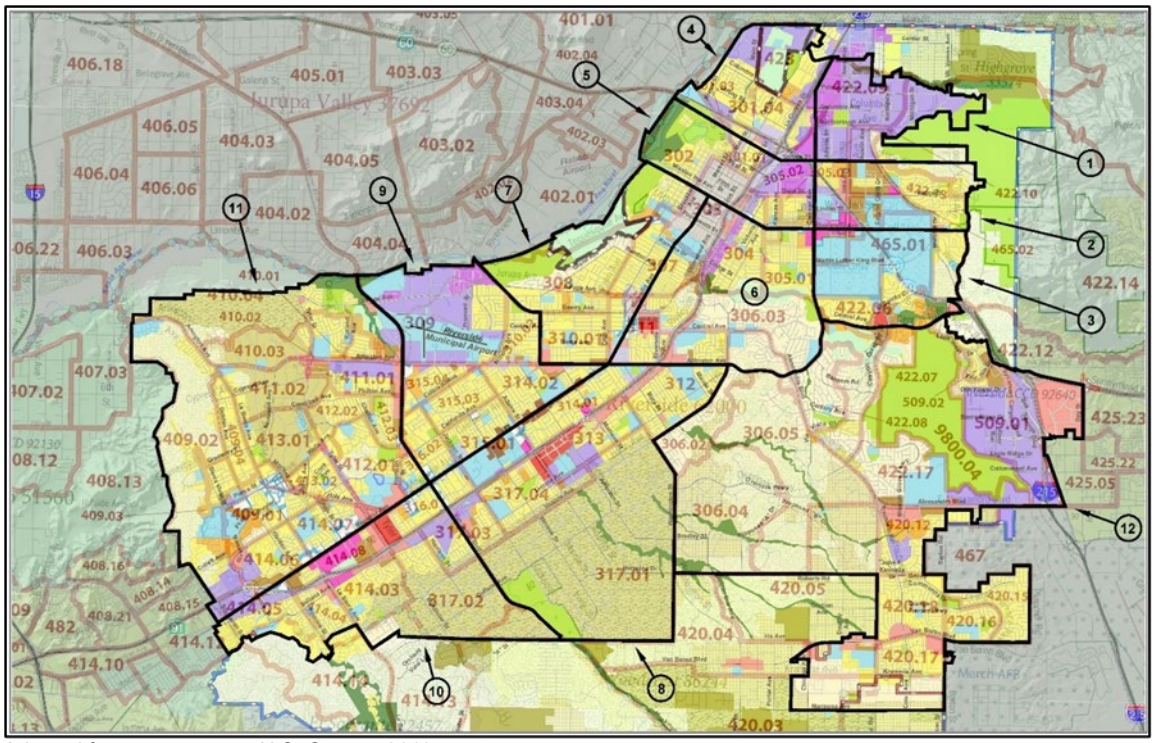


Figure 4-2, *Map of TAZ with Land Use and Census Tracts*



Adapted from map source: U.S. Census 2019

4.1 Discussion

According to the U.S. Census, the City of Riverside had a population of over 331,360 in 2019, with an average density of 4,083 people per square mile. However, the population density of the area within a 5-minute walk of the conceptual Phase 1 alignment (the 5-minute pedestrian catchment zone) was 14,596 (or 7,409 per square mile). The rate of population increases between 2010 and 2019 was 9% (or 1% per year). Using these factors, we can project that in 2025 (the year the Riverside Streetcar System is projected to begin operations in this study) the population of Riverside will be approximately 350,000 with an average density of 4,311 people per square mile with a population density in the 5-minute pedestrian catchment zone of approximately 24,845 (or 12,612 per square mile).

Examples of successful streetcar systems in cities of this size (and smaller) with similar population densities around the world are abundant, especially in northern Europe where there are over 40 cities with successful tram systems serving populations under 100,000.[54]

It is therefore considered likely that a similarly successful streetcar system within the City of Riverside can be feasible. The challenge is to design a project that has a sufficiently low CAPEX and OPEX and a sufficiently high potential ridership to make the Cost Model attractive to the Riverside City leadership.

A transportation mode that helped shape the thoroughfares and population centers of Riverside was the Electrified Railway (Streetcar). The Riverside Railroad Company (RRC) began operating horse powered streetcars on Main Street and 8th Street in 1886. The Riverside & Arlington Railway Company (R&A) was incorporated in 1887 and bought the RRC in 1895. In 1900 the R&A electrified all of its streetcar operations and Frank Miller, its manager, operated approximately 14 miles of streetcar lines until 1911 when it was incorporated into the Pacific Electric Railway (PE) of Henry Huntington.

The PE operated all of the streetcars and interurban systems in the Inland Empire until about 1943 when the proliferation of automobiles, buses, and trucks overtook the ability of electrified rail lines to modernize, and the systems were unfortunately abandoned.[55]

Figure 4-3, Old Hand-Drawn Route Map, Pacific Electric Railway Riverside-Corona Line

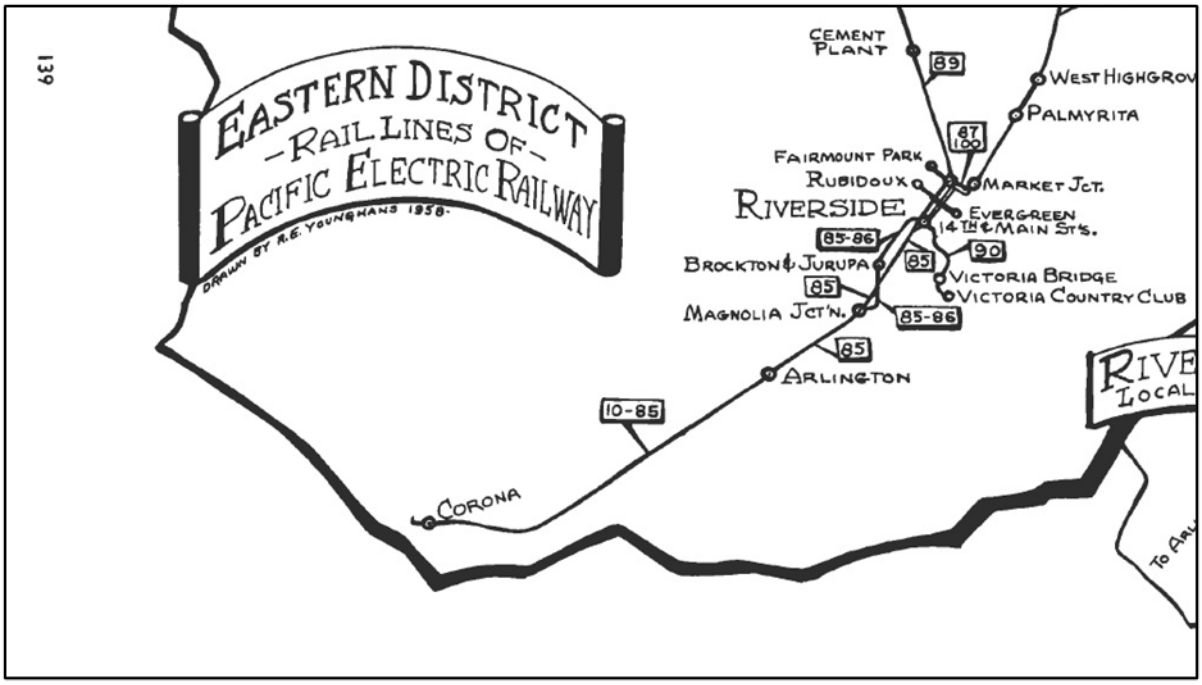


***Figure 4-4,** Old Postcard of a Trolley on Magnolia Avenue*

Source: Press Enterprise. 2011. [56]

Magnolia Avenue, which became the main line of the R&A and originally carried passengers between Downtown and Frank Miller's Chemewa Park near Arlington, has always been the prominent thoroughfare on the west side of Riverside and continuing all the way to neighboring Corona. When UCR opened in 1954 and University Avenue became the major eastside thoroughfare, the "L" shaped transit corridor was well established and remains the most viable route for a high-value fixed guideway transportation system today. Currently the RTA Rapid Link (Route 1) serves this corridor.

When establishing new streetcar lines, the guiding principle is to establish them along corridors with the highest bus ridership. The bus lines on these corridors, being easily movable, should be rearranged to intersect with the new streetcar corridor to function as feeder lines for the newly established fixed guideway transportation system. This is what we are proposing in Riverside. Although there are several current bus lines that will need to continue to function, as part of their overall route, along part of the proposed streetcar alignment, it should clear these two modes (bus and streetcar) in competition for ridership along the same end-to-end route would be counterproductive. When bus and streetcar are systems are planned correctly and work together to provide a comprehensive travel package, both modes will see increased ridership by modal shift from automobile trips. By providing a locally circulating higher frequency service in a quieter, smoother riding vehicle, it is proven by the experience of other streetcar systems that a modal shift from automobile ridership to streetcar ridership can be achieved. In fact, it has been established by passenger survey that many new streetcar systems (called tram systems in Europe and the UK) attribute up to 20% of their ridership to modal shift from automobile use.

What we will be showing in our ridership projection is that between the:

- Increase in population by the year 2025
- Reallocation of the bus ridership to the streetcar along the routes served
- Automobile to Streetcar Modal Shift (we will use a conservative 10% modal shift)

…we will be able to plausibly predict a ridership that will be within the current experience of peer cities of similar size, population density, and streetcar ridership as expressed in average daily boardings per mile.

A goal that we feel is achievable in Riverside and would render the project feasible based on peer city statistics and our experience in designing and implementing streetcar system is 900 average daily boardings per mile. This can be expressed in terms of ridership as:

710 bpm x 7 miles = 4,975 PPD

4,975 PPD ÷ 16 hours = 311 PPH

Section 5:
Conceptual Alignment Design

5 Conceptual Alignment Design

TIG/m primary design goals are:

- To the greatest extent possible, design a network of streetcar alignments that will directly interface with the current and conceptual ambient transit environment and community
- Improve penetration into the City of Riverside's most heavily trafficked areas, as well as those in development.
- Contribute to the creation of a vibrant multi-modal transit system that successfully interfaces with existing transit systems, thereby improving overall movement in the city while reducing automobile traffic, improving air quality, and supporting elevated social equity.

Alignment Development
Pursuant to these aims TIG/m conceptualizes the development of a streetcar network in five phases, with the assumption that phases will be built over time.

This section examines the design and engineering features necessary for a streetcar to operate in Riverside. These include right-of-way needs for the streetcar on lanes of existing roadways and on city- or privately-owned properties; streetcar alignment lane width and clearances (kinematic envelope), vertical clearances (structure gauge), station accommodations (which includes discussions of multi-modal transit hubs), station amenities including requirements for persons with disabilities; and the maintenance and storage facility needs for the fleet.

5.1 Concept Design Methodology

TIG/m was first introduced to city management in 2016 by the City Planner and has made yearly presentations to the mayor and staff since then. In 2019, TIG/m was presented to Riverside's City Council. After driving the main streets of Riverside with the previous Mayor, TIG/m started with sketches on large printouts of East and West Riverside. These initial ideas were presented to the stakeholders, through on-line presentations to generate and consider comments. Each iteration of design, in response to comments, was incorporated into a new presentation, until we reached a consensus among stakeholders. The result of this iterative process was a concept in five phases. The cost models included in this report will concentrate on Phase 1 of this concept. For maps and details of the five-phase concept, refer to ***Section 5.3*** and ***Appendix R: Phase Concept*** includes maps of different route options established with the initial conceptual Phase 1 alignment and those to be built in each successive phase.

TIG/m has a history of roadway, people mover, PRT (personal Rapid Transit), streetcar, and tramway system and alignment design going back to the 1900s (when incorporated under other names). We have designed dozens of such systems for projects around the world. This experience provides us with the expertise to quickly make judgement calls about the **basic configuration** of a fixed guideway transportation system while making an on-site survey; for example, driving on the roadways under consideration for such an alignment. During this initial survey we consider all possible locations on the existing roadway for fixed guideway placement, considering costs and the most important factor: the ease of access to the system by pedestrian patrons. All too often we have seen projects suffer in operation or cancellation in design stages due to reliance on expensive and hard-to-justify regimes such as median running which requires pedestrians to cross traffic in order to reach the transit system or necessitates expensive pedestrian overpasses which require the patrons to move vertically as well. Curb-rebates or bump-outs require making changes to the right-of-way and complicate parking and

turning lane configurations. In our practice, we feel that the most affordable and simplest solution is always the best.

After doing our initial site surveys, and working in conjunction with City Staff and interested groups in design charrettes, TIG/m developed a phase-able alignment concept. TIG/m civil engineers brought the entire Phase 1 alignment up to the level of schematic design (geometrically able to support engineered track) in order to assess the buildability of the trackwork in the existing streets and to provide a basis for accurate estimation of construction costs using unit quantities. Close liaison with City Managers, Planners, and Engineers has informed this design process with all available current data relative to rights of way, traffic controls, as well as at-grade and sub-grade utilities.

Moving forward, the City and stakeholders including RTA should work closely with TIG/m to examine locations where the alignment is proposed to effect on-street parking, the configuration of bike lanes, existing bus stops, and where the alignment makes lane changes, turning movements, or pulls into or out of proposed stop locations. Much of the detailed design of entering and exiting the right-hand lane of traffic and the all-important consideration of safely accommodating the bicycle lane will need to be addressed during design development, but none of these considerations are show-stoppers

Active cost models are applied, based on the assumptions developed in the design charrettes, concerning a potential duty-cycle which will take into account operation and maintenance costs for the first year of Phase 1 operation, costs for five-year increments thereafter, and concluding in a 30-year life cycle. Refer to ***Sections 9, 10, and 11*** in this report.

5.1.1 Right-of-Way Needs

Tracks and specialwork (turnouts, etc.) must be installed in both existing city roadway, both at-grade and on overpasses, for the passenger service revenue alignment. Additionally, access to the conceptual depot as well as a test track will require rights-of-way along a defunct rail spur north of 3rd Street, as described in ***Section 5.1.1.1***. The conceptualized UCR terminus of the system includes a turnaround “loop” on UCR property diagonally opposite to Parking Lot 19 (see ***Section 5.5.3***). TIG/m envisions this turnaround loop to be an ideal opportunity for construction of a multi-modal transit hub for streetcars, busses, and bicycles and is in discussions with UCR.

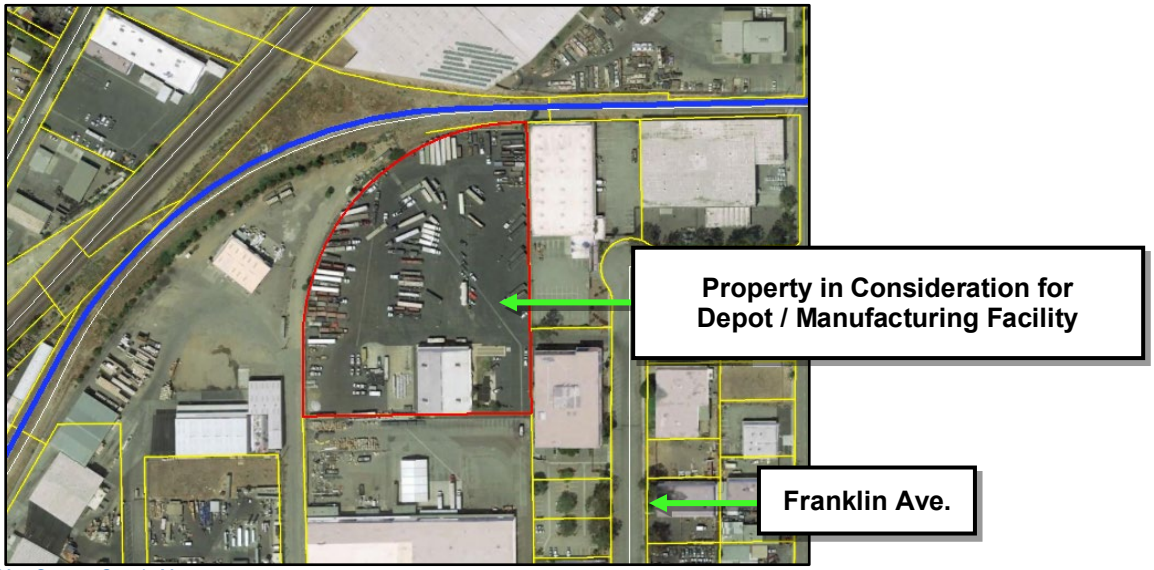
Structure Gauge
The “structure gauge” of the rolling stock is based on the dimensions of the vehicle plus a minimum clearance from any vertical structures while the vehicle is in motion. For the TIG/m MRV-3A Tram the structure gauge is 13.5’ high by 14’ wide. This has been considered in the alignment design process.

5.1.1.1 Depot/ Manufacturing Facility Access and Test Track

At the time of this report’s preparation, TIG/m is considering, for the streetcar depot and engineering/manufacturing facility, a property at 3031 Franklin Avenue, Riverside, 92507. This property sits adjacent to a defunct rail spur. ***Figure 5-1*** shows the property outlined in red, and the defunct rail spur in blue. The rail spur still has some track, some of that track is buried in soil.

Access to the depot/manufacturing facility and test track described herewith will require rights-of-way along a defunct railway spur as shown below in ***Figure 5-1.***

Figure 5-1, *Depot & Manufacturing Facility: Property in Consideration*



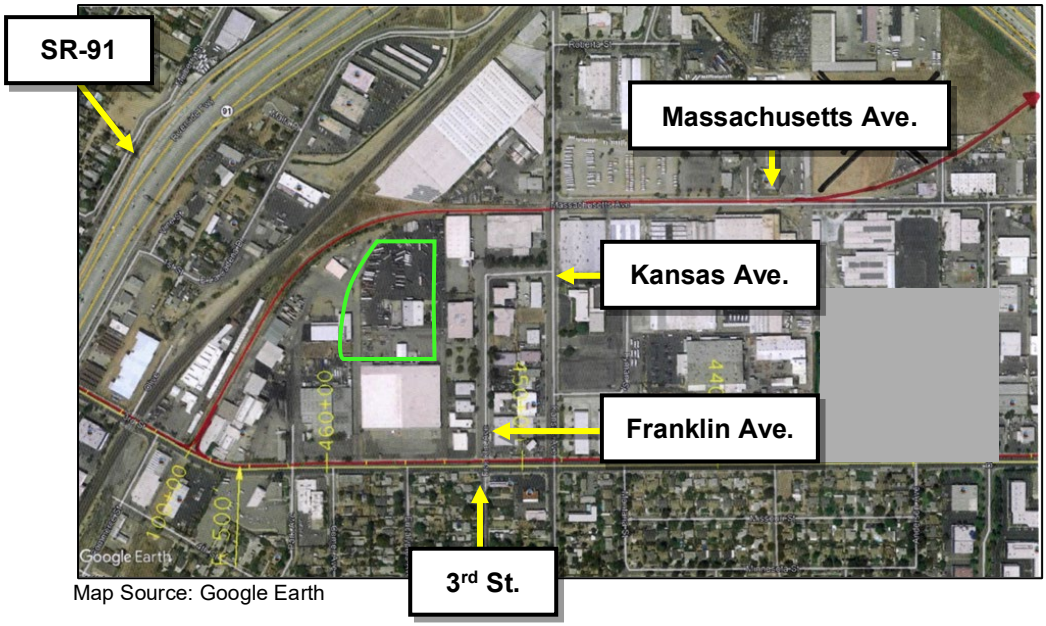
Map Source: Google Maps

Access to the depot/manufacturing site would be from a wye (3-track intersection) installed where the spur meets 3rd Street. A dedicated rail access track would be installed between 3rd street and Kansas Avenue. Ideally, the access rail line to the depot would continue from Kansas Avenue east along Massachusetts Avenue, diverting left, just west of Durham Street, in a northeasterly direction onto the continuing defunct railway spur, to serve as a test track for TIG/m vehicles during manufacturing and testing stages.

A wye would be installed on the access alignment at the north side of the property to provide turnaround functions as well as access to and from the test track.

The sketch in ***Figure 5-2*** shows the revenue alignment on 3rd Street, as well as the depot access alignment and test track in red; the depot/manufacturing facility is outlined in green.

Figure 5-2*, Depot/Manufacturing Facility, Access Alignment, & Test Track*



Map Source: Google Earth

5.1.2 Streetcar Alignment Corridor Lane Width

Streetcars in Riverside would be sharing the curb-side lanes with other road vehicular traffic, The widest kinematic envelope of the TIG/m MRV-3A and MRV-4A trams is 14 feet. The narrowest lane requirement along any of the five development phases is 10 feet.

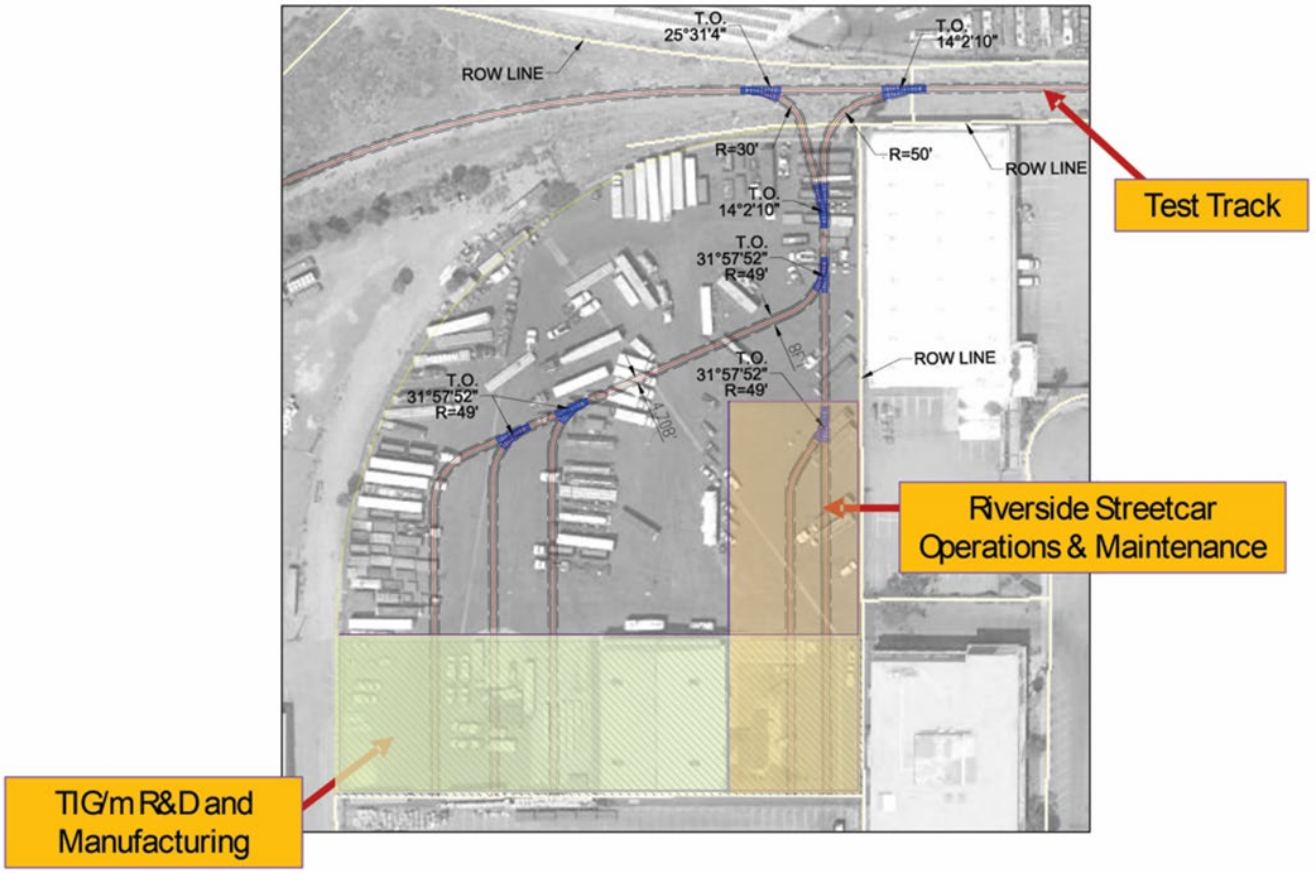
5.1.3 Freeway and Heavy Railway Underpass Vertical Clearance

The height of TIG/m MRV streetcars is 13’ from top of rail, requiring a minimum of 13.5’ for lift. The minimum clearance in the freeway and railroad underpasses relevant to the alignment concepts herein is sufficient at 15’.

5.1.4 Stabling Depot / Maintenance / Manufacturing Facility

For a well-functioning stabling and maintenance facility, as well as switching yard, and a manufacturing facility with design, engineering, and administrative offices, TIG/m will require a minimum of five acres of land (60K sq. ft. for the R&D/manufacturing facility and 20K sq. ft. for the O&M facility) and additional mile of defunct railway spur to use as a test track.

Figure 5-3, *Depot: O&M, R&D/Manufacturing, and Test Track Facilities*



5.2 Basic Alignment Features

The Riverside Streetcar system will operate as a curb-running streetcar line which will benefit from a Tram Priority Signalization system along all tracks and will not have posted schedules but will operate using a Real-Time Arrival system which will post streaming data on-board each vehicle, on PDA apps, and at each station identifying the number of minutes and seconds until the next arrival. The benefits of this system for the patrons are shorter travel times due to the "green wave" through traffic lights and easier choice-making supported by next-vehicle-arrival information.

5.2.1 Reciprocation vs. Circulation

Two basic philosophies in streetcar operations conceptual planning are: reciprocation and circulation.

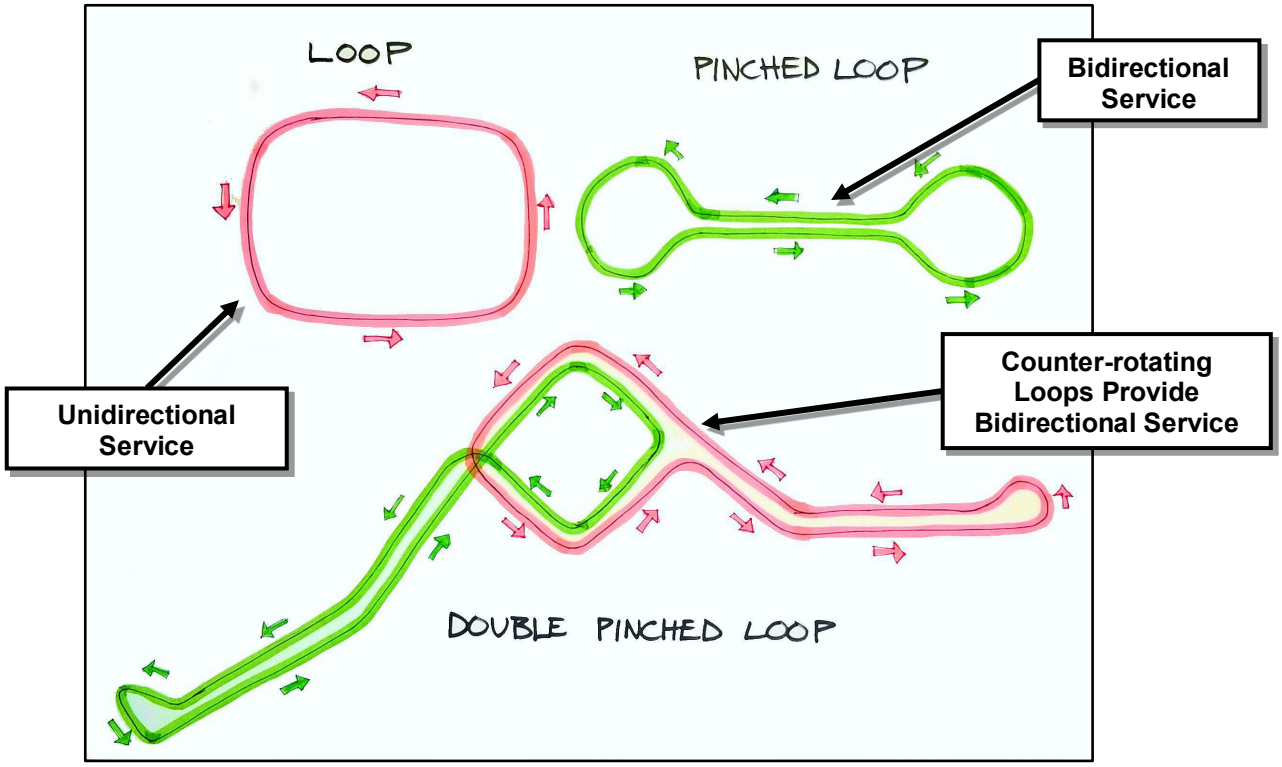
"Reciprocation" is the operation of one or more streetcars that travel back and forth on a single track or set of tracks. Vehicles need to be double ended, with an operator's console at both ends of the car. These vehicles are more complex, more expensive, have higher maintenance costs, and can carry fewer passengers because the operator's station consumes space that could otherwise be allocated to seats or standing room. Additionally, layover and recovery times at every cycle are inherent in this operation, to allow time for the operator to change positions on the streetcar to the "front-facing" direction.

"Circulation" is the operation of streetcars that travel in one direction on a continuous track. This type of system requires a turnaround (either a loop, a wye, or a mechanical turntable at each end of a track alignment) or full alignment loop configurations as described in ***Section 5.2.2.*** A circulator can use single-ended cars, which are less expensive, less complex, have lower maintenance costs as well as more seats or standing room. Because layover and recovery are avoided, headways can be more symmetrical and therefore more efficient and dependable. For these reasons, TIG/m favors circulation.

5.2.2 Track Loops

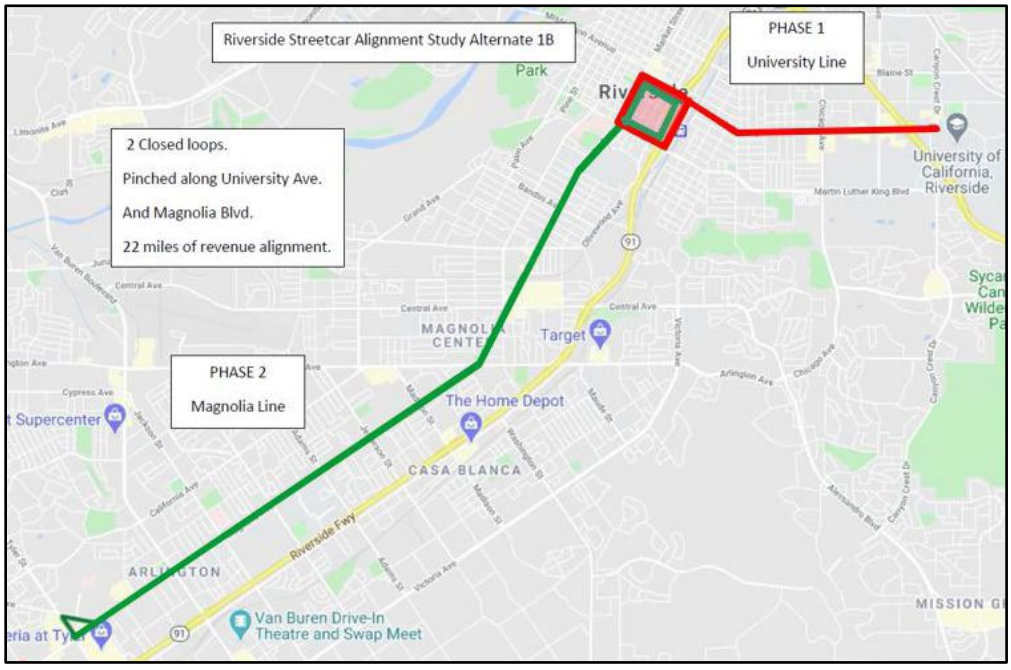
Two types of loops are considered for this study: open loops and pinched loops. An open loop allows for one-way travel on four (or more) streets. Pinching that loop for a long stretch of a main thoroughfare, for example, allows for two-way travel for the length of the pinch. This would reduce travel time for passengers, as they would not be required to ride perhaps a majority of the loop to arrive at their destination. **Figure** 5-4 describes loop configuration.

Figure 5-4, *Open Loop; Pinched Loop*



TIG/m conceptualizes that alignment Phases 1 and 2 in this study should be double pinched loops, "overlapping" into a counter-rotational, bidirectional loops around the Downtown area and adjacent to the two spines alone the main street-level thoroughfares.

Figure 5-5, *Phases 1 and 2 Form Two "Spines" of the Streetcar Network*



5.3 Route Options

In preparation for this report, a conceptual streetcar network in five phases was investigated, with the assumption that 5 phased loops could be built over time. Each loop would operate single-ended trams on an 8-minute headway with transfer between loops at selected passenger stations. The first two phase alignment tracks would be pinched loops with four open sections running between Downtown and UCR (phase 1) and Downtown and La Sierra (Phase 2). These could serve as the spine for a multiple loop system built-out over time. See ***Appendix R f***or the full concept.

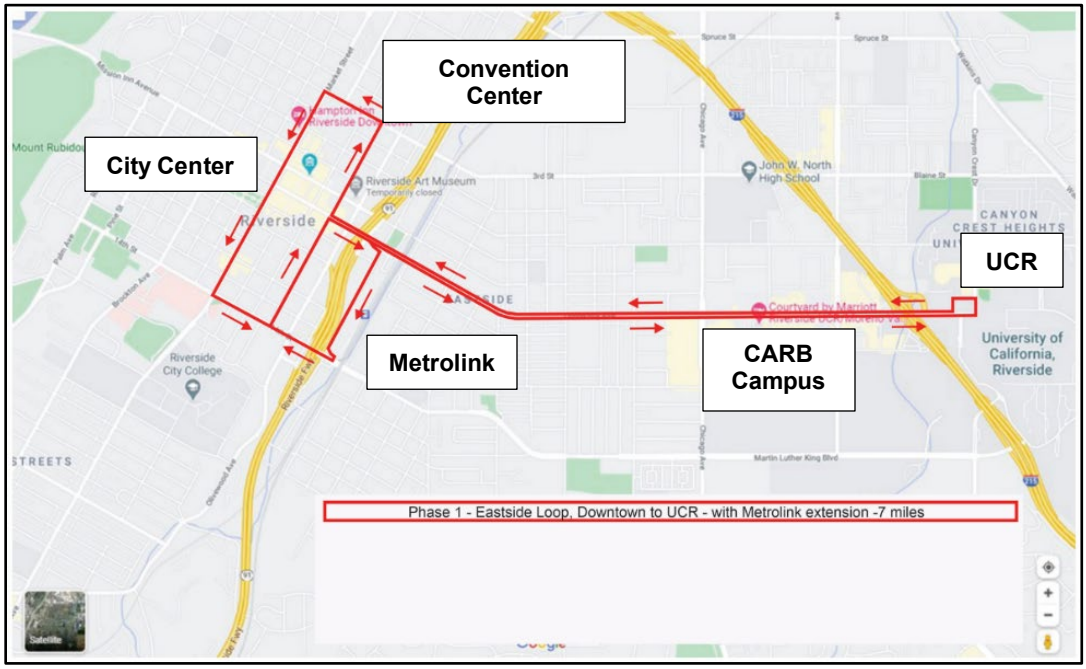
Ultimately the Phase 1 loop (Downtown to UCR) was selected for concentrated study and presentation in this Report for a number of reasons:

- An initial phase transportation circulator must be a viable transit corridor with clearly defined destinations to be successful. Both Phase 1 and Phase 2 meet this criterion
- Phase 1 has the highest existing bus ridership (see Section 4 Travel Market Analysis)
- Phase 1 contains less than ½ of the track mileage (7 vs. 15) and is therefore much more affordable as an initial project
- Phase 1 lies within the Innovations District
- Phase 1 has a higher percentage of developable land per mile and is therefore more likely to show early benefits from the installation of a fixed-guideway transit system (see ***Section 12 Cost / Benefit***).

Several alternatives to the Phase 1 route were considered in the early design phases. Input from stakeholders including Councilmembers and Neighborhood Groups from Downtown and the East Side helped to focus the design on the current configuration based on land use, traffic volumes, and key destinations that were considered to be essential.

5.3.1 Phase 1 (for Phases 2-5, see ***Appendix R)***

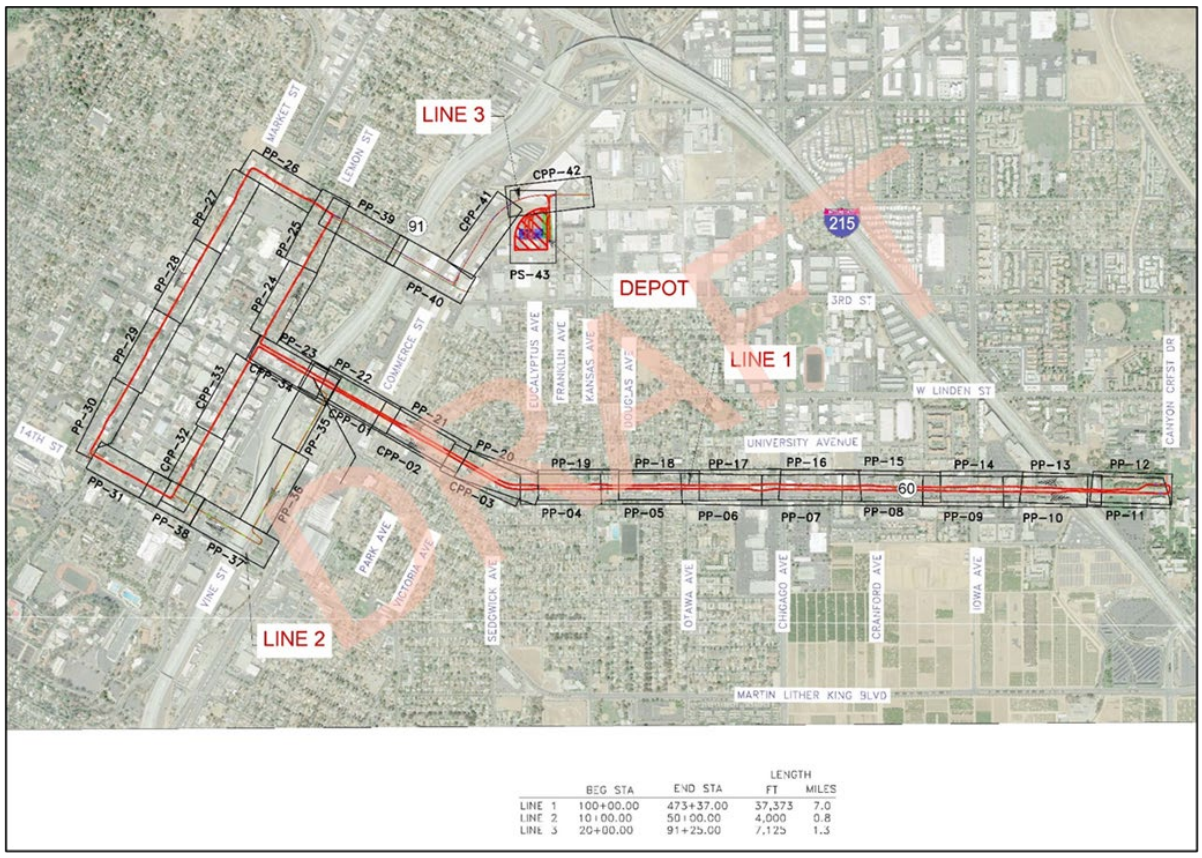
Figure 5-6, *Phase 1 Alignment Concept*



The east end of this Phase 1 alignment shows a turnaround loop on what is currently an undeveloped parcel, diagonally opposite to the entrance to UCR's entrance to Parking Lot 19 at the corner of University Avenue and Canyon Crest Drive. TIG/m suggests that this area, which belongs to UCR, would be an ideal location for a multi-modal mobility hub. An alternative turnaround could be a mobility hub on the UCR property, as shown in *Figure 5-19.*

Figure 5-7 is the key drawing for the civil engineering schematic drawing set found in ***Appendix E.***

Figure 5-7, *Civil Engineering Schematic Drawing Key Sheet: Phase 1 Alignment*



5.4 Track Type

TIG/m steel wheeled streetcars are designed for use on standard-gauge steel railway track.

Please note that TIG/m, LLC is a proud American design/build firm. All of our products are manufactured, to the largest extent possible, with American-made components. Our rolling stock and O&M equipment all qualify for Buy-America mandates. When it comes to rail infrastructure, some of the highest quality essential components are not made in America and we use European sources. For example: 51R1 girder rail and flange-bearing special-work, which we consider essential for longevity, safety, and passenger comfort, are produced in quantities that result in affordability and high quality in Austria and the Czech Republic. TIG/m intends to continue using these suppliers and would seek waivers to Buy America mandates if those mandates were a requirement for this project.

5.4.1 Basic Trackform Design Parameters

The track will be standard gauge: 1435mm 51R1 girder rail will be used throughout. The specification of the rail profile is determined by the specific vehicle typology, axle arrangement, and wheel profile. Rail will be welded and embedded throughout, with the top-of-rail being flush with the pavement. TIG/m specifies bottom-up fixation using steel crossties in a continuously reinforced concrete slab which is poured in place. Expansion joints will be used at intervals determined by calculation. Gauge widening in curves will be subject to calculation upon adoption of a project duty cycle and track speed calculation. TIG/m uses double-point flexive-type switches and .75" compliance bias-cut expansion joints from DT Vyhkbharna of the Czech Republic.

Geometry of the Master Plan and the vehicular street designs in which the majority of the alignment will be placed will define the minimum turning radius required of the alignment. The maximum speed and the average operating speed will determine the parameters for transition (or spiral) curve geometry and the amount of cant (superelevation) required at curves. Minimum curve radius and operating speed through the curves will determine the allowable cant deficiency. Vehicle geometry will determine the minimum tangent required between curves. Until the project enters Design Development, the geometry of the alignments will remain in a schematic stage. Many of the general parameters can be applied but substantial adjustments to the alignment are to be expected.

Nominal horizontal track alignment design parameters
Minimum recommended radius---------- 15m Non-revenue alignments
Minimum recommended radius---------- 20m Revenue alignments
Minimum tangent section---------- 7m
Minimum transition curve length (bogie offset) ---------- 7m (n)
Maximum cant (superelevation) ---------- 120mm
Cant deficiency (superelevation unbalance) ---------- 60mm
Maximum cant deficiency ---------- 100mm

Nominal vertical track alignment design parameters
Maximum gradient (nominal) ---------- 5%
Maximum gradient (exceptional) ---------- 7%
Minimum sag or crest radius (at minimum speed) ---------- 180m*
*Corresponds to a Kv = 3.16m/degree, reflecting a 16 meter (51.5 ft.)
long (horizontal distance) vertical curve, joining a level grade and a 5% grade

5.4.2 Rail

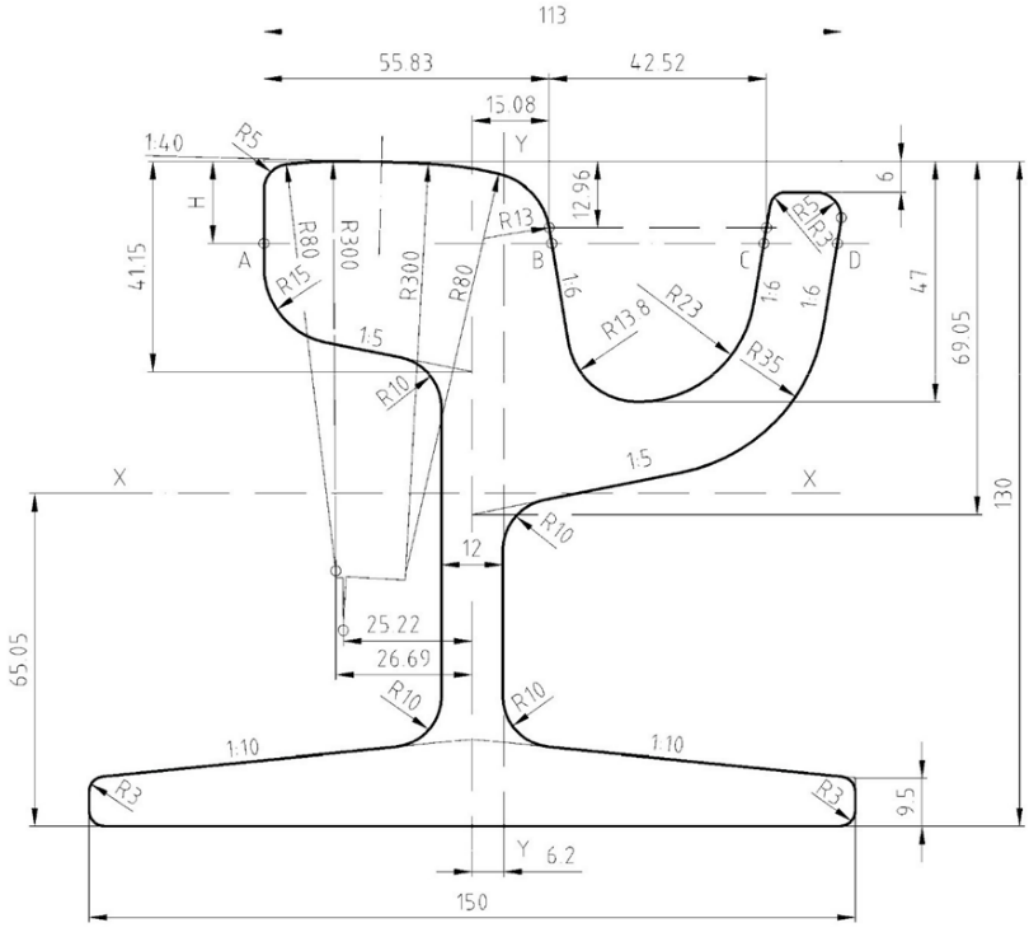
Grooved rail (or girder rail as it sometimes called) was designed specifically for street running railway systems prevalent throughout Europe and Asia. It is superior for this application because it has a built-in restraining and guide rail function which is very useful in the small radius turns that are frequently found in city streets. It is also superior for embedded-in-street applications because the steel flangeway provides a hard edge against which the roadway surface can abut on both sides of the rail, keeping the paving edge from deteriorating. This type of rail was manufactured in the US until the elimination of the majority of US streetcar systems after WWII.

Rail section: 51R1 (see ***Figure 5-8***).
Supplier: Voestalpine, Austria

Figure 5-8, *Grooved Rail Profile 51R1*

EN 14811:2006+A1:2009 (E)

Dimensions in millimetres



H	AB	BC	CD
9	54,49	44,52	13,57
10	54,97	43,88	14,06
14	56,00	42,17	14,39

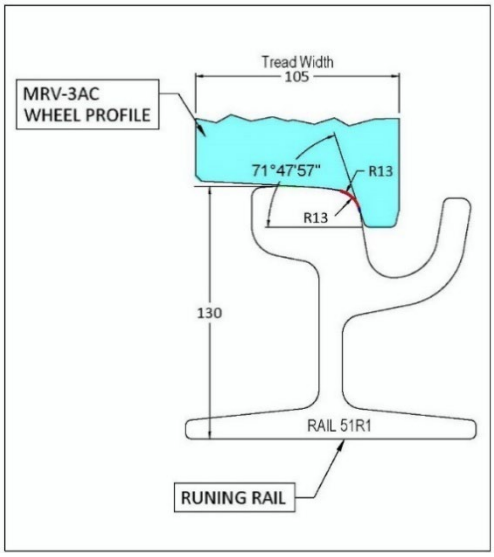
Cross-sectional area: 65,44 cm^2
Linear mass: 51,37 kg/m
Moment of inertia I_{xx}: 1 288,7 cm^4
Moment of inertia I_{yy}: 695,6 cm^4
Section modulus W_{xf}: 198,1 cm^3
Section modulus W_{xh}: 198,4 cm^3
Section modulus W_{yh} 85,7 cm^3
Section modulus W_{ygh}: 101,1 cm^3

Figure A.2 — Grooved rail profile 51R1

5.4.3 Wheel/Rail Interface

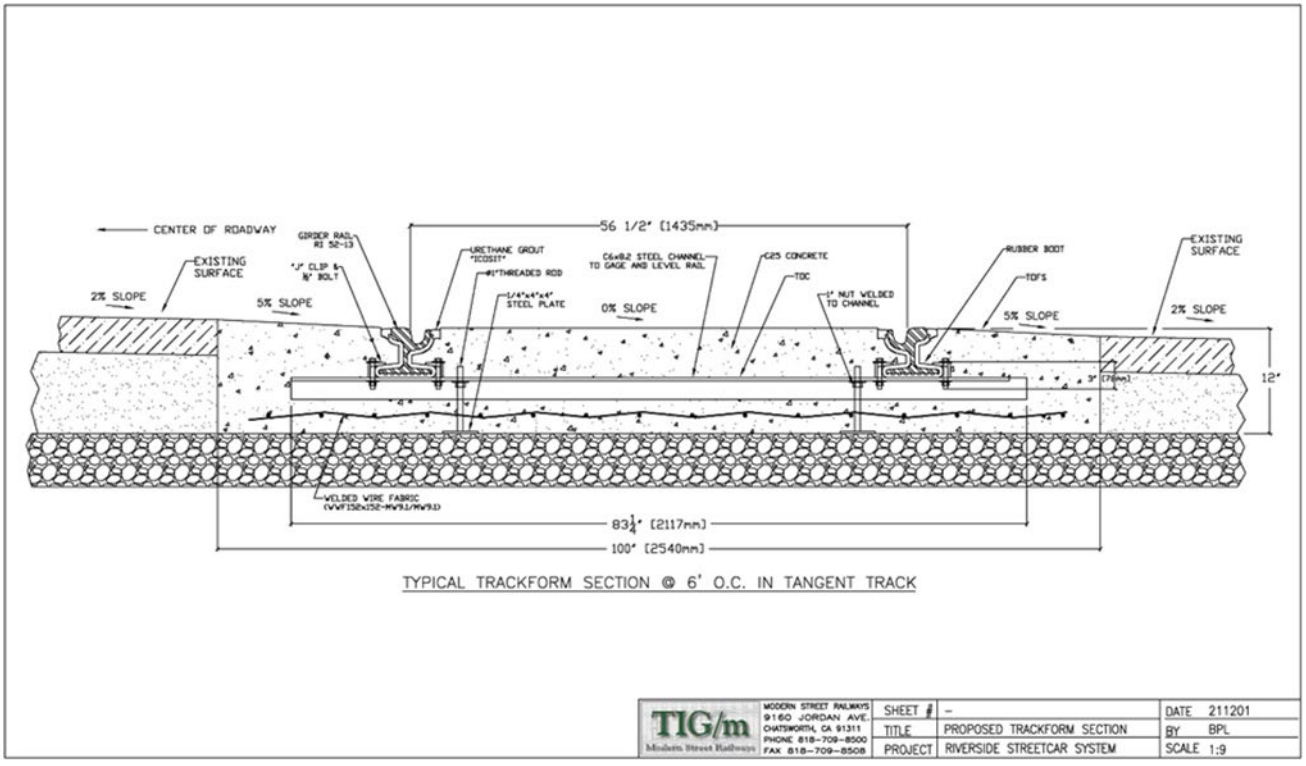
For the longevity of a rail system the conformality of the wheel profiles and track section are of utmost importance. The TIG/m Wheel/Rail Interface is designed under TCRP, Report 155 for maximum conformality to mitigate all derailment hazards:[57]

Figure 5-9, *Wheel/Rail Interface*



5.4.4 Trackform

Figure 5-10, *Typical Paved Trackform Section*



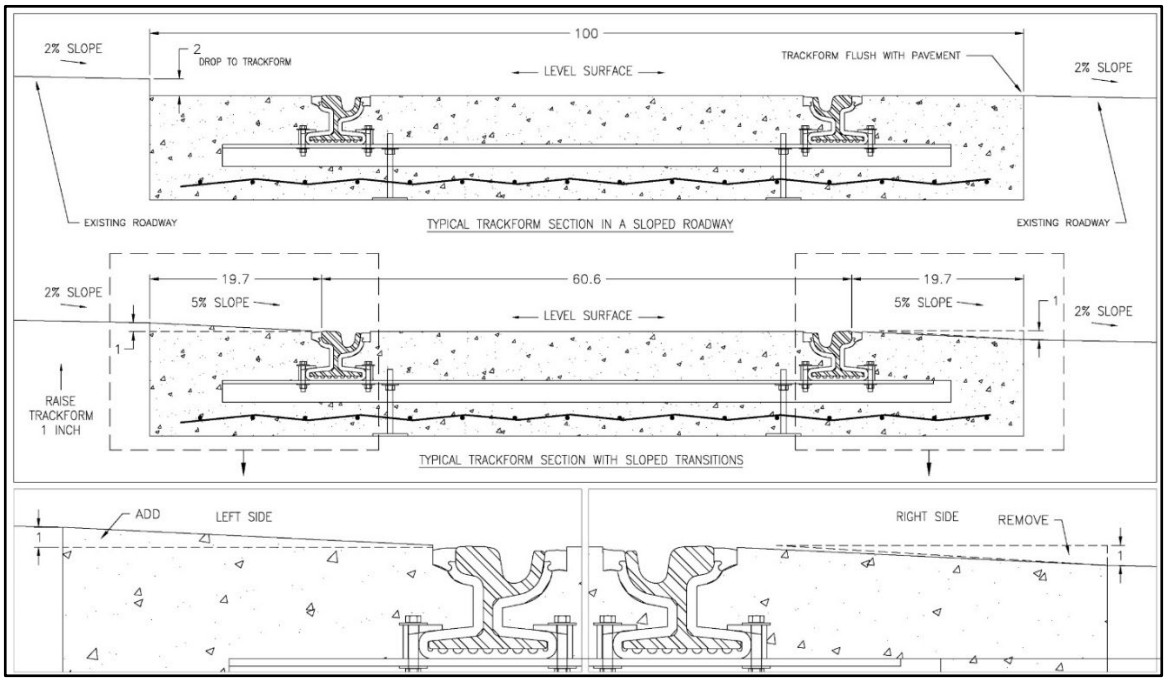
Phase 1 and 2 track installations would include turnouts that anticipate the installation of subsequent phases, to eliminate service disruption while new track is installed for the newest phase (see ***Section 5.4.5 Specialwork: Turnouts and Crossings***).

5.4.4.1 Dealing with Crowned Roadways

City documents indicate that there is a typical crowned roadway section on Market Street and University Avenue that includes a 2% cross-slope. Typically, streetcar track is flat—meaning there is no cross-slope—and the rail heads are at the same elevation (level in cross-section), unless design speed in turning movements indicates that superelevation (or cant) is necessary to offset centripetal force on the car and passengers. For the Riverside Streetcar System design, we will be using low speeds throughout all the curves and so will not be including superelevation. The streetcar track will be level between the rail heads in all circumstances.

When introducing a flat section into a cross-slope, it is necessary to increase the slope to account for the shorter distance allowed to make up the vertical offset. In the case of the TIG/m trackform we are only adding a 60” (nominal) flat which can be made up by two 20” (nominal) slopes of 5% in a four-lane roadway.

Figure 5-11, *Cross-Slope Modification in a Four-Lane Roadway*



Streets with different widths may require other solutions. Should the city have a capital improvement program (CIP) for street resurfacing that could be utilized during the track installation phase, multiple lanes of roadway could be used to distribute the change in slope over the entire crown.

Other streetcar design programs, such as the Kansas City Streetcar Main Street Extension, have shown 5% cross slopes in the traveled way, due to the inclusion of a flat streetcar cross section, as acceptable.

Panelized track sections can be manufactured with the same gauge-side flat section and field-side cross slopes shown in ***Figure 5-11.***

5.4.4.2 Utilities Relocation

A detailed study of available city documents relative to sub-grade in-street utilities was undertaken to determine where utilities are placed in the streets in relation to the proposed streetcar alignment. Not all potential utilities were found; telecommunications, underground power, and sewer systems were not included in the drawings available to us. Where active utilities run parallel to, and underneath, the proposed streetcar track slab, an estimate was produced for relocating those utilities. For water lines we used a figure of $35/inch diameter/ foot provided by the RPU. For the gas lines, we used Unit Cost Database for Utility Relocation Projects by Kathuria. We found this system of estimation to be very well defined. The unit costs were derived by comparing RS Means (U.S. national averages) with actual contract costs for full scope projects performed for the Texas Department of Transportation (TxDOT). Any deficiencies in this estimation represented by conversion to California costs should be amply addressed in the 78% contingency applied to this Line Item in the CAPEX Cost Table.[58]

For our estimate we used Kathuria's highest unit cost given for the specified utility and pipe size, installed using the boring and casing method. Example: 4" Gas Line+ $236/foot. For the full worksheet of utilities costs and drawings see ***Appendix H: Utilities Relocation.***

In total we have identified the relocation of approximately 9,100 linear feet of water line, and approximately 4,700 linear feet of gas line.

Where utilities are not directly beneath the proposed track slab or are running beneath the track slab at oblique angles, the TIG/m panelized trackform (See Section 5.4.4.3) may be employed if deemed necessary during design development review of the utilities in coordination with City Staff and RPU to allow for future access. A contingency cost is added to the track construction for panelized track installation in ***Table 9-1*** on line 1.5.

Figure 5-12, *Utilities Relocation - Downtown*

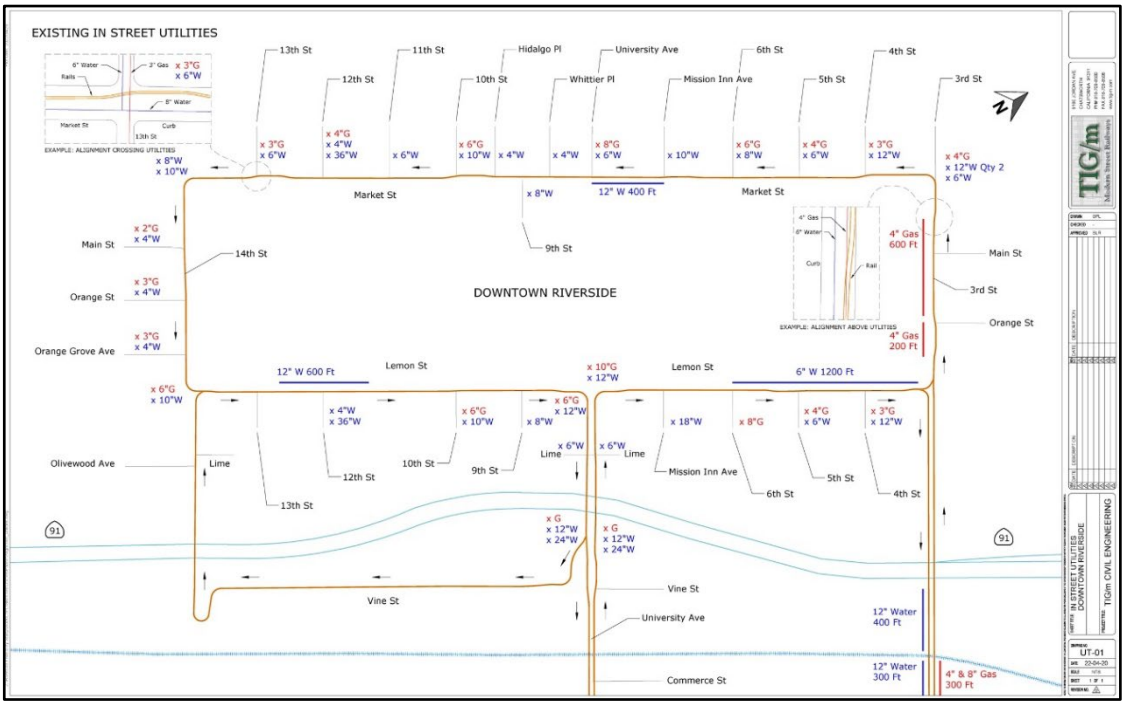


Figure 5-13, *Utilities Relocation Costs – Eastside*

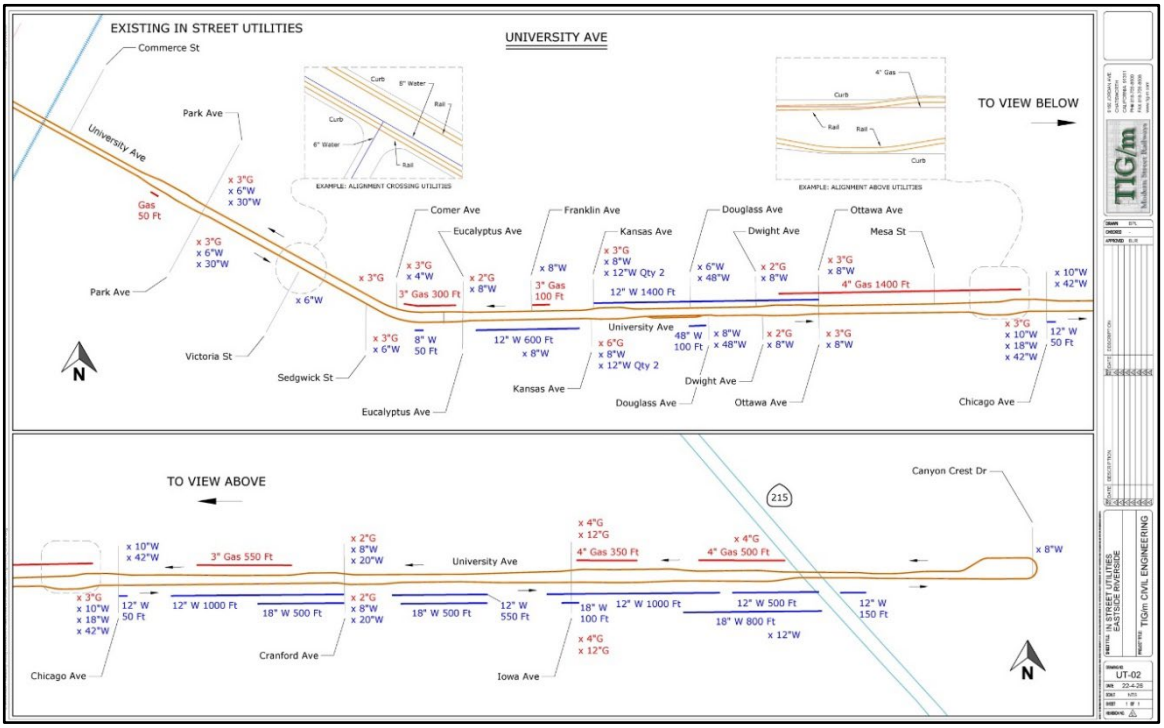
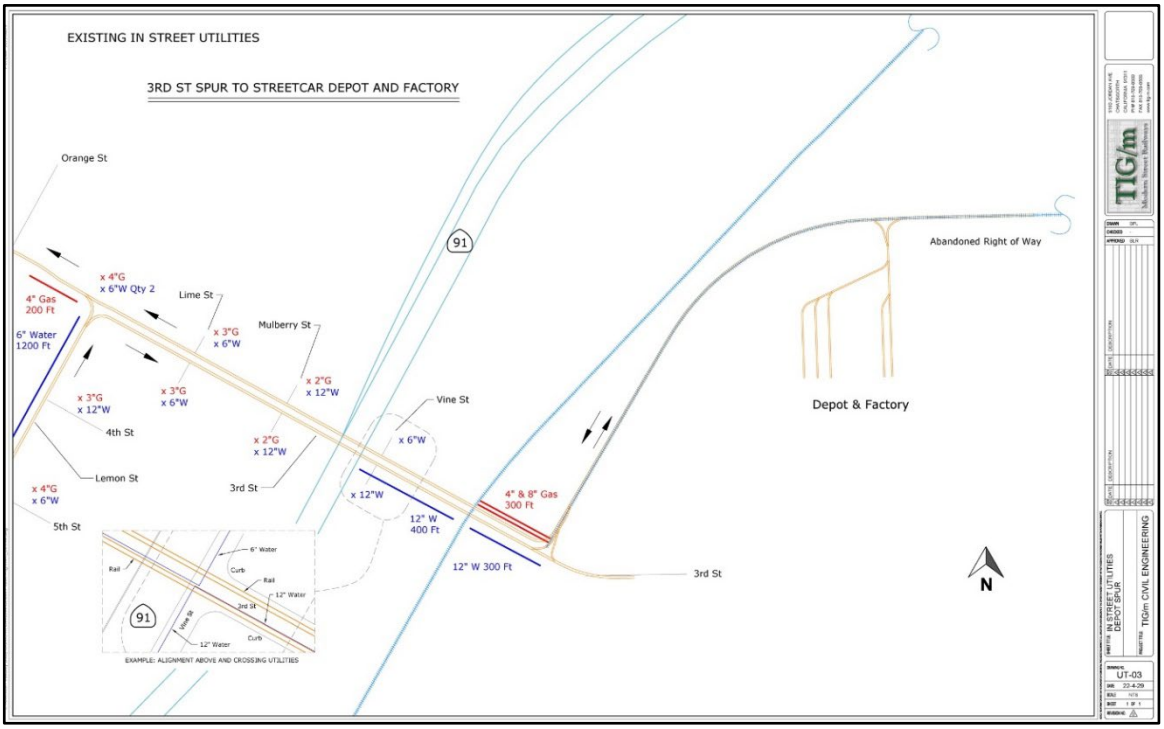


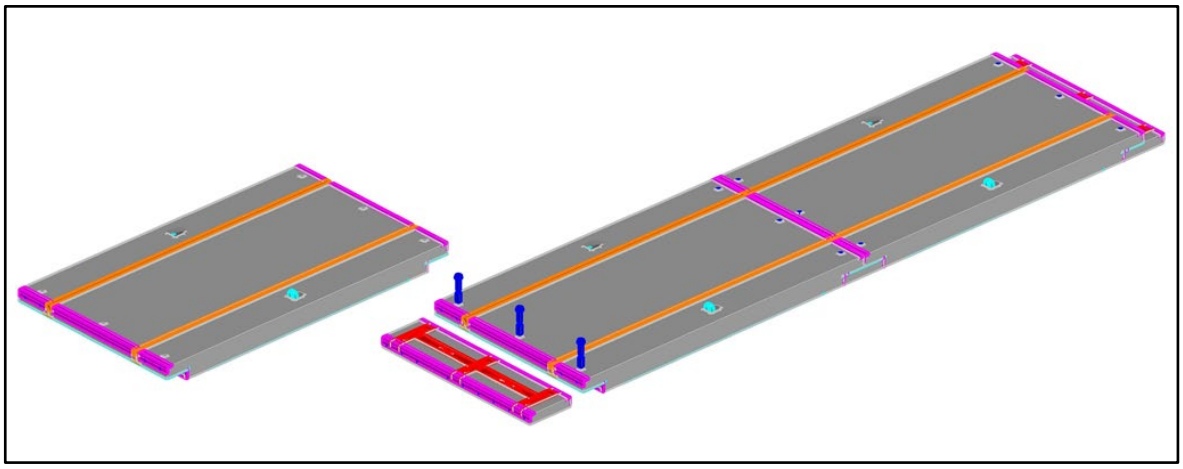
Figure 5-14, *Utilities Relocation Costs, 3rd Street*



5.4.4.3 Panelized Trackform Sections

To help avoid underground utilities relocation costs, TIG/m offers low-impact pre-cast panelized sections of concrete embedded standard-gauge railway track, to provide access to installed underground utilities. These panelized sections are 10" deep and 12'-14' long and can be removed to access sub-grade utilities where remediation is expected or where access in the future is necessary. Base and sub-base conditions for application of the panelized trackform will be identical to CalTrans Standard Plans for cast-in-place concrete roadway. Track panels and precast cross-tie panels are designed to handle load-transfer with no special base preparation. Panelized track sections are installed with elastomeric grout sealant at all joints between panels and existing roadway, obviating the need for special drainage of the panel system. See ***Appendix N: Modified Trackforms: Removable Panelized Track Sections*** for detailed drawings.

Figure 5-15, Panelized Trackform Section

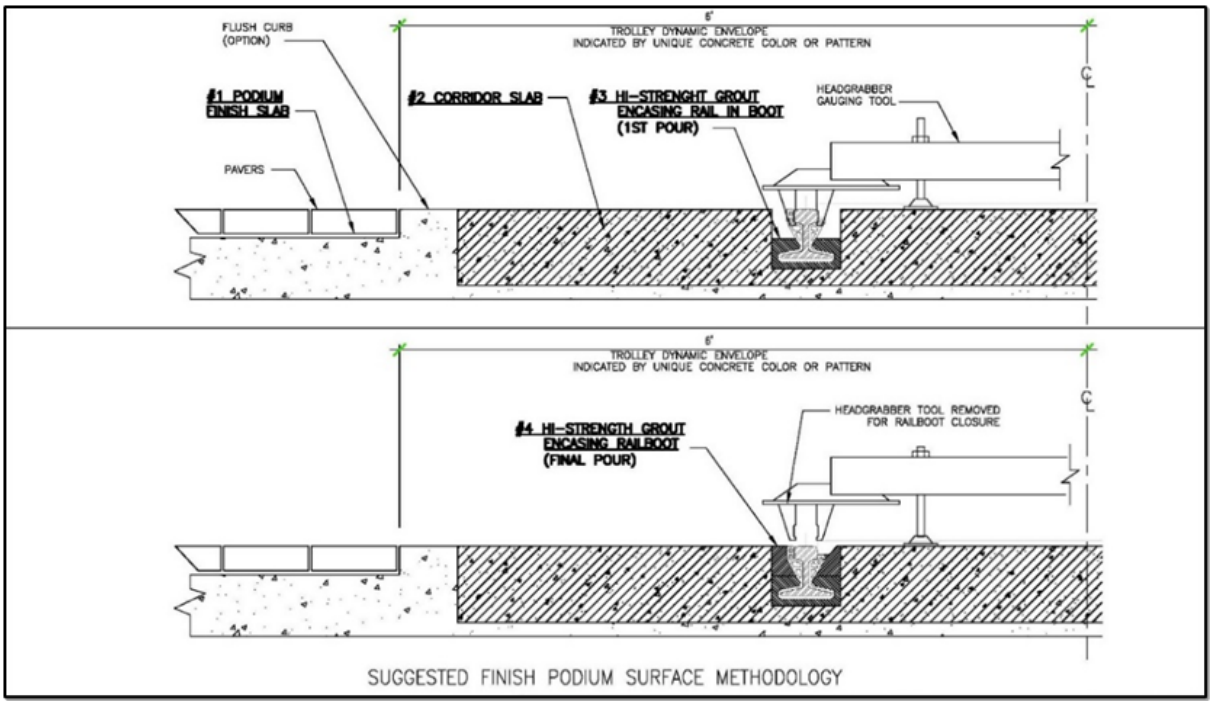


5.4.4.4 Highway Overpass Trackform

For the 14th Street overpass of SR-91, track will need to be applied to the existing bridge structure. The 5-ton axle loads of the TIG/m Trams is much lighter than the required AASHTO H20-24 loading requirement of Caltrans highway overpasses but adding rail will require coordinated design efforts with Caltrans. Two options are embedment by saw-cutting individual channels, 6½" deep by 8" wide to install rails or adding a plinth with track to the existing roadway surface. In either case rail will be fully embedded throughout with the top-of-rail being co-planar with the roadway surface.

If CalTrans indicates that existing structural design will permit saw-cutting, then the following top-down track installation would be specified:

Figure 5-16, *Finish Surface Methodology for Track on Overpass*



If saw-cutting will not be allowed, then adding a track lane plinth, or a full bridge resurfacing with embedded track will be investigated. TIG/m has previously been involved in design and build of both the saw-cut and the build-up solutions for other projects and does not believe this issue to be a potential “fatal flaw” in the Riverside Streetcar concept.

5.4.5 Specialwork: Turnouts and Crossings

Specialwork, as a category of track system components, comprises all custom and typical pre-manufactured metal parts required to join running rails into a contiguous system. Examples are: turnouts (switches and frogs between diverging and converging tracks), expansion joints, and track diamonds (crossings). These components are normally manufactured according to the track construction drawings prepared by the designers. TIG/m is an experienced track engineering and design firm and for passenger ride comfort and equipment life-cycle longevity, we use flange-bearing specialwork throughout the design. TIG/m uses specially designed turnout machinery including double-point, flexive type switches, manual or automatic spring boxes, and grooved closure rails and frogs, all pre-assembled and encapsulated in the factory.

It is a good practice to include specialwork necessary to accommodate known future track system expansions to avoid interruptions in service during future construction. These have been included in our design for conceptual phases 3-5. However, for this Study, cost for the added turnouts is not included in the CAPEX.

There are many considerations for drainage and pedestrian/bicycle safety that are important to consider in the final design of specialwork placement. TIG/m is experienced in this work and will seek to incorporate all stakeholder input in the final designs.

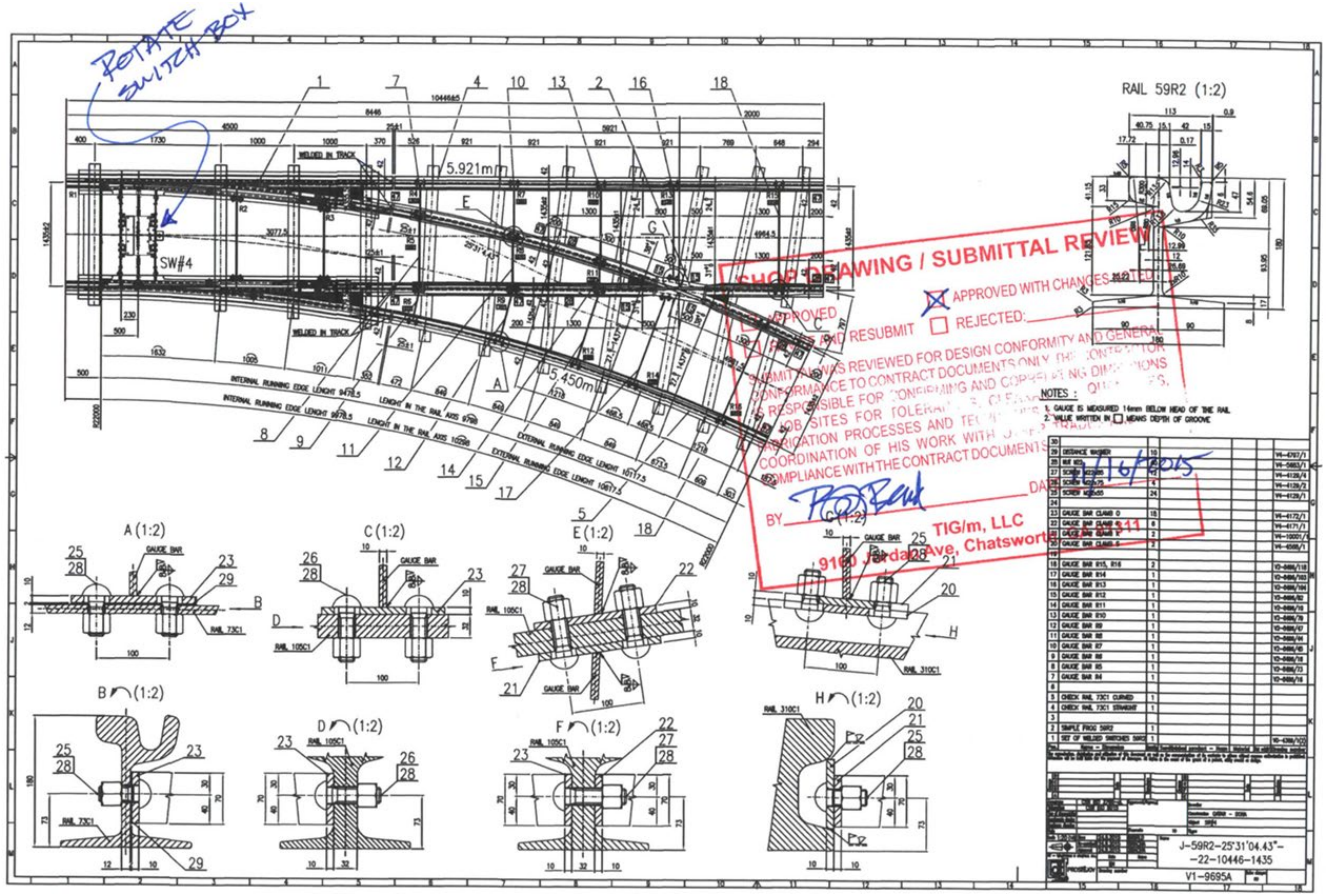
5.4.5.1 Turnout Design

For reference, a TIG/m-approved shop drawing shown in ***Figure 5-17*** describes details of a turnout design used in several of our passenger service and maintenance alignment projects.

For details of Phase 1 turnout and crossing locations please refer to ***Appendix G.***

- **Switch type**: Double-point, Flexive type
- **Supplier:** DT Vyhbkharna, Czech Republic

Figure 5-17, Specialwork: Turnouts



5.5 Streetcar Stations

5.5.1 Station Locations

Figure 5-18 shows conceptual station locations on the Phase 1 streetcar alignment. The orange shaded circles represent a five-minute pedestrian catchment radius from each station stop. Phase 2 through Phase 5 station locations are to be determined but five-minute walking distances between stations along all alignments in the pedestrian catchment will be described. Passenger Station final location within the right-of-way or in the public domain along sidewalks and easements will require close coordination between the TIG/m design team, the City, and the adjacent property owners.

Figure 5-18, *Station Location Concept, Phase 1*

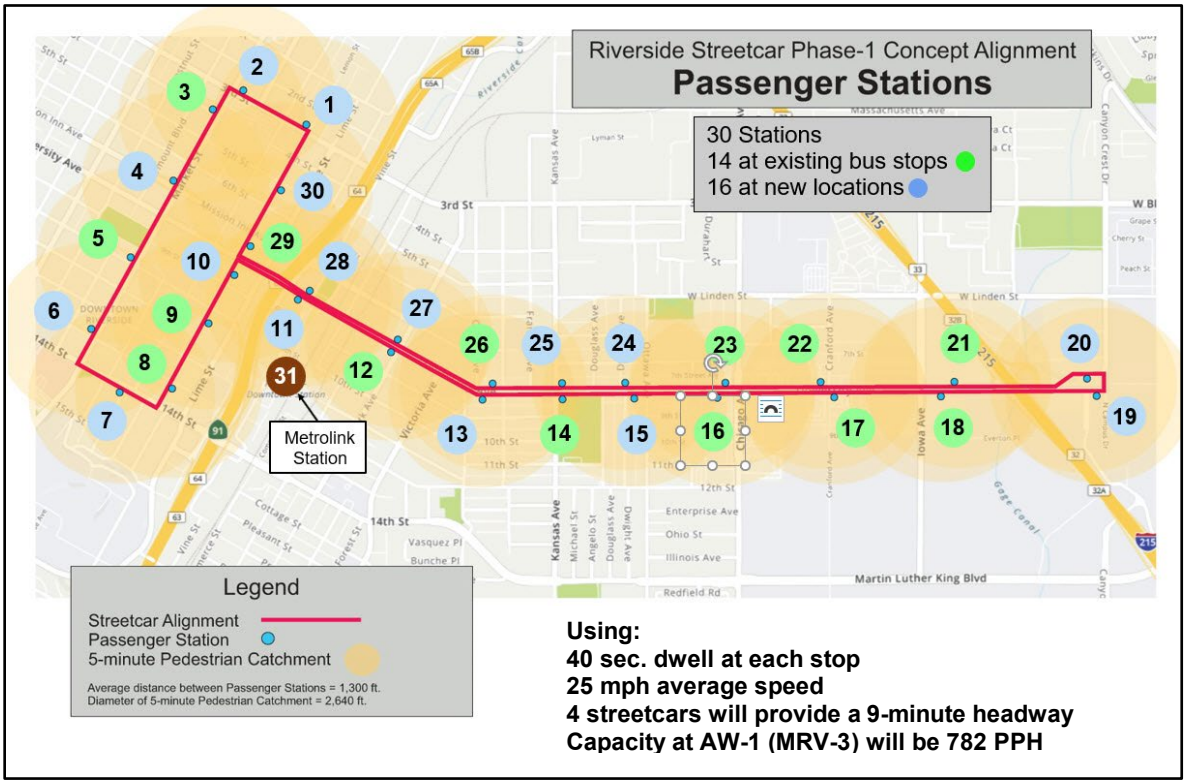


Table 5-1, Conceptual Station Locations

	Location	Travel Direction	New Station Location or at Existing Bus Stop
1	3rd Street at Lemon Street	NW	New
2	3rd Street at Market Street	NW	New
3	Market Street at 4th Street	SW	Existing
4	Market Street at Mission Inn Avenue	SW	New
5	Market Street at 10th Street	SW	Existing
6	Market Street at 13th Street	SW	New

	Location	Travel Direction	New Station Location or at Existing Bus Stop
7	14th Street at Orange Street	SE	New
8	Lemon Street at 13th Street	NE	Existing
9	Lemon Street at 9th Street	NE	Existing
10	Lemon Street at University Avenue	NE	New
11	University Avenue at Vine Street	SE	New
12	University Avenue at Park Avenue	SE	Existing
13	University Avenue at Comer Avenue	E	New
14	University Avenue at Kansas Avenue	E	Existing
15	University Avenue at Dwight Avenue	E	New
16	University Avenue at Chicago Avenue	E	Existing
17	University Avenue at Cranford Avenue	E	Existing
18	University Avenue at Iowa Avenue	E	Existing
19	University Avenue at N. Canyon Drive	E	New
20	University Avenue at N. Canyon Drive	W	New
21	University Avenue at Iowa Avenue	W	Existing
22	University Avenue at Cranford Avenue	W	Existing
23	University Avenue at Chicago Avenue	W	Existing
24	University Avenue at Dwight Avenue	W	New
25	University Avenue at Kansas Avenue	W	New
26	University Avenue at Comer Avenue	W	Existing
27	University Avenue at Park Avenue	NW	New
28	University Avenue at Lemon Street	NW	New
29	Lemon Street at Mission Inn Drive	NE	Existing
30	Lemon Street at 5th Street	NE	New
31	Vine Street Metrolink Station	SW	New

5.5.2 Station Accommodations / Recommendations

Stations will be designed to be easily recognizable, safe, easily maintained and also comply with the latest Americans with Disabilities Act (ADA) requirements. Next Vehicle Arrival (NVA) signage, which lets awaiting passengers know how many minutes it will be until they can hop on the next arriving streetcar, is highly recommended for each station. The digital signage could be programmed to include various messaging, including information about accidents on the alignment or other public service alerts provided by the city.

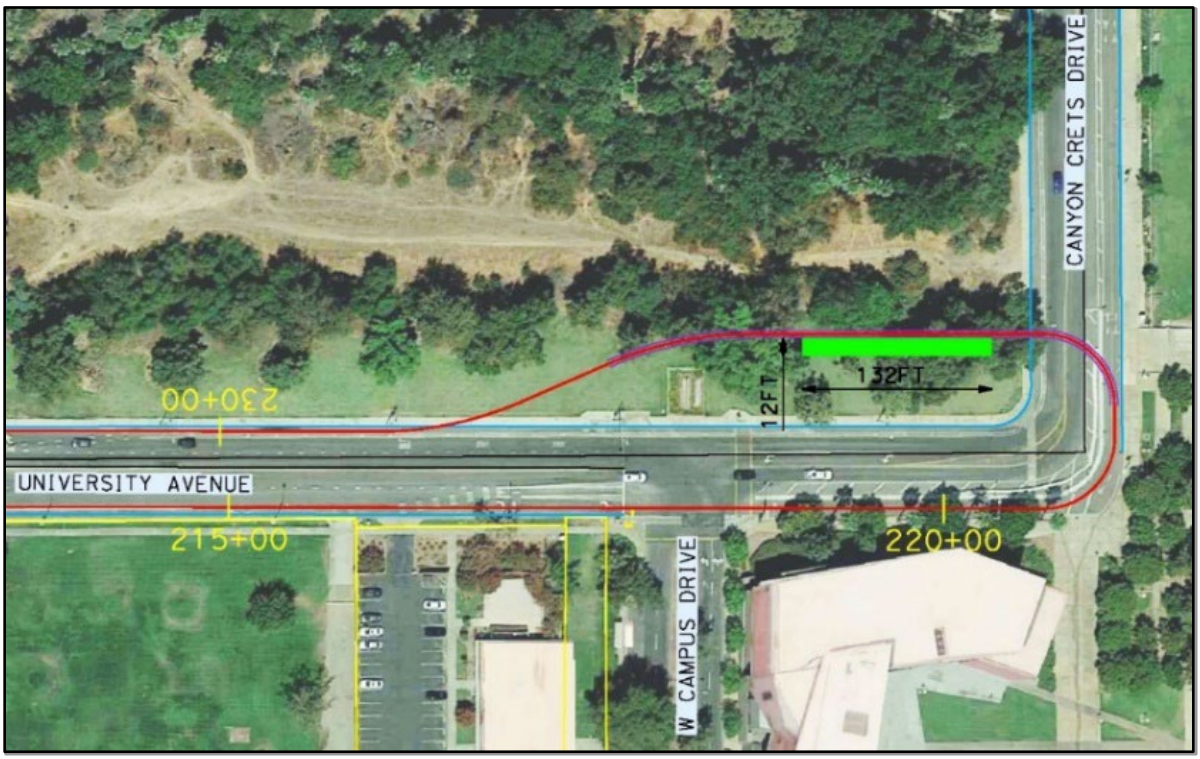
Possible amenities to consider that will be discussed further herein include:

- ADA Access
- Shelters
- General information
- Audible announcements and advertising
- Revenue -generating announcements
- Seating
- NVA Signage, including visual announcements
- Ticket/transit pass vending/refilling machines
- Lighting
- Trash receptacles.

5.5.3 Alignment East End Turnaround and Stations

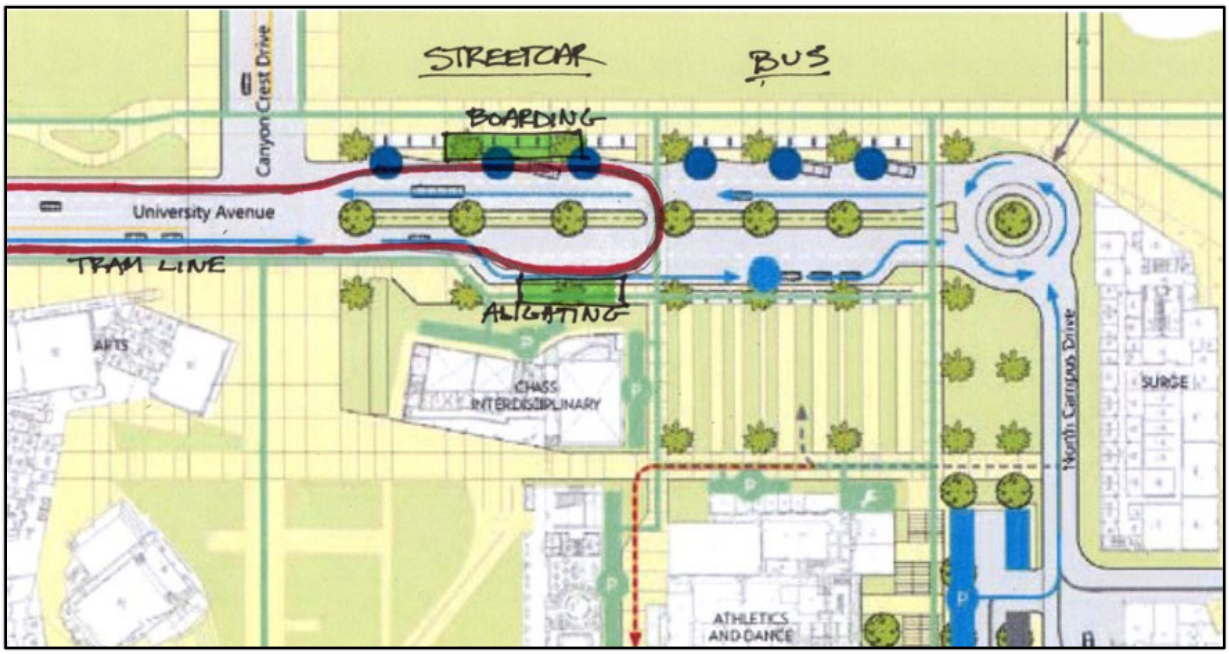
At the time of this study, two options have been discussed for the Phase 1 turnaround at the east end of the alignment. One is a turnaround at North Canyon Crest Drive with stations on both the south and north sides of the street—the northside station occupying a portion of the lot adjacent to University Avenue (see ***Figure 5-19***). An alternative turnaround would be a mobility hub on the UCR property, as shown in ***Figure 5-20.***

Figure 5-19, *Conceptual Turnaround at East End University Avenue (Phase 1)*



Map source: Google Maps

Figure 5-20, *Alternative Turnaround: Conceptual UCR Mobility Hub Configuration*



Background drawing source: PDC UCR [59]

5.5.4 Station and Multimodal Transit Hub Amenities

Station and transit hub amenities must include ADA access, should include digital “Next Vehicle Arrival” (NVA) signage, and may include shelter and seating, fare purchasing and refill capabilities, accommodations for printed schedules and brochures, bicycle parking and securement, and trash receptacles.

5.5.4.1 ADA Access

It is important to consider ADA Accessibility Guidelines when designing every aspect of the streetcar system, and this includes station stops. One of the most significant considerations when it comes to ADA compliance is boarding accessibility. In the Code of Federal Regulations, light rail is defined as a streetcar-type vehicle operated on city streets, semi-exclusive rights of way, or exclusive rights of way.

According to Title 49 CFR Part 38, ADA Accessibility Specifications for Transportation Vehicles Subpart D – Light Rail Vehicles and Systems, all new light rail, other than new level entry vehicles, must provide a level change mechanism or boarding device (e.g., lift, ramp, or bridge plate) and sufficient clearances to permit at least two wheelchairs to reach areas, each with a minimum clear floor space of 48 inches by 30 inches, which does not restrict passenger flow.
Paragraph 38.83(b)(8), Platform Entrance Ramp, states:

> The entrance ramp, or loading-edge barrier used as a ramp, shall not exceed a slope of 1:8 measured on level ground, for a maximum rise of 3 inches, and the transition without edge treatment up to ¼ inch. Thresholds between ¼ inch and ½ inch high shall be beveled with slope no greater than 1:20. [60]

At a minimum, each station will require a platform built to 11” above top of rail, to accommodate level boarding and alighting. Additional amenities will be discussed during the design phase of the project.

Figure 5-21, *TIG/m Passenger Station with Ramped Level Boarding for ADA Access*

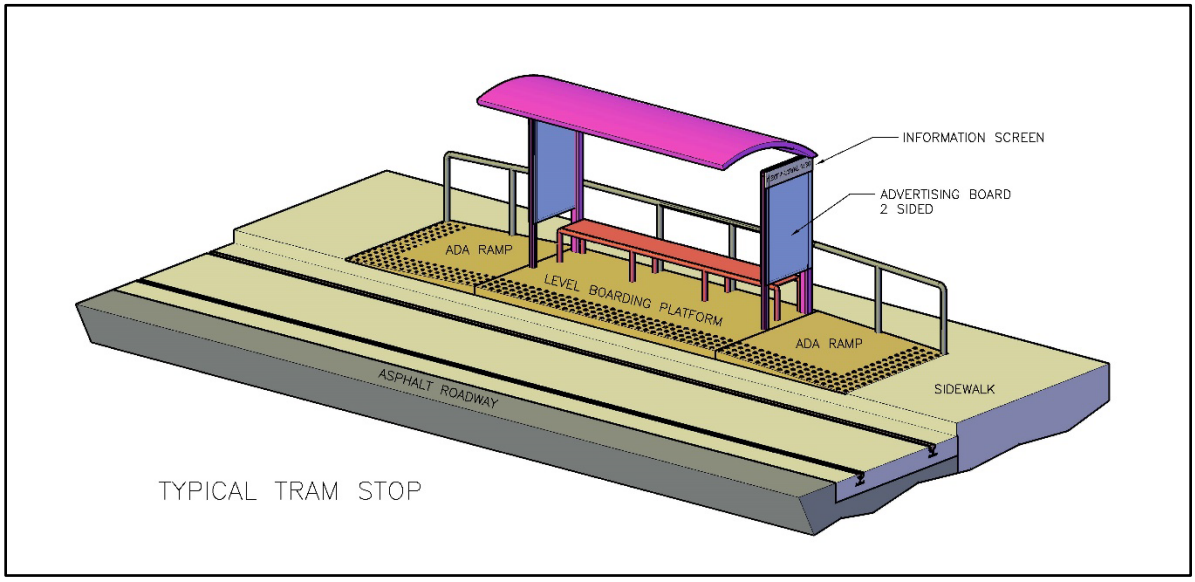
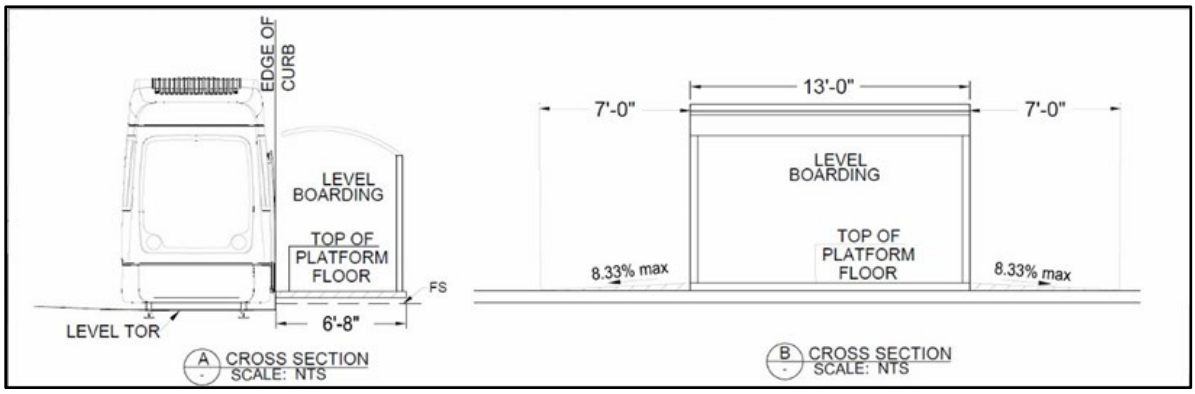


Figure 5-22, *Station Elevation Cross Section, Level Boarding*



5.5.4.2 Shelters

Shelters provide passengers with a sense of security and protection from weather and are important design elements of a streetcar stop. Most cities use ridership figures as the primary criterion for warranting shelter placement. Some studies suggest that stops with ridership exceeding 40 boardings per day are candidates for shelters. The following additional criteria are considered:

- Infrequent service (minimum of 30 daily boardings on routes where peak headways are greater than fifteen minutes)
- Proximity to senior housing and a minimum of 20 daily boardings
- Shelters funded and maintained by others
- Development of large new activity centers adjacent to transit where ridership is projected to meet criteria
- Consolidated bus stops (combined ridership totals increase likelihood of shelter placement).

TIG/m recommends shelter that provides shade as well as protection from rain.

Figure 5-23 shows a typical streetcar station in Seattle, Washington, which includes a shelter. Note that Seattle has installed a shelter with a transparent cantilevered roof section.

Figure 5-23, *Streetcar Station in Seattle, Washington, Showing Shelter*

5.5.4.2.1 Shelter Placement

Placements of shelters can greatly effect pedestrian movement along the sidewalk. A distance of 2' / 0.6m should be allowed between the shelter and the curb to allow for free movement when boarding and exiting. The shelters should have their long side parallel to the sidewalk to minimize interference in boarding and exiting from the streetcar. Streetcar shelters near intersections should be situated at least 3m from a crosswalk to avoid conflicts with pedestrian crossing. Shelters should not be placed between an extensively used building exit and the curb so that pedestrians retain direct access to the street from the building. Also, where possible, shelters should not be placed in front of building windows used for commercial purposes.

A major purpose of a shelter is to provide comfort and weather protection for riders while waiting for the streetcar service. Wherever possible, shelters should be located to avoid exposing passengers to splashing water from passing vehicle and runoff from adjacent buildings and landscape. They also should be orientated to provide as much protection as possible from wind and rain, with careful consideration of the sun's angles to allow maximum shade during peak use hours. Exit and entry openings should be oriented so that people are protected from the wind keeping in mind that the side of the shelter facing the street should remain open to allow easy boarding and exiting.

Typical dimensions of a streetcar shelter are listed below:

- Height: 8’ / 2.5m
- Length (parallel to the sidewalk): 15’ / 4.5m
- Canopy width: 7’ / 2.15m

5.5.4.2.2 General Information

It is important to provide general transit information at all stops, such as schedule and fare information as well as maps. It is recommended that the signs be high enough to be seen from a distance when there is a crowd and large enough to be read from a few feet away. Signs should be no closer than 600mm’ to the curb to prevent breaking of mirrors on vehicles and the scratching of vehicles.

5.5.4.2.3 Audible Announcements

Another option for conveying information is audio or “talking stops and streetcars” that would call out the arrival of the next streetcar, ADA announcements, and vehicle departure and arrival information at stops.

5.5.4.2.4 Revenue-Generating Advertising

Many cities of the world participate in advertising shelter programs. Along with providing and installing the shelters at no upfront cost to the transit agency, the advertising agencies comply with local rules regarding advertising content and all maintenance is provided by the advertising company or contracted by the company. Toronto is an example of a city where advertising in streetcar stops is prevalent. CBS Outdoor, contracted to post ads in all Toronto Transit Commission (TTC) systems including buses, streetcars, subway, and rapid transit. TTC received 2.3% of its revenue, or almost $17 million, from advertising in 2003.[61]

Print ads or digital/video options are available for transit stop advertising.

Figure 5-24, *Typical Advertising in a Toronto Transit Shelter*

Source: The Star[62]

Figure 5-25, *Creative Transit Stop Advertising*

Source: "The Bus Stops Here! 34 Bus Stop Guerilla Marketing Hacks" [63]

Rather than installing elaborate roofs over platforms, simple bus-stop style waiting shelters may be adequate. More elaborate stations can include, in addition to the shelter itself, amenities such as seating, trees, telephones, trash receptacles, information kiosks, drinking fountains, sculptures, clocks, and food vending. Although amenities at transit stops may enhance passenger (and pedestrian) experience and can lead to increased ridership, the mere presence of amenities does not guarantee usage--design and location are key factors. For instance, seating may go unused if it is too far from areas of activity, and some shelters provide little protection from sun, rain, and wind.

5.5.4.3 Seating

The design consideration for benches includes placement so that the bench faces the street, strength and durability of structure and materials, resistance to vandalism, placed on the back side of sidewalk a minimum of six to nine feet from the streetcar signpost, anchored to prevent unauthorized movement, and constructed for easy relocation to allow for events, such as stop relocations and street improvement projects.

There are several different types of seating including the following:

- Shelter bench - simply a bench found inside shelters
- Ad bench - containing advertising on the back of the bench
- Premium bench - about 3.2m in length, ideal for stops with minimum of 25 daily boardings and for stops located in business and retail districts where shelters are not appropriate
- Flip seat - a space saving option that should be reserved for special situations with minimum of 20 daily boardings
- Simme seat - mounted on a bus stop pole and is appropriate where there are curb tight sidewalks (see ***Figure 5-26***).

Figure 5-26, Simme Seat

Source: Simme Seat[64]

5.5.4.4 Next Vehicle Arrival Signage

TIG/m recommends digital "Next Vehicle Arrival" (NVA) signage at all stations, to display how many minutes it will be before the next streetcar arrives. Signs can be programmed to display other information, such as delay notifications and other public service announcements.

5.5.4.5 Ticket/Transit Pass Vending/Refilling Stations

The opportunity exists for the installation of transit pass vending and refilling machines at each station or at a centralized location. Many systems are now centered around an app with mobile phone activation used as well as smart cards.

5.5.4.6 Lighting

Lighting at stops increase riders' feeling of overall safety. Lighting should be directed so that it illuminates the waiting and boarding areas and be housed in a protective casing to reduce vandalism. Solar lighting is being implemented in several cities as a less costly, environmentally friendly alternative to running a power line to shelters. About 90 transit authorities throughout the world have installed solar lighting systems from Carmanah Technologies Corporation. Carmanah is a leading integrator of renewable and energy-efficient technology solutions that focuses on solar powered LED lighting, solar power systems (off grid and grid tie), and LED illuminated signage. A fully charged solar powered transit system can provide a minimum of 10 hours of normal lighting without any additional charging (sunlight). The system's energy management software tracks charging and discharging patterns, and dims lights accordingly to conserve power. This technology is what allows the systems to operate through a span of cloudy days.[65]

5.5.4.7 Trash Receptacles

A variety of trash receptacle size and styles are available, maintenance of which would need to be coordinated with local waste management contractors. Decisions regarding the installation and maintenance of trash receptacles would be those of the City of Riverside.

5.6 Virtual Streetcar Detection

Streetcars would be installed with equipment to produce a signal that would be transmitted via access points along the service alignment to the streetcar dispatcher's post in the depot. Dispatchers monitor the position of each streetcar on the alignment and can advise drivers to dwell, if necessary, in order to

manage a symmetrical headway, in the event of a delay due to an obstruction (accidents, traffic gridlock, obstruction on the tracks, etc.).

Streetcar location detection also supplies the NVA signage at stations as well as on the streetcars, via a signal sent from the equipment at the dispatcher's post.

5.7 Streetcar Priority Traffic Signalization

Streetcar Priority traffic signalization provides traffic green-light priority override for streetcars at signalized intersections. Pre-emption is a technical term that describes any occurrence where a normal automated traffic signal cycle is interrupted.

Traffic intersections along the conceptual passenger service alignments are currently equipped with traffic signalization systems typical of those found elsewhere in California. These signalized intersections will be equipped with detection systems to recognize a streetcar's approach, and are designed to automatically provide a green light in favor of a moving streetcar. The streetcar location detection system would facilitate streetcar priority signalization—to give streetcars priority over intersecting vehicular and pedestrian traffic at signalized intersections.

Efficient operation of a streetcar priority signalization pre-emption system is intended to:

- Allow streetcars to traverse intersections without the impediment of stopping for red traffic lights
- Allow streetcars to traverse and completely clear intersections before the light turns red, which would otherwise result in a streetcar obstructing other vehicular and pedestrian traffic
- Reduce the time requires to traverse the length of the alignment.

In practice, however, streetcars will be driven concurrent with ambient traffic flow. Streetcar drivers must always be prepared, as a default operating procedure, to observe and obey normal traffic rules—including stopping at all red traffic signals and refraining from entering a junction that the streetcar cannot completely clear before the light again turns to red, which would result in a streetcar obstructing other vehicular and pedestrian traffic.

The traffic signal tram priority system activates when a moving streetcar is detected as it enters a signalized junction "approach zone" and remains active until the streetcar completes its travel through the approach zone. The upcoming traffic signal light is designed to then change to green, to allow streetcar priority through the junction.

The activation and completion of a streetcar priority signalization pre-emption sequence requires a moving streetcar that will enter, traverse, and clear an approach zone. Therefore:

- If a streetcar is stopped within an approach zone because of heavy traffic, for example, automatic signal pre-emption will be cancelled. The streetcar driver will need to manually request signal pre-emption, by pressing a button on the driver's console when streetcar acceleration is about to commence. The streetcar driver must wait until the traffic signal light turns green before entering and traversing the intersection.
- When a streetcar stops and parks at a station within an approach zone, automatic signal pre-emption will be cancelled. After passengers have alighted, new passengers have boarded, and the passenger doors have been closed, the streetcar driver will need to manually request signal pre-emption by pressing a button on the streetcar's driver's console.

5.7.1 Potential Travel Time Savings Due to Priority Signalization

Streetcar priority signalization theoretically removes from journey times the 75-second average wait time at red lights. Tram Passenger stop times will be subtracted from maximum advantage of green wave. For example, if an automobile were required to stop at each traffic light, and:

- If a streetcar did not need to stop at any of the eight (8) traffic signals on Market Street between 3rd Street and 14th Street, the travel time could be up to 10 minutes shorter. Subtracting the dwell time at 4 tram passenger stops (4 x 40 sec. = 2.7 min) the resulting time advantage over automobile travel at the same speed is 7.3 minutes.
- If a streetcar did not need to stop at any of the 13 traffic signals along University Avenue between Canyon Crest Drive and Lemon Street, the travel time could be up to 16 minutes shorter. Subtracting the dwell time at 9 tram passenger stops (9 x 40 sec. = 6 min) the resulting time advantage over automobile travel at the same speed is 10 minutes.
- A streetcar operating on the proposed Phase 1 alignment, from UCR as a starting point and running the entire circulation of Phase 1 back to UCR, could see a reduction of up to approximately 50 minutes Subtracting the dwell time at 30 tram passenger stops (30 x 40 sec. = 20 min) the resulting time advantage over automobile travel at the same speed is 30 minutes due to traffic signal “green wave”.

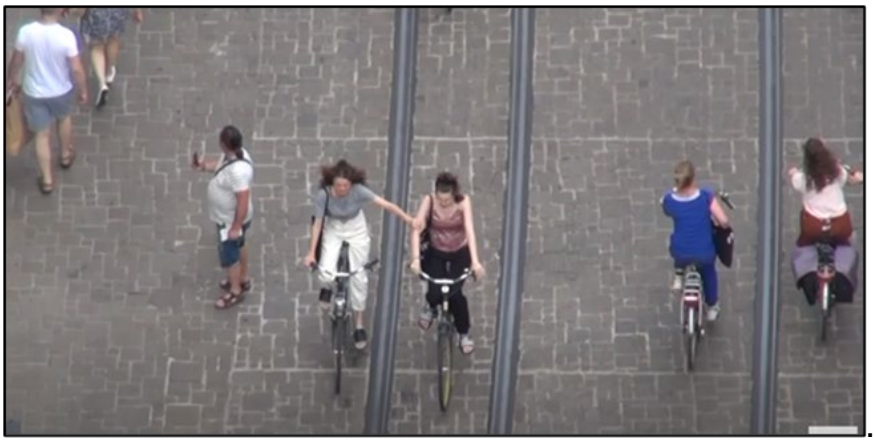
In addition to this numerical time advantage of streetcar travel over automobile travel, remaining automobiles traveling along with the streetcar-generated “green wave” between stations benefit from a progressive cascade of green lights without the need to stop for red lights at those intersections, resulting in continuous traffic flow over several intersections.

5.8 Bicycle Facilities

The bicycle mode of transportations is very important to the multi-modal vision for a walkable city and the utmost importance will be given to working with the Public Works Department in correlating the design of the streetcar alignment to the optimal configuration of bike lanes. The most important consideration when designing the streetcar and bike lanes together is to mitigate, however possible, the feeling that the bicyclist is “trapped” between the large vehicles and other traffic. All of the roadway considered for the streetcar network includes dedicated bicycle lane facilities or is “bicycle-friendly”.

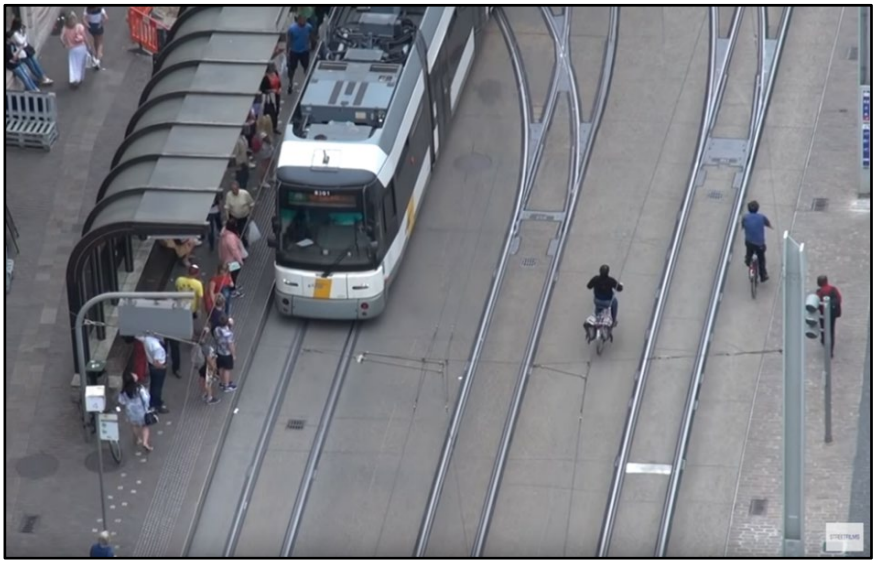
Bicycles and Trams have been shown to coexist beautifully in many northern European towns and cities where bicycling has become a major and, in some cases, dominant mode of transportation.

Figure 5-27, *Bicyclists and Pedestrians in Concert with Tram Tracks in Ghent, Belgium*



Source: Streetfilms. “Watch People Bike the Rails in Ghent, Belgium (Streetfilms Extra)”. [66]

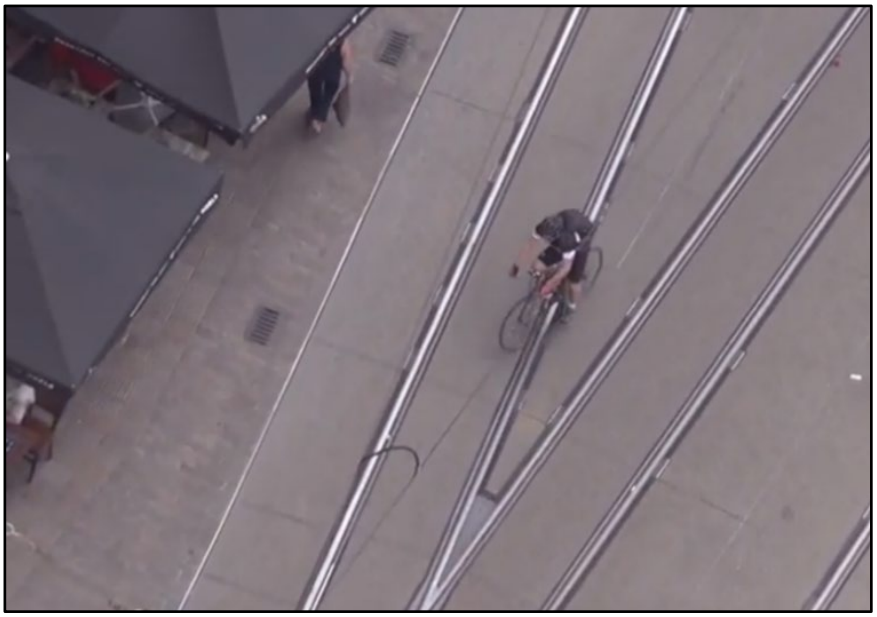
Figure 5-28, *Bicyclists Sharing the Roadway with a Tram in Ghent*



Source: Streetfilms. "The Innovative Way Ghent, Belgium Removed Cars From The City". [67]

Although crossing tracks, especially at a low angle, has been seen as hazard for bicyclists, the best way to mitigate this is to use rubber in-fill in the flangeway. This will be used in the Riverside streetcar alignment at any bicycle lane crossing. The rubber in-fill will support the weight of a bike rider, preventing the bicycle tire from entering the flangeway, but will compress under the weight of the tram wheel allowing it to pass unhindered.

Figure 5-29, *Cyclist Crossing Tram Tracks in Ghent*



Source: Streetfilms. "Watch People Bike the Rails in Ghent, Belgium (Streetfilms Extra)". [68]

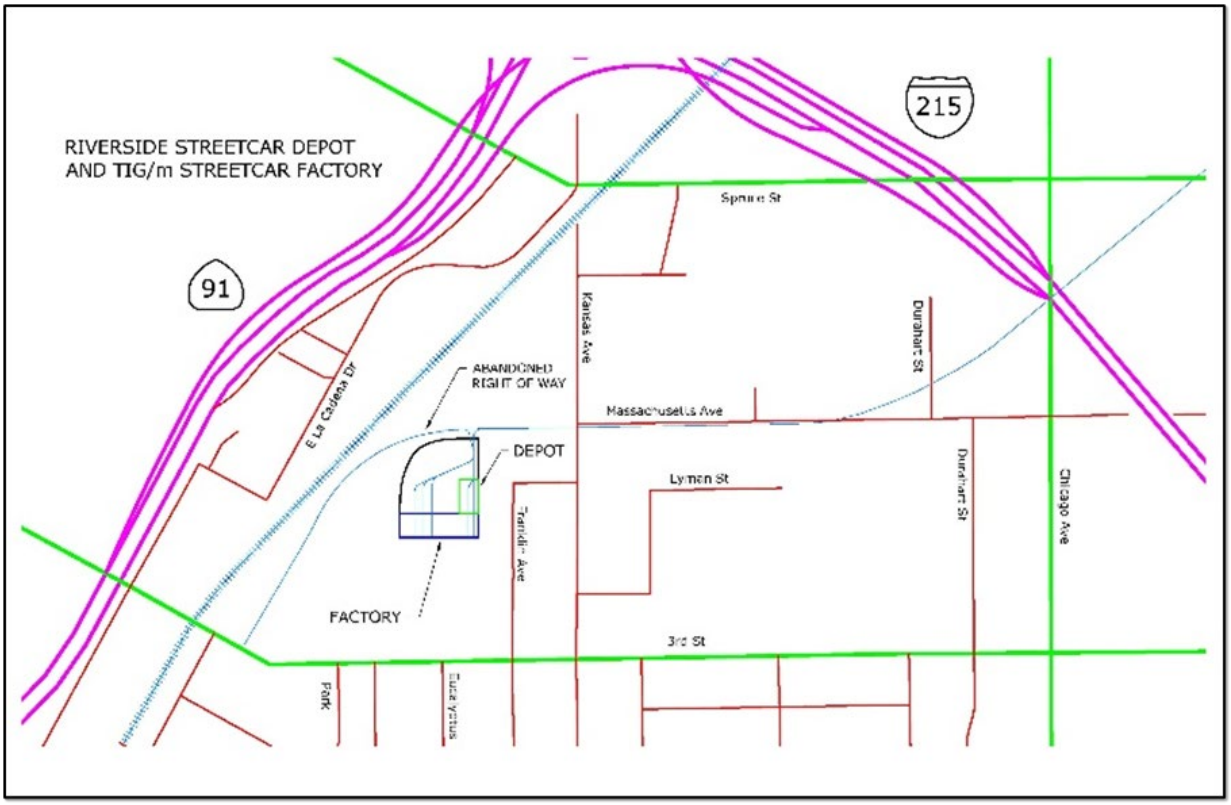
TIG/m considers the cooperative design of bicycle lane/tram way as one of the most important aspects of the Riverside Streetcar Project and looks forward to working in collaboration with Public Works on this configuration. Further considerations for reconfigured bicycle lanes will be included during design development stages, when contracted.

5.8.1 Maintenance Depot

TBD, but ***Figure 5-30*** and ***Figure 5-31*** show sketches of a layout for a depot on a property currently under consideration. The depot requires a switching yard, indoor and outdoor stabling areas, dispatch and administrative offices, break and hygiene facilities maintenance pits, vehicle charging and fueling stations, hydrogen fuel generation and storage equipment, as well as all tools and equipment required to maintain the fleet of streetcars.

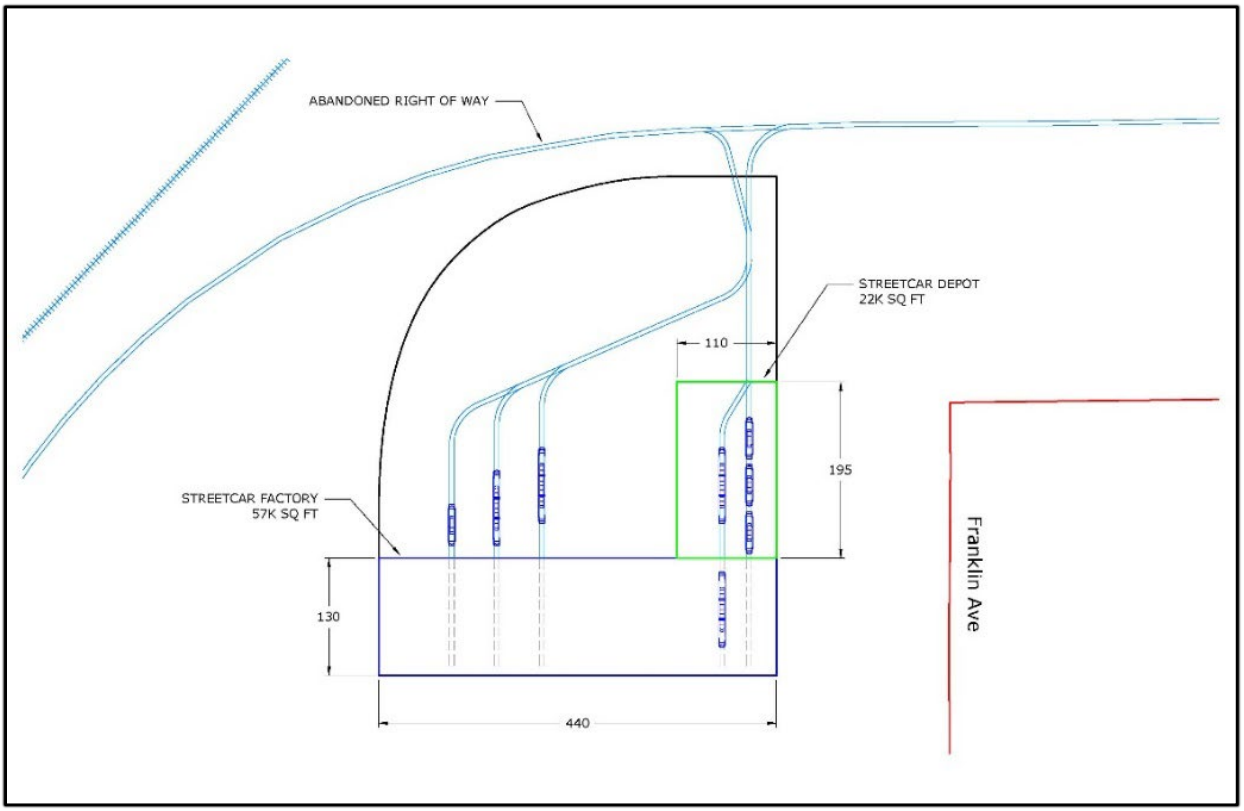
Figure 5-30, *Phase 1 Operations Alignment with Depot Access Spur and Test Track*

Figure 5-31, *Conceptual Depot Location*



A TIG/m design research and manufacturing facility is included in the sketch shown in ***Figure 5-32.***

Figure 5-32, *Depot and Manufacturing Facility Layout Sketch*



5.8.2 TIG/m Research, Design, and Manufacturing Facility

TIG/m is in discussions with the City of Riverside regarding moving its world headquarters to the city as part of its Technology Innovations District development. This facility would house TIG/m's research, design, engineering, manufacturing, and testing activities. TIG/m would welcome the opportunity to be a part of Riverside's Strategic Plan for attracting and maintaining technology innovators, and discussions between TIG/m and elected officials, city planners, and a variety of stakeholders have indicated the strong potential for a mutually beneficial association.

Its final location is TBD, but ***Figure 5-32,*** above, shows a rough sketch of a layout for a facility on a property currently under consideration.

Although the O&M Facility and the Manufacturing plant would be autonomous operations there would be internal communication between the two facilities through large roll-up doors and internal shared tracks. It is obvious that the O&M teams would benefit greatly from long-term maintenance and large scale rebuild/overhaul capabilities on-site. Normally, large scale rebuilds, such as bogie refurbishments, would require expensive and time-consuming transshipment of the equipment back to the manufacturer. This unique situation would provide many internships and training opportunities for student engineers and technicians from local schools and universities and jobs for new graduates as well.

TIG/m is a full-service street railway designer, vehicle manufacturer, and infrastructure builder. Our offices and factory new Research & Development Center and Manufacturing Facility will include Departments of Civil, Track, Structural, and Electrical and Mechanical Engineering, as well as state-of-the-art Fabrication Departments for the following disciplines:

- Metalworking (machining, forming, welding)
- Plastics (machining, forming, joining)
- Composites (engineering, forming, lay-up)
- Electronics (engineering, fabrication)
- Hydraulics and pneumatics
- Woodworking
- Assembly
- Finishing (painting, glazing)
- Testing and Certification

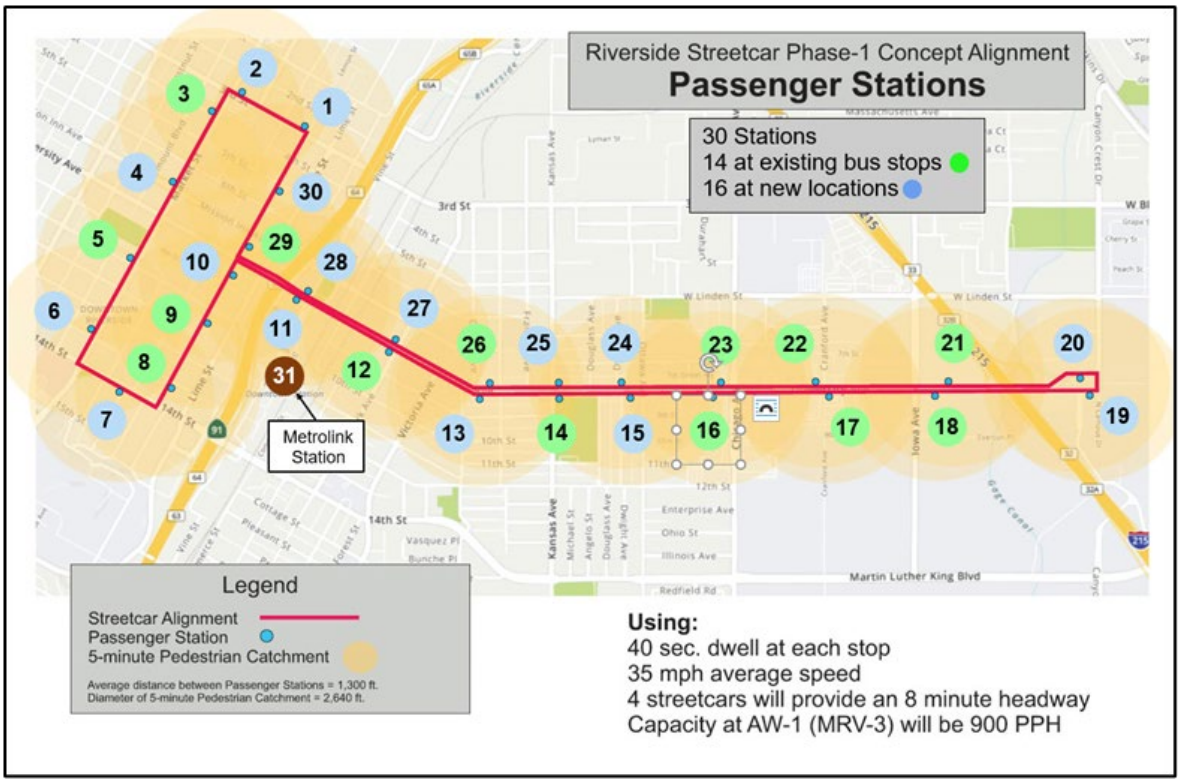
Section 6:
Operations Plan

6 Operations Plan

This section will examine theoretical capacity calculations and scheduling options considered for the Phase 1, as presented in ***Section 5***, followed by suggested staffing requirements for Phase 1 system operations and maintenance. We assume that these recommendations will change according to actual requirements, determined during design development of Phase 1, as it is explored and developed over time. For the sake of simplifying the duty-cycle calculation, the intermittent Metrolink service (three times per day) is not included in the following work. However, the track and infrastructure for that service is included in the CAPEX and Cost Model.

Passenger service would commence at Station 1, the first station after exiting the depot alignment and proceed in a counter-clockwise direction around the alignment.

Figure 6-1, *Theoretical Passenger Station Locations*



6.1 Duty Cycle Calculations and Theoretical Capacity

Terms

AW-1 = 32 passengers, seated only
AW-2 = 80 passengers, seated and standing @ four (4) per square meter (p/m^2)
AW-3 = 110 passengers, seated and standing @ six p/m²
PPH: passengers per hour
PPD: passengers per day
PPY: passengers per year
FPM: feet per minute

Assumptions

- Using TIG/m MRV-3 100-passenger (nominal) streetcar
- 30 passenger stations
- 7 miles of revenue alignment
- 40 second dwell at passenger stations
- 25 mph average speed
- Average passenger trip length, 8 stops

30 station stops →	@ 40 second dwell time 30 x 40 ÷ 60 = 20 minutes
25 mph average travel speed →	@ 2,200 FMP 7 mi. x 5280' ÷ 2,200 = 16.8 minutes 1 cycle = 36.8 minutes
	60 min. ÷ 36.8 min. = 1.63 cycles per hour
9-minute headway →	36.8 min. cycle ÷ 9 min. headway = 4 peak vehicles
16-hour passenger service day →	16 hours x 1.63 hourly cycles = 26 cycles per day
14-hour passenger service day →	14 hours x 1.63 hourly cycles = 22.82 cycles per day
12-hour passenger service day →	12 hours x 1.63 hourly cycles = 19.56 cycles per day
Average trip = 8 station stops →	30 stops ÷ 8 stops per trip = 3.75 trips/seats/cycle

Factors

- 36.8-minute full cycle
- 1.63 cycles per hour
- 4 peak vehicles
- 26 cycles per day (16 hours, weekdays)
- 22.82 cycles per day (14 hours, Saturdays)
- 19.56 cycles per hour (12 hours, Sundays)
- 3.75 trips/seat/cycle
- 365 operational days/year

Using these Factors, we can calculate the capacity of the streetcar fleet during each day of the week. This then allows us to find the average capacity for the year, which is used in the Cost Model, where the yearly ridership is expressed as a percentage of capacity at AW-1.

AW-1 (32 passengers, seated only) Weekdays
4 cars x 1.63 cycles/hour x 32 passengers x 3.75 trips/seat/cycle = **782 PPH**
4 cars x 26 cycles/day x 32 passengers x 3.75 trips/seat/cycle = **12,480 PPD**

AW-1 (32 passengers, seated only) Saturdays
4 cars x 1.63 cycles/hour x 32 passengers x 3.75 trips/seat/cycle = **782 PPH**
4 cars x 22.82 cycles/day x 32 passengers x 3.75 trips/seat/cycle = **10,954 PPD**

AW-1 (32 passengers, seated only) Sundays
4 cars x 1.635 cycles/hour x 32 passengers x 3.75 trips/seat/cycle = **782 PPH**
4 cars x 19.56 cycles/day x 32 passengers x 3.75 trips/seat/cycle = **9,389 PPD**

AW-1 Yearly

Weekdays (260 x 12,480)	= 3,244,800
Saturdays (52 x 10,954)	= 569,608
Sundays (52 x 9,389)	= 488,228
	4,302,636 PPY ÷365 = 11,788 PPD Avg.

6.1.1 Potential Travel Time Savings Due to Priority Signalization

As described in other Sections, including Section 5, streetcar priority signalization theoretically removes from a typical journey time the 75-second average wait time at red lights. When the tram dwell-time at stations is deducted, this can provide a baseline for overall time savings over automobile travel assuming equal average speeds between the two modes. For example, if an automobile were required to stop at each traffic light, and:

- If a streetcar did not need to stop at any of the eight (8) traffic signals on Market Street between 3rd Street and 14th Street, the travel time could be up to 10 minutes shorter. Subtracting the dwell time at 4 tram passenger stops (4 x 40 sec. = 2.7 min) the resulting time advantage over automobile travel at the same speed is 7.3 minutes.

- If a streetcar did not need to stop at any of the 13 traffic signals along University Avenue between Canyon Crest Drive and Lemon Street, the travel time could be up to 16 minutes shorter. Subtracting the dwell time at 9 tram passenger stops (9 x 40 sec. = 6 min) the resulting time advantage over automobile travel at the same speed is 10 minutes.

- A streetcar operating on the conceptual Phase 1 alignment, from UCR as a starting point and running the entire circulation of Phase 1 back to UCR, could see a reduction of up to approximately 50 minutes Subtracting the dwell time at 30 tram passenger stops (30 x 40 sec. = 20 min) the resulting time advantage over automobile travel at the same speed is 30 minutes due to traffic signal “green wave”.

In addition to this numerical time advantage of streetcar travel over automobile travel, remaining automobiles traveling along with the streetcar-generated “green wave” between stations benefit from a progressive cascade of green lights without the need to stop for red lights at those intersections, resulting in continuous traffic flow over several intersections.

6.2 Operations and Maintenance Staffing Requirements

The following draft organization chart is based on our experience with actual O&M organizations at our projects elsewhere around the world. The numbers of staff included may change when we receive confirmation of daily hours of operation for the Riverside Streetcar System. Please note as well that projected personnel numbers may require additional adjusting during the development of Operations and Maintenance Plans, when contracted.

The O&M organization chart (***Figure 6-2)*** and staffing recommendations table (***Table 6-1***) are based on two full shifts of drivers—with one driver for each vehicle—and maintenance personnel. Assume for these recommendations that full operations during Phase 1 will be:

- 16-hour passenger service day (Monday through Friday)
- 14-hour passenger service day (Saturday)
- 12-hour passenger service day (Sunday)

Until we have a confirmed daily schedule of hours, we will not be able to value engineer the personnel configuration. However, it should be noted that most maintenance functions are performed at night and a small maintenance staff is required to be present throughout the day to respond to any issues that may arise during passenger service operations. This fact always requires that two shifts of maintenance personnel are always required.

Figure 6-2, *Recommended O&M Organization Chart, Phase 1*

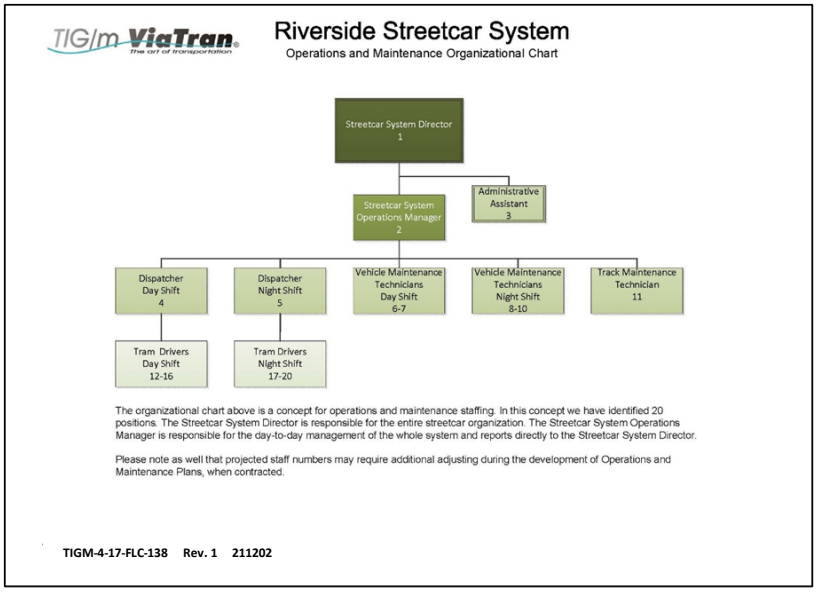


Table 6-1, *O&M Staffing Recommendations, Phase 1*

STAFFING RECOMMENDATIONS **Two 8-hour shifts per 16-hour day (Monday through Friday)** **Two 7-hour shifts per 14-hour day (Saturday)** **Two 6-hour shifts per 12-hour day (Sunday)**	
Personnel	**Per # of Cars in Service**
	4
Office staff	
O&M Director	1
Administration Manager	1
Administration Assistant	1
Dispatcher	2
Rolling Stock Operators	
Drivers	9
Conductor	0
Maintenance staff	
Maintenance/Mechanics	5
Maintenance/Welder/Track	1
	20
Max. Total Staff per Shift 10	

The above duty cycle results in:

- 55,124 annual man hours
- 22,048 annual vehicle revenue hours.

These quantities are used in the Operations and Maintenance Cost Model in ***Section 10.8 Initial and Yearly Operating Costs.***

6.2.1 Drivers and Line Management

The streetcar will operate 16-hours each day, five days per week. 14 hours per day on Saturday, and 12 hours per day on Sunday. The streetcar service will operate 365 days per year. This operating plan can be met with one operator (driver) per car, each driving an eight-hour shift. At least one “extra board” driver will need to be available to the streetcar system at all times. Riverside may choose to train a pool of potential streetcar drivers who may all alternate as the extra board for the streetcars. To cover all shifts seven-days per week, a minimum of 8 drivers will need to be trained to drive the streetcars for the Riverside Streetcar System.

Line supervision and dispatch for the streetcar line will be incorporated into the responsibilities of the Administrator and dispatcher.

A total of 18 hours per week of passenger station supervision are budgeted in the initial operating plan, as reflected in the efficiency factor.

6.2.2 Maintenance Staff

Riverside will have some flexibility in staffing this medium-sized facility. A total of two full time maintenance workers per day are assumed to be on site and a total of six trained maintenance staff will be needed to fill all shifts, seven days per week.

6.2.3 Fare Inspection and Supervision

Every transit line requires some level of supervision, to maintain reliability and provide assistance during incidents and delays. For a system of this size, the administrator (manager) will be allocated several tasks as part of his/her management duties. One of these duties would be inspections of the operations during service. About 18 hours per week has been budgeted to cover supervision needs, which would be done periodically, at various times of day and on various days of week. Costs for supervision have been included in the cost factor for operating costs.

Section 7:
Ridership Forecast

7 Ridership Forecast

7.1 Methodology

Ortúzar asserts, “Mathematical models do not solve any real-life transport problems: it is the interpretation of mathematical solutions which is useful to make decisions concerning transport problems. Simplified models may help in reducing the effort required to find a mathematical answer and in facilitating the subsequent interpretation of this solution in relation to the real problem. We use conceptual or mental models to understand, interpret and act in our professional life.

Better and richer mental models in the minds of planners and decision makers are probably as important as the use of rigorous and sound behavioral models in the computer, if transport planning is to be improved. Given the key role played by mental models in the use and application of mathematical ones, it seems sensible to investigate techniques for improving the first in order to get better solutions through the second.

But how are mental models acquired, revised, and enhanced? The main factors seem to be formal and informal education, discussions, and, above all, practical experience. One of the main problems facing planning education and training is how to provide realistic experience. This is particularly acute in the transport field where the most important consequences of a policy measure or infrastructure project may follow only after considerable time. Besides, it is surprisingly easy to become too involved in the details of particular techniques and lose sight of the wider process where they must fit.”[69]

The main source for this four-step procedure model is *Modelling Transport*, by Juan de Dios Ortúzar and Luis G. Williamson L. G. (2011). [70]

TIG/m’s extensive experience in designing and building streetcar systems in various countries around the world is just such practical experience mentioned above. This experience qualifies us to place primary emphasis on the “mental model” of ridership projection and rely on the computer run programs simply as a “sanity check”. For a list of TIG/m projects and references please see ***Appendix S.***

Step 1, Trip Generation: Where do trips originate?
This step calculates an estimate of the total number of trips generated by individuals in each zone, or from the zone in which a non-resident enters the city. Using U.S. Census data, Land Use Maps provided by the city, and the Institute of Transportation Engineers “Trip Generation Handbook, and Manual” we generate a total population of potential travelers and calculate a total number of trips generated within Riverside by residents and non-residents.

Step 2, Trip Distribution: Where are the destinations of these trips?
This step allocates trips originating in each TAZ within and to other TAZs within the overall city area and a Limited Travel Analysis Area (LTAA) which we will be using for the detailed model for Phase 1, thus producing a trip distribution matrix. In our Study this matrix will take the form of graphic illustrations showing the real-world movements of the respondents to our public survey.

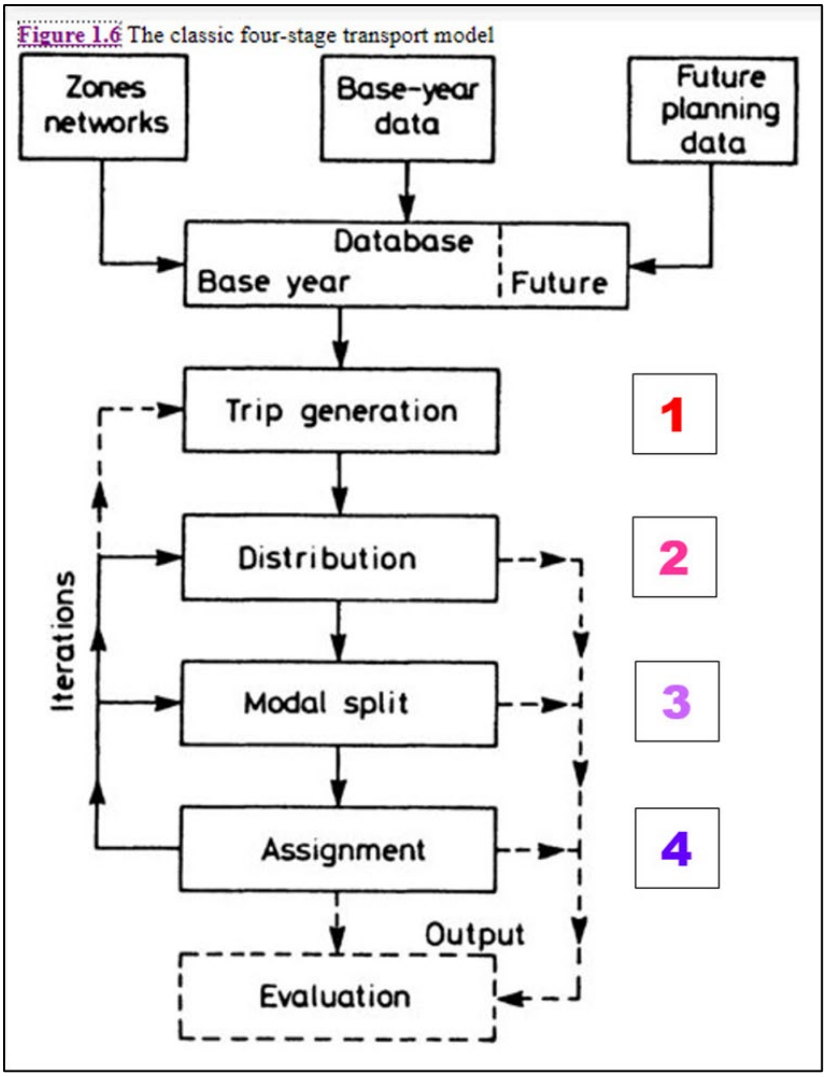
Step 3, Modal Split: What transit mode(s) are being used to travel within or between TAZs? This step defines choices of transit modes used within the Travel Study Area and splits the trips generated in Step 1 between the various modes, based on the aggregate response of the Riverside residents who participated in our survey, and a review of the documented bus ridership and traffic volumes in the study area.:

- Auto
- Bus / Tram
- Ride Hail
- Bicycle
- Ride Share
- Other

Step 4: Trip Assignment: To what route will the modal trips be assigned?

Trips within a given mode are assigned to routes that are available to them and *benefit them in terms of travel time, comfort, convenience, and cost.* This study is interested in public-transportation trips only and therefore we will be concentrating on assigning Bus/Tram trips. ***Figure 7-1*** describes this methodology in flowchart format.

Figure 7-1, *Demand Analysis Methodology Flow Chart*



Source: adapted from Ortúzar J. & Willumsen L. G. "Modelling Transport"[71]

7.2 Step 1: Trip Generation

Working from the U.S. Census for Riverside, California, and correlating the census tracts with our Travel Analysis Zones we have arrived at a resident population for each TAZ in the years 2019 and 2025. The U.S. Census projects an increase in the population of Riverside of 1% per year (see ***Figure 7-2***).

Figure 7-2, *TAZ Populations, 2019*

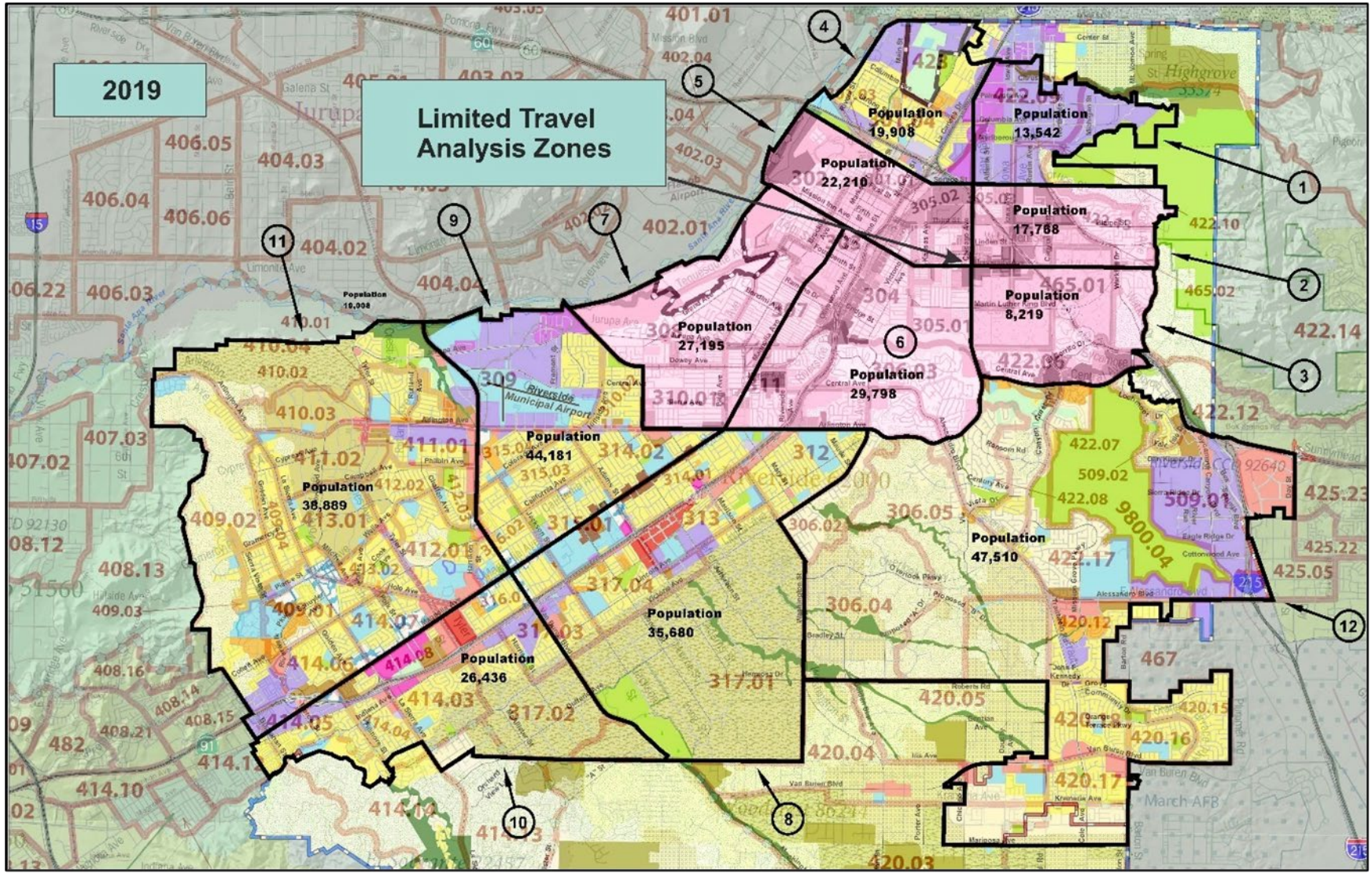


Figure 7-3, *TAZ Populations, 2025 Projection*

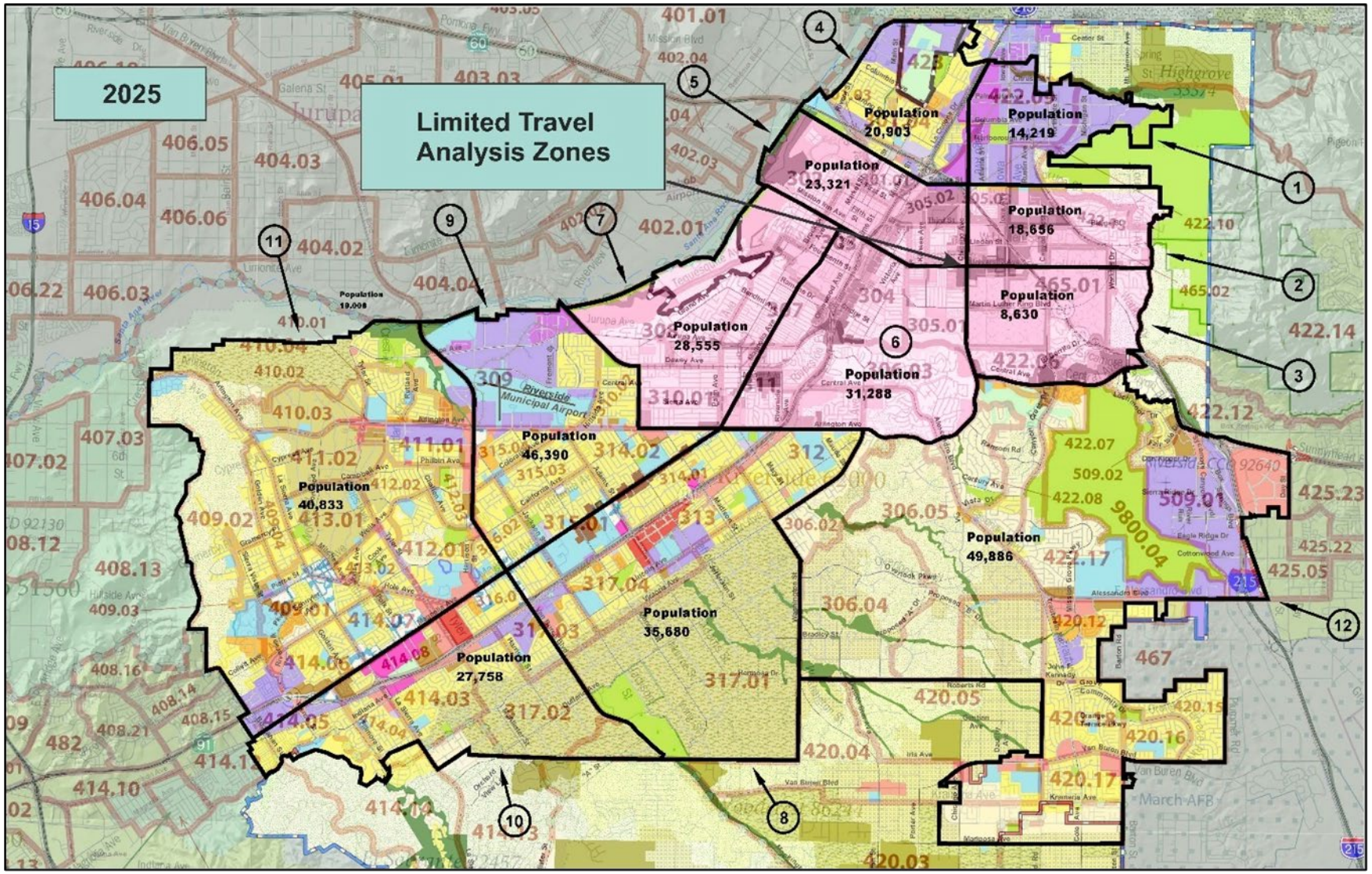
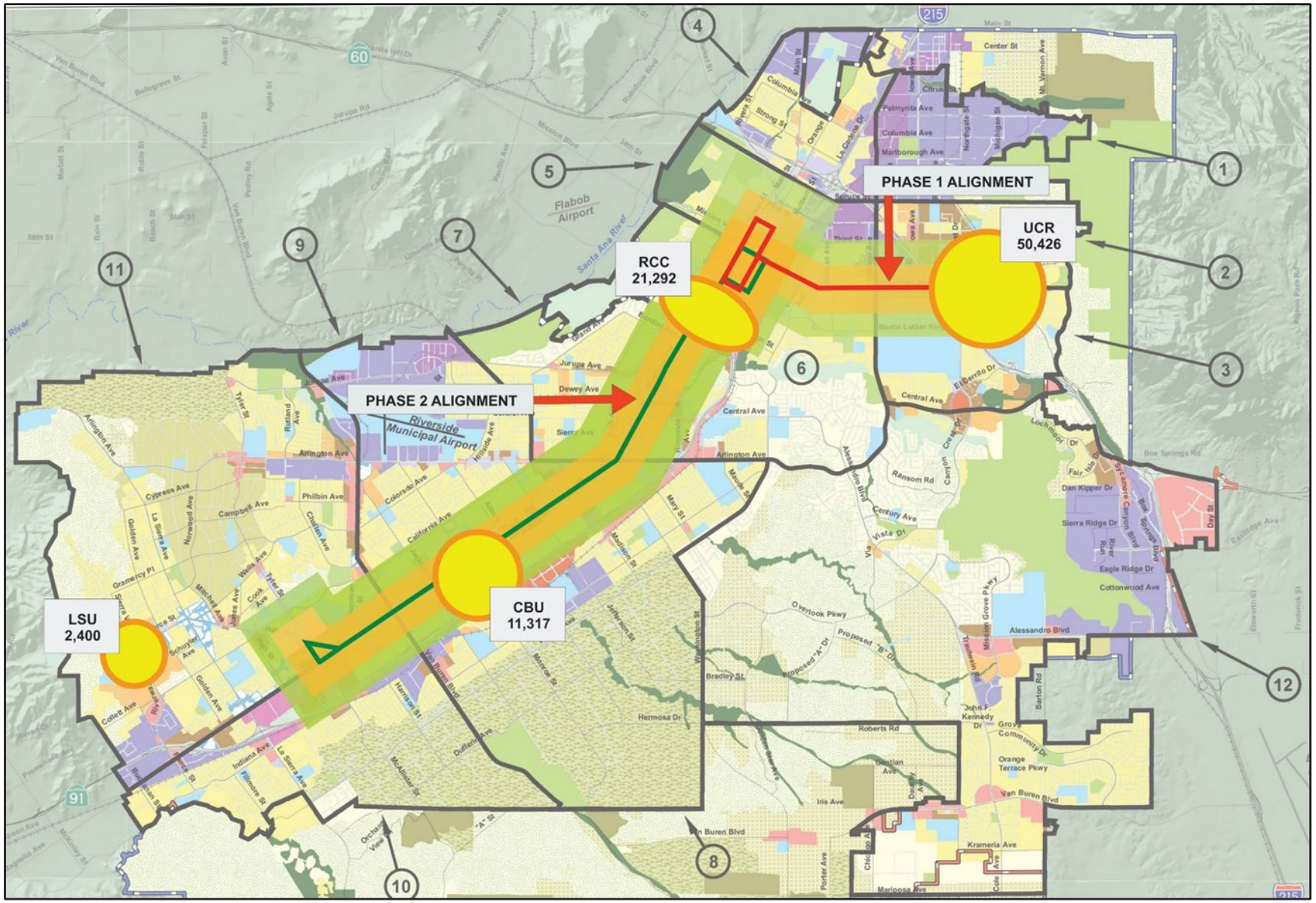


Figure 7-4, TAZs, *Riverside's Major Institutions of Higher Education*



Using data from the U.S. Census QuickFacts page [72] and the census tracts correlated to our TAZs (increased by 1% per year to achieve 2025 projected population), we have then reduced the populations by subtraction, assuming that 75% of those under 18 years of age (23%) are too young to produce individual trips, and 25% of those over 65 years of age (10.7%) are too old to produce individual trips, thereby calculating a Resident Traveling Population. Non-Resident populations consisting of arrivals at Metrolink Stations, hotel visitors (at 50% occupancy), and higher education student populations (at institution posted enrollment +5% to project for 2025) were added to derive a Total Population figure. The total enrollment from University of California, Riverside (UCR), and California Baptist University (CBU) are included, but enrollment from Riverside Community College is included at 50% of enrollment, based on the assumption that half of the total enrollment is derived from the resident population. Non-resident daily workers arriving to the city by auto and bus from surrounding communities (55,733 daily, according to SCAG) are not counted in the populations spreadsheet but are accounted for in the Site-Based Trip Generation category in the Trip Generation spreadsheet.

Table 7-1, *Travel Forecasting: Populations*

Travel Forecasting Populations

TAZ	**Residents** from US Census				**Non-Residents**					**Limited Travel Analysis Area (LTAA)**	
	All ages	Under 18 by %	Over 65 by %	Remainder	Metrolink	Hotel Visitors	HE Students	Sub Total per	TAZ Totals		
1	14,219	2,460	380	11,380	0	0	0	0	11,380		
2	18,656	3,228	498	14,931	0	307	26,306	26,613	41,543	41,543	TAZ 2
3	8,630	1,493	230	6,907	0	41	26,306	26,347	33,253	33,253	TAZ 3
4	20,903	3,616	559	16,728	0	0	0	0	16,728		
5	23,321	4,034	623	18,663	0	945	0	945	19,608	19,608	TAZ 5
6	31,288	5,413	835	25,040	5,250	35	5,323	10,608	35,648	35,648	TAZ 6
7	28,555	4,940	762	22,852	0	21	5,323	5,344	28,196	28,196	TAZ 7
8	35,680	6,173	953	28,555	0	23	11,883	11,906	40,461	**158,249**	
9	46,390	8,025	1,239	37,126	0	75	0	75	37,201		
10	27,758	4,802	741	22,215	0	35	0	35	22,250		
11	40,833	7,064	1,097	32,672	0	362	0	362	33,034		
12	49,886	8,630	1,127	40,128	0	0	0	0	40,128		
Totals	346,119	59,879	9,045	277,195	5,250	1,844	75,140	82,234	359,429		
Factors and Explanation	100% Resident Sub Total per TAZ	23% Resident Sub Total per TAZ (@75%)	10.7% Resident Sub Total per TAZ (@25%)	**Resident Traveling Population (RTP)**	Metrolink Arrivals	Total Rooms @ 50% Occupancy X 1.5	Student Bodies UCR and CBU, RCC@50%				

Residents	277,195
Non-Residents	82,234
Total	**359,429**

The Resident Traveling Population (RTP) by TAZ is then factored by Home Based trips per day; it is assumed that all of the population within the RTP makes one trip in the Work/School trip type (+1 to account for return trips to the point of trip origination). Student trips (considered Home Based) of the Work/School trip type + 1 for return trips are included. A Residential Visitor category is included that adds 0.5 trips per 4-person household. All other trip types for the RTP, Student, and non-resident workers are considered as site-based trips generated using the Land Use maps provided by the city, gross area for commercial, industrial, and business/office use were measured and trips using the ITE Trip Generation Manual where applied. Hotel visitor trips and are included to find a total number of trips including residents and non-residents.

Table 7-2, *Travel Forecasting: Trips*

Travel Forecasting
Trips

TAZ	Home-Based Trips (RTP all)	Residential Visitor Trips	Metrolink-Based Trips	Site-Based Trips	Hotel Visitor Trips	Student Trips	TAZ Totals	Limited Travel Analysis Area (LTAA)	
1	22,759	2,073		186,981	0	0	211,813		
2	29,861	2,720		22,151	921	52,611	108,264	108,264	TAZ 2
3	13,813	1,258		13,320	123	52,611	81,125	81,125	TAZ 3
4	33,455	3,047		84,653	0	0	121,156		
5	37,327	3,399		102,257	2,835	0	145,818	145,818	TAZ 5
6	50,079	4,561	10,500	102,741	105	0	167,986	167,986	TAZ 6
7	45,705	4,163		43,394	63	0	93,324	93,324	TAZ 7
8	57,109	5,201		130,003	69	23,766	216,148	**596,519**	
9	74,252	6,762		148,713	225	0	229,952		
10	44,429	4,046		99,817	105	0	148,397		
11	65,344	5,952		179,926	1,086	0	252,309		
12	80,256	7,272		383,869	0	0	471,397		
Totals	554,390	50,455	10,500	1,497,825	5,532	128,988			
Factors and Explanations	Work/School + Return	.5 per Household	Trips Originating and returning	From Site-Based by TAZ Spreadsheet	Hotel Visitors x2 Trips + Return	Work/School + Return			
						Total Trips	**2,247,690**		

At this point, because we are only considering the Phase 1 alignment in our Cost Modeling, we create a special case, the Limited Travel Analysis Area which consists of the five TAZs (2, 3, 5, 6, and 7) in which the Phase 1 alignment will operate if the project is approved by the City Council.

For the Site-Based Trip Generation by Land Use spreadsheet, measurement of buildings within the LTAA, shows that the average Gross Floor Area is 30% of the Gross Land Use area. Therefore, the area (by Kft²) of Industrial, Commercial, and Business/Office for each TAZ was factored by .3 and the number of trips indicated for that land use type in the ITE Trip Generation Manual. The GFA average used is very conservative for Commercial and Business/Office categories where buildings are often multi-stored.

For the Commercial Land Use category, the number of trips generated is further reduced by 25% to account for pass-by trips (visits that were not primary to the journey's purpose). ITE Trip Generation Handbook shows that the average pass-by trip percentage is 25.

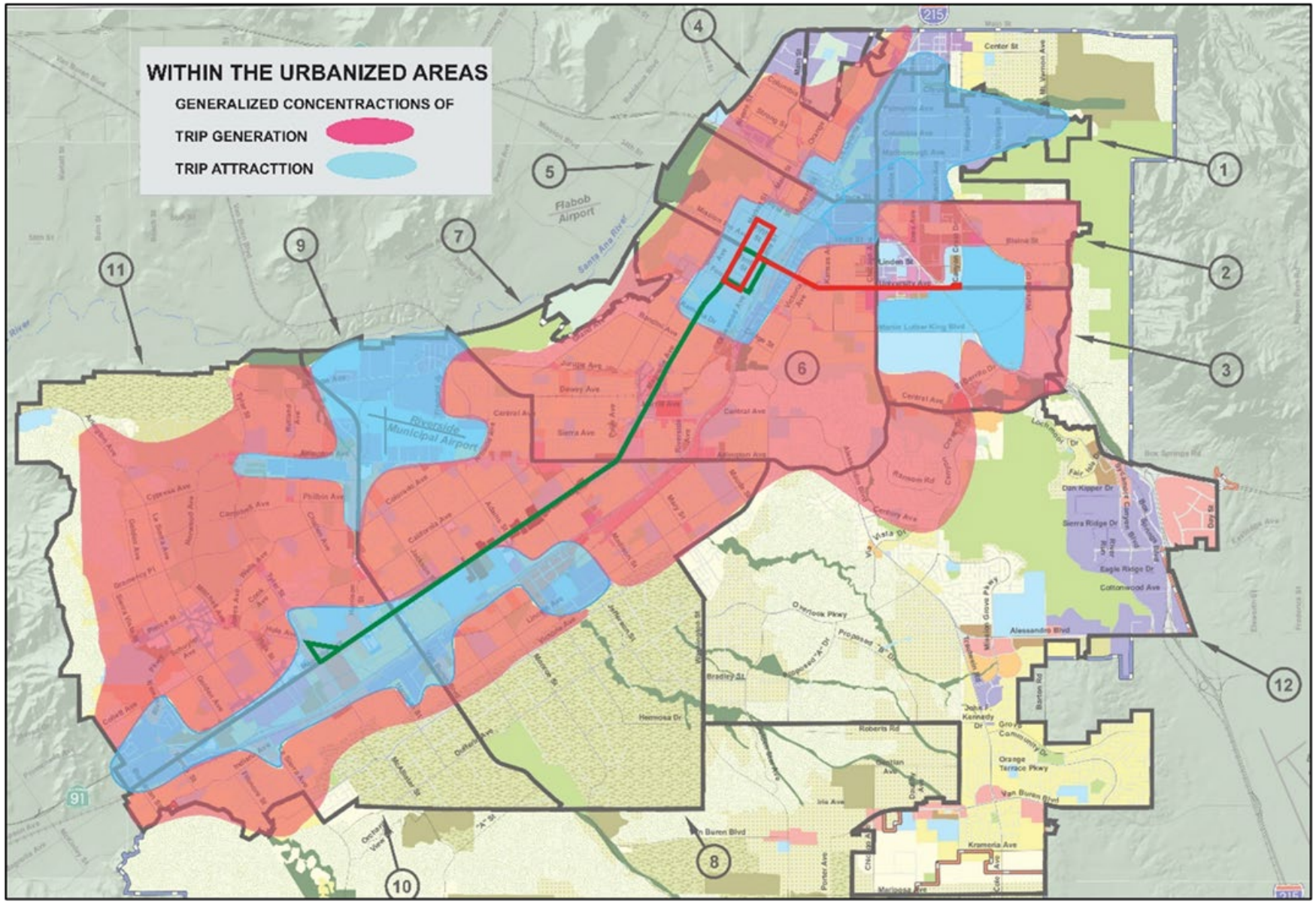
Table 7-3, *Site-Based Trip Generation by Land Use*

Non-Residential Land Use by TAZ / with Trips Generated (ITE Trip Generation Manual)									
TAZ Number	Land Use INDUSTRIAL (Kft² x .3)	Trips @ 6.97	Land Use COMMERCIAL (Kft² x .3)	Trips @ 35.75 (x .75 for Pass-by)	Land Use BUSINESS/OFFICE (Kft² x .3)	Trips @ 12.76	Downtown Specific Plan (Ksf x .3)	Trips @ 12.76	Total Comm. Trips
1	2,369	16,513	0	0	13,360	170,468			186,981
2	0	0	416	11,165	861	10,986			22,151
3	0	0	449	12,041	100	1,279			13,320
4	1,073	7,482	230	6,170	5,141	65,604	423	5,397	84,653
5	1,748	12,182	358	9,599	2,345	29,923	3,962	50,553	102,257
6	1,154	8,040	2,121	56,869	986	12,575	1,979	25,257	102,741
7	0	0	619	16,602	307	3,920	1,793	22,872	43,394
8	79	548	3,427	91,884	2,945	37,572			130,003
9	1,824	12,713	902	24,188	8,763	111,812			148,713
10	0	0	2,543	68,171	2,480	31,646			99,817
11	0	0	3,988	106,926	5,721	73,000			179,926
12	0	0	7,633	204,657	14,045	179,212			383,869
								Total Comm. Trips	1,497,826

7.3 Step 2: Trip Distribution

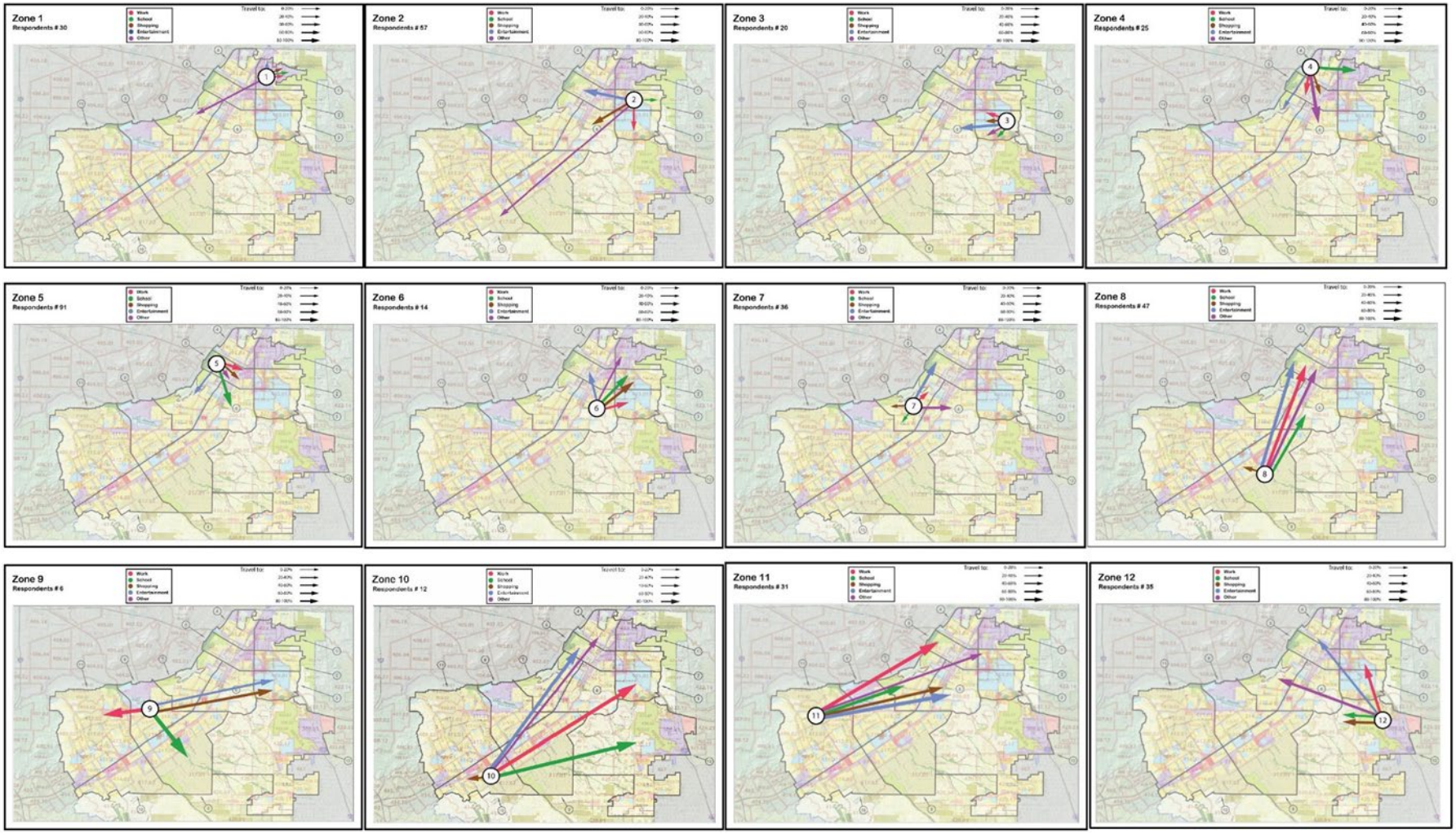
Based on the Land Use map provided by the City of Riverside we can visualize a general distribution of Trip Generators and Attractors. In a general sense, most trips for work, school, and entertainment will be journeys originating in the red areas and moving toward the blue areas. This visualization supports the logic of the two Phases shown, and indicates how Phase 1 prioritization makes sense based on relative size of the two phases (see ***Figure 7-5****,* next page**).**

Figure 7-5, *Generalized Concentrations of Trip Generation and Attraction*



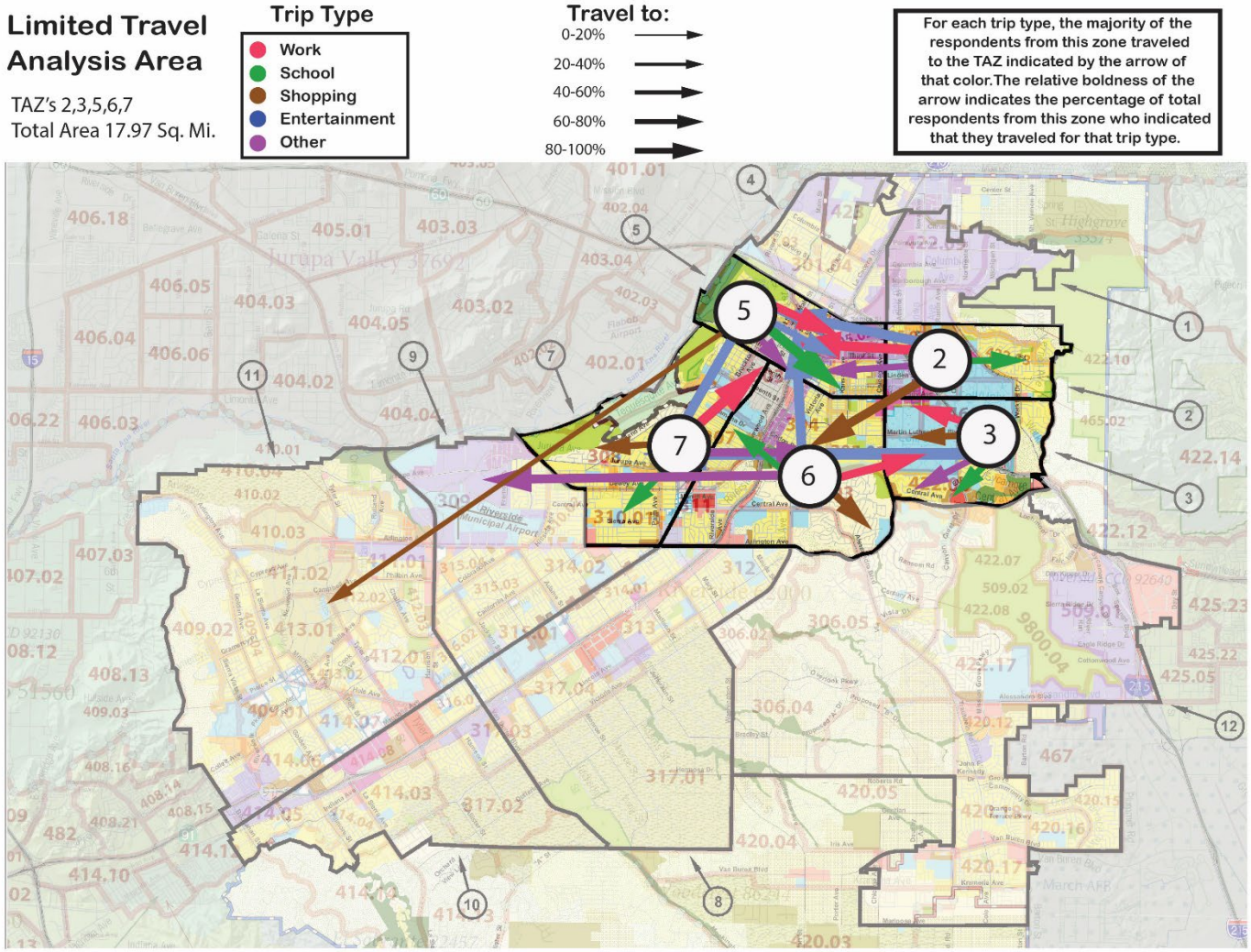
By utilizing the real-world responses from our Survey Participants, we have created a series of trip distribution maps illustrating trip **origination and destinations grouped by trip types and relative response volume, as reported by residents from each of the twelve TAZs.** For full-size images of these very indicative graphs, please see ***Appendix L.***

Figure 7-6, *Zones 1-12*



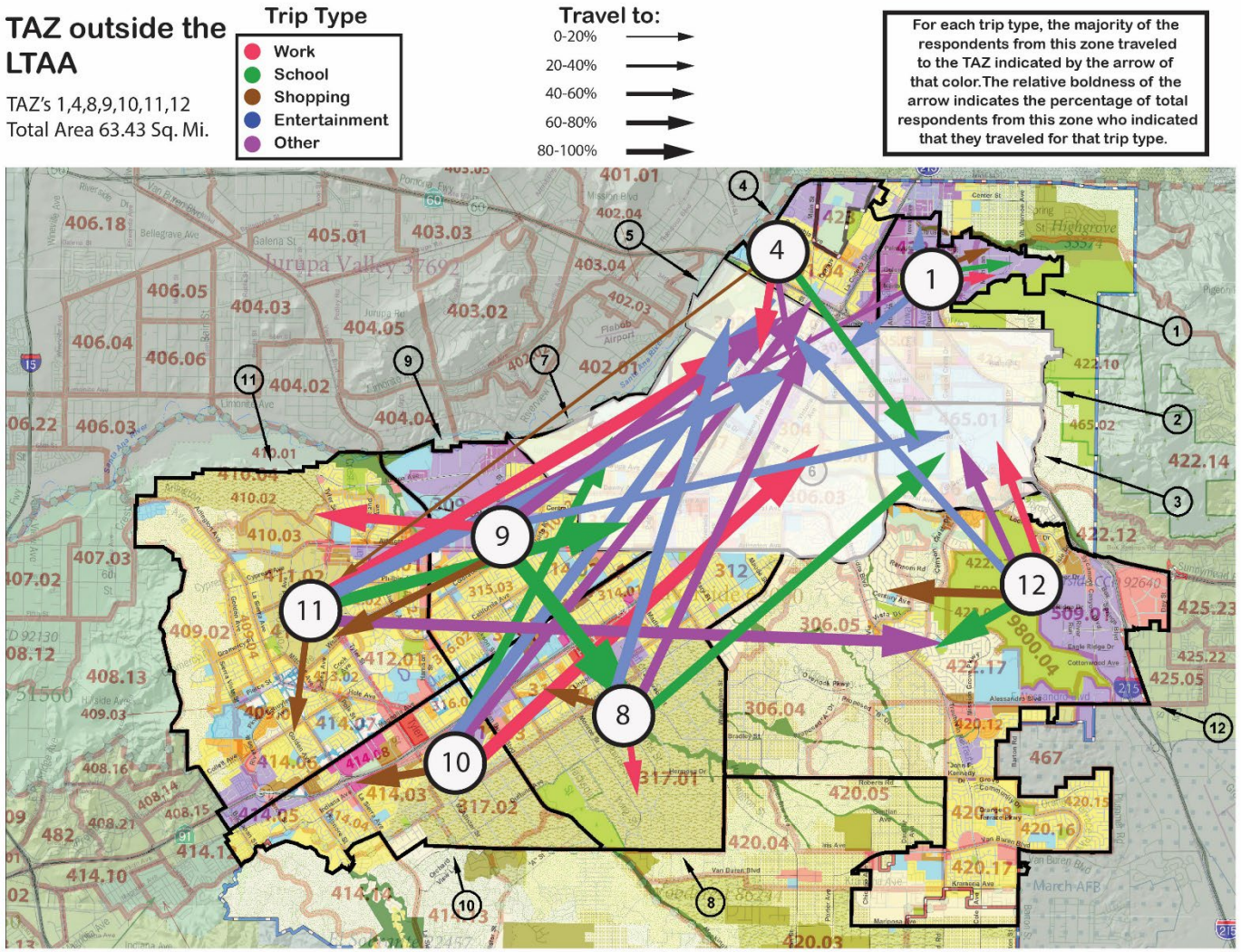
When viewing the visualizations derived directly from the Community Survey Questionnaire results, we see that very few of the residents reporting from the Limited Travel Analysis Area (LTAA) are travelling outside of the LTAA on a regular basis, instead reporting that most of their trips of all types are completed within that area. This observation strongly supports the theory that a more frequent, comfortable, and time-saving circulator within the Downtown to East-Side corridor will be successful as a Phase 1 Streetcar project.

Figure 7-7, *Limited Travel Analysis Area (LTAA)*



Alternately, TAZs from the west side show that the residents travel significantly more far afield and are predominantly traveling to Downtown and the Eastside. This conclusion supports basic premise of the TIG/m concept and the argument to continue with design and installation of Phase 2 of the Streetcar project.

***Figure 7-8, TAZs** Outside the Limited Travel Analysis Area (LTAA)*



7.4 Step 3: Modal Split

Our Community Survey Questionnaire contained questions which were intended to define current travel mode preferences in the city. The residents of Riverside responded to our Community Survey Questionnaire Question #2: "**What modes of transportation do you currently use?".**

The responses were tabulated in the following percentage-based table. This response from the public heavily favors the public transportation mode and is not supported by national averages or recorded automobile vehicle counts and bus ridership data. As a result, we will be using a mode split table that is a combination of Community Survey results and vehicle counts and bus ridership figures compiled by TIG/m from data supplied by the City of Riverside and the RTA. This data is compiled in *Error! Reference source not found.* and shows the number of automobile trips and bus trips recorded at eight key locations around the LTAA. These numbers reflect a mode split of 94.7% auto and 5.25% bus at these locations. This nominal 5% figure corresponds to the national average, and we will be using this figure for mode split within the LTAA. The Bus mode in the survey is understood to reflect the use of "public transportation" more generally, and thus is used to compute the "Bus/Tram" mode in the modal split:

Table 7-4, Modal Split Projections from Survey Question #2

Question #2	**Transportation Modes**	
Total Responses	566	
Mode	**Total**	**Percentage**
Auto	299	53%
Bus/Tram	77	14%
Ride Hail	74	13%
Bicycle	68	12%
Ride Share	28	5%
Other	20	4%
Totals	566	100%

Table 7-5, Mode Split: Phase 1 LTAA

MODE Split - PHASE 1 - LTAA						
Auto (64%)	**Bus/Tram (5%)**	**Ride Hail (13%)**	**Bicycle (11%)**	**Ride Share (3%)**	**Other (4%)**	**TAZ**
69,289	5,413	14,074	11,909	3,248	4,331	TAZ 2
51,920	4,056	10,546	8,924	2,434	3,245	TAZ 3
93,324	7,291	18,956	16,040	4,375	5,833	TAZ 5
107,511	8,399	21,838	18,478	5,040	6,719	TAZ 6
59,728	4,900	12,132	10,266	2,800	3,733	TAZ 7
381,772	**30,059**	**77,547**	**65,617**	**17,896**	**23,861**	

7.5 Step 4: Trip Assignment

For the purposes of this study, the Phase 1 alignment is our focus and for this reason we will limit the consideration of trip assignment to the Limited Travel Analysis Area defined under Step 1. The area of the LTAA is 17.97 square miles and contains a projected 2025 resident and non-resident population of 165,108, and a calculated Total number of trips of 596,519. This area encompasses Downtown and the East Side and is served by 14 bus lines which essentially converge on the Downtown area providing a well-defined feeder system for a potential downtown circulator (Phase 1 Streetcar). The construct of the LTAA and the conclusion reached through the trip distribution graphics resulting from the Travel Analysis Questionnaires, namely that the majority of trips generated in the LTAA have their destination within the LTAA (see ***Figure 7-7***), leads directly to the following per capita assignment of LTAA trips within the 5-minute pedestrian catchment to the bus/tram mode.

The 5-minute pedestrian catchment Area is 1.97 square mile and contains a population of 24,845. This figure is derived by correlating data from Census Tracts with the City Land Use map apportioned to the TIG/m TAZs. Refer to ***Appendix B: Land Use by TAZ***. More specifically by aerial and ground-based photographs of building types within the Land Use plots using number of units and area. Considering that the streetcar service at the center of this corridor will provide an improved public transportation service based on an 8-minute headway and travel time reduction resulting from the tram priority signalization system, increased comfort, ease of boarding, and reduced operational noise, it is likely that the Bus/Tram journeys taken within this area will favor the Tram, including the first leg of a journey that may extend beyond the pedestrian corridor area.

Figure 7-9, Acreage & Population within 5-Minute Pedestrian Catchment

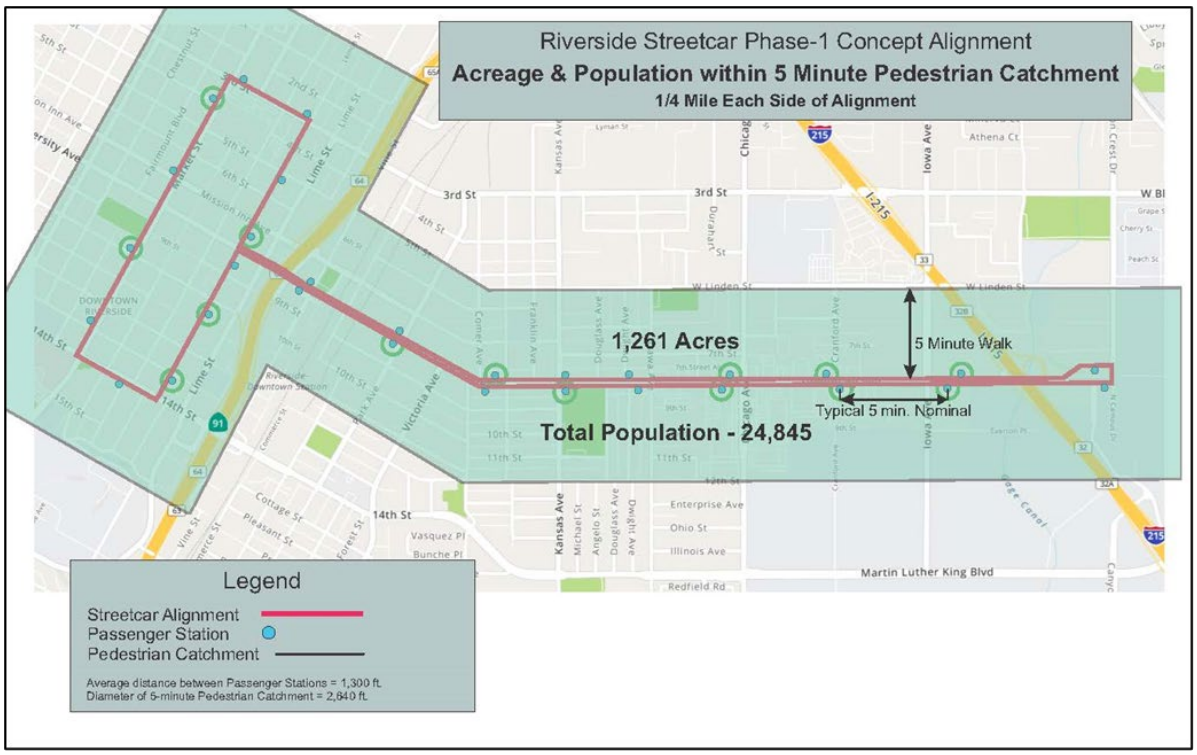
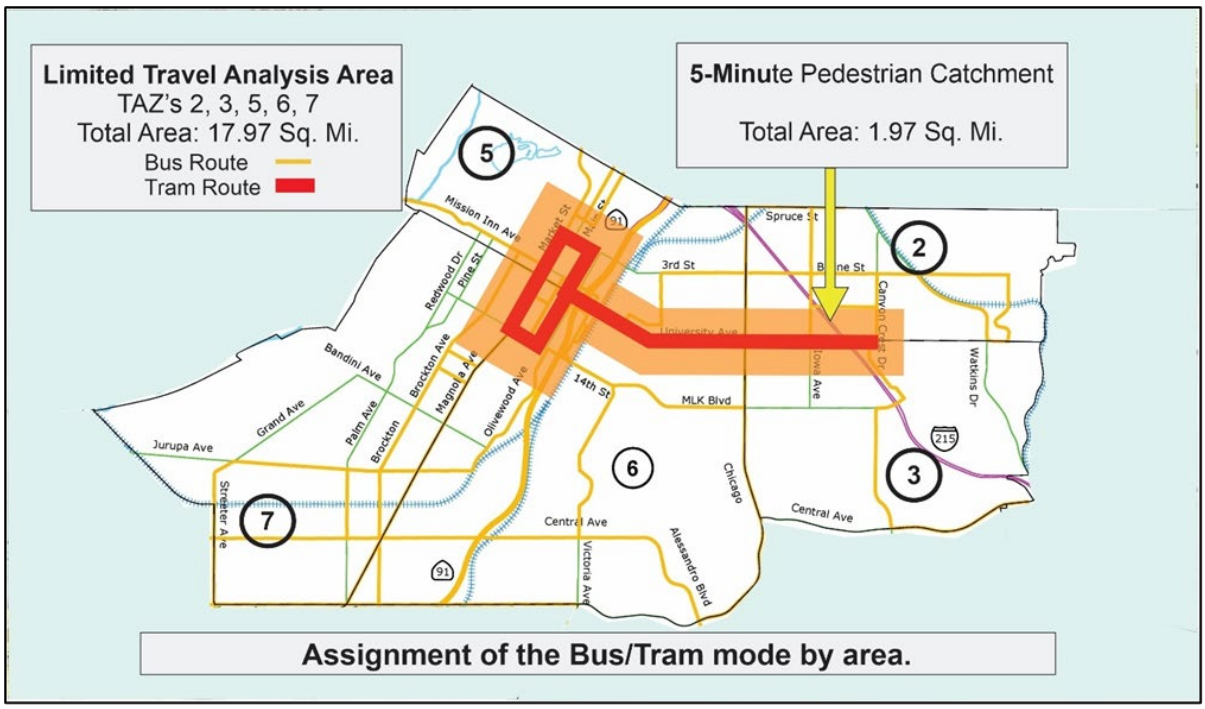


Table 7-6, Populations in 5-Minute Pedestrian Catchment, By TAZ, Phase 1

TAZ on Alignment	Total Population From Population Spreadsheet LTAA Column	% of Population in 5 Minute Catchment	Population in 5 Minute Catchment	Notes
2	41,543	5.00%	2,077	This figure is derived by correlating data from Census Tracts with the City Land Use map apportioned to the TIG/m TAZ's. More specifically by aerial and ground based photographs of building types within the Land Use plots using number of units and area.
3	33,253	3.00%	998	
5	19,608	48.87%	9,583	
6	35,648	33.40%	11,906	
7	28,196	1.00%	282	
		Total	24,846	

Figure 7-10, Assignment of Bus/Tram Mode Per Capita



Trips in the LTAA will therefore be assigned per capita. 30,059 total LTAA bus/tram trips averaged over the 165,108 LTAA residents equals an average of 0.182 Bus/Tram trips per person.

0.182 trips x the 24,845 Pedestrian Catchment population results in 4,521 Tram trips assigned to the Phase 1 Streetcar alignment.

7.6 Modal Shift from Automobile Use

The Travel Survey questionnaires showed that a significant majority of the Riverside respondents would shift their mode of transportation to the Streetcar if they had the opportunity and it served to facilitate their journey.

Survey Question #9:

If an electric streetcar were to provide service on the routes of the normal trips you have identified in this survey, how likely would it be that you would switch from your current mode of transportation or add the new streetcar system to it? (please check only one)

Table 7-7, Likelihood of Modal Shift; Responses from Survey Question #9

Question #9	Likelihood of Mode Shift	
Total Responses: 478		
	Total	Percentage
Likely	379	**79.3%**
Not Likely	99	**20.7%**
Totals	**478**	**100%**

For the purposes of this study, we will use a nominal figure of 10% for modal shift from automobile use. To see supporting arguments for modal shift from automobile use as high as 20%, please refer to ***Appendix J.***

7.6.1 Ridership Conclusions

Our ridership projection results are supported by the fact that the calculated ridership projection for the Phase 1 streetcar alignment is similar to the projected bus ridership for 2025 on the same corridor. When this base ridership is augmented by modal shift, we find the following:

Base ridership total	= 4,521 PPD
Augmentation by Modal Shift (@10%)	+ 452
TOTAL Projected Ridership (TPR)	**= 4,973 PPD**

TPR ÷ 7 track mi. = 710 Average Daily Boardings per track mile.
When we include the potential increases in ridership modal shift, we achieve a daily ridership that equals 34% of the capacity of the streetcar fleet at condition AW-1 (32 seated passengers only per streetcar) or 12 passengers per streetcar. This is the ridership projection used in the Project Cost Model in ***Section 11*** of this report.

7.7 Peer City Analysis

A contributing factor in making ridership assumptions for a streetcar system in Riverside is a comparative view of existing systems in other cities both within the United States and in cities worldwide.

Table 7-8 shows a sampling of ridership data for urban fixed guideway systems in cities, most of which have population totals and densities (averages of persons per square mile) comparable to those in

Riverside. The systems examined are used by local commuters as well as by visitors and tourists. These data provide a benchmark from which some ridership assumptions and projections can be made.

The following figures are based on **track miles**.

Table 7-8, *Ridership Comparisons in Cities with Populations Similar to Riverside*

Urban Fixed Guideway Systems / Average Ridership Comparison*						
Mode	**Location**	**Population**	**Average Density / mi.²**	**Revenue track miles**	**Avg. Daily Boardings**	**Avg. Daily Boardings / mi.**
Streetcar/Tram						
A + B Loops	Portland, OR	645,300	4,375**	14.7	20,011	1,361
SLUS	Seattle, WA	724,300	7,251**	2.6	3,000	1,153
5 lines	New Orleans, LA	390,850	2,029**	22.3	21,600	968
TECO	Tampa, FL	385,000	2,960**	2.7	2,500	926
Projected	Riverside, CA	331,360	4,083	7	6,425	710
	Croydon (South London), UK	405,000	6,750^^	30	95,161	3,172
	Edinburgh, UK	500,000	4,695***	17	24,195	1,512
	Nottingham, UK	331,300	10,898****	40	60,645	1,516
	Nice, FR	342,500	12,000*****	30	90,000	3,000
BRT						
	Cleveland, OH	385,300	5,107**	13.6	16,129	1,168
LRT						
	Los Angeles, CA (Red Line)	340,650^	8,092**	32.8	133,413	4,118

* See ***Appendix K: Average Ridership Comparisons*** for an expanded table and data sources.
** U.S. Census 2010 [73]
*** National Records of Scotland, 2011 [74]
**** Population UK 2019 [75]
***** World Population Review 2021 [76]
^ Localities served along Red Line
^^ Croydon population density map [77]

7.8 Comparison with Computer Model Ridership Forecast

In an effort to further validate our efforts in projecting potential ridership quantities as part of the case for the feasibility of a streetcar system in Riverside we have decided, outside of the written scope of our Feasibility Study proposal and contract, to include a parallel ridership analysis using the FTA STOPS computer program. Although the program is not optimally configured for a micro travel market such as the LTAA defined in ***Section 1.6***, we have engaged an experienced consultant and done our best to replicate the input data and conditions used in our manual analysis in order to be able to make a meaningful comparison between the results of these two approaches.

7.8.1 Methodology

The STOPS computer program was commissioned by the FTA in order to help reduce the time-consuming scrutiny required in interpreting the results of the various demand modeling methods and

software packages available in the marketplace when municipalities apply for Federal transportation grants.

Although TIG/m is basing our project delivery plan to avoid the use of Federal funding; instead, using private sector financing, we hope that the use of a Federally endorsed analysis program will increase confidence levels in the local, regional, and State grant programs that may be necessary to cover potential shortfalls in project cash flow on the pathway to becoming a profit-making venture for the city.

The following is from the FTA website:

“STOPS is a limited implementation of the conventional "4-step" travel model. STOPS replaces the standard trip generation and trip distribution steps with the Census Transportation Planning Package (CTPP) – tabulations from the 2000 Census to describe overall travel markets. It also replaces the traditional coded transit network with standard transit-services data in the General Transit Feed Specification (GTFS) format.”

“To make forecasts for a project, you will code modifications to the GTFS data to represent the new and modified transit services associated with the project. The GTFS specification uses latitudes and longitudes to represent the location of each stop and transit station. STOPS uses these coordinates to relate boarding and alighting locations with trip origin and destination locations obtained from the CTPP.”[78]

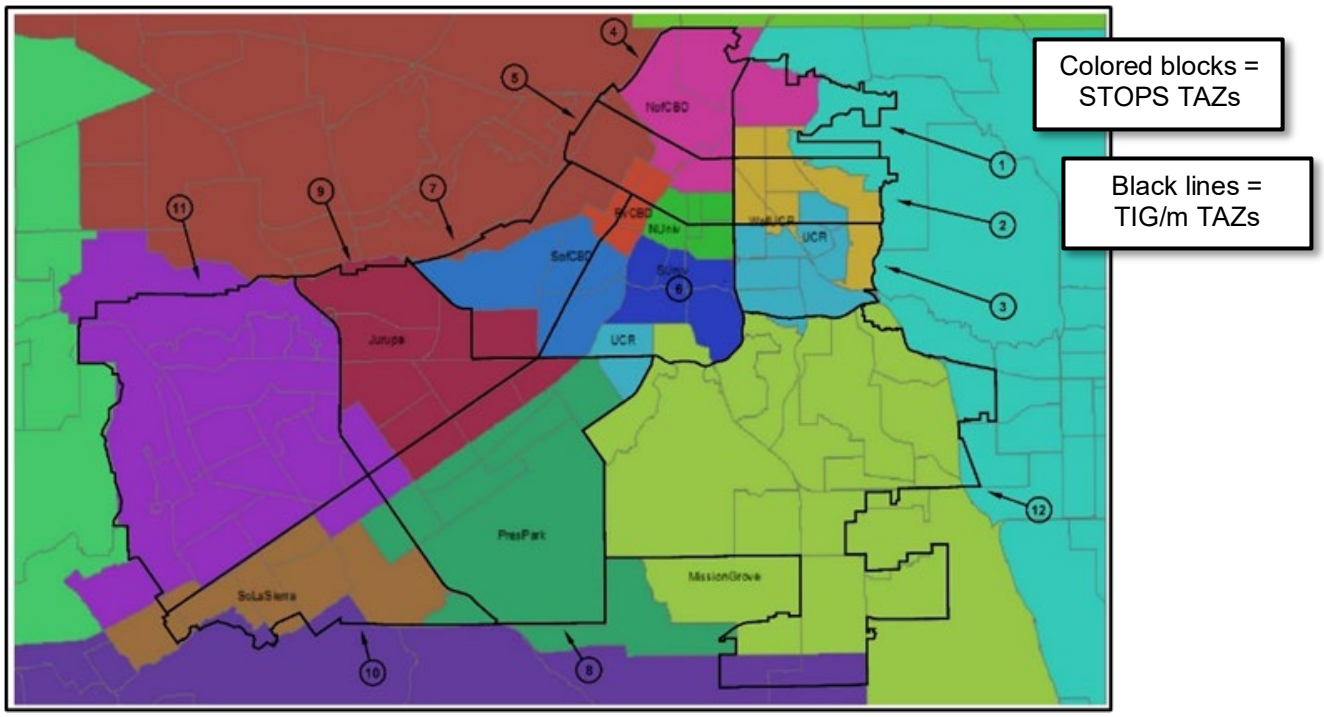
STOPS internal calibration and validation method relies on averaging the data Federal programs have gathered from 15 metro areas. The areas chosen include 24 fixed-guideway systems only two of which are streetcar systems.

Essentially, then, the STOPS method is a 2-Step procedure utilizing census data and transit feed information to estimate a potential number of transit passengers arriving at geographic coordinates input for each passenger station. There is very limited ability to calibrate the model and no way of knowing the exact method that is used to distribute trips, what mode split is used, or how the trips are assigned.

7.8.2 Input Data

We attempted to partition the CTPP data to resemble the TIG/m TAZ configuration, but there is limited ability to create sub-articulations in the GIS data provided by SCAG. Furthermore, the populations derived through the CTPP method are applied as point concentrations at the centroid of the STOPS TAZ shape as opposed to weighted distribution according to the correlation with Land Use Maps as TIG/m has done in our TAZ areas. The result is that STOPS shows a 32% reduction in resident population and a 52% reduction in resident + non-resident populations reported in the LTAA as compared to the TIG/m analysis:

Figure 7-11, *STOPS TAZs and TIG/m TAZs*



GTFS folders for a no-build scenario and a streetcar scenario were created. The modifications to the GTFS streetcar scenario can be found in ***Appendix M: STOPS Model.***

7.8.3 Results

Based on the forgoing descriptions of the methods of analysis and the means of calibration of the STOPS model it is unsurprising that the resulting STOPS ridership projection is lower than the TIG/m projection.

The base ridership figure is 4,047, or 10.5% lower than the TIG/m manually calculated base ridership. We will make assumptions identical to the TIG/m model regarding augmentation of the base figure by adding potential riders from the conceptual Park-and-Ride system and the modal shift from automobile use. Using these assumptions, we find that total potential ridership of the system is 5,903. (8.13% lower than the TIG/m model):

4,047	Base ridership from STOPS
404	Augmentation from Modal Shift
4,451	Total

Additional Output data from the STOPS model can be found in ***Appendix M***. These include:

- Summary of Linked/Unlinked Trips
- Changes id Vehicle Miles Traveled
- Daily Ridership by Station
- Systemwide Ridership by Mode
- District to District total Transit Trips
- District to District Trips-on-Project

7.8.4 Summary

The low CAPEX and OPEX of the TIG/m system which is a direct result of the self-powered vehicle technology remains the salient feature that renders the project feasible for the City of Riverside. The lower ridership predicted by the STOPS model simply increases the portion of Operations and Maintenance subsidized by the public sector (state and local grant programs) by a negligible 4 percent for the first several years. The Riverside Streetcar System still becomes profitable at Year 16 and the system makes essentially the same profit by Year 30.

7.9 Potential Use of Park and Ride Facilities

In order to help alleviate “last mile” problems and encourage higher public transportation participation, many municipalities and transportation agencies include P&R facilities in their plans. It is part of our vision for a walkable Riverside, including fixed guideway and micro-mobility transit at the center, that P&R should form part of the solution by delivering a higher percentage of public transit riders to the Downtown-to-Eastside corridor via the bus system.

It is important to consider that this vision necessitates Riverside building in preparation for the future. While it may now seem farfetched for residents to leave their cars for a five-mile bus ride to reach the tram system—because downtown parking is currently reasonably available—consider that, in the not-too-distant future, easily accessible parking will very likely be scarce, parking levies may be enforced, and land currently available (and relatively inexpensive) for P&Rs will no longer be comfortably obtainable.

If you are interested in seeing the TIG/m concepts for P&R in Riverside, please refer to ***Appendix J.***

7.10 Streetcar Fleet Design

TIG/m LLC self-powered battery/dominant, hydrogen fuel-cell APU trams are used in the Capital Cost Model, the Operations and Maintenance Cost Model, and the Project Cost model.

TIG/m recommends that both 100- and 200-passenger vehicles (50’ and 80’ long, respectively) be considered in the fleet. However, for this Phase 1 study, **100-passenger MRV-3A streetcars are suggested as appropriate to the projected ridership**.

7.10.1 Fleet Scalability

For Phase 1, the fleet should provide scalability during the service day with the ability to add capacity at peak hours of operation if needed, while keeping one car in reserve for operational contingencies. Just as the streetcar fleet should be scalable in daily operation it should also be scalable in the long term, allowing it to grow commensurate with the build-out of the project.

Employing TIG/m’s Virtual Coupler™ to create a non-mechanically connected consist (convoy) during peak hours or as needed, vehicles in the fleet can be expanded to consists of up to three cars, operated by a single driver. Refer to *Section 8* for details of TIG/m modern streetcar vehicles.

7.10.2 Vehicle Quantities

For the purposes of this iteration of the Riverside Streetcar Project Feasibility Study, fleet vehicle quantity recommendations apply to Phase 1 only. To support ridership projections, for the Phase 1 alignment, the recommended fleet should comprise five TIG/m MRV-3 100 passenger streetcars (four regular and peak use vehicles and one reserve vehicle).

Section 8:
TIG/m ViaTran®
Streetcar Vehicles

8 TIG/m ViaTran® Streetcar Vehicles

TIG/m, LLC manufactures several different types of rail vehicles, all falling within the category of electric streetcar or tram vehicle. By far the unique defining characteristic that sets TIG/m vehicles apart from its competition is that all TIG/m vehicles are self-powered, requiring no wayside power systems of any kind. All power for a full day of passenger service is carried onboard each vehicle. TIG/m is the only company that has achieved this in an all-electric streetcar. Current independently verified performance data from our Msheireb Downtown Doha Tramway Transportation system shows that under the specific operating parameters of that tramway, TIG/m vehicles are capable of continuous air-conditioned operation for over 30 hours before requiring battery recharging.

Table 8-1, *TIG/m Self-Powered Trams: Performance Data*

TIG/m SELF-POWERED TRAMS - PERFORMANCE DATA

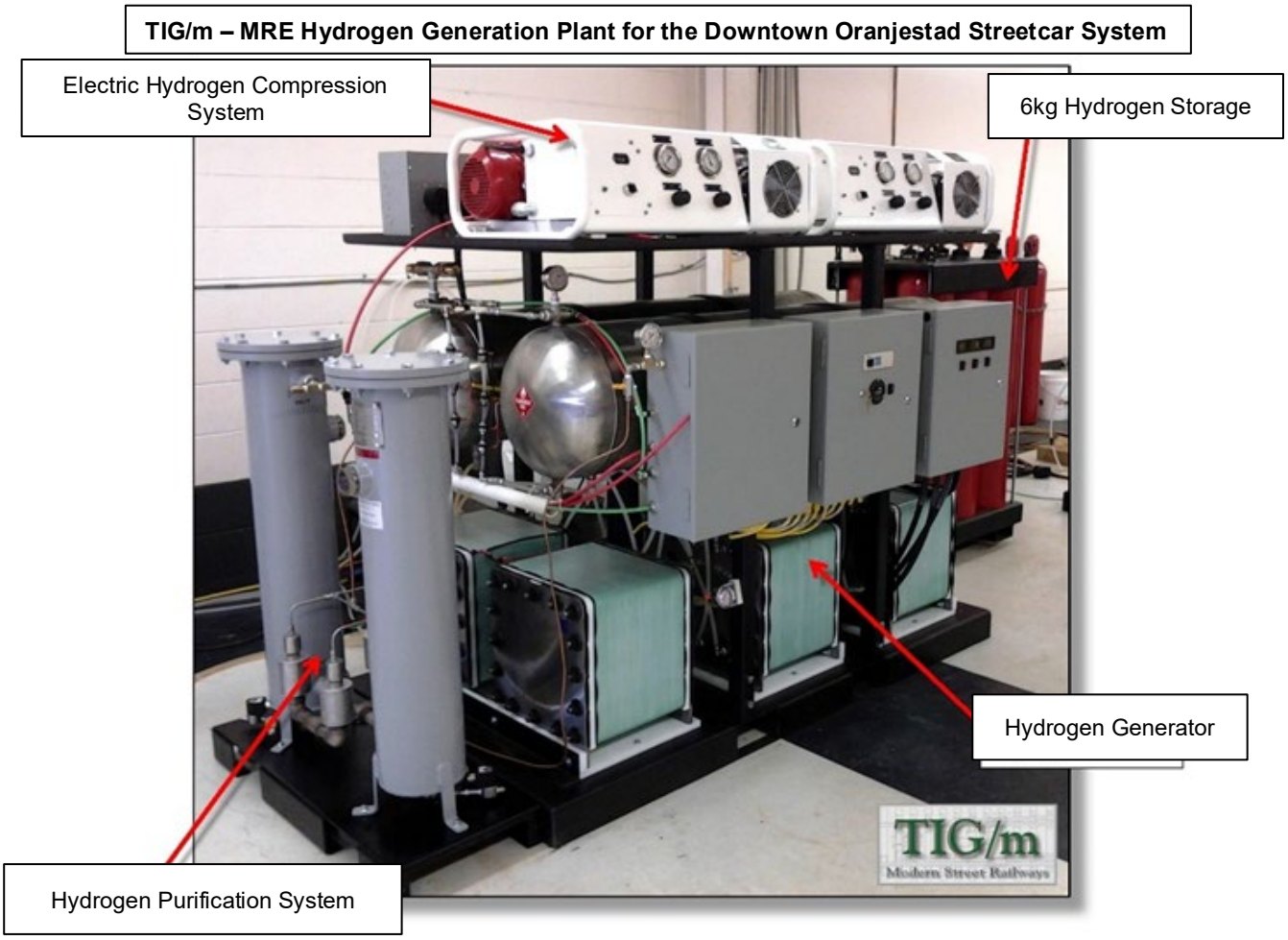
- This Data was compiled from our on-board Analytics program during **certified passenger service** operations at our **Msheireb Downtown Doha Tramway Transportation System** in Doha, Qatar.
- It shows three randomly selected daily passenger service sessions from each of three different trams identical to the tram being demonstrated. Each session included seated and standing passengers with the air conditioner operating.
- The Hydrogen Fuel Cell (HFC) was not utilized, all power was supplied by the battery systems. HFC adds 30% to range.

Date	Tram	Run Time HH:MM	Idle Time HH:MM	Session Total Time HH:MM	Generator Run Time HH:MM	Distance Traveled KM	Amps Used	Amps Gained	Total Energy Used kWH	Total Energy Regen kWH	Range Remaining KM	Total Range	Total Hours
3/8/2021	1	8:14	5:01	13:20	0:00	75.1	230.00	(147.00)	96.50	8.60	95.00	170.10	**30.10**
2/27/2021	1	8:02	4:33	12:39	0:00	72.0	335.00	(170.00)	92.10	9	100.00	172.00	**30.00**
1/21/2021	1	7:57	3:57	11:57	0:00	73.5	290.00	(100.00)	80.70	8.7	130.00	203.50	**33.10**
3/28/2021	2	8:31	3:44	12:18	0:00	76.6	331.00	(98.00)	82.80	4.70	121.00	197.60	**31.70**
2/7/2021	2	8:32	5:43	14:20	0:00	76.6	331.00	(29.00)	78.90	5.9	134.00	210.60	**35.40**
3/30/2021	2	8:34	4:22	13:00	0:00	78.3	257.00	(134.00)	86.50	5.50	115.00	193.30	**32.00**
2/23/2021	3	8:45	5:38	14:28	0:00	76.5	333.00	(175.00)	87.30	6.7	102.00	178.50	**33.80**
1/10/2021	3	8:46	3:29	12:19	0:00	78.2	264.00	(106.00)	87.40	6.9	117.00	195.20	**30.70**
2/16/2021	3	8:48	4:00	12:52	0:00	76.5	266.00	(108.00)	87.60	6.6	115.00	191.50	**32.30**

Third Party verification by SNC Lavalin

The propulsion technology can most accurately be described as a battery-dominant hydrogen/ electric system. Approximately 60% of the daily energy budget is carried on-board in the energy storage system (ESS) batteries, with 20% in carried in the gaseous hydrogen fuel (H2) for the hydrogen fuel cell auxiliary power unit (APU), and the final 20% being produced in passenger service by regenerative braking. Fleet fueling of the H2 APU is accomplished by on-site hydrogen production through the electrolysis of water. Because the daily consumption of hydrogen per vehicle is so low (approximately 20% of daily energy budget, or 2 Kg), the H2 production plant is relatively small and affordable. TIG/m has developed a partnership with Millennium Reign Energy (MRE) of Ohio for the manufacture and delivery of our hydrogen production facilities. This product is unique in using all electric hydrogen compression, substantially reducing the cost of a Kg of 350 bar 5-nines H2.

Figure 8-1, *MRE Hydrogen Generation Plant*

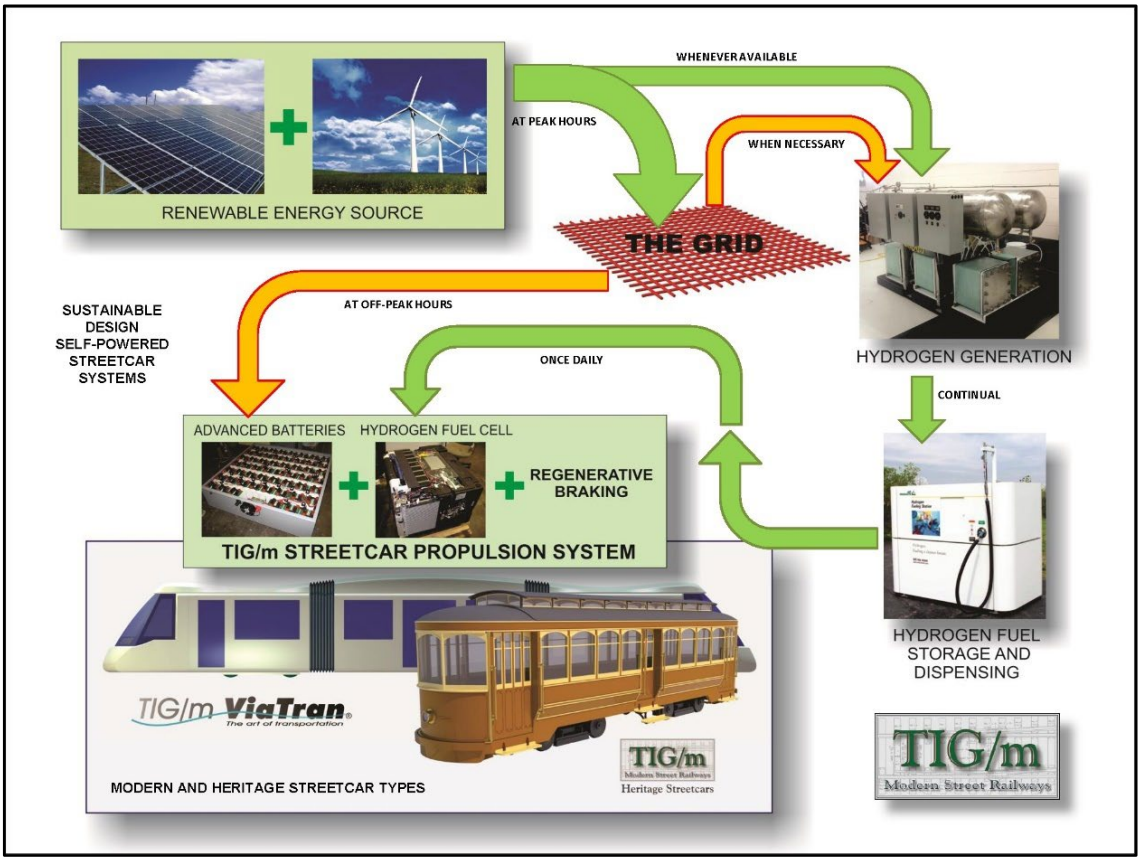


Shown below is the complete hydrogen production and fueling appliance for a fleet of four TIG/m MRV-3 trams prior to shipment to the Emirate of Dubai for installation supporting the Dubai Trolley system. This comprised the first hydrogen fueling station in the Emirate of Dubai.

Figure 8-2, *Hydrogen Production, Storage, and Fueling Appliances*

TIG/m encourages all of our clients to utilize renewable energy sources for battery charging, hydrogen production, and other energy needs for the administration of the O&M facility. We have had the good fortune to have found two clients who have adopted our philosophy and contracted us to install such systems: the Éilan Project in San Antonio, Texas, and the Downtown Oranjestad Streetcar System, in Aruba.

Figure 8-3, *TIG/m's Philosophy: 100% Carbon-Neutral Electrical Power Supply*



These projects represent the installation of the first carbon-neutral public transportation systems in the world, with no carbon gases produced in the energy cycle from harvesting the energy from renewable sources to producing work at the wheel. Further reduction of greenhouse gases (GHG) in the construction of the projects can be attributed to the elimination of the requirement to install distributed power systems along the wayside.

The Proposed TIG/m Riverside Streetcar System would take full advantage of all of these measures to reduce GHG and enhance the city's ability to meet or exceed near term and future targets for sustainability and GHG reduction. The cost of installing the hydrogen production and fueling appliance is included in the CAPEX, line 3.5 (see ***Section 9, Table 9-1***).

Eliminating wayside power systems results in a number of very significant benefits:

Cost Reduction

From design through construction, the cost of infrastructure is reduced considerably. Depending on many site-specific factors costs for OCS (Overhead Catenary Systems) are quoted between $4 million and $10 million per mile.

Simplicity

Vehicles are simplified mechanically by eliminating the pantograph systems required to bring OCS power onto the vehicle. The track systems are passive (non-electrified) and do not require electrical isolation. This also eliminates the possibility of future stray current problems.

Resiliency

Elimination of the **single-point failure mode** inherent in off-board power systems means that each vehicle can independently operate in inclement track and weather conditions without having to rely on wayside or city-wide power sources. Other systems that have been developed to provide “off-wire” tram systems such as Alstom’s APS, Ansaldo TramWave, and various schemes for opportunity charging at stations still require distributed power from a single source. As such, they are not only extremely expensive (more expensive than OCS), but they are also all subject to single point failure.

Reliability

Three on-board battery systems including two traction battery banks and a hydrogen fuel cell auxiliary power unit (APU) means that multiple sources of on-board power are always available.

The contract between TIG/m and The City of Riverside for this study specifies that TIG/m evaluate and present the feasibility of installing and operating its streetcar vehicles, as well as moving its manufacturing headquarters to a location within the city. Planners have expressed interest in TIG/m’s modern low-boarding style streetcars, which are described in this section.

8.1 TIG/m Vehicles and Simple Specifications

For the Riverside Streetcar Project, TIG/m conceptualizes a fleet of both its MRV-3A and MRV-4A Modern Self-Powered Zero-Emission Streetcars.

A noteworthy benefit of operating a fleet of streetcars not dependent upon any wayside power is that they avoid the single-point failure issue inherent to a system reliant upon an overhead catenary or other perpetual power supply. That is, if the power supply fails anywhere in the network, all vehicles in the network are rendered immobile until the power is restored.

8.1.1 TIG/m MRV-3A 100-Passenger Modern Low-Boarding Streetcar

The TIG/m MRV-3A is a 100-passenger streetcar with a central low-boarding section that includes floor-installed securement hardware for two wheelchairs.

Figure 8-4, *TIG/m 100-Passenger MRV-3A*

Table 8-2, *TIG/m MRV-3A Single-Ended Streetcar Simple Specifications*

MRV-3A Simple Specifications (single-ended)		
Item	**Specification**	**Notes**
Tram Dimensions and Weights		
Tram Height: Exterior	12 ft / 3.65m	Height above Top of Rail (TOR)
Tram Height: for Shipping	12.5 ft. / 3.75m	Additional king pin spacer used for shipping.
Minimum Overhead Clearance Requirement for Lift	13 ft. / 4m	
Tram Length: Exterior	50 ft. / 15.24m	
Tram Width: Overall	7.5 ft. / 2.32m	
Floor Height: Center Level-Boarding	11 in. / 280mm	Height above TOR
Floor Height: High-floor Sections	32.5 in. / 826mm	Height above TOR
Interior Cabin height: Passenger Level-Boarding Section	100 in. / 2.55m	From floor to cabin ceiling (add 54mm along center aisle)

MRV-3A Simple Specifications (single-ended)		
Item	**Specification**	**Notes**
Interior Cabin Height: Passenger High-floor and Driver's Cab Sections	79 in. / 2m	Height from floor to cabin ceiling (add 54mm along center aisle in passenger cabin only)
Truck (Bogie) Wheelbase	6 ft. / 1.82m	
Truck (Bogie) Centers	24 ft. / 7.3m	
Overall Wheelbase	30 ft. / 9.12m	
Wheels (per Bogie)	4	Flanged, super-resilient steel, with flange lubrication system at each wheel
Track Gauge	1435mm	Standard gauge
Minimum Curve Radius Capability	15m	
Weight of 1 Truck (Bogie) w/ Motors, Motor Controllers and Cooling Systems	8,000 lb. 3,630 kg	2 bogies per tram: 16,000 lb. / 7,260 kg total weight
Weight of 1 Battery Bank	2300 lb. 1043 kg	2 battery banks per tram: 4600 lb. / 2086 kg total weight
Light Car Weight (AW0)	40,000 lb. 18,144 kg	Weight ready-to-run, including all fluids, with no on-board passengers
Loaded Car Weight (AW1)	45,000 lb. 20,412 kg	Full seated load @ 170 lbs. / 77 kg per passenger
Loaded Car Capacity (AW2)	100 Passengers	Full seated and standing load

Propulsion System		
Fully-Charged Battery Bank Voltage	375VDC	Per battery bank (two battery banks per tram)
Minimum Battery-Bank Voltage for Tram operation	340VDC	Per battery bank or combined
Generator	20kW, 500 lb.	Hydrogen fuel cell (auxiliary power: recharges battery bank during passenger service)
Hydrogen Bottles	6.5 lb./bottle 3kg/bottle	2 per Tram
12V Battery System/s		PLC, exterior lights, audio system, smoke/gas leak detection, driver doorsteps, gong sound
36V Battery System/s		Electromagnetic track brakes, interior lights, passenger doors

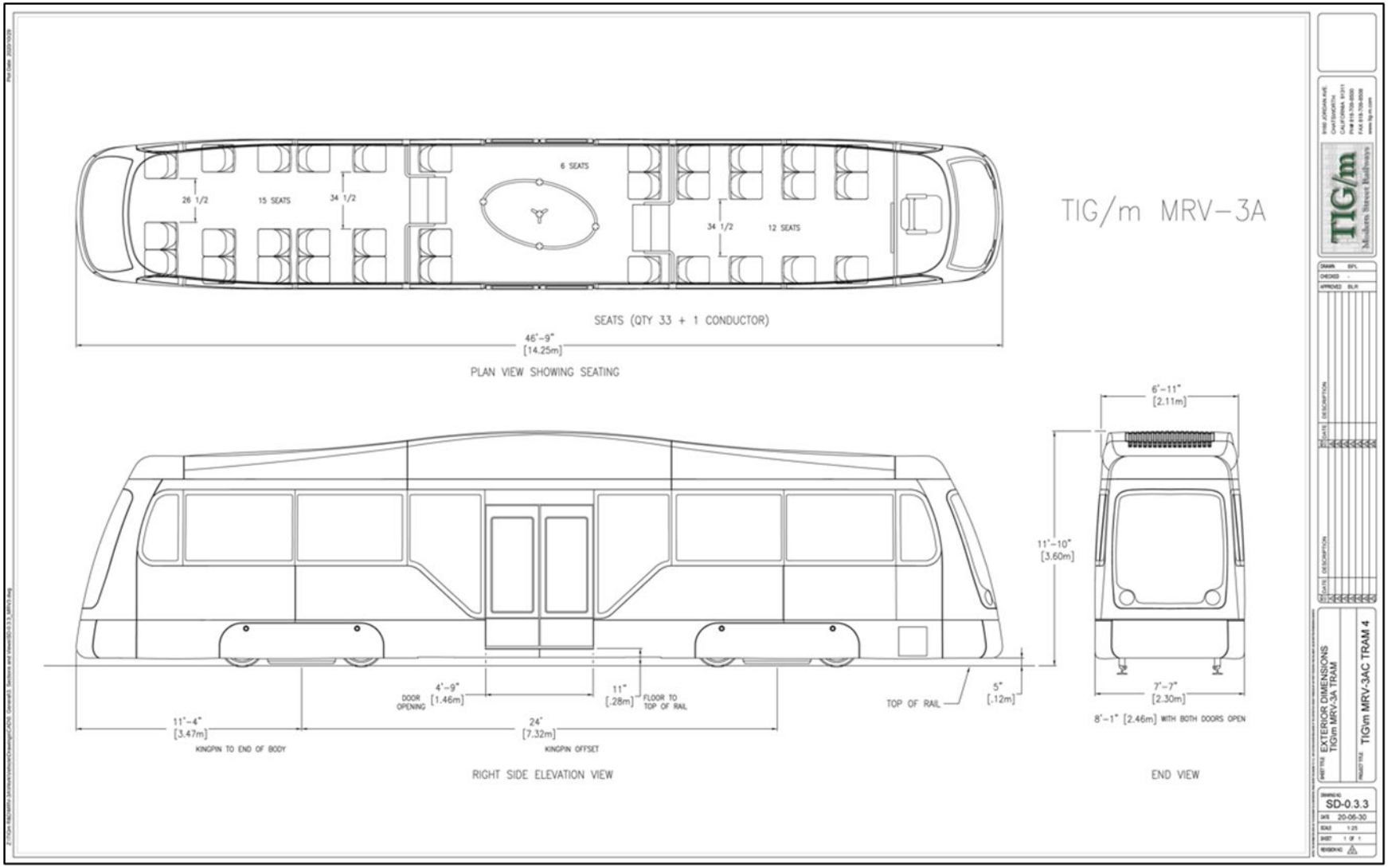
MRV-3A Simple Specifications (single-ended)		
Item	**Specification**	**Notes**
Accommodations		
Driver's Cab Door	1	Manual door with electro-mechanical unfolding and retractable steps
Driver's Console	1	Includes tram operations and communications systems
Seats: Driver's Cab	1	Adjustable
Seats: Passenger cabin	33	Each passenger seat includes seat-top handholds
Handholds: Driver's Cab	2	Includes: 1 vertical handrail at cab interior back wall adjacent to door (for support when boarding and alighting 1 horizontal (for closing door only) handrail on door interior
Handholds, Vertical: Passenger Cabin	1	Includes: 14 aisle handrails; 4 vertical handrails, 2 at each central passenger door; 1 central vertical tripartite handrail with 4 overhead strap handholds
Handholds, Horizontal: Passenger Cabin	15	Between Window Frames and at Top of Steps
Handholds, Diagonal: Passenger Cabin	4	2 sets
Handholds, Additional: Passenger Cabin	132	66 1m-high passenger seat-top handholds (2 per seat)
Handholds, Additional: Passenger Cabin	4	Hanging strap handholds at center low-boarding section (1.85m from passenger cabin floor)
Wheelchair Securement	2 sets	Floor-mounted hardware for two wheelchairs; Straps for securing wheelchair wheels: lap-straps for securing passenger to wheelchair
Emergency Egress Windows	2	2 rear side windows are equipped with emergency release and can be pushed outward to allow emergency egress.

Acceleration / Braking		
Motor Horsepower	45 hp	4 Motors: 180 hp total
Average Acceleration Rate	5 ft/sec^2 1.5 m/sec^2	3.5 mph/sec or 5.6 kph/sec
Maximum Acceleration Rate	5.25 ft/sec^2 1.6 m/sec^2	
Average Deceleration: Service Braking	4.5 ft/sec^2 1.38 m/sec^2	3 mph/sec or 5.0 kph/sec
Deceleration: Emergency	7.5 ft/sec^2 2.3 m/sec^2	5 mph/sec or 8.4 kph/sec

MRV-3A Simple Specifications (single-ended)		
Item	**Specification**	**Notes**
Top Speed	20 mph 32 kph	Programmable to 50 mph (80 kph)
Average Speed	10 mph 16 kph	Theoretical

Mild and Harsh Environment Components		
Passenger Plug-Doors	2 Sets	Driver-operated, central level boarding (ADA compliant) weather-sealed plug doors w/emergency release system
Air Conditioning Compressor	120 lb.	(1) Located in tram attic compartment
Air Conditioning Chillers	4	Located in tram attic compartment; 1 directing conditioned air into driver's cab; 3 directing into in passenger cabin; can be pre-set to desired temperature. 74°F capable.
Air conditioning remote	1	1 in Driver's cab -- to control temperature in driver's cab only
Windshield Wiper	1	Dual-arm reciprocating wiper
Dust/sand filters, gaskets, seals, etc.		All filters are upgraded for harsh climate conditions
Heat/sun resilient paints, plastic, fabrics		All materials are upgraded for harsh climate conditions

Figure 8-5, *TIG/m MRV-3A Plan and Elevations*



8.1.2 TIG/m MRV-4A 200-Passenger Modern Low-Boarding Streetcar

The TIG/m MRV-4A is a 200-passenger streetcar with a central low-boarding section that includes floor-installed securement hardware for four wheelchairs.

Figure 8-6, *TIG/m 200-Passenger MRV-4A*

Table 8-3, *TIG/m MRV-4A Single-Ended Streetcar Simple Specifications*

MRV-4A Simple Specifications (single-ended)		
Item	Specification	Notes
Tram Dimensions and Weights		
Tram Height: Exterior	12 ft. / 3.65m	Height above Top of Rail (TOR)
Tram Height: for Shipping	12.5 ft. / 3.75m	Additional king pin spacer used for shipping.
Minimum Overhead Clearance Requirement for Lift	13 ft. / 4m	
Tram Length: Exterior	85 ft. / 25.9m	
Tram Width: Overall	7.5 ft. / 2.32m	
Floor Height: Center Level-Boarding	11 in. / 280mm	Height above TOR
Floor Height: High-floor Sections	32.5 in. / 826mm	Height above TOR

MRV-4A Simple Specifications (single-ended)		
Item	Specification	Notes
Interior Cabin Height: Passenger Level-Boarding Section	100 in. / 2.55m	From floor to cabin ceiling (add 54mm along center aisle)
Interior Cabin Height: Passenger High-floor and Driver's Cab Sections	79 in. / 2m	Height from floor to cabin ceiling (add 54mm along center aisle in passenger cabin only)
Truck (Bogie) Wheelbase	6 ft. / 1.82m	
Overall Wheelbase	57.5 ft. / 17.5m	
Wheels (per Bogie)	4	Flanged, super-resilient steel, with flange lubrication system at each wheel
Track Gauge	1435mm	Standard gauge
Minimum Curve Radius Capability	15m	
Weight of 1 Truck (Bogie) w/ Motors, Motor Controllers and Cooling Systems	8,000 lb. 3,630 kg	3 bogies per tram: 16,000 lb. / 7,260 kg total weight
Weight of 1 Battery Bank	2300 lb. 1043 kg	3 battery banks per tram: 4600 lb. / 2086 kg total weight
Light Car Weight (AW0)	73,000 lb. 33,100 kg	Weight ready-to-run, including all fluids, with no on-board passengers
Loaded Car Weight (AW1)	107,000 lb. 48,500 kg	Full seated load @ 170 lbs. / 77 kg per passenger
Loaded Car Capacity (AW2)	200 Passengers	57 seated and 143 standing.

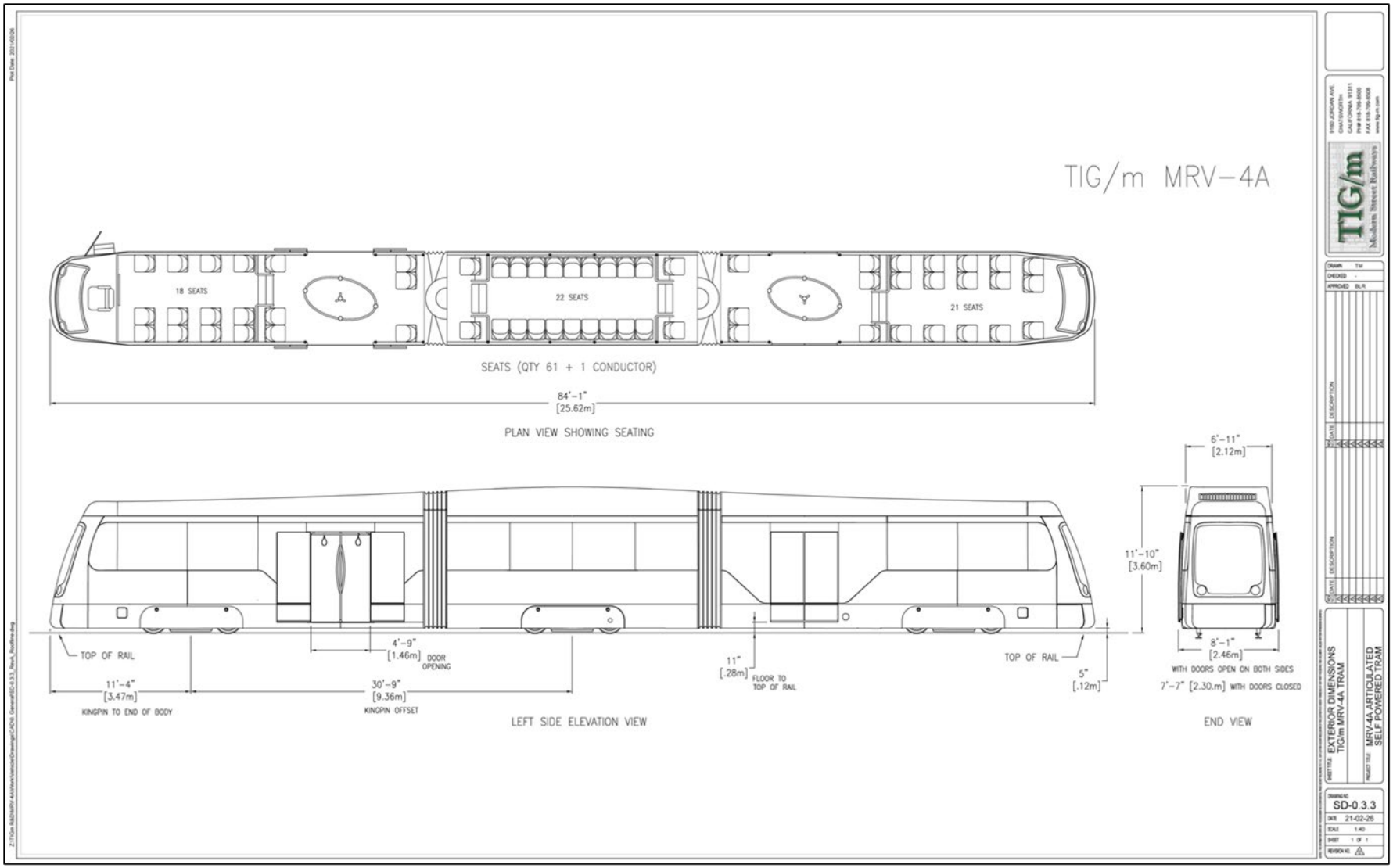
Propulsion System		
Fully-Charged Battery Bank Voltage	375VDC	Per battery bank (three battery banks per tram)
Minimum Battery-Bank Voltage for Tram operation	340VDC	Per battery bank or combined
Generator	20kW, 500 lb.	Hydrogen fuel cell (auxiliary power: recharges battery bank during passenger service)
Hydrogen Bottles	6.5 lb./bottle 3kg/bottle	2 per Tram
12V Battery System/s		PLC, exterior lights, audio system, smoke/gas leak detection, driver doorsteps, gong sound
36V Battery System/s		Electromagnetic track brakes, interior lights, passenger doors

MRV-4A Simple Specifications (single-ended)		
Item	Specification	Notes
Accommodations		
Driver's Cab Door	1	Manual door with automatic electro-mechanical unfolding and retractable steps
Driver's Console	1	Includes all tram operating interfaces (driver and driverless) and communications systems
Seats: Driver's Cab	1	Adjustable
Seats: Passenger cabin	57	Each passenger seat includes seat-top handholds
Handholds: Driver's Cab	2	Includes: 1 vertical handrail at cab interior back wall adjacent to door (for support when boarding and alighting 1 horizontal (for closing door only) handrail on door interior
Handholds, Total: Passenger Cabin	202	Includes: 32 aisle handrails 8 vertical handrails, 2 at each central passenger door 2 central vertical tripartite handrail with 4 overhead strap handholds
Handholds, Horizontal: Passenger Cabin	32	Between Window Frames and at Top of Steps
Handholds, Diagonal: Passenger Cabin	8	2 sets of 4 in each center low-floor boarding section
Handholds, Additional: Passenger Cabin	132	66 1m-high passenger seat-top handholds (2 per seat)

Acceleration / Braking		
Motor Horsepower	50 hp	4 Motors: 200 hp total
Average Acceleration Rate	1.5 m/sec²	
Maximum Acceleration Rate	1.6 m/sec²	
Average Deceleration: Service Braking	1.38 m/sec²	
Deceleration: Emergency	2.3 m/sec²	
Top Speed	50 mph / 80 km/hr	Programmable
Average Speed	20 km/hr	Theoretical

MRV-4A Simple Specifications (single-ended)		
Item	Specification	Notes
Mild and Harsh Environment Components		
Passenger Plug-Doors	4 Sets	Driver-operated, central level boarding (ADA compliant) weather-sealed plug doors w/emergency release system
Passenger Door Clear opening	1.7m	
Air Conditioning Compressor	240 lb.	(1) Located in tram attic compartment
Air conditioning remote	1	1 in Driver's cab -- to control temperature in driver's cab only
Windshield Wiper	1	Dual-arm reciprocating wiper
Dust/sand filters, gaskets, seals, etc.		All filters are upgraded for harsh climate conditions
Heat/sun resilient paints, plastic, fabrics		All materials are upgraded for harsh climate conditions

Figure 8-7, *TIG/m MRV-4A Plan and Elevations*



8.1.3 Additional International Standards Referred to by TIG/m

During previous and current projects, TIG/m refers to additional international standards that include but are not limited to those listed in ***Table 8-4,*** *below.*

Table 8-4, *Referenced International Codes and Standards*

Standard/Code	Description	Application
AISC	American Institute of Steel Construction Steel Construction Manual, 14th Edition AWS-Allowable Stress Design	Tram Chassis and Structure
ANSI/AWS D1.1:2001	AWS Structural Steel Welding Code-Steel	Tram Chassis and Structure
APTA PR-M-S-18-10	Standard for Powered Exterior Side Door System Design for New Passenger Cars (this standard is now a part of EN 14752)	Passenger Doors
AS-3	Safety Glazing Material for use anywhere in a motor vehicle Except Windshield and Certain Specified Locations (driver's side and front passenger locations)	Interior Glass
ASME RT-1-2009	Standard for Structural Requirements for Light-Rail Vehicles	Tram Chassis and Structure
ASTM E 162	Standard Test Method for Surface Flammability of Materials Using Heat Energy Source (test method criteria of NFPA 130)	Passenger Seats
ASTM E 62	Test Methods for Chemical Analysis of Coper Alloys (Photometric Methods)	Passenger Seats
ASTM E 662 - 15a	Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials (test method criteria of NFPA 130)	Passenger Seats
ASTM E 84	15b Test Method for Surface Burning Characteristics of Building Materials	Passenger Seats
ASTM R1-2009	Standards for Metal Powders and Metal Powder Products	Tram Chassis and Structure
BS 7671	Requirements for Electrical Installations	Electrical
CENELEC IEC 60571	Electrical Equipment used on Railway Vehicles	Electrical
DIN 50049-2.2u	Inspection documents for the delivery of metallic products	Rail: track and specialwork
EN 10204-e bzw	Metallic products - Types of inspection documents	Rail: track and specialwork
EN 14811:2010	Railway applications - Track - Special purpose rail - Grooved and associated construction	Rail: track and specialwork
EN 13272	Railway Applications -- Electrical Lighting for Rolling Stock in Transport Systems	Lighting

Standard/Code	Description	Application
EN 14752	Railway Applications Door Systems for Rolling Stock	Passenger Doors
EN 15227	Railway Applications: Crashworthiness of railway car bodies.	Tram Chassis and Structure
EN 15227	Railway Applications -Crashworthiness Requirements for Railway Vehicle Bodies	Tram Chassis and Structure
EN 45545	Railway Applications -- Fire Protection on Railway Vehicles Part 1: General Part 2: Requirements for fire behavior of materials and components Part 4: Fire Safety requirements for rolling stock design Part 7: Fire Safety requirements for flammable liquid and flammable gas installations	Fire Safety
EN 50121-3-2	Railway Applications Electromagnetic Compatibility Part 3-2 Rolling Stock apparatus	Passenger Doors
EN 50124-1	Railway Applications -- Insulation coordination part 1 Basic requirements Clearances and creepage distances for all electrical and electronic equipment	Electrical / Electronics
EN 50125-1	Environmental conditions for equipment Part 1 Equipment on board rolling stock.	Passenger Doors
EN 50126-1	Railway Applications—The specification and demonstration of Reliability, Availability, Maintainability, and Safety (RAMS)	Tram Vehicle, Passenger Doors
EN 50128	Railway applications. Communications, signaling and processing systems. Software for railway control and protection systems	Electronics, Passenger Doors
EN 50129	Railway Applications—Communication, signaling and processing systems—Safety Related electronic systems for signaling	Electronics
EN 50155	Railway Applications: Electrical Equipment used on rolling stock.	Electrical, Passenger Doors
EN 50215	Railway Applications: Inspections of rolling stock for delivery	FAT / SAT
EN 61373	Railway Applications Rolling Stock Shock and Vibration tests.	Passenger Doors
FAR 25.853 Appendix F	Fire Testing for Interior Materials	Passenger Seats
MODSafe WP 4 - D4.2	Modular Urban Transport Safety and Security Analysis of Safety Requirements for Continuous Safety Measures and Functions.	Electronics and Tram Safety
NF P-92-507	Fire safety - Building - Interior fitting materials - Classification according to their reaction to fire	Passenger Seats
IBC	International Building Code	General Building Code

Standard/Code	Description	Application
IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety- Related Systems. (superseded by EN 50128 and EN 50129	Electronics/Software
IEEE1558-2004	IEEE Standard for Software Documentation for Rail Equipment and Systems.	Passenger Doors
IPC-A-601C	Electronic PCB	Passenger Doors
NFPA 130	Standard for Fixed Guideway Transit and Passenger Rail Systems	Fire Safety, Passenger Doors
TCRP Report 15	Procurement Specification Guidelines for Mass Transit Vehicle Window Glazing	Interior and Exterior Glass Systems
TCRP Report 155	Track Design Handbook for Light Rail Transit	Track / Rail

8.1.4 Gap Analysis

TIG/m ViaTran® MRV streetcar vehicles are internationally certified by Certifer of France (ISA), under compliance to European norms (EN 50126, 50128, and 50129 and all attending railway standards listed above) as documented in a comprehensive safety case compiled by TÜV Rhineland. Equivalency between these European norms and the CPUC GO164-E are currently being studied under a gap analysis, with Ricardo Rail consulting. Compliance is assured.

8.1.5 Scalable Streetcar Size / Virtual Coupler™

With TIG/m Virtual Coupler™, both the MRV-3A 100-passenger and the MRV-4A 200-passenger modern trams are available and these trams can be linked non-mechanically to form 300- and 400-passenger trams—requiring only one driver—at the push of a button.

Figure 8-8, *Scalable Streetcar Size and TIG/m Virtual Coupler™*

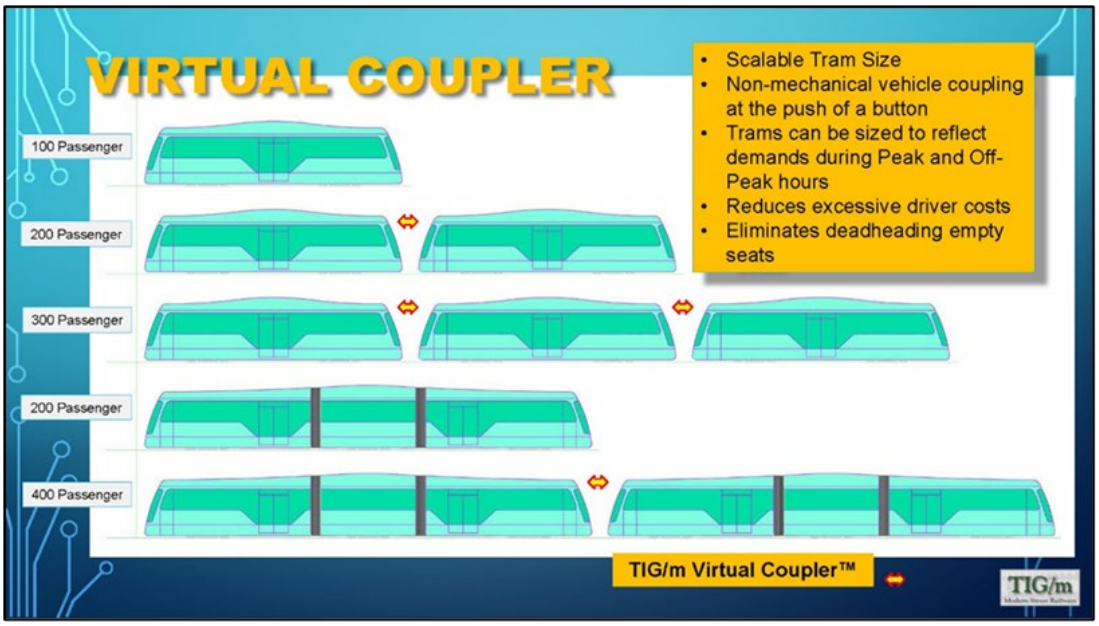


Figure 8-9, *Consist of Three TIG/m MRV-3As Using Virtual Coupler™*

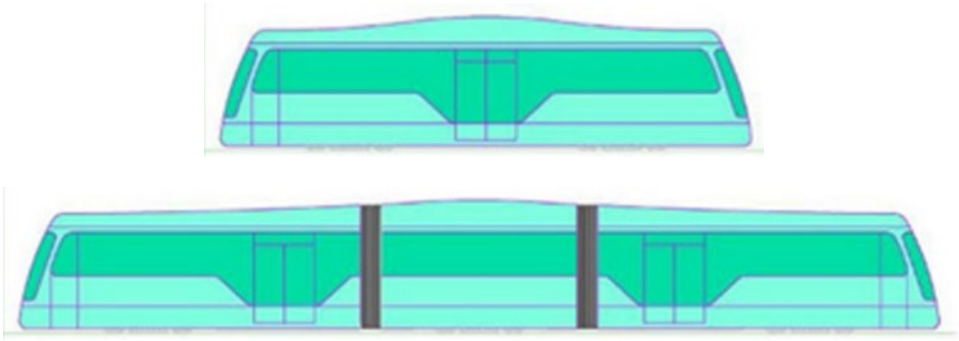
8.2 Level Boarding, ADA Access, and Wheelchair Securement

TIG/m MRV streetcar models are designed for passenger boarding and alighting on both left and right sides of the vehicles. The MRV-3A includes two passenger door sets, both located in the center section of the car. The MRV-4A includes four passenger door sets.

The floor at the central boarding section of the streetcars is 11’ / 280mm above the top of the rail. Ramped station platforms must be built to that height to allow for level boarding and ADA access and egress.

Each low-boarding section of TIG/m streetcars is equipped with floor-mounted wheelchair securement sufficient to secure two wheelchairs. The MRV-3A is equipped with two securement sets; the MRV-4A is equipped with four sets.

Figure 8-10, *Passenger Door Locations: MRV-3A and MRV-4A*



8.3 On-Board Safety Systems

On-board safety systems include but are not limited to the following:

- Driver Alertness Monitoring System
- Battery monitor
- Low voltage interlocks
- Battery backup for drive computer
- Built-in voltage and amperage limits
- Wheel slip / slide control
- Circuit Protection
- Minimum Voltage Requirement
- Emergency Track Brakes
- Door Safety Interlock
- Circuit Protection
- Event Recorder
- Enhanced sensing
- Speed Control
- CCTV of passenger cabin and doors
- Rear-view camera and monitor
- Communication Signals / Audible Warnings

8.4 Auxiliary Systems

- On-board Hydrogen Storage and Hydrogen Fuel Cell APU
- 12V and 36V Power Supply
- Interior Lighting.
- Headlights and Marker Lights
- PA System
- Stop Request Buttons, Passenger Compartment.
- Emergency Call Box, Passenger Compartment.
- “Next Stop” Indicator
- Passenger Plug Doors
- On-board Air Conditioning System
- WiFi

Section 9:
Capital Cost Estimates

9 Capital Cost Estimates

9.1 Cost Estimation Methodology

TIG/m designed a conceptual streetcar system for the City of Riverside based on a series of phases to be built out over time. The Phase 1 of this concept was then taken to a schematic level of track and infrastructure design and is used as the basis for all of the detailed analysis in this study. This allows us to apply unit costs to each component of the design. Our experience in construction of turnkey streetcar systems gives us the ability to use the actual unit costs from our construction partners and material suppliers from current and previous projects. This method does not require TIG/m to include large contingencies for each line item in the CAPEX cost table as we have included all materials, components, and labor in our estimates. Where there are significant unknowns, such as utilities relocation, large, allocated contingencies are included. Other current construction costs were derived from the U.S. national average costs in *Gordian, Heavy Construction Cost with RS Means Data, 35th Edition, 2021*.[79] Streetcar and other rolling stock costs come from the application of the TIG/m vehicle technology as it applies to the conceptual Phase 1 alignment. Resulting detailed capital costs are provided below in ***Table 9-1,*** as described in the following subsections.

Exclusions from the following CAPEX, which are considered the responsibility of the City, include:

- EIR Studies (if required pursuant to SB 288)
- Roadway re-paving outside of the 8-10ft wide track corridor
- Remediation of existing ageing or sub-code street surfaces and structures
- Costs associated with Independent Safety Certification and Assessment which must, by definition, remain independent from the delivery team.

9.2 Track and Specialwork

Lines 1 through 1.6 include the construction costs for the cast-in-place embedded track-form, the turnouts and expansion joints, the panelized track form sections, and the embedded and open trackwork forming the spur to the operations and maintenance yard. Refer **to *Appendix F: Track Construction Quantities*** for details.

9.3 Passenger Stations

Lines 2.1 through 2.3 include modification of existing bus stations used in the design, construction of new passenger stations along the alignment and multi-modal upgrades for stations that will host both streetcars and buses.

9.4 Operations and Maintenance Yard

Lines 3.1 through 3.4 include leasing of the land for the O&M facilities and manufacturing/R&D center. Also included are the open trackwork and turnouts and expansion joints to facilitate moving and stabling the streetcars as well as constructing a 22,000 square foot O&M Facility, including hydrogen fleet fueling equipment. Proposed manufacturing facility is not included in this cost estimate.

9.5 Civil Works and General Conditions

Lines 4.1 through 4.7 include the saw-cutting, excavation and hauling of the track channel within the existing roadways. Line 4.3 is a detailed estimate of utilities relocations where our panelized trackform is not considered as a suitable solution. This estimate uses RPU's current estimating guideline of

$35/inch dia./foot for water lines. Line 4.3 also includes a 78% contingency. Also included are costs covering traffic management, safety management, and temporary structures which will be required during track construction.

9.6 Support Systems

Line 5.1 through 5.6 include costs for virtual tram detection systems (VTDS) which will be utilized to provide tram priority signalization and real-time arrival information to be displayed in the dispatch office, the vehicle interiors, and at the passenger stations. The system includes tram-side and wayside equipment as well as a server within the operations and maintenance facility. Existing traffic signal modification and construction of five new traffic signals, if required, is included in this section. Also included in this section is the fare collection system including both tramside and wayside equipment.

9.7 Rolling Stock

Lines 6.1 through 6.4 include five (5) TIG/m MRV-3A 100 passenger streetcars, a tug vehicle for moving disabled streetcars, and a track maintenance vehicle (TMV) for daily inspection and maintenance of the tracks as well as emergency response during operations. Also included in this section are spare parts for the five streetcars at 5% of the vehicle cost.

9.8 Project Services

Lines 7.1 through 7.9 include design and engineering for the track and infrastructure of the Riverside Streetcar System Phase 1. Site-specific modifications in the vehicle design are included, as are the costs associated with supporting the work of the project safety case manager and the independent safety assessor. A major cost in the project—construction management—is included as Line 7.7 and the costs associated with testing and certification of the rolling stock and integrating the rolling stock with the wayside equipment is included in Line 7.8. Finally, the insurance requirements for the site construction portions of the project are addressed in Line 7.9.

9.9 Documentation

Lines 8.1 through 8.5 cover the costs associated with documenting the project including track construction documents, safety certification documentation, manuals, catalogs and SOP's (Standard Operating Procedures), and as-built drawings for the rolling stock and civil work.

9.10 Project Total

The project totals shown in Lines 9.1 through 9.4 show the sum of all the capital cost scope categories above, the addition of $10MM of unallocated contingency and prepayment of three years financing charges on the resulting figure. The final line represents the total scope of the project plus contingency and financing charges. This TOTAL CAPEX is used in the project cost model.

Table 9-1, *Capital Cost Estimate*

RIVERSIDE STREETCAR FEASIBILITY STUDY

CAPITAL COST ESTIMATE ($MM)

LINE	SCOPE	UNITS	UNIT COST	QUANTITY	EXTENDED COST	ALLOCATED CONTINGENCY	TOTAL	PERECENTAGE OF PROJECT
1	**Track and Special Work**							
1.1	Cast-in-place trackform (Line 1)	Miles	5.226	7.12	37.20912		37.209	
1.2	Cast-in-place trackform (Line 2)	Miles	5.226	0.772	4.034472		4.034	
1.3	Turnouts	Assy.	0.0975	9	0.8775		0.878	
1.4	Expansion joints	Assy.	0.0273	41	1.1193		1.119	
1.5	Panelized Trackform	14' panel	0.0124		0	1	1.000	
1.6	O&M Spur (embedded and open)	Miles	4.2	1.2	5.04		5.040	
	Sub-Total						**49.280**	**34.5%**
2	**Passenger Stations**							
2.1	Repurposed Bus Stops	1 Station	0.055	14	0.77		0.770	
2.2	New Streetcar stops	1 Station	0.15	16	2.4		2.400	
2.3	Multimodal Upgrades	1 Station	0.06	10	0.6		0.600	
	Sub-Total						**3.770**	**2.6%**
3	**Operations and Maintenance Yard**							
3.1	Property Lease	Plot	5 yrs.			1.2	1.200	
3.2	Switch Yard Track (open)	Miles	3.6	0.45	1.62		1.620	
3.3	Switch Yard Turnouts	Assy.	0.0975	8	0.78		0.780	
3.4	Switch Yard Expansion joints	Assy.	0.0273	6	0.1638		0.164	
3.5	O&M Facility	Sq. Ft.	0.000246	22,000	5.412		5.412	
	Sub-Total						**9.176**	**6.4%**
4	**Civil Works, General Conditions**							
4.1	Demolition, Earthworks	Miles	0.063	9	0.567		0.567	
4.2	Hauling / Disposal or Recycling	Ton			0	0.518	0.518	
4.3	Utilities Relocation	Various			3.62	5.88	9.500	
4.4	Park and Ride Facilities	Acre	0.834	12	10.008		10.008	
4.5	Traffic Management	Day	0.001	915	0.915		0.915	
4.6	Safety Management	Day	0.001	915	0.915		0.915	
4.7	Temporary structures				0	0.5	0.500	
	Sub-Total						**22.923**	**16.0%**
5	**Support Systems**							
5.1	Existing Traffic Signal Interface	Kit	0.0154	29	0.4466		0.447	
5.2	New traffic signals	Install	0.225	5	1.125		1.125	
5.3	Streetcar Priority Signalization	System	0.64	1	0.64		0.640	
5.4	Virtual Tram Location	System	In 5.2	N/A	N/A			
5.5	Next Vehicle Arrival Station Signs	Kit	0.0135	30	0.405		0.405	
5.6	Fare Collection	Per vehicle	0.06	5	0.3	0.3	0.300	
	Sub-Total						**2.917**	**2.0%**
6	**Rolling Stock**							
6.1	Streetcars	MRV-3	2.87	5	14.35		14.350	
6.2	Tug	MB	0.23	1	0.23		0.230	
6.3	Track Maintenance Vehicle	TMV-2	0.16	1	0.16		0.160	
6.4	Spare Parts 1 year (5% cost)	Lot	0.15	5	0.75		0.750	
	Sub-Total						**15.490**	**10.8%**
7	**Project Services**							
7.1	Design-Alignments	Project	1.4	1	1.4		1.400	
7.2	Track Engineering	Project	2.2	1	2.2		2.200	
7.3	Design-O&M Facilities	Project	0.45	1	0.45		0.450	
7.4	Design-Vehicles	Project	0.15	1	0.15		0.150	
7.5	Liaise - Safety Case Manager	Project	0.34	1	0.34		0.340	
7.6	Liaise - ISA	Project	0.075	1	0.075		0.075	
7.7	Contruction Management	Project	8.5	1	8.5		8.500	
7.8	FAT, SAT, SIT, Certification	Project	0.35	1	0.35		0.350	
7.9	Project Insurance	Project	2.17	1	2.17		2.170	
	Sub-Total						**15.635**	**10.9%**
8	**Documentation**							
8.1	Construction Documents	Project	0.26	1	0.26		0.260	
8.2	Safety Certification Documents	Project	0.505	1	0.505		0.505	
8.3	Manuals, Catalogs, SOP's	Project	0.206	1	0.206		0.206	
8.4	As-Built Drawings - Civil	Project	0.112	1	0.112		0.112	
8.5	As-Built Drawings-Vehicle	Project	0.065	1	0.065		0.065	
	Sub-Total						**1.148**	**0.8%**
9	**Project Total**							
9.1	Subtotal (lines 1.1 - 8.5)						120.339	84.2%
9.2	Unalloctated Contingency						10.000	7.0%
9.3	Finance Charges 3 YEARS (4%)						12.511	8.8%
9.4	**TOTAL CAPEX**						**142.850**	100%

Section 10:
Operations and Maintenance Cost Estimates

10 Operations and Maintenance Cost Estimates

Based on preliminary designs developed for this study and results of the demand analysis, an O&M cost model was developed. The O&M cost model takes into account all aspects of the ongoing system functionality for the life of the project (projected for 20 years).

A preliminary operating cost model was developed for the Riverside Streetcar that is based on the current costs for labor, power, and other materials purchased by systems in the U.S.

Project financing/funding sources are taken into account in ***Section 13, Next*** Steps***.***

10.1 O&M Cost Model Methodology

The cost model assumes that all functions related to the operations and maintenance of the streetcar line are performed by Riverside Streetcar, Inc.

The cost model is designed to provide a rough yet comprehensive estimate of operating and maintenance costs for the Riverside Streetcar line. It is possible that Riverside may wish to contract for some services, or to operate them differently than a standard “turnkey” operation. These alternatives may have an impact on the overall costs and based on local labor laws. Riverside may allocate some costs differently between partner agencies and vendors. In addition, it should be noted that this model is not intended to be directly scalable as the service increases. For example, operating a 16-hour service day can be done with two eight-hour drivers being assigned to each streetcar. Should service increase to an 18-hour service day, overtime may be required to fill the hours, at a higher rate. This makes changes in the scale of service more difficult to cost. This cost model is not intended to develop a line-item budget, but rather to break the cost of providing streetcar service down to its basic elements. These elements are set forth in ***Table 10-1,*** below.

10.2 Operations Materials and Services

While most of the cost of operating the streetcar line can be attributed to the hourly labor costs, the costs of materials, supplies and services are charged on a per km or per peak vehicle basis. Costs for materials and services were based on the current Transportation Cooperative Research Program (TCRP) streetcar data, validated by a report from Travel Modeling Group (TMG) for “MiWay UTS Form data. [80]

Table 10-1, *Riverside Streetcar Operating Cost Model – Key Elements*

Cost Item	Major Cost Elements	Unit Cost
Vehicle Operations	Average of salaries including supervision and fare inspection (burdened). Streetcar operators (burdened).	$62.00 per revenue hour
Material and Services	Materials and supplies; Power; Parts, including lubricants and consumables	$2.25 per revenue mile
Vehicle Maintenance	Maintenance labor (not during operations); Other salaries and support contracts.	$64,600 per peak vehicle
Non-Vehicle Maintenance	Maintenance of trackway and stations .	$35,750 per track mile

10.3 Vehicle Maintenance

Costs for vehicle maintenance were based on the current TCRP streetcar data, adjusted for the actual cost experience with TIG/m self-powered streetcar vehicles. All unit costs were derived from currently reported American Transportation Association (APTA) data.

10.4 Non-Vehicle Maintenance

Non-vehicle maintenance includes maintenance of right of way and stations. It must be emphasized here that due Riverside's vision that there be no OCS, a self-powered vehicle system has been assumed and a correspondingly low cost of trackway maintenance has been used based on TIG/m's experience with such systems. If an in-gauge high-voltage power system is chosen, this unit cost will most likely increase by a factor of three.

10.5 General Administration

It is assumed that all operations and maintenance (O&M) services will be carried out by Riverside Streetcar Inc. with no services allocated to contracted service providers, therefor no administrative overhead has been applied other that the burden on revenue hours.

10.6 Start-Up Costs

A specific allocation for start-up costs was included in the model. We assume that first year start-up costs would not exceed 10% of the operating budget for the first full year of operations, based on the anecdotal examples of other systems. Start-up costs include vehicle inspection, testing and break-in, driver and mechanic training and training for other staff involved in streetcar operations. These onetime costs are enumerated in the following section and are included in the model.

10.7 First Year Operating Cost Estimates

Using the cost model described above and the duty cycle for Riverside Streetcar System described in ***Section 6: Operations*** Plan of this report, the initial operating cost for the Riverside Streetcar is expected to total approximately $5.1 MM. This estimate includes all administrative overheads and is based on a conservative assumption about labor productivity. An additional 10% of the initial operating

budget or about $465.5K is included as a one-time startup cost for training and implementation of the line.

The calculation of operating costs is shown below in Section 10.8, Table 10-2, Initial Operating Costs (First Year of Operation).

10.8 Initial and Yearly Operating Costs

The following tables list projected operating costs for the first year of operations, and projected yearly operating costs for the subsequent four years of operations.

Table 10-2, *Initial Operating Costs (First Year of Operation)*

First-Year Operating Costs Two 8-hour shifts per 16-hour day (Monday through Friday) Two 7-hour shifts per 14-hour day (Saturday) Two 6-hour shifts per 12-hour day (Sunday)			
Cost Model Factor	Unit Cost	Initial # of Units from Operating Plan	Total Cost
Man-Hours Labor	$62.00	55,120	$3,417,440.00
Revenue mi	$2.25	306,600	$689,850.00
Peak Vehicles	$64,600.00	4	$258,400.00
Track mi	$35,750.00	7	$250,250.00
Subtotal			$4,615,940.00
One Time Start-up Cost	10.00%		$461,594.00
TOTAL			$5,067,534.00

Table 10-3, *Yearly Operating Costs (Years 2-5)*

Yearly Operating Costs (Years 2 Through 5) **Two 8-hour shifts per 16-hour day (Monday through Friday)** **Two 7-hour shifts per 14-hour day (Saturday)** **Two 6-hour shifts per 12-hour day (Sunday)**			
Cost Model Factor	**Unit Cost**	**Initial # of Units from Operating Plan**	**Total Cost**
Man-Hours Labor	$62.00	55,120	$3,417,440.00
Revenue mi	$2.25	306,600	$689,850.00
Peak Vehicles	$64,600.00	4	$258,400.00
Track mi	$35,750.00	7	$250,250.00
TOTAL			$4,615,940.00

Section 11:
Project Cost Model

11 Project Cost Model

11.1 Project Cost Methodology

Having developed the capital cost of the project (CAPEX) in the capital cost spreadsheet and operating and maintenances costs (OPEX) through the O&M cost model, we will now bring these expenses together into a project cost model which will show the project expenditures and revenues over three years of construction and 30 years of operations.

The CAPEX includes the costs to construct the project plus 8% contingency and three years of prepaid interest at 4% on a private sector loan. The CAPEX is exhausted over three years of construction and operations begin in 2025.

OPEX begins in 2025 and includes a 10% start-up cost for the initial year. Thereafter, OPEX is increased by 10% every fifth year.

The ridership projection is developed in Section 4 Travel Market Analysis and is shown as a percentage of fleet capacity (at AW-1 seated passengers only [32 passengers per vehicle]) increasing over time at a rate of 2% per year for the first 12 years, and 3% per year thereafter.

The Revenue section of the Cost model show three sources of income:

1. Farebox revenue beginning at the projected 2025 RTA rate ($2) and increasing at the industry average of 25 cents every fifth year. Full fares are used in this calculation. Fare reduction programs for specific segments of the population will be negotiated with stakeholders' whose constituents avail themselves of the service and who will therefor contribute to the Streetcar O&M program.
2. Advertising at stations as four lighted boards at each station ($1K/mo./station). This cost is derived from current Riverside advertisers

Figure 11-1, *Photo of Lighted Advertising at a Tram Station*

3. Sponsorships of Trams in the form of full-body advertising wraps ($5/mo./tram). This cost is derived from current Riverside advertisers.

Figure 11-2, *Full Tram Wrap Advertising on TIG/m Trams*

Advertising and sponsorship income increases by 5% every 5th year.

The bottom half of the spreadsheet represents the cash flow: Yearly payments on the loan principal, an annual interest payment at 4%, and the annual O&M cost make up the yearly expense. This is offset by the total annual operating revenue, yielding the annual net.

For the first 15 years of operations the annual net is negative (year 1 = $9.5MM, decreasing yearly thereafter) and will require public sector funding from greenhouse gas reduction grant programs. At year 16 the operation breaks even and becomes increasingly profitable thereafter. These GGR funding sources are listed in ***Section 13: Next*** Steps

A shortfall agreement will be included in the P3 Contract to clearly allocate responsibility in the event that ridership projections are not reached.

Table 11-1, *Riverside Streetcar System ROM Project Cost-Revenue Model*

(See ***Appendix O: Project Cost Model*** for a larger PDF of this table)

TIG/m ViaTran The art of transportation

RIVERSIDE STREETCAR SYSTEM
ROM PROJECT COST MODEL (TIG/m)

YEAR	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	Total Expense	Total Revenue
CAPEX	$47,616,666	$47,616,666	$47,616,666																																$142,849,998	
OPEX				$5,067,534	$4,615,940	$4,615,940	$4,615,940	$4,615,940	$5,077,534	$5,077,534	$5,077,534	$5,077,534	$5,585,287	$5,585,287	$5,585,287	$5,585,287	$6,143,816	$6,143,816	$6,143,816	$6,143,816	$6,758,198	$6,758,198	$6,758,198	$6,758,198	$7,434,018	$7,434,018	$7,434,018	$7,434,018	$8,177,419	$8,177,419	$8,177,419	$8,177,419	$8,177,419	$8,995,161	$8,995,161	$198,226,705	
Capacity [PPY] @AW-1 *	4,975,200	Number of Passengers/Tram		15	16	16	17	18	18	19	20	20	21	22	24	25	26	27	28	28	29	29	30	31													
% of AW-1 Capacity Used				47%	49%	51%	53%	55%	57%	58%	61%	64%	67%	70%	74%	77%	80%	84%	86%	88%	90%	92%	94%	96%	96%	98%	99%	100%	102%	104%	105%	106%	108%	110%		
Estimated Ridership (PPY)				2,343,319	2,427,898	2,537,352	2,636,856	2,736,360	2,835,864	2,935,368	3,034,872	3,184,128	3,333,384	3,482,640	3,681,648	3,830,904	3,980,160	4,179,168	4,278,672	4,378,176	4,477,680	4,577,184	4,676,688	4,776,192	4,776,192	4,875,696	4,925,448	4,975,200	5,074,704	5,174,208	5,223,960	5,273,712	5,373,216	5,472,720		
Fare Box Charge				$2.00	$2.00	$2.00	$2.00	$2.25	$2.25	$2.25	$2.25	$2.50	$2.50	$2.50	$2.50	$2.75	$2.75	$2.75	$2.75	$3.00	$3.00	$3.00	$3.00	$3.25	$3.25	$3.25	$3.25	$3.50	$3.50	$3.50	$3.50	$3.75	$3.75	$3.75		
Revenue - Fare Box				$4,686,638	$4,855,795	$5,074,704	$5,273,712	$6,156,810	$6,380,694	$6,604,578	$6,828,462	$7,960,320	$8,333,460	$8,706,600	$9,204,120	$10,534,986	$10,845,440	$11,492,712	$11,766,348	$13,134,528	$13,433,040	$13,731,552	$14,030,064	$15,522,624	$15,522,624	$15,846,012	$16,007,706	$17,413,200	$17,761,464	$18,109,728	$18,283,860	$19,776,420	$20,149,560	$20,522,700		
Revenue Advertising				$1,440,000	$1,440,000	$1,440,000	$1,440,000	$1,512,000	$1,512,000	$1,512,000	$1,512,000	$1,587,600	$1,587,600	$1,587,600	$1,587,600	$1,666,980	$1,666,980	$1,666,980	$1,666,980	$1,750,329	$1,750,329	$1,750,329	$1,750,329	$1,837,845	$1,837,845	$1,837,845	$1,837,845	$1,929,737	$1,929,737	$1,929,737	$1,929,737	$2,026,223	$2,026,223	$2,026,223		
At Stations																																				
Revenue Sponsorships of Trams				$300,000	$300,000	$300,000	$300,000	$315,000	$315,000	$315,000	$315,000	$330,750	$330,750	$330,750	$330,750	$347,287	$347,287	$347,287	$347,287	$364,651	$364,651	$364,651	$364,651	$382,884	$382,884	$382,884	$382,884	$402,028	$402,028	$402,028	$402,028	$422,130	$422,130	$422,130		
Total Operational Revenue				$6,426,638	$6,595,795	$6,814,704	$7,013,712	$7,983,810	$8,207,694	$8,431,578	$8,655,462	$9,878,670	$10,251,810	$10,624,950	$11,122,470	$12,549,253	$12,859,707	$13,506,979	$13,780,615	$15,249,508	$15,548,020	$15,846,532	$16,145,044	$17,743,353	$17,743,353	$18,066,741	$18,228,435	$19,744,965	$20,093,229	$20,441,493	$20,635,625	$22,224,773	$22,597,913	$22,971,053		$438,063,885
Loan Amount**	$142,850,000	$0	$0	$138,088,333	$133,326,667	$128,565,000	$123,803,333	$119,041,667	$114,280,000	$109,518,333	$104,756,667	$99,995,000	$95,233,333	$90,471,667	$85,710,000	$80,948,333	$76,186,667	$71,425,000	$66,663,333	$61,901,667	$57,140,000	$52,378,333	$47,616,667	$42,855,000	$38,093,333	$33,331,667	$28,570,000	$23,808,333	$19,046,667	$14,285,000	$9,523,333	$4,761,667	$0	$0		
Principal Payments	$0	$0	$0	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$4,761,667	$0		
Interest Payments (@4%)	$0	$0	$0	$5,523,533	$5,333,067	$5,142,600	$4,952,133	$4,761,667	$4,571,200	$4,380,733	$4,190,267	$3,999,800	$3,809,333	$3,618,867	$3,428,400	$3,237,933	$3,047,467	$2,857,000	$2,666,533	$2,476,067	$2,285,600	$2,095,133	$1,904,667	$1,714,200	$1,523,733	$1,333,267	$1,142,800	$952,333	$761,867	$571,400	$380,933	$190,467	$0	$0	$82,853,000	
OPEX Costs (Line 7)	$0	$0	$0	$5,067,534	$4,615,940	$4,615,940	$4,615,940	$4,615,940	$5,077,534	$5,077,534	$5,077,534	$5,077,534	$5,585,287	$5,585,287	$5,585,287	$5,585,287	$6,143,816	$6,143,816	$6,143,816	$6,143,816	$6,758,198	$6,758,198	$6,758,198	$6,758,198	$7,434,018	$7,434,018	$7,434,018	$7,434,018	$8,177,419	$8,177,419	$8,177,419	$8,177,419	$8,995,161	$8,995,161		
Total Annual Expense	$0	$0	$0	$15,352,734	$14,710,673	$14,520,207	$14,329,740	$14,139,273	$14,410,401	$14,219,934	$14,029,467	$13,839,001	$14,156,287	$13,965,821	$13,775,354	$13,584,887	$13,952,949	$13,762,483	$13,572,016	$13,381,549	$13,805,464	$13,614,998	$13,424,531	$13,234,064	$13,719,418	$13,529,951	$13,338,484	$13,148,018	$13,700,953	$13,510,486	$13,320,019	$13,129,553	$13,756,828	$8,995,161		
Annual Income (TOR)	$0	$0	$0	$6,426,638	$6,595,795	$6,814,704	$7,013,712	$7,983,810	$8,207,694	$8,431,578	$8,655,462	$9,878,670	$10,251,810	$10,624,950	$11,122,470	$12,549,253	$12,859,707	$13,506,979	$13,780,615	$15,249,508	$15,548,020	$15,846,532	$16,145,044	$17,743,353	$17,743,353	$18,066,741	$18,228,435	$19,744,965	$20,093,229	$20,441,493	$20,635,625	$22,224,773	$22,597,913	$22,971,053		
Annual Net	$0	$0	$0	-$8,926,096	-$8,114,878	-$7,705,503	-$7,316,028	-$6,155,463	-$6,202,707	-$5,788,356	-$5,374,005	-$3,960,331	-$3,904,477	-$3,340,871	-$2,652,884	-$1,035,634	-$993,243	-$255,504	$208,599	$2,076,558	$1,742,556	$2,231,534	$2,720,513	$4,509,286	$4,023,935	$4,537,790	$4,889,951	$6,596,947	$6,392,276	$6,931,007	$7,295,606	$8,095,220	$8,841,085	$13,975,892	
State and Local Funding***	$0	$0	$0	$8,926,096	$8,114,878	$7,705,503	$7,316,028	$6,155,463	$6,202,707	$5,788,356	$5,374,005	$3,960,331	$3,904,477	$3,340,871	$2,652,884	$1,035,634	$993,243	$255,504	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Cash Flow	$142,850,000	$95,233,334	$47,616,668	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$208,599	$2,076,558	$3,819,113	$6,050,648	$8,771,160	$13,280,449	$17,304,384	$21,842,175	$26,732,125	$33,329,073	$39,721,349	$46,652,956	$53,947,962	$63,043,182	$71,884,268	$85,860,159		
																																		TOTALS	$423,929,703	$438,063,885

Total Expense	$423,929,703
Total Revenue	$438,063,885
Profit	$14,134,182

* AW-1 = Seated Passengers only, 32 passengers per Tram
**$120,331 (from Section 9.10) + 3 Yr. Prepaid Interest
***State and Local Funding Sources are identified in Section 14.6

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Section 12:
Cost / Benefit

12 Cost / Benefit

12.1 Methodology

The scope of cost/benefit analysis for this Study Report is limited by our Professional Service Agreement with the City of Riverside, which is based upon TIG/m's formal Proposal to conduct a feasibility study and to posit the benefits of the TIG/m system over OCS trams or buses.

Currently the predominant method of public transportation in Riverside, California is rubber-tired, internal combustion engine (ICE)-powered, buses and shuttles. This feasibility study will therefore be analyzing the benefits of including an electric steel-wheeled transit system in the transportation mix and specifically the benefits of self-powered rail system over traditional overhead catenary systems (OCS). Alternate technologies (overhead wire or other wayside power systems) and associated projected capital cost estimates are shown as comparisons.

12.2 Benefit of Streetcar Compared to Buses

Why can adding streetcars be better that running busses alone?

- More frequent service (8 min. headway vs. 15-16 min. headway)
- Shorter travel times (due to Tram Priority signalization)
- Smoother, quieter ride (electric propulsion, rail borne)
- Easier, more rapid boarding (level boarding, wider doors)
- Pollution free (no emissions from tailpipe, traction, wheels, or brakes [99% of braking is done by the motors])
- Lower propulsion energy costs, over 50% less (due to low rolling resistance at wheels)
- Lower operations costs, 30%* less (due to all of the above + low vehicle and wayside maintenance costs). See ***Figure 12-1.***

Figure 12-1, *OPEX Cost Comparison*

STREETCAR: From *Riverside Streetcar Feasibility Study*

Year 2026 Streetcar Operations Budget	= $4,615,940
PPY 2026	= 1,815,000**
Operations cost per trip	**= $2.54**
Average trip length	**= 2 miles**
Average cost per trip/mile	**= $1.27**

BUS: From *Company Summary provided by RTA*

Year 2017 Bus Operations Budget	= $87,000,000
PPY 2017	= 8,500,000
Operations cost per trip	**= $10.24**
Average trip length	**= 6.27 miles**
Average cost per trip/mile	**= $1.63**

****Percentage of Capacity**

36% @ AW-1: 32 Passenger

Steel wheel/steel rail transit vehicles experience only 15% of the rolling resistance of rubber-tired vehicles. This translates into lifetime propulsion energy savings of over 50%.

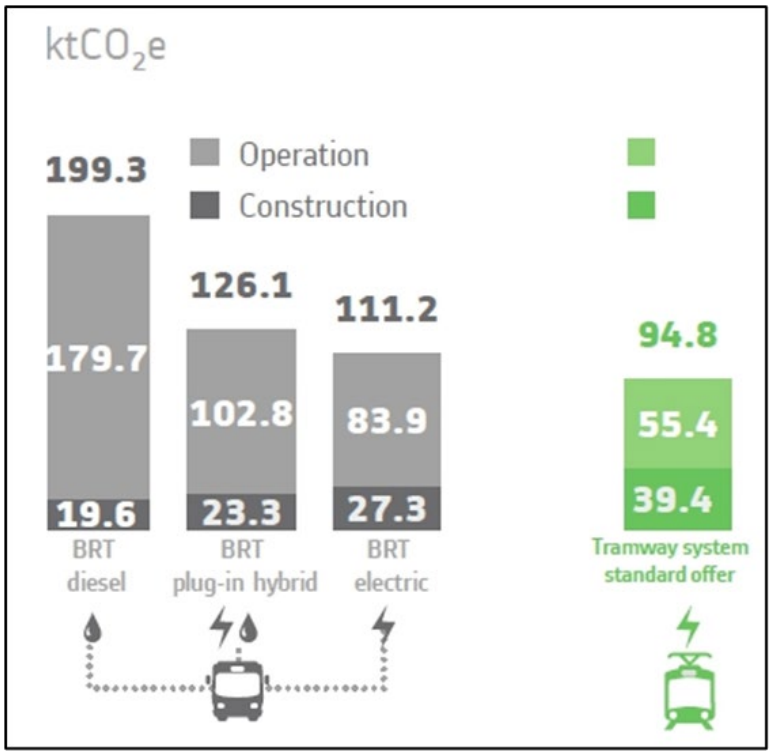
In the heavy rail sector this energy savings is illustrated by a simple comparison of efficiency:

- Freight by rail carries 400 ton per mile per gallon of fuel
- Freight by truck carries 90 ton per mile per gallon of fuel.

No matter how the energy of propulsion is produced, the low coefficient of rolling resistance enjoyed by the vehicles will guarantees that far less will be consumed in a steel wheel transit system thereby reducing the pollution of energy production and the waste heat of consumption.

Rail transit vehicles last, on average, up to four times longer than rubber-tired transit vehicles. This translates into the reduction of GHG generated in the manufacturing process and whole-life cycle of the transportation system.

Figure 12-2, *Economic Benefit of Streetcars, Compared to Busses*

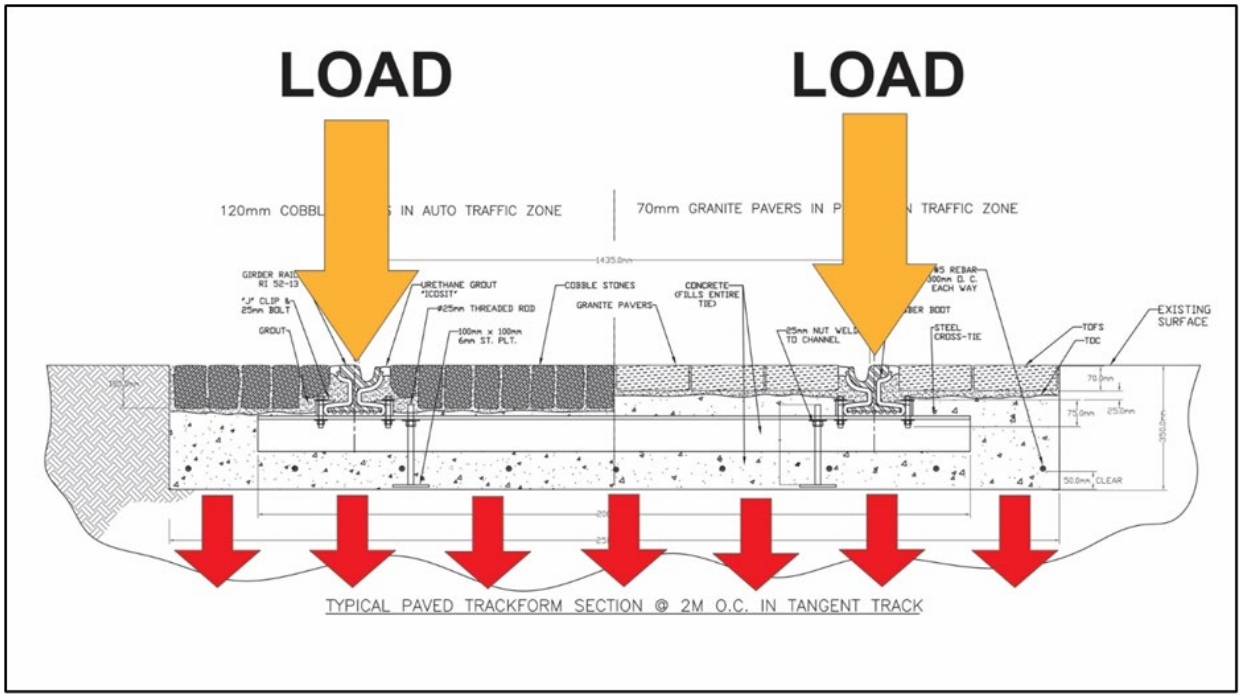


Rubber-tired transit systems produce hazardous non-tailpipe pollution in the form of tire and brake dust. Even if they are electric, they still pollute.

Rail-borne streetcar wheels have 15% of the rolling resistance of tires. This greatly reduces friction during propulsion translates directly to a substantial savings in power supply costs.

Tracks structurally improve the street surface, extending its usable lifetime. The structure of the track form consists of a highly reinforced concrete slab installed in the street. The transit vehicles running on the track do not impart moving loads to the street surface, in fact they never even touch the street itself, instead imparting their loads through the trackform directly to the earth below the street.

Figure 12-3, *Decreased Load Leads to Increased Road Surface Longevity*



Alternatively, buses impart all of the forces and impacts of moving loads directly to the street surface, exacerbating any surface anomalies over time (bumps and irregularities) eventually destroying the surface they run on by their very passage. This is a quantifiable comparison and can be expressed as the cost of keeping the roadways in a state of good repair.

Published statistics show that real estate values within ¼-mile on each side of a permanent guideway (track) increase, on average, by a factor of four times that of citywide averages. This does not happen with bus lines. See ***Section 12.5 Cost Benefits Compared to Other Types of Installation in the US***.

To provide a rough cost comparison to other cities, ***Table 12-1*** shows the capital costs of streetcar systems that have been constructed in the United States between 2000 and 2012.

It should be noted that capital costs can vary greatly from project to project depending upon site-specific issues such as land acquisition, engineering challenges, environmental clearance, and whether other supporting projects are planned to be constructed simultaneously (such as bridges, bicycle lanes, or pedestrian facilities).

Additionally, general costs of construction often vary from region to region depending upon the local costs of labor, materials, and legal requirements.

Finally, the effects of inflation and rising infrastructure costs over time must be considered when looking at past projects. For all these reasons, the cost data in ***Table 12-1*** must be viewed only as a rough comparison.

Note that all streetcar systems listed in the table below are installed with vehicles that require wayside power, which TIG/m eliminates completely, considerably reducing initial CAPEX and overall OPEX.

Table 12-1, *Capital Costs of Streetcar Systems in Peer Cities*

System	Start of Service	System Length		# of Vehicles	Capital Cost (including vehicles)	System Capital Cost	
		Corridor Miles	Track Miles			Per Corridor Mile	Per Track Mile
St. Louis	2016	2.2	2.2	2	$ 100,000,000	$45,454,545	$ 45,454,545
Cincinnati	2016	3.6	7.2	5	$ 150,000,000	$41,666,667	$ 20,833,333
Detroit	2017	3.3	6.6	6	$ 187,000,000	$56,666,667	$ 28,333,333
Tempe	2021	3	6	6	$ 192,400,000	$64,133,333	$ 32,066,667
Tucson	2017	3.9	7.16	8	$ 196,800,000	$50,461,538	$ 27,486,034
Riverside Phase 1	**2025**	**6.22**	**9.61**	**5**	**$ 131,830,000**	**$21,194,534**	**$ 13,718,002**

Sources: Refer to ***Appendix K: Average Ridership Comparisons***

12.3 Other Benefits of Self-Powered Streetcar, Compared to OCS Streetcar

Wayside power systems (including passenger station charging systems of so-called “wireless” streetcars) represent, on average, 30-50% of the cost of streetcar infrastructure (in some cases, much more, e.g., CAF Tramwave). In its 2016 application for a Small Starts Grant for its planned streetcar system, the City of Los Angeles calculated its wayside traction power infrastructure needs as requiring $4.2 million per mile. The elimination of any and all wayside power (catenary, opportunity charging stations, third rail, or substations) represents a considerable savings.

Wayside power systems have a greater impact on the built environment than the tracks or the vehicles themselves.

Eliminating wayside power represents the removal of the two major impediments to implementation of new streetcar lines:

- High cost of Infrastructure (both short and long term, both CAPEX and OPEX)
- Resistance of the public to visible power lines, poles, and substations.

Dispensing with OCS when installing and operating a streetcar system has several and noteworthy benefits. These systems are far less expensive to build and operate. They minimize property acquisition requirements and eliminate all off-board electrical traction power infrastructure costs on revenue alignments. Their construction schedules are shorter and much less disruptive, especially when subgrade utilities do not require relocation. Alignment maintenance costs are lower. Depot and yard maintenance activities are made easier. Safety is improved, both on the alignment and in the stabling facility, because high-voltage overhead wires are not exposed, and their repair does not occur.

Beyond economics and safety, they are more aesthetically pleasing. The visual pollution of a labyrinthine web of overhead wires, support poles, and clumsy feeder substations simply doesn’t exit, and the vehicles themselves are sleeker because they do not require pantograph equipment installed

on their roofs. Their overall environmental impact is markedly less because, when the vehicles' auxiliary power supply comes from a hydrogen fuel cell, they generate zero GHG emissions—only a few drops of clean water. And the "single-point failure" vulnerability of a catenary-dependent system is eliminated.

12.3.1 Minimized Property Requirements Otherwise Needed for OCS Equipment

The elimination an OCS system greatly reduces the property requirements needed to install a streetcar system. Not only does it increase the likelihood of public acceptance of a system's installation and operation due to the absence of clutter, but it also greatly reduces expenses and construction (and constructed) impositions.

Figure 12-4, *Overhead Catenary Wires and Traction Power Substation*

Source: Public domain [81]

Source: Wongm's Rail Gallery [82]

Each and every overhead wire needs to be attached either to a support pole or structure, or to a building—perhaps an historic building. The above picture is an actual Streetcar OCS, some may not be quite so dense, but they all require many guy wires for one power line. Traction power supply substations need to be installed approximately every mile and their footprint for the substation itself plus the required easement and fencing can require from 500 to 1,000 square feet, which requires finding an empty lot or acquiring existing residential or commercial property to convert to this industrial application. Underground cables and their installation also impact construction costs, schedules, and create often extended disruptions.

At-station opportunity-charging equipment still requires substantial horizontal, vertical, and sub-grade space for its installation, as well as feeder lines and Public Utility contracts. It is not uncommon for rights-of-way alone for these infrastructure requirements to cost more than $2 million per mile (Russo & Redd, 2011).

A self-powered streetcar system would eliminate all of the power distribution equipment, hardware, infrastructure, construction, and maintenance required for an OCS-dependent system, which can include:

- Excavation and duct bank construction
- Overhead wires—many overhead wires
- Line poles and their foundations, as well as hardware to fasten wires to existing buildings
- Tie-offs, guy wires, and other devices to maintain proper tension of the installed wires

- Substations and their feeds
- Power distribution cables and negative return cables
- Relocation of sub-grade utilities
- Cathodic protection for sub-grade utilities
- Electric isolation of the track rails.

This infrastructure would be required on the alignment as well as in the maintenance alignment, depot, and the stabling yard. Without OCS, the depot and stabling yard can be designed more gracefully because it does not include the complexity of wire geometry and support structures.

Figure 12-5, *A Depot Yard with OCS, and Exposed High-Voltage Wires inside a Depot*

Source: Pinterest

Source: Wikipedia

Figure 12-6, *A Simplified, Catenary-Free Maintenance Depot*

Source: TIG/m, Trams in Downtown Doha Depot

12.3.2 Eliminating the Requirement for Isolation of Stray Current

In a streetcar system in which vehicles do not rely upon wayside power, the track systems are passive—they are not electrified. This type of system also eliminates the problem of stray current and its damage to sub-grade utilities. In order to control stray current in an electrified system, rails must be either wrapped in an insulating material, called a “boot’, or be controlled by installing the cathodic protection of several electrical devices along the alignment that counteract the effects of stray current.

12.3.3 Traction Power Capital Cost Savings

Not only does a TIG/m's self-powered streetcar system relieve initial construction from the design and construction of sub-grade electrical isolation materials and components, but because the trackform is so shallow it can also reduce relocation of existing underground utilities to some degree. As presented in ***Section 5 Conceptual Alignment Design*** and detailed in ***Appendix E: Civil Engineering Schematic Drawings***, TIG/m can install track in such a way as to avoid access vaults, provide access between rails, and also offers panelized trackform sections that can be removed to get to these sub-grade utilities access points when required.

The CAPEX savings shown in ***Table 12-2*** show results from a Russo & Redd study prepared in 2011, adjusted (at 1% per year) to 2021 values.

Table 12-2, *CAPEX Savings*

CAPEX Estimated Savings Per Mile		
	2011	**2021**
Poles and Wires	2,500,000	2,761,555
Special hardware	250,000	276,156
Substations	1,250,000	1,380,778
Utility power feeds	500,000	552,311
Duct banks	300,000	331,387
Special rail isolation	250,000	276,156
Cathodic protection	200,000	220,924
Utility relocation	500,000	552,311
Savings per mile	**$5,750,000**	**$6,351,577**

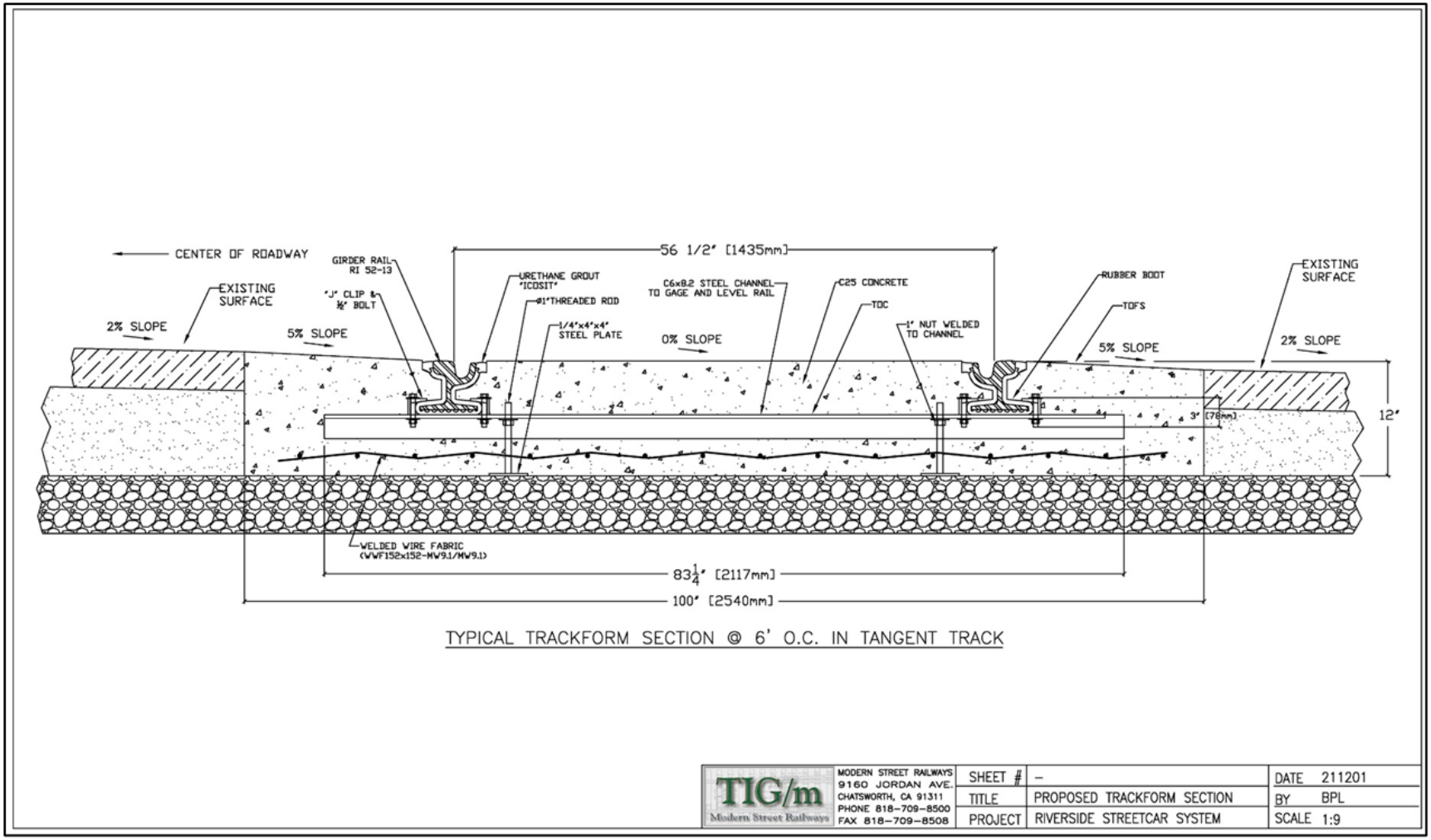
Source: Adapted from Russo & Redd Consulting Group LLC. "Wireless Streetcar Systems: Estimated Cost Savings". 2011[83]

12.3.4 Reducing Construction Impacts

Without the need for above-grade OCS equipment and sub-grade electrical isolation installation, construction time and costs are substantially reduced. The extensive excavation that would otherwise be required for a heavier system are reduced to only that which is required to support embedded 51R1 rail, which is typically 10- 12" (see ***Figure 12-7***), and TIG/m's removable panelized track-form sections are only 10" deep.

The figure below is repeated for your convenience in viewing relative to this content.

Figure 12-7, *Typical Paved Trackform Section*



Reduced excavation, lower labor times and equipment costs, shorter installation schedules all translate to less traffic disruption and inconvenience durations (including the last-stage testing of the installed electrical equipment): all lowering costs significantly and reducing installation time significantly.

12.3.5 Operations and Maintenance Simplification and Savings

A self-powered streetcar system simplifies both operations and maintenance. Without overhead wires or pantographs to malfunction or lose connection with each other, both the streetcar operators and passengers can rely on service that is more dependable and far less interrupted.

Without overhead wires, there will never be a traffic obstruction due to a maintenance team with its trucks and lifts required for inspection, maintenance, or repairs. Substation maintenance is eliminated.

Maintenance activities in the depot and stabling yard are simplified and safer due to the absence of pantograph inspection and repair, as well as exposed high-voltage catenary wires. Spare parts acquisition and storage is reduced also; no need to replace an extensive inventory of non-existent OCS equipment.

The OPEX estimated annual savings shown in ***Table 12-3*** show results from a Russo & Redd study prepared in 2011, adjusted (at 1% per year) to 2021 values.

Table 12-3, *OPEX Savings Table*

OPEX Estimated Annual Savings		
	2011	**2021**
Wire & substation maintenance	$460,000	508,126
Materials, parts, supplies	$55,000	60,754
Special equipment & tools	$15,000	16,569
Operating efficiencies	$30,000	33,139
3rd-party support	$40,000	44,185
Annual savings	**$600,000**	**$662,773**

Source: Adapted from Russo & Redd Consulting Group LLC. "Wireless Streetcar Systems: Estimated Cost Savings". 2011.[84]

Refer to ***Appendix I: Estimated Cost Savings*** to read Russo & Redd's complete report.

12.3.6 Eliminating Wayside Power's "Single Point Failure" Vulnerability

Wayside power systems represent a "single point failure" mode; if the wayside power system fails, all vehicles are immobilized. Not so with self-powered TIG/m powered streetcars. Three on-board battery systems including two traction battery banks and a hydrogen fuel cell APU means that multiple sources of on-board power are always available.

Unpredictable weather extremes pose a serious problem to an OCS. Ice buildup can damage pantographs and cause snags that can pull and detach wires. The expansion and contraction that occur between cold and hot conditions causes wire tension variations that can be damaging. Extreme heat causes wire sagging and sudden degradation, which can bring an entire circulator system to a standstill. Oregon's Portland Streetcar operators were forced to suspend all system service for at least a full day after only one of its power supply cables apparently melted in the anomalous 112° heat in late June 2021 (which set a new record the next day at 116°).[85] The OCS system there was designed

to withstand heat up to 100°, and with Portland's average high temperature at about 63° and its earlier record high reaching 107° in 1965, it's safe to say that they the recent heat event was a severely inconvenient surprise to its citizens and its transit infrastructure.[86]

Figure 12-8, *Streetcar Power Cable Damaged in Record Portland Heat, June 2021*

Source: @PXStreetcar, Twitter. Twitter: Portland Streetcar melted power cable.[87]

12.3.7 Safety

System maintenance technician are made safer when OCS is not used. Critical safety and proficiency training specific to the OCS is not required and technicians can concentrate on other safety activities.

With an OCS, the depot is the most dangerous section of the system alignment. In order to move a vehicle in or out of the shop, technicians must either employ overhead power or use a "hot stick", winches or a tug (the latter two choices are much safer). Technicians who work above the roofline of the vehicle either in the depot or on the alignment (e.g., when a pantograph detaches from the overhead wire) are exposed to and risk contact with the high-voltage equipment. Stabling yard activities are more easily coordinated and effected, without the need to coordinate and navigate around and between overhead wires.

On the alignment, an OCS-free system improves safety for third-party workers who need to maintain, repair, or access equipment surrounding or adjacent to the wires. Extra protection and monitoring for workers and emergency responders is required when any equipment employed in close proximity to the wires. Often, power to the wires needs to be discontinued and grounds must be applied to protect those who are working near them.

Not all safety concerns are removed, of course, but those associated with off-board electrical traction power are.

12.4 Summary, Cost Benefits of Self-Powered Streetcars

Figure 12-9, *OCS-Free System Estimated Cost Savings Summary*

TIG/m Self-Powered Streetcar System Cost Benefit Summary (US$MM)						Riverside Streetcar 20-Year Project Costs (US$MM)	
	Cost	Unit	Quantity	With OCS	TIG/m System	System with OCS	TIG/m System
Capital Cost of OCS	6.33	mi.	9.7	61.35	0.00	Assuming all other costs are comparable	As quoted in the Project Cost Model
Total Capital Cost Savings:				**0.00**	**61.35**		
Vehicle Maint. Cost of OCS	0.11	year	20	2.10	0.00		
Maintenance of Way, OCS	0.66	year	20	13.20	0.00		
Total O&M Cost of OCS				15.30	0.00		
Value of O&M Savings: (9.7-mile system, 5 vehicles, 20 years)				**0.00**	**15.30**		
Value -- Total Savings: Aproximately 27%					**76.65**	**366.50**	**289.86**

12.5 Cost Benefits Compared to Other Types of Installation in the US.

To provide a rough cost comparison to other cities, ***Table 12-4*** shows the capital costs of streetcar systems that have been constructed in the United States between 2000 and 2012.

It should be noted that capital costs can vary greatly from project to project depending upon site-specific issues such as land acquisition, engineering challenges, environmental clearance, and whether other supporting projects are planned to be constructed simultaneously (such as bridges, bicycle lanes, or pedestrian facilities).

Additionally, general costs of construction often vary from region to region depending upon the local costs of labor, materials, and legal requirements.

Finally, the effects of inflation and rising infrastructure costs over time must be considered when looking at past projects. For all these reasons, the cost data in ***Table 12-4*** must be viewed only as a rough comparison.

Note that all streetcar systems listed in the table below are installed with vehicles that require wayside power, which TIG/m eliminates completely, considerably reducing initial CAPEX and overall OPEX.

Table 12-4, *Capital Costs of Streetcar Systems in Peer Cities*

System	Start of Service	System Length		# of Vehicles	Capital Cost (including vehicles)	System Capital Cost	
		Corridor Miles	Track Miles			Per Corridor Mile	Per Track Mile
St. Louis	2016	2.2	2.2	2	$ 100,000,000	$45,454,545	$ 45,454,545
Cincinnati	2016	3.6	7.2	5	$ 150,000,000	$41,666,667	$ 20,833,333
Detroit	2017	3.3	6.6	6	$ 187,000,000	$56,666,667	$ 28,333,333
Tempe	2021	3	6	6	$ 192,400,000	$64,133,333	$ 32,066,667
Tucson	2017	3.9	7.16	8	$ 196,800,000	$50,461,538	$ 27,486,034
Riverside Phase 1	**2025**	**6.22**	**9.61**	**5**	**$ 131,830,000**	**$21,194,534**	**$ 13,718,002**

Sources: Refer to ***Appendix K: Average Ridership Comparisons***

12.6 Value Recapture and Economic Benefits

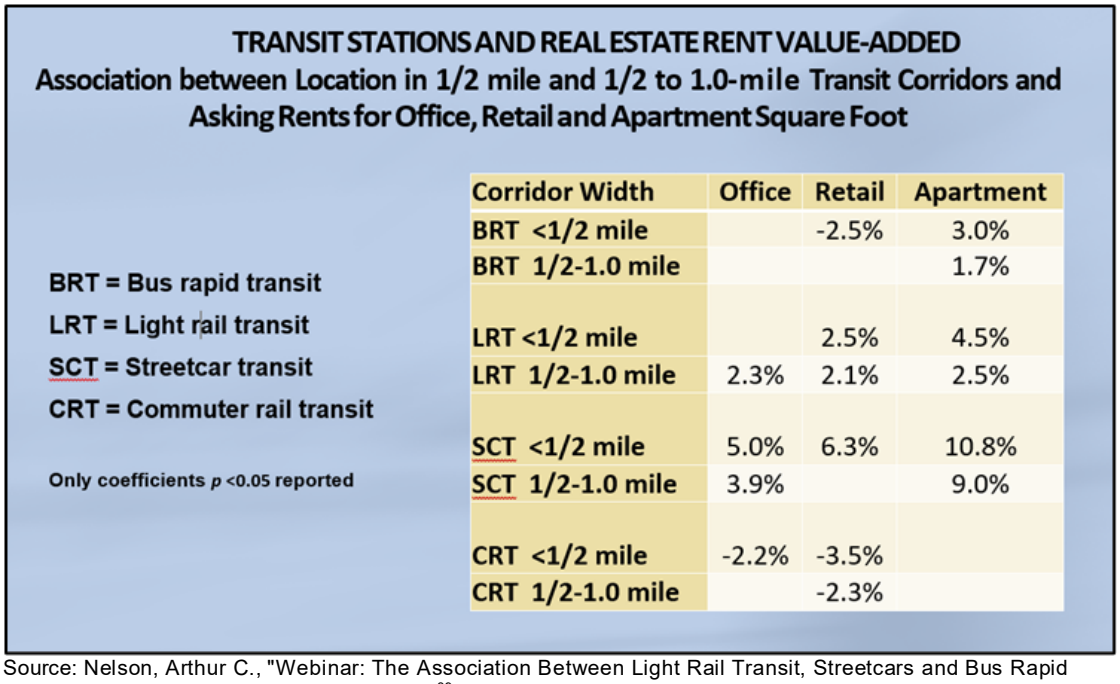
12.6.1 Transit Stations and Real Estate Value Added

Included in a study, reported in 2016 by Arthur C. Nelson (University of Arizona), supported by the national Institute for Transportation and Communities (NITC), are findings that show the association between real estate proximity (½ mile and ½-to-1-mile) within transit corridors and the asking rents for office, retail, and apartment square footage. Findings show that:

- LRT and streetcar transit systems have positive associations with respect to office, retail, and apartment rents. Rents are highest in the closest corridor to transit lines. Residential has the highest percent association followed by retail and the office.
- BRT systems have no association with respect to office rents, a negative one with respect to retail rents in the closest corridor, but positive ones with respect to apartment location in both.
- CRT systems have negative associations with respect to office and retail land uses, and ambiguous associations with respect to apartments.

Nelson asserts the implications are that LRT and streetcar transit systems have the most robust associations between transit corridor location and all land uses with the strongest influences on residential land uses. BRT systems do not appear to have strong influences on office rents, a minor and perhaps negative influence on retail rents, but positive though small influences on apartment rents. CRT systems' negative associations may be the result of insufficient planning. Refer to for a chart showing these findings.[88]

Figure 12-10, *Transit Stations and Real Estate Rent Value Added*



Corridor Width	Office	Retail	Apartment
BRT <1/2 mile		-2.5%	3.0%
BRT 1/2-1.0 mile			1.7%
LRT <1/2 mile		2.5%	4.5%
LRT 1/2-1.0 mile	2.3%	2.1%	2.5%
SCT <1/2 mile	5.0%	6.3%	10.8%
SCT 1/2-1.0 mile	3.9%		9.0%
CRT <1/2 mile	-2.2%	-3.5%	
CRT 1/2-1.0 mile		-2.3%	

Source: Nelson, Arthur C., "Webinar: The Association Between Light Rail Transit, Streetcars and Bus Rapid Transit on Jobs, People and Rents" (2016).[89]

Fixed-guideway transit systems confer both regional and local benefits. Regionally, they elevate overall economic performance as well as provide a wide range of public goods such as lower levels of greenhouse gas emissions and more mobility options. Locally, they generate value to private property that is spatially related to transit station proximity.[90]

The nation will add about 100 million people between now and mid-century. One of us (Nelson 2013) has estimated that about a quarter of American households want to live near fixed guideway transit opportunities though less than 20 percent have those options now. Perhaps one reason is that Americans understand the cost savings associated with living near transit stations. Yet, even if all new homes built between now and mid-century were located near existing or planned fixed-guideway transit stations the demand for living near those stations would still not be met.[91]

In terms of housing property values, a press release in May 2017 from Lloyds Bank UK, indicates:

1. House prices near improved transport infrastructure strongly grow two years after routes open.
2. Half of locations with a tram stop see house prices outperform the rest of the city.
3. House prices along the Elizabeth Line [London] up by 22% in two years before line opened.

House prices have been boosted by improved rail transport hubs, with new tram lines driving up property values, according to research by Lloyds Bank. House prices along tram routes in Manchester, Birmingham, and Edinburgh [UK] grew by an average of 12% in the first two years after opening and, along the Elizabeth Line [in London] grew by 22% in two years *before the line opened*. This contrasts with the two years before construction when property values remained unchanged in those same cities.[92]

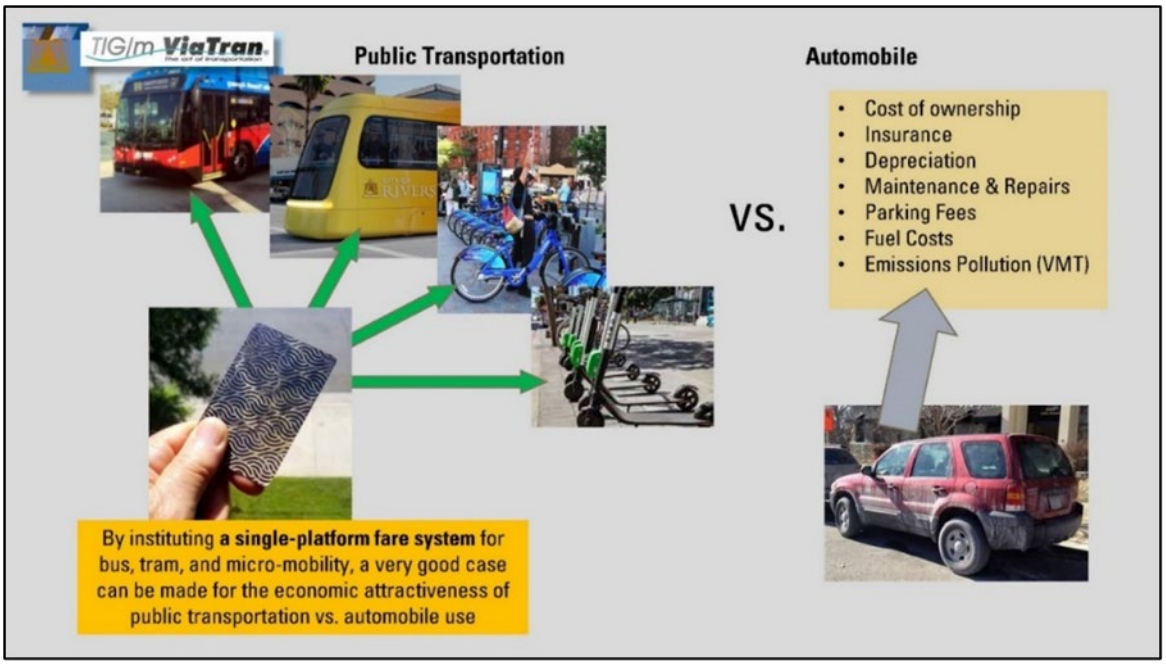
Litman's studies show that the "cost efficiency of alternative modes tends to increase if implemented as an integrated program that includes suitable incentives and land use development. For example, cycling facilities and public transit services [including streetcars] will attract more users and provide more benefits if implemented with commute trip reduction programs, efficient road and parking pricing, and smart growth land use policies. An integrated program can result in substantial mode shifts, benefits, and economic returns. Even people who never use these modes themselves can benefit from reduced automobile traffic problems." [93]

12.6.2 GHG Reduction and Other Economic Benefits

The STOPS analysis resulted in an output metric showing a reduction of daily VMT in Riverside of 4,179 for Phase 1 (refer to ***Appendix M: STOPS Model*** for details). That figure can be used to realize savings in the FTA State of Good Repair (SGR) of roadways and reduction of greenhouse gasses (GHG).

Additionally, use of CARB's calculator for Caltrans' Transit and Intercity Rail Capital Program (TIRCP) will show the value of grant packages for GHG reduction and co-benefits based upon VMT. Results of these calculations will be provided with the final iteration of this report; any adjustments to these findings will be included in a proposal for design/build.

Figure 12-11, *Public Transportation vs. Personal Automobile*



According to the analysis (shown in ***Figure 12-12***) by the U.S. National Building Museum, only an estimated 16% of automobile (vehicles and fuel) expenditures stay in a local economy. As a result, more efficient and affordable transport supports local economic development

Figure 12-12, *Reduction of Automobile Ownership and Local Economic Retention*

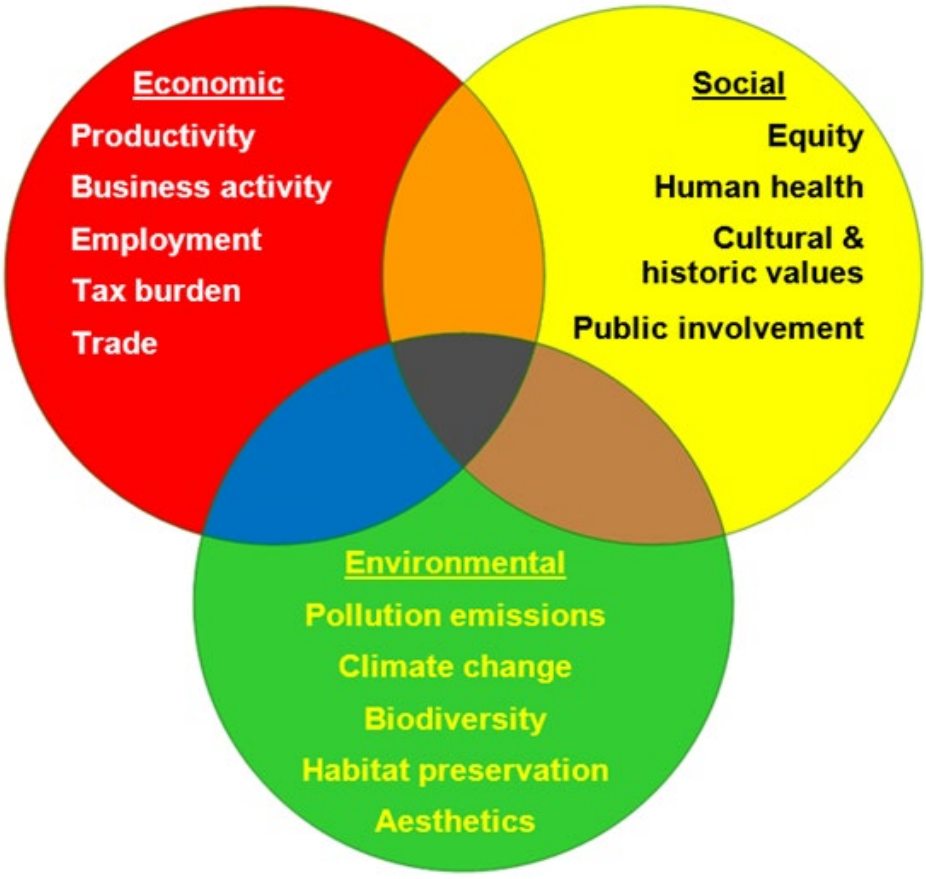
Source: Litman, Todd. "Evaluating Transportation Economic Development Impacts"[94]

12.7 Community Benefits

12.7.1 Mobility, Sustainability, Accessibility, Walkability, Familiarity, Health

Where "sustainability" can be applied to the sum of several community issues, Litman simplifies their overlap in the diagram shown below in ***Figure 12-13.***

Figure 12-13, *Sustainability: Issue Overlap in Transport Planning*



Source: adapted from Litman, Todd. "Social Inclusion As A Transport Planning Issue in Canada" [95]

Litman writes that "to be efficient and fair transportation must be multimodal," noting that "most communities include people who need each one. For example, not everybody uses public transit or needs universal design features such as curb cuts and ramps, but most communities include some people who require them to travel independently, and most people will need them sometime in their lives. As a result, even people who don't currently use a particular mode may value having it in their community, similar to lifeboats on a ship that are seldom used but important to have available; called option value."[96]

A variety of multi-modal mass transit benefits regarding safety, physical health, economics an equity, as well as general accessibility, are shown in ***Table 12-5,*** which also describes their consideration in "conventional" city planning.

Table 12-5, *Transit-Related Social and Environmental Benefits*

Health Benefit	Public Transit Impacts	Consideration in Conventional Planning
Traffic safety: Reduced traffic crash injuries, disabilities, and deaths.	Significant reductions in per capita injuries and deaths, particularly if total vehicle travel is reduced.	Considers per-mile crash injury rates, but often ignores mileage reduction safety benefits.
Pollution reduction: Reduced exposure to harmful air, water, and noise pollution.	Generally reduces emissions per passenger-mile and per capita, particularly if transit uses alternative fuels or state-of-the-art emission controls.	Considers differences in emission rates per VMT, but often ignores mileage reduction impacts.
Physical fitness: Increased physical activity by walking and cycling.	Since most transit trips involve walking or cycling links—and TOD improves nonmotorized conditions—multimodal mass transit improvements tend to increase fitness.	Not generally considered a transportation planning issue and is generally overlooked in quantitative analysis.
Affordability: Reduced financial burdens, particularly for lower-income households.	Public transit and TOD can reduce transportation costs, which leaves more money to purchase housing, healthy food, and medical care.	Sometimes considered but not generally quantified.
Basic mobility: Ability for people to access essential goods and services.	Public transit and TOD development provide basic mobility and accessibility.	Sometimes considered when evaluating specific policies and projects, but not generally quantified.

Source: Litman, Todd. *Evaluating Public Transit Benefits*. 2010. Victoria Transportation Policy Institute, for APTA. [97]

Arthur C. Nelson, reporting from an over ten-year study, reiterates John Renne's 2009 characteristics of station precinct [proximity] that describes the qualitative spectrum from transit-adjacent developments (those near high-quality transit but may not be 'oriented' towards the transit) to transit-oriented developments (those that "maximize the amount of residential, business and leisure space within walking distance of public transport, promoting a symbiotic relationship between dense, compact urban form and public transport use."[98]

Figure 12-14, *Transit-Adjacent to Transit-Oriented Development Spectrum*

Characteristics of Station Precinct:

TAD	TOD
• Suburban street pattern • Low population densities • Dominance of surface street parking • Limited or no pedestrian access or facilities • Limited or no bicycle facilities • Dominance of single-family homes • Dominance of single-purpose buildings • Segregated land uses (industrial, gas stations, car dealerships, drive-through stores/restaurants, and other auto-centered land uses)	• Grid street pattern • High population densities • Underground and structured parking • Pedestrian-focused design • Plentiful bicycle facilities and rentals • Multi-family structures • Vertical mixed-use buildings (office, retail, residential) • Vertical and horizontal mixed land uses, especially along main streets

Source: Adapted from Renne, John L. 2009. "From Transit-Adjacent to Transit-Oriented Development." [99]

Transit-adjacent development (TAD) exists in areas of urban and rural sprawl, and may offer connection between remote points, but does not provide circulating service within neighborhoods and municipalities. Transit-oriented development (TOD) typically includes one or more transit stops and hubs surrounded by mixed-use development, which provides a variety of accessible mobility modes to a more densely populated area that is more appropriate in scale for pedestrians, who are able to have many of their needs met in within walking distance.

Familiarity with a place, whether urban or rural is always enhanced and can seem to be proportionally measurable to pace. A slower pace inherently makes apparent to the walker that which can easily be missed when traveling in a vehicle at a higher velocities, resulting in a greater “sense of place” in any environment. Urban pedestrians naturally avail themselves to more goods and services in their immediate proximity, dining at restaurants and stopping in at stores and boutiques along their way. Lingering in an area for meals and shopping generates a convivial urban space that are a factor in sustainability, the definition of which embraces the amalgamation of economic, social, and environment influences, and their accessibility to a greater number of people.

In their article, ”Accessibility in Practice: 20-Minute City as a Sustainability Planning Goal”, Capasso De Silva et al. present a case study of Tempe, Arizona (aiming to “promote travel for daily activities that is less reliant on private autos”), which puts accessibility (the ease of reaching a destination) into practice using a 20-minute threshold via multi-modal transit that includes walking, biking, or public transit. They assert that cities “can enhance their sustainability planning by prioritizing accessibility as a performance metric for transportation planning,” and conclude that “accessibility can be implemented as a local sustainability strategy. Improved accessibility is not just a transport goal, but one that supports sustainability and climate action goals.”[100]

12.7.2 Travel Time Reduction: Benefits of Tram Priority Signalization

As described in other Sections, including Section 5, streetcar priority signalization theoretically removes from a typical journey time the 75-second average wait time at red lights. When the tram dwell-time at stations is deducted, this can provide a baseline for overall time savings over automobile travel assuming equal average speeds between the two modes. For example, if an automobile were required to stop at each traffic light, and:

- If a streetcar did not need to stop at any of the eight (8) traffic signals on Market Street between 3rd Street and 14th Street, the travel time could be up to 10 minutes shorter. Subtracting the dwell time at 4 tram passenger stops (4 x 40 sec. = 2.7 min) the resulting time advantage over automobile travel at the same speed is 7.3 minutes.

- If a streetcar did not need to stop at any of the 13 traffic signals along University Avenue between Canyon Crest Drive and Lemon Street, the travel time could be up to 16 minutes shorter. Subtracting the dwell time at 9 tram passenger stops (9 x 40 sec. = 6 min) the resulting time advantage over automobile travel at the same speed is 10 minutes.

- A streetcar operating on the conceptual Phase 1 alignment, from UCR as a starting point and running the entire circulation of Phase 1 back to UCR, could see a reduction of up to approximately 50 minutes Subtracting the dwell time at 30 tram passenger stops (30 x 40 sec. = 20 min) the resulting time advantage over automobile travel at the same speed is 30 minutes due to traffic signal “green wave”.

In addition to this numerical time advantage of streetcar travel over automobile travel, remaining automobiles traveling along with the streetcar-generated "green wave" between stations benefit from a progressive cascade of green lights without the need to stop for red lights at those intersections, resulting in continuous traffic flow over several intersections.

12.7.3 Pollution, GHG Reduction, and Other Benefits

Instituting an electric street railway system represents not only a reduction in automobile vehicle miles travel, but also the reduction of public transportation vehicle miles powered by internal combustion engines and running on rubber tires, as well as a reduction in noise pollution.

12.7.3.1 Air Pollution: Greenhouse Gases (GHG) and Toxic Particulates

The U.S. Environmental Protection Agency reports that the transportation sector is one of the largest anthropogenic greenhouse gas (GHG) contributors in the country, representing a 29% share in total 2019 emissions. Within the transportation sector, on-road vehicles including passenger cars, light-duty trucks, motorcycles (all typically conveying one person only), and busses produce over 58% of that share. GHG emissions from transportation sources include:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O) and
- Various hydrofluorocarbons (HFCs).[101]

12.7.3.1.1 Modal Shift Factor for Environmental Benefits

In An Update on Public Transportation's Impacts on Greenhouse Gas [GHG] Emissions, researchers at the TCRP assert that:

"One of the key [greenhouse gas] GHG benefits of public transportation is that it enables passengers to avoid emissions that would have otherwise occurred if they had driven a private automobile. APTA calls this a "transportation efficiency" gain (APTA 2018). It may also be described as the direct effect of transit on vehicle miles traveled (VMT). The tradeoff between passenger miles and private automobile miles is not a one-to-one replacement. Some passengers would drive if they were not taking transit, but others would carpool, bicycle, walk, use a taxi, use a ride hailing service, or not take a trip at all.

Transit agencies conduct passenger surveys to understand the modes of transportation that passengers would choose if they were not taking a transit trip. This mode shift is an important factor in estimating the GHGs avoided by transit passengers. APTA gathers passenger survey data from transit agencies and compiles them into a national average, which is what was used for this research.[102]

12.7.3.1.2 Non-Tailpipe Pollution: Tire and Brake Wear

While tailpipe emissions have been more thoroughly evaluated and regulated, the particulate matter pollution generated by tire and brake wear as well as road-dust resuspension is considerable and can be 1,000 times worse than what comes out of a car's exhaust pipe, Emissions Analytics has found.[103]

"Exposure to airborne particulate matter (PM) is associated with acute respiratory infections, lung cancer, and chronic respiratory and cardiovascular diseases. Road traffic is behind a quarter of PM2.5, the most damaging type, in urban areas yet only exhaust emissions of PM are regulated. No standards exist for measuring or regulating non-exhaust PM emissions."[104]

While the axle brakes on TIG/m streetcars are friction brakes that employ brake pads these brakes are not use for normal braking. The vehicles use dynamic braking via their motor to slow to less than one (1) mph, beyond which the friction brakes are used as parking brakes. Only if an emergency stop is initiated are the friction brakes fully engaged. This braking technology virtually eliminates brake pad wear and the resultant brake dust.

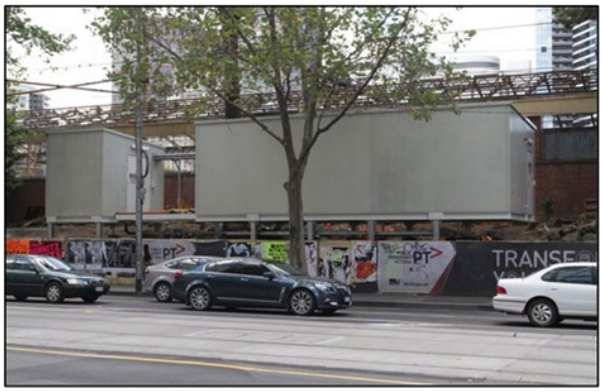
A successful steel-wheel on rail, self-powered, zero-emission streetcar system would remove cars from Riverside's roadways without generating these pollutants.

12.7.3.2 Visual Pollution

A valuable—but often unappreciated until experienced—benefit of a self-powered streetcar system is that it eliminates the visual pollution created by the unsightly spiderweb of overhead catenary wires tethered to poles and buildings as well as their associated clunky wayside power substations, which are required approximately every one (1) mile along an alignment. Some wayside substations may be smaller than the one depicted, some may be larger.

Figure 12-15, *Labyrinthine OCS Wire Clutter, and a Street-side Substation*

Source: Seattle First Hill Streetcar, Photo Credit: SDOT Flickr



Source: Wongm's Rail Gallery

Figure 12-16, *Uncluttered Views of a Clean Urban Street and Skyline*

Source: TIG/m Trams in Doha, Qatar

12.7.3.3 Noise Pollution

Urban noise is a common problem, and the vast majority of it is created by motor vehicles. Noise is far too often dismissed as a minor nuisance, rather than the legitimate health issue that it is.[105]

While water and air pollution receive the most attention from environmentalists, noise pollution disturbs the greatest number of people in their daily lives and we city dwellers accept this background clangor as normal. Cities are not necessarily inherently noisy, but the wall of noise created by automobile traffic can literally be damaging; engines roaring as car drivers race to the next traffic signal, horns honking in irritation or exasperation, and sirens wailing loudly so as to be heard over the din of the river rush of traffic and car audio systems (which, in some cases, is audible outside the confines of the car).[106]

Noises above 85 dBA can cause noise-induced hearing loss (NIHL). The louder the sound, the less time it takes for hearing damage to occur. Normal conversation rates at approximately 60-65 dBA. Traffic noise rates are substantially higher:

- Single autos: 73-76 dBA; aggregate rush hour noise between 85 and 110 dBA
- Motorcycles: 80-110 dBA
- Sirens: 110-129 dB

The consistent noise from automobile comes from two sources: engine noise and the friction of rolling tires on the road surface, with tire noise becoming significant at speeds above only 18 mph and louder than the car's propulsion system at only 35 mph (a difference of about 6 dBA). Add horn honking and sirens, and, well…[107]

Noise pollution in Riverside is currently rated as moderate[108] , but an urban arterial road averages 80 dBA at ground level—five times louder than the noise intensity recommended by the World Health Organization.[109] In addition to hearing loss, Bruntlett and Bruntlett cite several other physical, emotional, and social maladies resulting from "the world's most prevalent pollution" they assert is an "invisible threat to health and happiness".

It is possible to reduce noise pollution, and many European cities are successful by removing significant numbers of rubber-tired automobiles from their roads. Some Dutch cities are notably quiet, particularly Delft, Netherlands, which takes noise pollution very seriously. It has reduced its traffic volumes considerably by implementing a traffic circulation plan that routes most traffic outside the city center as much as possible, encouraging public transit and bicycling as healthy alternatives.

Figure 12-17, *Public Square in Delft*

As a Parking Lot (before)

Pedestrians and Cyclists only (**after!**)

Source: Slaughter, Jason. "Cities Aren't Loud: Cars Are Loud"[110]

Decibel levels in Delft have been recorded and are noteworthy:

- Outside a train station reading at 55 dBA (about as loud as a household refrigerator)
- Pedestrianized city center streets often reading below 40 (as quiet as a library).[111]

Delft demonstrates—quietly and clearly—that it is possible to escape incessant urban noise without needing to escape a city altogether, simply by reducing the volume of automobile traffic.

Section 13:
Next Steps

13 Next Steps

Should the City of Riverside opt to move ahead with the Riverside Streetcar Project along the lines presented in this Report, TIG/m will propose a DFBOM Agreement which would be negotiated during an Exclusive Negotiating Period. Major considerations to be defined within this period are: final budget parameters (with fixed costs coming after design development and value engineering), the form of the agreement, the definition and formation of the Joint Development Partners to act for the public and private sectors (Riverside Streetcar, Inc., Streetcar O&M Partners LLC, etc.), and the building of agreements between the City of Riverside, the RTA, and the RCTC relative to the implementation of the project.

Funding the project through an Institutional Private Placement with the private sector financial corporation that TIG/m brings to the Joint Development team.

Application for Exemption from CEQA pursuant to SB 288

"In addition to supporting public transit agencies, SB 288 can also create opportunities for new public-private partnerships. The private sector has shown increasing interest in investing in proposed streetcar, light rail, and bus transit projects over the past several years. The new exemptions may help fast-track new transportation projects by eliminating CEQA review and thereby reducing one of the most time-consuming and risky elements of project development. Transportation agencies and private developers should carefully evaluate proposed projects to determine if they can take advantage of the new exemption over the next two years."[112]

Within the P3 structure developed for the Riverside Streetcar project delivery, institute a Grant Funding Committee. This Committee will be tasked with formulating the permanent strategy for the grant funding requirement identified in the Cost Model and potential shortfall recovery. No grant funding will be required during the three years of project construction which is funded by the private sector loan but will need to be in place for the first year of Operations.

Coordinated work with the CPUC (Railway Authority) to determine the structure of the Safety Certification program for the project and appointment of a Safety Case Manager and ISA (Independent Safety Assessor).

Coordinated work with Caltrans to determine the way forward with design of the crossings of Caltrans properties at the 14th Street overpass at SR 91, and the new 3rd Street Railroad Grade Separation.

Proceed with Schematic Design, Design Development, Final Design, Construction Documents, Construction, Manufacturing, Testing and Commissioning.

13.1 Detailed Planning

TIG/m will work closely with City Staff, local agencies, and stakeholders to arrive at agreed plans for design of alignments, locations of stations, O&M facilities, manufacturing facilities, as well as construction through delivery, installation, commissioning, and fare collection strategies. Operations and maintenance plans, as well as safety and emergency response procedures will be thoroughly detailed and demonstrated.

13.2 Final Engineering

From the plans detailed, TIG/m would then deliver schematic engineering, design development, value engineering, final design, and construction documents for infrastructure and vehicles for review, revision, and initialization.

13.3 Public Outreach

On its web site, the City of Riverside is hosting a page for the streetcar feasibility study, www.riversideca.gov/streetcar. At the time of this draft writing, the page includes a survey, in both English and Spanish, to gather data about travel behaviors in and around the city. This data will inform streetcar ridership estimates. Additionally, visitors to the site have the opportunity to offer their contact information, which will be used to invite them to in-person or virtual on-line charettes and presentations. The page will be updated as new information becomes available and ready for publishing.

Additionally, community groups and stakeholders, as listed in ***Section 2.10***, may be conducting their own outreach programs. The goal is to provide details about the study and the prospective streetcar network to as many residents, students, and visitors, to provide a forum for an open discussion. Public opinion is of great value and the success of large-scale projects can be significantly improved if a locale's citizenry feels that it is heard, appreciated, and part of the process.

13.4 Schedule and Streetcar System Implementation

Scheduling for design/build of vehicles and infrastructure would be organized according to an agreed-upon contract, which is expected late in 2022, and would be followed by an estimated three years of construction. System implementation can commence upon the completion of Phase 1, with system operations uninterrupted during design/build of vehicles and infrastructure for subsequent phases, due to the installation of specialwork that anticipates those subsequent phases if agreed to by the parties.

13.5 Safety Codes, Standards, General Orders, and Guidelines

Those responsible for design, build, installation, operations, and maintenance phases all must refer to and follow sets of safety guidelines and standards. TIG/m, from design conception through operations and maintenance, observes the guidelines recommended by the railway authority, as well as numerous international codes and standards.

13.5.1 California Public Utilities Commission (CPUC)

The CPUC would be the regulatory body regarding rail safety for the Riverside Streetcar Project. A safety case must be prepared and presented to the CPUC for review and approval before a Commission Resolution is granted.

TIG/m has been in dialogue with CPUC relative to this Report for most of 2021. We have provided them with our current Safety Certification Documentation under European Norms which were developed to qualify for Certified Public Operation in the Emirate of Qatar. CPUC agents have been to our factory in Chatsworth several times over a period of 6 years, the most recent being in October of this year to inspect our rolling stock for use in the Coast Future Project on the Santa Cruz Branch Line. The Project was approved and CPUC agents were present in the vehicle and on the wayside to observe the interface with railroad signalization. There were no incidents reported.

The initial document to be prepared is a Safety Certification Plan (SCP), which includes a SCP checklist. Additional documentation in support of a safety case, must follow the guidelines in the following CPUC General Orders (GO) where applicable to the system, which may include but not be limited to:

System Safety

- GO 108: Filing of Railroad Operating Department Rules
- GO 110: Radio Communications in Railroad Operations
- GO 127: Regulations Governing Automatic Train Control Functions
- GO 143-B: Safety Rules and Regulations Governing Light Rail Transit
- GO 159-A Rules Governing Commercial Mobile Radio Service
- GO 164-E: Safety Oversight of Rail Fixed Guideway Systems
- GO 172: CPUC GO 172 Onboard Electronic Devices
- GO 175-A: CPUC GO 175-A Roadway Worker Protection

Construction and Maintenance Regulations

- GO 26-D: Regulations Governing Clearances on Railroads and Street Railroads with Reference to Side and Overhead Structures, Parallel Tracks, Crossings of Public Roads, Highways, and Streets
- GO 72-B: Standard Types of Pavement Construction at Railroad Grade Crossings
- GO 118-A: Regulations Governing the Construction, Reconstruction, and Maintenance of Walkways Adjacent to Railroad Trackage and the Control of Vegetation Adjacent Thereto.
- GO 33-B: Construction, Reconstruction, Maintenance, and Operation of Interlocking Plants of Railroads
- GO 131-D - Planning and Construction of Facilities for the Generation of Electricity and Certain Electric Transmission Facilities

13.5.2 Other California Guidelines

The following California guidelines will be referred to, as applicable:

- California Department of Transportation (Caltrans):
  - Standard Specifications (latest edition)
  - Standard Plans (latest edition)
  - Bridge Planning and Design Manual (latest updates)
- State of California, Energy Commission, Title 24, Part 6
- California Building Code, Title 24, Part 2

13.5.3 Additional International Standards Referred to by TIG/m

During previous and current projects, TIG/m refers to additional international standards that include but are not limited to those listed below: (Please refer to ***Section 8.1.3*** for details).

- AISC
- ANSI/AWS
- APTA
- AS-3
- ASME
- ASTM
- BSEN
- CENELEC
- DIN
- EN-50126,8,9
- IBC
- IEEE
- IEC
- IPC
- FAR
- MODSafe
- NFPA

13.5.4 Gap Analysis

TIG/m ViaTran® MRV streetcar vehicles are internationally certified by Certifer of France (ISA), under compliance to European norms (EN 50126, 50128, and 50129 and all attending railway standards listed above) as documented in a comprehensive safety case compiled by TÜV Rhineland. Equivalency between these European norms and the CPUC GO164-E are currently being studied under a gap analysis, with Ricardo Rail consulting. Compliance is assured.

13.6 Funding Sources and Strategies

A variety of funding sources and strategies are available. TIG/m advocates Public/Private Partnerships.

TIG/m Research & Development Center and Manufacturing Headquarters

In order to accommodate its growing business as an international tram system design/builder and enhance its ability to respond to recent invitations to joint-venture with several large international transportation consortiums, TIG/m plans to build a new R&D Facility and Manufacturing headquarters in Riverside. The catalyst for this move from our current location in Chatsworth, California, would be the initiation of the Riverside Streetcar System project which would allow us to take advantage of incentives available in the Innovations District and Opportunity Zone to place on one property; an Operations and Maintenance Facility for the Streetcar, a R&D and Manufacturing center for worldwide operations, and a test track large enough to viably test articulated trams above 25m in length.

13.6.1 Private Financing/Investment Opportunities

Funding Through an Institutional Private Placement

McDonald Financial Corporation (“MFC”) has entered into an agreement with TIG/m by which it will provide its knowledge and expertise to structure a very innovative proprietary funding model to finance The Riverside Streetcar Transportation System. This model allows the cars and the necessary infrastructure to repay their own investment through a non- debt funding instrument that does not encumber the City bonding capacity or Bank lines of credit. This allows for increased economic infrastructure, without the traditional corresponding liability, funded under a self-sufficient structure that is utilized as a form of credit rating enhancement.

The City would be responsible for any short fall, if one were ever to occur, under a shortfall agreement instrument. Usually, the City determines the pricing and revenues which would flow to them directly. They can either subsidize the consumers prices for below market services or allow it to repay itself to amortize the payments.

The following is MFC's summary of the benefits of this method of private sector financial investment. For the full MacDonald Financial Statement please refer to ***Appendix Q.***

13.6.2 Local/Regional Funding Opportunities

In 2015 the Riverside Reconnects Streetcar Study identified State, Regional, and City funding sources which could be allocated to the CAPEX totaling $55MM from the following sources:

- STEP 20MM
- STIP 5MM
- Greenhouse Gas Reduction Fund 5MM
- Measure A Renewal, Local Share 8MM
- Development Impact Fees/Charges 37MM

The same Study identified over $3MM from the following Sources for annual Operating Funds:

- EIFD 1.47MM
- Transit Benefit District .8MM
- State STA -revenue-share allocation .8MM

During the definition, formulation, and contract phase of the organization of governance for the Riverside Streetcar Project, a permanent Grant Funding Committee will be formulated to apply for these funds and grants, we can make the reasonable assumption that between the state, regional, and local sources that are available to the project we will be able to combine funds to make up the relatively minor costs identified in the project cost model needed to make up shortfalls during the years 2025 through 2040 after which the project becomes profitable for the city:

Table 13-1, *Funding Required*

Year	Funding required ($USMM)
2025	9.3
2026	9.6
2027	8.2
2028	7.8
2029	6.6
2030	6.8
2031	6.5
2032	6.0
2033	4.9
2034	5.0
2035	4.6
2036	3.9
2037	2.5
2038	2.5
2039	1.9
2040	1.3

Following is an overview of programs that provide funding at the state, regional and local level:

- Western Riverside Council of Governments (WRCoG)
- Transportation Uniform Mitigation Fee (TUMF)
- Southern California Association of Governments.

Transit and Intercity Rail Capital Program

The Transit and Intercity Rail Capital Program (TIRCP) program provides grants from the Greenhouse Gas Reduction Fund and SB 1 to fund transformative capital improvements that will modernize California's intercity, commuter and urban rail systems, and bus and ferry transit systems, to significantly reduce emissions of greenhouse gases, vehicle miles traveled and congestion.

TIRCP has provided $5.3 billion statewide since 2015 in the first three award cycles – geographic equity is a key goal of the program, allowing funds to be awarded to the best projects from each region. This program is leveraging local funding to advance more than $23 billion of total projects throughout the state.

Today, major service expansions and improvements are being funded by the TIRCP program, including:

- **Los Angeles:** LOSSAN Rail Corridor and throughout the Metrolink system, as well as on the LA Metro transit corridors that are also funded by Measure M.
- **San Francisco Bay Area:** as BART is expanded and its capacity under the Bay enhanced, in Caltrain as it electrifies and lengthens trains, in SMART expansions to Larkspur and Windsor, and in the Muni rail vehicle expansion.
- **Sacramento and Central Valley:** SacRT service expansion on the Gold Line, expansion of ACE and Amtrak services to Sacramento and Merced, and in the Fresno bus system.
- **Inland Empire and High Desert:** electrification of the Antelope Valley bus system, the hydrogen-battery Redlands Passenger Rail service, and in the SunLine bus system.
- **Orange County and San Diego:** OC Streetcar, the LOSSAN Rail Corridor, and in MTS Blue Line improvements.

13.6.3 State Funding

Senate Bill 1 Programs

Senate Bill 1, the Road Repair and Accountability Act of 2017, provides $54 billion in public investment to fix roads, freeways, and bridges in communities across California. Programs under SB 1 include funding opportunities such as the Active Transportation Program (ATP) and Trade Corridor Enhancement Program (TCEP).

State Rail Assistance

Senate Bill 1 (SB 1), the *Road Repair and Accountability Act of 2017,* created the State Rail Assistance (SRA) Program by directing a portion of new revenue specifically to commuter rail and intercity rail, estimated at almost $240 million over the next five years. The majority of program funding is directed by statutory formula to rail operators, divided equally between commuter rail and intercity operators (CalSTA awards 25 percent of the intercity SRA portion via discretionary grants). **There will be a call for SRA intercity rail discretionary grants this year for an estimated $30 million of available revenues over the next five years**.

State Transit Assistance and State of Good Repair Program

SB 1 also provides about $250 million annually for the State Transit Assistance (STA) Program to help transit agencies fund their capital infrastructure and operational costs. This money is distributed via current funding formulas based on agency revenue and population.

Additionally, SB 1 provides more than $105 million annually for the State of Good Repair Program (SGR) that funds transit capital projects or services to maintain or repair existing transit fleets and facilities; new vehicles or facilities that improve existing transit services; or transit services that complement local efforts to repair and improve local transportation infrastructure. This money is made available to eligible transit operators based on the STA formula.

Low Carbon Transit Operations Program

The Low Carbon Transit Operations Program (LCTOP) is one of several programs that are part of the Transit, Affordable Housing, and Sustainable Communities Program established by the California Legislature in 2014 with Senate Bill 862 (SB 862). LCTOP, which has an apportionment of $146 million for FY19-20, provides operating and capital assistance for transit agencies to reduce GHG emissions and improve service, with a priority on serving disadvantaged communities. LCTOP is noncompetitive, formulaic program administered by Caltrans and funded through a continuous five percent appropriation from annual Cap and Trade auction proceeds through the GGRF. Approved projects include new or expanded bus or rail services, free or reduced transit passes, expanded intermodal transit facilities, equipment acquisition, fueling, maintenance and other costs to operate services. FY19-20 LCTOP funding will be distributed before June 30, 2020.

State Transportation Improvement Program

The State Transportation Improvement Program (STIP) is the biennial five-year plan adopted by the California Transportation Commission (CTC) to fund state highway improvements, intercity rail, and regional highway and transit improvements. The STIP was adopted in March of 2020, programming projects for the next five years.

State Transportation Improvement Program/Proposition 1B/Other Programs

State Rail Assistance, the State Transportation Improvement Program, and various California Transportation Commission (CTC) discretionary programs have provided substantial additional funding for transit and rail projects statewide (over $1 billion since 2018).

Project examples include new rolling stock for intercity rail, major transit corridor projects in southern California and Sacramento, grade separations throughout the state, and light rail vehicles and locomotives for transit operators in Southern California.

13.6.3.1 Environmental Impact Assessment Document Preparation

Exemption from California Environmental Quality Act (CEQA) under B-288 will be sought as an early step in the process of governance of the Riverside Streetcar Project. For specific state funding, an initial study will be conducted by the lead agency (City of Riverside), which will include a preliminary review of CEQA requirements remaining for those specific proposal (if any). These may include proposed project's environmental impacts of system construction and operation. Potential impacts and applicable mitigations will be reviewed in the following categories, as applicable to the proposed system design, and analyzed in preparation for a final EIR/EA, as appropriate and required:

CEQA

- Aesthetics
- Air Quality and Greenhous Gas Emissions (or lack thereof)
- Cultural Resources
- Energy
- Geology and Soils
- Greenhouse Gas Emissions
- Hazards and Hazardous Materials
- Land Use and Planning
- Noise and Vibration
- Transportation/Traffic
- Construction Impacts
- Cumulative Impacts

Should CEQA be required, the lead agency (the City of Riverside) and stakeholders may want to consider working with the Association of Environmental Professionals (AEP), a non-profit organization of professionals working to improve their skills as environmental and resource managers. Since its formation in 1974, AEP has grown to over 1,700 members: planners, environmental scientists, biologists, lawyers, noise specialists, transportation planners, paralegals, archeologists, geologists, engineers, visual analysts, and other professionals in numerous disciplines.[113]

The federal National Environmental Policy Act (NEPA) guidelines are not expected to apply since federal transit funding will not be used or anticipated for the project's development and construction.

TIG/m will provide data for the study applicable to its part of the project.

13.6.3.2 New 2-Year CEQA Exemption to Fast Track Transportation Projects[114]

Potentially applicable to the Riverside Streetcar Project, this CEQA exemption could potentially reduce the time to reach the construction phase by six months to a year and reduce pre-construction costs by up to five hundred thousand dollars. More study will need to be done to assure that all requirements for the exemption can be met. The following paragraphs in this section are quoted directly from the web site of Meyers/Nave, Attorneys at Law:

"A new bill enacted in October of 2020 by the California legislature provides an opportunity to speed up approval of new and stalled transportation projects by limiting environmental review requirements. The legislation adds a new exemption to the California Environmental Quality Act (CEQA) for sustainable transit projects, including new projects that would be built in existing public rights-of-way. Quickly approved by Governor Newsom, the bill is intended to stimulate economic recovery, and boost public transit agencies that are struggling with massive ridership declines as a result of COVID-19.

New Sustainable Transit Exemption Categories

Senate Bill (SB) 288 creates a new statutory exemption from environmental review pursuant to CEQA. The new statutory exemption takes effect on January 1, 2021, and expires on January 1, 2023. The exemption applies to (1) pedestrian and bicycle facilities; (2) wayfinding and customer information projects for transit riders, bicyclists, or pedestrians; (3) transit prioritization projects; (4) designation of

highway lanes or shoulders for bus-only lanes; (5) new or increased light rail, bus, or bus rapid transit service on existing public rights-of-way; and (6) charging or refueling infrastructure for zero-emission transit buses. Also exempted are utility infrastructure works associated with any of those six project categories, or projects that combine components of the exempted categories. Projects by cities or counties to reduce minimum parking requirements are also subject to the new statutory exemption. SB 288 also modifies an existing statutory exemption for bicycle transportation plans by deleting the requirements for a traffic and safety impact assessment and mitigation of potential impacts. The bill also extends that bicycle transportation plans exemption until January 1, 2030, instead of expiring on January 1, 2021.

Requirements for Application of Exemption

To rely on the new exemption, projects must be located in urbanized areas and on or within an existing public right-of-way. Exempt projects also cannot add new automobile capacity or require the demolition of affordable housing units. If a project's cost exceeds $100 million, additional requirements apply: (1) the project must be incorporated into a regional transportation plan or other plan that has undergone programmatic-level environmental review, (2) all construction impacts must be fully mitigated and (3) the lead agency must prepare a business case analysis and a racial equity analysis. The lead agency must also hold at least three public meetings prior to approving the project, including one to review the project's business case and racial equity analysis. Two public meetings are also required annually during project construction. In addition, the lead agency must commit to using a skilled and trained workforce, including by use of a project labor agreement.

Purposes and Benefits of New Exemption

The bill notes that the COVID-19 pandemic has resulted in unemployment for 4.5 million Californians, and further threatens the 1.6 million transportation workers in the state. To avoid a surge in driving as the state reopens, the legislature wants to incentivize building public transit and completing street and bicycle lane projects as proven job generators with a 5:1 economic return. The purpose of the bill is to reduce the time and cost associated with delivering "sustainable transportation projects that can accelerate progress towards California's environmental goals and improve the public health of Californians." The new exemption should facilitate on-going efforts by public transit agencies in several California cities to make transit improvements in existing roadways while traffic volumes are reduced by the COVID-19 pandemic. San Francisco is moving forward with several traffic calming and safety projects, as well as implementation of new transit lanes for faster and more efficient bus routes. In downtown Los Angeles, active street improvement projects include addition of bus-only lanes and protected bike lanes in major corridor streets.

In addition to supporting public transit agencies, SB 288 can also create opportunities for new public-private partnerships. The private sector has shown increasing interest in investing in proposed streetcar, light rail, and bus transit projects over the past several years. The new exemptions may help fast-track new transportation projects by eliminating CEQA review and thereby reducing one of the most time-consuming and risky elements of project development. Transportation agencies and private developers should carefully evaluate proposed projects to determine if they can take advantage of the new exemption over the next two years."[115]

13.6.4 Federal Funding

TIG/m considers federal funding to be the last resource to be accessed for the Riverside Streetcar Project and, as such, is not including information relevant to it in this study.

13.7 Conceptual Project Schedule

The following is a conceptual project schedule for the Riverside Streetcar Project. Please refer to ***Appendix P*** to view this schedule in a larger format.

Table 13-2, *Riverside Streetcar Project Conceptual Schedule*

Riverside Streetcar Project Conceptual Schedule

ID	Notes	Task Name	Duration	Start	Finish	Predecessors
1		**Summary**	**1317 days?**	**Fri 9/9/22**	**Mon 9/27/27**	
2		Contract Award	1 day?	Fri 9/9/22	Fri 9/9/22	
3		Apply for Exemption From CEQA under SB288	80 days	Mon 9/12/22	Fri 12/30/22	2
4		**System Design**	**461 days**	**Mon 1/2/23**	**Mon 10/7/24**	3
5		**Civil Systems Design**	**461 days**	**Mon 1/2/23**	**Mon 10/7/24**	
6		Alignment Schematic Design	90 days	Mon 1/2/23	Fri 5/5/23	
7		Alignment Track Development	110 days	Mon 5/8/23	Fri 10/6/23	6
8		Depot & Manufacturing Plant Design	100 days	Mon 2/13/23	Fri 6/30/23	6FS-60 days
9		Track Eng, Procurement, Delivery	261 days	Mon 10/9/23	Mon 10/7/24	7
10		Depot Equipment Procurement, Delivery	120 days	Mon 7/3/23	Fri 12/15/23	8
11		**Vehicle Systems Design**	**180 days**	**Mon 1/2/23**	**Fri 9/8/23**	
12	Chatsworth	Vehicle Mock-ups, Bench Tests	180 days	Mon 1/2/23	Fri 9/8/23	
13		**Site Construction**	**790 days**	**Mon 7/3/23**	**Fri 7/10/26**	
14		Factory, O&M Facility	180 days	Mon 7/3/23	Fri 3/8/24	8
15		Utilities Relocation	440 days	Mon 7/17/23	Fri 3/21/25	7FS-60 days
16		Track	459 days	Tue 10/8/24	Fri 7/10/26	9
17		Signage & Signals	200 days	Mon 10/6/25	Fri 7/10/26	16FS-200 days
18		Passenger Stations	250 days	Mon 7/28/25	Fri 7/10/26	16FS-250 days
19		Vehicle Manufacture	575 days	Mon 3/11/24	Fri 5/22/26	14
20		Commission System	90 days	Mon 5/25/26	Fri 9/25/26	19
21		Operations First Year	261 days	Mon 9/28/26	Mon 9/27/27	20

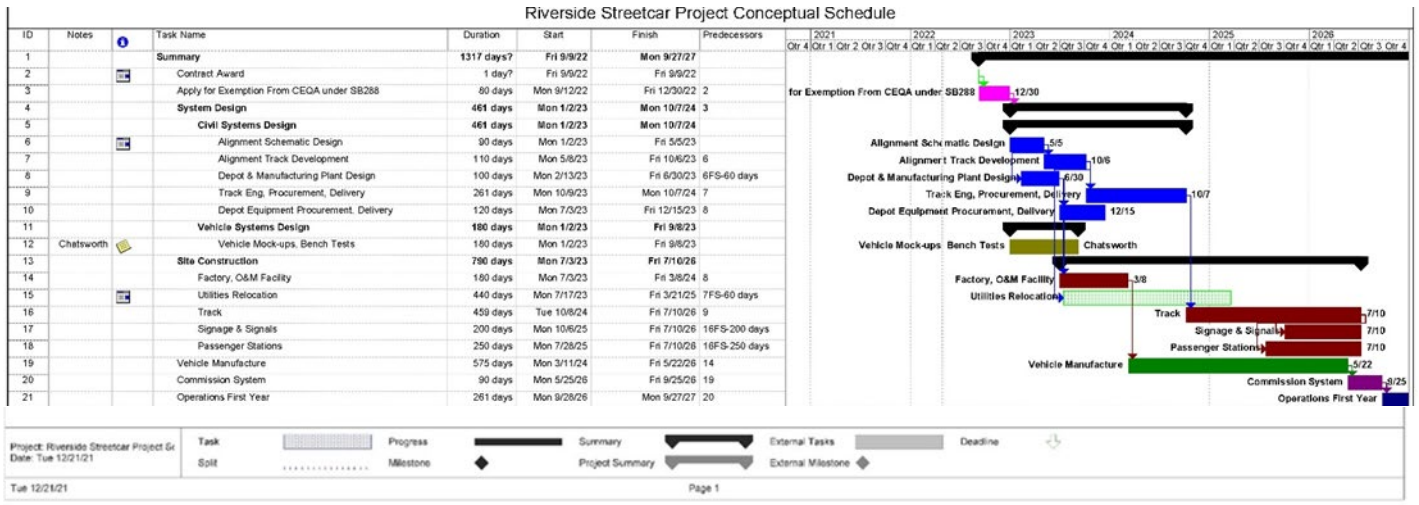


Figure 13-1, *TIG/m MRV-3 Streetcar in Doha, Qatar*

Section 14:
Endnotes and Cited References

14 Endnotes and References

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Riverside Streetcar System Feasibility Study Report

Appendix A:

U.S. Census Quick Facts for Riverside, California

May, 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
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Chatsworth, California 91311
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QuickFacts

Riverside city, California; United States

QuickFacts provides statistics for all states and counties, and for cities and towns with a ***population of 5,000 or more***.

Table

All Topics	Riverside city, California	United States
Population per square mile, 2010	**3,745.0**	**87.4**
PEOPLE		
Population		
Population estimates, July 1, 2019, (V2019)	331,360	328,239,523
Population estimates base, April 1, 2010, (V2019)	303,933	308,758,105
Population, percent change - April 1, 2010 (estimates base) to July 1, 2019, (V2019)	9.0%	6.3%
Population, Census, April 1, 2020	X	331,449,281
Population, Census, April 1, 2010	303,871	308,745,538
Age and Sex		
Persons under 5 years, percent	▲ 6.2%	▲ 6.0%
Persons under 18 years, percent	▲ 23.8%	▲ 22.3%
Persons 65 years and over, percent	▲ 10.7%	▲ 16.5%
Female persons, percent	▲ 50.2%	▲ 50.8%
Race and Hispanic Origin		
White alone, percent	▲ 58.3%	▲ 76.3%
Black or African American alone, percent (a)	▲ 6.2%	▲ 13.4%
American Indian and Alaska Native alone, percent (a)	▲ 0.8%	▲ 1.3%
Asian alone, percent (a)	▲ 7.6%	▲ 5.9%
Native Hawaiian and Other Pacific Islander alone, percent (a)	▲ 0.3%	▲ 0.2%
Two or More Races, percent	▲ 4.9%	▲ 2.8%
Hispanic or Latino, percent (b)	▲ 53.7%	▲ 18.5%
White alone, not Hispanic or Latino, percent	▲ 29.8%	▲ 60.1%
Population Characteristics		
Veterans, 2015-2019	12,065	18,230,322
Foreign born persons, percent, 2015-2019	22.6%	13.6%
Housing		
Housing units, July 1, 2019, (V2019)	X	139,684,244
Owner-occupied housing unit rate, 2015-2019	54.0%	64.0%
Median value of owner-occupied housing units, 2015-2019	$365,300	$217,500
Median selected monthly owner costs -with a mortgage, 2015-2019	$1,905	$1,595
Median selected monthly owner costs -without a mortgage, 2015-2019	$491	$500
Median gross rent, 2015-2019	$1,378	$1,062
Building permits, 2020	X	1,471,141
Families & Living Arrangements		
Households, 2015-2019	90,722	120,756,048
Persons per household, 2015-2019	3.43	2.62
Living in same house 1 year ago, percent of persons age 1 year+, 2015-2019	86.6%	85.8%
Language other than English spoken at home, percent of persons age 5 years+, 2015-2019	45.1%	21.6%
Computer and Internet Use		
Households with a computer, percent, 2015-2019	93.8%	90.3%
Households with a broadband Internet subscription, percent, 2015-2019	87.6%	82.7%
Education		
High school graduate or higher, percent of persons age 25 years+, 2015-2019	80.6%	88.0%
Bachelor's degree or higher, percent of persons age 25 years+, 2015-2019	23.0%	32.1%
Health		
With a disability, under age 65 years, percent, 2015-2019	7.7%	8.6%
Persons without health insurance, under age 65 years, percent	▲ 10.3%	▲ 9.5%
Economy		
In civilian labor force, total, percent of population age 16 years+, 2015-2019	63.0%	63.0%
In civilian labor force, female, percent of population age 16 years+, 2015-2019	56.5%	58.3%
Total accommodation and food services sales, 2012 ($1,000) (c)	516,559	708,138,598
Total health care and social assistance receipts/revenue, 2012 ($1,000) (c)	2,611,813	2,040,441,203
Total manufacturers shipments, 2012 ($1,000) (c)	2,802,939	5,696,729,632
Total merchant wholesaler sales, 2012 ($1,000) (c)	2,747,573	5,208,023,478
Total retail sales, 2012 ($1,000) (c)	4,127,390	4,219,821,871
Total retail sales per capita, 2012 (c)	$13,158	$13,443

Transportation		
Mean travel time to work (minutes), workers age 16 years+, 2015-2019	31.4	26.9
Income & Poverty		
Median household income (in 2019 dollars), 2015-2019	$69,045	$62,843
Per capita income in past 12 months (in 2019 dollars), 2015-2019	$26,028	$34,103
Persons in poverty, percent	▲ 13.9%	▲ 10.5%
BUSINESSES		
Businesses		
Total employer establishments, 2019	X	7,959,103
Total employment, 2019	X	132,989,428
Total annual payroll, 2019 ($1,000)	X	7,428,553,593
Total employment, percent change, 2018-2019	X	1.6%
Total nonemployer establishments, 2018	X	26,485,532
All firms, 2012	24,046	27,626,360
Men-owned firms, 2012	12,152	14,844,597
Women-owned firms, 2012	9,203	9,878,397
Minority-owned firms, 2012	12,088	7,952,386
Nonminority-owned firms, 2012	10,841	18,987,918
Veteran-owned firms, 2012	2,045	2,521,682
Nonveteran-owned firms, 2012	21,012	24,070,685
GEOGRAPHY		
Geography		
Population per square mile, 2010	**3,745.0**	**87.4**
Land area in square miles, 2010	81.14	3,531,905.43
FIPS Code	0662000	1

About datasets used in this table

Value Notes

⚠ Estimates are not comparable to other geographic levels due to methodology differences that may exist between different data sources.

Some estimates presented here come from sample data, and thus have sampling errors that may render some apparent differences between geographies statistically indistinguishable. Click the Quick Info ⓘ icon to the left of each row in TABLE view to learn about sampling error.

The vintage year (e.g., V2019) refers to the final year of the series (2010 thru 2019). *Different vintage years of estimates are not comparable.*

Fact Notes

- **(a)** Includes persons reporting only one race
- **(c)** Economic Census - Puerto Rico data are not comparable to U.S. Economic Census data
- **(b)** Hispanics may be of any race, so also are included in applicable race categories

Value Flags

- **-** Either no or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest or upper interval of an open ended distribution.
- **F** Fewer than 25 firms
- **D** Suppressed to avoid disclosure of confidential information
- **N** Data for this geographic area cannot be displayed because the number of sample cases is too small.
- **FN** Footnote on this item in place of data
- **X** Not applicable
- **S** Suppressed; does not meet publication standards
- **NA** Not available
- **Z** Value greater than zero but less than half unit of measure shown

QuickFacts data are derived from: Population Estimates, American Community Survey, Census of Population and Housing, Current Population Survey, Small Area Health Insurance Estimates, Small Area Income and Poverty Estimates, State and County Housing Unit Estimates, County Business Patterns, Nonemployer Statistics, Economic Census, Survey of Business Owners, Building Permits.

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Riverside Streetcar System Feasibility Study Report

Appendix B:

Maps: Land Use by TAZ

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
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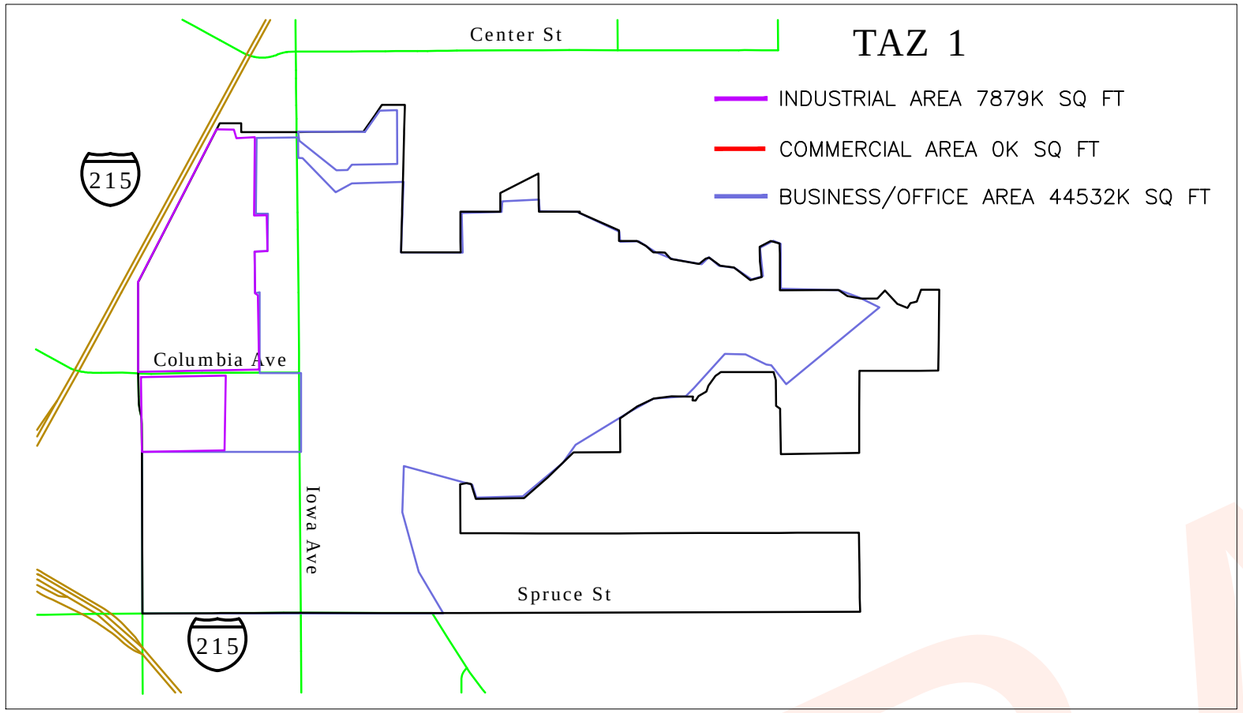
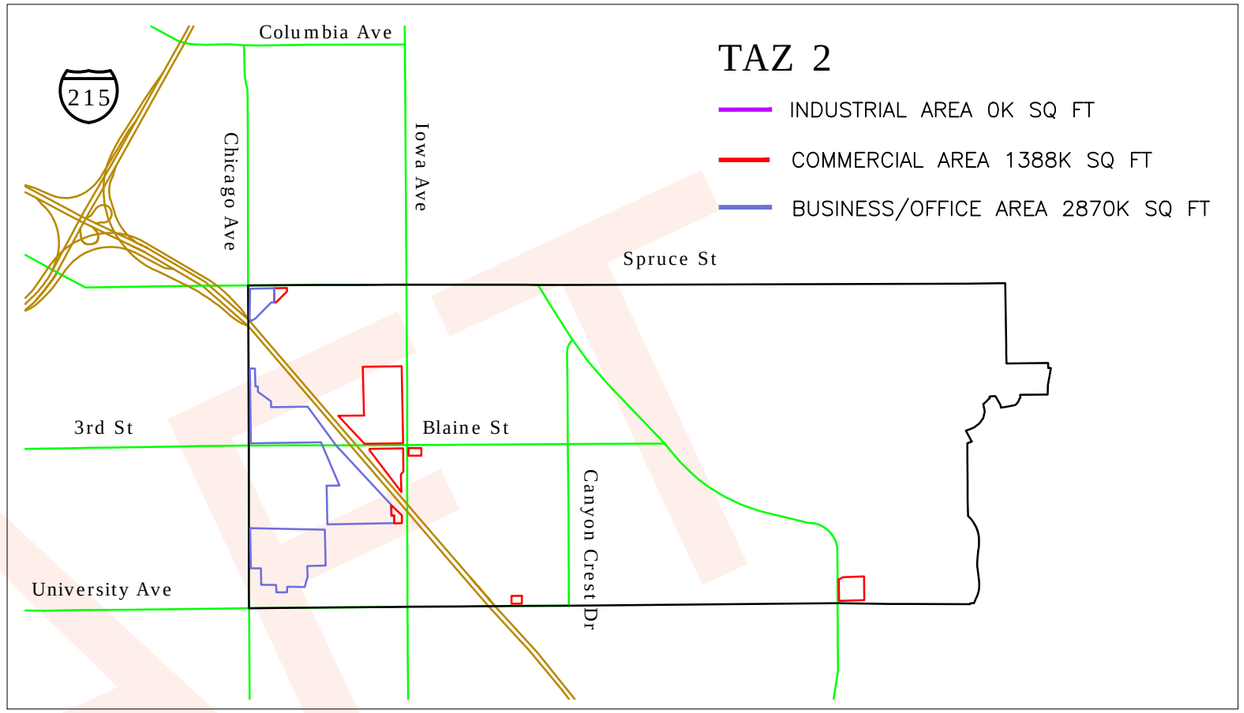
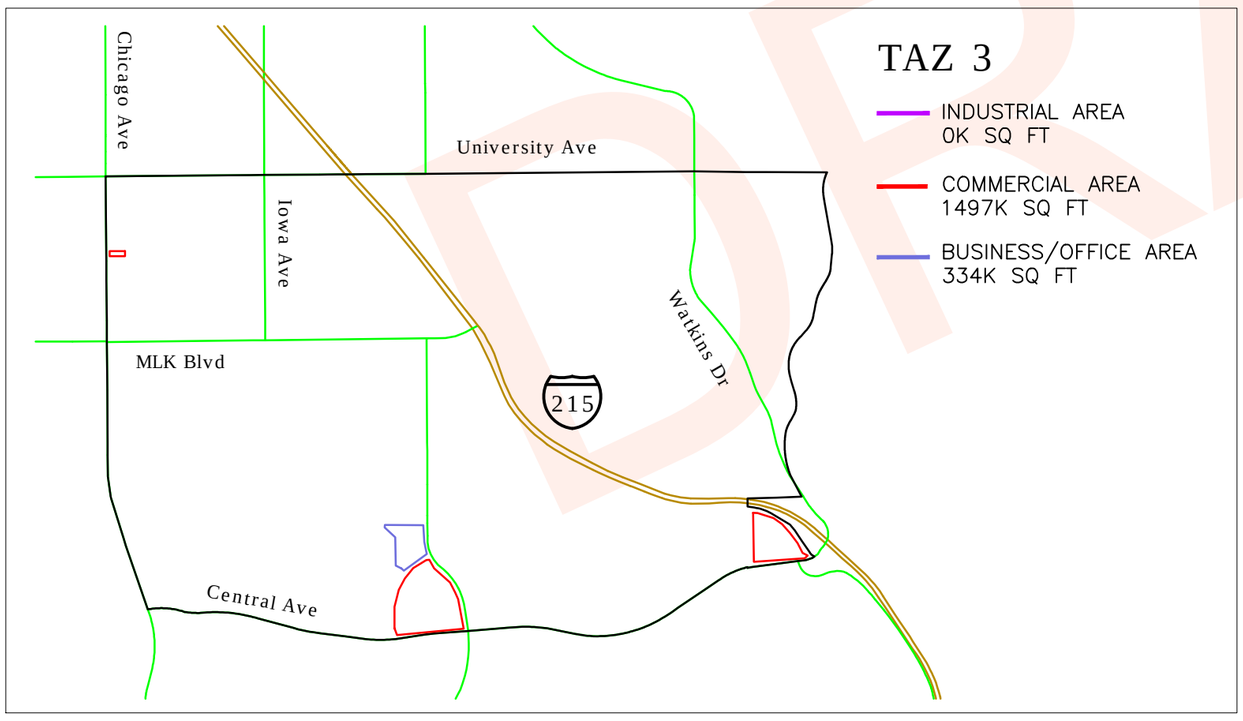

TAZ 1
INDUSTRIAL AREA 7879K SQ FT
COMMERCIAL AREA 0K SQ FT
BUSINESS/OFFICE AREA 44532K SQ FT
Center St
215
Columbia Ave
Iowa Ave
Spruce St
215


TAZ 2
INDUSTRIAL AREA 0K SQ FT
COMMERCIAL AREA 1388K SQ FT
BUSINESS/OFFICE AREA 2870K SQ FT
Columbia Ave
215
Chicago Ave
Iowa Ave
Spruce St
3rd St
Blaine St
Canyon Crest Dr
University Ave


TAZ 3
INDUSTRIAL AREA 0K SQ FT
COMMERCIAL AREA 1497K SQ FT
BUSINESS/OFFICE AREA 334K SQ FT
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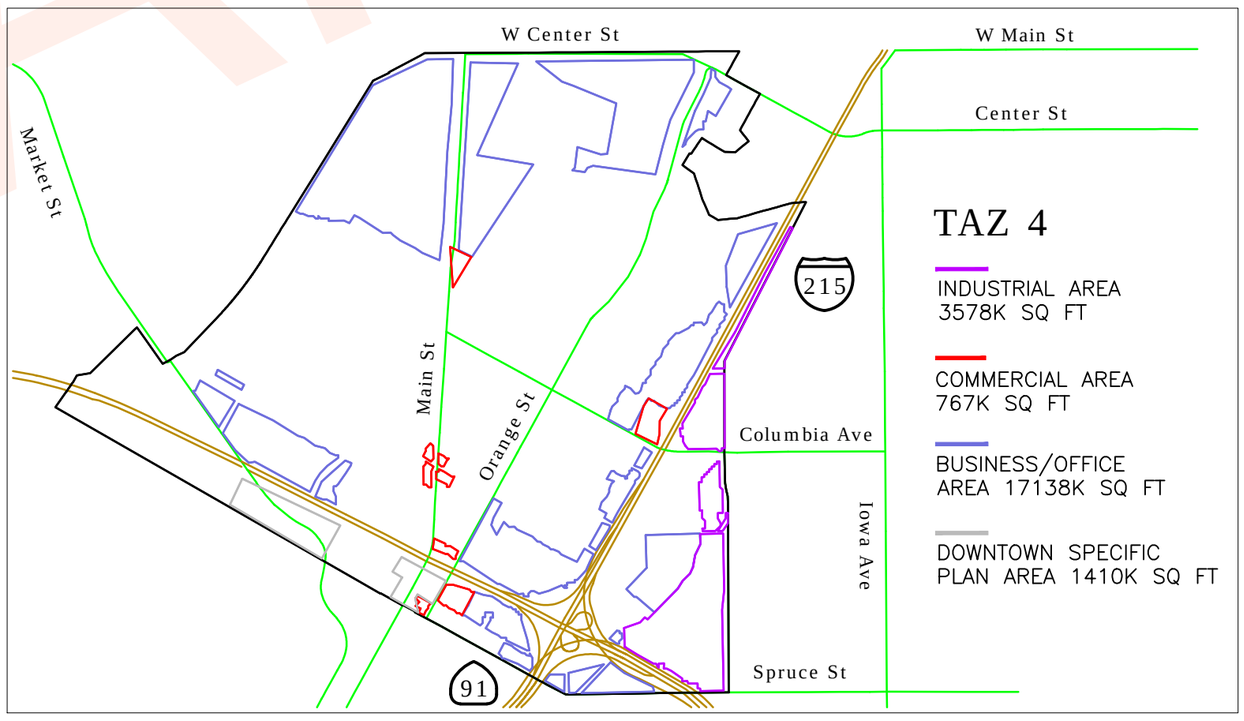
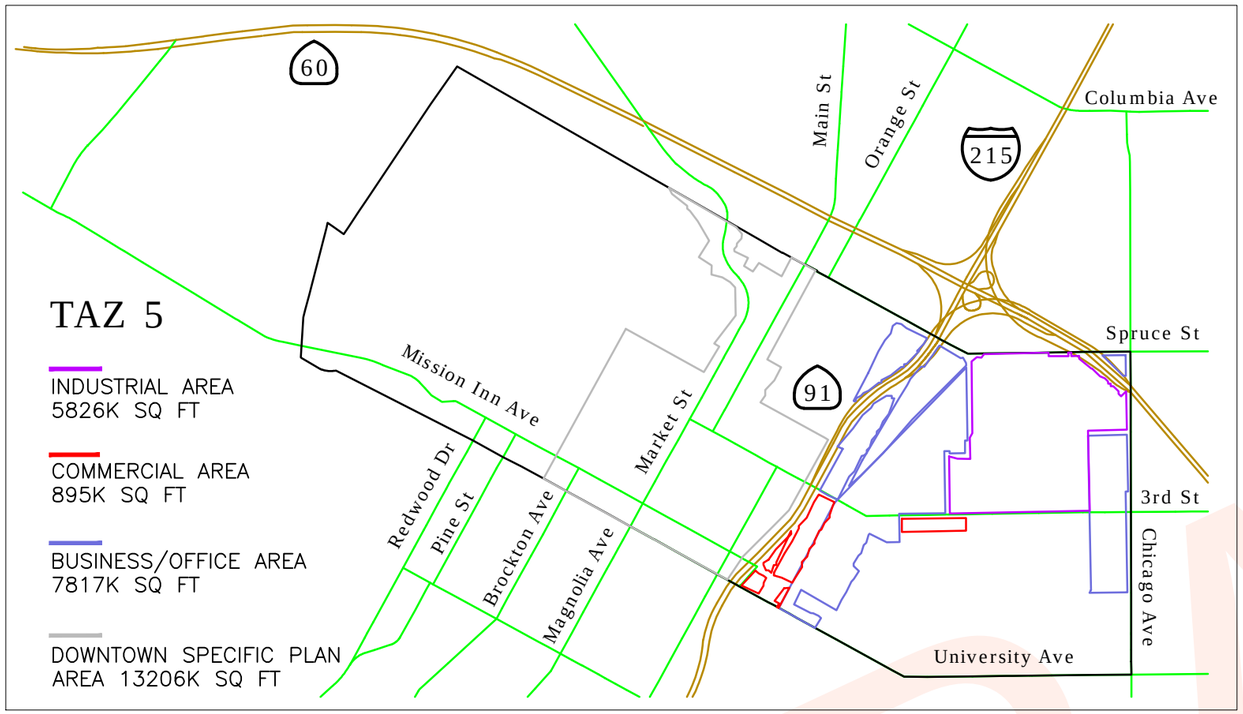
University Ave
Iowa Ave
Watkins Dr
MLK Blvd
215
Central Ave


TAZ 4
INDUSTRIAL AREA 3578K SQ FT
COMMERCIAL AREA 767K SQ FT
BUSINESS/OFFICE AREA 17138K SQ FT
DOWNTOWN SPECIFIC PLAN AREA 1410K SQ FT
W Center St
W Main St
Center St
Market St
215
Main St
Orange St
Columbia Ave
Iowa Ave
Spruce St
91



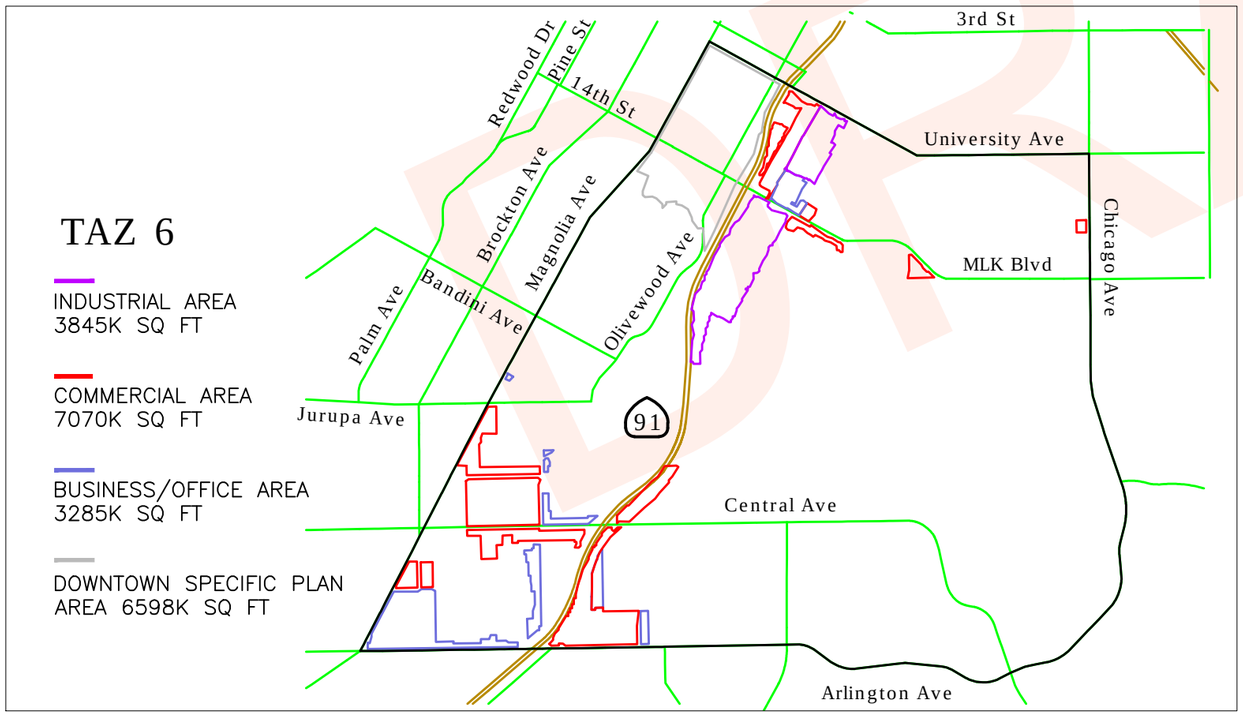
TAZ 5

INDUSTRIAL AREA
5826K SQ FT

COMMERCIAL AREA
895K SQ FT

BUSINESS/OFFICE AREA
7817K SQ FT

DOWNTOWN SPECIFIC PLAN
AREA 13206K SQ FT



TAZ 6

INDUSTRIAL AREA
3845K SQ FT

COMMERCIAL AREA
7070K SQ FT

BUSINESS/OFFICE AREA
3285K SQ FT

DOWNTOWN SPECIFIC PLAN
AREA 6598K SQ FT

TAZ 7

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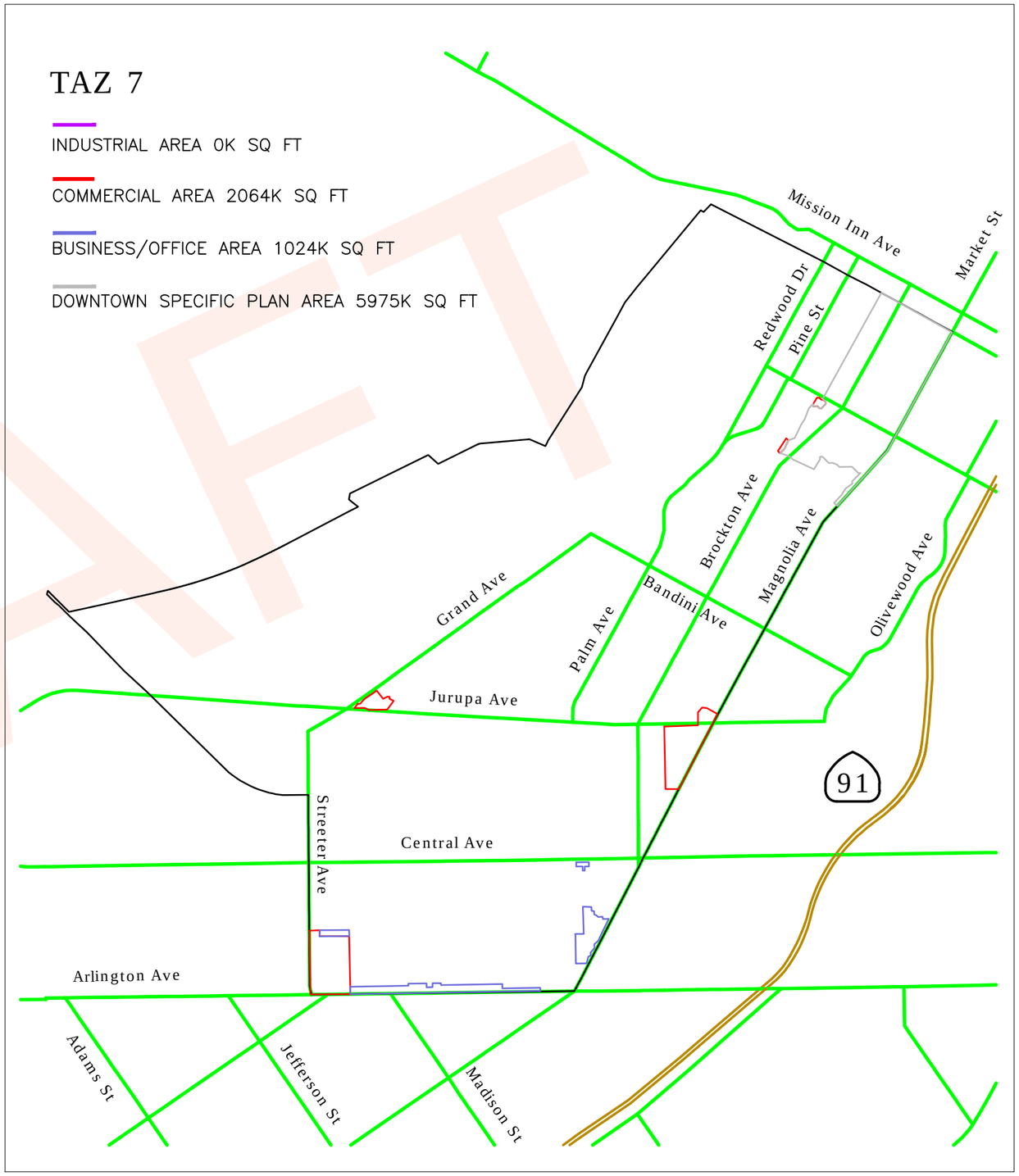
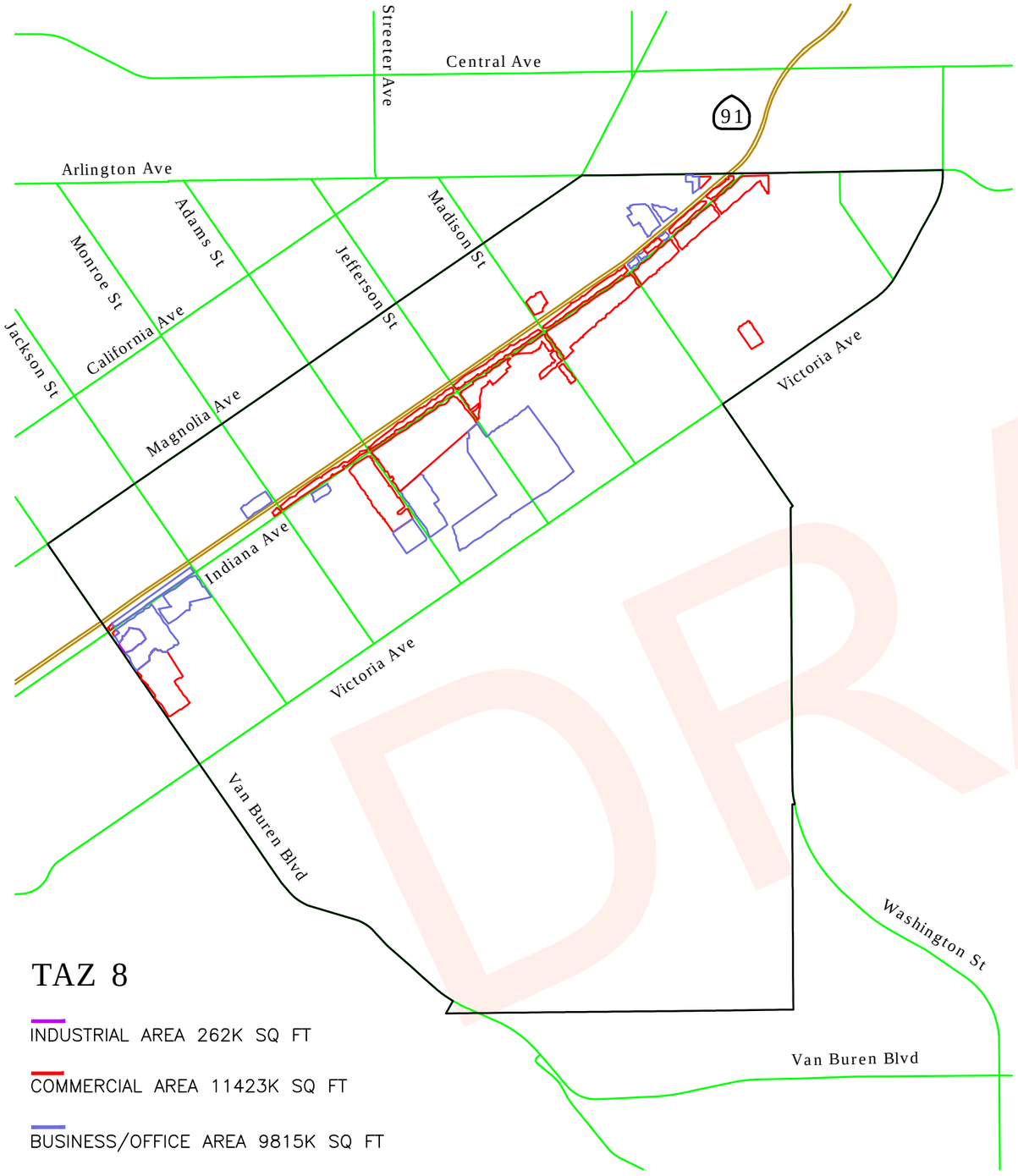
COMMERCIAL AREA 2064K SQ FT

BUSINESS/OFFICE AREA 1024K SQ FT

DOWNTOWN SPECIFIC PLAN AREA 5975K SQ FT





TAZ 8

INDUSTRIAL AREA 262K SQ FT

COMMERCIAL AREA 11423K SQ FT

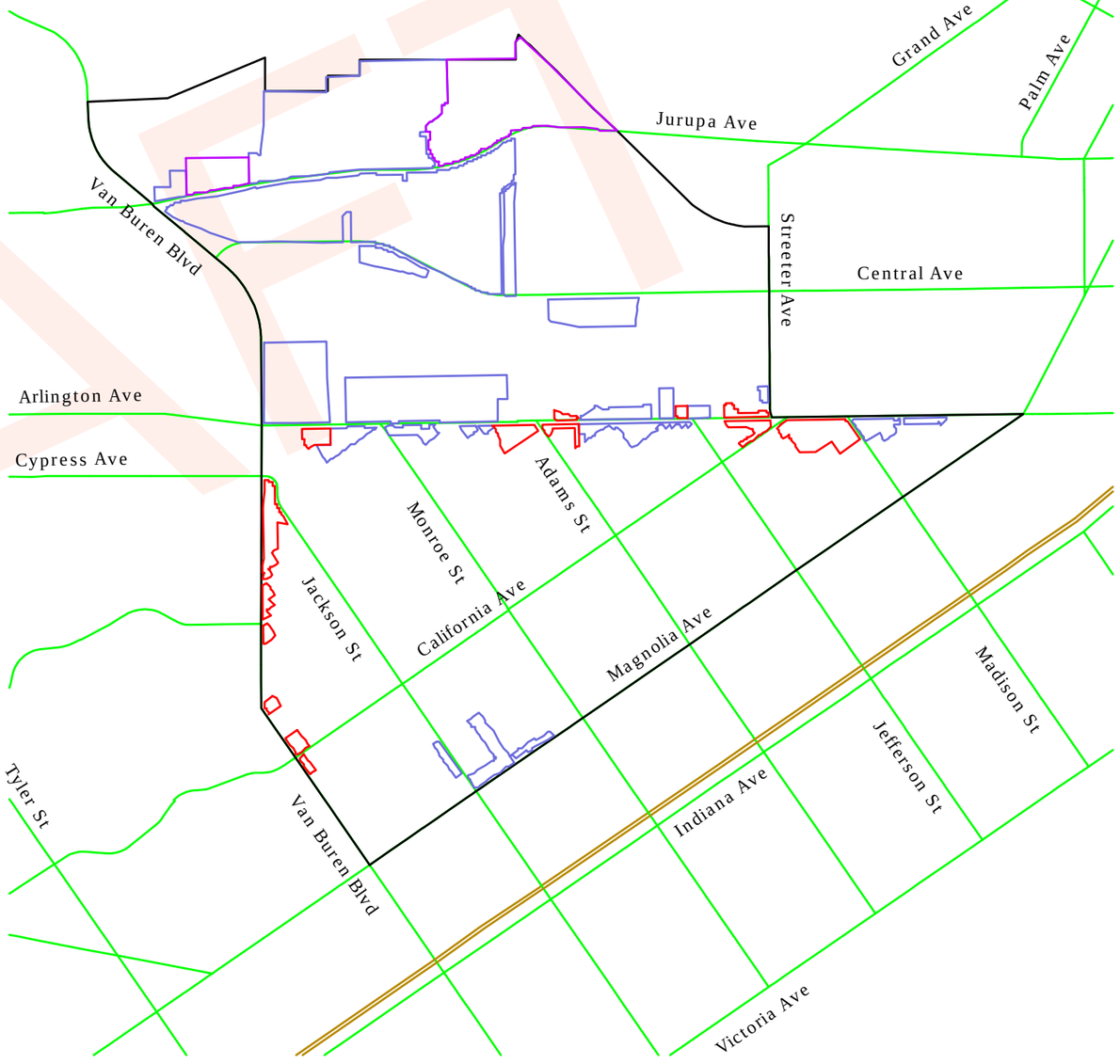
BUSINESS/OFFICE AREA 9815K SQ FT

TAZ 9

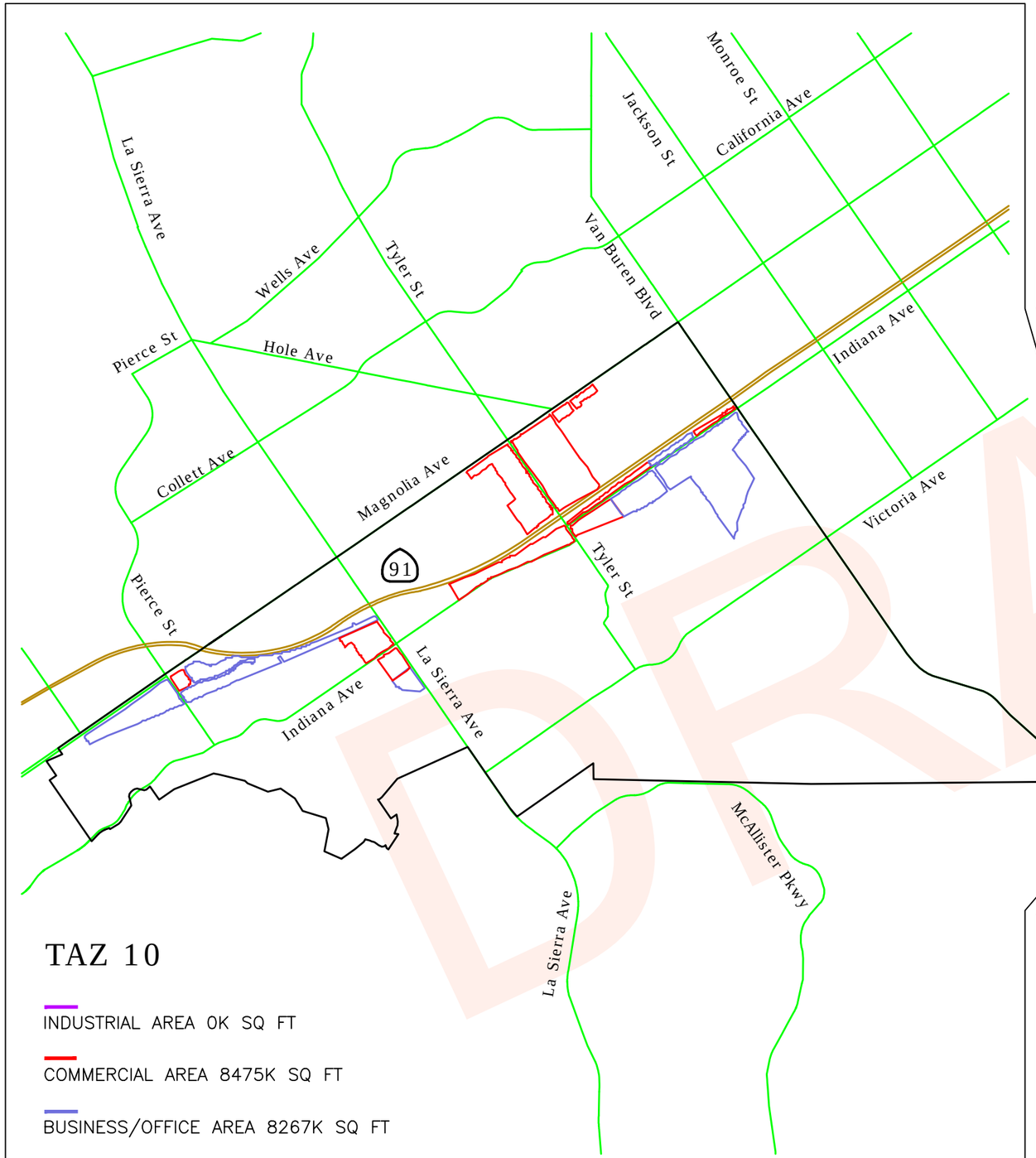
INDUSTRIAL AREA 6080K SQ FT

COMMERCIAL AREA 3007K SQ FT

BUSINESS/OFFICE AREA 29209K SQ FT



DRAFT

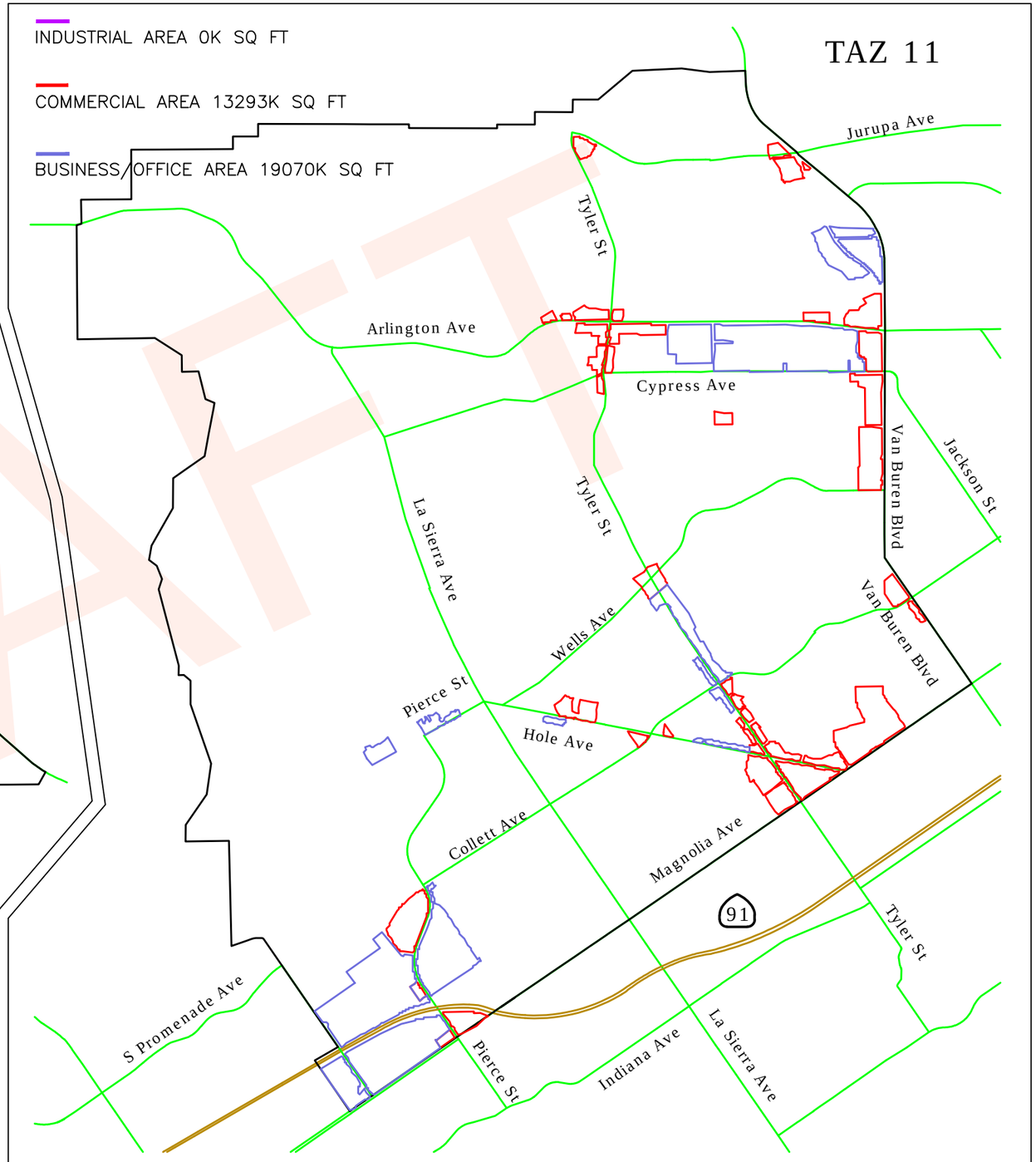


TAZ 10

INDUSTRIAL AREA 0K SQ FT

COMMERCIAL AREA 8475K SQ FT

BUSINESS/OFFICE AREA 8267K SQ FT



TAZ 11

INDUSTRIAL AREA 0K SQ FT

COMMERCIAL AREA 13293K SQ FT

BUSINESS/OFFICE AREA 19070K SQ FT

DRAFT

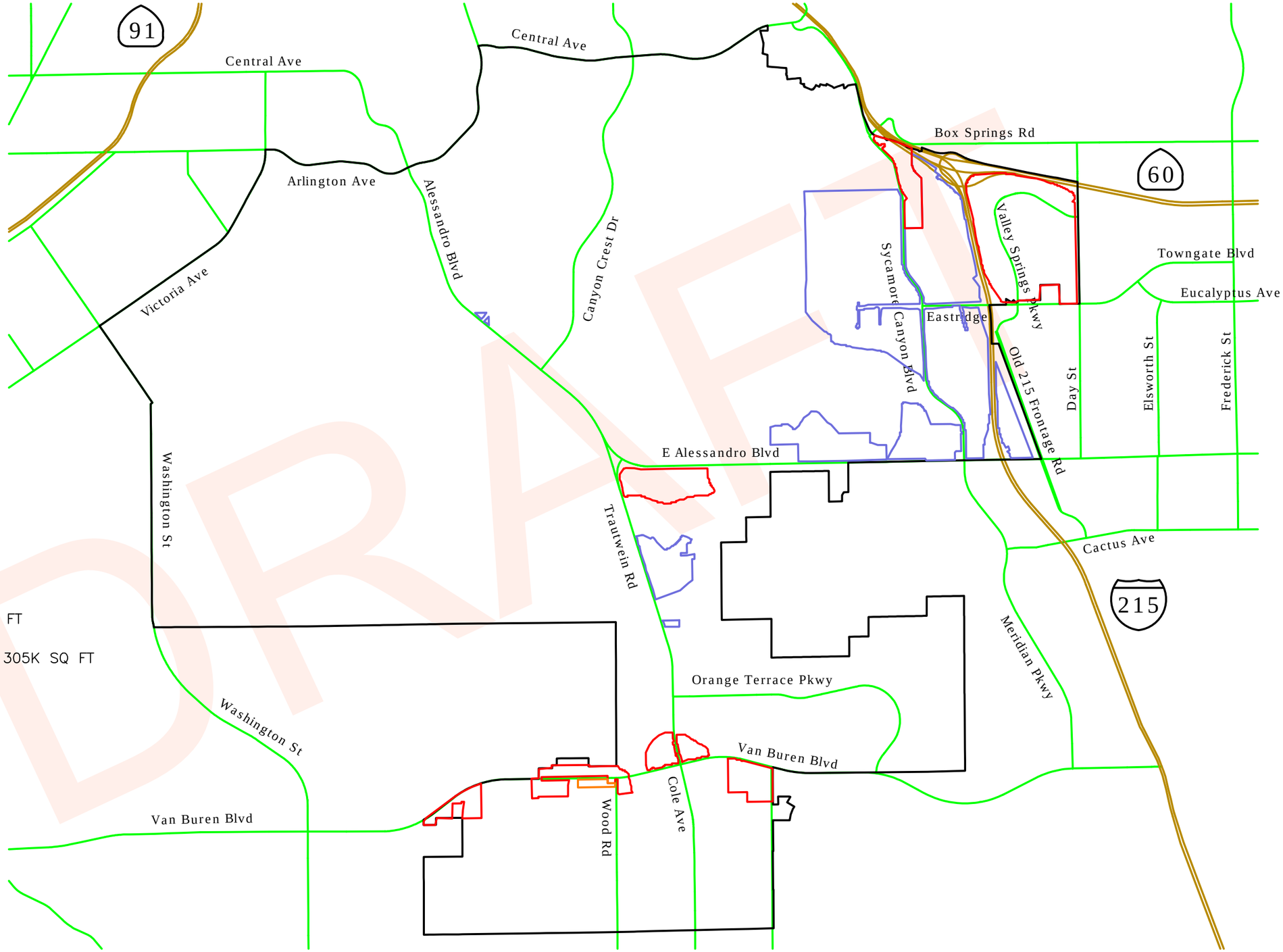
TAZ 12

INDUSTRIAL AREA 0K SQ FT

COMMERCIAL AREA 25443K SQ FT

BUSINESS/OFFICE AREA 46816K SQ FT

ORANGECREST SPECIFIC PLAN AREA 305K SQ FT



DRAFT

Riverside Streetcar System Feasibility Study Report

Appendix C:

TAZ Maps with Traffic Counts

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500

TAZ 2
24 Hour Counts

Eastbound
Westbound
Total

Northbound
Southbound
Total

Spruce\ S

17,942
8,752
9,200

13,983
25,915
11,932

9,842
19,250
9,408

Blaine\ S

Canyon\ Crest\

4,671
9,464
4,803

Mt\ Vernon\ A

6,904
13,771
6,867

Chicago\ Av

9,379
21,210
11,831

University\ Av

Iowa\ Av

Watkins\ D

Big\ Springs\

DRAFT

TAZ 3
24 Hour Traffic Counts

Eastbound
Westbound
Total

Northbound
Southbound
Total

Chicago\ Av

University\ Av

21,210
9,379
11,831

Iowa\ Av

6,655
12,879
6,224

MLK\ Blv

24,308
12,105
12,203

Canyon\ Crest\

11,180
19,200
8,020

9,687
20,060
10,373

Central\ Av

10,296
22,219
11,923

Watkins\ D

Big\ Springs\

215

DRAFT

TAZ 5
24 Hour Traffic Counts

Eastbound
Westbound
Total
Northbound
Southbound
Total

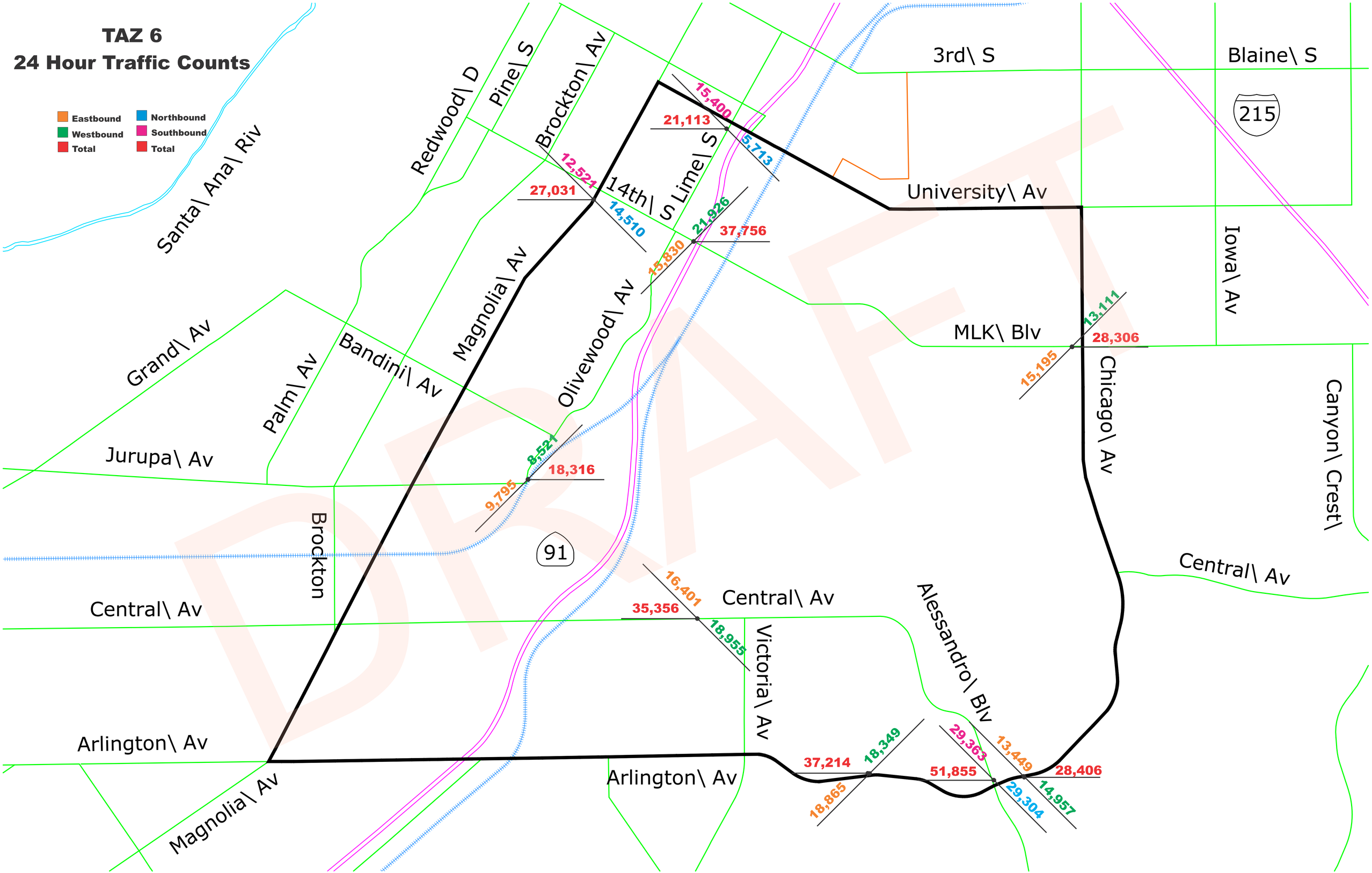
Columbia\ Av
Orange\ S
Main\ S
Iowa\ Av
215
60
91
Mission\ Inn\ A
Santa\ Ana\ Riv
Redwood\ D
Pine\ S
Brockton\ Av
Market\ S
3rd\ S
Eucalyptus\ Av
Chicago\ Av
Lime\ S
Magnolia\ Av
14th\ S
University\ Av
Spruce\ S

6,305
12,218
5,913
10,415
20,301
9,886
9,657
18,836
5,510
14,846
9,179
9,336
14,710
27,203
12,493
8,8807
15,067
6,260
4,338
7,445
15,086
7,637
3,107
7,449
780
1,940
1,160
9,842
19,250
9,408

TAZ 6
24 Hour Traffic Counts

Eastbound
Westbound
Total

Northbound
Southbound
Total



TAZ 7
24 Hour Traffic Counts

Eastbound	Northbound
Westbound	Southbound
Total	Total

Santa\ Ana\ Riv
Mission\ Inn\ A
Market\ S
91
3rd\ S
Redwood\ D
Pine\ S
4,023
4,923
8,983
17,634
8,651
Lime\ S
University\ Av
Bandini\ Av
2,195
5,608
3,413
Grand\ Av
Palm\ Av
Brockton\ Av
10,893
Magnolia\ Av
23,296
12,403
Olivewood\ Av
14th\ S
Jurupa\ Av
8,266
15,981
7,715
Brockton
91
Central\ Av
6,891
14,383
7,492
7,218
10,819
3,601
Streeter\ Av
Victoria\ Av
Alessandro\ Blv
Arlington\ Av
10,838
22,448
11,610

This Table shows ADT counts for motorized vehicle traffic on specified dates for specifically identifies sections of roads within the City of Riverside.

Daily (ADT) Counts, Dates Specified

Location	Day/Date	Year	NB AM	NB PM	Total		SB AM	SB PM	Total		EB AM	EB PM	Total		WB AM	WB PM	Total	Combined Total
N/S Main St. between 1st St. & 3rd St. Day 1	Mon May 15	2006	1,235	2,323	3,558		1,582	2,175	3,757				-				-	7,315
N/S Main St. between 1st St. & 3rd St. Day 2	Tue May 16	2006	935		935		471		471				-				-	1,406
Main St. between Spruce St. & Poplar St.	Mon May 06	2006	2,269	4,419	6,688		2,471	3,973	6,444				-				-	13,132
Iowa Ave. & University Ave. eastbound lefts	Tue Jan 09	2007							-		1,226	2,633	3,859					3,859
Linden W/ Canyon Crest Dr.	Thu May 17	2007			-				-		1,295	3,421	4,716		1,018	2,428	3,446	8,162
Main St. Southbound N/ 3rd St. Day 1	Fri Nov 23	2007			-		994	3,234	4,228				-				-	4,228
Main St. Southbound N/ 3rd St. Day 2	Sat Nov 24	2007			-		962	2,042	3,004				-				-	3,004
Main St. Southbound N/ 3rd St. Day 3	Sun Nov 25	2007			-		797	1,699	2,496				-				-	2,496
Mission Inn Ave. westbound E/Lime St. Day 1	Fri Nov 23	2007			-				-				-		1,194	3,572	4,766	4,766
Mission Inn Ave. westbound E/Lime St. Day 2	Sat Nov 24	2007			-				-				-		1,807	5,192	6,999	6,999
Mission Inn Ave. westbound E/Lime St. Day 3	Sun Nov 25	2007			-				-				-		1,560	4,131	5,691	5,691
3rd St. at BNSF Railroad Crossing	Tue Sep 18	2007	2,605	3,945	6,550		2,194	5,494	7,688				-				-	14,238
Main St. Southbound Traffic N/ 3rd St. Day 1	Fri Feb 15	2008			-		2,591	4,764	7,355				-				-	7,355
Main St. Southbound Traffic N/ 3rd St. Day 2	Sat Feb 16	2008			-		1,264	3,759	5,023				-				-	5,023
Main St. Southbound Traffic N/ 3rd St. Day 3	Sun Feb 17	2008			-		858	1,675	2,533				-				-	2,533
University Ave. between Kansas Ave. & Chicago Ave.	Thu Jun 19	2008			-				-		3,746	8,806	12,552		3,673	6,064	9,737	22,289
Lime St. between 9th & 10th Day 1	Tue Dec 15	2009			-				-		1,663	2,956	4,619		2,371	3,882	6,253	10,872
Lime St. between 9th & 10th Day 2	Wed Dec 16	2009			-				-		1,481	2,898	4,379		2,173	3,776	5,949	10,328
Lime St. between University & 9th Day 1	Tue Dec 15	2009			-				-		1,375	2,650	4,025		5,170	8,595	13,765	17,790
Lime St. between University & 9th Day 2	Wed Dec 16	2009			-				-		1,176	2,765	3,941		4,945	8,209	13,154	17,095
Lime St. between Mission Inn Ave. & University Day 1	Tue Dec 15	2009			-				-		1,172	2,272	3,444		3,314	5,973	9,287	12,731
Lime St. between Mission Inn Ave. & University Day 2	Wed Dec 16	2009			-				-		1,074	2,156	3,230		3,124	5,414	8,538	11,768
Mission Inn Ave. between Lemon St. & Lime St. Day 1	Tue Dec 15	2009	2,510	4,718	7,228		1,539	3,798	5,337				-				-	12,565
Mission Inn Ave. between Lemon St. & Lime St. Day 2	Wed Dec 16	2009	2,363	4,474	6,837		1,756	3,795	5,551				-				-	12,388
Mission Inn Ave. between Lime St. & SR-91 WB Ramps Day 1	Tue Dec 15	2009	4,605	7,424	2,029		1,534	3,834	5,368				-				-	17,397

Location	Day/Date	Year	NB AM	NB PM	Total		SB AM	SB PM	Total		EB AM	EB PM	Total		WB AM	WB PM	Total	Combined Total
Mission Inn Ave. between Lime St. & SR-91 WB Ramps Day 2	Wed Dec 16	2009	4,449	7,132	11,581		1,698	3,754	5,452				-				-	17,033
University Ave. between Lime St. & Mulberry St. Day 1	Tue Dec 15	2009	4,039	7,019	11,058		2,675	5,802	8,477				-				-	19,535
University Ave. between Lime St. & Mulberry St. Day 2	Wed Dec 16	2009	3,952	6,600	10,552		2,525	5,729	8,254				-				-	18,806
Lime St. between 3rd St. & 4th St.	Thu Oct 13	2011	402	845	1,247		271	537	808				-				-	2,055
Main St. between 1st St. & 2nd St.	Thu Oct 13	2011	1,111	1,703	2,814		1,234	2,702	3,936				-				-	6,750
Mission Inn Ave. between Main St. & Orange St.	Thu Oct 13	2011			-				-		1,535	3,316	4,851		2,001	4,094	6,095	10,946
3rd St. at BNSF Railroad Crossing	Tue Sep 27	2011			-				-		1,768	3,942	5,710		1,881	3,001	4,882	10,592
University Ave. between Main St. & Orange St.	Thu Oct 13	2011			-				-		2,426	5,023	7,449		2,280	5,357	7,637	15,086
Spruce St. at 2050 E/ La Candena Dr.	Thu Aug 23	2012			-				-		2,974	4,806	7,780		1,834	3,700	5,534	13,314
University Ave. between Chicago Ave. & Iowa Ave.	Wed Apr 18	2012			-				-		3,255	8,576	11,831		2,795	6,584	9,379	21,210
Main St. at Poplar eastbound	Thu Nov 13	2014			-				-		122	161	283				-	283
N/S Main St. at Poplar	Thu Nov 13	2014	2,190	3,723	5,913		1,922	3,907	5,829				-				-	11,742
3rd St. W/ Park Ave.	Thu May 22	2014			-				-		1,819	4,197	6,016		1,891	3,409	5,300	11,316
University Ave. west of Park Ave.	Thu May 22	2014			-				-		3,062	7,356	10,418		3,754	5,729	9,483	19,901
Lime between 9th & University Ave.	Thu Feb 12	2015	1,318	2,449	3,767		3,958	6,558	10,516				-				-	14,283
Lime between 11th St. & 12th St.	Thu Feb 12	2015	1,206	2,137	3,343		1,732	2,364	4,096				-				-	7,439
Lime between Mission Inn Ave. & 6th St.	Thu Feb 12	2015	1,143	1,964	3,107		1,277	3,061	4,338				-				-	7,445
Mission Inn Ave. between Park St. & Comer Ave.	Thu Feb 12	2015			-				-		604	1,711	2,315		468	660	1,128	3,443
Mission Inn Ave. between Vine St. & Commerce St.	Thu Feb 12	2015			-				-		911	2,373	3,284		666	1,058	1,724	5,008
University Ave. between Lemon St. & Lime St.	Thu Feb 12	2015			-				-		2,550	4,877	7,427		2,502	4,346	6,848	14,275
University Ave. between Park Ave. & Victoria Ave.	Thu Feb 12	2015			-				-		3,122	7,245	10,367		3,643	5,886	9,529	19,896
Chicago Ave. At Railroad Tracks	Wed Jan 18	2017	2,174	3,914	6,088		2,144	3,714	5,858									11,946
Spruce St. at Railroad Tracks	Wed Jan 18	2017			-				-		3,180	5,337	8,517		2,149	4,183	6,332	14,849
3rd St. at Railroad Tracks	Wed Jan 18	2017			-				-		1,754	5,149	6,903		1,776	3,095	4,871	11,774
N/S Iowa Ave. & E/W Everton Pl (E/W)	Thu Jan 25	2018			-				-				-		176	522	698	698
N/S Iowa Ave. & E/W Everton Pl (N/S)	Thu Jan 25	2018	2,654	3,570	6,224		1,824	5,178	7,002				-				-	13,226
Chicago Ave. between Linden St. & University Ave.	Tue Dec 10	2019	4,122	5,286	9,408		2,850	6,992	9,842									19,250

Location	Day/Date	Year	NB AM	NB PM	Total		SB AM	SB PM	Total		EB AM	EB PM	Total		WB AM	WB PM	Total	Combined Total
Lime St. & E/W 5th Ave.	Wed Oct 16	2019			-				-		245	541	786		103	373	476	1,262
N/S Lime St. & 5th Ave.	Wed Oct 16	2019	1,377	2,410	3,787		1,111	1,988	3,099				-				-	6,886
Linden St. between Chicago Ave. & Iowa Ave.	Tue Dec 10	2019			-				-		925	2,168	3,093		1,197	1,753	2,950	6,043
Linden St. between Ottawa Ave. & Anderson Ave.	Tue Dec 10	2019			-		695	1,326	2,021		647	1,540	2,187				-	4,208
3rd St. east of Vine St.	Tue May 7	2019			-				-		1,960	6,113	8,073		2,014	3,300	5,314	13,387
3rd St. west of Park Ave.	Tue Apr 30	2019			-				-		1,784	5,343	7,127		2,155	3,271	5,426	12,553
3rd St. at Railroad Crossing	Tue Oct 01	2019			-				-		2,126	5,682	7,808		2,236	3,408	5,644	13,452
University Ave. near Ottawa Ave.	Tue Dec 10	2019			-				-		3,396	8,124	11,520		3,094	5,285	8,379	19,899
University Ave. near Park Ave.	Tue Dec 10	2019			-				-		3,346	8,374	11,720		3,968	5,686	9,654	21,374

Source: City of Riverside, January 2021

Riverside Streetcar System Feasibility Study Report

Appendix D:

Community Survey Questionnaire

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500

Community Survey Questionnaire

Please participate in this survey if you live, work, or go to school in Riverside, CA.

Riverside is studying the feasibility of a streetcar system.

We are reaching out to members of the community who live, work, or go to school within the City of Riverside and would greatly appreciate your input regarding your current travel practices and patterns.

By gathering this data from you we will be better able to predict the ridership of a potential streetcar system. Individual responses to this survey and any personal information provided will not be made public; however, the data you provide will be used and shared to inform future mobility efforts. Of course, it is not mandatory, but we really hope that you will join the discussion by taking this survey.

Your input is valuable, and we want to hear from you.

Use this paper questionnaire or scan the QR code to take the survey online.

Please include trips by all members of your household who travel *independently* around the city. If you live in college housing, consider it your home for this survey.

If you have been working from home during COVID-19 and would normally be commuting to your workplace, please answer these survey questions as if you were traveling to that workplace.

1. If you live outside the City of Riverside, check here ☐

2. What modes of transportation do you currently use? (please check all that apply)

- ☐ Car
- ☐ Bus
- ☐ Ride-hail (Uber, Lyft)
- ☐ Motorcycle
- ☐ Bicycle
- ☐ Ride-share (Carpool)
- ☐ Walking
- ☐ Other (please specify) _____

3. How many cars does your household currently have? (please check only one)

- ☐ 0
- ☐ 1
- ☐ 2+

4. Let us know about your work. (please check only one)

- ☐ I work within the City of Riverside.
- ☐ I work outside the City of Riverside.
- ☐ I am a full-time home manager and/or not employed outside my home.

5. How often do you use Metrolink? (please check only one)

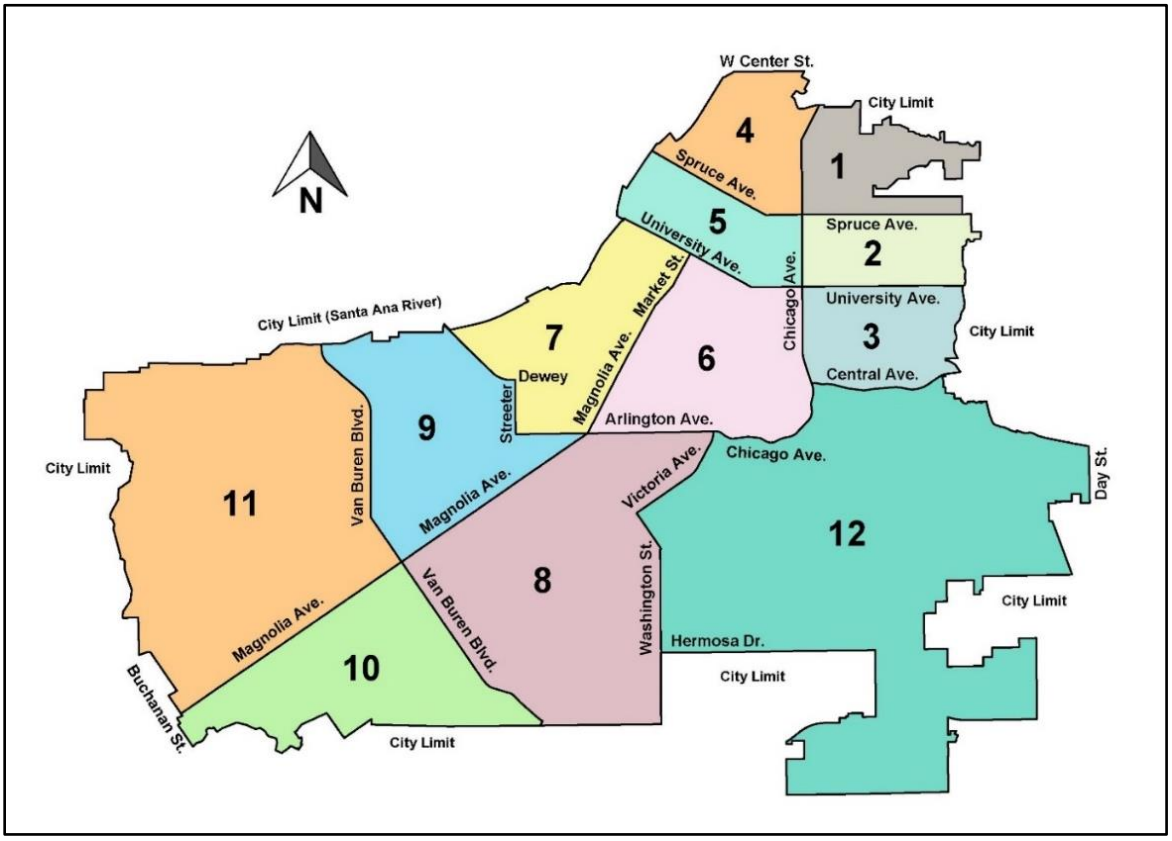
- ☐ Daily for work
- ☐ Occasionally for other reasons
- ☐ Never

6. Do you often group multiple errands into a single trip? (please check only one)

- ☐ Yes
- ☐ No

MAP of Travel Areas

This map divides the City of Riverside into 12 areas.



7. From the above map, please identify the area in which you live: Area #_____. If you checked the box in Question 1, please identify the area where you enter Riverside: Area # _____.

In question **7**, you identified the **area** in which you live or enter and **travel from**.

In question **8,** please indicate the **area to which** you **travel** for the reasons stated, **how many times per week,** and during which **time(s) of day.**

8. How often do you and members of your household travel to:

Reason for Travel	Area Number	Times Per Week?	Time of Day			
			Morning	Midday	Afternoon	Night
Work						
School						
Shopping						
Entertainment						
Other						

9. If an electric streetcar were to provide service on the routes of the normal trips you have identified in this survey, how likely would it be that you would switch from or your current mode of transportation or add the new streetcar system to it? (please check only one)

- ☐ Highly likely
- ☐ Somewhat likely
- ☐ Somewhat unlikely
- ☐ Highly unlikely

OPTIONAL

We would love to hear from you!

We want to hear your stories and point of view about the feasibility study.
We are working towards organizing online community meetings.
If you would be interested in joining the discussion, please give us your name, email address, and if you would like, your phone number as well.
Let's discuss the potential for online community meetings.

Get in touch!

Name_____

Email_____

Phone_____ Best time(s) to call _____

If you would like to leave a question or a comment, please do so in the box provided below.

Thank you for taking our survey.

For updates about the feasibility study's progress, visit https://www.riversideca.gov/streetcar

Cuestionario de Encuesta a la Comunidad

Participe en esta encuesta si vive, trabaja o estudia en Riverside, CA.

Riverside está estudiando la viabilidad de un sistema de tranvía.

Estamos llegando a los miembros de la comunidad que viven y/o trabajan o estudian dentro de la ciudad de Riverside y agradeceríamos enormemente sus comentarios con respecto a sus actuales prácticas y formas de transportarse.

Al recopilar estos datos, podremos proyectar mejor el número de pasajeros de un posible sistema de tranvía. Las respuestas individuales a esta encuesta y cualquier información personal proporcionada no se harán públicas; sin embargo, los datos que proporcione se utilizarán y compartirán para informar los esfuerzos de movilidad futuros. Por supuesto, no es obligatorio, pero realmente esperamos que participe respondiendo esta encuesta.

Su opinión es valiosa y queremos saber de usted.

Por favor incluya los viajes de todos los miembros de su hogar que se movilicen de forma independiente por la ciudad. Si vive en una vivienda universitaria, considérelo su hogar para esta encuesta.

Si ha estado trabajando desde casa durante el COVID-19 pero normalmente se desplaza a su lugar de trabajo, responda estas preguntas de la encuesta como si estuviera desplazándose a su lugar de trabajo.

1. Si vive fuera de la ciudad de Riverside, marque aquí

- ☐ Marque aquí

2. ¿Qué medios de transporte utiliza actualmente? (por favor marque todos los que apliquen)

- ☐ Carro
- ☐ Bus
- ☐ Aplicaciones móviles de transporte (Uber, Lyft)
- ☐ Motocicleta
- ☐ Bicicleta
- ☐ Transporte compartido (Carpool)
- ☐ Caminando (A pie)
- ☐ Otros (por favor especifique) _____

3. ¿Cuántos automóviles utilizan en su hogar actualmente? (marque solo uno)

- ☐ 0
- ☐ 1
- ☐ 2+

4. Déjenos saber sobre su trabajo. (marque solo uno)

- ☐ Yo trabajo en la ciudad de Riverside.
- ☐ Yo trabajo fuera de la ciudad de Riverside.
- ☐ Yo estoy encargado de la casa tiempo complete y/o no trabajo fuera de mi casa.

5. ¿Con qué frecuencia usa Metrolink? (marque solo uno)

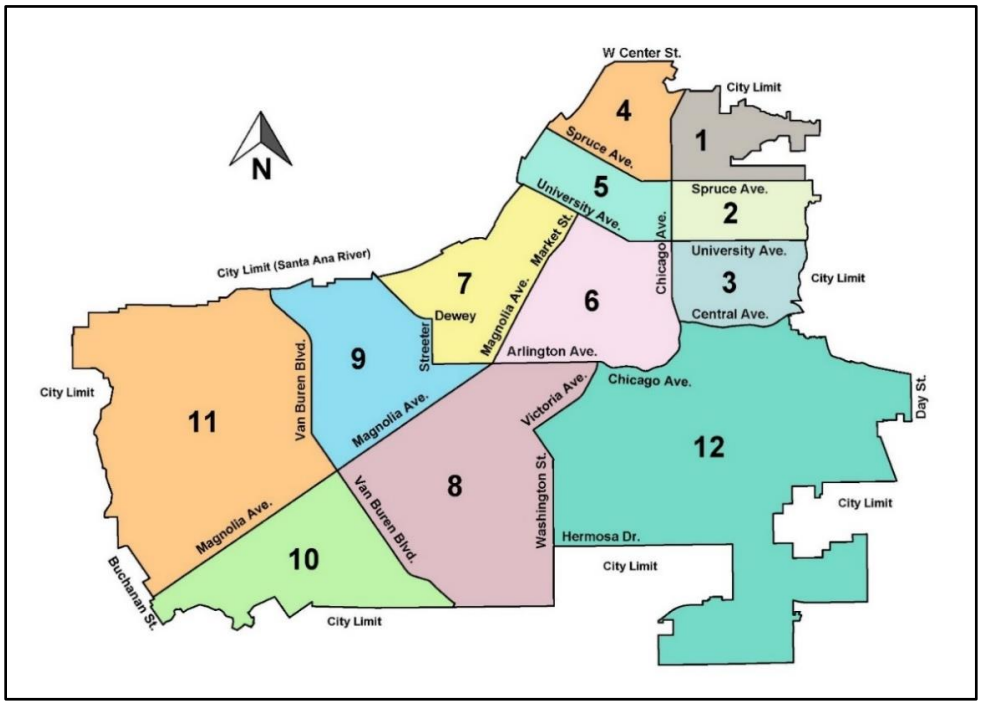
- ☐ Diariamente para el trabajo.
- ☐ Ocasionalmente por otras razones.
- ☐ Nunca

6. ¿Sueles agrupar varios mandados en un solo viaje? (marque solo uno)

- ☐ Yes
- ☐ No

Mapa de Areas de Desplazamiento

Este mapa divide la ciudad de Riverside en 12 áreas.



7. Usando el mapa de arriba, identifique el área en que vive: Area #_____
Si marco la casilla en la Pregunta 1, por favor identifique el área de ingreso a Riverside. Area # _____

En la pregunta **7**, identificó el **Area** donde vive o donde ingresa para desplazarse.

En la pregunta **8**, indique **el área** a la cual **se dirige** por las razones indicadas,

cuántas veces por semana y durante qué **hora (s) del día**.

8. Con qué frecuencia viajan usted y los miembros de su hogar a:

Razon del desplazamiento	Numero de Area	# Veces por Semana?	Time of Day			
			Mañana	Medio día	Tarde	Noche
Trabajo						
Estudio						
Compras						
Entretenimiento						
Otros						

9. Si un tranvía eléctrico brindara el servicio de transporte en las rutas de los desplazamientos normales que ha identificado en esta encuesta, ¿Qué probabilidad hay de que cambie su modo de transporte actual al nuevo sistema de tranvía? (marque solo uno)

- ☐ Muy Probable
- ☐ Algo Probable
- ☐ Algo Improbable
- ☐ Muy improbable

OPCIONAL

¡Nos encantaría escuchar su opinión!

Queremos saber de usted y su punto de vista sobre el estudio de viabilidad.
Estamos trabajando para organizar reuniones con la comunidad en línea.
Si está interesado en unirse a la discusión, por favor déjenos su nombre,
dirección de correo electrónico y, si lo desea, también su número de teléfono.
Analizaremos el potencial en las reuniones con la comunidad en línea.

¡Póngase en Contacto!

Nombre_____

Email_____

Teléfono _____Mejor tiempo para llamar
_____

Si desea dejar una pregunta o un comentario, hágalo en el cuadro que se proporciona a continuación.

¡Gracias por participar en nuestra encuesta!

Para obtener actualizaciones sobre el progreso del estudio de viabilidad, visite https://www.riversideca.gov/

Riverside Streetcar System Feasibility Study Report

Appendix E:

Civil Engineering Schematic Drawings

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
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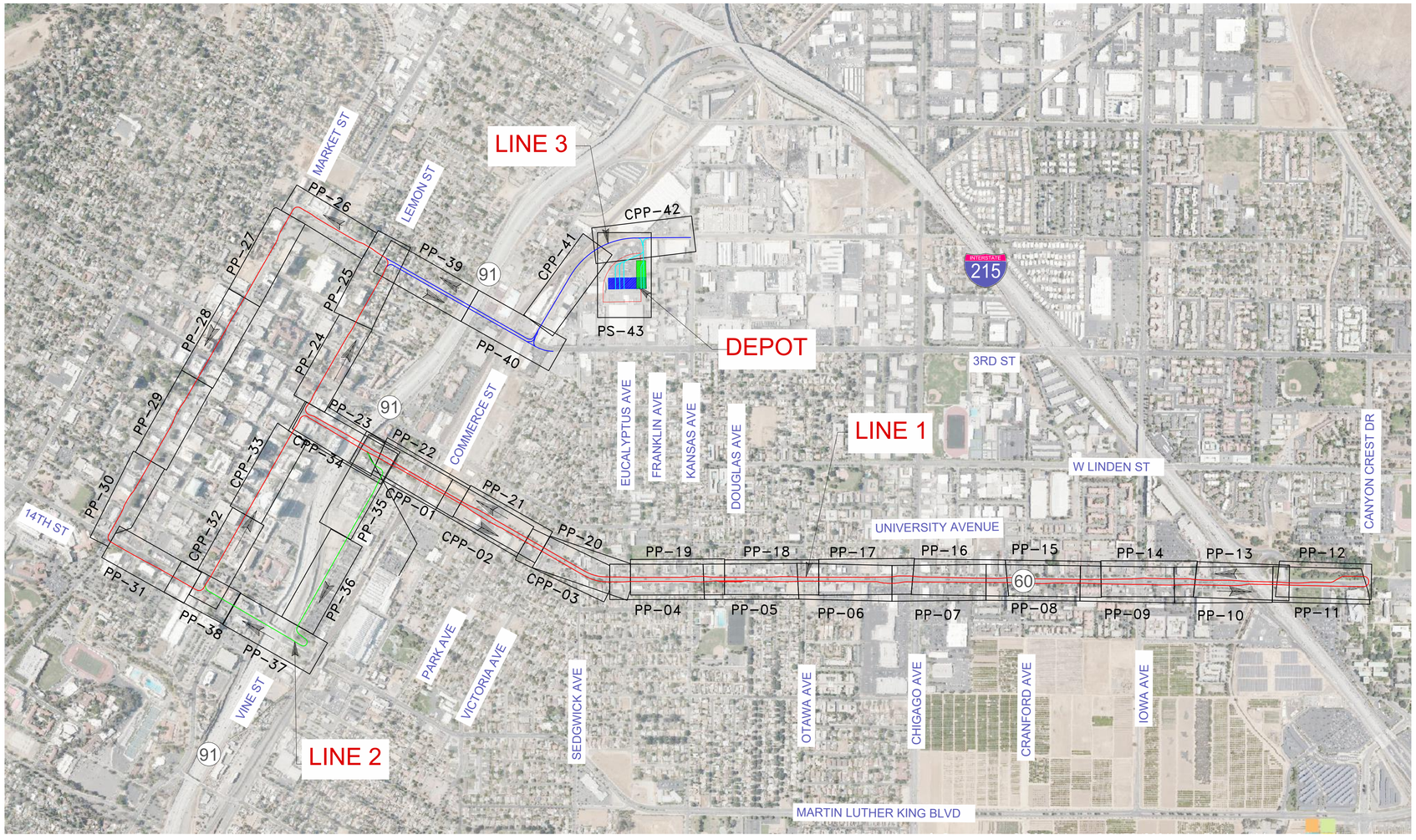
RIVERSIDE STREETCAR
PROJECT FEASIBILITY STUDY

1. GENERAL

DRAWING No.	DESCRIPTION	REVISION DATE
KEY–01	COVER SHEET & INDEX OF DRAWINGS	
GEN–01	GENERAL NOTES	
ABS–01	ABBREVIATIONS AND SYMBOLS	

2. TRACK GEOMETRY

DRAWING No.	DESCRIPTION	REVISION DATE
TYP–01	TYPICAL SECTIONS 1 & 2– UNIVERSITY AVENUE	
TYP–02	TYPICAL SECTIONS 3 & 4 – MARKET PLACE	
TYP–03	TYPICAL SECTIONS 5 & 6 – 14TH STREET	
TYP–04	TYPICAL SECTIONS 7, 8 & 9 – 3RD STREET AND VINE STREET	
TYP–05	EXAMPLES OF LEVEL TRACK FORM	
LAY–01	HORIZONTAL GEOMETRY LAYOUT	
LAY–02	HORIZONTAL CURVES LESS THAN 100'	
LAY–03	HORIZONTAL GEOMETRY DATA TABLE – LINE 1	
LAY–04	HORIZONTAL GEOMETRY DATA TABLE – LINE 2	
	PLAN AND PROFILE SHEETS – LINE 1	
PP–01	PLAN AND PROFILE – FROM STA 100+00 TO STA 110+40	
PP–02	PLAN AND PROFILE – FROM STA 110+40 TO STA 121+40	
PP–03	PLAN AND PROFILE – FROM STA 121+40 TO STA 132+40	
PP–04	PLAN AND PROFILE – FROM STA 132+40 TO STA 143+40	
PP–05	PLAN AND PROFILE – FROM STA 143+40 TO STA 154+40	
PP–06	PLAN AND PROFILE – FROM STA 154+40 TO STA 165+40	
PP–07	PLAN AND PROFILE – FROM STA 165+40 TO STA 176+40	
PP–08	PLAN AND PROFILE – FROM STA 176+40 TO STA 187+40	
PP–09	PLAN AND PROFILE – FROM STA 187+40 TO STA 198+60	
PP–10	PLAN AND PROFILE – FROM STA 198+60 TO STA 209+60	
PP–11	PLAN AND PROFILE – FROM STA 209+60 TO STA 221+20	
PP–12	PLAN AND PROFILE – FROM STA 221+20 TO STA 231+40	
PP–13	PLAN AND PROFILE – FROM STA 231+40 TO STA 242+40	
PP–14	PLAN AND PROFILE – FROM STA 242+40 TO STA 253+40	
PP–15	PLAN AND PROFILE – FROM STA 253+40 TO STA 264+40	
PP–16	PLAN AND PROFILE – FROM STA 264+40 TO STA 275+40	
PP–17	PLAN AND PROFILE – FROM STA 275+40 TO STA 286+40	
PP–18	PLAN AND PROFILE – FROM STA 286+40 TO STA 297+40	
PP–19	PLAN AND PROFILE – FROM STA 297+40 TO STA 308+40	
PP–20	PLAN AND PROFILE – FROM STA 308+40 TO STA 319+40	
PP–21	PLAN AND PROFILE – FROM STA 319+40 TO STA 330+40	
PP–22	PLAN AND PROFILE – FROM STA 330+40 TO STA 341+40	
PP–23	PLAN AND PROFILE – FROM STA 341+40 TO STA 352+40	
PP–24	PLAN AND PROFILE – FROM STA 352+40 TO STA 363+40	
PP–25	PLAN AND PROFILE – FROM STA 363+40 TO STA 373+40	
PP–26	PLAN AND PROFILE – FROM STA 373+40 TO STA 385+40	
PP–27	PLAN AND PROFILE – FROM STA 385+40 TO STA 396+40	
PP–28	PLAN AND PROFILE – FROM STA 396+40 TO STA 407+40	
PP–29	PLAN AND PROFILE – FROM STA 407+40 TO STA 418+40	
PP–30	PLAN AND PROFILE – FROM STA 418+40 TO STA 429+40	
PP–31	PLAN AND PROFILE – FROM STA 429+40 TO STA 440+00	
PP–32	PLAN AND PROFILE – FROM STA 440+00 TO STA 451+00	
PP–33	PLAN AND PROFILE – FROM STA 451+00 TO STA 462+20	
PP–34	PLAN AND PROFILE – FROM STA 462+20 TO STA 474+00	
	PLAN AND PROFILE SHEETS – LINE 2	
PP–35	PLAN AND PROFILE – FROM STA 10+00 TO STA 19+00	
PP–36	PLAN AND PROFILE – FROM STA 19+00 TO STA 29+00	
PP–37	PLAN AND PROFILE – FROM STA 29+00 TO STA 40+00	
PP–38	PLAN AND PROFILE – FROM STA 40+00 TO STA 50+60	
	PLAN AND PROFILE SHEETS – LINE 3 (DEPOT)	
PP–39	PLAN AND PROFILE – FROM STA 50+00 TO STA 60+50	
PP–40	PLAN AND PROFILE – FROM STA 60+50 TO STA 71+50	
PP–41	PLAN AND PROFILE – FROM STA 71+50 TO STA 83+00	
PP–42	PLAN AND PROFILE – FROM STA 83+00 TO STA 93+83	
PS–43	PLAN SHEET – DEPOT–	



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SHEET TITLE: KEY SHEET
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-KEY-01
REV. 2
211217
PROJECT TITLE: RIVERSIDE STREETCAR PROJECT FEASIBILITY STUDY

DRAWING NO. KEY-01
DATE 2021-12-17
SCALE NTS
SHEET 1 OF 56
REVISION NO. 2

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Plot Date: 2021/12/20

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ABBREVIATIONS

GENERAL

AC	ASPHALT CONCRETE
ADA	AMERICAN WITH DISABILITY ACT
ADJ	ADJUSTABLE
AHD	AHEAD
ALIGN	ALIGNMENT
ALT	ALTERNATE
APPROX	APPROXIMATE
ARCH	ARCHITECTURE
AS	AGGREGATE SUBBASE
ASPH	ASPHALT
AVE	AVENUE
AVG	AVERAGE
BBR	BEGINNING OF BRIDGE
BCR	BEGIN CURB RETURN
BEG	BEGIN
BK	BACK
BKF	BACKFILL
BLDG	BUILDING
BM	BENCHMARK
BOC	BOTTOM OF CURB
BOP	BOTTOM OF PIPE
BOT	BOTTOM
BOW	BOTTOM OF WALL
BR	BRIDGE
BS	BOTTOM OF SLOPE
C	CURB
C&G	CURB AND GUTTER
CAB	CABINET
CAP	CAPACITY
CB	CATCH BASIN
CEM	CEMENT
CJ	CONSTRUCTION JOINT
CL	CENTER LINE
CLR	CLEAR
COL	COLUMN
CONC	CONCRETE
CONST	CONSTRUCTION
CONT	CONTINUOUS
COORD	COORDINATE
CP	CONTROL POINT
CTR	CENTER LINE
DEP	DEPTH
DET	DETAIL
DIA	DIAMETER
DIM	DIMENSION
DIR	DIRECTION
DTR	DETOUR
DWG	DRAWING
EX	EXISTING
EA	EACH
EBR	END OF BRIDGE
ECR	END OF CURB RETURN
EJ	EXPANSION JOINT
EL,ELEV	ELEVATION
EMB	EMBANKMENT
EP	EDGE OF PAYMENT
ES	EDGE OF SHOULDER
ESMT	EASEMENT
ETW	EDGE OF TRAVEL WAY
EW	EDGE OF WALL
EXC	EXCAVATION
EXP	EXPANSION
FC	FACE OF CURB
FD	FLOOR DRAIN
FG	FINISH GRADE
FH	FIRE HYDRANT
FIN	FINISH
FL	FLOW LINE
FLR	FLOOR DRAIN
FS	FINISH SURFACE
FT	FEET
FWY	FREEWAY
GB	GRADE BREAK
GA	GAUGE OR GAGE
GND	GROUND
GR	GUARDRAIL
H	HEIGHT
HOR	HORIZONTAL
HP	HIGH POINT
HR	HAND RAIL
HST	HOLLOW STEEL TIE
HW	HEADWALL
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IJ	INSULATED JOINT
IN	INCHES
INV	INVERT ELEVATION
IR	INSIDE RADIUS
JB	JUNCTION BOX
JT	JOINT
LEG	LEGEND
LF	LINEAR FEET
LG	LONG
L,LGTH	LENGTH
LIM	LIMITS
LN	LANE
LONG	LONGITUDINAL
LP	LOW POINT
LVL	LEVEL
LRV	LIGHT RAIL VEHICLE
MH	MANHOLE
MON	MONUMENT
MP	MILE POST
MSE	MECHANICALLY STABILIZED EARTH
MSL	MEAN SEA LEVEL
MTL	MATERIAL
N	NORTH
N/A	NOT APPLICABLE
NB	NORTH BOUND
NTS	NOT TO SCALE
OC	ON CENTERS
OCS SYSTEM	OVERHEAD CONTACT
OD	OUTSIDE DIAMETER
OG	ORIGINAL GRADE
OH	OVERHEAD
PAX	PASSENGER
PB	PULL BOX
PED	PEDESTRIAN
PF	PLATFORM
PGL	PROFILE GRADE LINE
PH	POTHOLE
PL	PLATE
P/L	PROPERTY LINE
PNL	PANEL
PP	POWER POLE
PVMT	PAVEMENT
QTY	QUANTITY
R	RADIUS
RC	REINFORCED CONCRETE
RCP PIPE	REINFORCED CONCRETE
RR	RAIL ROAD
RT	RIGHT
RTE	ROUTE
RW	RETAINING WALL
ROW	RIGHT-OF-WAY
S	SOUTH
SD	STORM DRAIN
SG	SUBGRADE
SL	SLOPE
SPEC	SPECIFICATION
SS	STAILESS STEEL
	SANITARY SEWER
STA	STATION ALONG ALIGNMENT
STL	STEEL
SWK	SIDEWALK
TAN	TANGENT
TBD	TO BE DETERMINED
TC	TOP OF CONCRETE
TD	TRENCH DRAIN
TEMP	TEMPORARY
TF	TRACK FEET
TH	THICK
TO	TURNOUT
TOC	TOP OF CURB
TOG	TOP OF GRATE
TOL	TOLERANCE
TOP	TOP OF PAVEMENT
TOR	TOP OF RAIL
TOS	TOP OF SLOPE
TOT	TOP OF TIE
TOW	TOP OF WALL
TRANS	TRANSITION
TVM MACHINE	TICKET VENDING
TYP	TYPICAL
UB	UTILITY BOX
UD	UNDERDRAIN
UG	UNDERGROUND
UP	UNDERPASS
UTIL	UTILITY
VAR	VARIES
VEH	VEHICLE
VEL	VELOCITY
VERT	VERTICAL
VMB	VISUAL MESSAGE BOARD
VMS	VISUAL MESSAGE SIGN
W	WIDTH
W/	WITH
W/O	WITHOUT
WL	WATER LEVEL
WPF	WATER PROOF
WT	WEIGHT
WWM	WELDED WIRE MESH
XING	CROSSING
XOVER	CROSSOVER

TRACK GEOMETRY – HORIZONTAL

CC	COMPOUND CURVATURE
CS	POINT OF CHANGE FROM CIRCULAR TO SPIRAL
LC	TOTAL LENGTH OF CIRCULAR CURVE FROM PC TO PT OR SC TO CS
LSC	LENGTH OF COMPOUND SPIRAL FROM CS TO SC
LS1	LENGTH OF SPIRAL FROM TS TO SC
LS2	LENGTH OF SPIRAL FROM CS TO ST
PC	POINT OF CURVATURE/POINT OF CHANGE FROM TANGENT TO CIRCULAR CURVE
PCC	POINT OF COMPOUND CURVE
PI	POINT OF INTERSECTION
POS	POINT OF SPIRAL
PRC	POINT OF REVERSE CURVATURE
PS	POINT OF SWITCH
PT	POINT OF TANGENT/POINT OF CHANGE FROM CIRCULAR CURVE TO TANGENT
SC	POINT OF CHANGE FROM SPIRAL TO CIRCULAR CURVE
SS ONE	POINT OF CHANGE FROM SPIRAL
ST	POINT OF CHANGE FROM SPIRAL TO TANGENT
SPO	POINT ON ORIGIN OF COMPOUND CURVE
TS1	TANGENT DISTANCE FROM TS TO PI
TS2	TANGENT DISTANCE FROM ST TO PI
TS	POINT OF CHANGE FROM TANGENT TO SPIRAL

TRACK GEOMETRY – VERTICAL

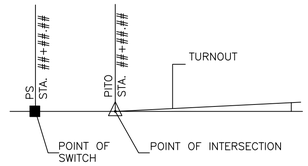
BVC	BEGIN VERTICAL CURVE
BVCE	BEGIN VERTICAL CURVE ELEVATION
BVCS	BEGIN VERTICAL CURVE STATION
EVC	END VERTICAL CURVE
EVCE	END VERTICAL CURVE ELEVATION
EVCS	END VERTICAL CURVE STATION
HP	HIGH POINT
HPE	HIGH POINT ELEVATION

SYMBOLS

GENERAL

- RAILROAD SWITCH BOX
- TRAFFIC SIGNAL
- TRAFFIC SIGNAL W/ARM ONLY
- TRAFFIC SIGNAL W/ARM AND POLE
- SIGN
- TELEPHONE POLE
- EXISTING POLE
- LIGHT POLE
- SIGNAL HOUSE
- RAILROAD SIGNAL
- SIGNAL BASE
- TEMPORARY DRAINAGE INLET
- CID — CARD INTERFACE DEVICE
- D## — DISTRIBUTION CABINET
- SAV — STAND ALONE VALIDATOR
- TVM — TICKET VENDING MACHINE
- VMS — VISUAL MESSAGE SIGN
- TEL — PUBLIC TELEPHONE
- CER — COMMUNICATIONS EQUIPMENT ROOM
- CIC — COMMUNICATION INTERFACE CABINET
- PB — PULL BOX
- ER — EQUIPMENT ROOM
- TRANSFORMER

TRACK GEOMETRY



- HORIZONTAL CONTROL POINT
- HORIZONTAL AND VERTICAL CONTROL POINT
- VERTICAL CONTROL POINT
- POINT OF VERTICAL INTERSECTION (PVI)
- BENCHMARK
- CURVE MARKER

SPECIAL TRACKWORK

- INSULATED JOINT
- WELDED JOINT

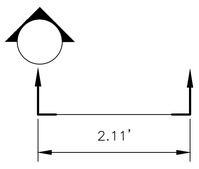
ANNOTATION

VIEW TITLE

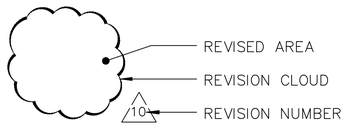
A / C2035 — DETAIL, ELEVATION, PLAN OR SECTION

SCALE: 1"=1'-0"

1 / C127 — A / C127 — 1 / C127



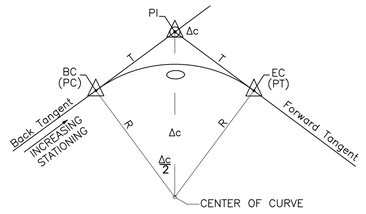
REVISIONS



PATTERNS

- NEW ASPHALT CONCRETE
- PORTLAND CEMENT CONCRETE
- WOOD
- BALLAST
- COMPACTED SUBGRADE / EARTH
- STONE/BRICK PAVING
- TOP SOIL

HORIZONTAL CURVES



Δc = TANGENT DEFLECTION ANGLE
R = RADIUS OF CIRCULAR CURVE
L = LENGTH OF CURVATURE
BC, PC = BEGINNING OF CURVE (PC)
EC, PT = END OF CURVE (PT)
PI = POINT OF INTERSECTION
T = TANGENT LENGTH

$T = R \tan$

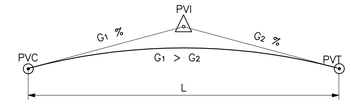
$L = \frac{\Delta c \pi R}{180}$

VERTICAL CURVES

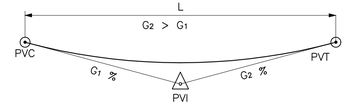
r = RATE OF CHANGE OF GRADE
L = LENGTH OF CURVE
G1 = ENTRANCE GRADE
G2 = EXIT GRADE
K = DISTANCE TO ACHIEVED 1% OF CHANGE IN GRADE

$r = \left| \frac{G_2 - G_1}{L} \right|$ (L in stations)

$K = \left| \frac{L}{G_2 - G_1} \right|$



CREST VERTICAL CURVE



SAG VERTICAL CURVE

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FAX 818-709-8508
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REV NO	DATE	DESCRIPTION
A	210730	REVISED
A	211217	REVISED

DRAWN DC
CHECKED BR
APPROVED BR

SHEET TITLE: ABBREVIATIONS AND SYMBOLS
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-GEN-02
REV. 2
211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. GEN-02
DATE 2021-12-17
SCALE NTS
SHEET # OF #
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GENERAL NOTES

RAIL

TRACK GAUGE

1. TRACK GAUGE SHALL BE 1.435 m [4.708'] ±0.0031 m [1/8"] IN TANGENT TRACK AND CURVES GREATER THAN 152.40[500'] RADII.
2. TRACK GAUGE SHALL BE WIDENED AS FOLLOWS:
   - CURVES WITH 152.40[500'] RADII TO 30.48[100'] RADII SHALL BE WIDENED TO 1.441[4.728']
   - CURVES WITH LESS THAN 30.48[100'] RADII SHALL BE WIDENED TO 1.448[4.751'].
3. TRACK GAUGE SHALL BE MEASURED 6.35 mm [1/4"] FROM TOP OF RAIL.

RESTRAINING RAILS

4. RESTRAINING RAIL SHALL BE USED IN CURVES WITH CENTERLINE RADII LESS THAN 60.96 m [200.00'] AND SHALL EXTEND THROUGH THE TRANSITIONAL CURVES 2.0 m [6.56'] INTO TANGENT TRACK ON BOTH ENDS OF CURVE.
5. RESTRAINING RAIL SHALL BE LOCATED BETWEEN RUNNING RAILS, 38.1 mm [1-1/2"] FROM INSIDE RUNNING RAIL AS MEASURED FROM RAIL GAUGE LINES.
6. RESTRAINING RAIL SHALL BE MADE BY REMOVING ONE FOOT FROM 85 LB. A.S.C.E RAIL. RESTRAINING RAINING RAIL SHALL BE BOLTED TO THE RUNNING RAIL WITH RESTRAINING RAIL SEPARATOR BLOCKS SPACED AT 0.914 mm [3.00'] O.C.

FLANGE WAY

7. FORMED FLANGEWAY SHALL BE 44.5mm [1-3/4"] WIDE AND 30.0mm [1-3/16"] DEEP AND SHALL BE UNIFORMLY OFFSET FROM TOP OF RAIL TO INSURE ADEQUATE DRAINAGE OF FLANGEWAY.

RAIL LEVELING PADS

8. RAIL SHALL BE PLACED ON A 6.35 mm[1/4"] STEEL TIE PLATE ATOP A BED OF NONSHRINK/HIGH COMPRESSIVE STRENGTH GROUT.
9. TOP OF TIE PLATE SHALL BE ELEVATED TO 0.1318[0.432'] BELOW TOP OF RAIL (.1778[0.583] FOR SPECIAL WORK) ELEVATION AS SHOWN ON REPLAN AND PROFILE SHEETS. TIE PLATES SHALL BE LEVEL PERPENDICULAR TO THE RAIL AND SLOPED TO MATCH THE RAIL GRADE IN THE DIRECTION THE RAIL IS RUNNING.
10. SPECIAL-WORK SHALL BE LEVELED WITH THE SPECIAL-WORK LEVELING PLATES AS FOLLOWS

    5 LEVELING PLATES PER SWITCH OR MATE.

    3 LEVELING PLATES PER FROG.
11. THE SPECIAL-WORK LEVELING PLATES WERE MANUFACTURED WITH ONE HOLE PRE DRILLED. THE 2ND HOLE WILL NEED TO BE LOCATED AND DRILLED IN THE FIELD TO MATCH THE WIDTH OF THE SPECIALWORK AT EACH OF THE LEVELING PLATE LOCATIONS.

ANCHOR RODS

12. ANCHOR ROD HOLES SHALL BE THOUROUGHLY CLEANED BEFORE ROD IS INSERTED.
13. ANCHOR RODS SHALL BE EMBEDDED INTO CONCRETE PAN 0.152 [0.50'] MIN. (GROUT THICKNESS NOT INCLUDED).
14. WHEN SETTING THREADED ANCHOR RODS, ENSURE THAT 0.051 [0.166'] MIN. OF ROD IS PROTRUDING ABOVE TIE PLATE.
15. OBEY SETTING TIME FOR CHEMICAL ANCHORS, AS SPECIFIED BY THE MANUFACTURER, BEFORE ADDING AND TIGHTENING.
16. INSTALL THEADED RODS USING SIMPSON ET ADHESIVE EPOXY PER MANUFACTURERS RECOMMENDATIONS.

PAN FILL

17. ONCE RAIL IS SECURED IN PLACE, FILL PAN WITH CONCRETE ENSURING THAT THERE ARE NO AIR POCKETS LEFT UNDER RAIL.

RAIL JOINTS

18. RAIL SECTIONS SHALL BE JOINED WITH JOINT BARS COMPATIBLE WITH THE RAIL SECTIONS TO BE JOINED.
19. ALL JOINT BARS SHALL BE FASTENED WITH NEW BOLTS, NUTS AND WASHERS.
20. JOINT BAR LOCATIONS OF ADJACENT RAILS SHALL STAGGER A MINIMUM OF 2.0[6.56'].
21. COMPROMISE JOINT BARS SHALL BE USED WHERE TWO DIFFERENT TYPES OR SIZES OF RAIL ARE JOINED TOGETHER.
22. RAIL LENGTHS TO BE JOINED TOGETHER SHALL BE AT LEAST 4.305[14.12'] IN LENGTH. (3X NOMINAL TRACK GAUGE).
23. A LIMITED QUANTITY OF JOINT BARS HAVE BEEN MODIFIED AND SUPPLIED FOR THE FOLLOWING PURPOSES:
    1. TOE REMOVED FROM JOINT BAR TO FIT INSIDE THE FLANGE WAY BETWEEN INSIDE RUNNING RAIL AND RESTRAINING RAIL.
    2. JOINT BARS HAVE BEEN CROPPED 0.057[0.187'] ON ONE END TO JOIN RUNNING RAIL TO THE TONGUE SWITCH IN LOCATIONS OF RESTRAINING RAIL. FOUR(4) CROPPED JOINT BARS SHALL BE USED PER TURNOUT: TWO(2) JOINT BARS CROPPED ON THE RIGHT SIDE AND TWO(2) JOINT BARS CROPPED ON THE LEFT SIDE.

RAIL BENDING

24. ALL RAIL OF RADIUS 106.68 m [350'] OR LESS SHALL BE BENT WITH THE USE OF A RAIL BENDER WITH MINOR BENDING MADE IN PLACE.
25. ALL RAIL WITH A RADIUS LESS THAN 30.0 m [94.42'] SHALL PREFERABLY BE BENT IN A RAIL BENDING SHOP.

RAIL DRILLING

26. ALL HOLES DRILLED THROUGH RAIL SHALL BE DONE WITH A RAIL DRILL AND NOT BURNED THROUGH WITH A TORCH.

CONSIDERATIONS WHEN WORKING WITH RELAY RAIL

24. WE SUGGEST WHEN THE RAIL ARRIVES ON SITE TO INSPECT AND DIVIDE IT INTO 3 PILES:
    - PILE 1 - WORST 10% OF RAIL. MAY HAVE ENGINE BURNS, MORE SEVERE HEAD WEAR, POOR RAIL ENDS. PILE 1 WILL BE USED FOR RESTRAINING RAIL OR SHORTER SECTIONS OF RAIL THAT CAN BE SALVAGED TO LEAVE THE UNDESIRABLE PORTIONS.
    - PILE 2 - THAT WHICH FALLS BETWEEN THE WORST 10% AND BEST 45% OF RAIL. BETTER RAIL HEAD THAN PILE #1 BUT MAY NOT BE STRAIGHT. PILE 2 WILL BE USED FOR CURVED SECTIONS OF RUNNING RAIL
    - PILE 3 - BEST 45% OF RAIL. BEST RAIL HEAD CONDITION AND STRAIGHT. PILE 3 WILL BE USED FOR TANGENT SECTIONS OF RUNNING RAIL
27. DURING INSPECTION, MARK THE RAIL HEAD SIDE THAT WILL BE MOST SUITED FOR THE GAUGE SIDE OF RAIL.

RAIL FABRICATION NOTES

1. BEFORE A RAIL PART IS BENT, THE SIDE OF THE RAIL HEAD MOST WORTHY OF CONTACT WITH THE WHEEL SHALL BE SPECIFIED AS THE GAUGE SIDE. EACH RAIL PART SHALL BE BENT WITH THE GAUGE SIDE APPROPRIATLY ORIENTED IN RELATION TO THE CURVATURE OF THE RAIL.
2. FABRICATOR SHALL CLEARLY MARK A LINE ON THE HEAD OF THE RAIL INDICATING THE TRANSITION POINTS BETWEEN EACH SEGMENT ON THE RAIL (CURVED AND TANGENT AS SHOWN OF EACH PIECE %%U GUAGE SIDE ABOVE). THE PART NUMBER SHALL BE CLEARLY MARKED ON THE OF RAIL.
3. ALL PARTS ENDING IN "RR" ARE RESTRAINING RAIL AND REQUIRE THE BASE ON THE INSIDE OF RAIL CURVE TO BE REMOVED AS SHOWN IN "RESTRAINING RAIL FOOT REMOVAL" SEE DETAIL 4 ABOVE. THIS IS TO BE DONE AFTER THE RAIL HAS BEEN BENT.
4. HOLES SHALL BE DRILLED IN RESTRAINING RAIL AS SPECIFIED IN "RESTRAINING RAIL DRILLING FOR SEPARATOR BLOCKS".
5. ALL RAIL ENDS SHALL BE DRILLED TO END DRILLING SPECIFICATIONS AS SHOWN ON THIS SHEET UNLESS SPECIFIED OTHERWISE.
6. IF AT ANY TIME THERE IS A QUESTION REGARDING DIMENSIONS OR INSTRUCTIONS, TIG SHALL BE CONTACTED BEFORE THE PART IS FABRICATED.

MAINTENANCE FACILITY

1. ELECTRIC POWER IN MAINTENANCE FACILITY:
2. 200 AMP 3-PHASE SERVICE.
   - 110 VOLT SINGLE PHASE FOR LIGHTING AND HAND TOOLS.
   - 220 VOLT SINGLE PHASE FOR BATTERY CHARGERS.
   - 220 VOLT THREE PHASE FOR HYDRAULIC POWER UNITS FOR TROLLEY JACKS.
3. MAINTENANCE FACILITY IS NOT STAFFED ON FULL DAY BASIS. MAJOR MAINTENANCE AND REPAIRS ARE TYPICALLY PERFORMED BY A OUTSIDE CONTRACTOR. THE OPERATORS (CONDUCTOR AND MOTORMAN) WILL TYPICALLY BE OUT ON THE VEHICLES EXCEPT DURING PRE-OPERATION VEHICLE CHECK, LUNCH BREAK, AND POST-OPERATION DATA ACQUISITION AND PLUG-IN. FOR THIS REASON WE SUGGEST THE USE OF SPACE HEATERS AND FANS WHEN NEEDED AS OPPOSED TO CENTRAL HEATING AND AIR CONDITIONING. WE WILL ASK THE ARCHITECTS TO IMPLEMENT PASSIVE HEATING AND COOLING WHERE POSSIBLE AND TO PROVIDE AMPLE VENTILATION.
4. WE ARE NOT FAMILIAR WITH THE LOCAL CODES BUT ASSUME THAT AN OIL SEPARATOR WILL BE NECESSARY FOR THE FACILITY. WE HAVE FOUR OIL LUBRICATED GEAR BOXES PER VEHICLE AND 2 DRAINS FOR WASH DOWN (ONE IN THE LIFT AREA AND ONE IN THE PIT).

CONCRETE

CONCRETE

1. ALL PHASES OF WORK PERTAINING TO THE CONCRETE CONSTRUCTION SHALL CONFORM TO THE "BUILDING CODE REQUIREMENTS FOR REINFORCES CONCRETE ", ACI 318, WITH MODIFICATIONS AS NOTED IN THE CONTRACT DOCUMENTS.
2. CONCRETE MIX SHALL BE DESIGNED BY A QUALIFIED LABORATORY IN ACCORDANCE WITH CODE. THE CONCRETE MIX DESIGN SHALL STATE THE SOURCE OF THE AGGREGATES AND SHALL INCLUDE AS AFFIDAVIT THE THE AGGREGATE IS NOT EXPANSIVE OF OTHERWISE CHEMICALLY DETRIMENTAL. IF AN AFFIDAVIT IS NOT PROVIDED THE AGGREGATE SHALL BE TESTED FOR POTENTIAL REACTIVITY ACCORDING TO ASTM-C289. THE RESULT SHALL BE INNOCUOUS, CONCRETE MIX DESIGN TO BE SUBMITTED TO THE STRUCTURAL ENGINEER FOR REVIEW BEFORE POURING.

ITEM	ULTIMATE STRENGTH AT 28 DAYS (PSI	MAXIMUM AGGREGATE SIZE (INCH)	MAXIMUM SLUMP (INCH)
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3. PORTLAND CEMENT SHALL CONFORM TO ASTM C-150, TYPE I OR TYPE II, LOW ALKALI.
4. AGGREGATE FOR HARDROCK CONCRETE C-33. EXCEPTIONS MAY BE USED ONLY WITH PERMISSION OF THE STRUCTURAL ENGINEER.
5. THE CONCRETE SLAB THICKNESS SHALL BE MAINTAINED UNLESS OTHERWISE SHOWN.
6. DRY PACK OR NON SHRINK GROUT UNDER BASE PLATES, SILL PLATES, ETC., SEE CONTRACT DOCUMENTS.
7. CONCRETE MIXING OPERATIONS, ETC., SHALL CONFORM TO C-94.
8. PLACEMENT OF CONCRETE SHALL CONFORM TO ACI 304 AND CONTRACT DOCUMENTS. SANDBLAST ALL CONCRETE SURFACES AGAINST WHICH CONCRETE IS TO BE PLACED.
9. THE FOLLOWING MINIMUM CONCRETE COVER SHALL BE PROVIDED FOR REINFORCEMENT PLACED IN CAST-IN-PLACE CONCRETE:

   MINIMUM COVER , INCHES

   A. CONCRETE CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH:.....3"

   B. CONCRETE EXPOSED TO EARTH OR WEATHER:

   #6 THROUGH #18 BARS.....2"

   #5 BAR, W31 WIRE, AND SMALLER..... 1.5"

   C. CONCRETE NOT EXPOSED TO WEATHER OR IN CONTACT WITH GROUND:

   SLABS AND JOISTS:

   #14 AND #18.....1.5"

   #11 BAR AND SMALLER..... 1"

   BEAMS, COLUMNS AND WALLS PRIMARY REINFORCES, TIES

   STIRRUPS AND SPIRALS:

   #3 THROUGH #11..... 1.5"

   #14 AND #18 BARS..... 2.5"

10. ALL REINFORCING BARS, ANCHORS BOLTS AND OTHER CONCRETE INSERTS SHALL BE WELL SECURED IN POSITION PRIOR TO PLACING CONCRETE.
11. PROVIDE SLEEVES FOR PLUMBING AND ELECTRICAL OPENINGS IN CONCRETE BEFORE PLACING. DO NOT CUT REINFORCING WHICH MAY CONFLICT. CORING IN CONCRETE IS NOT PERMITTED EXCEPT AS SHOWN. NOTIFY THE STRUCTURAL ENGINEER IN ADVANCED OR CONDITIONS NOT SHOWN ON THE DRAWINGS.
12. CONDUIT OR PIPE SIZE (0.D) SHALL NOT EXCEED ON THE THIRD OF SLAB THICKNESS AND SHALL BE PLACES BETWEEN THE TOP AND BOTTOM REINFORCING, UNLESS SPECIFICALLY DETAILED OTHERWISE. CONCENTRATIONS OF CONDUITS OR PIPES SHALL BE AVOIDED EXCEPT WHERE DETAILED OPENINGS ARE PROVIDED.
13. CURING COMPOUNDS USED ON CONCRETE TO RECEIVE A FINISH SHALL BE APPROVED BE THE FINISH APPLICATOR BEFORE USE.
14. ADMIXTURE SHALL BE USED AS REQUIRED BY JOB SITE CONDITIONS TO MINIMIZE CRACKS AND SHRINKAGE WITH SUBMITTAL TO STRUCTURAL ENGINEER FOR REVIEW.
15. CONSTRUCTION JOINTS NOT INDICATED ON THE PLANS SHALL BE SO MADE AND LOCATE AS NOT TO IMPAIR THE STRENGTH OF THE STRUCTURE. WHERE A JOINT IS TO BE MADE, THE SURFACE OF THE CONCRETE SHALL BE THOROUGHLY CLEANED AND ALL LAITANCE REMOVED.
16. THERE SHALL BE AT LEAST A 48 HOUR WAITING PERIOD BETWEEN PLACING ADJACENT SLABS. POURING PROCEDURE AND A LAYOUT SHOWING LOCATIONS OF EXPANSION, WEAKENED OR CONSTRUCTION JOINTS FOR SLABS ON GRADE SHALL BE SUBMITTED TO THE STRUCTURAL ENGINEER FOR REVIEW.
17. SLABS ON GRADE HAVE F DESIGNATIONS OF FF 25/FL 20 MINIMUM OVERALL FOR COMPOSITE OF ALL MEASURED VALUES; FF 18/FL 13 MINIMUM FOR ANY INDIVIDUAL FLOOR SECTION.
18. REMOVAL OF FORMS:

    A. SUPPORTING VERTICAL SURFACES 2 DAYS MINIMUM.

    B. SUPPORING FLOOR SLABS 7 DAYS MINIMUM.

    C. SUPPORTING SEAMS AND GIRDERS 15 DAYS MINIMUM.

REINFORCED STEEL

1. ALL REINFORCED STEEL SHALL BE DETAILED AND PLACED IN CONFORMANCE WITH THE "BUILDING CODE REQUIREMENTS FOR REINFORCES CONCRETE" (ACI-318), AND THE "MANUAL OF STANDARD PRACTICE FOR REINFORCES CONCRETE CONSTRUCTION" BY THE C.R.S.I. AND THE W.C.R.S.I., OR AS MODIFIED BY THE CONSTRUCTION DOCUMENTS.
2. REINFORCING BARS: A -615 GRADE 60 OR A-709 GRADE 60 UNLESS NOTED OTHERWISE.
3. WELDING OR REINFORCEMENT SHALL BE WITH LOW HYDROGEN ELECTRODES IN CONFORMANCE WITH "RECOMMENDED PRACTICES FOR WELDING REINFORCING STEEL, ETC.," AMERICAN WELDING SOCIETY, AWS-D1.4.
4. ALL REINFORCING BAR BENDS SHALL BE MADE COLD.
5. WELDED WIRE FABRIC : A-185.
6. MINIMUM LAP OF WELDED WIRE FABRIC SHALL BE 6 INCHES, OR ONE FULL MESH PLUS TWO INCHES, WHICHEVER IS GREATER.
7. REINFORCING SPLICES SHALL BE 40X DIAMETER OF BARS OR AS INDICATED ON THE DRAWINGS.
8. ALL BARS SHALL BE MARKED SO THEIR IDENTIFICATION CAN BE MADE WHEN THE FINAL IN-PLACE INSPECTION IS MADE.
9. CONTRACTOR SHALL PROVIDE FOR AN ALLOWANCE OF 5 TONS OF REINFORCING TO BE FABRICATED AND PLACED DURING PROGRESS OF WORK AS MAY BE DIRECTED BY THE STRUCTURAL ENGINEER. THE UNUSED PORTION SHALL BE CREDITED TO THE OWNER AT THE COMPLETION OF THE CONCRETE WORK.
10. SHOP DRAWINGS SHOWING ALL SPLICES, CLEARANCES AND PLACEMENT OF REINFORCING STEEL SHALL BE SUBMITTED TO THE STRUCTURAL ENGINEER FOR REVIEW AND COMMENT BEFORE FABRICATION.

NOTES ARE INDICATIVE.

NOT SPECIFIC TO THE RIVERSIDE STREETCAR SYSTEM.

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REV NO	DATE	DESCRIPTION
A	210730	REVISED
A	211217	REVISED

DRAWN	DC
CHECKED	BR
APPROVED	BR

SHEET TITLE: GENERAL NOTES
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-GEN-01
REV. 2
211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. GEN-01
DATE 2021-12-17
SCALE NTS
SHEET # OF #
REVISION NO. 2

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Plot Date: 2021/12/17
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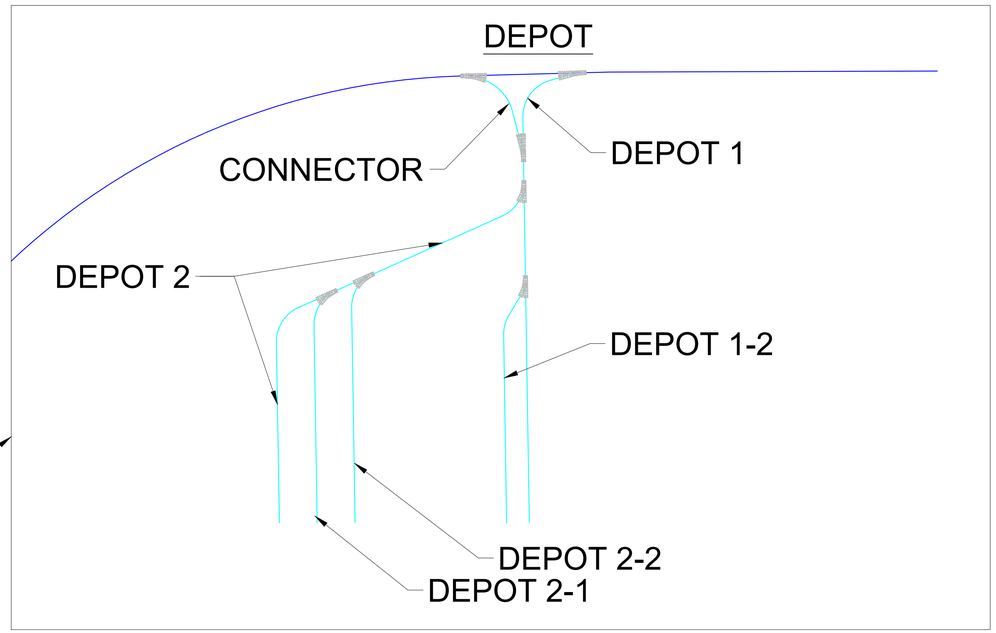
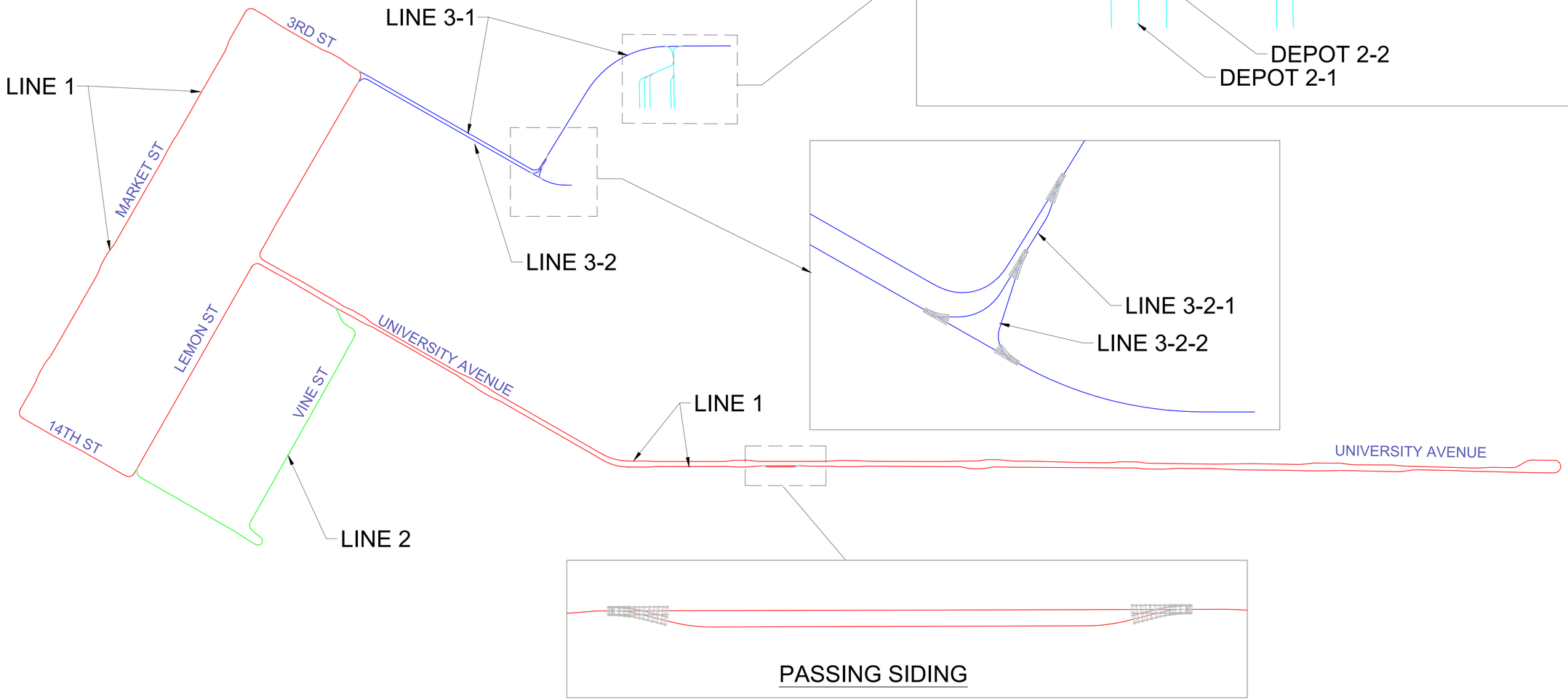
	FROM STA	TO STA	TOTAL FT	TOTAL MILES
LINE 1	100+00.00	472+87.41	37,287	7.06
LINE 2	10+00.00	50+76.32	4,076	0.77
LINE 3-1	50+00.00	93+82.72	4,383	0.83
LINE 3-2	60+00.00	83+00.00	2,300	0.44
LINE 3-2-1	0+00.00	2+37.71	238	0.05
LINE 3-2-2	0+00.00	1+23.80	124	0.02
CONNECTOR	0+00.00	1+29.98	130	0.02
DEPOT 1	0+00.00	6+39.04	639	0.12
DEPOT 1-2	0+00.00	3+18.62	319	0.06
DEPOT 2	0+00.00	6+39.11	639	0.12
DEPOT 2-1	0+00.00	3+08.91	309	0.06
DEPOT 2-2	0+00.00	3+29.85	330	0.06
PASSING SIDING	0+00.00	3+92.74	393	0.07
TOTAL LENGTH ALONG CL			**51,166**	9.7





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REV NO	DATE	DESCRIPTION
1	210730	REVISED
2	211217	REVISED

DRAWN DC
CHECKED BR
APPROVED BR

SHEET TITLE: HORIZONTAL ALIGNMENT LAYOUT
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-LAY-01 REV. 2 211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. LAY-01
DATE 2021-12-17
SCALE 1: 40
SHEET # OF #
REVISION NO. 2

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Plot Date: 2021/12/14

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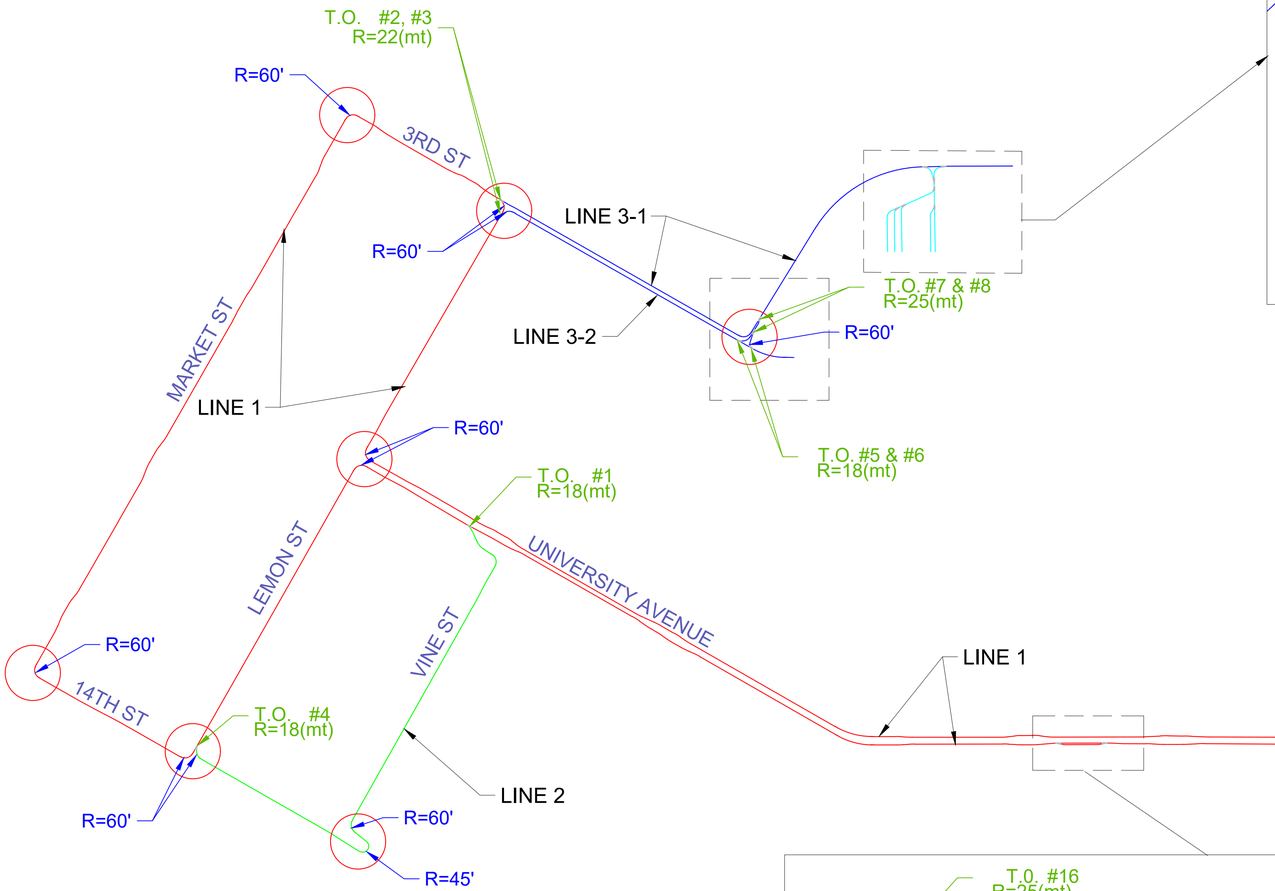
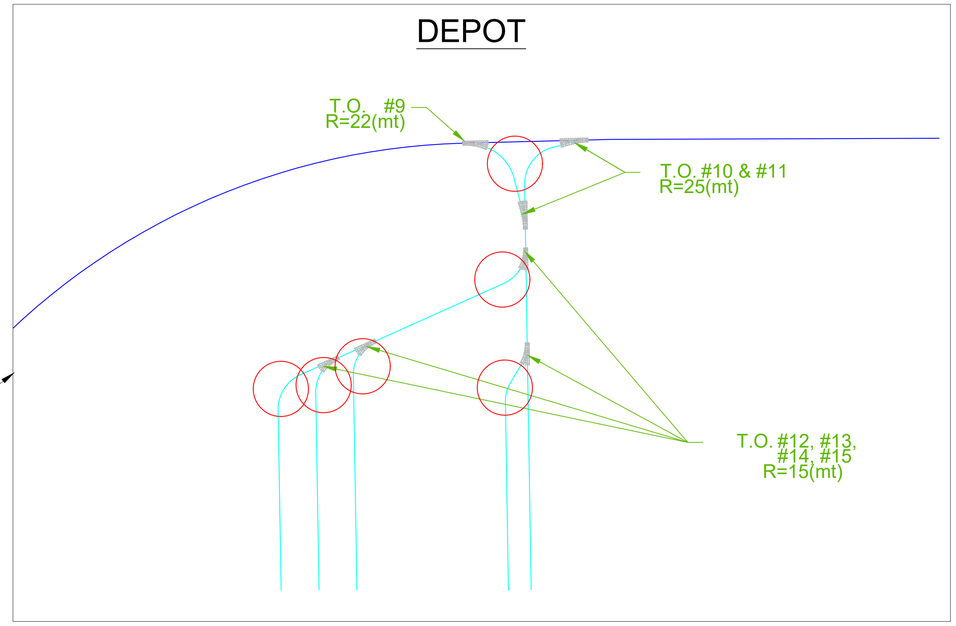
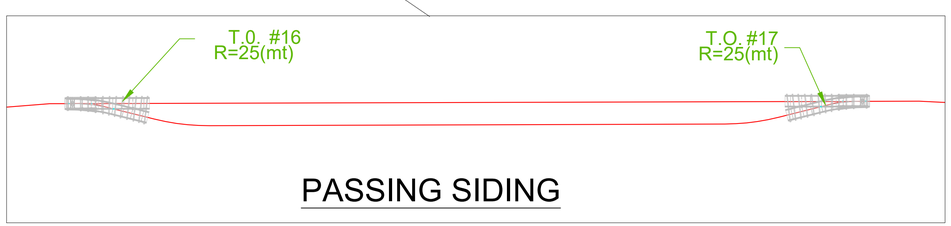
Plot Date: 2021/12/14
D:\2 PROJECTS\CALIFORNIA\TIG-M\RIVERSIDE\A. Track Design Plans\20210730_Rev02\8-9_LAY-01_LAY-04_Geom Info_Data.dwg

LOCATION WHERE CURVES
HAVE A RADIUS LESS THAN 100'







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REV NO	DATE	DESCRIPTION
1	210730	REVISED
2	211217	REVISED

SHEET TITLE: CURVES LESS THAN 100'
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-LAY-02
REV. 2
211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. LAY-02

DATE	2021-12-17
SCALE	1: 40
SHEET	# OF #
REVISION NO.	2

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HORIZONTAL GEOMETRY DATA TABLE - LINE 1

Number	Type	Length	Radius	Direction	Start Station	End Station	Delta angle	Chord length	Chord Direction	NORTING	EASTING	External Tangent	PI Station	Degree of Curvature by	PI Point	Spiral Definition	Total X	Total Y	Short tan	Long tan	P	K
1	Line	176.164'		S62° 15' 16.44"E	100+00.00'	101+76.16'				(6222207.5848',2301898.4011',0.0000')	(6222363.4945',2301816.9888',0.0000')											
2	Line	110.699'		S60° 13' 45.35"E	101+76.16'	102+86.86'				(6222263.4945',2301816.9888',0.0000')	(6222482.4321',2301748.3535',0.0000')											
3	Curve	52.596'	500.000'		102+86.86'	103+39.46'	006.0271 (d)	52.572'	S63° 14' 34.15"E	(6222482.7438',2301748.9716',0.0000')		26.322'	103+13.19'	011.4592 (d)	(6222482.4321',2301748.3535')							
4	Line	41.939'		S66° 13' 22.94"E	103+39.46'	103+81.40'				(6222482.4321',2301748.3535',0.0000')	(6222569.0149',2301710.2675',0.0000')											
5	Curve	52.606'	500.000'		103+81.40'	104+34.01'	006.0282 (d)	52.582'	S63° 14' 32.14"E	(6222568.7031',2301709.6490',0.0000')		26.327'	104+07.73'	011.4592 (d)	(6222569.0149',2301710.2675')							
6	Line	861.648'		S66° 13' 41.33"E	104+34.01'	112+95.65'				(6222569.0149',2301710.2675',0.0000')	(6223364.8055',2301255.0329',0.0000')											
7	Curve	57.611'	650.000'		112+95.65'	113+53.26'	005.0782 (d)	57.592'	S57° 41' 20.49"E	(6223364.4640',2301254.4931',0.0000')		28.824'	113+24.48'	008.8147 (d)	(6223364.8055',2301255.0329')							
8	Line	47.652'		S55° 08' 59.64"E	113+53.26'	114+00.92'				(6223364.8055',2301255.0329',0.0000')	(6223447.3540',2301197.5531',0.0000')											
9	Curve	48.203'	650.000'		114+00.92'	114+48.12'	004.2490 (d)	48.192'	S57° 16' 27.76"E	(6223447.5957',2301197.9292',0.0000')		24.112'	114+25.03'	008.8147 (d)	(6223447.3540',2301197.5531')							
10	Line	42.206'		S59° 23' 55.88"E	114+48.12'	114+91.33'				(6223447.3540',2301197.5531',0.0000')	(6223524.2587',2301152.0697',0.0000')											
11	Curve	46.037'	600.000'		114+91.33'	115+37.36'	004.3962 (d)	46.026'	S57° 12' 02.68"E	(6223524.0196',2301151.6983',0.0000')		23.030'	115+14.35'	009.5493 (d)	(6223524.2587',2301152.0697')							
12	Line	42.091'		S55° 00' 09.48"E	115+37.36'	115+79.45'				(6223524.2587',2301152.0697',0.0000')	(6223598.2307',2301100.2790',0.0000')											
13	Curve	50.316'	500.000'		115+79.45'	116+29.77'	005.7658 (d)	50.294'	S57° 55' 07.83"E	(6223598.5675',2301100.8157',0.0000')		25.179'	116+04.63'	011.4592 (d)	(6223598.2307',2301100.2790')							
14	Line	67.814'		S60° 46' 06.19"E	116+29.77'	116+97.58'				(6223598.1307',2301100.2790',0.0000')	(6223702.0152',2301042.2006',0.0000')											
15	Curve	51.835'	550.000'		116+97.58'	117+49.42'	005.3999 (d)	51.816'	S63° 28' 05.98"E	(6223702.2885',2301042.7475',0.0000')		25.937'	117+23.52'	010.4174 (d)	(6223702.0152',2301042.2006')							
16	Line	38.679'		S66° 10' 05.78"E	117+49.42'	117+88.10'				(6223702.0152',2301042.2006',0.0000')	(6223785.3083',2301005.4111',0.0000')											
17	Curve	52.822'	500.000'		117+88.10'	118+40.92'	006.0530 (d)	52.798'	S63° 08' 30.36"E	(6223784.9878',2301004.7881',0.0000')		26.436'	118+14.53'	011.4592 (d)	(6223785.3083',2301005.4111')							
18	Line	507.781'		S60° 06' 54.94"E	118+40.92'	123+48.70'				(6223785.3083',2301005.4111',0.0000')	(6224248.4851',2300739.2339',0.0000')											
19	Line	574.446'		S60° 06' 36.28"E	123+48.70'	129+23.15'				(6224248.4851',2300739.2339',0.0000')	(6224875.0667',2300579.0801',0.0000')											
20	Spiral-Curve-Spiral	30.000'			129+23.15'	129+53.15'	001.7189 (d)									Clothoid	29.997'	0.300'	10.001'	20.001'	0.075'	15.000'
20	Spiral-Curve-Spiral	230.445'	500.000'		129+53.15'	131+83.59'	026.4071 (d)	228.411'	S75° 01' 56.91"E			117.309'	130+70.45'	011.4592 (d)	(6224876.0874',2300382.8979')							
20	Spiral-Curve-Spiral	30.000'			131+83.59'	132+13.59'	001.7189 (d)									Clothoid	29.997'	0.300'	10.001'	20.001'	0.075'	15.000'
21	Line	148.990'		S89° 57' 17.56"E	132+13.59'	133+62.58'				(6224875.0667',2300379.0801',0.0000')	(6225196.2440',2300378.8271',0.0000')											
22	Curve	47.821'	750.000'		133+62.58'	134+10.40'	003.6533 (d)	47.813'	N 88° 13' 06.59"E	(6225196.2321',2300379.2080',0.0000')		23.910'	133+86.50'	007.6394 (d)	(6225196.2440',2300378.8271')							
23	Line	34.083'		N 86° 23' 30.74"E	134+10.40'	134+44.49'				(6225196.2440',2300378.8271',0.0000')	(6225277.3695',2300383.9427',0.0000')											
24	Curve	46.554'	750.000'		134+44.49'	134+91.04'	003.5565 (d)	46.547'	N 88° 10' 12.41"E	(6225277.3810',2300383.5815',0.0000')		23.285'	134+67.77'	007.6394 (d)	(6225277.3695',2300383.9427')							
25	Line	610.426'		N 86° 56' 54.08"E	134+91.04'	141+01.47'				(6225277.3695',2300383.9427',0.0000')	(6225930.3959',2300384.5313',0.0000')											
26	Curve	38.625'	800.000'		141+01.47'	141+40.09'	002.7663 (d)	38.621'	S88° 40' 06.58"E	(6225930.3905',2300384.2982',0.0000')		19.316'	141+20.78'	007.1620 (d)	(6225930.3959',2300384.5313')							
27	Line	55.060'		S87° 17' 07.23"E	141+40.09'	141+95.15'				(6225930.3959',2300384.5313',0.0000')	(6226024.3246',2300380.0776',0.0000')											
28	Curve	39.310'	950.000'		141+95.15'	142+34.46'	002.3708 (d)	39.307'	S88° 24' 16.76"E	(6226024.3282',2300382.2809',0.0000')		19.658'	142+14.81'	006.0311 (d)	(6226024.3246',2300380.0776')							
29	Line	63.827'		S89° 39' 22.28"E	142+34.46'	142+98.29'				(6226024.3246',2300380.0776',0.0000')	(6226133.2861',2300379.4238',0.0000')											
30	Curve	50.927'	600.000'		142+98.29'	143+49.21'	004.8632 (d)	50.912'	N 87° 54' 43.98"E	(6226133.2664',2300379.9642',0.0000')		25.479'	143+23.77'	009.5493 (d)	(6226133.2861',2300379.4238')							
31	Line	114.999'		N 89° 28' 50.24"E	143+49.21'	144+64.21'				(6226133.2861',2300379.4238',0.0000')	(6226273.3267',2300390.4929',0.0000')											
32	Line	385.378'		N 89° 50' 17.20"E	144+64.21'	148+49.59'				(6226273.3267',2300390.4929',0.0000')	(6226658.7034',2300391.9818',0.0000')											
33	Line	89.275'		S87° 11' 24.18"E	148+49.59'	149+38.87'				(6226658.7034',2300391.9818',0.0000')	(6226747.8707',2300387.2052',0.0000')											
34	Line	155.782'		S89° 52' 52.55"E	149+38.87'	150+94.65'				(6226747.8707',2300387.2052',0.0000')	(6226927.3645',2300386.5024',0.0000')											
35	Curve	47.437'	850.000'		150+94.65'	151+42.08'	003.1976 (d)	47.431'	S88° 16' 56.93"E	(6226927.3645',2300386.5024',0.0000')		23.725'	151+18.37'	006.7407 (d)	(6226927.3744',2300386.8332')							
36	Line	32.593'		S86° 41' 01.33"E	151+42.08'	151+74.68'				(6226927.3744',2300386.8332',0.0000')	(6227006.3250',2300382.2584',0.0000')											
37	Curve	45.520'	850.000'		151+74.68'	152+20.20'	003.0684 (d)	45.513'	S88° 13' 04.43"E	(6227006.3345',2300382.5631',0.0000')		22.766'	151+97.44'	006.7407 (d)	(6227006.3250',2300382.2584')							
38	Line	99.511'		S88° 45' 07.52"E	152+20.20'	153+19.71'				(6227006.3250',2300382.2584',0.0000')	(6227145.1918',2300381.6576',0.0000')											
39	Curve	45.175'	1000.000'		153+19.71'	153+58.88'	002.5883 (d)	45.171'	N 88° 57' 13.49"E	(6227145.1871',2300381.9127',0.0000')		22.591'	153+36.30'	005.7296 (d)	(6227145.1918',2300381.6576')							
40	Line	99.067'		N87° 39' 34.50"E	153+58.88'	154+57.95'				(6227145.1918',2300381.6576',0.0000')	(6227290.2241',2300387.5851',0.0000')											
41	Curve	46.982'	1000.000'		154+57.95'	155+04.93'	002.6919 (d)	46.978'	N 89° 00' 19.85"E	(6227290.2288',2300387.3092',0.0000')		23.495'	154+81.44'	005.7296 (d)	(6227290.2241',2300387.5851')							
42	Line	831.917'		S88° 58' 54.79"E	155+04.93'	163+36.85'				(6227290.2241',2300387.5851',0.0000')	(6228172.6564',2300382.1723',0.0000')											
43	Curve	53.927'	300.000'		163+36.85'	163+90.77'	010.2993 (d)	53.855'	S88° 29' 56.00"E	(6228172.5399',2300380.9621',0.0000')		27.036'	163+63.88'	019.0986 (d)	(6228172.6564',2300382.1723')							
44	Line	49.466'		S79° 20' 57.22"E	163+90.77'	164+40.24'				(6228172.6564',2300382.1723',0.0000')	(6228274.7545',2300362.9715',0.0000')											
45	Curve	54.620'	300.000'		164+40.24'	164+94.86'	010.4316 (d)	54.544'	S84° 57' 54.10"E	(6228274.8726',2300364.2137',0.0000')		27.386'	164+67.63'	019.0986 (d)	(6228274.7545',2300361.9715')							
46	Line	56.066'		S86° 46' 50.98"E	164+94.86'	165+50.93'				(6228274.7545',2300362.9715',0.0000')	(6228383.8743',2300362.5541',0.0000')											
47	Curve	51.214'	300.000'		165+50.93'	166+02.14'	009.7811 (d)	51.151'	N 85° 19' 43.11"E	(6228383.7852',2300363.6466',0.0000')		25.669'	165+76.60'	019.0986 (d)	(6228383.8743',2300362.5541')							
48	Line	57.288'		N80° 26' 17.19"E	166+02.14'	166+59.43'				(6228383.8743',2300362.5541',0.0000')	(6228492.7124',2300380.8883',0.0000')											
49	Curve	54.676'	300.000'		166+59.43'	167+14.10'	010.4424 (d)	54.601'	N 85° 39' 33.52"E	(6228492.8070',2300379.6419',0.0000')		27.414'	166+86.84'	019.0986 (d)	(6228492.7124',2300380.8883')							
50	Line	171.166'		S89° 07' 10.15"E	167+14.10'	168+85.27'				(6228492.7124',2300380.8883',0.0000')	(6228691.2686',2300377.8366',0.0000')											
51	Line	1143.292'		S89° 36' 54.23"E	168+85.27'	180+28.56'				(6228691.2686',2300377.8366',0.0000')	(6229854.7767',2300370.0196',0.0000')											
52	Curve	40.439'	350.000'		180+28.56'	180+69.00'	006.6199 (d)	40.416'	S86° 18' 18.33"E	(6229854.7390',2300369.4359',0.0000')		20.242'	180+48.80'	016.3702 (d)	(6229854.7767',2300370.0196')							
53	Line	39.943'		S82° 59' 42.43"E	180+69.00'	181+08.94'				(6229854.7767',2300370.0196',0.0000')	(6229934.6957',2300360.1998',0.0000')											
54	Curve	40.625'	350.000'		181+08.94'	181+49.57'	006.6504 (d)	40.602'	S86° 19' 13.11"E	(6229934.7336',2300360.7889',0.0000')		20.335'	181+29.28'	016.3702 (d)	(6229934.6957',2300360.1998')							
55	Line	141.535'		S89° 18' 43.79"E	181+49.57'	182+91.10'				(6229934.6957',2300360.1998',0.0000')	(6230126.6060',2300359.0124',0.0000')											
56	Curve	60.059'	800.000'		182+91.10'	183+51.16'	004.3014 (d)	60.045'	N 88° 12' 13.65"E	(6230126.5883',2300359.5761',0.0000')		30.044'	183+21.15'	007.1620 (d)	(6230126.6060',2300359.0124')							
57	Line	51.624'		N88° 03' 11.09"E	183+51.16'	184+02.79'				(6230126.6060',2300359.0124',0.0000')	(6230238.4064',2300366.7262',0.0000')											
58	Curve	60.767'	800.000'		184+02.79'	184+63.55'	004.3521 (d)	60.753'	N 88° 13' 44.96"E	(6230238.4245',2300366.1491',0.0000')		30.398'	184+33.19'	007.1620 (d)	(6230238.4064',2300366.7262')							
59	Line	311.377'		S85° 35' 41.18"E	184+63.55'	187+74.93'				(6230238.4064',2300366.7262',0.0000')	(6230580.1736',2300364.3090',0.0000')											
60	Line	255.009'		S87° 18' 01.92"E	187+74.93'	190+29.94'				(6230580.1736',2300364.3090',0.0000')	(6230834.9000',2300352.3000',0.0000')											
61	Line	448.082'		S89° 35' 27.20"E	190+29.94'	194+78.02'				(6230834.9000',2300352.3000',0.0000')	(6231182.9709',2300349.1006',0.0000')											
62	Line	184.475'		S88° 20' 19.06"E	194+78.02'	196+62.50'				(6231182.9709',2300349.1006',0.0000')	(6231467.3688',2300343.7522',0.0000')											
63	Line	161.762'		S88° 54' 55.32"E	196+62.50'	198+24.26'				(6231467.3688',2300343.7522',0.0000')	(6231629.1266',2300342.5722',0.0000')											
64	Line	175.974'		N88° 43' 23.56"E	198+24.26'	200+00.24'				(6231629.1266',2300342.5722',0.0000')	(6231805.0564',2300346.4935',0.0000')											
65	Line	117.815'		S89° 12' 40.32"E	200+00.24'	201+18.05'				(6231805.0564',2300346.4935',0.0000')	(6231932.8605',2300346.4935',0.0000')											
66	Line	413.596'		S88° 39' 20.05"E	201+18.05'	205+31.65'				(6231932.8605',2300344.8713',0.0000')	(6232376.6591',2300334.2211',0.0000')											
67	Curve	80.480'	500.000'		205+31.65'	206+12.13'	009.2224 (d)	80.393'	N 86° 43' 59.70"E	(6232376.5666',2300335.8421',0.0000')		40.327'	205+71.97'	011.4592 (d)	(6232376.6591',2300334.2211')							
68	Line	59.835'		N82° 07' 19.45"E	206+12.13'	206+71.96'				(6232376.6591',2300334.2211',0.0000')	(6232515.0455',2300353.3695',0.0000')											
69	Curve	78.920'	500.000'		206+71.96'	207+50.88'	009.0436 (d)	78.838'	N 86° 38' 57.85"E	(6232515.1368',2300351.8130',0.0000')		39.542'	207+11.50'	011.4592 (d)	(6232515.0455',2300353.3695')							
70	Line	329.643'		S88° 50' 03.74"E	207+50.88'	210+80.52'				(6232515.0455',2300353.3695',0.0000')	(6232884.1537',2300345.8595',0.0000')											
71	Line	103.141'		S87° 24' 20.06"E	210+80.52'	211+83.67'				(6232884.1537',2300345.8595',0.0000')	(6232987.1892',2300341.1905',0.0000')											
72	Line	675.416'		S88° 40' 31.25"E	211+83.67'	218+59.08'				(6232987.1892',2300341.1905',0.0000')	(6233662.4249',2300325.5766',0.0000')											
73	Line	184.599'		S88° 23' 30.55"E	218+59.08'	220+43.68'				(6233662.4249',2300325.5766',0.0000')	(6233847.0132',2300323.6172',0.0000')											
74	Curve	188.504'	60.000'		220+43.68'	222+32.19'	180.0282 (d)	120.000'	N 00° 36' 14.61"E	(6233907.6467',2300282.9812',0.0000')		#33620.463'	-81+76.83'	095.4930 (d)	(5400273.4636',2309172.1406')							
75	Line	188.926'		N 89° 24' 00.24"W	222+32.19'	224+21.11'				(6233844.2783',2300243.6105',0.0000')	(6233603.2019',2300446.1767',0.0000')											
76	Spiral-Curve-Spiral	30.000'			224+21.11'	224+51.11'	005.7296 (d)									Clothoid	29.970'	0.999'	10.010'	20.017'	0.250'	14.995'
76	Spiral-Curve-Spiral	50.231'	150.000'		224+51.11'	225+01.34'	019.1868 (d)	49.997'	S75° 16' 37.02"W			25.353'	224+76.46'	038.1972 (d)	(6233604.1322',2300441.6365')							
76	Spiral-Curve-Spiral	30.000'			225+01.34'	225+31.34'	005.7296 (d)									Clothoid	29.970'	0.999'	10.010'	20.017'	0.250'	14.995'
77	Line	34.680'		S59° 57' 14.28"W	225+31.34'	225+66.02'				(6233603.2019',2300446.1767',0.0000')	(6233475.4907',2300372.3058',0.0000')											
78	Spiral-Curve-Spiral	30.000'			225+66.02'	225+96.02'	005.7296 (d)															
78	Spiral-Curve-Spiral	51.214'	150.000'		225+96.02'	226+47.24'	019.5622 (d)	50.965'	S75° 27' 52.73"W			25.859'	226+21.88'	038.1972 (d)	(6233474.5581',2300375.9031')							
78	Spiral-Curve-Spiral	30.000'			226+47.24'	226+77.24'	005.7296 (d)									Clothoid	29.970'	0.999'	10.010'	20.017'	0.250'	14.995'
79	Line	143.592'		N 89° 01' 28.82"W	226+77.24'	228+20.83'				(6233475.4907',2300372.3058',0.0000')	(6233250.1042',2300376.1429',0.0000')											
80	Curve	50.251'	800.000'		228+20.83'	228+71.08'	003.5990 (d)	50.243'	S89° 10' 33.01"W	(6233250.1099',2300375.7482',0.0000')		25.134'	228+45.96'	007.1620 (d)	(6233250.1042',2300376.1429')							
81	Line	89.263'		S87° 22' 34.84"W	228+71.08'	229+60.34'				(6233250.1042',2300376.1429',0.0000')	(6233109.4394',2300369.6971',0.0000')											
82	Curve	52.811'	800.000'		229+60.34'	230+13.15'	003.7823 (d)	52.802'	S89° 16' 03.02"W	(6233109.4339',2300370.1331',0.0000')		26.415'	229+86.76'	007.1620 (d)	(6233109.4394',2300369.6971')							
83	Line	104.487'		N 88° 50' 28.81"W	230+13.15'	231+17.64'				(6233109.4394',2300369.6971',0.0000')	(6232978.5639',2300372.3441',0.0000')											
84	Line	112.885'		N 88° 08' 06.74"W	231+17.64'	232+30.53'				(6232978.5639',2300372.3441',0.0000')	(6232865.7387',2300376.0175',0.0000')											
85	Line	409.239'		N 88° 30' 15.22"W	232+30.53'	236+33.77'				(6232865.7387',2300376.0175',0.0000')	(6232438.8574',2300387.1643',0.0000')											
86	Curve	47.564'	900.000'		236+33.77'	236+81.33'	003.0280 (d)	47.558'	N 86° 59' 24.84"W	(6232438.8739',2300387.4781',0.0000')		23.787'	236+57.55'	006.3662 (d)	(6232438.8574',2300387.1643')							
87	Line	85.102'		N 85° 28' 54.45"W	236+81.33'	237+66.43'				(6232438.8574',2300387.1643',0.0000')	(6232297.8346',2300398.5219',0.0000')											
88	Curve	65.119'	900.000'		237+66.43'	238+31.55'	004.1456 (d)	65.105'	N 87° 32' 56.56"W	(6232297.8094',2300397.7331',0.0000')		32.574'	237+99.01'	006.3662 (d)	(6232297.8346',2300398.5219')							
89	Line	311.596'		N 89° 37' 18.67"W	238+31.55'	241+43.15'				(6232297.8346',2300398.5219',0.0000')	(6231924.1577',2300400.7881',0.0000')											
90	Curve	58.962'	500.000'		241+43.15'	242+02.11'	006.7566 (d)	58.928'	N 86° 14' 36.79"W	(6231924.2147',2300401.6567',0.0000')		29.515'	241+72.66'	011.4592 (d)	(6231924.1577',2300400.7881')							
91	Line	62.412'		N82° 51' 54.91"W	242+02.11'	242+64.52'				(6231924.1577',2300400.7881',0.0000')	(6231803.3733',2300415.9070',0.0000')											
92	Curve	59.529'	500.000'		242+64.52'	243+24.05'	006.8215 (d)	59.494'	N 86° 16' 33.66"W	(6231808.3156',2300415.0217',0.0000')		29.800'	242+94.32'	011.4592 (d)	(6231803.3733',2300415.9070')							
93	Line	188.723'		N 89° 41' 12.42"W	243+24.05'	245+12.77'				(6231808.3733',2300415.9070',0.0000')	(6231558.7469',2300417.2445',0.0000')											
94	Curve	52.167'	500.000'		245+12.77'	245+64.94'	005.9780 (d)	52.144'	S87° 19' 27.27"W	(6231558.7787',2300418.5639',0.0000')		26.107'	245+38.88'	011.4592 (d)	(6231558.7469',2300417.2445')							
95	Line	79.980'		S84° 20' 06.95"W	245+64.94'	246+44.92'				(6231558.7469',2300417.2445',0.0000')	(6231426.0999',2300404.0868',0.0000')											
96	Curve	54.368'	500.000'		246+44.92'	246+99.29'	006.2301 (d)	54.341'	S87° 27' 01.20"W	(6231426.0670',2300404.8260',0.0000')		27.211'	246+72.13'	011.4592 (d)	(6231426.0999',2300404.0868')							
97	Line	115.996'		N 89° 26' 04.56"W	246+99.29'	248+15.28'				(6231426.0999',2300404.0868',0.0000')	(6231182.9000',2300405.5000',0.0000')											
98	Line	328.453'		N 89° 01' 23.55"W	248+15.28'	251+43.74'				(6231182.9000',2300405.5000',0.0000')	(6230954.4947',2300411.0991',0.0000')											
99	Line	358.620'		S89° 19' 08.09"W	251+43.74'	255+02.34'				(6230954.4947',2300411.0991',0.0000')	(6230595.9167',2300406.8366',0.0000')											
100	Line	607.464'		N 89° 13' 00.35"W	255+02.34'	261+09.80'				(6230595.9167',2300406.8366',0.0000')	(6229960.5375',2300415.5228',0.0000')											
101	Curve	55.890'	500.000'		261+09.80'	261+65.69'	006.4045 (d)	55.861'	N 86° 00' 52.16"W	(6229960.5919',2300416.3029',0.0000')		27.974'	261+37.78'	011.4592 (d)	(6229960.5375',2300415.5228')							
102	Line	46.905'		N 82° 48' 43.98"W	261+65.69'	262+12.60'				(6229960.5375',2300415.5228',0.0000')	(6229857.5411',2300418.5120',0.0000')											
103	Curve	57.801'	500.000'		262+12.60'	262+70.42'	006.6235 (d)	57.769'	N 86° 07' 26.30"W	(6229857.4845',2300417.6775',0.0000')		28.933'	262+41.53'	011.4592 (d)	(6229857.5411',2300418.5120')							
104	Line	95.126'		N 89° 26' 08.65"W	262+70.42'	263+65.55'				(6229857.5411',2300418.5120',0.0000')	(6229706.8208',2300429.9964',0.0000')											
105	Curve	53.287'	500.000'		263+65.55'	264+18.81'	006.1062 (d)	53.262'	S87° 30' 40.13"W	(6229706.8512',2300429.2862',0.0000')		26.669'	263+92.20'	011.4592 (d)	(6229706.8208',2300429.9964')							
106	Line	55.409'		S84° 27' 28.88"W	264+18.81'	264+74.22'				(6229706.8208',2300429.9964',0.0000')	(6229597.8261',2300419.4208',0.0000')											
107	Curve	54.803'	500.000'		264+74.22'	265+29.03'	006.2800 (d)	54.776'	S87° 35' 52.90"W	(6229597.7945',2300420.1719',0.0000')		27.429'	265+01.65'	011.4592 (d)	(6229597.8261',2300419.4208')							
108	Line	284.463'		N 89° 15' 43.08"W	265+29.03'	268+13.49'				(6229597.8261',2300419.4208',0.0000')	(6229285.9594',2300423.4382',0.0000')											
109	Line	376.849'		N 88° 27' 05.09"W	268+13.49'	271+90.34'				(6229285.9594',2300423.4382',0.0000')	(6228909.2476',2300433.6224',0.0000')											
110	Line	205.409'		N 89° 33' 33.82"W	271+90.34'	273+95.75'				(6228909.2476',2300433.6224',0.0000')	(6228680.4645',2300436.2470',0.0000')											
111	Curve	46.756'	600.000'		273+95.75'	274+42.50'	004.4648 (d)	46.744'	N87° 06' 37.14"W	(6228680.4875',2300436.7022',0.0000')		23.390'	274+19.14'	009.5493 (d)	(6228680.4645',2300436.2470')							
112	Line	89.043'		N 84° 52' 40.46"W	274+42.50'	275+31.55'				(6228680.4645',2300436.2470',0.0000')	(6228544.9312',2300448.3957',0.0000')											
113	Curve	47.263'	600.000'		275+31.55'	275+78.81'	004.5183 (d)	47.251'	N87° 08' 04.35"W	(6228544.9078',2300447.9306',0.0000')		23.644'	275+55.19'	009.5493 (d)	(6228544.9312',2300448.3957')							
114	Line	65.693'		N 89° 23' 28.24"W	275+78.81'	276+44.50'				(6228544.9312',2300448.3957',0.0000')	(6228434.9566',2300449.5644',0.0000')											
115	Curve	41.225'	300.000'		276+44.50'	276+85.73'	007.8734 (d)	41.195'	S89° 40' 19.64"W	(6228434.9968',2300448.8560',0.0000')		20.645'	276+65.15'	019.0986 (d)	(6228434.9566',2300449.5644')							
116	Line	58.295'		S82° 44' 07.52"W	276+85.73'	277+44.02'				(6228434.9566',2300449.5644',0.0000')	(6228339.8926',2300437.4462',0.0000')											
117	Curve	33.749'	300.000'		277+44.02'	277+77.77'	006.4456 (d)	33.731'	S85° 57' 29.56"W	(6228339.8591',2300437.9203',0.0000')		16.892'	277+60.91'	019.0986 (d)	(6228339.8926',2300437.4462')							
118	Line	332.394'		S89° 10' 51.59"W	277+77.77'	281+10.17'				(6228339.8926',2300437.4462',0.0000')	(6227990.6422',2300432.4536',0.0000')											
119	Line	77.767'		N 89° 54' 26.95"W	281+10.17'	281+87.93'				(6227990.6422',2300432.4536',0.0000')	(6227912.8757',2300432.5792',0.0000')											
120	Line	563.577'		N 89° 53' 52.04"W	281+87.93'	287+51.51'				(6227912.8757',2300432.5792',0.0000')	(6227326.1959',2300433.6258',0.0000')											

Number	Type	Length	Radius	Direction	Start Station	End Station	Delta angle	Chord length	Chord Direction	NORTING	EASTING	External Tangent	PI Station	Degree of Curvature by	PI Point	Spiral Definition	Total X	Total Y	Short tan	Long tan	P	K
121	Curve	46.198'	1000.000'		287+51.51'	287+97.71'	002.6470 (d)	46.196'	N88° 14' 27.48"W	(6227326.2026',2300433.8925',0.0000')		23.103'	287+74.61'	005.7296 (d)	(6227326.1959',2300433.6258')							
122	Line	81.259'		N87° 15' 02.92"W	287+97.71'	288+78.97'				(6227326.1959',2300433.6258',0.0000')	(6227194.3384',2300439.9575',0.0000')											
123	Curve	55.289'	1500.000'		288+78.97'	289+34.26'	002.1119 (d)	55.286'	N88° 18' 24.30"W	(6227194.3387',2300439.7028',0.0000')		27.648'	289+06.61'	003.8197 (d)	(6227194.3384',2300439.9575')							
124	Line	105.065'		N89° 21' 45.68"W	289+34.26'	290+39.32'				(6227194.3387',2300439.7028',0.0000')	(6227033.8818',2300441.7424',0.0000')											
125	Curve	55.511'	900.000'		290+39.32'	290+94.83'	003.5339 (d)	55.502'	S88° 52' 13.27"W	(6227033.8818',2300441.3144',0.0000')		27.764'	290+67.08'	006.3662 (d)	(6227033.8718',2300441.7424')							
126	Line	101.121'		S87° 06' 12.22"W	290+94.83'	291+95.95'				(6227033.8718',2300441.7424',0.0000')	(6226880.6282',2300433.9886',0.0000')											
127	Curve	49.100'	1000.000'		291+95.95'	292+45.05'	002.8132 (d)	49.095'	S88° 30' 35.99"W	(6226880.6282',2300434.2899',0.0000')		24.555'	292+20.51'	005.7296 (d)	(6226880.6287',2300433.9886')							
128	Line	588.838'		S89° 54' 59.76"W	292+45.05'	298+34.89'				(6226880.6287',2300433.9886',0.0000')	(6226241.4619',2300433.0582',0.0000')											
129	Curve	49.485'	400.000'		298+34.89'	298+84.37'	007.0883 (d)	49.454'	N86° 32' 21.35"W	(6226241.5088',2300433.8233',0.0000')		24.774'	298+59.60'	014.3239 (d)	(6226241.4619',2300433.0582')							
130	Line	44.993'		N82° 59' 42.47"W	298+84.37'	299+29.37'				(6226241.4619',2300433.0582',0.0000')	(6226148.8412',2300444.4386',0.0000')											
131	Curve	47.035'	367.723'		299+29.37'	299+76.40'

HORIZONTAL GEOMETRY DATA TABLE- LINE 2

Number	Type	Length	Radius	Direction	Start Station	End Station	Delta angle	Chord length	Chord Direction	NORTING	EASTING	External T	PI Station	Degree of	PI Point	Spiral Definition	Total X	Total Y	Short tan	Long tan	P	K
1	Line	15.963'		S33° 32' 58.82"E	10+00.00'	10+15.96'				(6222207.5848',2301898.4011',0.0000')	(6222230.7028',2301863.5393',0.0000')											
2	Curve	51.607'	300.000'		10+15.96'	10+67.57'	009.8562 (d)	51.543'	S28° 37' 17.74"E	(6222229.7257',2301863.0061',0.0000')		25.867'	10+41.83	9',2301719.	019.0986 (d)							
3	Line	34.552'		S23° 41' 36.66"E	10+67.57'	11+02.12'				(6222230.7028',2301863.5393',0.0000')	(6222275.9188',2301760.5027',0.0000')											
4	Spiral-Curve-Spiral	25.000'			11+02.12'	11+27.12'	005.5092 (d)									Clothoid	24.977'	0.801'	8.341'	16.675'	0.200'	12.496'
4	Spiral-Curve-Spiral	51.777'	130.000'		11+27.12'	11+78.90'	022.8201 (d)	51.436'	S40° 36' 46.05"E			26.236'	11+53.36	9',2301849.	044.0737 (d)							
4	Spiral-Curve-Spiral	25.000'			11+78.90'	12+03.90'	005.5092 (d)									Clothoid	24.977'	0.801'	8.341'	16.675'	0.200'	12.496'
5	Line	42.779'		S57° 31' 55.43"E	12+03.90'	12+46.68'				(6222275.9188',2301760.5027',0.0000')	(6222417.2497',2301670.5761',0.0000')											
6	Spiral-Curve-Spiral	30.000'			12+46.68'	12+76.68'	014.3239 (d)									Clothoid	29.813'	2.489'	10.060'	20.066'	0.624'	14.969'
6	Spiral-Curve-Spiral	61.247'	60.000'		12+76.68'	13+37.93'	058.4868 (d)	58.623'	S13° 57' 52.91"E			33.593'	13+10.27	5',2301650.	095.4930 (d)							
6	Spiral-Curve-Spiral	30.000'			13+37.93'	13+67.93'	014.3239 (d)									Clothoid	29.813'	2.489'	10.060'	20.066'	0.624'	14.969'
7	Line	123.972'		S29° 36' 09.62"W	13+67.93'	14+91.90'				(6222417.2497',2301670.5761',0.0000')	(6222320.1299',2301499.6328',0.0000')											
8	Line	98.355'		S26° 52' 09.73"W	14+91.90'	15+90.25'				(6222320.1299',2301499.6328',0.0000')	(6222275.6777',2301411.8966',0.0000')											
9	Line	1774.781'		S29° 27' 07.17"W	15+90.25'	33+65.03'				(6222275.6777',2301411.8966',0.0000')	(6221370.2231',2299808.3775',0.0000')											
10	Spiral-Curve-Spiral	30.000'			33+65.03'	33+95.03'	014.3239 (d)									Clothoid	29.813'	2.489'	10.060'	20.066'	0.624'	14.969'
10	Spiral-Curve-Spiral	54.792'	60.000'		33+95.03'	34+49.82'	052.3223 (d)	52.908'	S11° 01' 59.20"E			29.473'	34+24.51	4',2299823.	095.4930 (d)							
10	Spiral-Curve-Spiral	30.000'			34+49.82'	34+79.82'	014.3239 (d)									Clothoid	29.813'	2.489'	10.060'	20.066'	0.624'	14.969'
11	Line	90.546'		S51° 31' 05.58"E	34+79.82'	35+70.37'				(6221370.2231',2299808.3775',0.0000')	(6221493.3314',2299710.5166',0.0000')											
12	Curve	135.961'	45.000'		35+70.37'	37+06.33'	173.1113 (d)	89.837'	S35° 02' 14.80"W	(6221502.1744',2299649.4553',0.0000')		747.662'	43+18.03	4',2299675.	127.3240 (d)							
13	Line	148.118'		N58° 24' 24.83"W	37+06.33'	38+54.45'				(6221441.7547',2299636.9597',0.0000')	(6221315.5895',2299714.5561',0.0000')											
14	Line	101.474'		N57° 11' 48.06"W	38+54.45'	39+55.92'				(6221315.5895',2299714.5561',0.0000')	(6221230.2971',2299769.5303',0.0000')											
15	Line	1012.679'		N60° 13' 36.99"W	39+55.92'	49+68.60'				(6221230.2971',2299769.5303',0.0000')	(6220307.8355',2300297.2532',0.0000')											
16	Spiral-Curve	30.000'			49+68.60'	49+98.60'	014.3239 (d)									Clothoid	29.813'	2.489'	10.060'	20.066'	0.624'	14.969'
16	Spiral-Curve	49.025'	60.000'		49+98.60'	50+47.63'	046.8157 (d)	47.673'	N22° 29' 42.59"W			25.974'	50+24.58	8',2300332.	095.4930 (d)							
16	Spiral-Curve	0.000'																				
17	Line	28.689'		N00° 54' 45.60"E	50+47.63'	50+76.32'				(6220307.8355',2300297.2532',0.0000')	(6220308.8684',2300362.0873',0.0000')											

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5		
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SHEET TITLE: HORIZONTAL CURVE DATA - LINE 2

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-LAY-03 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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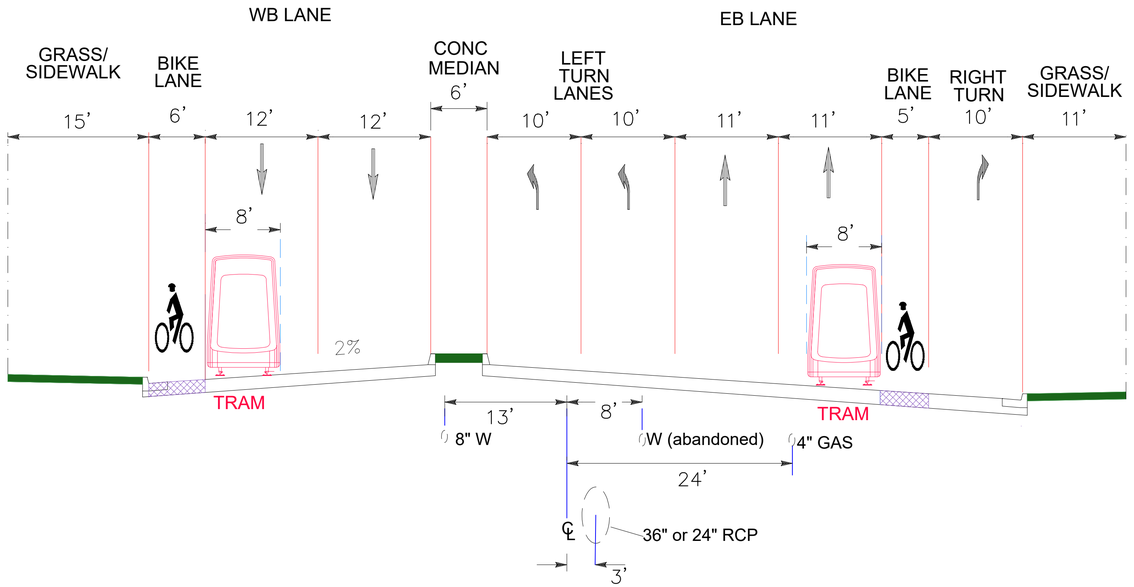
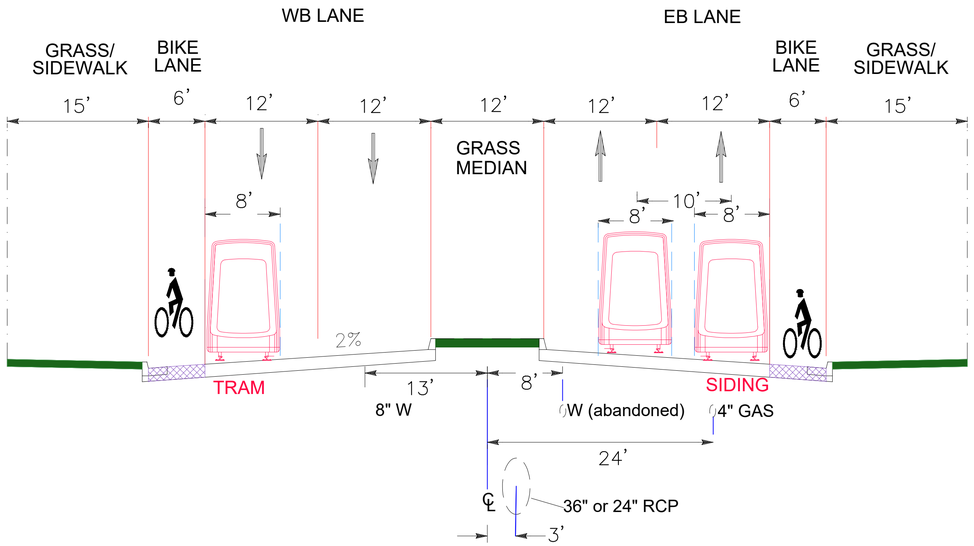


TYPICAL SECTION 1
UNIVERSITY AVENUE
TYPICAL INTERSECTION
(TRAM RUNS WB AND EB LANE)



TYPICAL SECTION 2
UNIVERSITY AVENUE
AT SIDING
(TRAM RUNS WB AND EB LANE)

Note:
1. Existing street dimensions need to be verified.
2. Existing utilities location are approximate.

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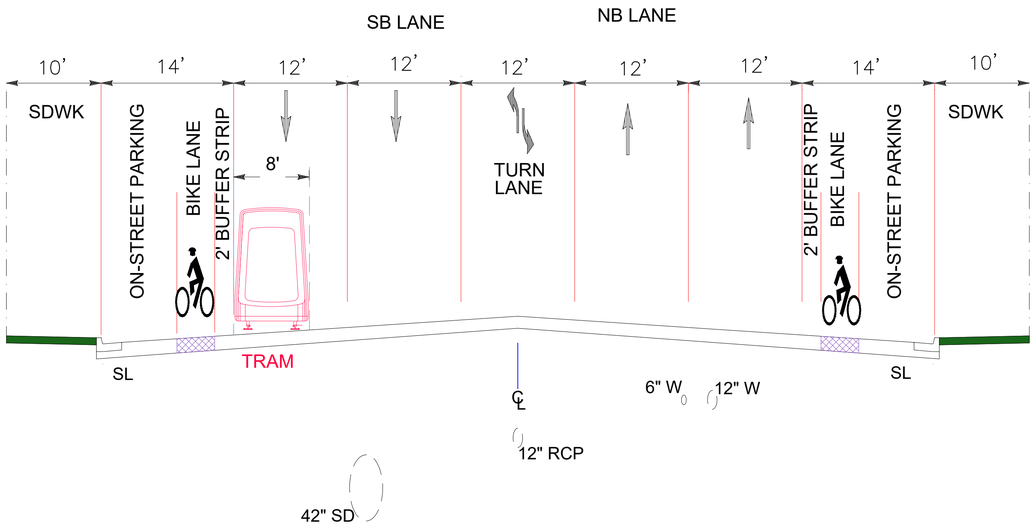
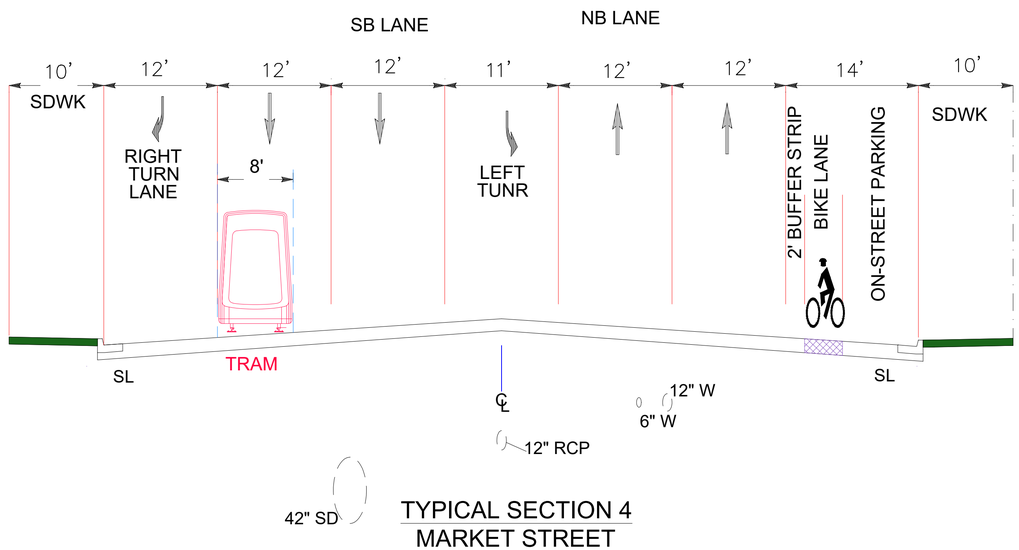


TYPICAL SECTION 3
MARKET STREET
(TRAM RUNS SB LANE)



TYPICAL SECTION 4
MARKET STREET
AT 14ST ST INTERSECTION
(TRAM RUNS SB LANE)

Note:
1. Existing street dimensions need to be verified.
2. Existing utilities location are approximate.

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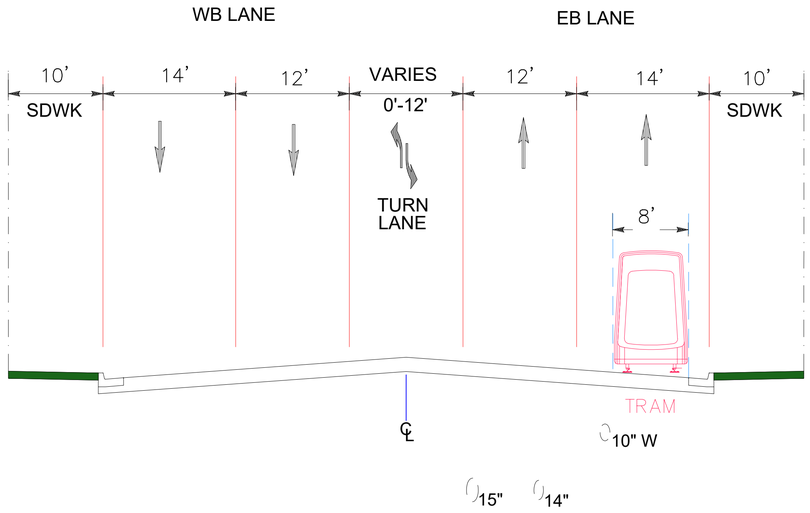
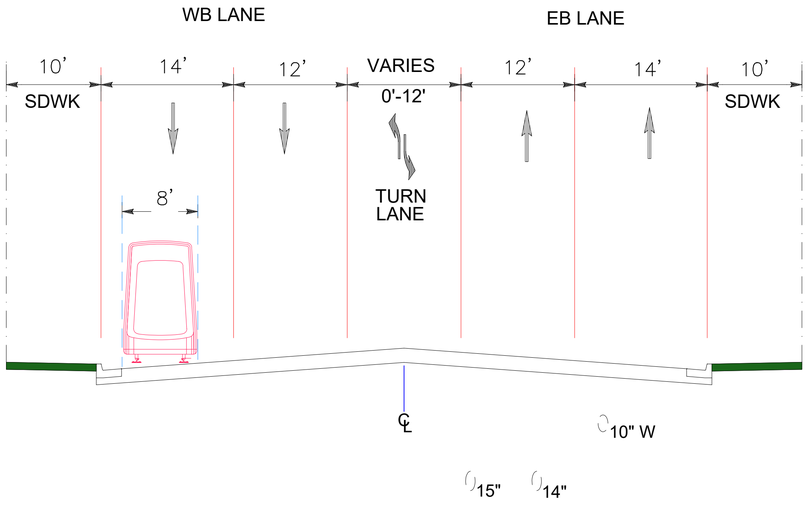


TYPICAL SECTION 5
14th STREET
FROM MARKET ST TO LEMON ST
(TRAM RUNS EB LANE)



TYPICAL SECTION 6
14th STREET
FROM VINE ST TO LEMON ST
(TRAM RUNS WB LANE)

Note:
1. Existing street dimensions need to be verified.
2. Existing utilities location are approximate.

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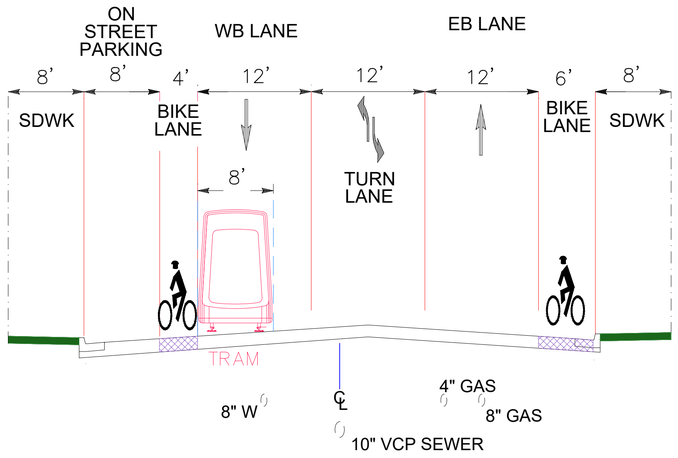
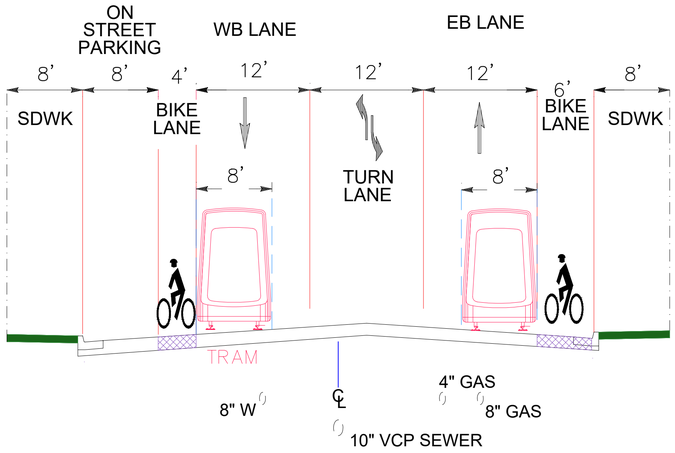
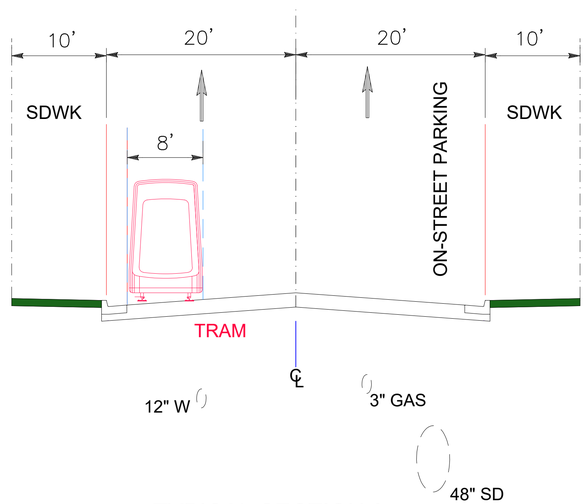


TYPICAL SECTION 7
3RD STREET
WEST OF LEMON STREET
(TRAM - WB LANE)

Note:
1. Existing street dimensions need to be verified.
2. Existing utilities location are approximate.



TYPICAL SECTION 8
3RD STREET
EAST OF LEMON STREET
(TRAM - WB LANE)



TYPICAL SECTION 9
LEMON STREET
(TRAM RUNS WB LANE)

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Plot Date: 2021/12/17

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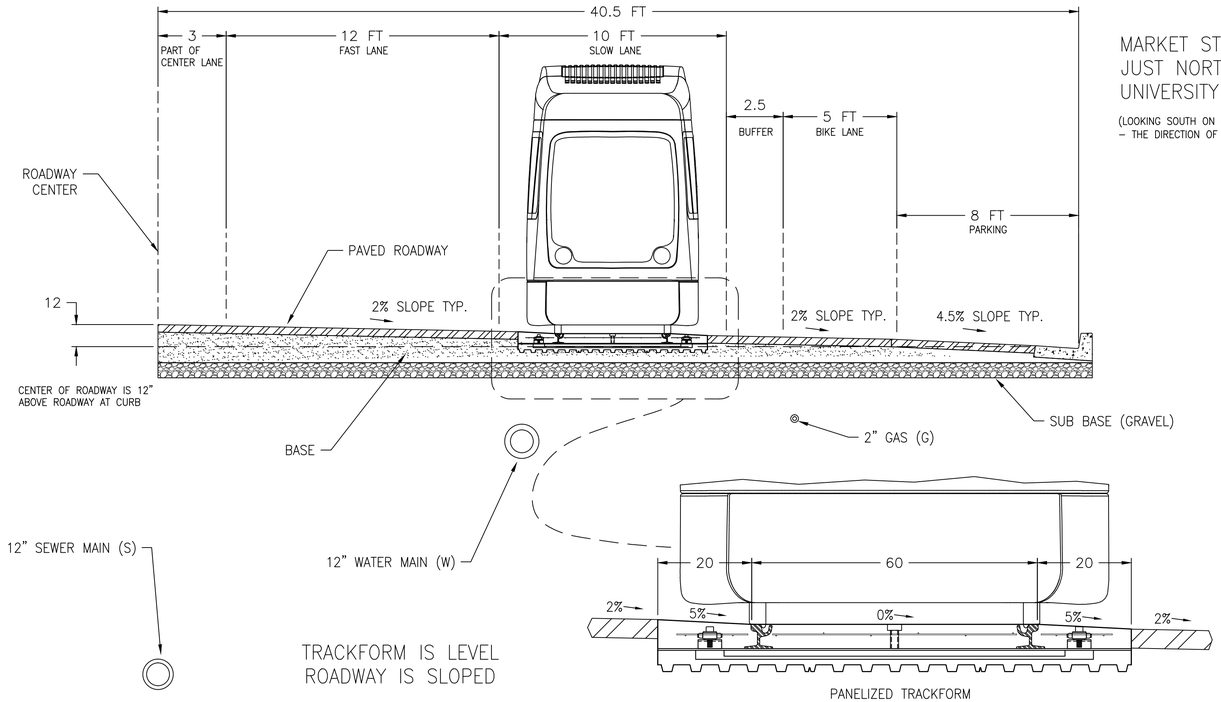


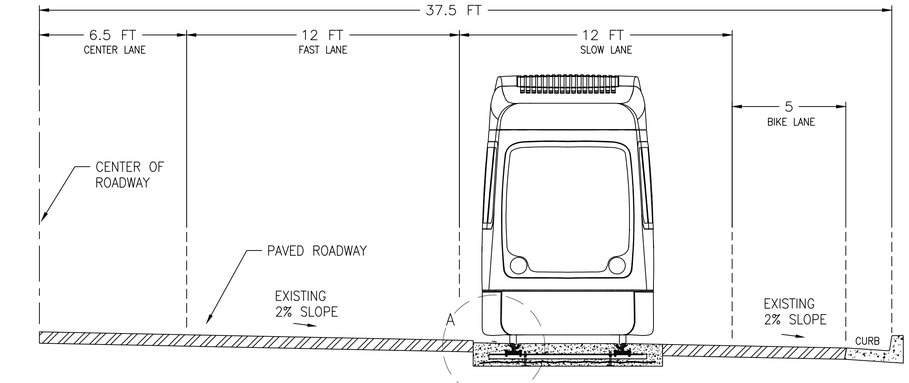
MARKET ST
JUST NORTH OF
UNIVERSITY AVE

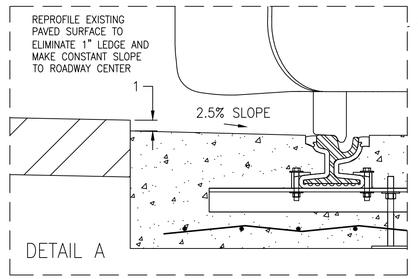
(LOOKING SOUTH ON MARKET – THE DIRECTION OF TRAVEL)

TRACKFORM IS LEVEL
ROADWAY IS SLOPED

PANELIZED TRACKFORM

IF FUNDS FOR PARTIAL ROADWAY REPAVING ARE AVAILABLE ROADWAY CAN BE REPROFILED TO ACHIEVE A CONSTANT SLOPE FROM CENTER OF ROADWAY TO STREETCAR RAIL

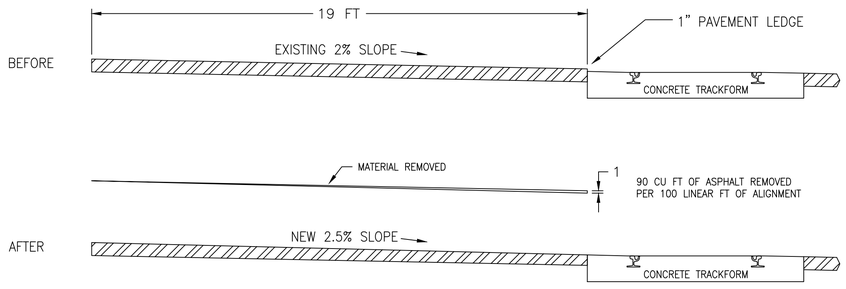


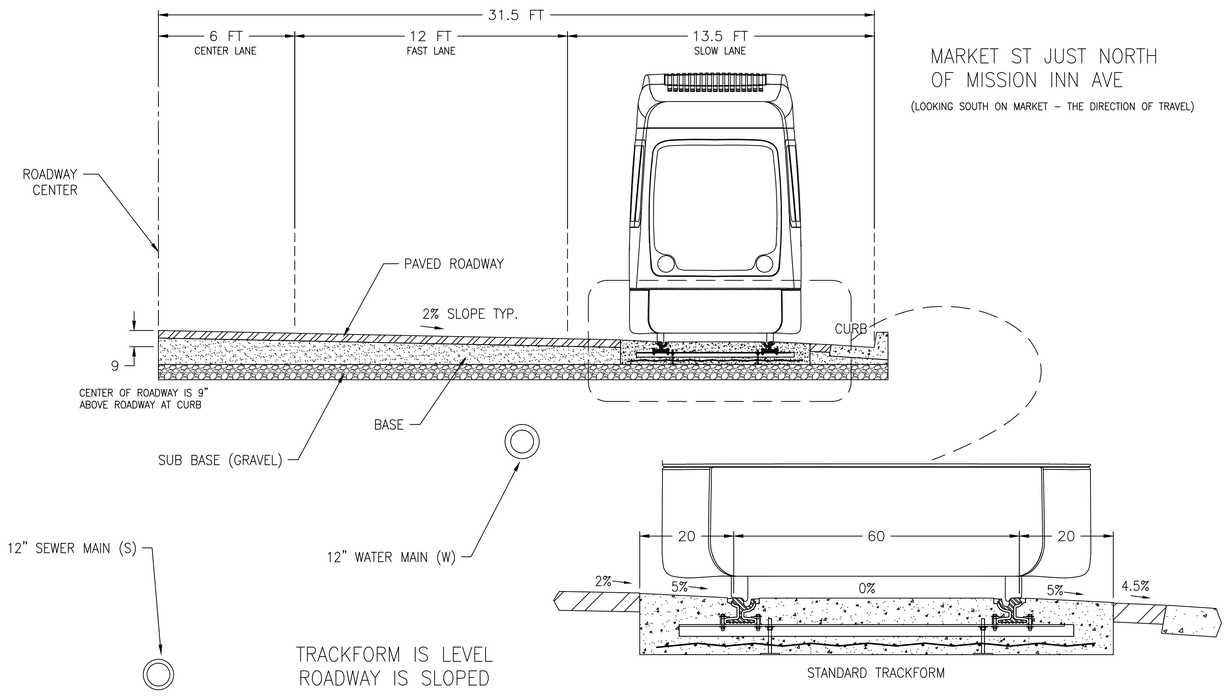


UNIVERSITY AVE JUST EAST OF CRANFORD AVE

(LOOKING EAST ON UNIVERSITY – THE DIRECTION OF TRAVEL)

REPROFILING ROADWAY SURFACE



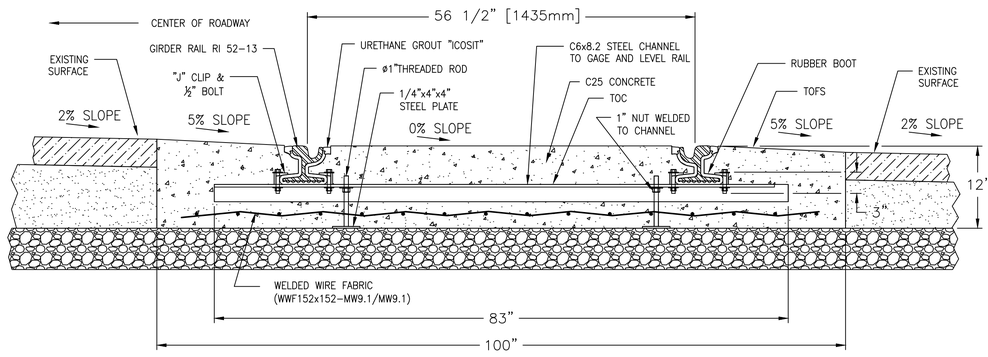


MARKET ST JUST NORTH
OF MISSION INN AVE

(LOOKING SOUTH ON MARKET – THE DIRECTION OF TRAVEL)

TRACKFORM IS LEVEL
ROADWAY IS SLOPED

STANDARD TRACKFORM



STANDARD TRACKFORM SECTION @ 6' O.C. IN TANGENT TRACK

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DRAWN BPL
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APPROVED BR

SHEET TITLE: EXAMPLES OF LEVEL TRACKFORM IN A SLOPED ROADWAY

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-005-FSR- REV. 0 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. TYP-05

DATE 2021-12-17

SCALE NTS

SHEET 1 OF 1

REVISION NO. 0

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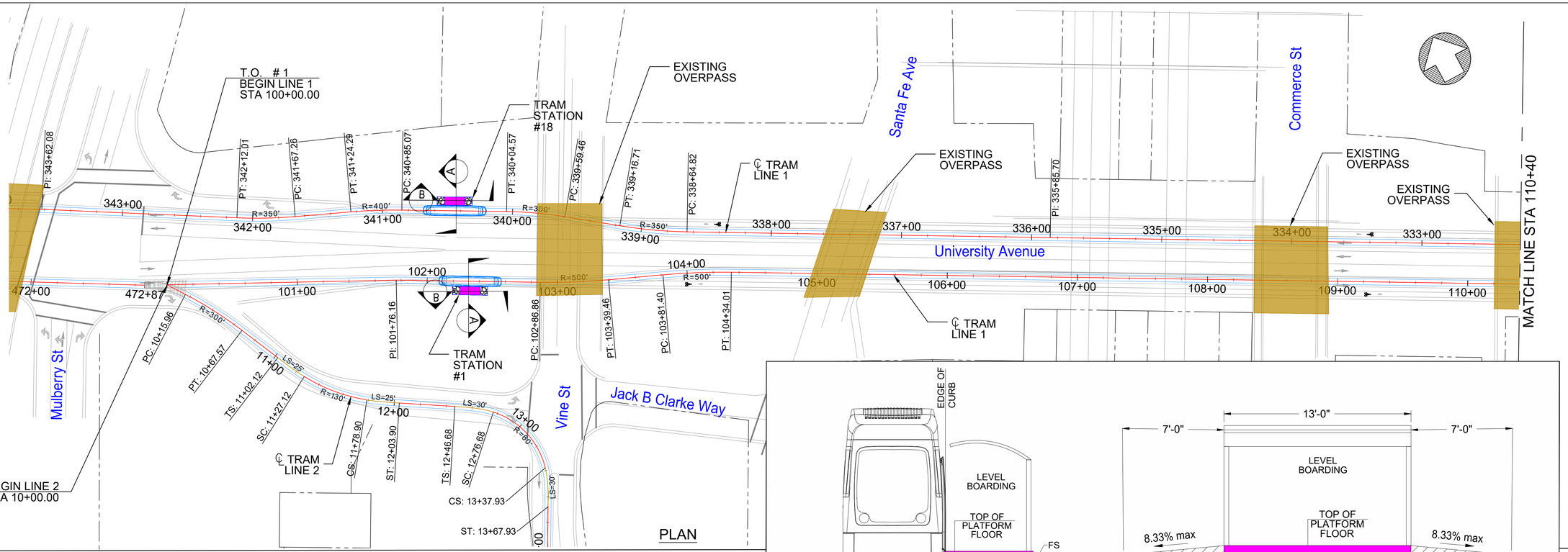
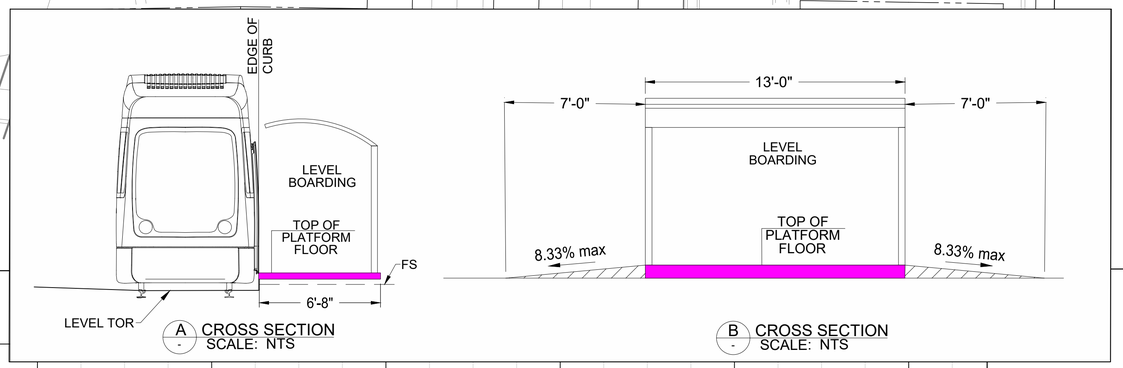
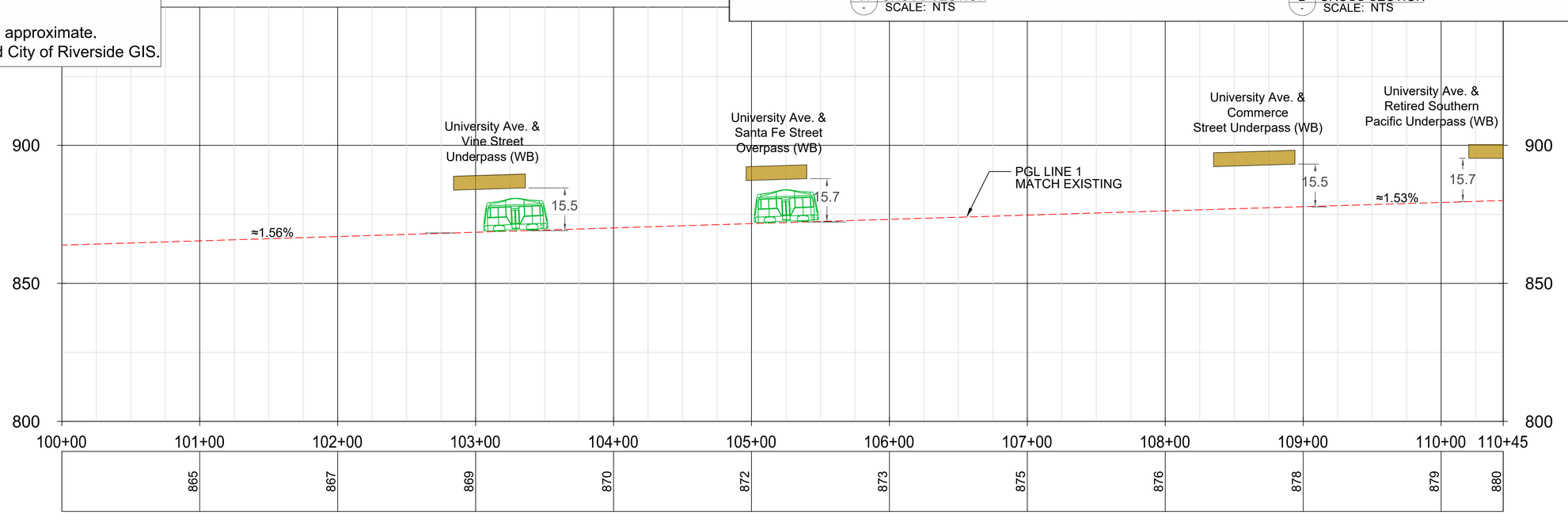


NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.





PROFILE

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REV NO	DATE	DESCRIPTION
1	210730	REVISED
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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 000+00 TO STA 110+40

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-01 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-01

DATE 2021-12-17

SCALE 1: 40

SHEET # OF #

REVISION NO. 2

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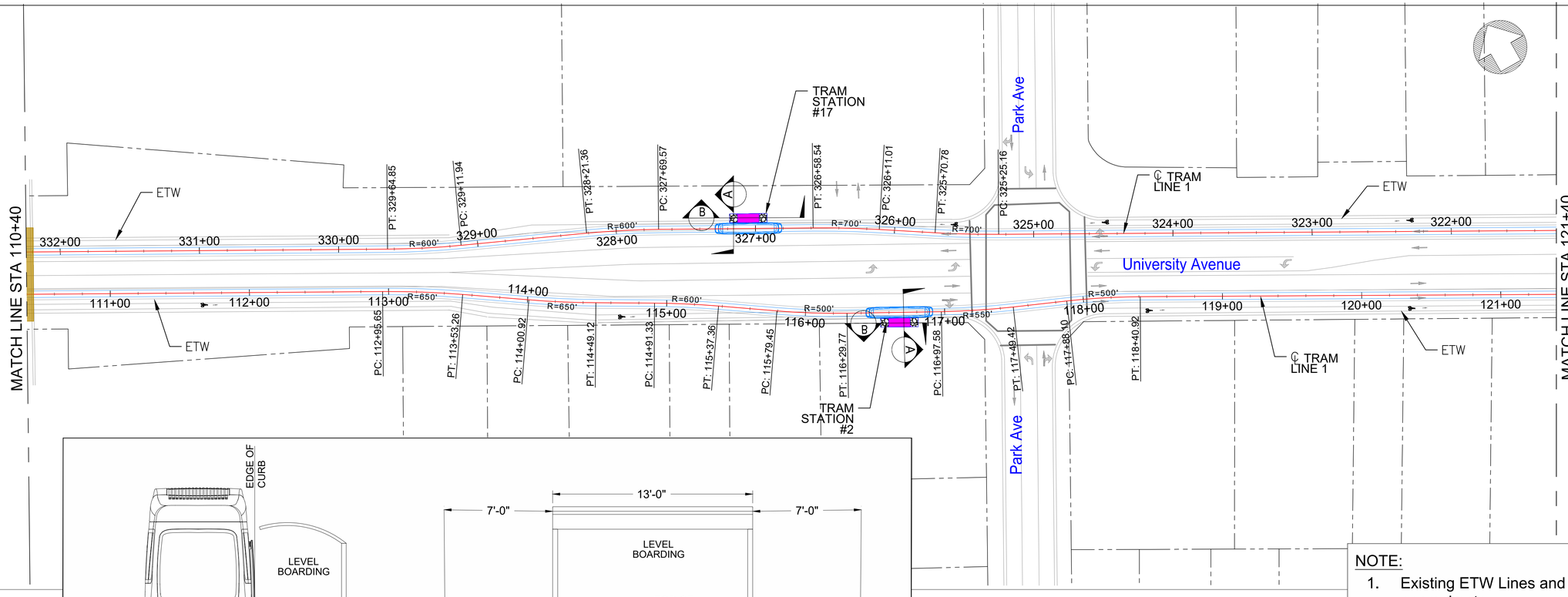
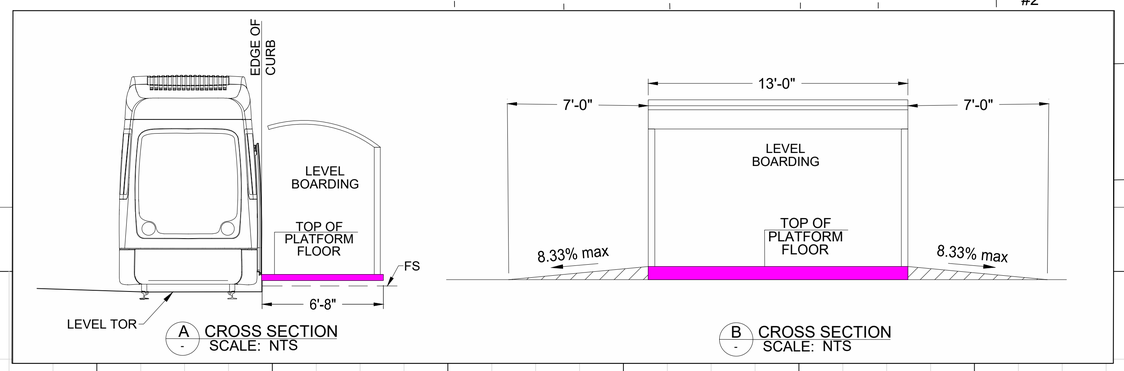


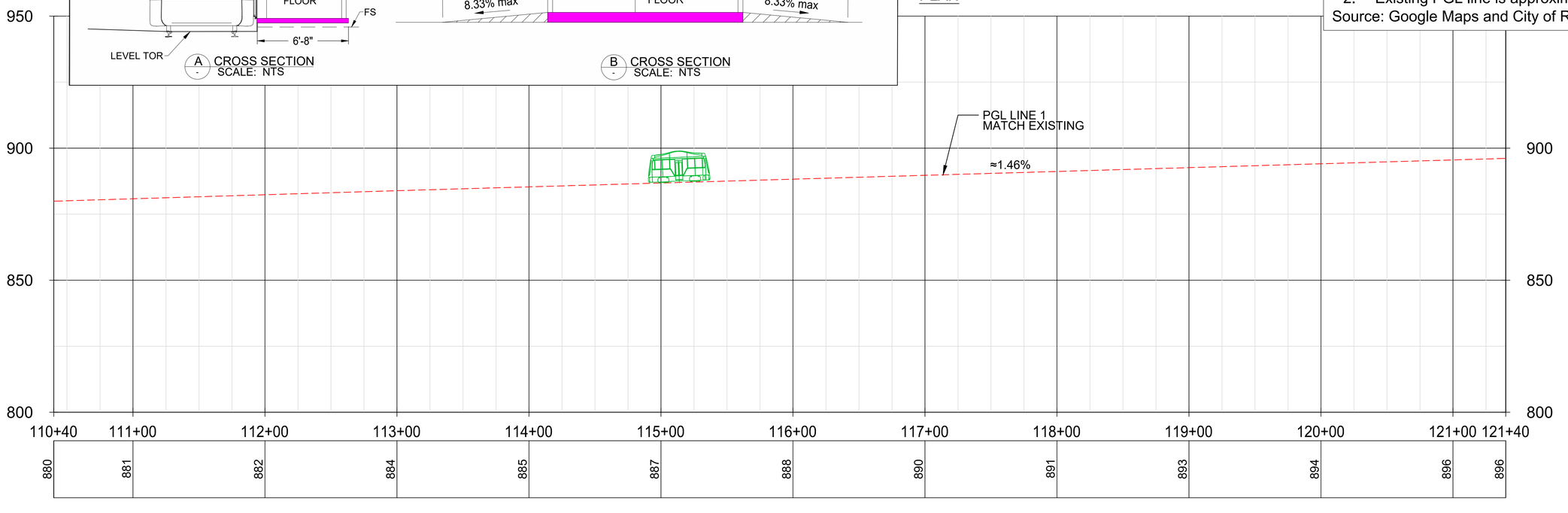


NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.

PLAN



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1	210730	REVISED
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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 110+40 TO STA 121+40

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-02 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-02

DATE	2021-12-17
SCALE	1: 40
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REVISION NO.	2

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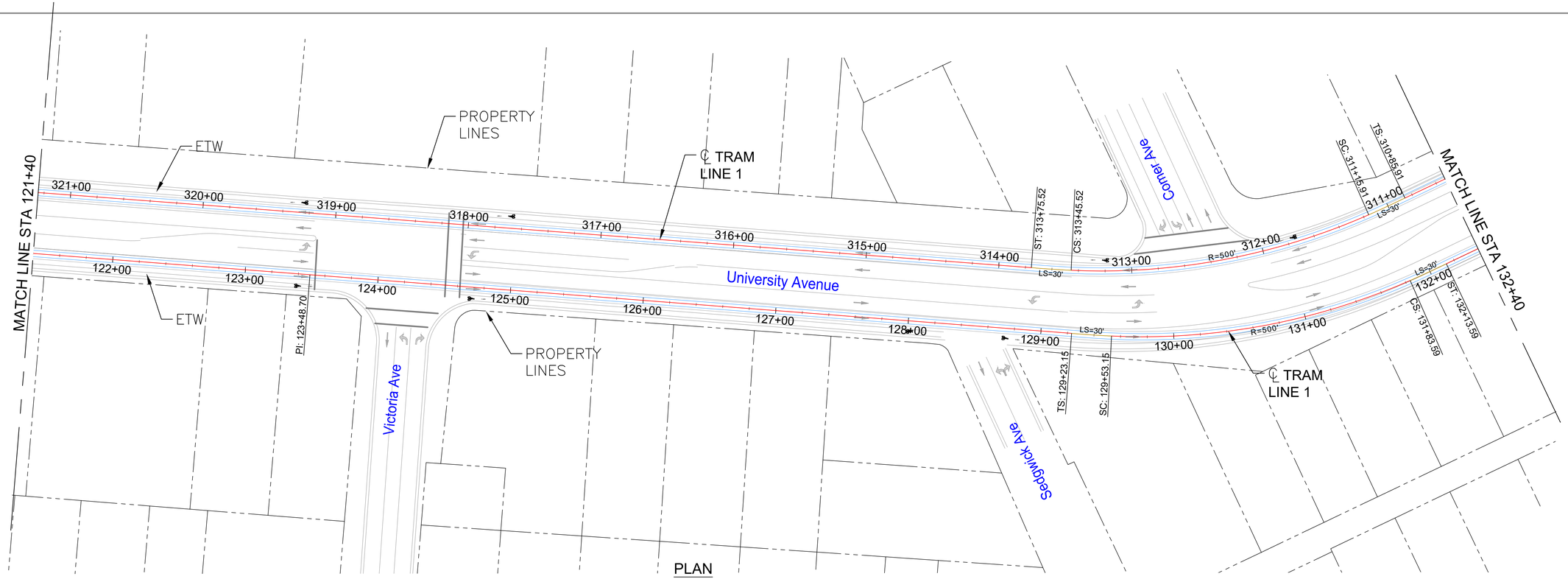
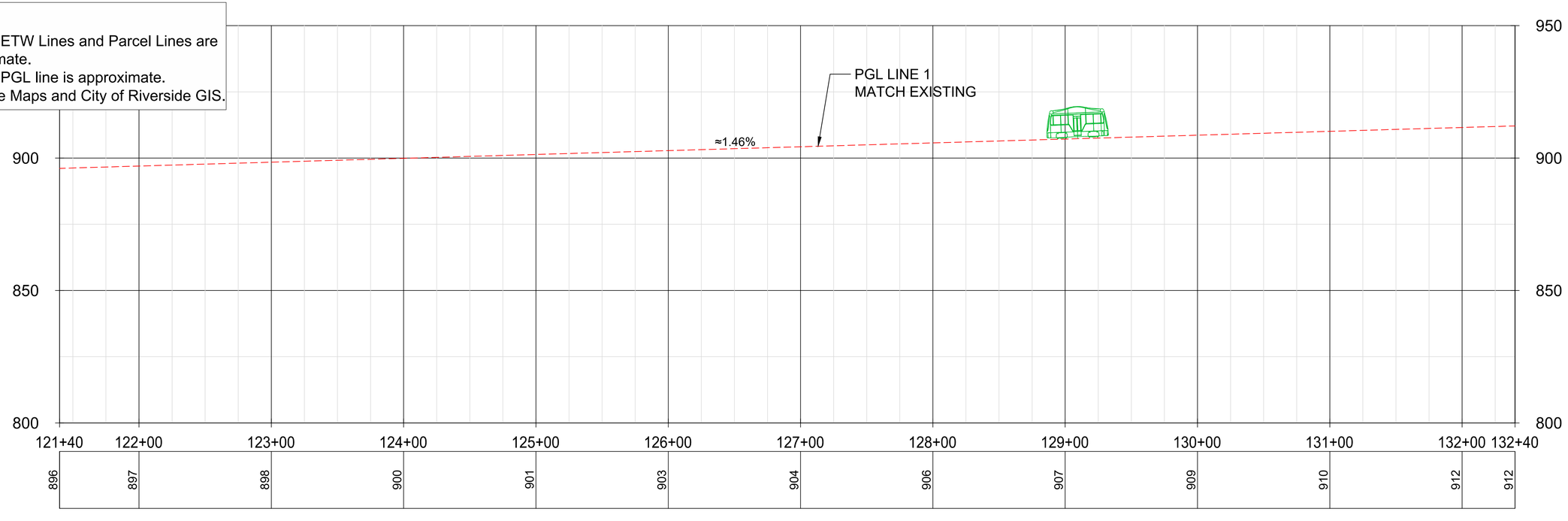


NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



PROFILE

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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 121+40 TO STA 132+40

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-03 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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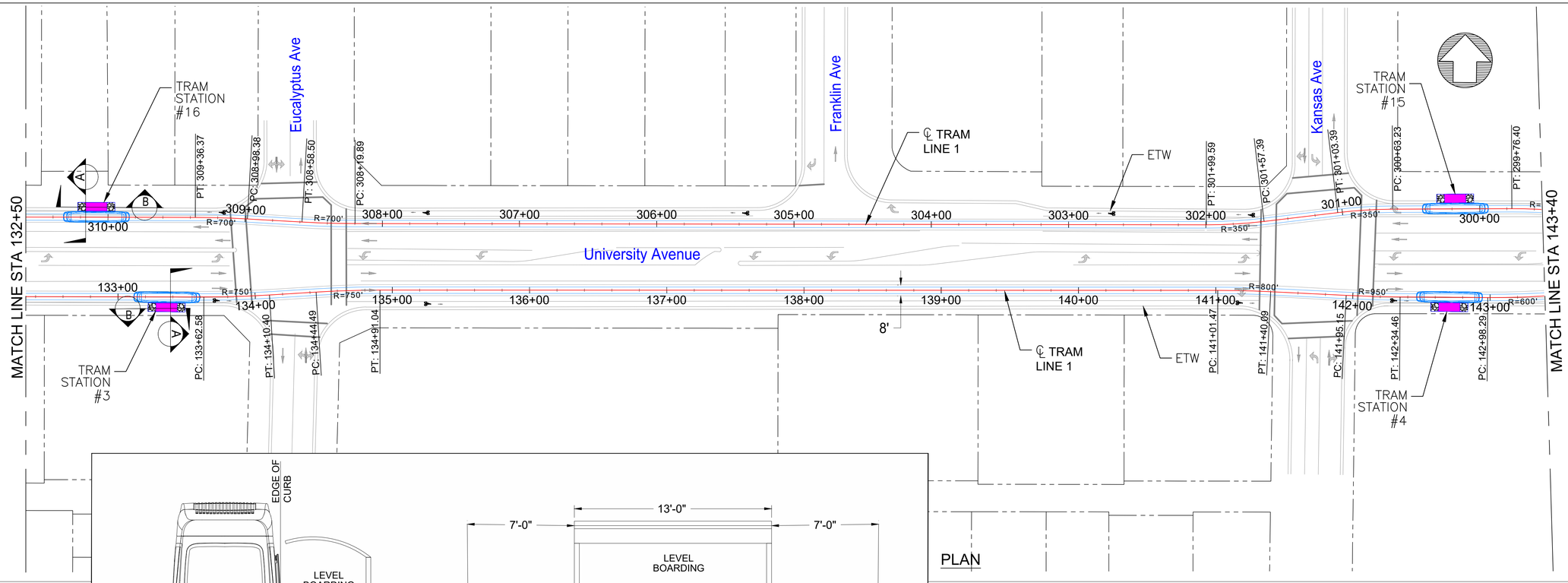
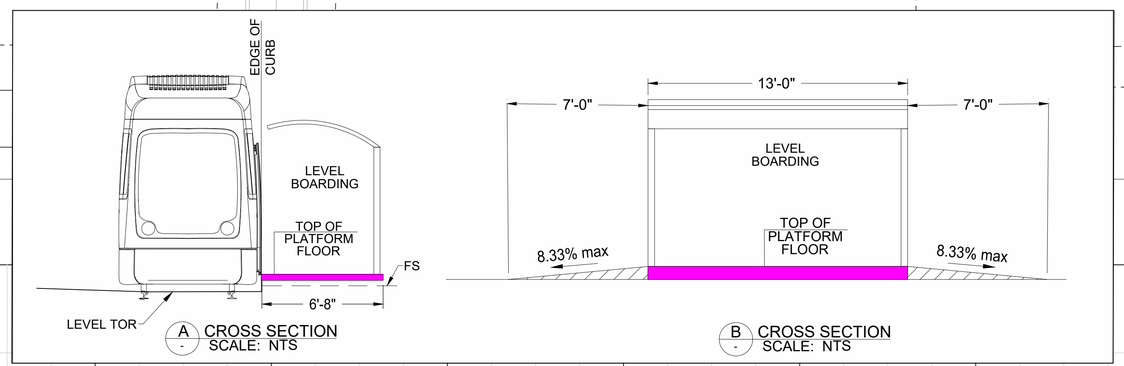
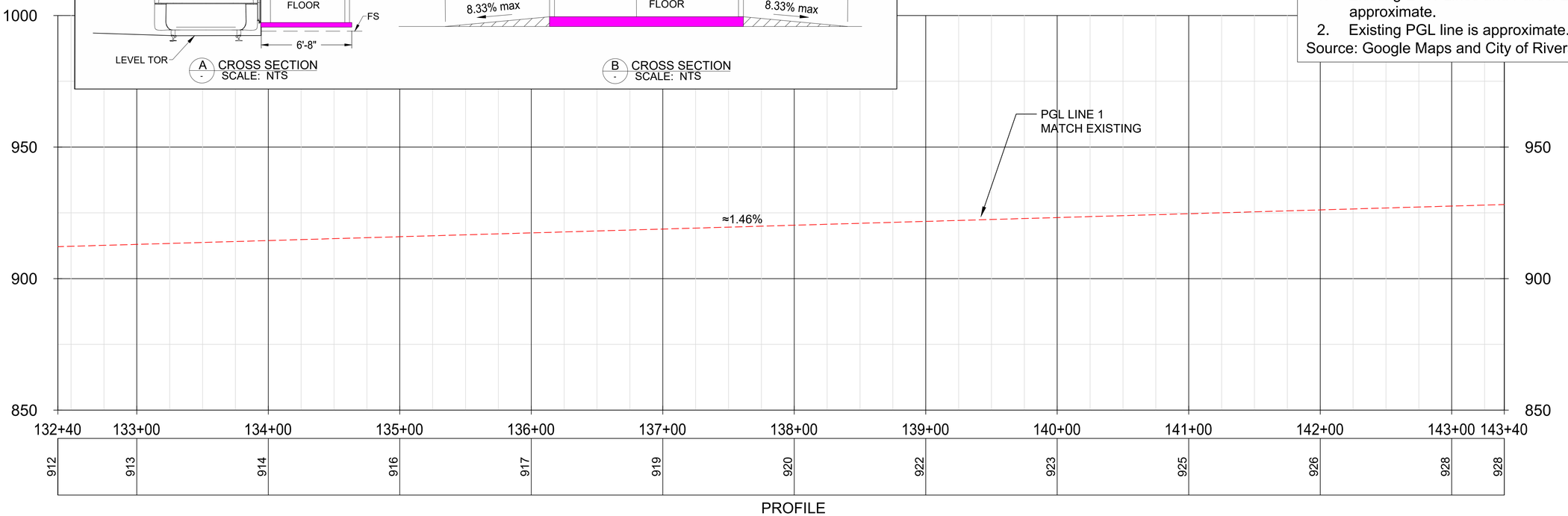




NOTE:
1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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1	210730	REVISED
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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 132+40 TO 143+40
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-04
REV. 2
211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-04
DATE 2021-12-17
SCALE 1: 40
SHEET # OF #
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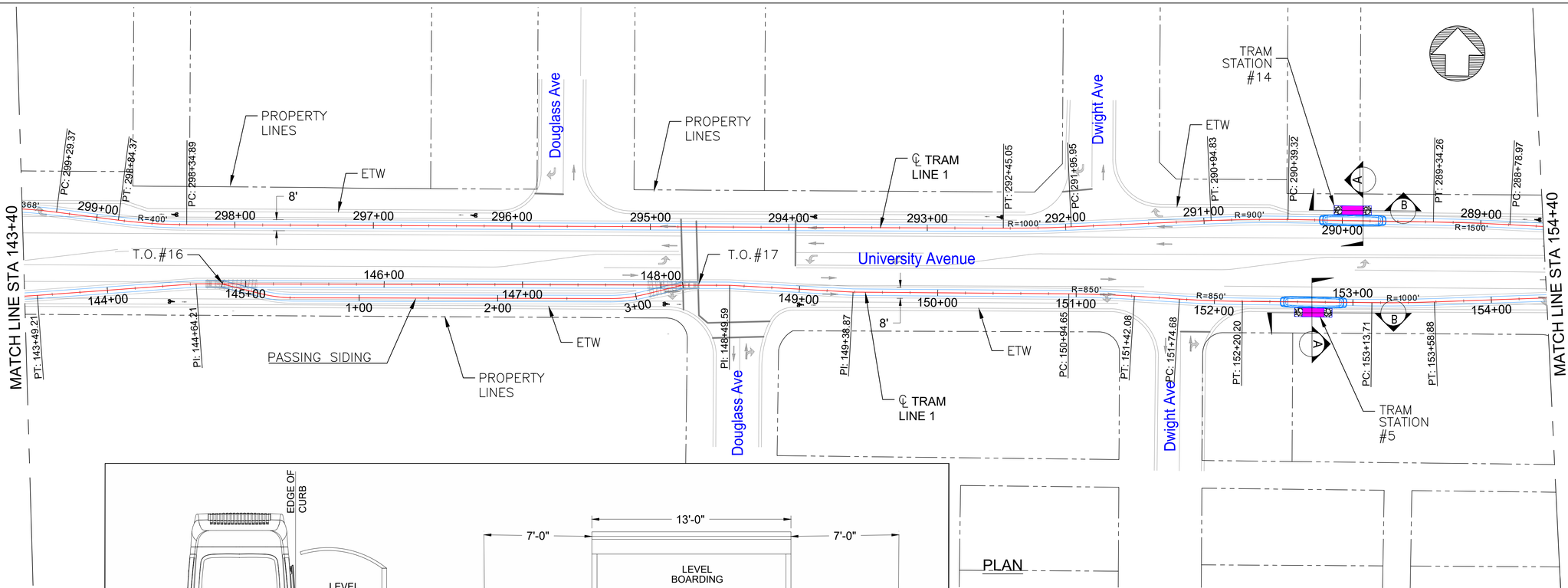
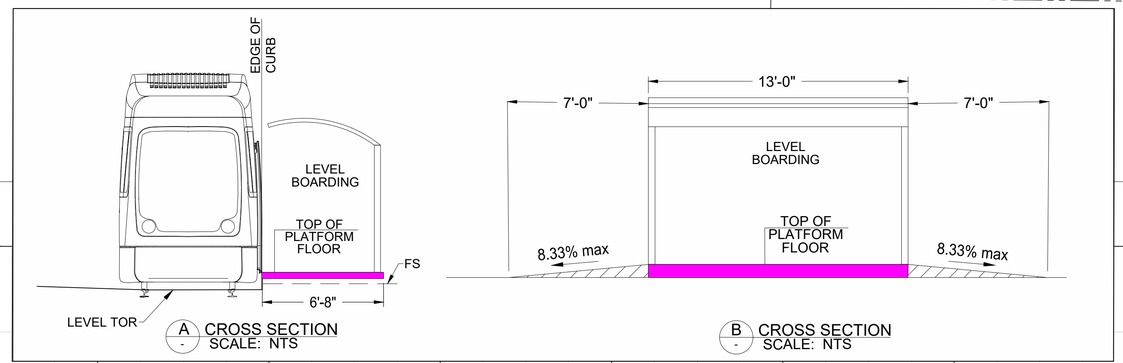
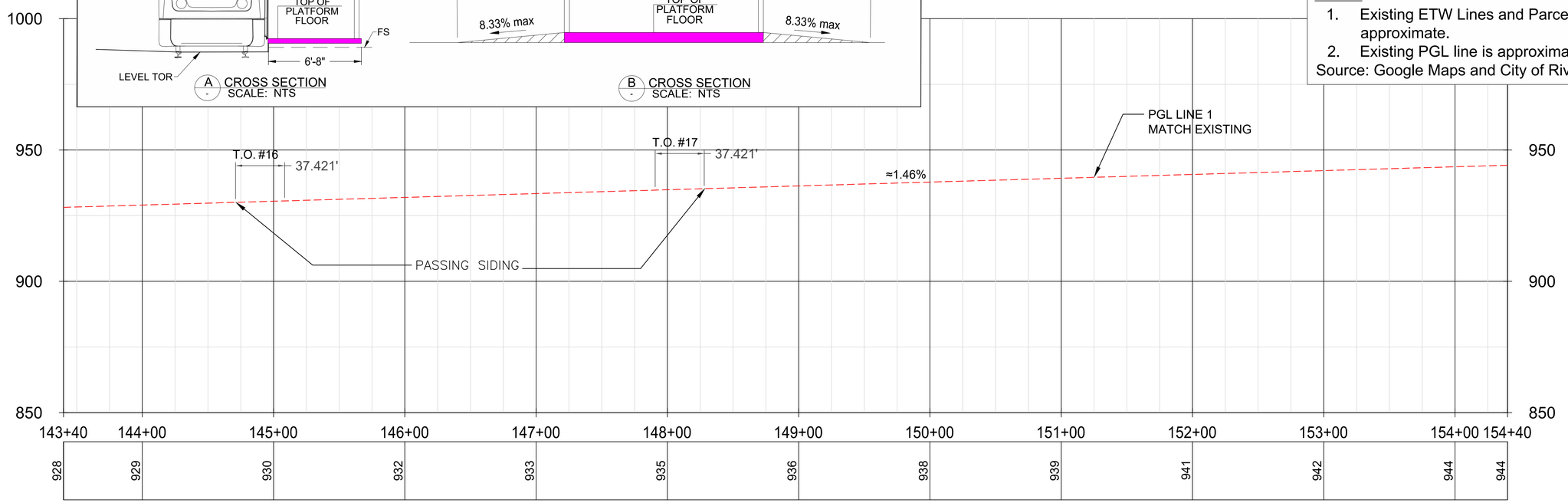




NOTE:
1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 143+40 TO STA 154+40
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-05 REV. 2 211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-05
DATE 2021-12-17
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REVISION NO. 2

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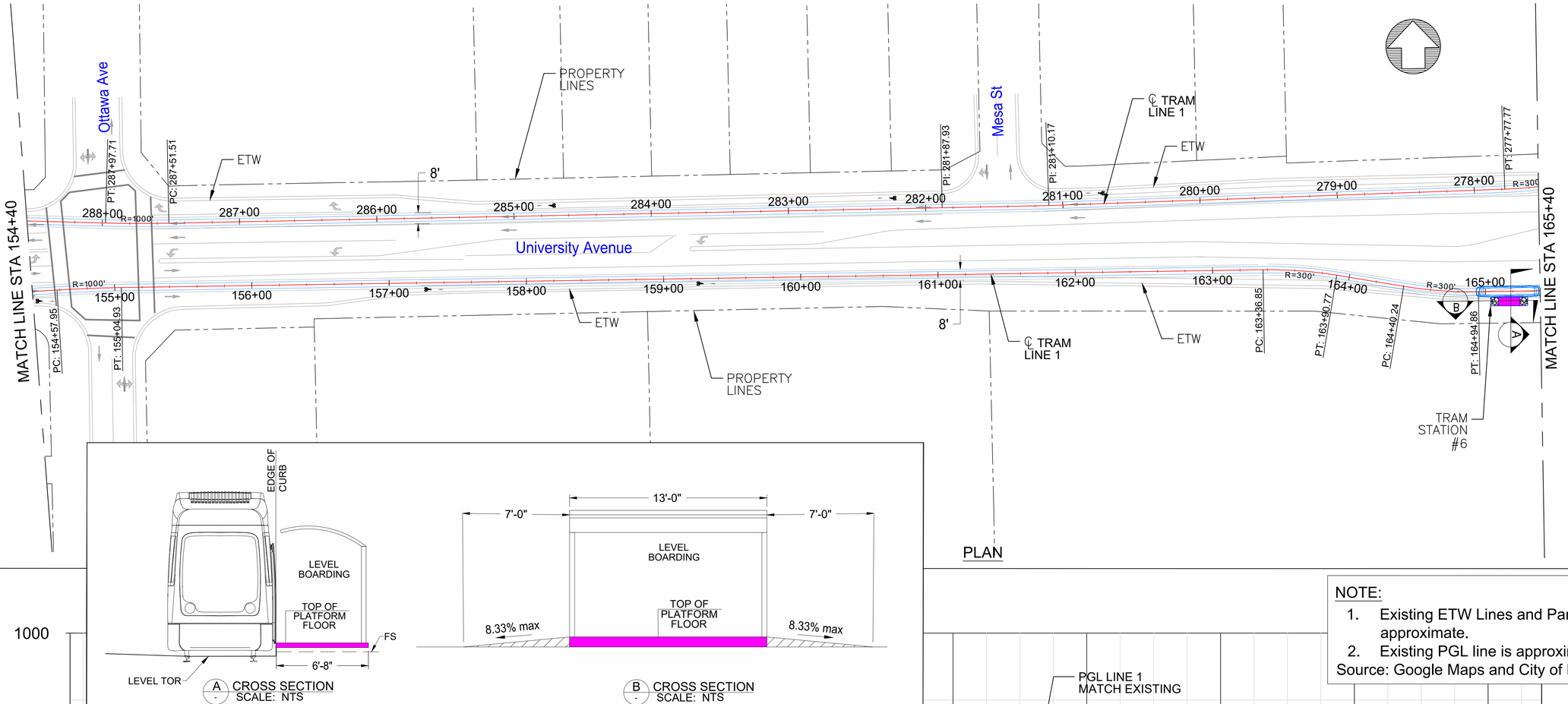

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.

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1	210730	REVISED
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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 154+40 TO STA 165+40

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-06 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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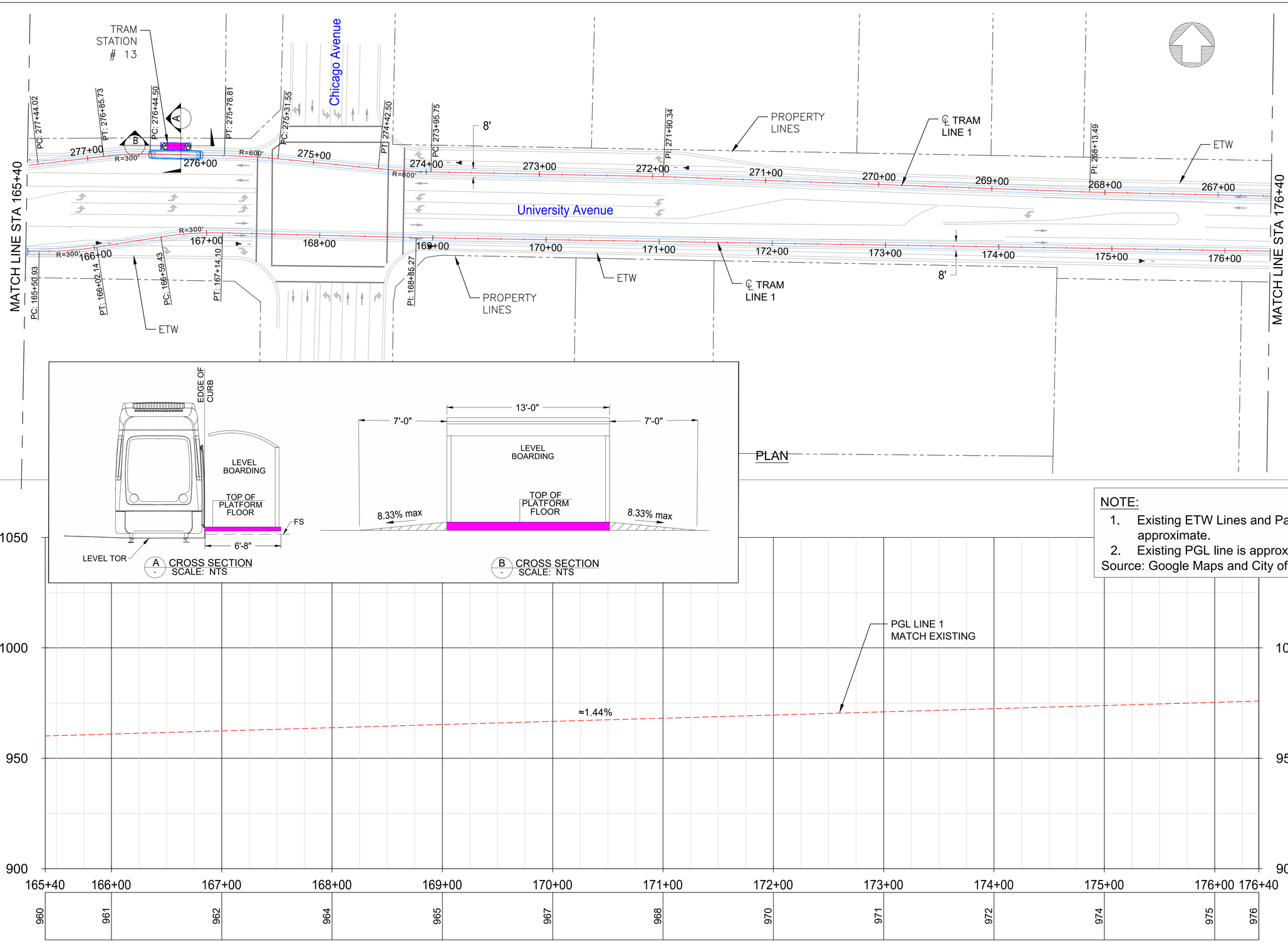

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 165+40 TO 176+40

DOCUMENT CONTROL NUMBER: RSC-4-006-DWG-004-FSR-PP-07 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-07

DATE 2021-12-17

SCALE 1: 40

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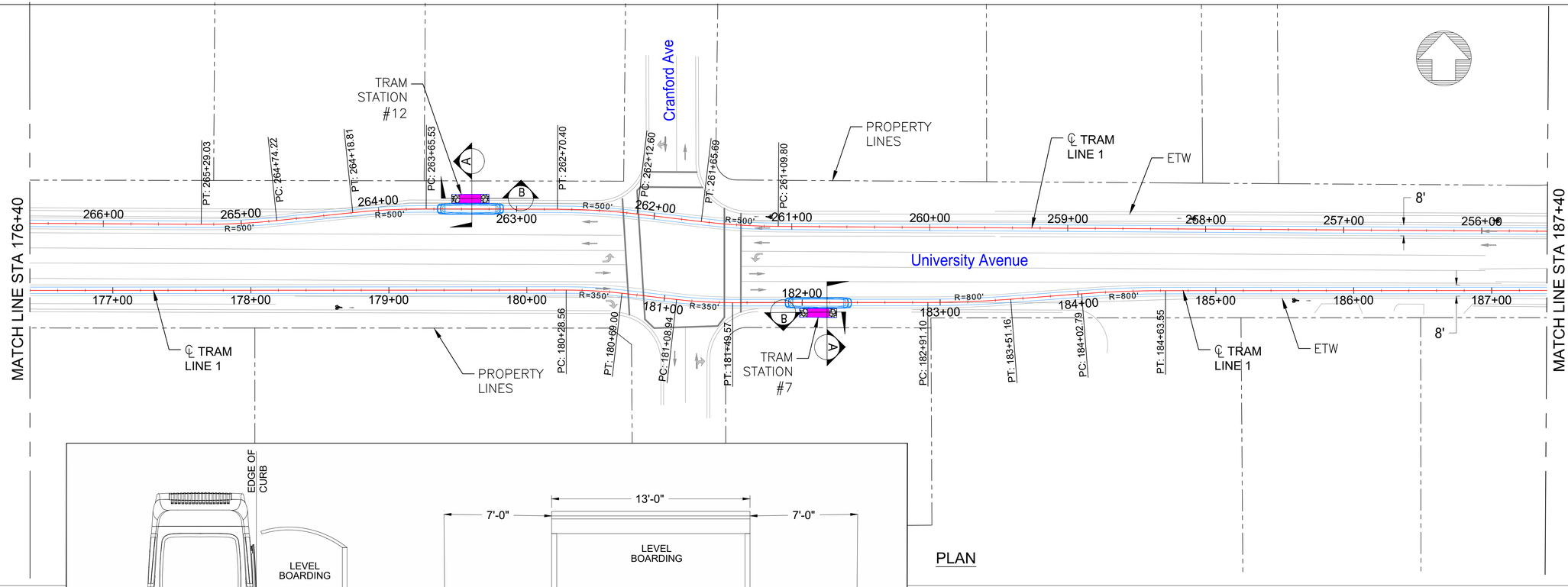

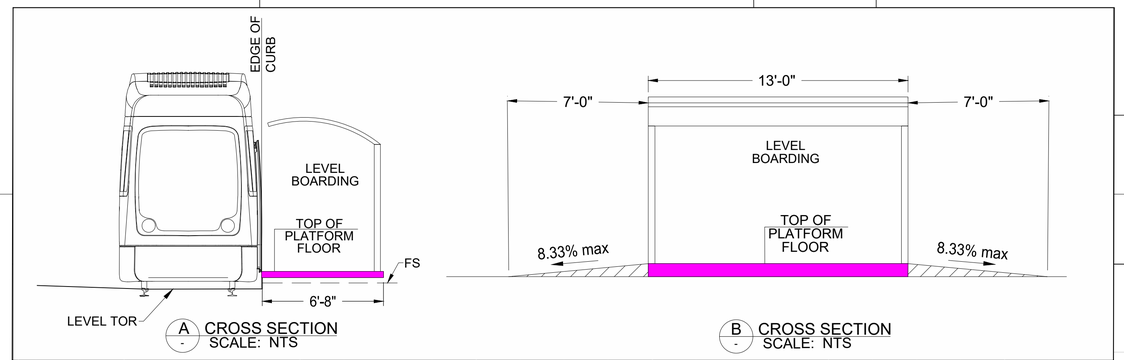

PLAN

NOTE:
1. Existing ETW Lines and Parcel Lines are approximate.
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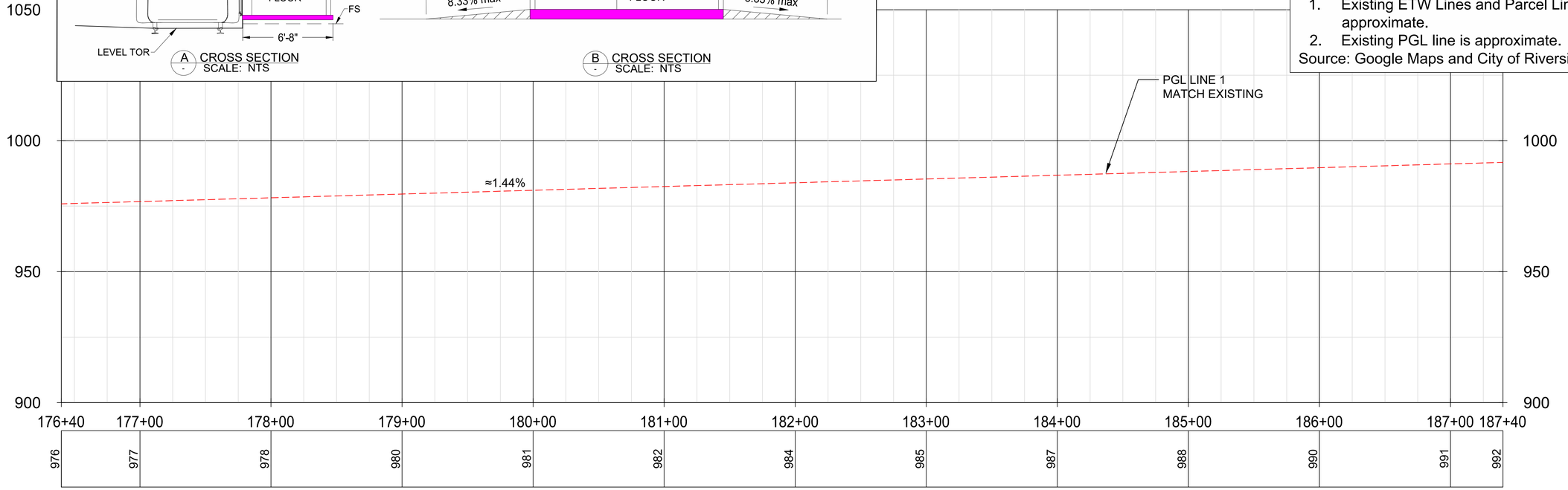
Source: Google Maps and City of Riverside GIS.



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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 176+40 TO STA 187+40

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-08 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-08

DATE 2021-12-17

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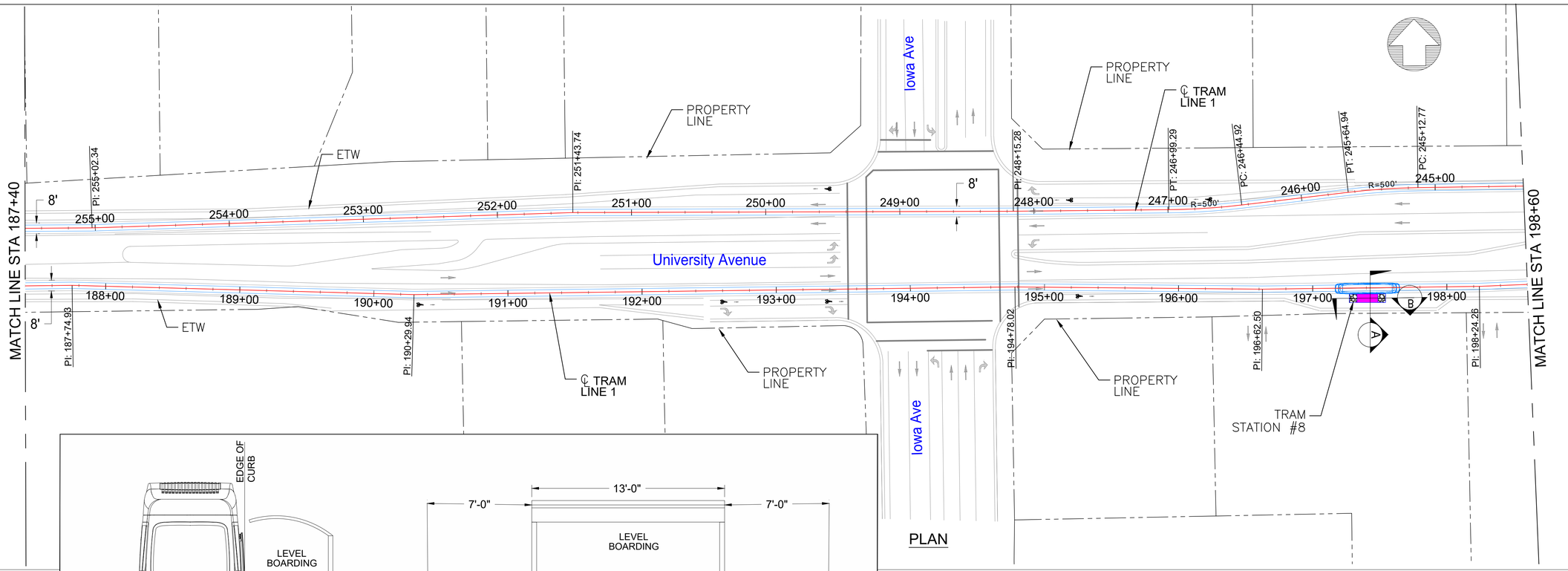

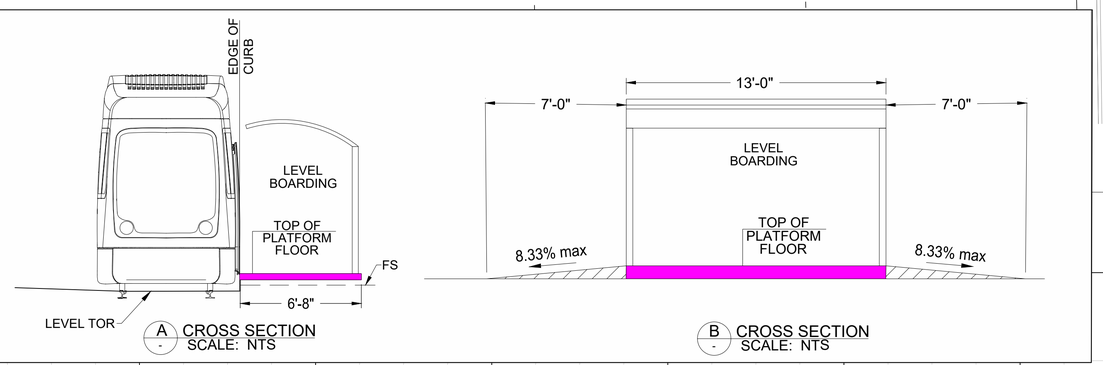

NOTE:

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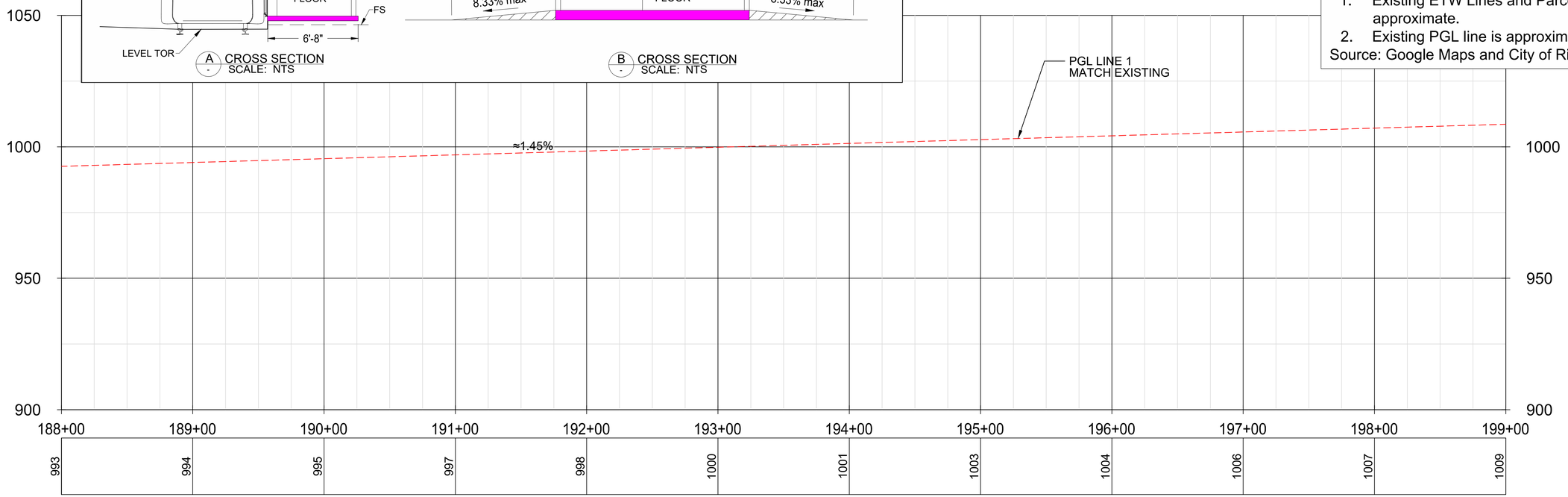
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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SHEET TITLE:	PLAN AND PROFILE SHEET FROM STA 187+60 TO STA 198+50
DOCUMENT CONTROL NUMBER:	RSC-4-06-DWG-004-FSR-PP-09
REV.	2
	211217
PROJECT TITLE:	PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO.	PP-09
DATE	2021-12-17
SCALE	1: 40
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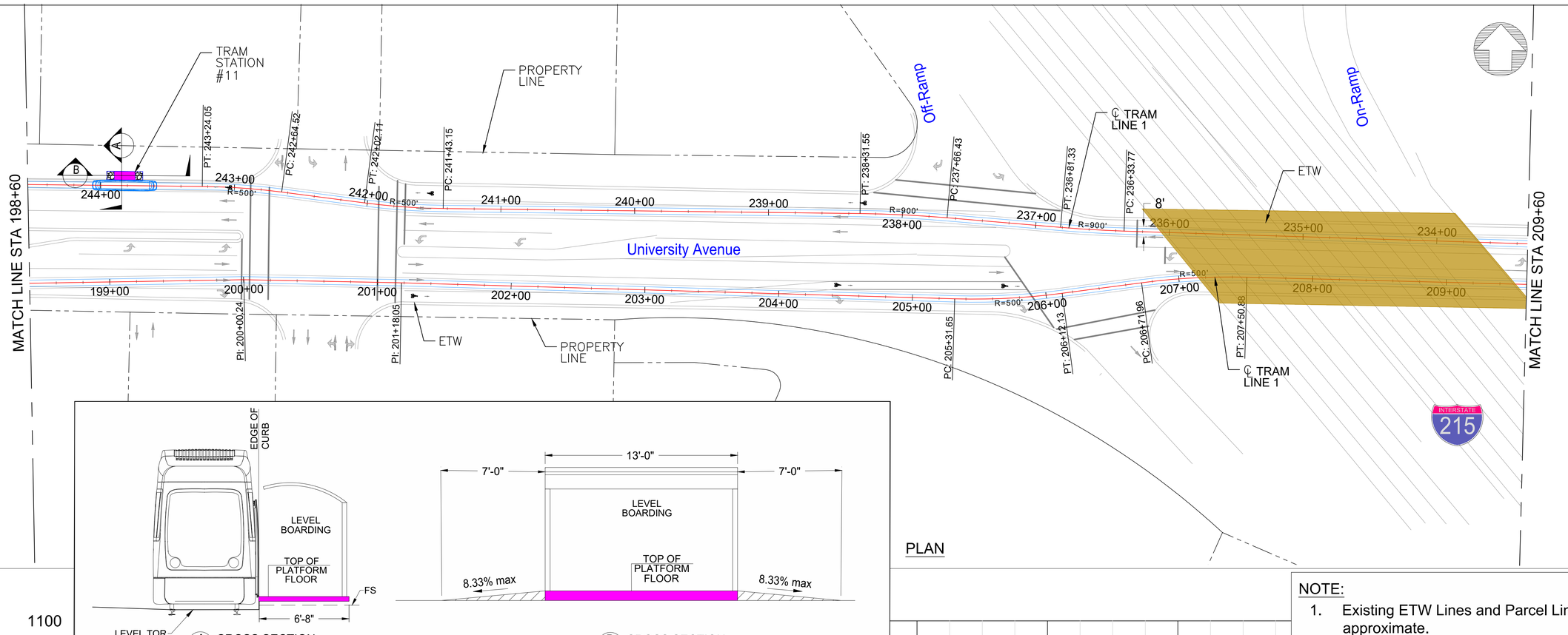

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
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Source: Google Maps and City of Riverside GIS.

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SHEET TITLE: PLAN AND PROFILE FROM STA 198+6 TO STA 209+80
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-10
REV. 2
211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-10
DATE 2021-12-17
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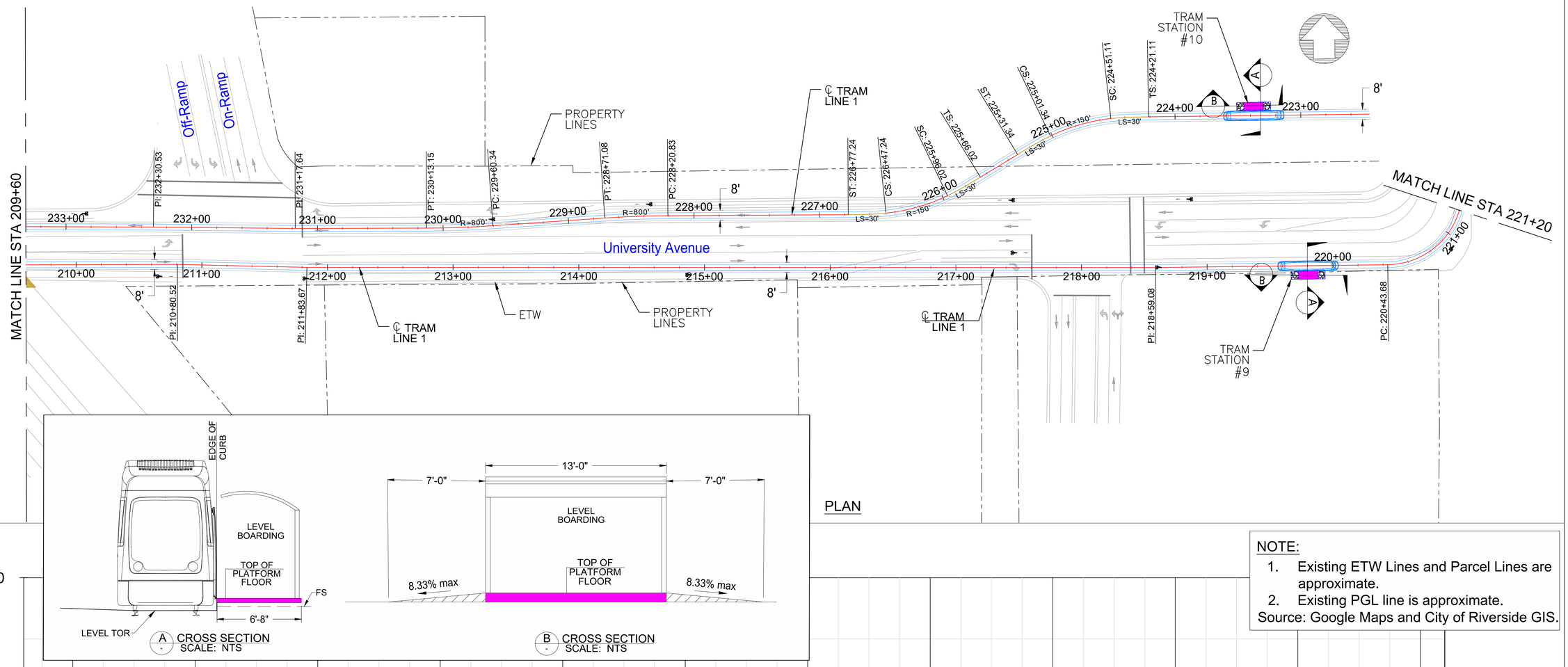

PLAN

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
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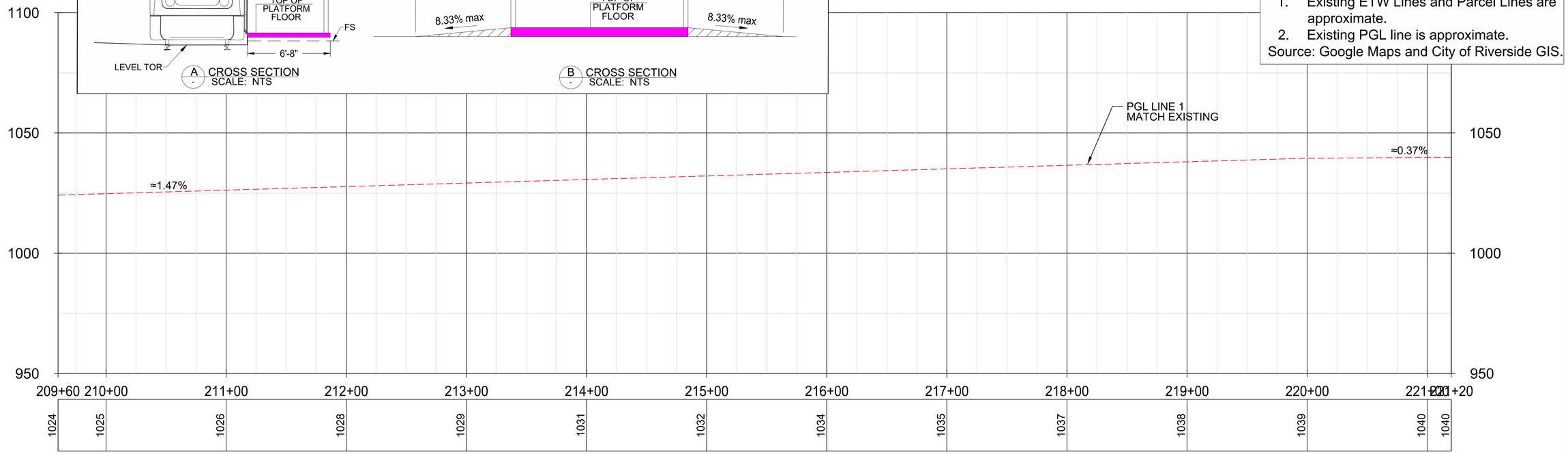
Source: Google Maps and City of Riverside GIS.



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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 209+60 TO STA 221+20

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-11 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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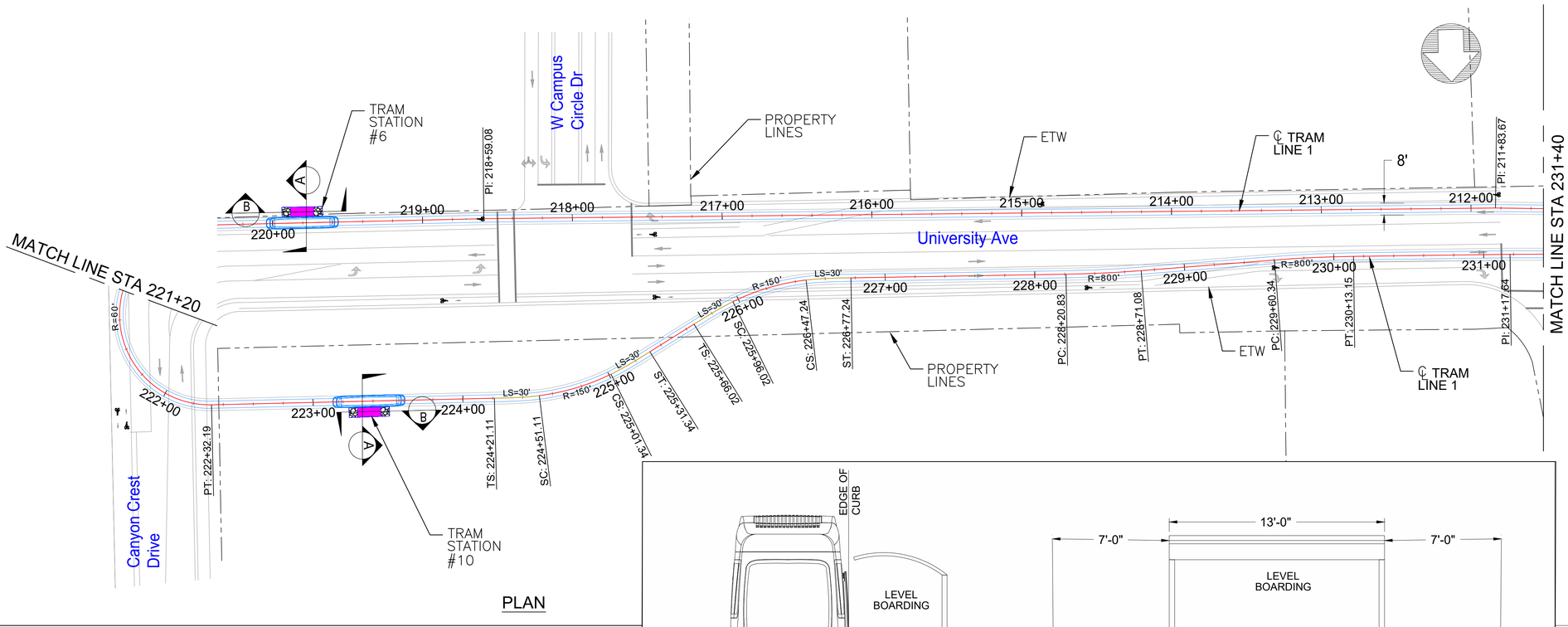

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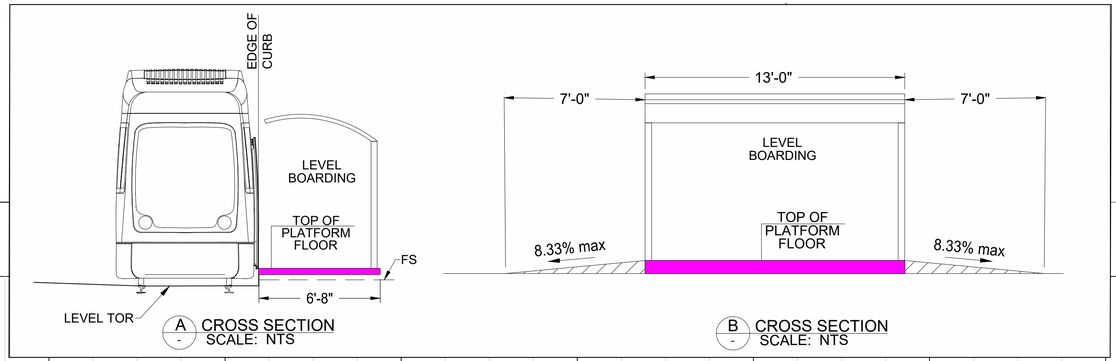

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

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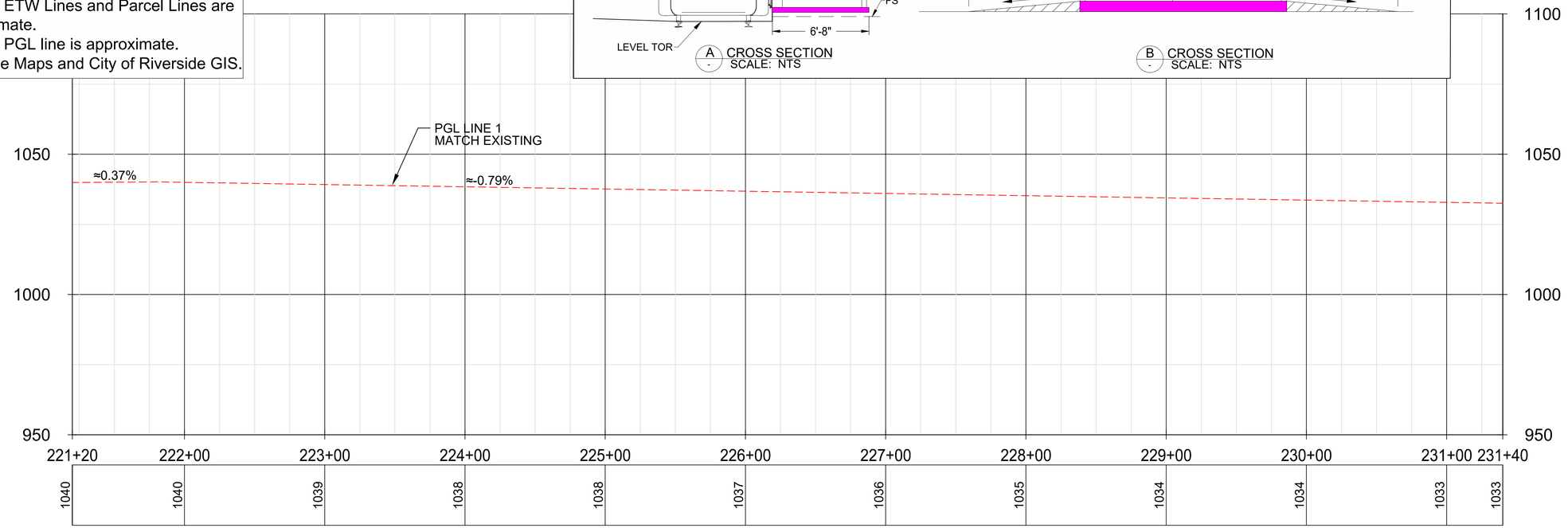

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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 221+60 TO STA 232+40

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-12 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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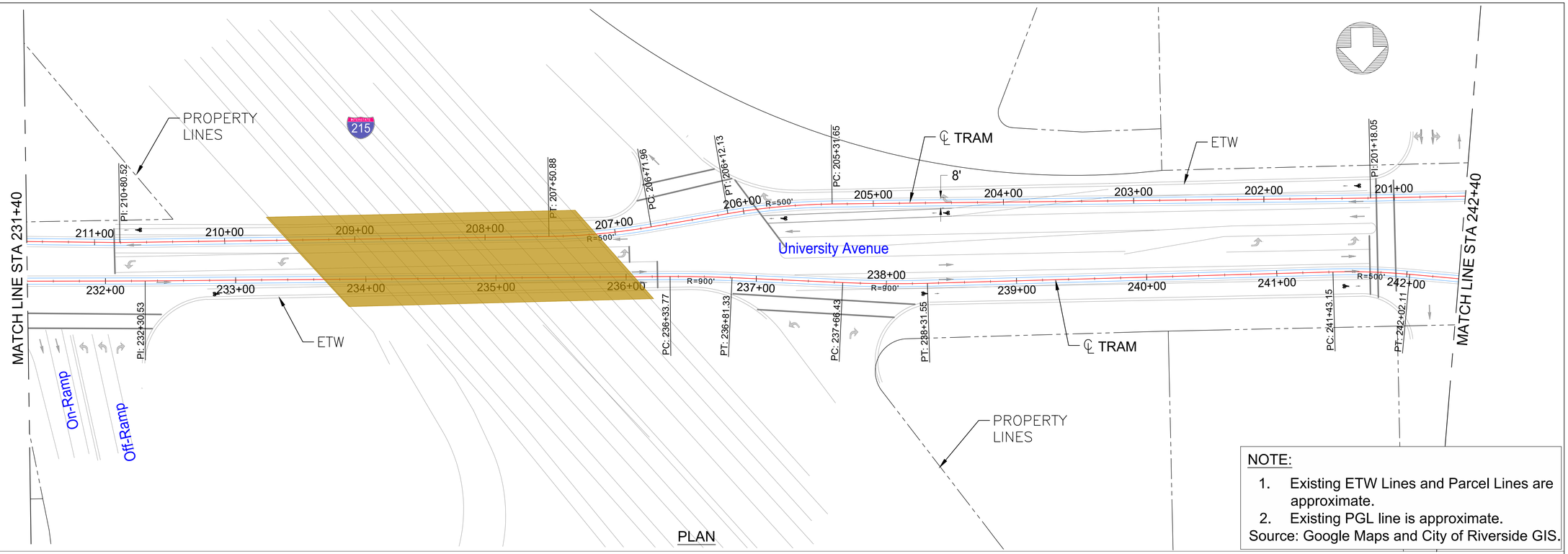
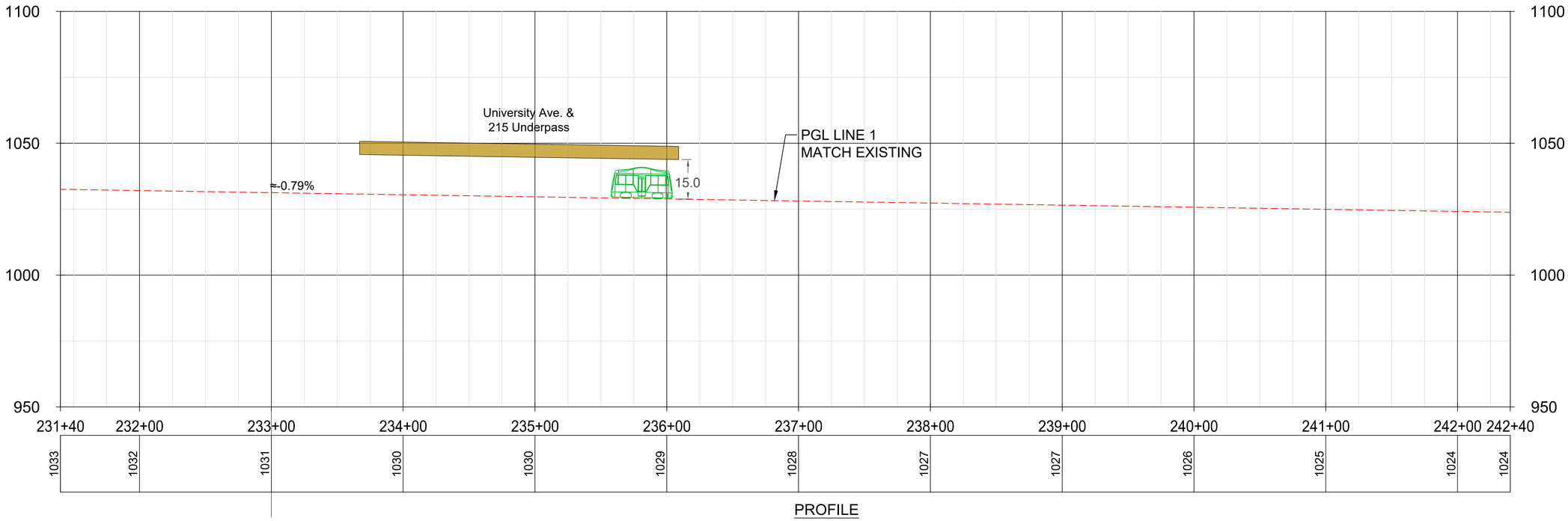


NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 232+40 TO STA 242+20

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-13 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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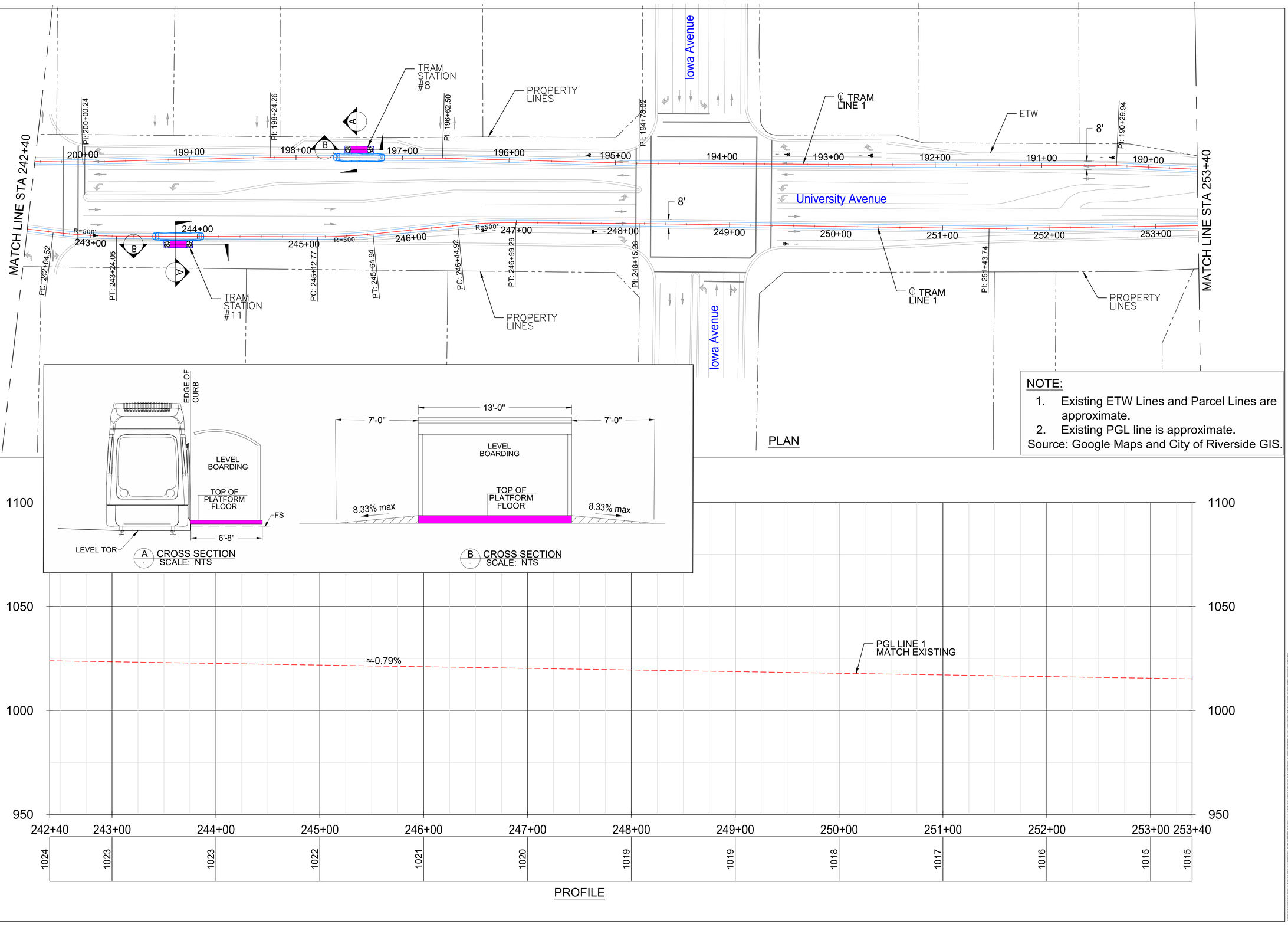

PLAN

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
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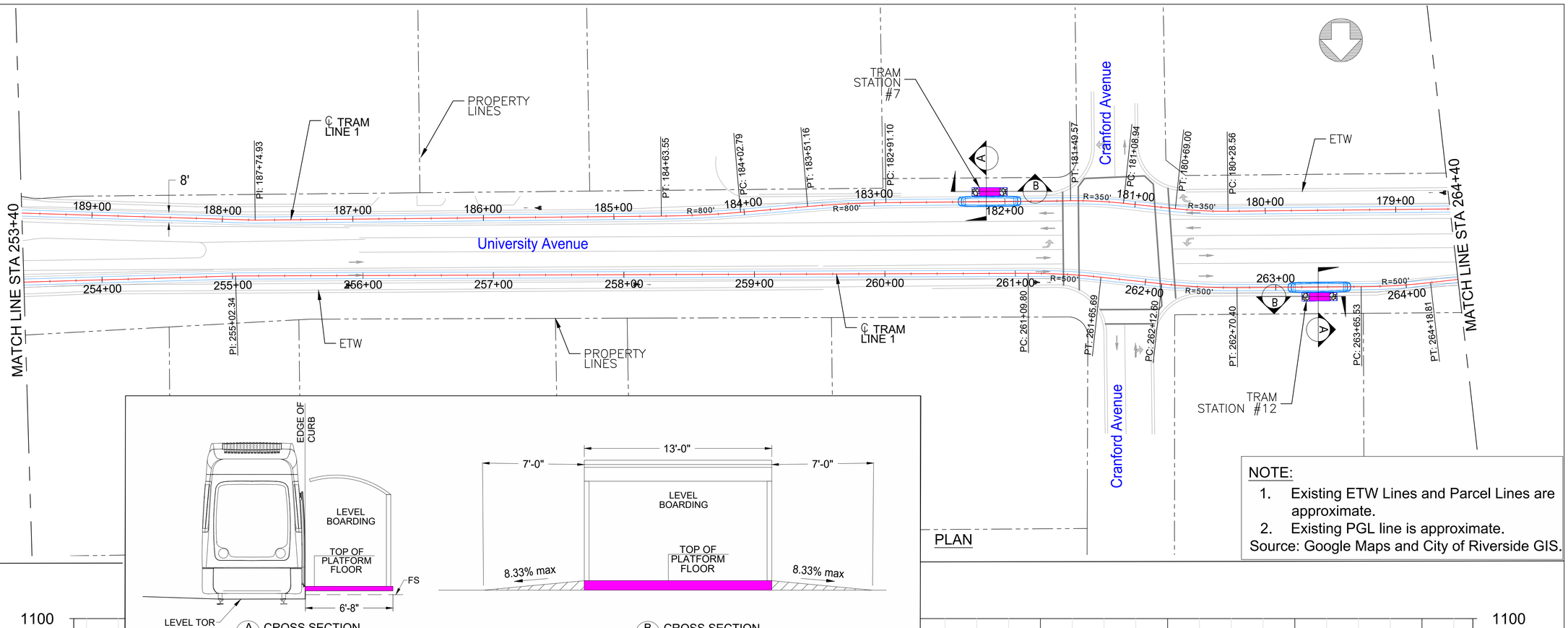
SHEET TITLE:	PLAN AND PROFILE SHEET FROM STA 242+40 TO STA 253+40
DOCUMENT CONTROL NUMBER	RSC-4-06-DWG-004-FSR-PP-14
REV.	2
	211217
PROJECT TITLE:	PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO.	PP-14
DATE	2021-12-17
SCALE	1: 40
SHEET	# OF #
REVISION NO.	2



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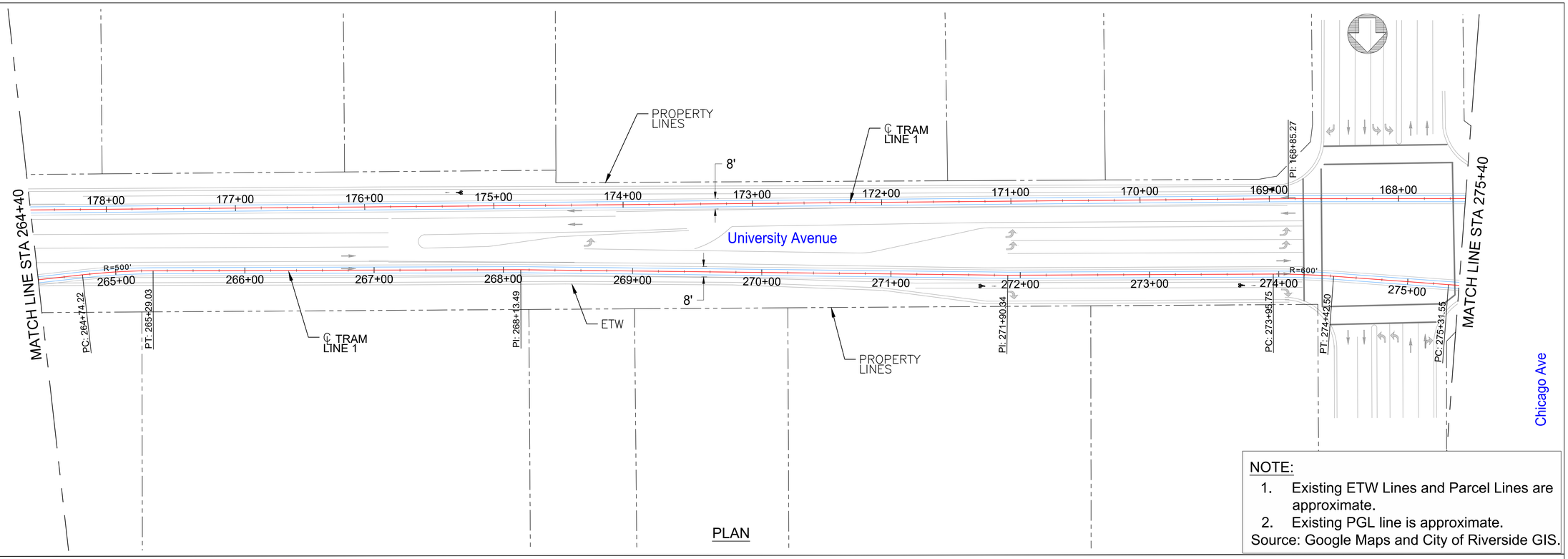
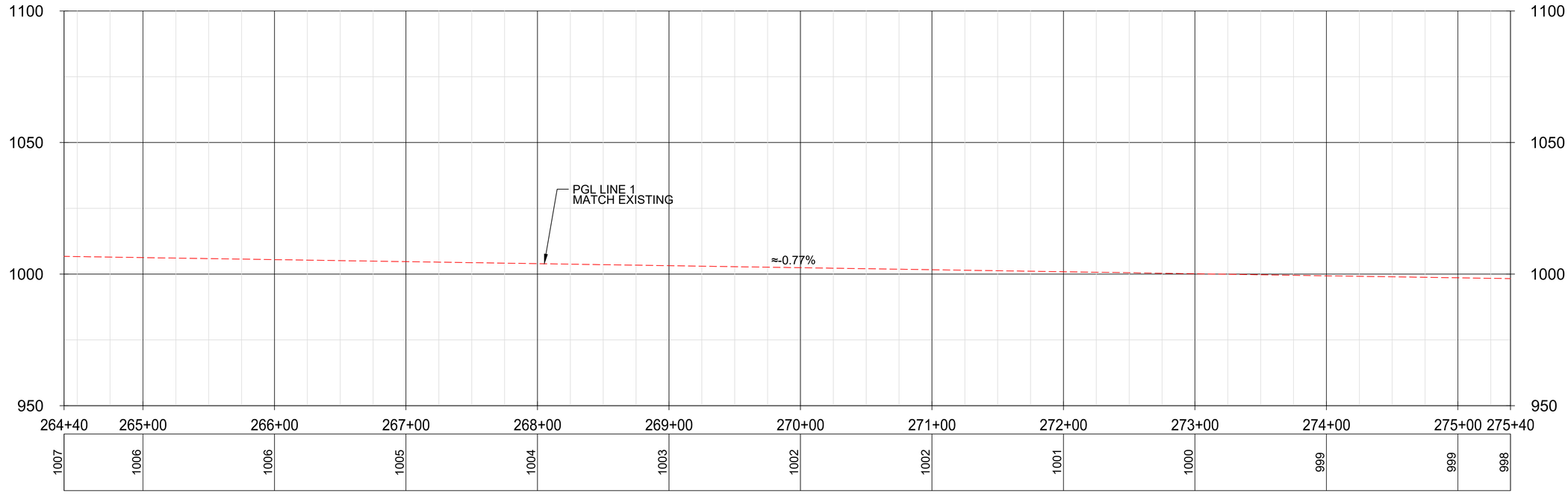


PLAN

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 264+40 TO STA 275+40

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-16

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PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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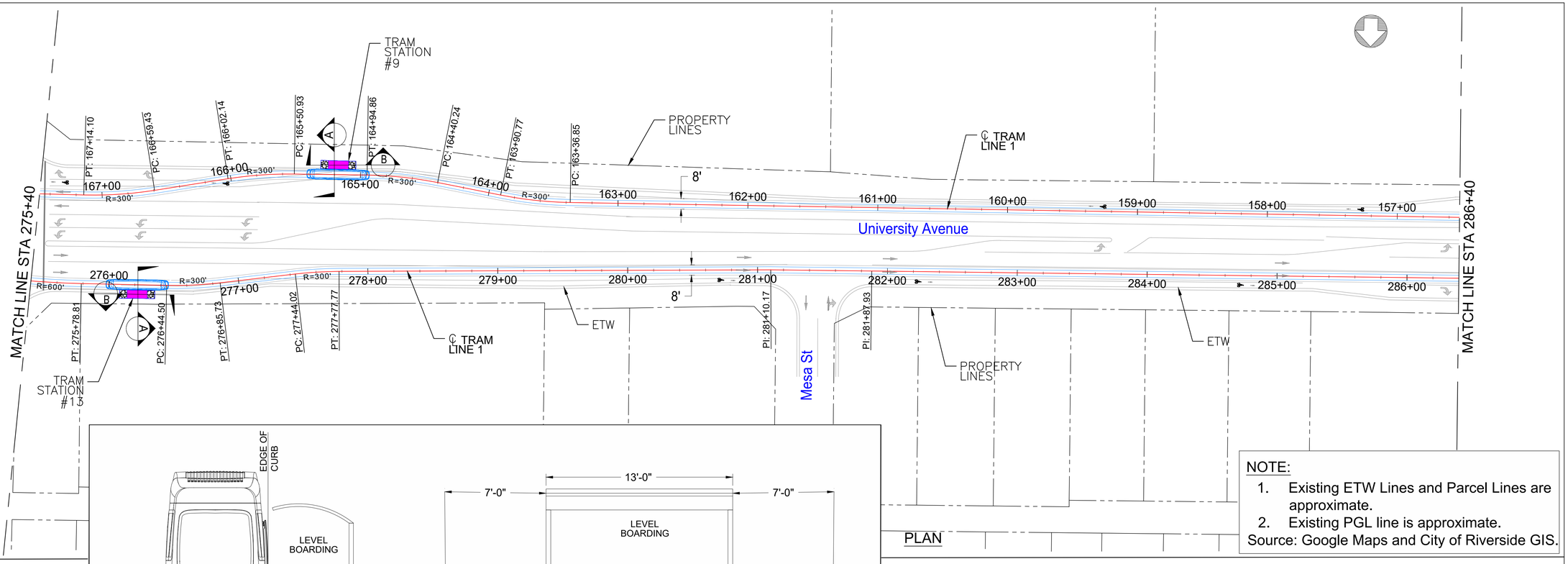
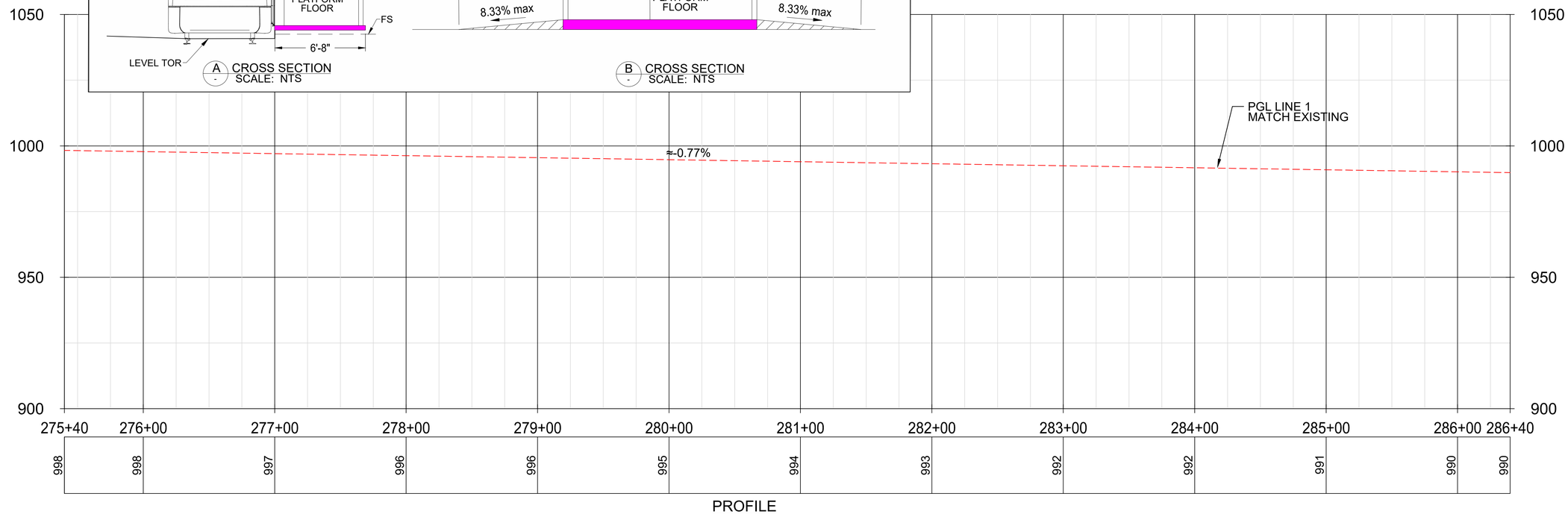


PLAN

NOTE:
1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 275+40 TO STA 286+40
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-17
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PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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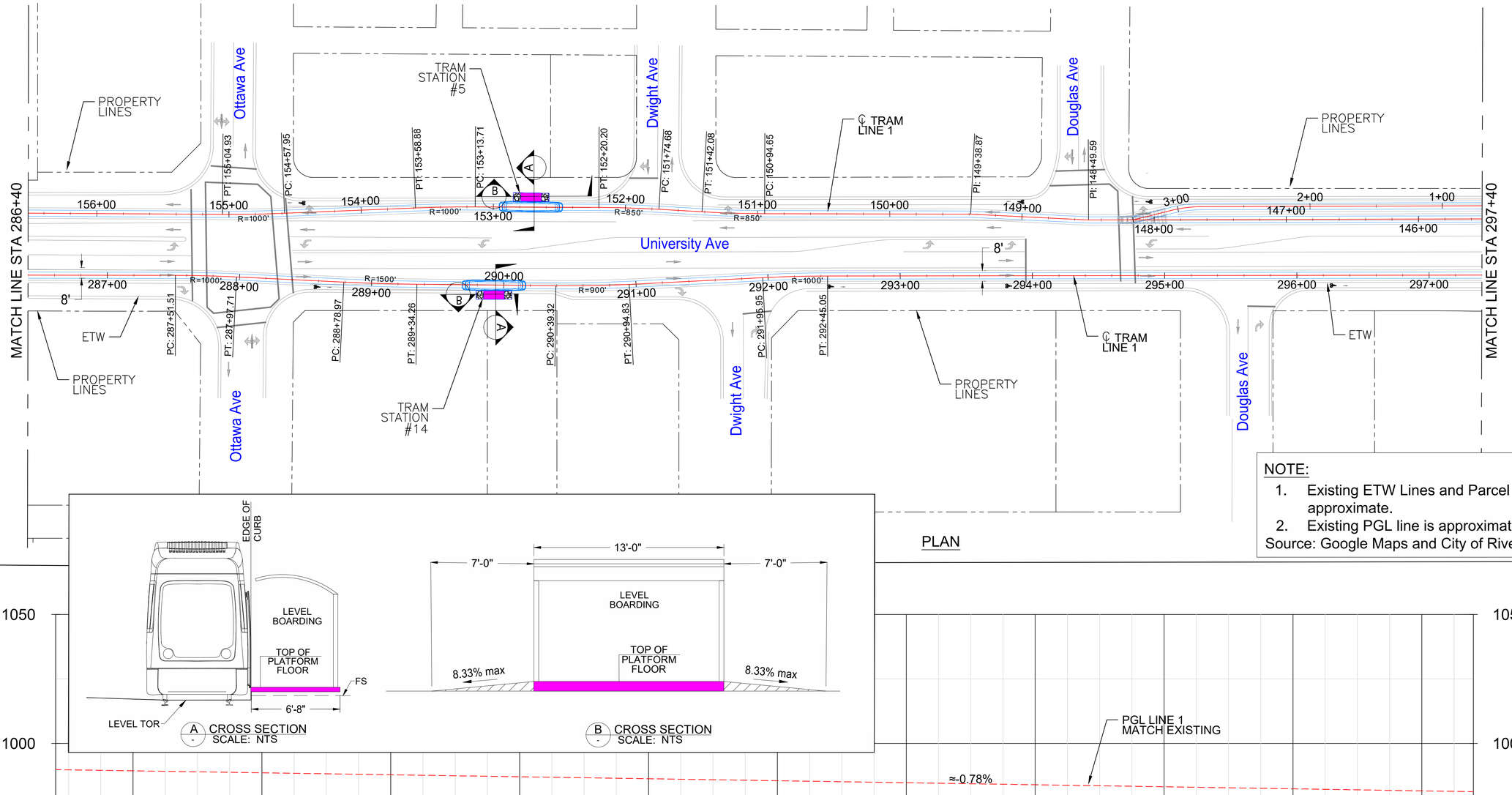

PLAN

NOTE:

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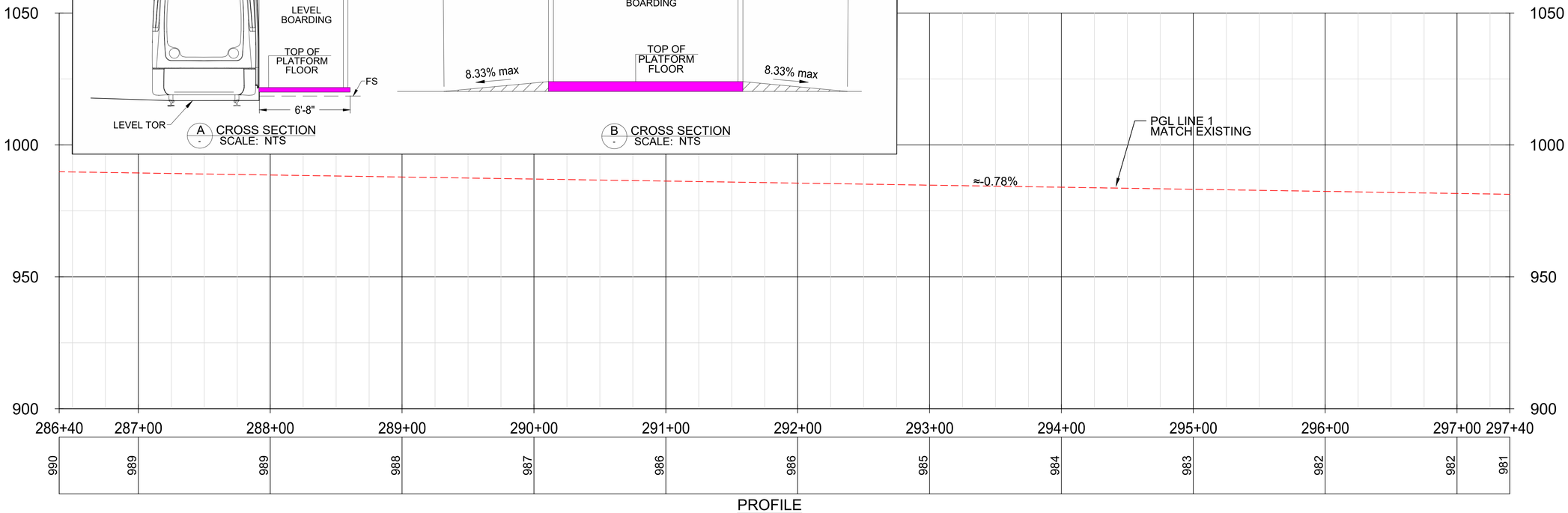

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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 286+50 TO STA 297+50

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-18 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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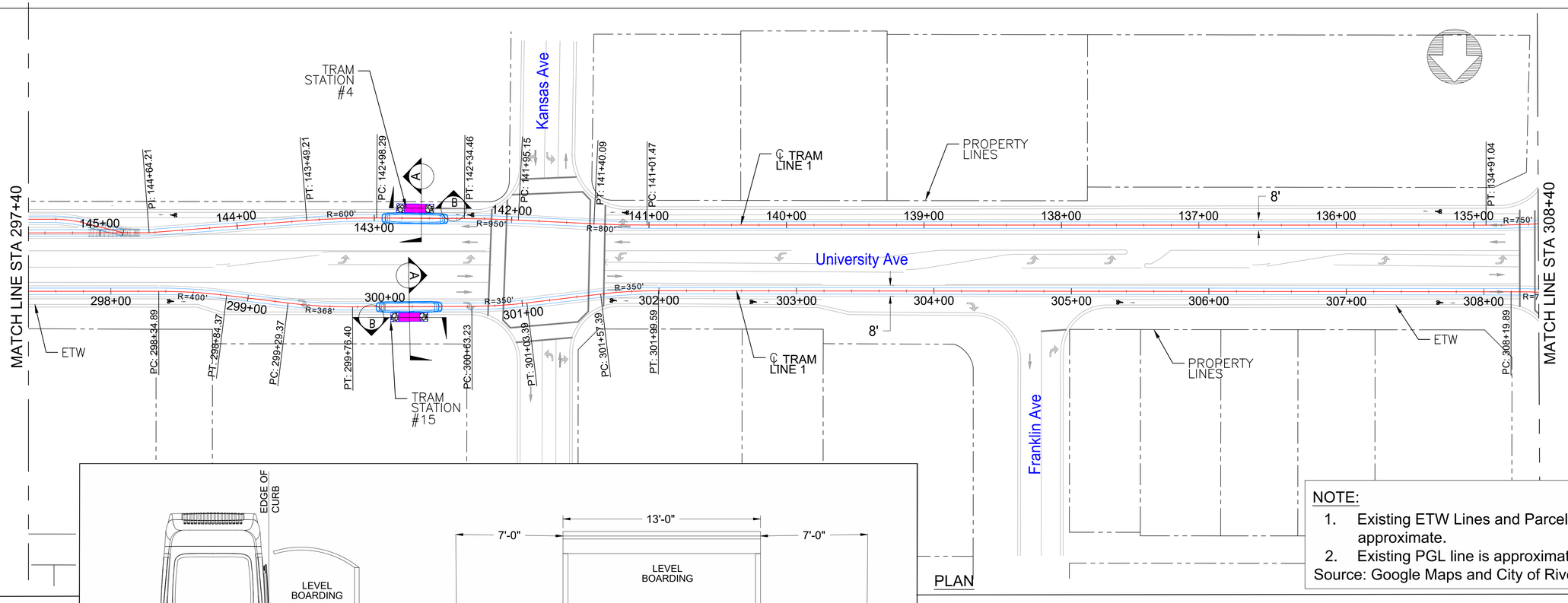

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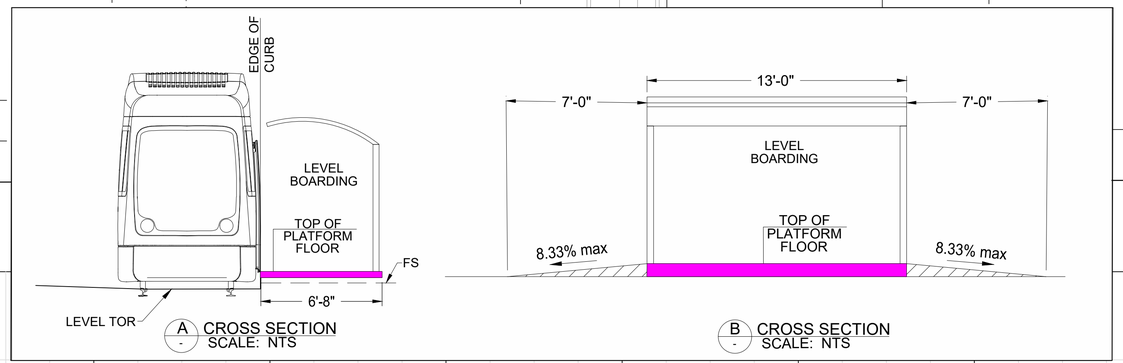

NOTE:

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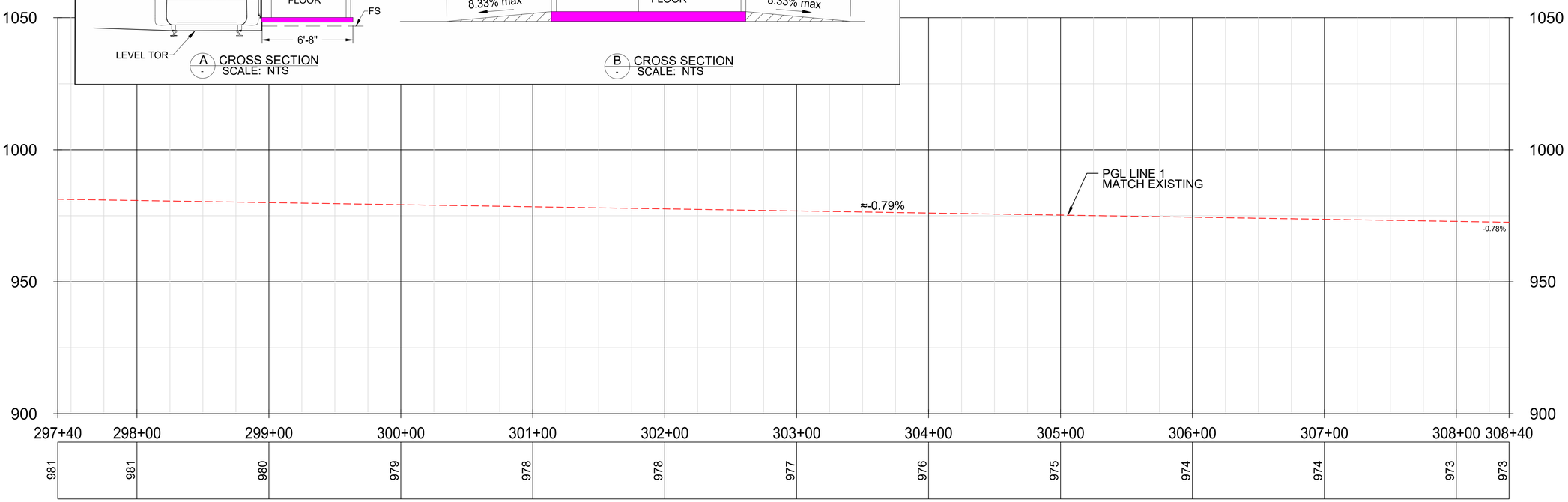

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DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-19

REV. 2

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PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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DATE	2021-12-17
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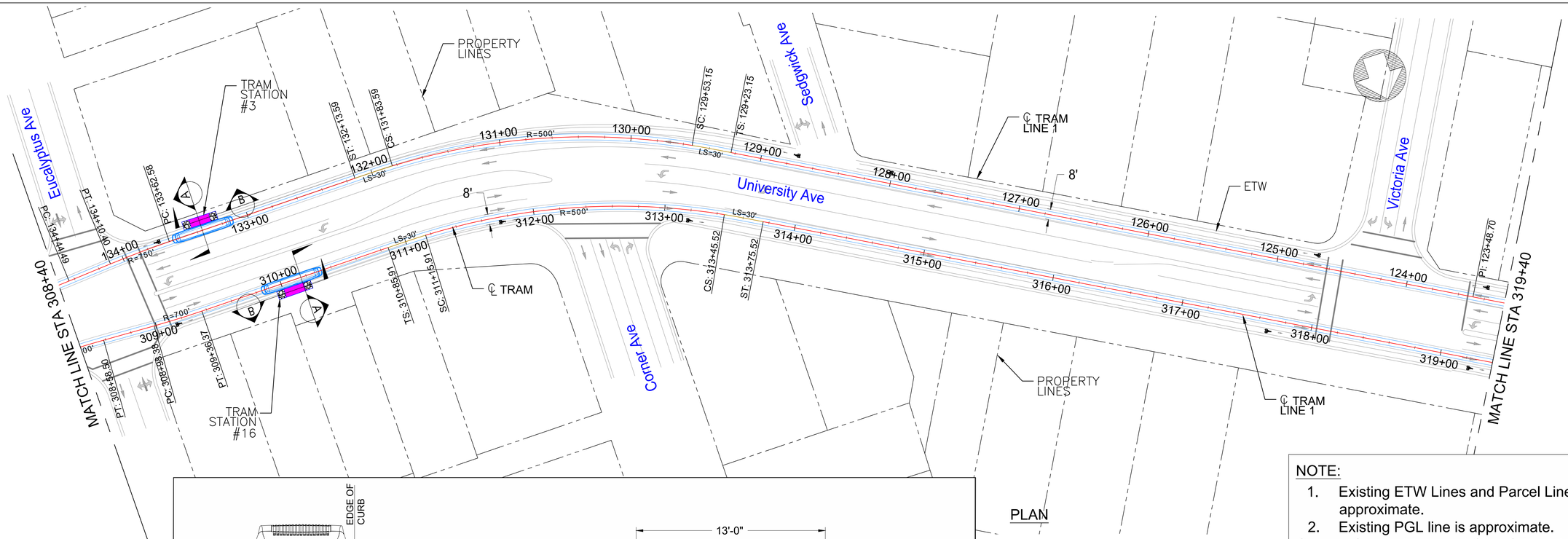

NOTE:

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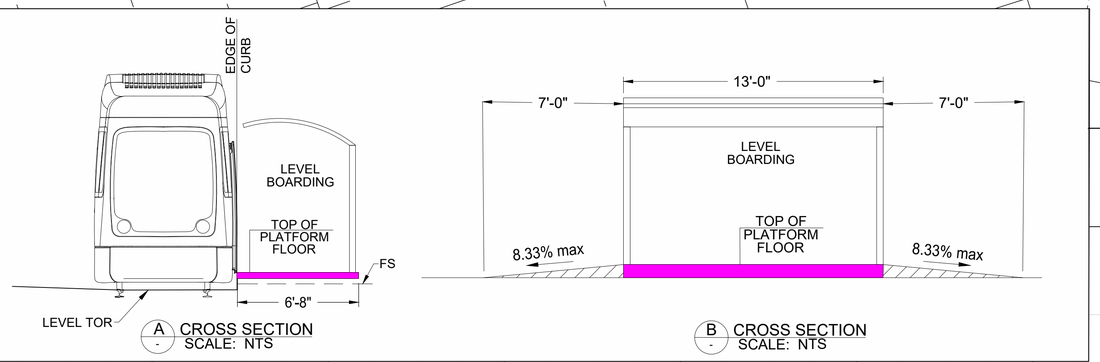
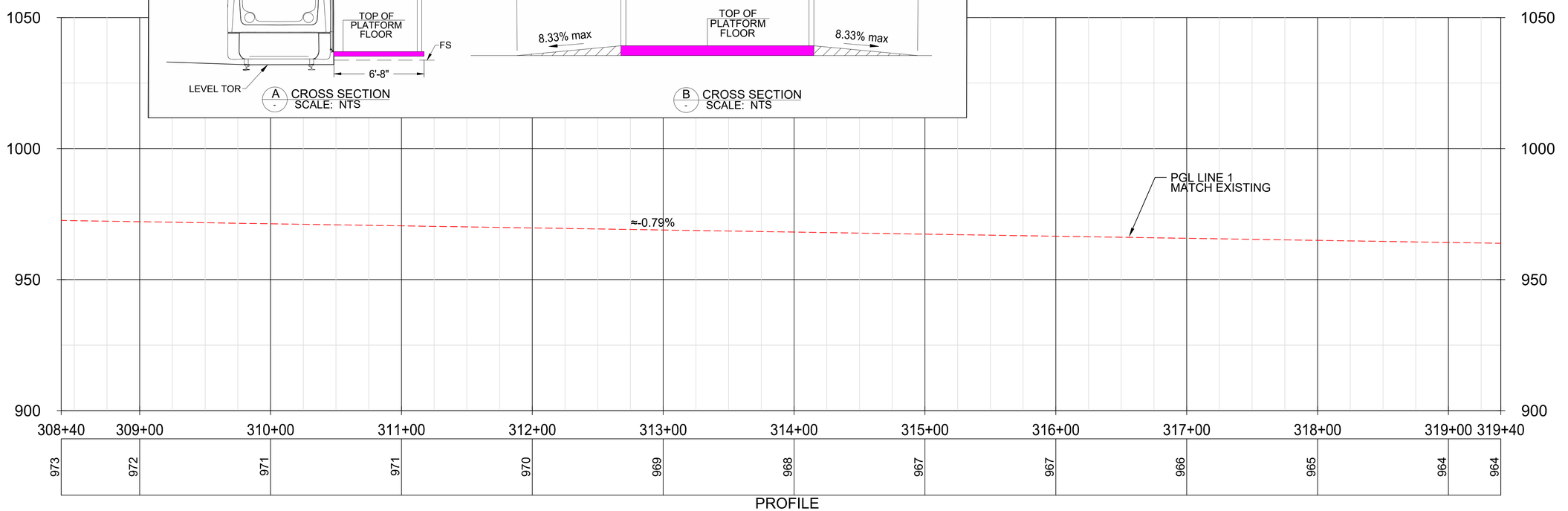
Source: Google Maps and City of Riverside GIS.





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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 308+50 TO STA 319+20

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-20 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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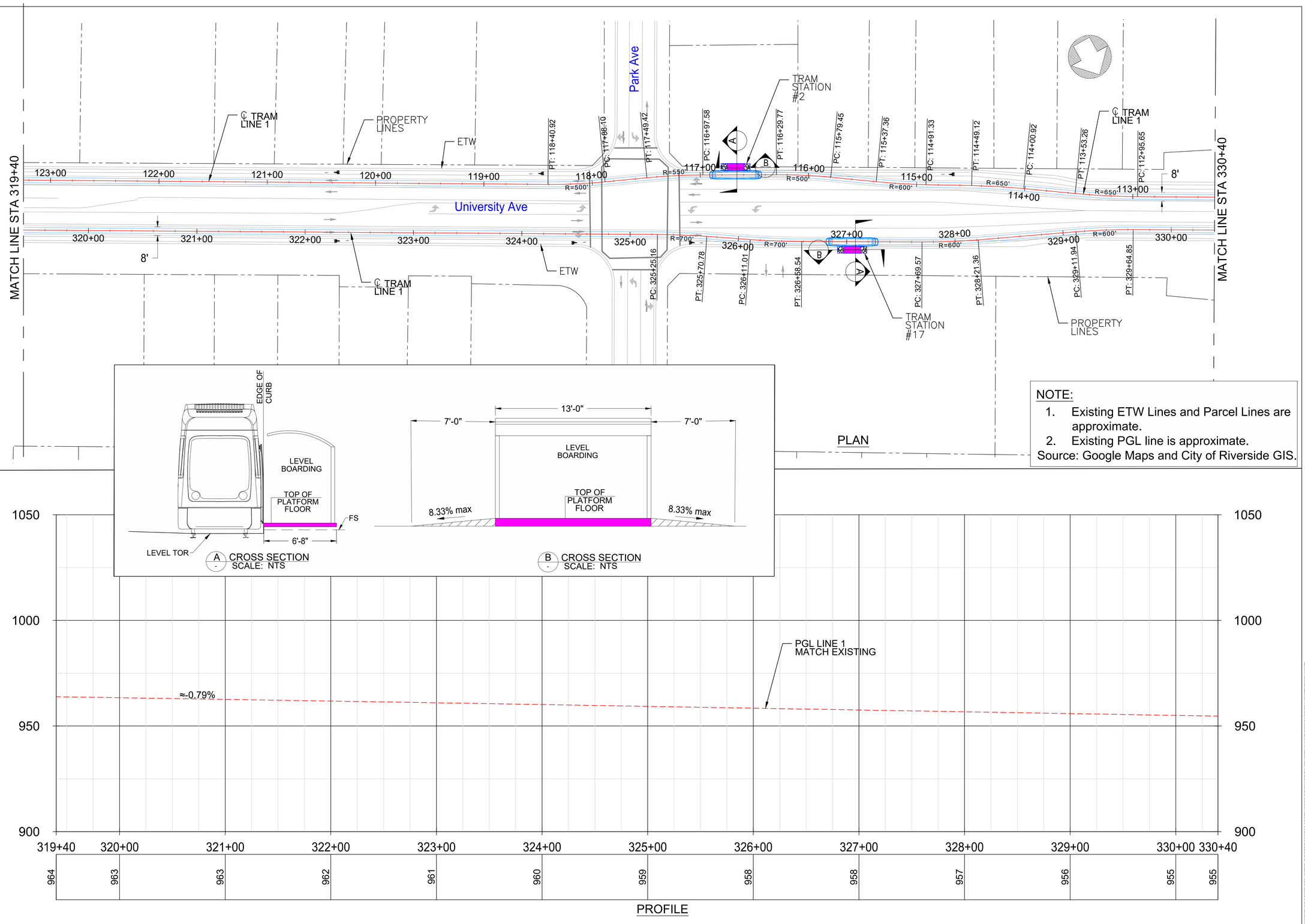

NOTE:

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SHEET TITLE:	PLAN AND PROFILE SHEET FROM STA 319+40 TO STA 330+40
DOCUMENT CONTROL NUMBER	RSC-4-06-DWG-004-FSR-PP-21 REV. 2 211217
PROJECT TITLE:	PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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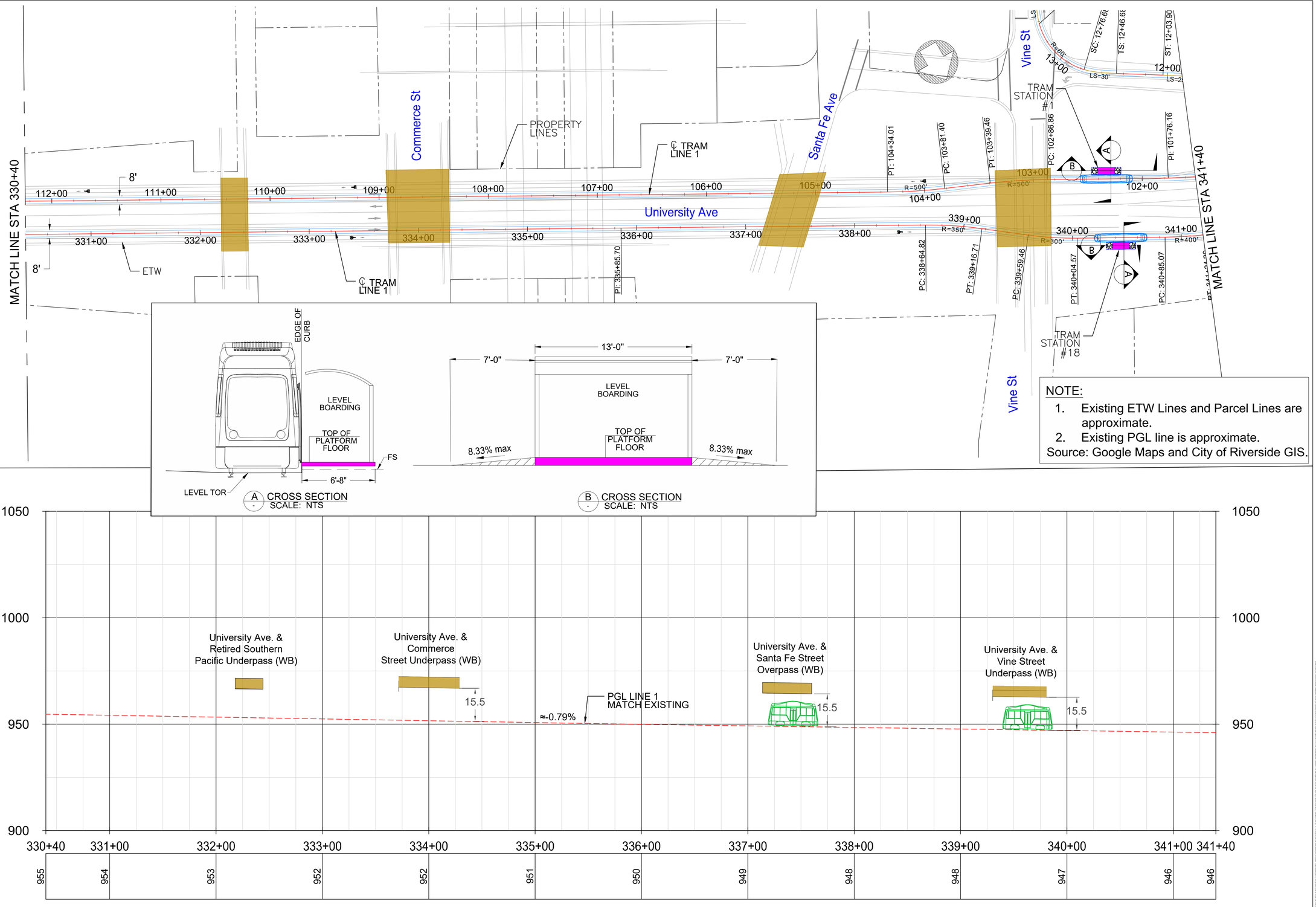

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REV NO.	DATE	DESCRIPTION
1	210730	REVISED

SHEET TITLE:	PLAN AND PROFILE SHEET FROM STA 330+40 TO STA 341+40
DOCUMENT CONTROL NUMBER	RSC-4-06-DWG-004-FSR-PP-22
REV.	2
	211217
PROJECT TITLE:	PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO.	PP-22
DATE	2021-12-17
SCALE	1: 40
SHEET	# OF #
REVISION NO.	2

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END LINE 1
BEGIN LINE 2
STA 10+00.00

℄ TRAM LINE 2
℄ TRAM LINE 1

11+78.90
R=130'
LS=25'
SC: 11+27.12
TS: 11+02.12
PT: 10+67.57
PC: 10+15.96
R=300'

MATCH LINE STA 341+40

Mulberry St
Riverside Fwy W
Riverside Fwy W
PROPERTY LINES
Lime St
University Ave
Lemon St
ETW
PROPERTY LINES

101+00
472+87
472+00
471+00
470+00
469+00
468+00
467+00
466+00
465+00
464+00
463+00
342+00
343+00
344+00
345+00
346+00
347+00
348+00
349+00
350+00
351+00
352+00

8'
8'

PC: 341+67.26
PT: 342+12.01
PI: 343+62.08
PI: 468+80.35
PI: 467+75.34
PI: 466+22.98
PI: 348+93.97
PI: 347+86.18

R=350'
R=80'
R=80'
R=80'
LS=30'
LS=30'
LS=30'
LS=30'

TS: 463+65.03
SC: 463+95.03
CS: 464+59.58
ST: 464+89.58
SC: 351+08.00
CS: 351+73.34
ST: 352+03.34
TS: 350+78.00

TRAM STATION #30
TRAM STATION #19

MATCH LINE STA 352+40

PLAN

EDGE OF CURB
LEVEL BOARDING
TOP OF PLATFORM FLOOR
FS
6'-8"
LEVEL TOR

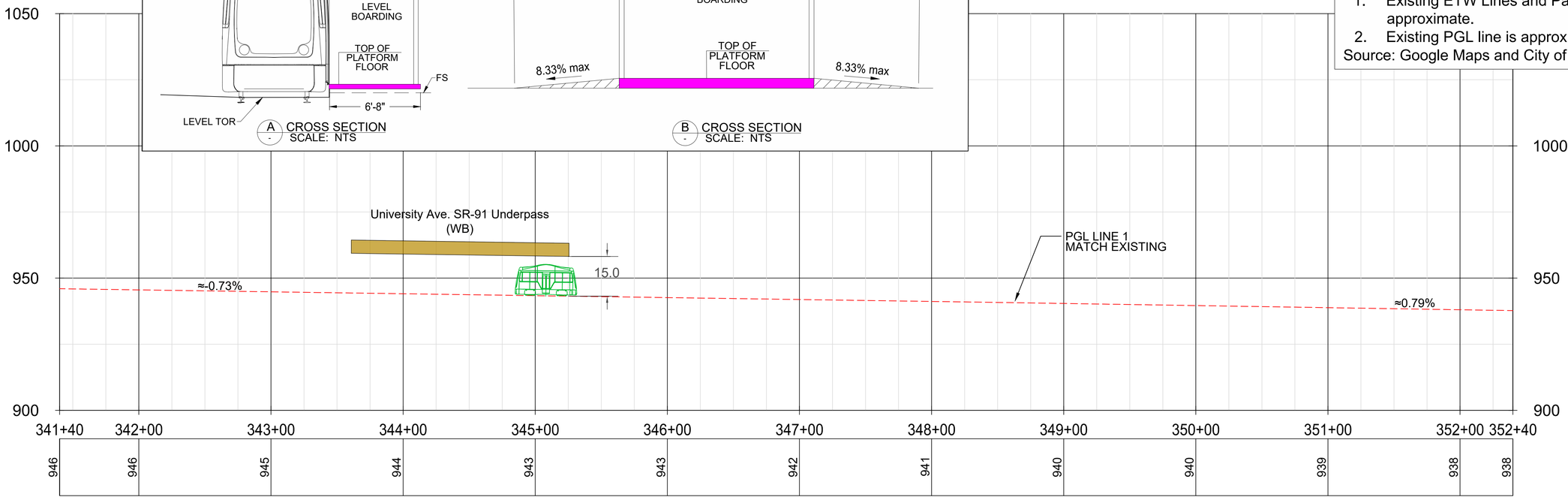
A CROSS SECTION
SCALE: NTS

13'-0"
7'-0"
7'-0"
LEVEL BOARDING
TOP OF PLATFORM FLOOR
8.33% max
8.33% max

B CROSS SECTION
SCALE: NTS

NOTE:
1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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3		
4		
5		
6		
7		

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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 341+40 TO STA 352+40
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-23
REV. 2
211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-23
DATE 2021-12-17
SCALE 1: 40
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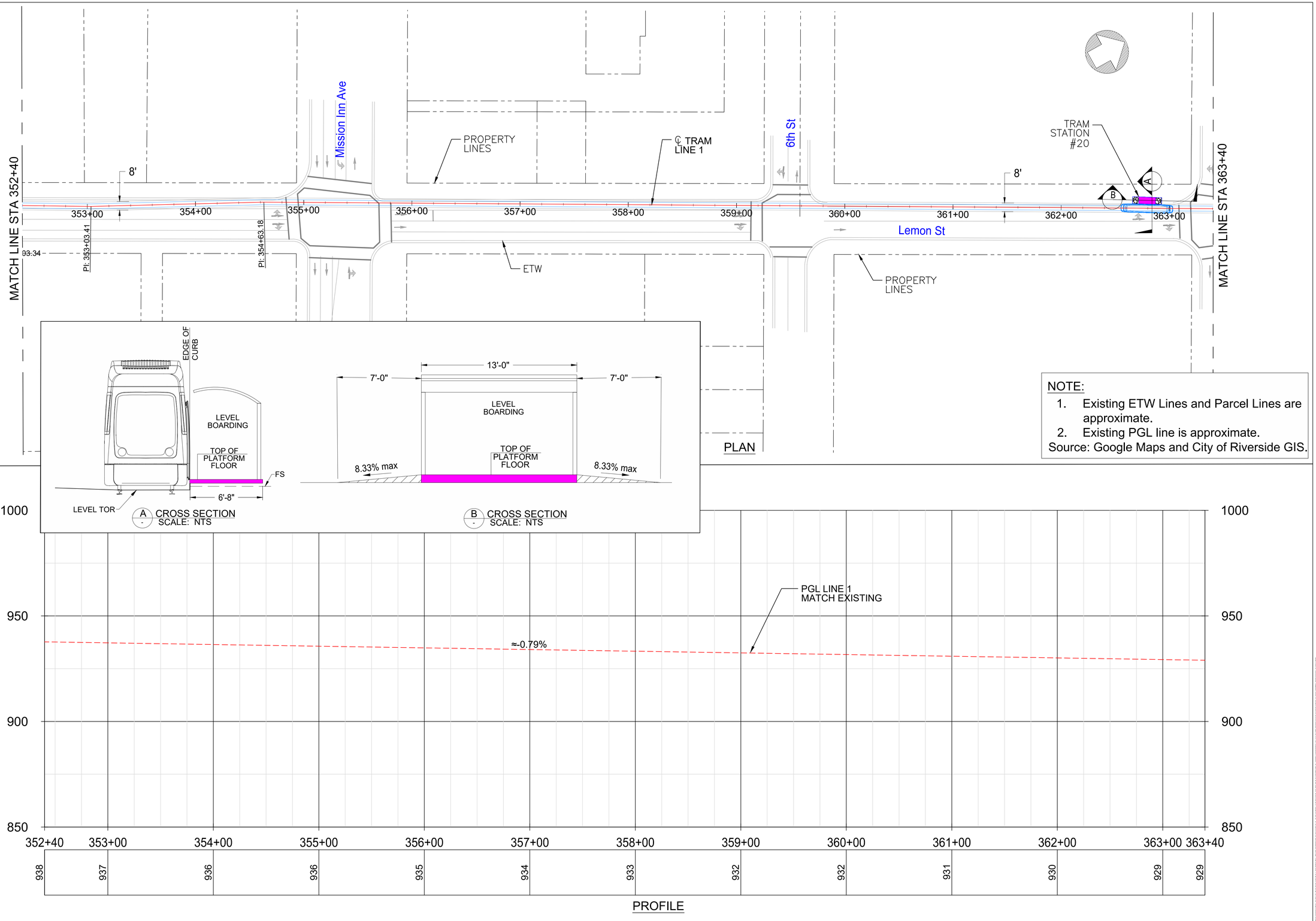

NOTE:
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A		
A		
A		
A		
A		
A		

SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 352+40 TO STA 363+40

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-24 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-24

DATE 2021-12-17

SCALE 1: 40

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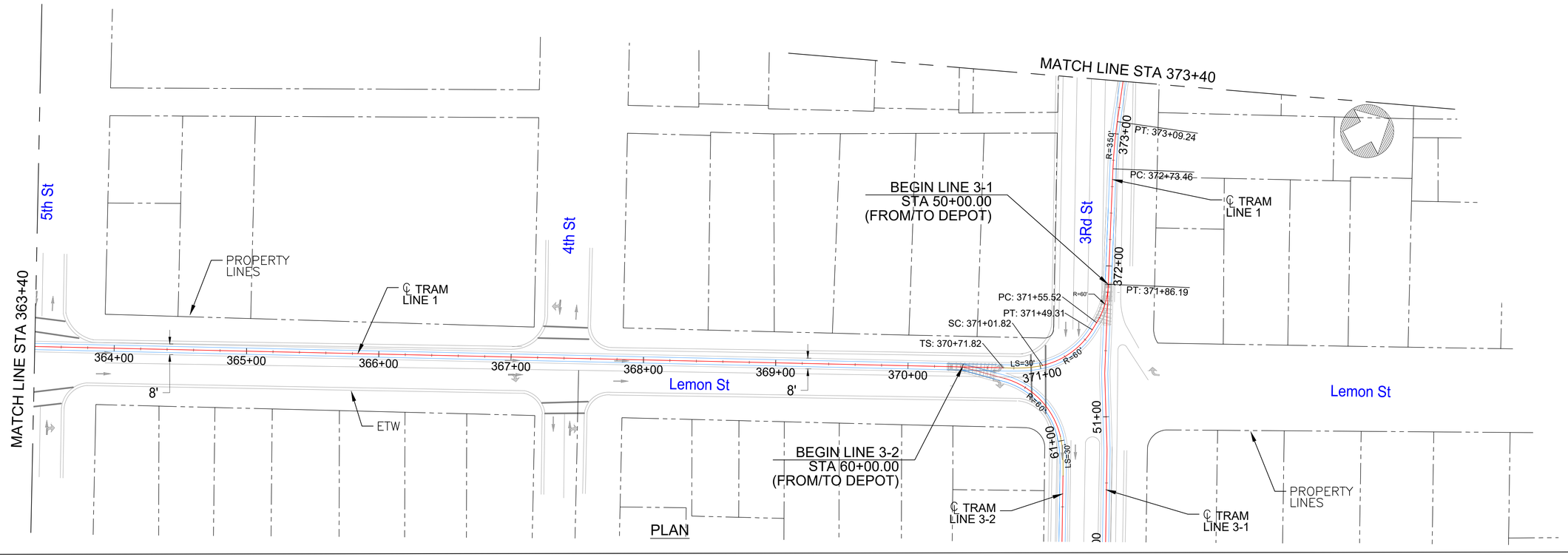

PLAN

NOTE:

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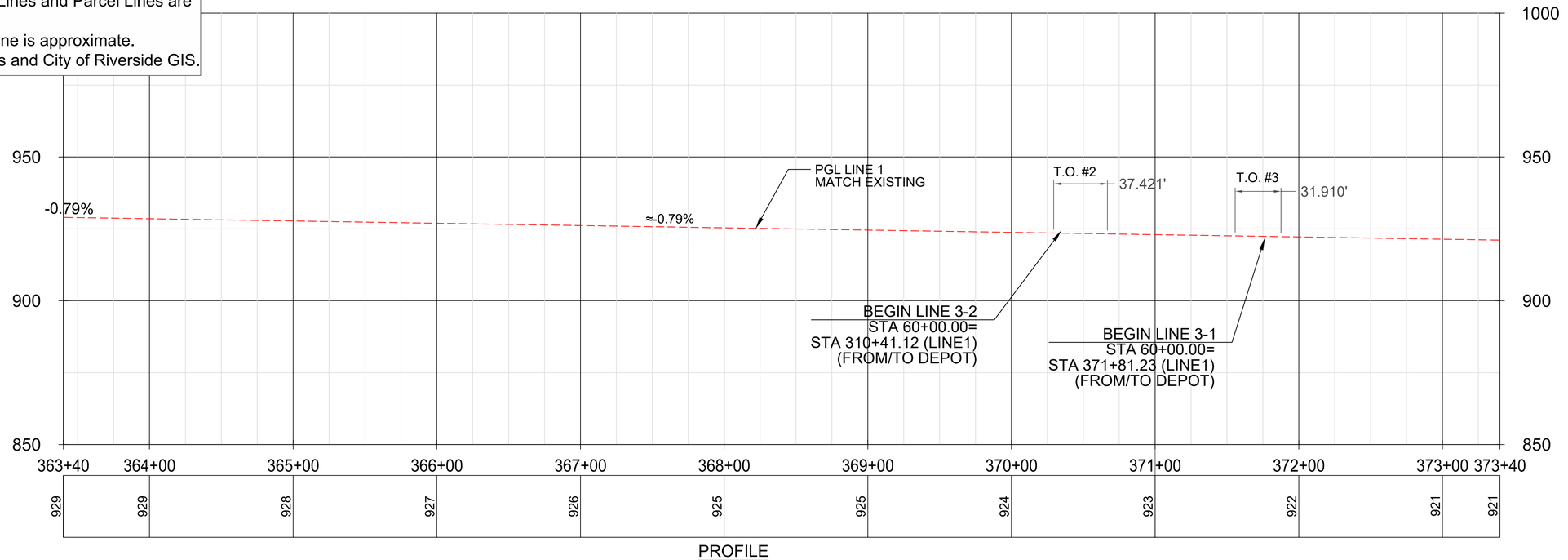
Source: Google Maps and City of Riverside GIS.



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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 363+40 TO STA 374+40

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-25 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-25

DATE 2021-12-17

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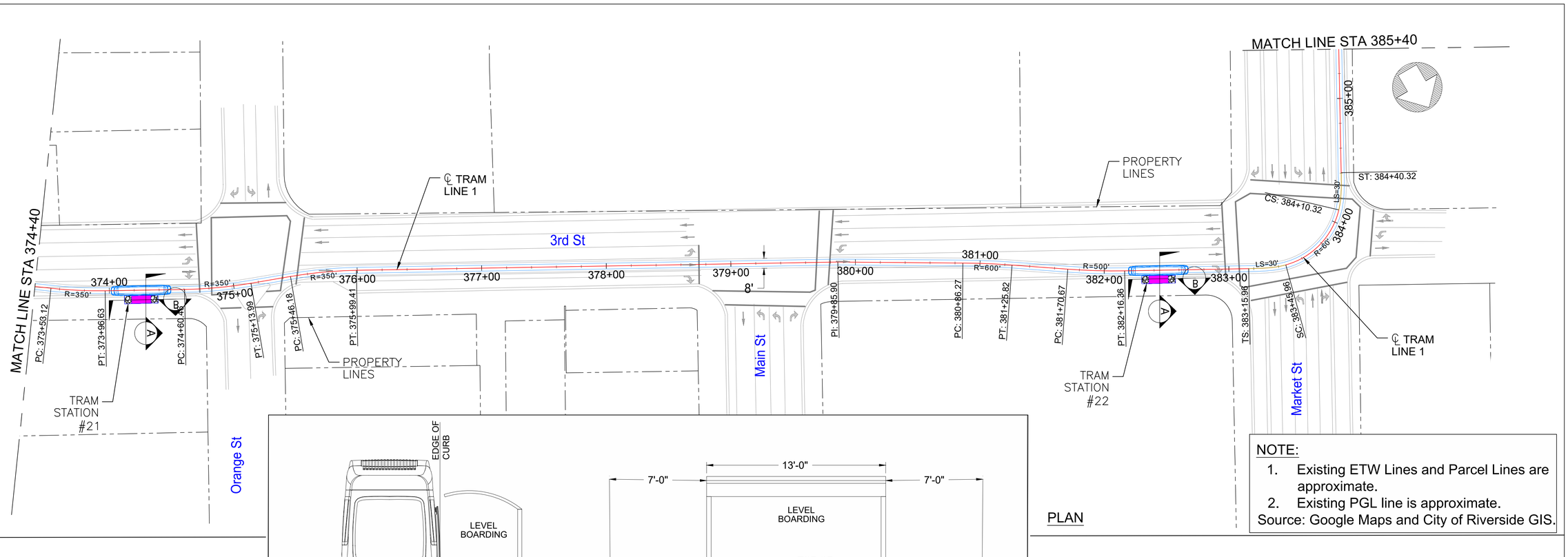

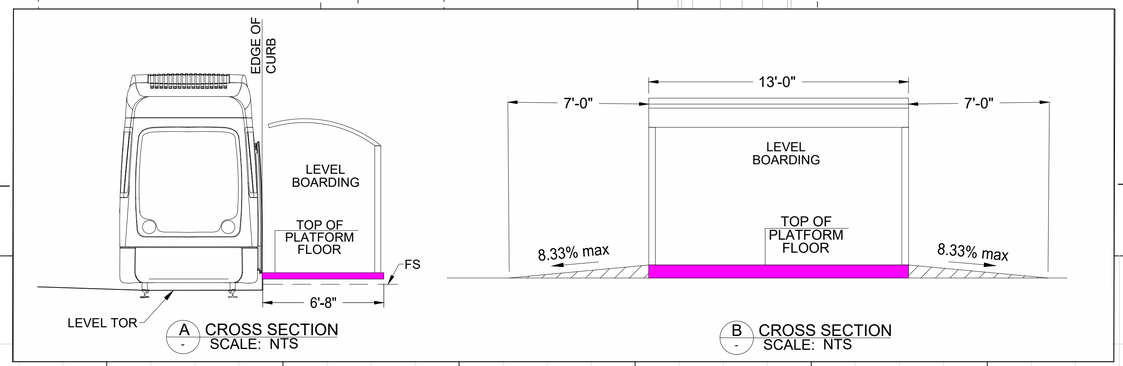

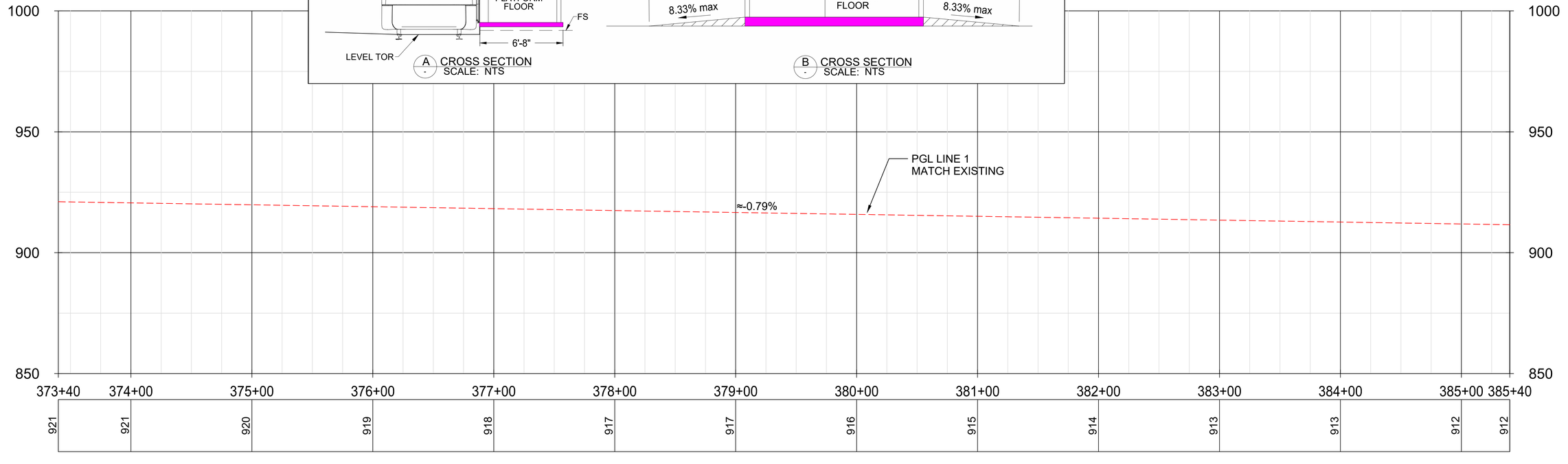

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SHEET TITLE:	PLAN AND PROFILE SHEET FROM STA 374+40 TO STA 385+40
DOCUMENT CONTROL NUMBER:	RSC-4-06-DWG-004-FSR-PP-26 REV. 2 211217
PROJECT TITLE:	PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR
DRAWING NO.	PP-26
DATE	2021-12-17
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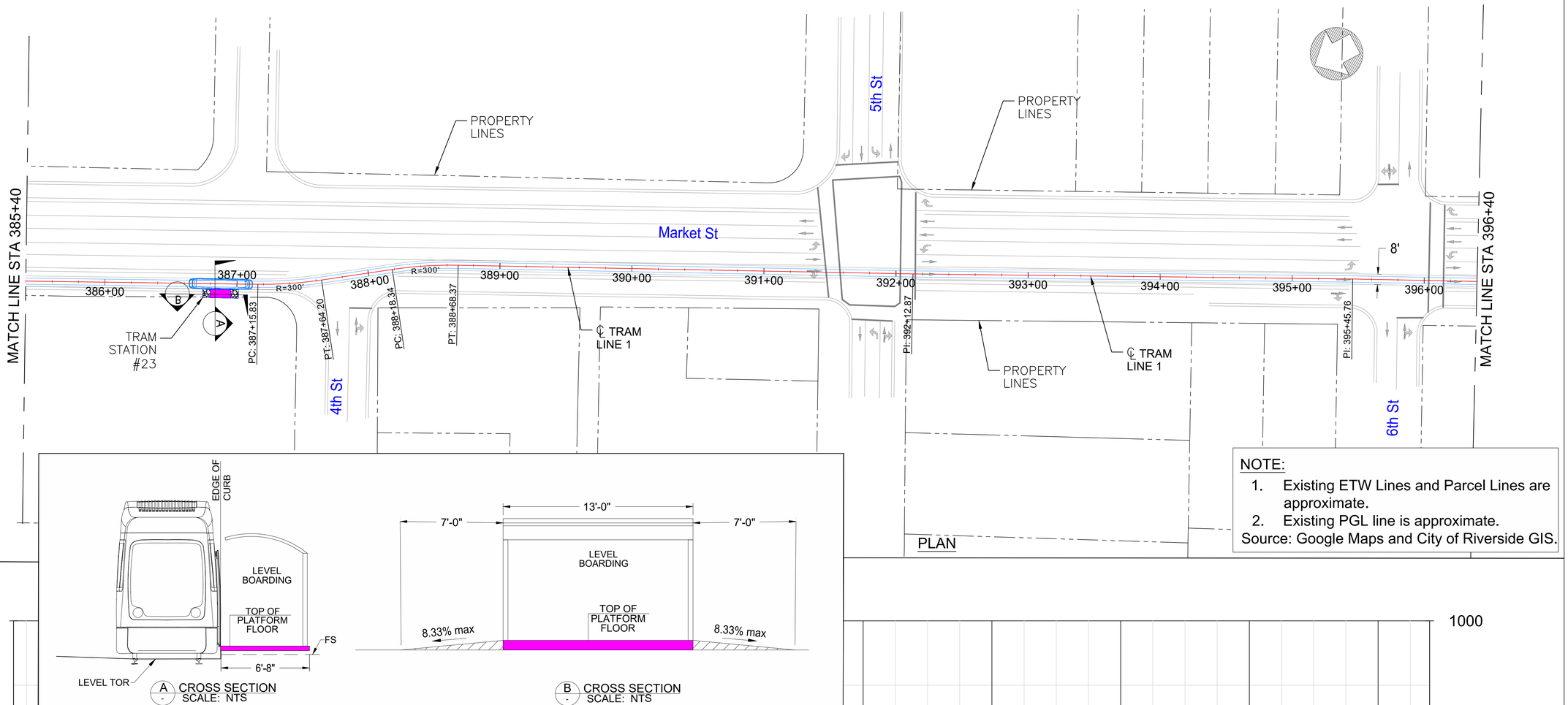

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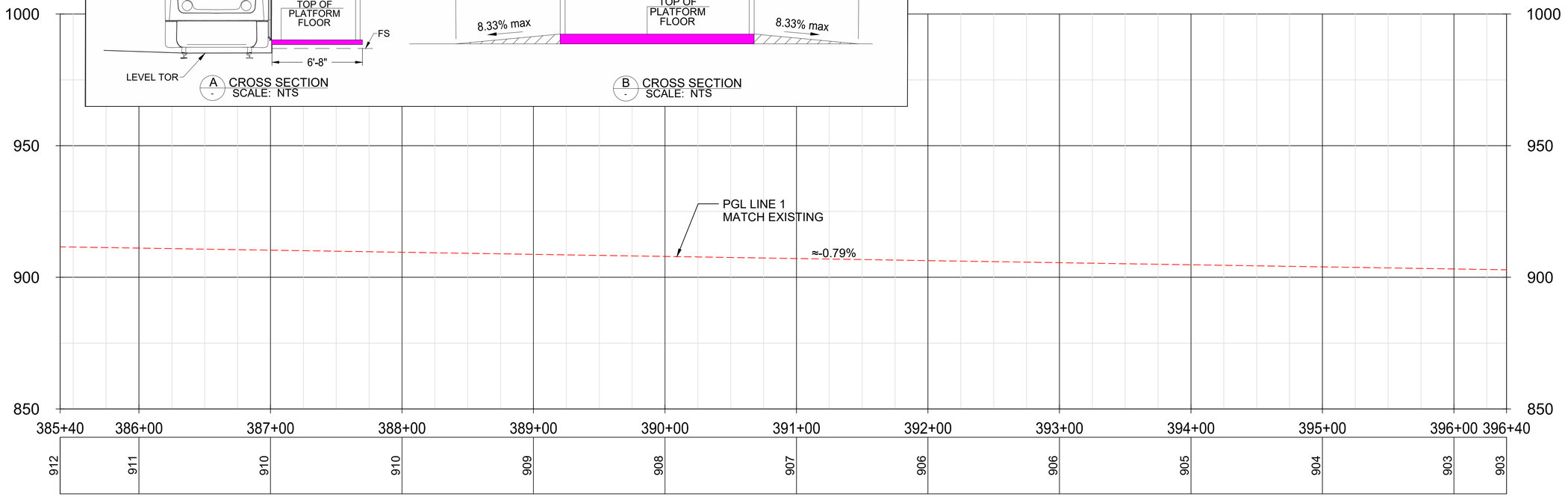

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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 385+40 TO STA 396+40
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-27 REV. 2 211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-27
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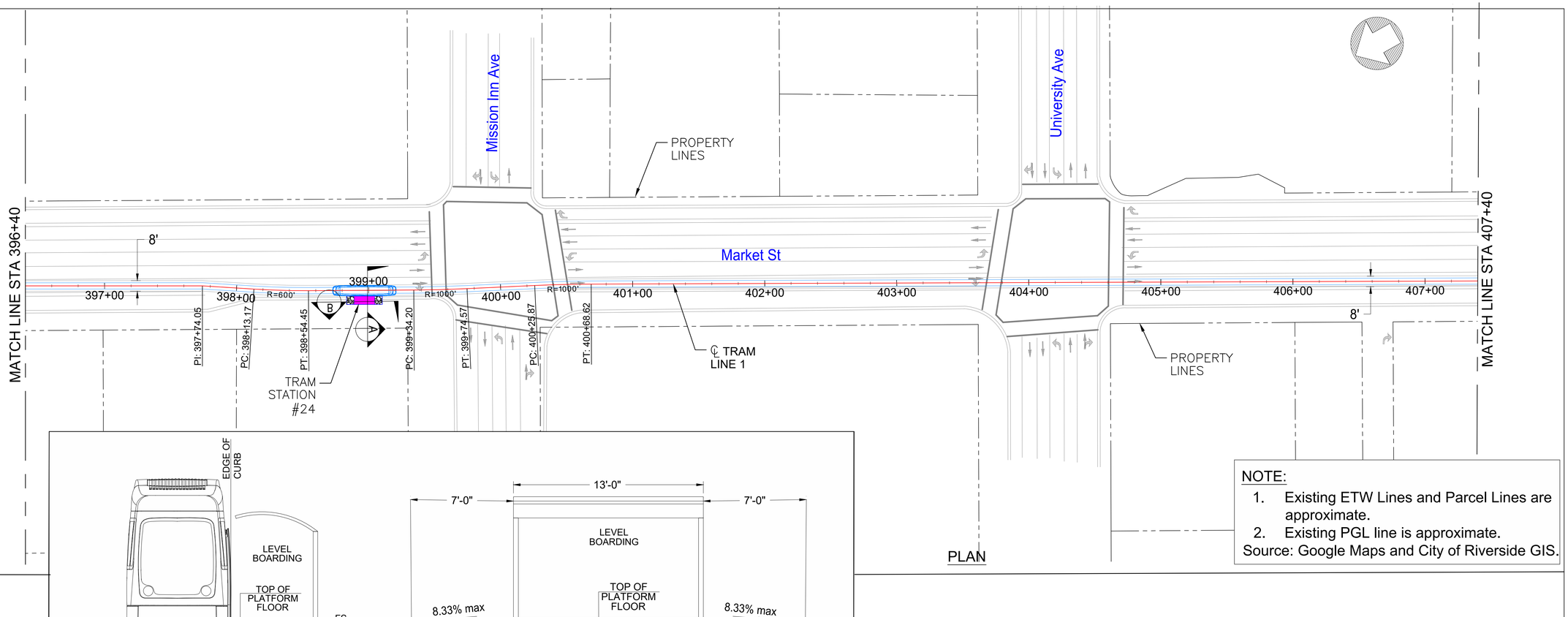

NOTE:
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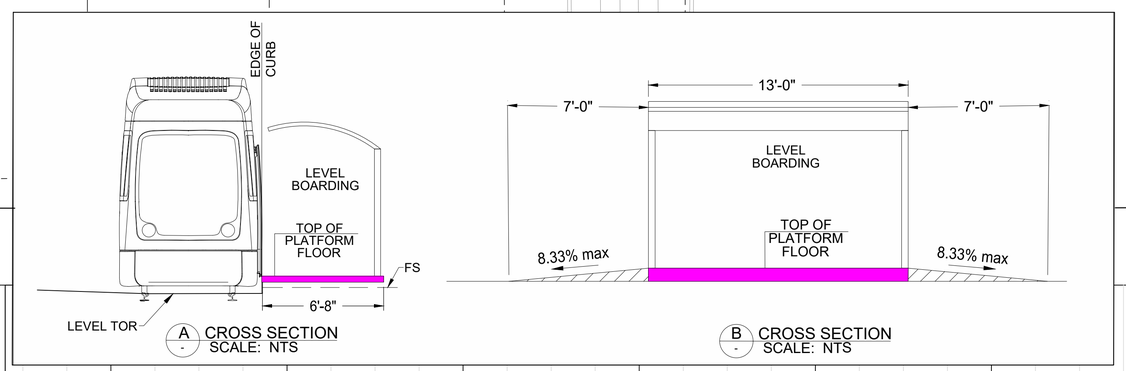
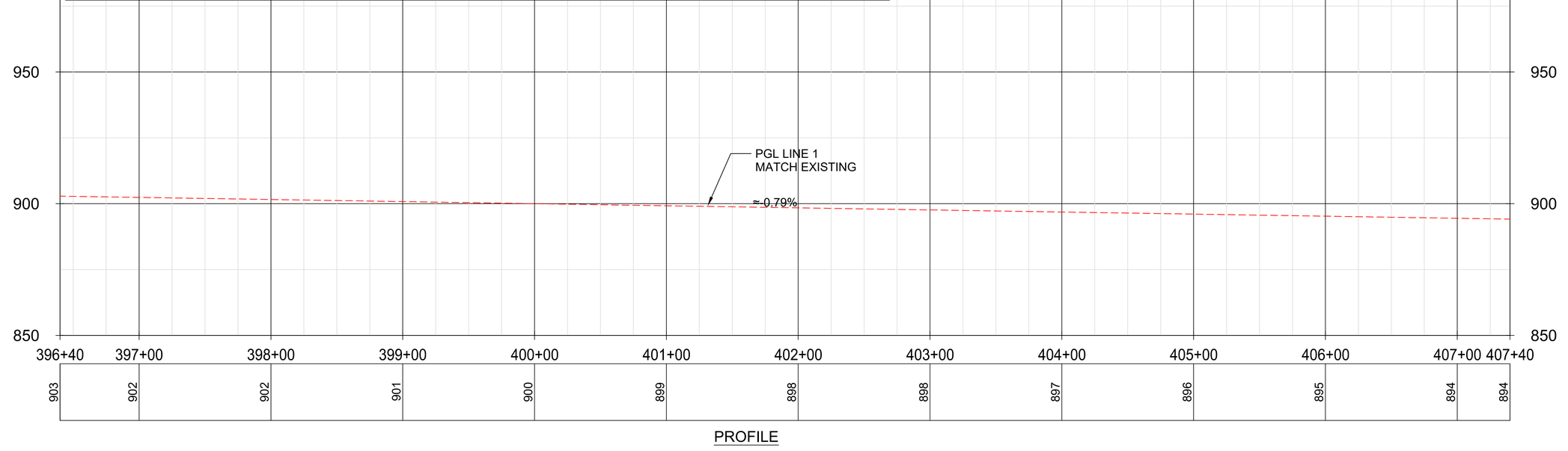
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.





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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 396+50 TO STA 407+50
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-28 REV. 2 211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-28
DATE 2021-12-17
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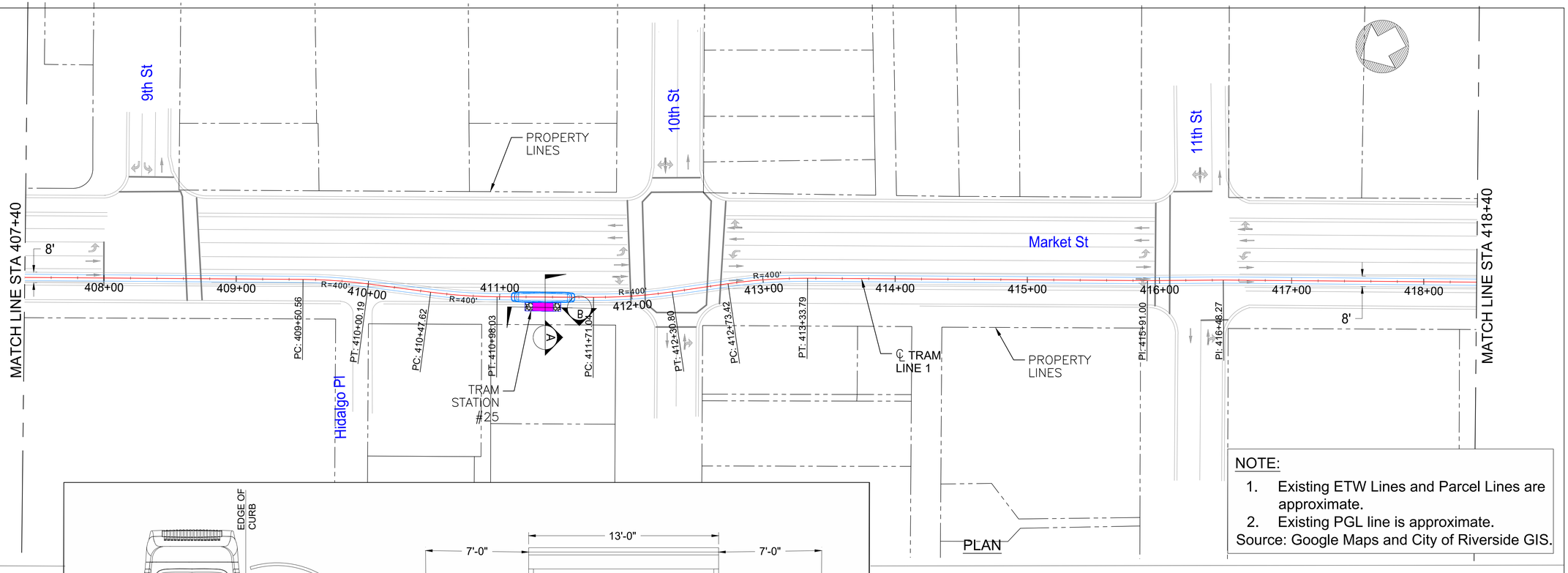
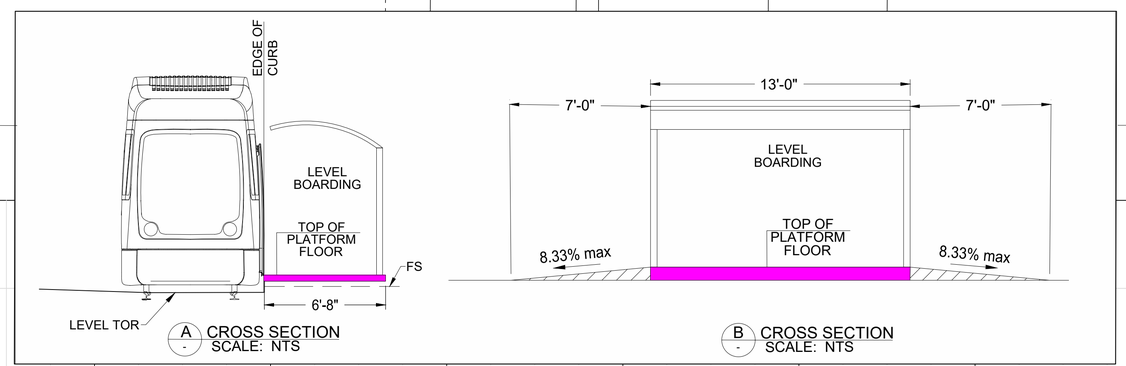
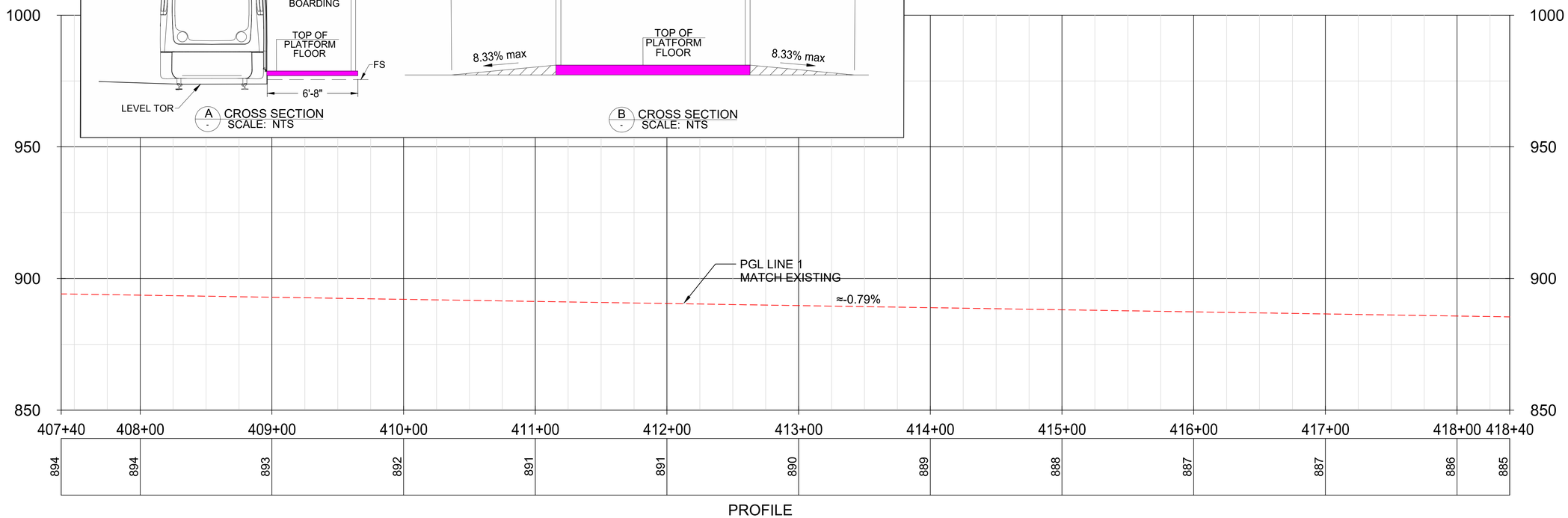


NOTE:
1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.

PLAN





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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 407+40 TO STA 418+40
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-29 REV. 2 211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-29
DATE 2021-12-17
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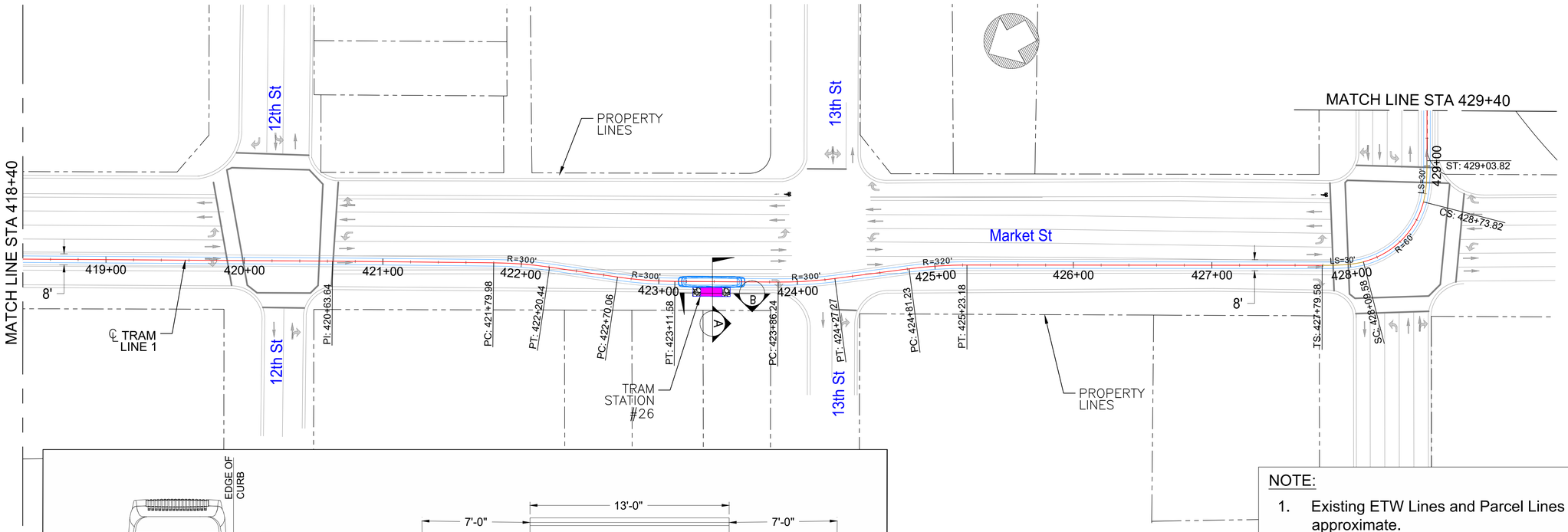
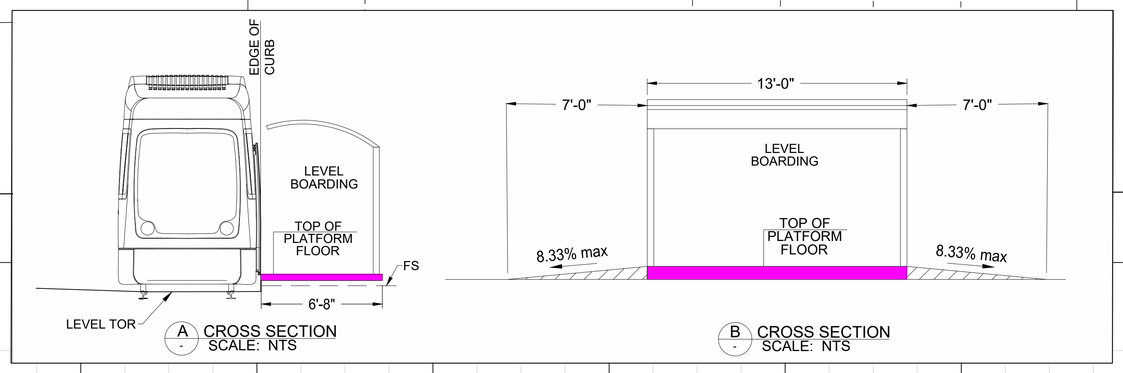


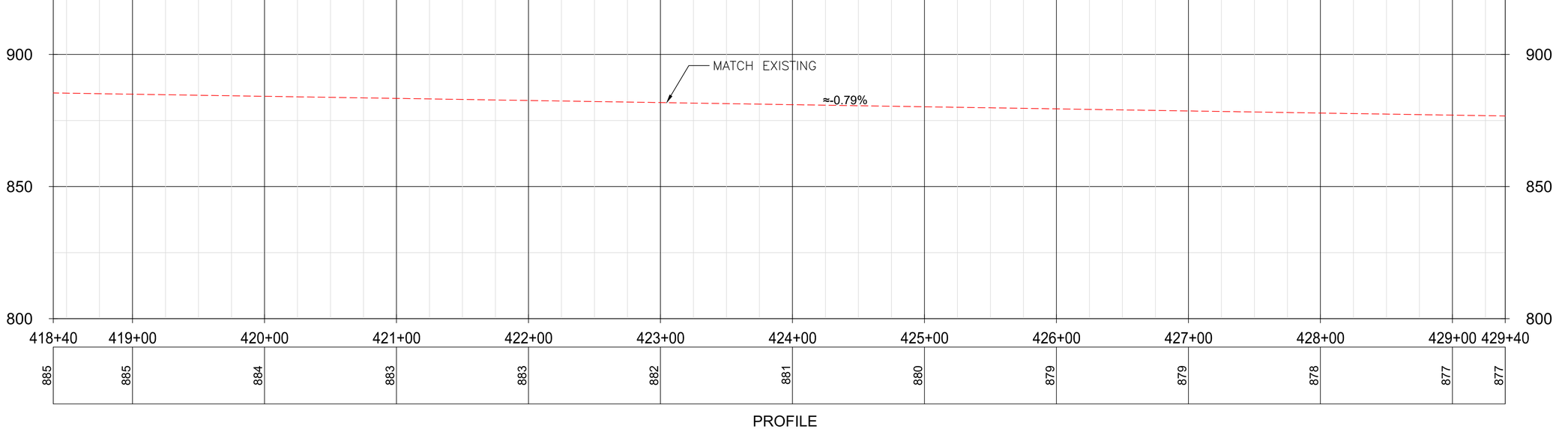
NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.

PLAN





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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 418+50 TO STA 429+50
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-30
REV. 2
211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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DATE 2021-12-17
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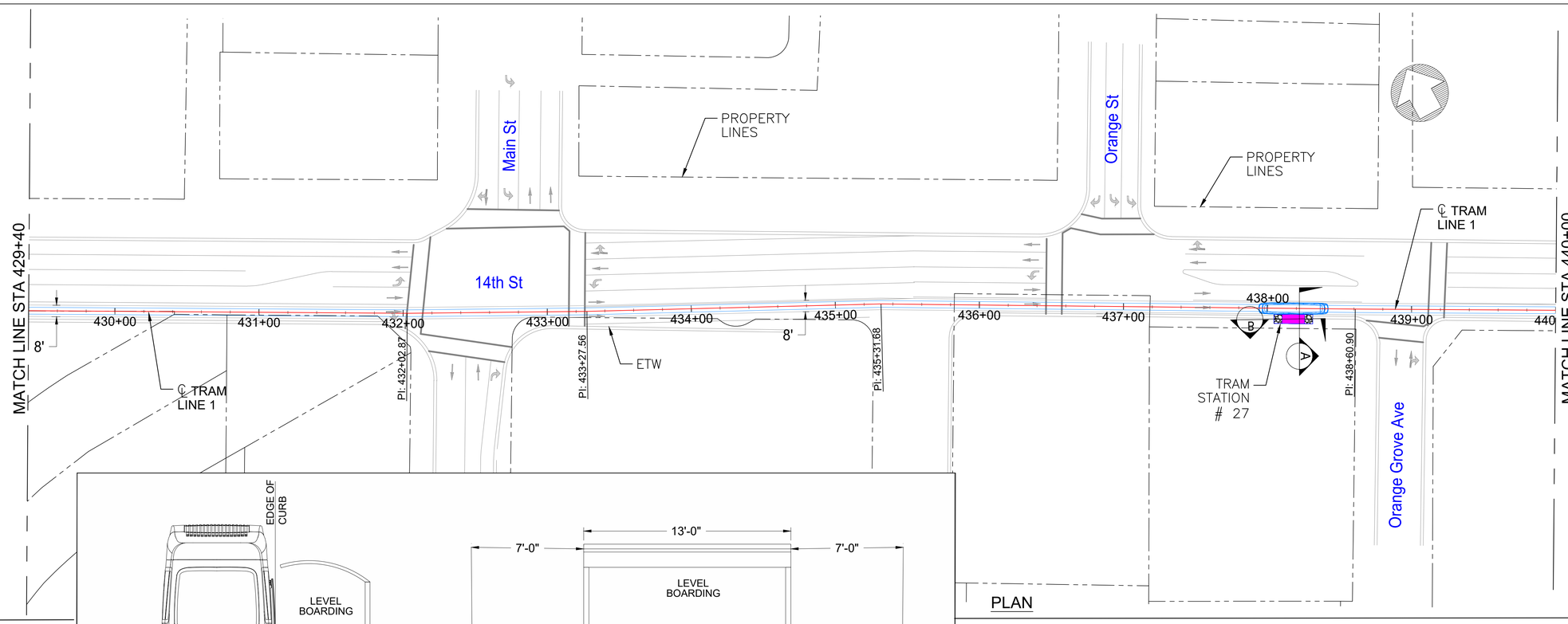

A CROSS SECTION
SCALE: NTS

B CROSS SECTION
SCALE: NTS

PLAN

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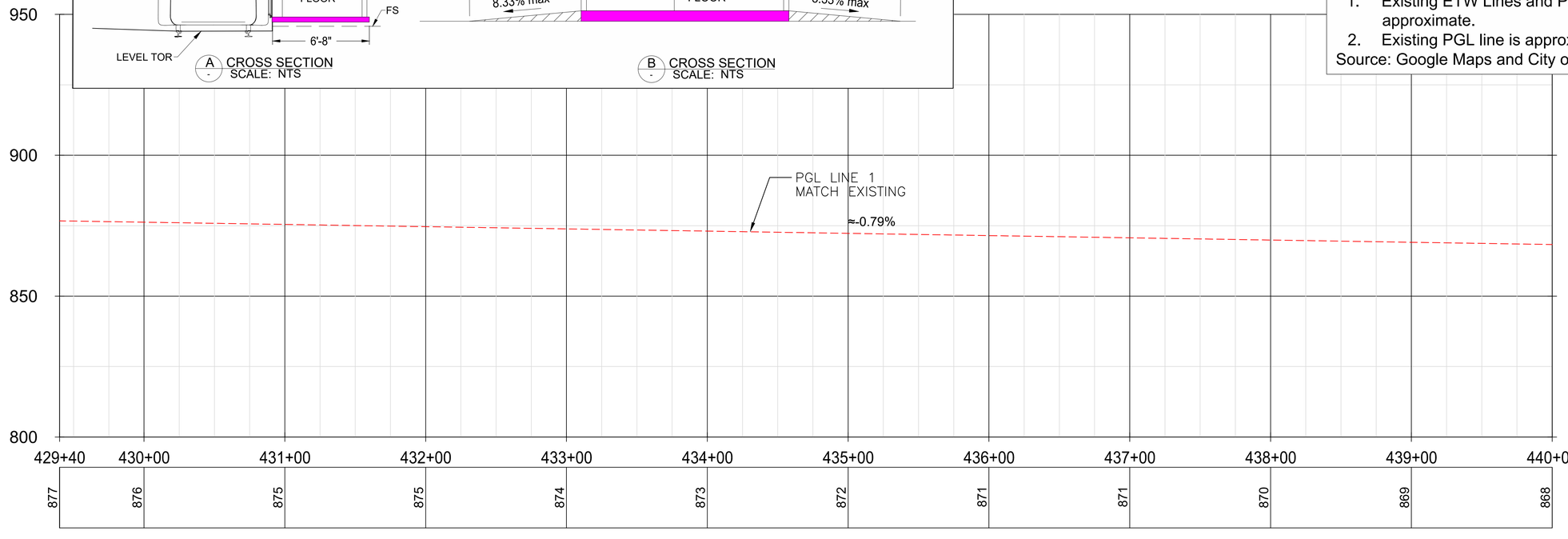
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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SHEET TITLE:	PLAN AND PROFILE SHEET FROM STA 429+40 TO STA 440+00
DOCUMENT CONTROL NUMBER:	RSC-4-06-DWG-004-FSR-PP-31
REV.	2
	211217
PROJECT TITLE:	PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO.	PP-31
DATE	2021-12-17
SCALE	1: 40
SHEET	# OF #
REVISION NO.	2

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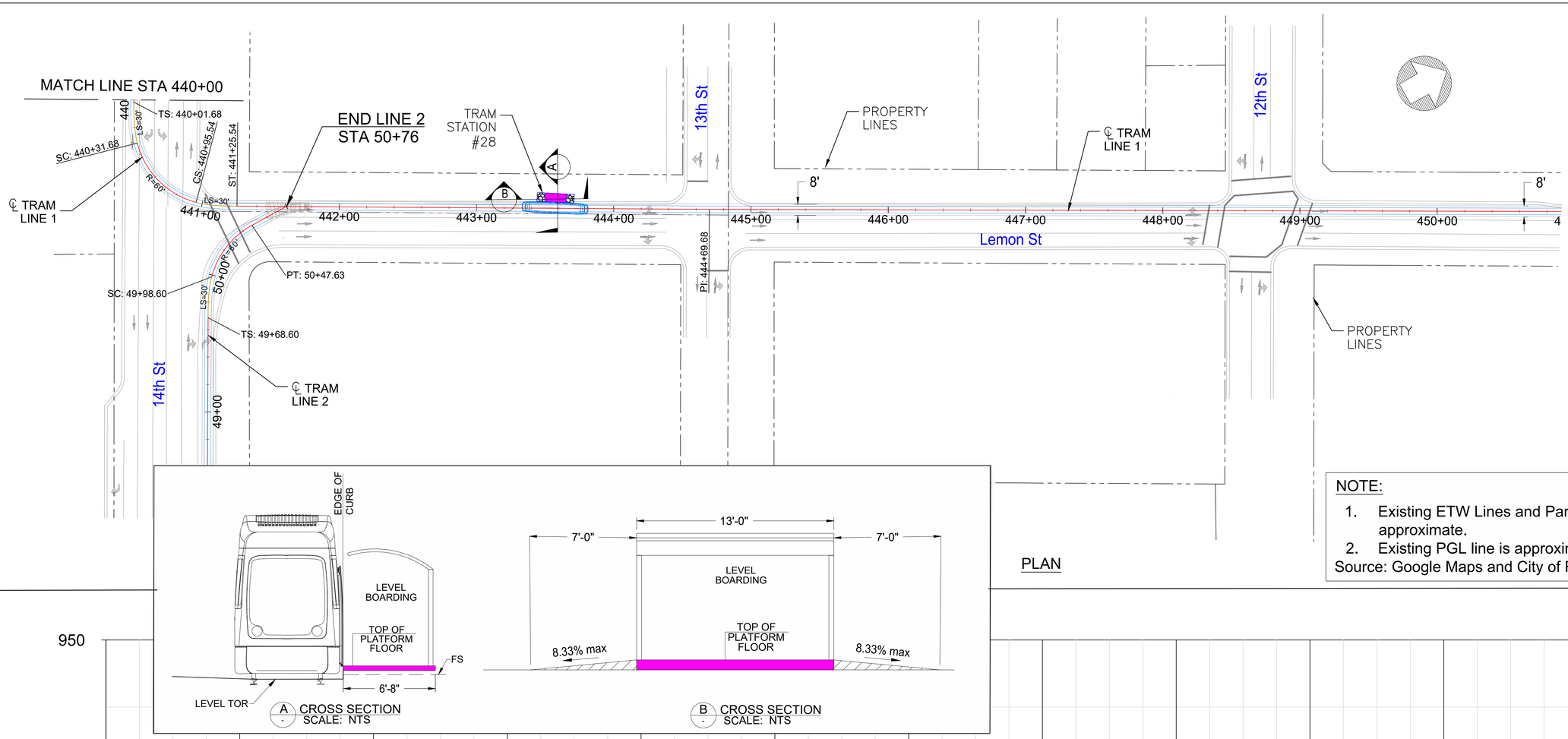

PLAN

NOTE:

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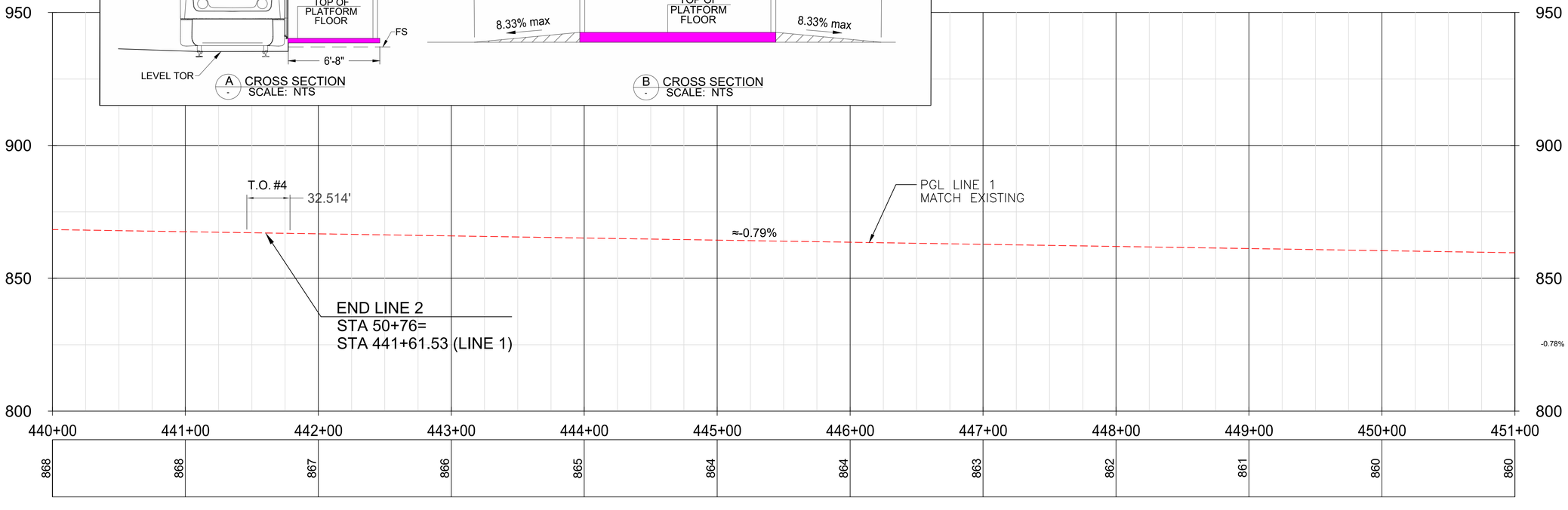
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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REV NO.	DATE	DESCRIPTION
A	210730	REVISED
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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 440+00 TO STA 451+00

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-32 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-32

DATE	2021-12-17
SCALE	1: 40
SHEET	# OF #
REVISION NO.	2

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Plot Date: 2021/12/16

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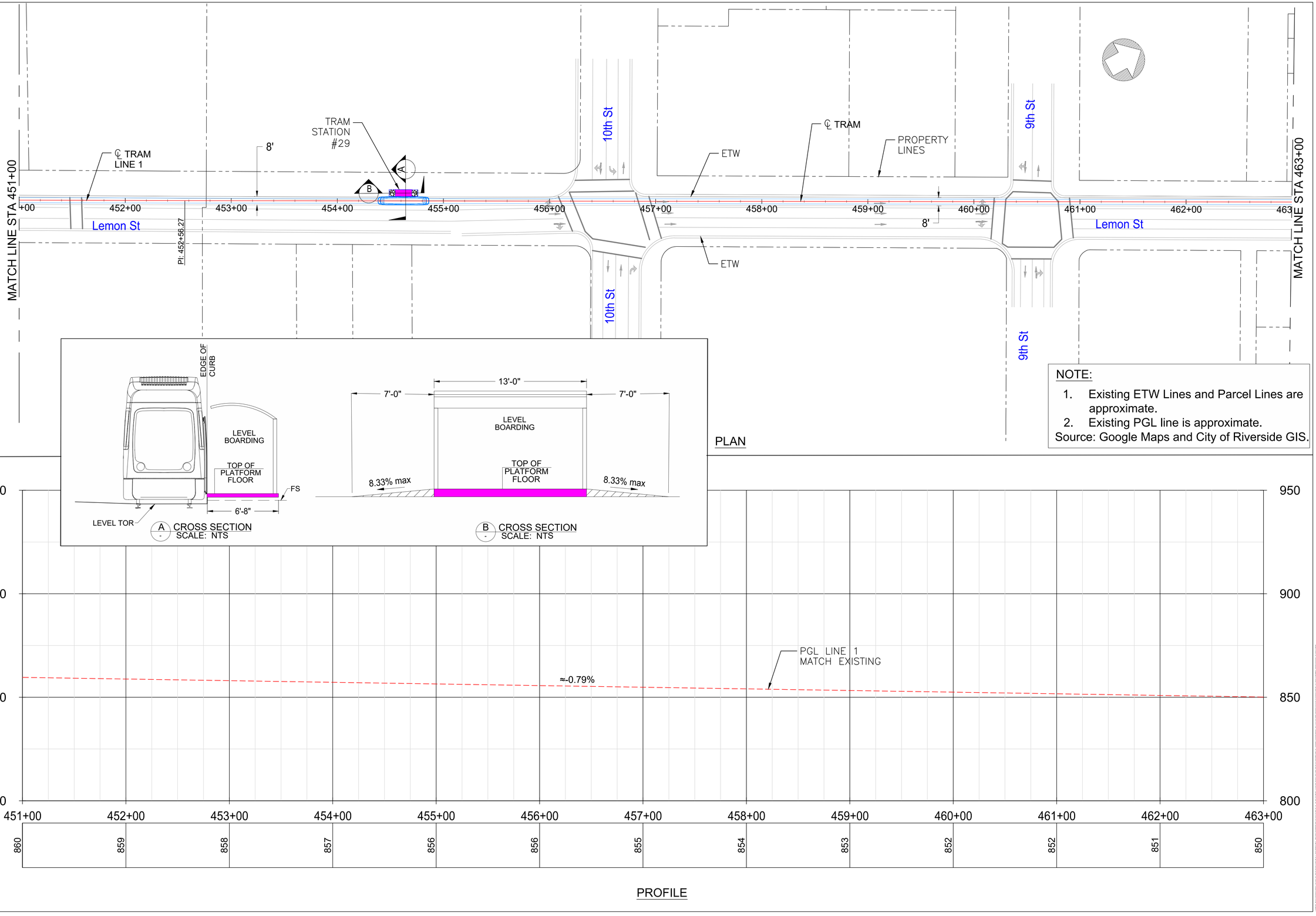

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.

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A	210730	REVISED

SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 451+00 TO ST 463+20

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-33 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-33

DATE 2021-12-17

SCALE 1: 40

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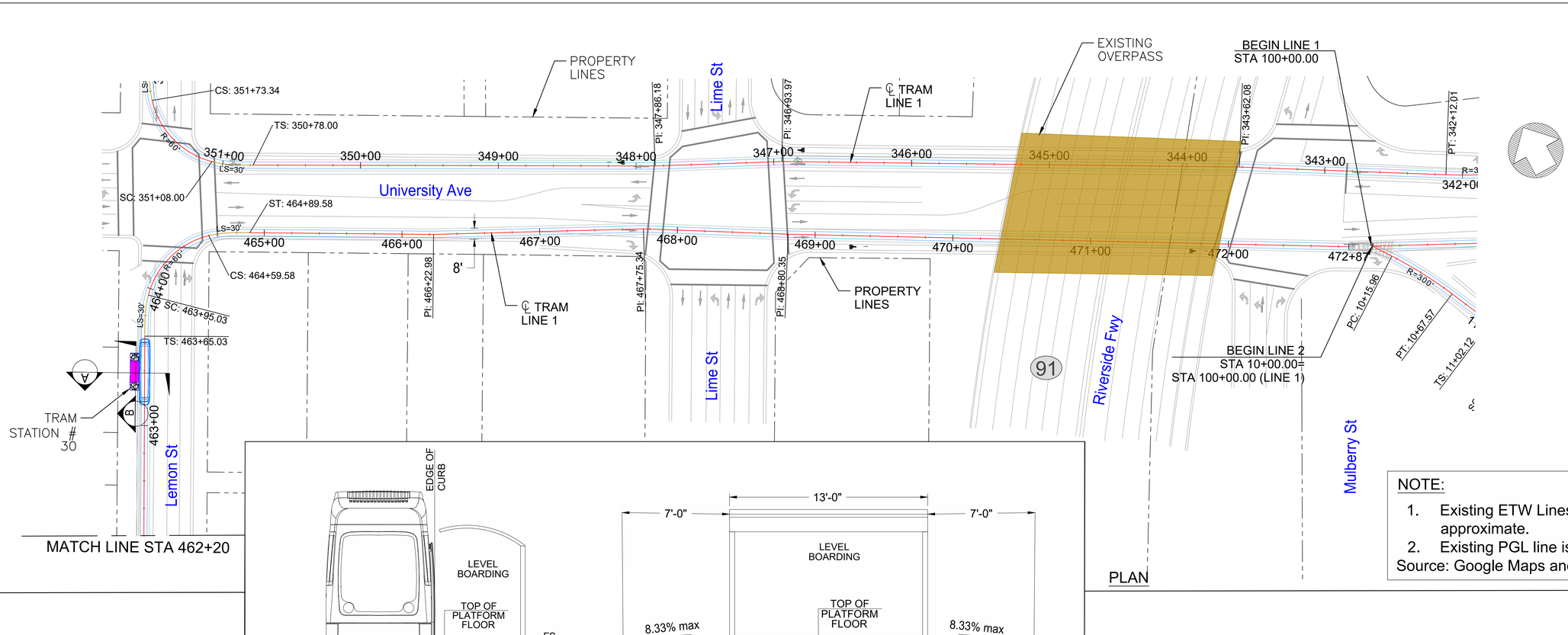

NOTE:

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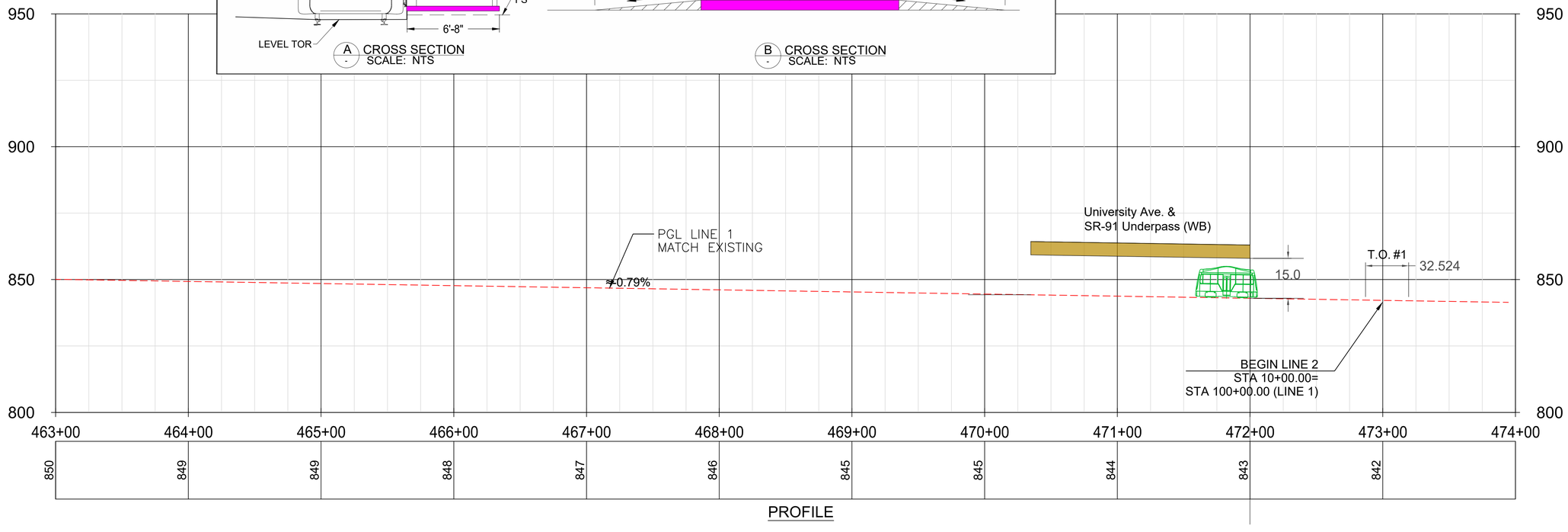
Source: Google Maps and City of Riverside GIS.



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1	210730	REVISED

SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 462+20 TO 474+00

DOCUMENT CONTROL NUMBER: RSC-4-006-DWG-004-FSR-PP-34 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-34

DATE 2021-12-17

SCALE 1: 40

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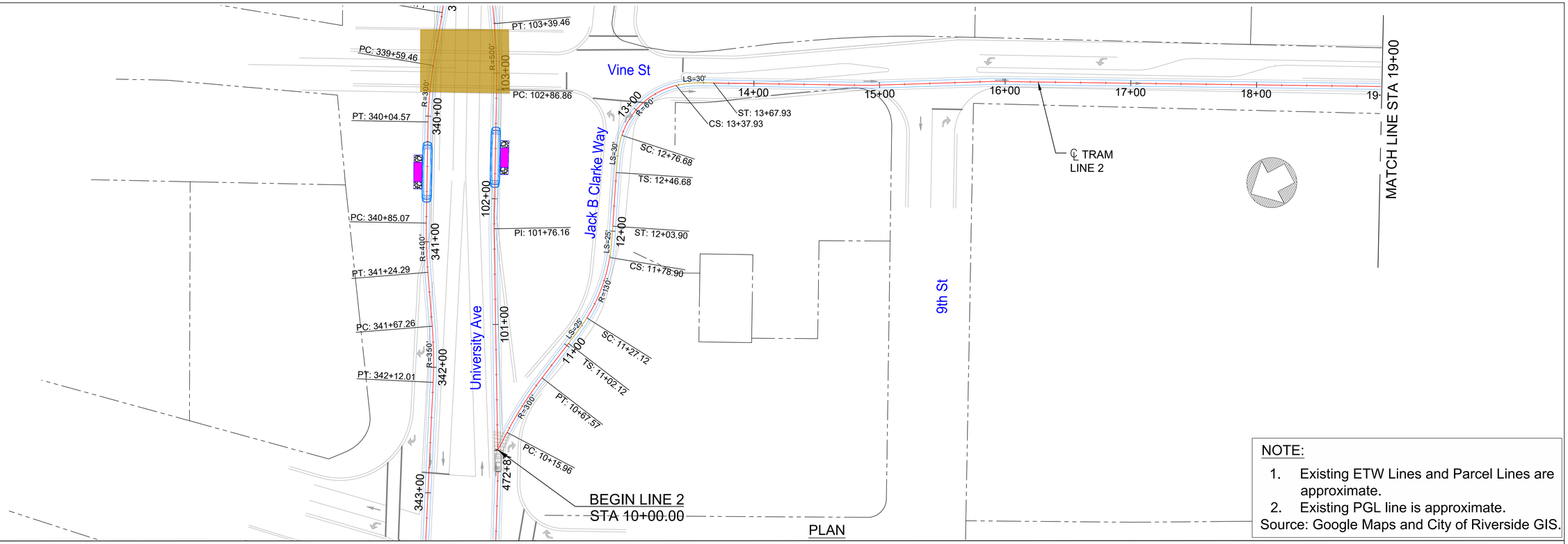
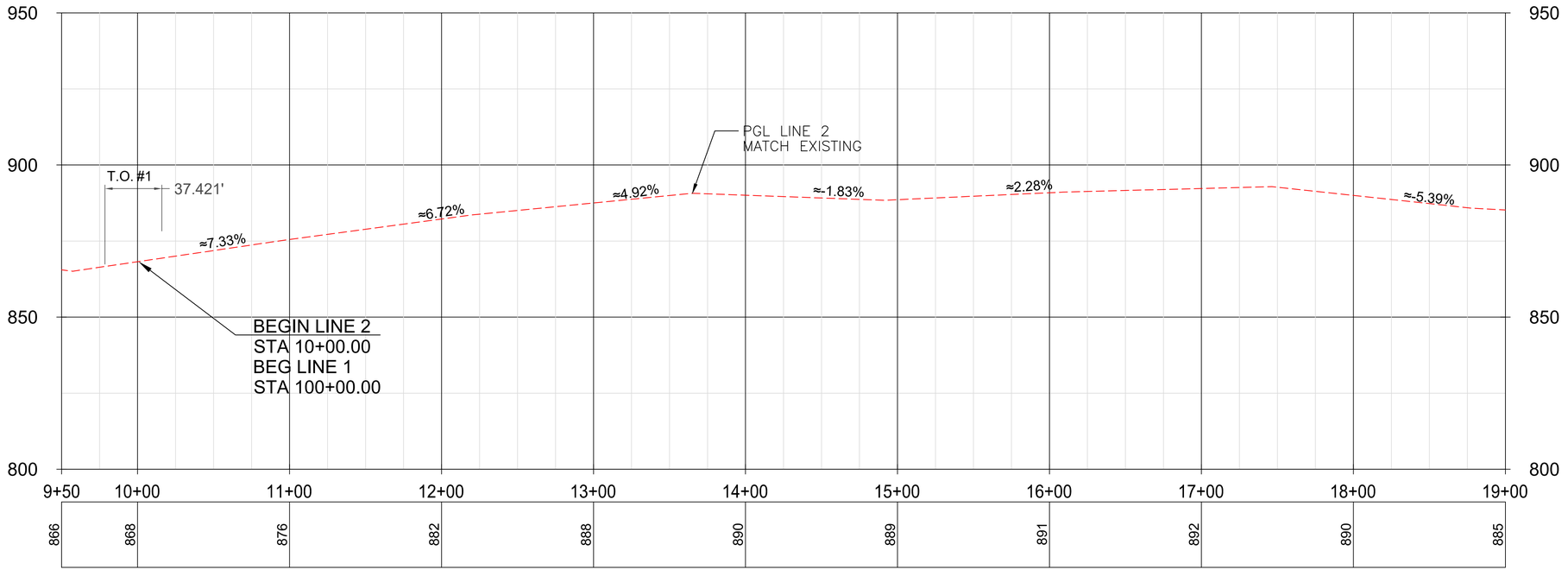


NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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2	210730	REVISED
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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 10+00 TO 19+00

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-35 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-35

DATE 2021-12-17

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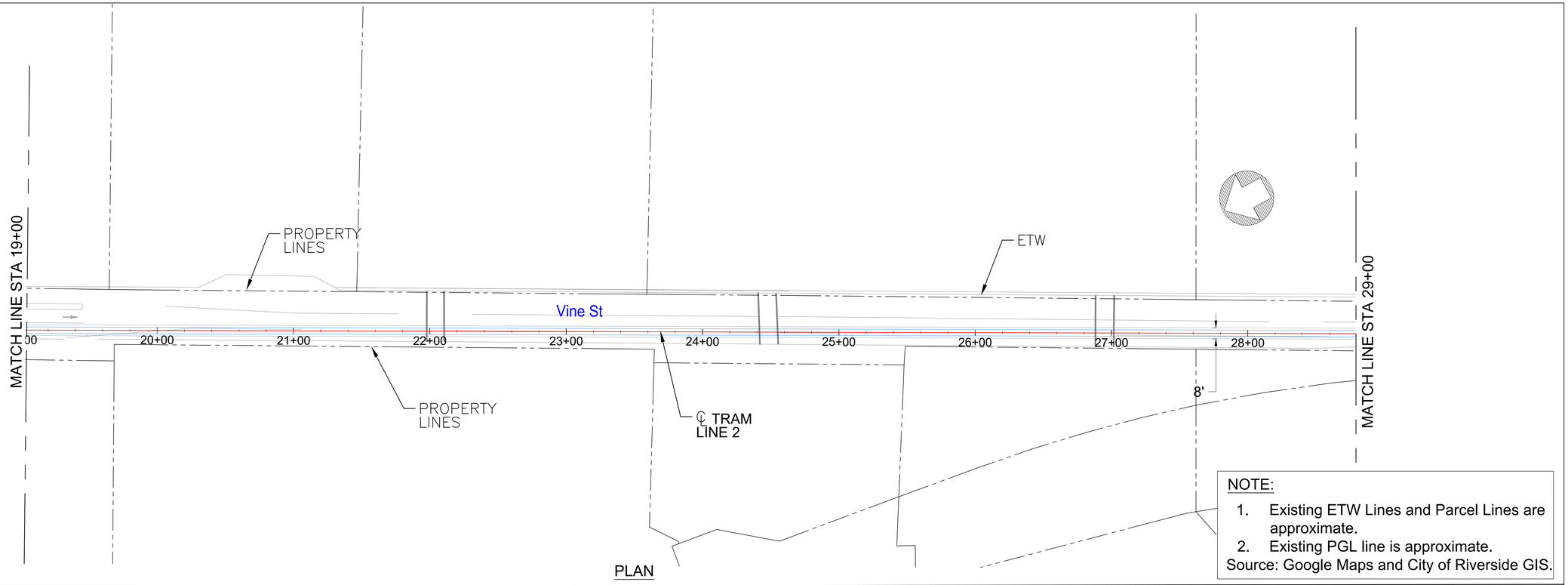
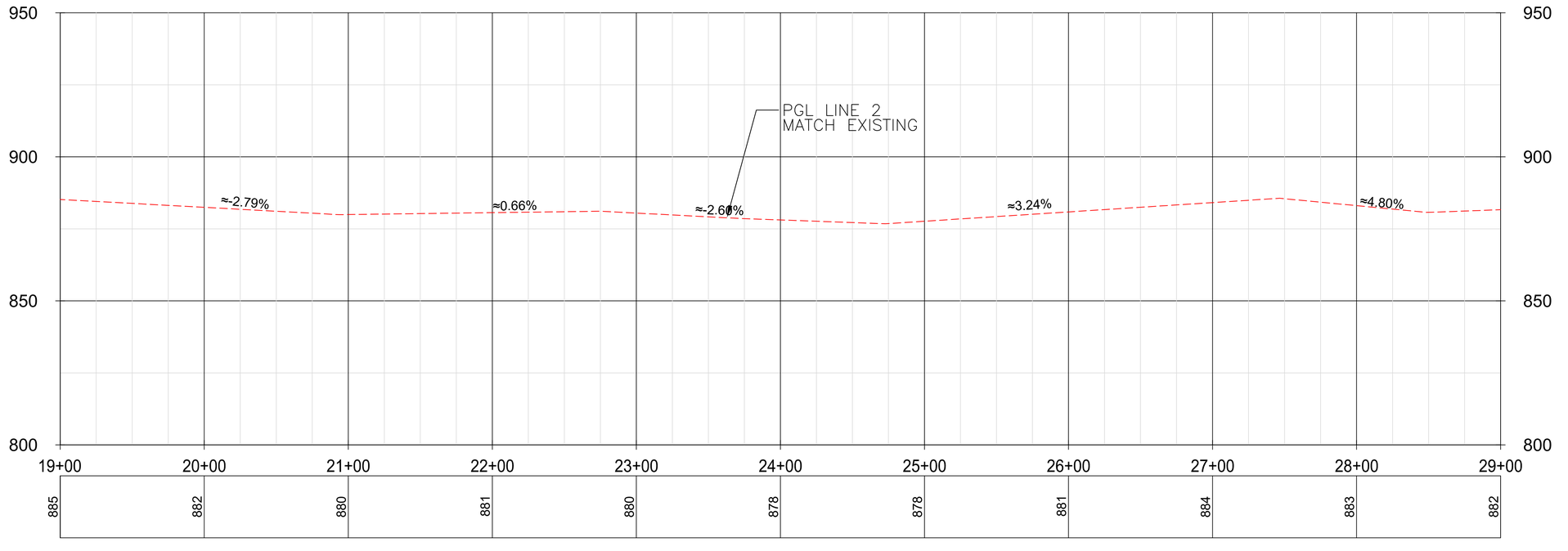


PLAN

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 19+00 TO 29+00

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-36 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-36

DATE 2021-12-17

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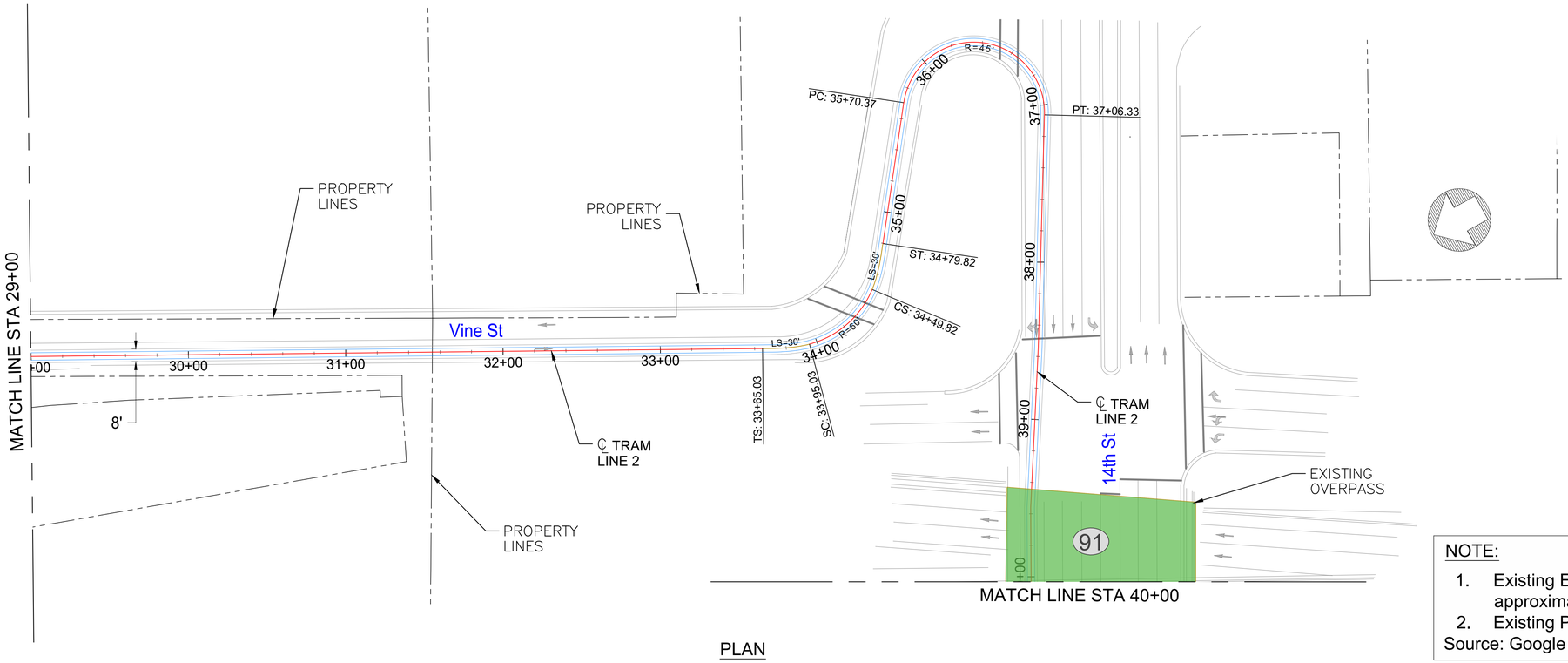
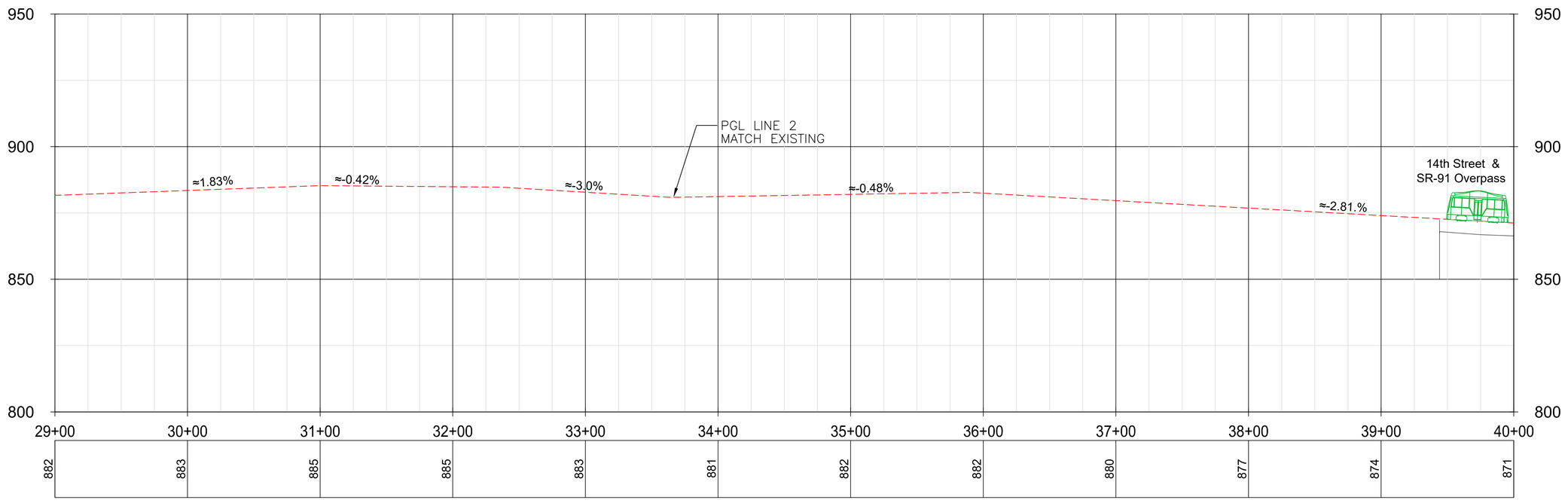


PLAN

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 29+00 TO 40+00

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-37 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-37

DATE 2021-12-17

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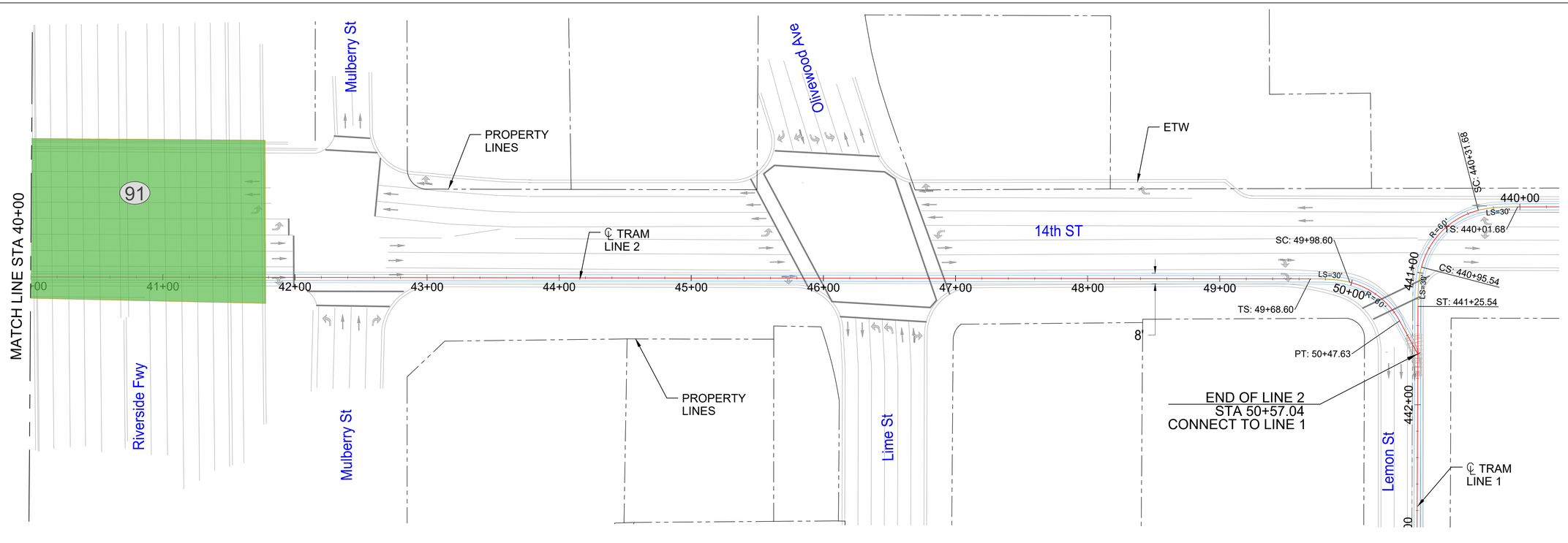
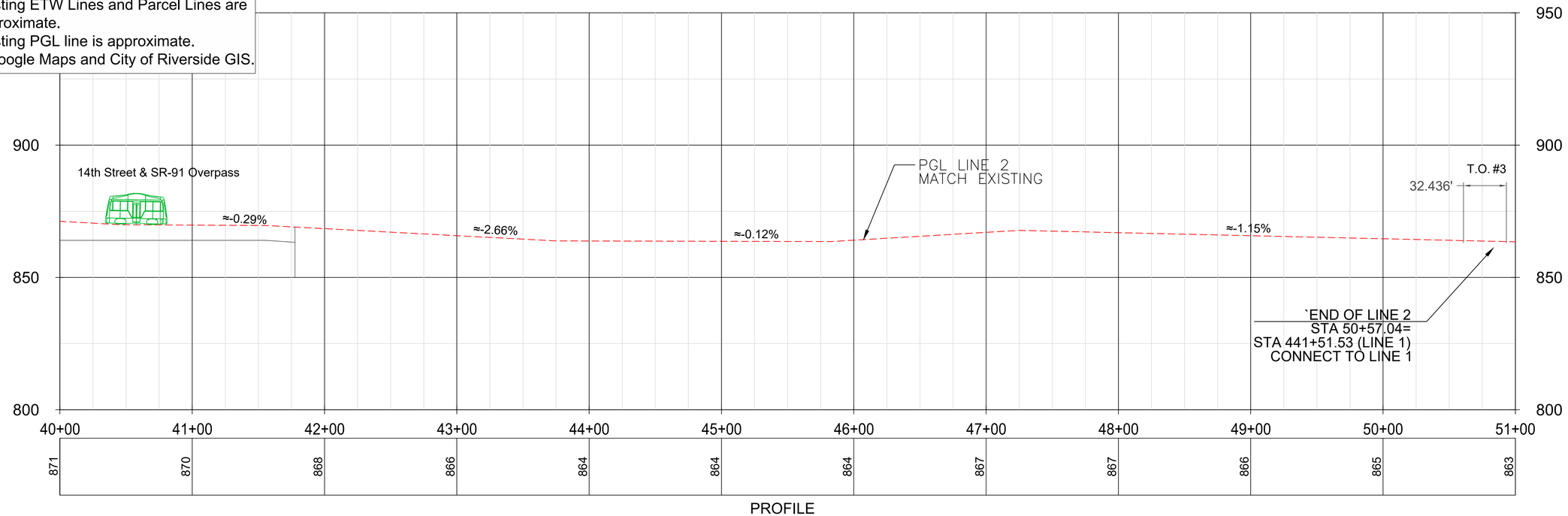


PLAN

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 40+00 TO 50+76
DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-38
REV. 2
211217
PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-38
DATE 2021-12-17
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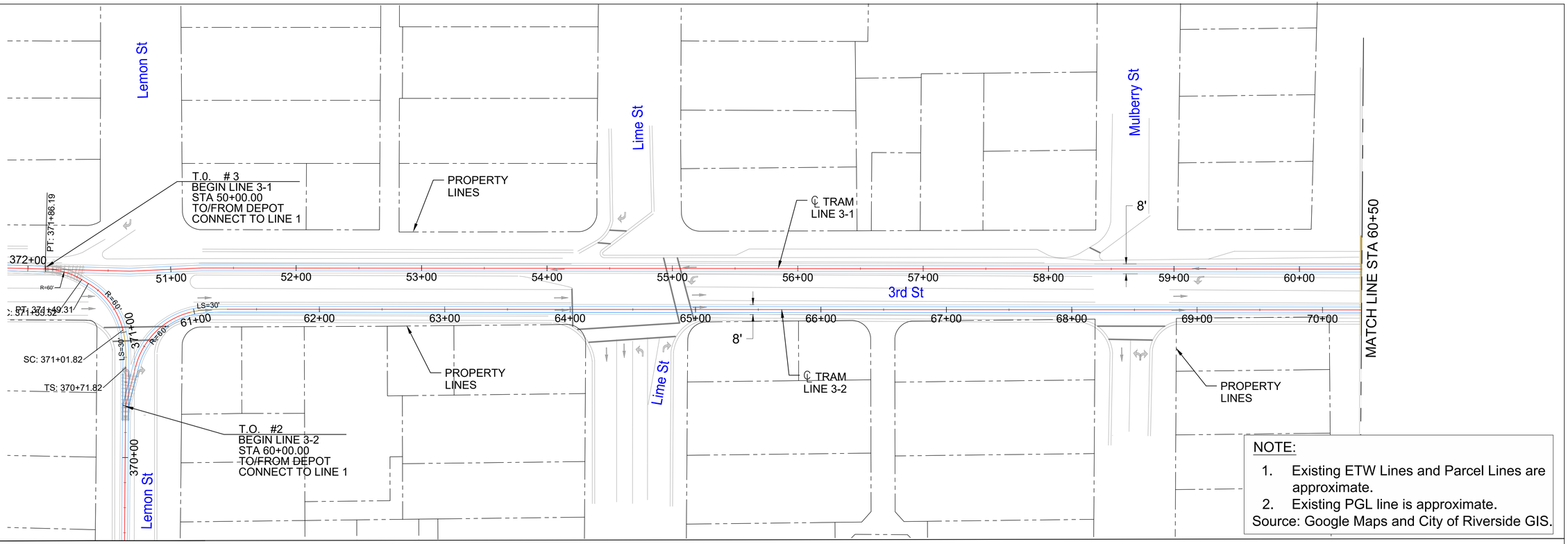

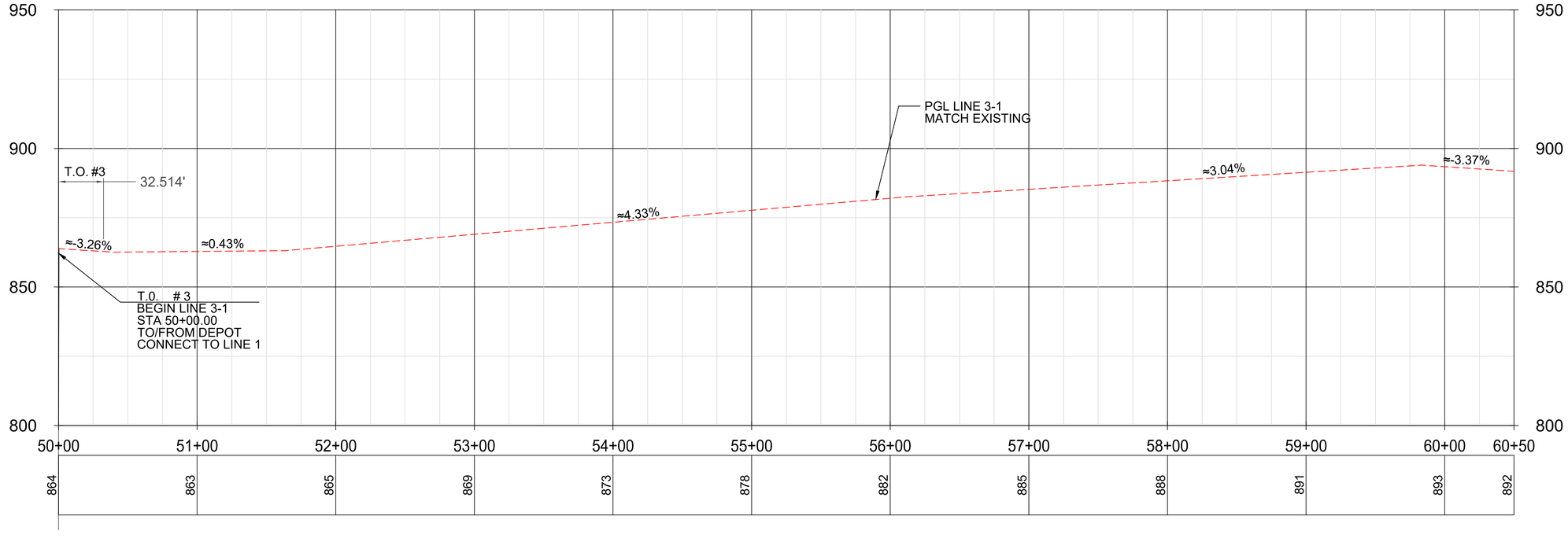

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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 50+00 TO 60+50

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-39 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-39

DATE 2021-12-17

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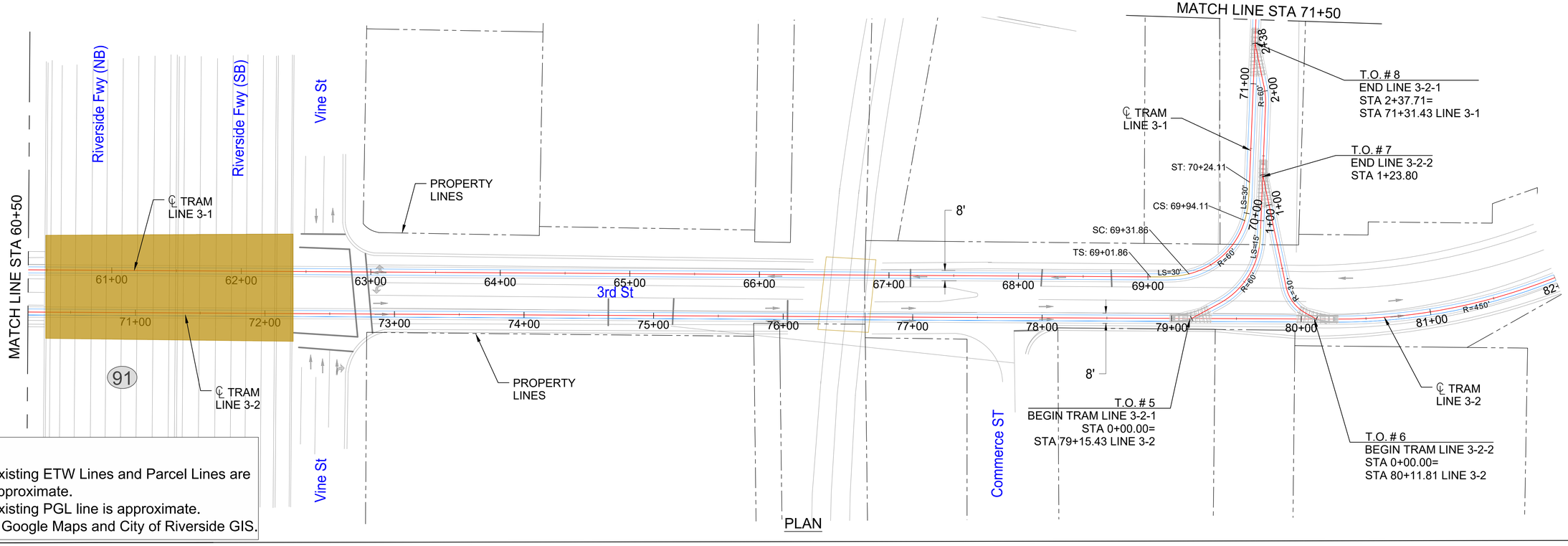
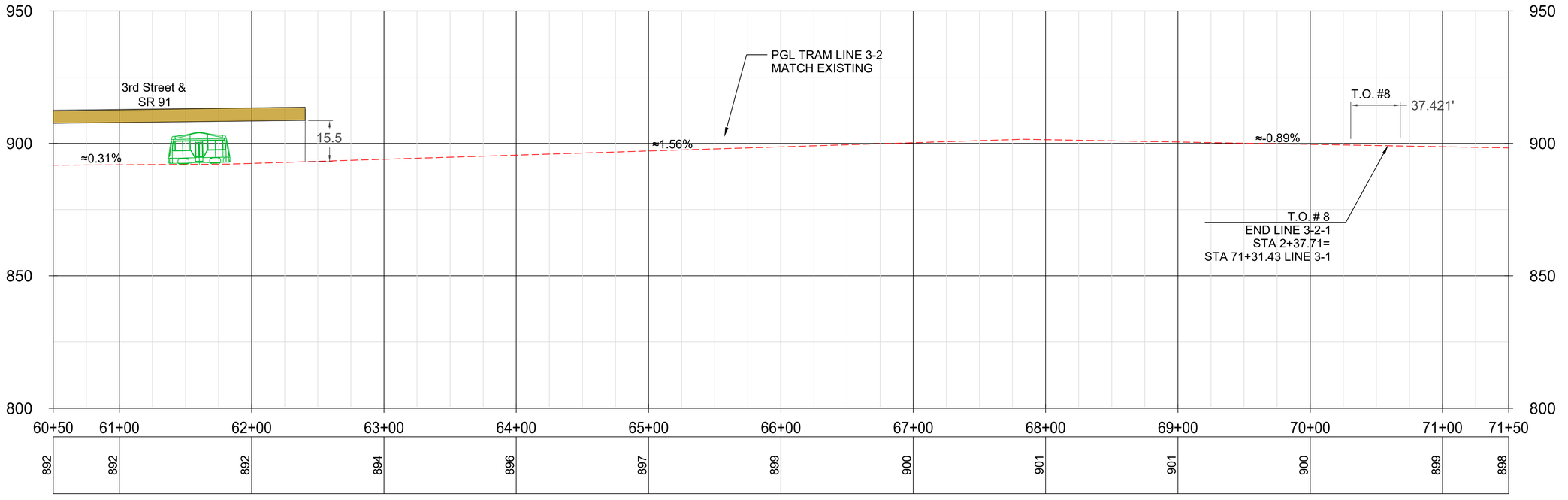


PLAN

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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1	210730	REVISED

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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 60+50 TO 71+50

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-40 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-40

DATE 2021-12-17

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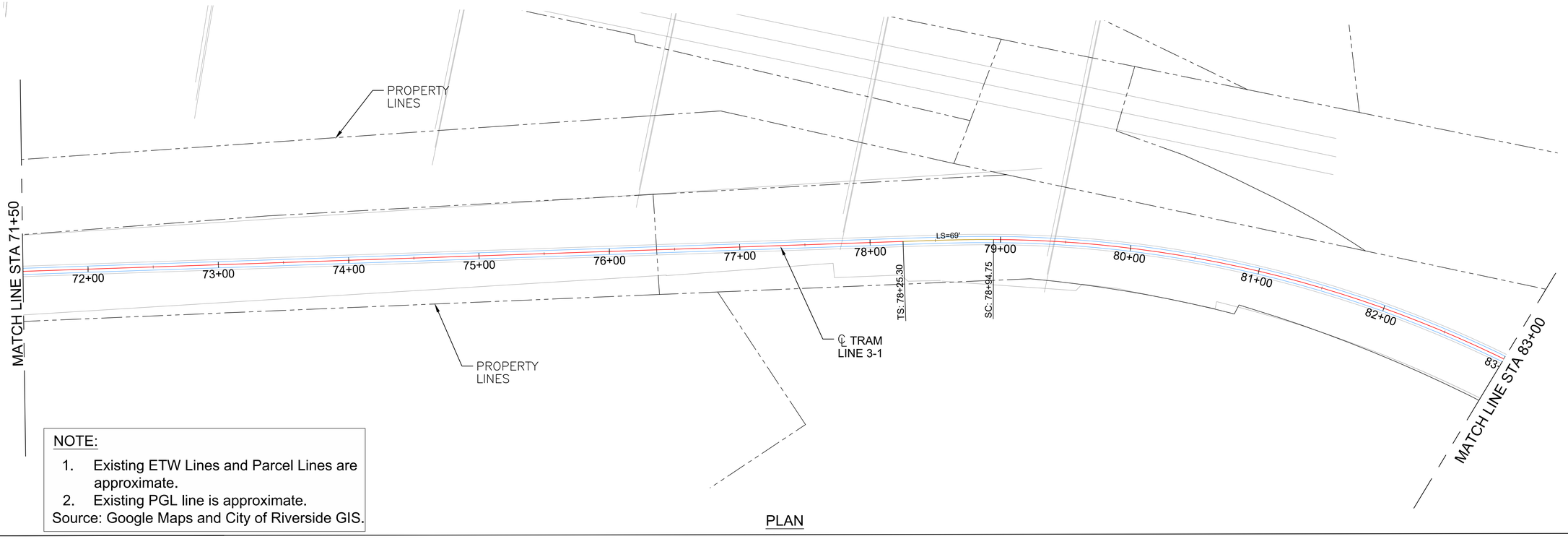

NOTE:

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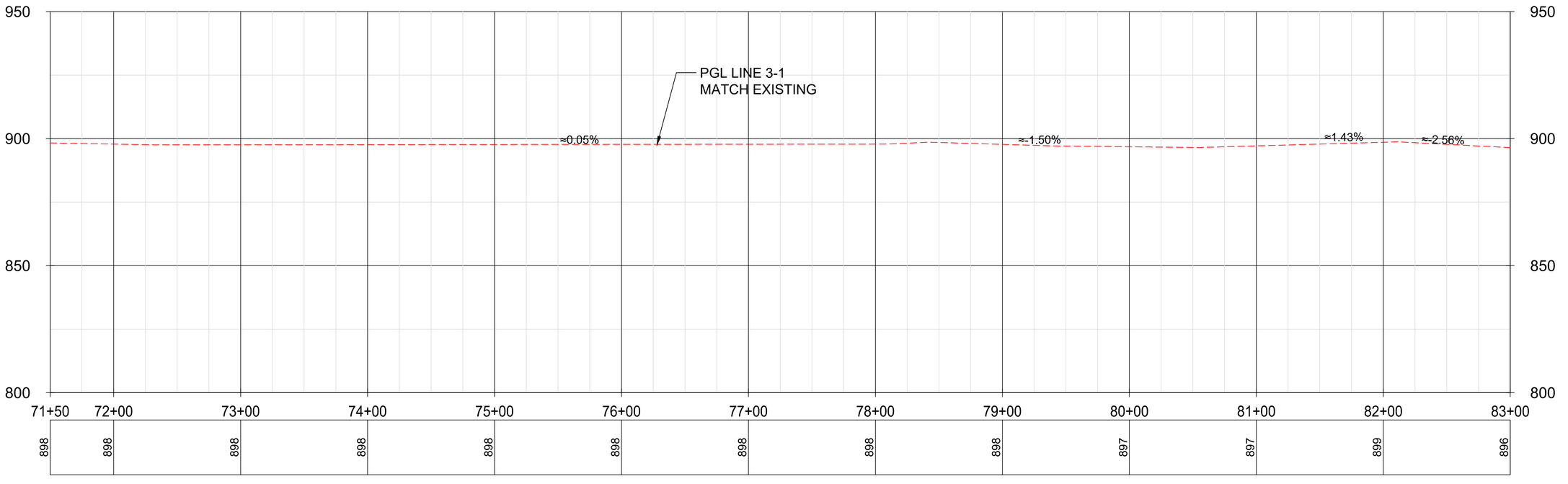
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.

PLAN



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SHEET TITLE: PLAN AND PROFILE SHEET FROM STA 71+50 TO 83+00

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-41 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO. PP-41

DATE 2021-12-17

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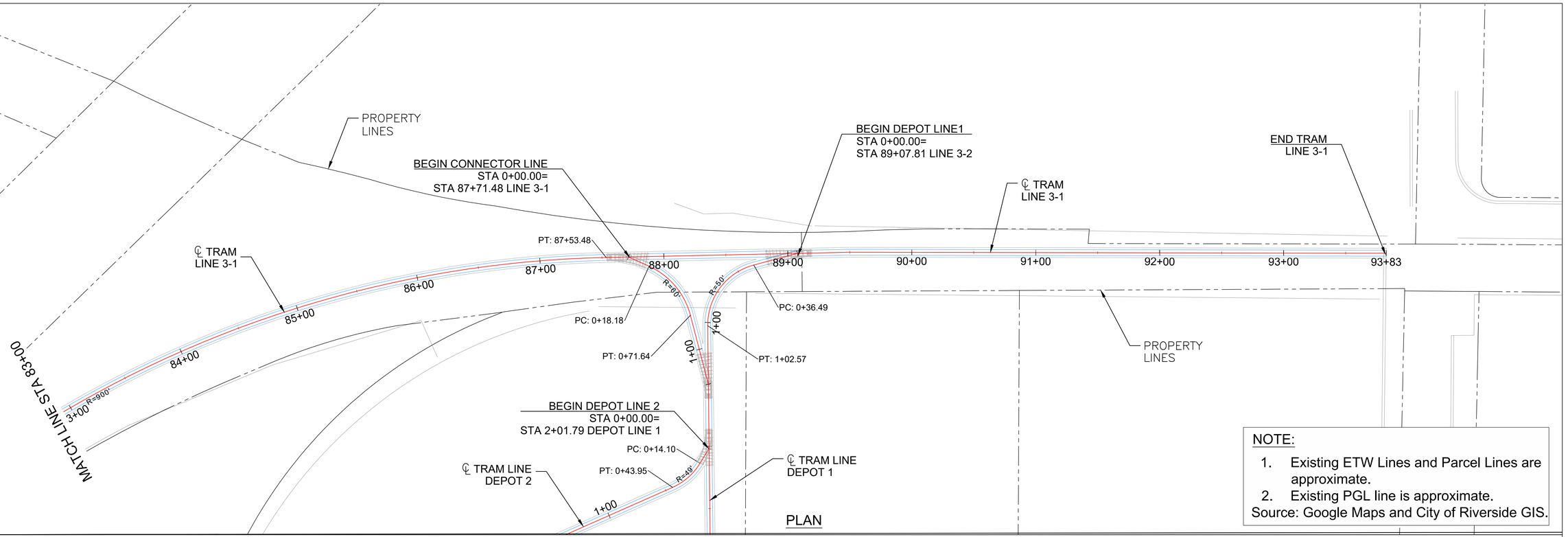

NOTE:

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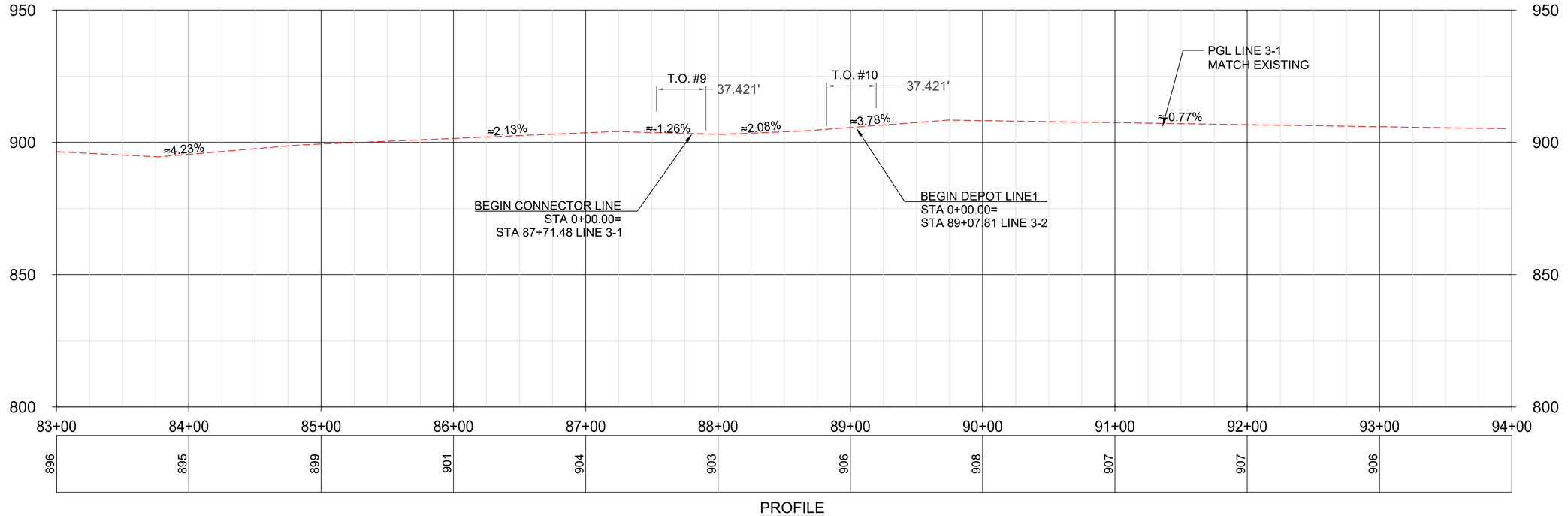
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.



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SHEET TITLE:	PLAN AND PROFILE SHEET FROM STA 40+00 TO 94+00
DOCUMENT CONTROL NUMBER:	RSC-4-06-DWG-004-FSR-PP-42
REV.	2
	211217
PROJECT TITLE:	PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

DRAWING NO.	PP-42
DATE	2021-12-17
SCALE	1: 40
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Plot Date: 2021/12/16

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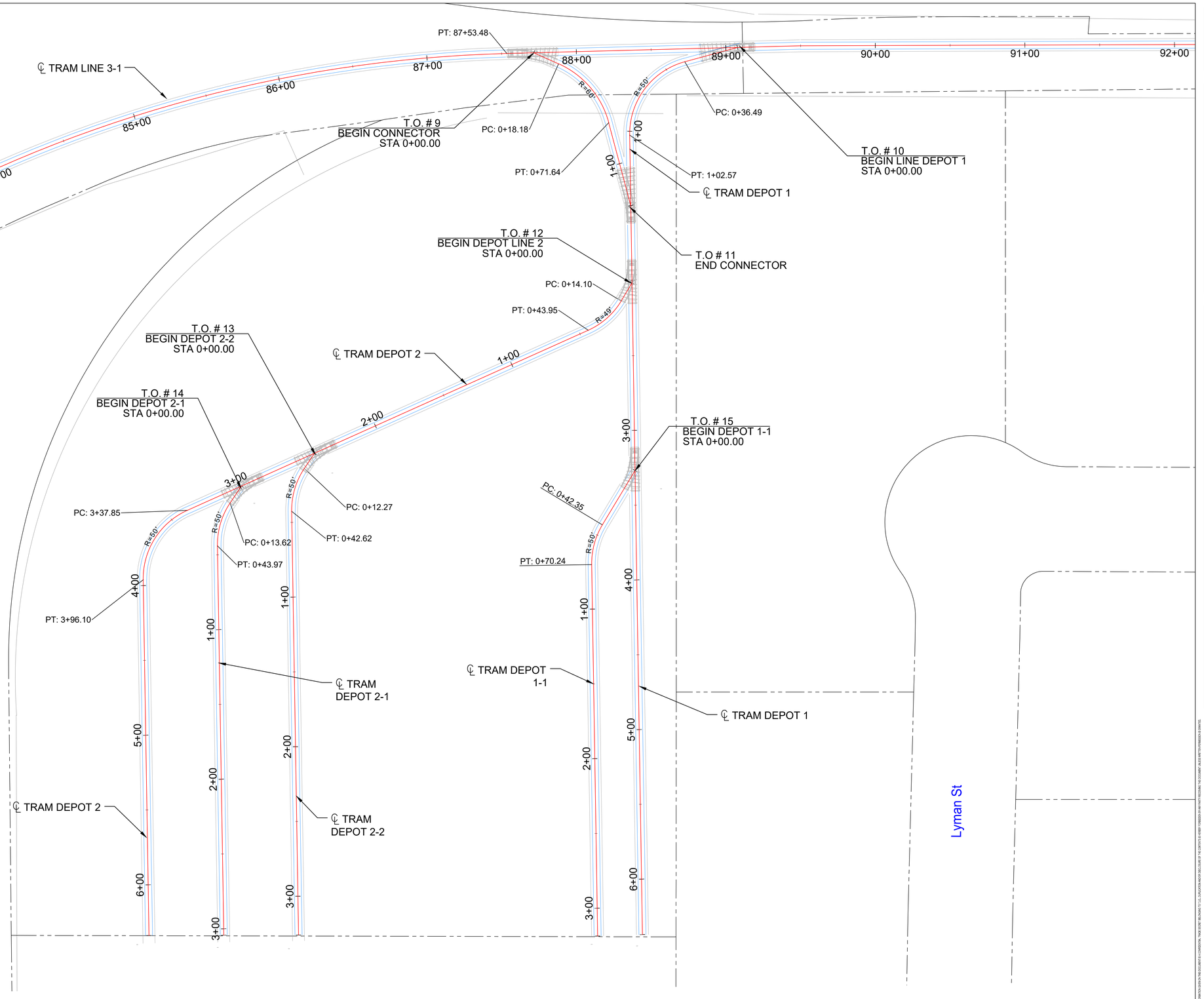

NOTE:

1. Existing ETW Lines and Parcel Lines are approximate.
2. Existing PGL line is approximate.

Source: Google Maps and City of Riverside GIS.

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SHEET TITLE: PLAN SHEET FROM STA 40+00 TO 94+00

DOCUMENT CONTROL NUMBER: RSC-4-06-DWG-004-FSR-PP-42 REV. 2 211217

PROJECT TITLE: PROJECT FEASIBILITY STUDY RIVERSIDE STREETCAR

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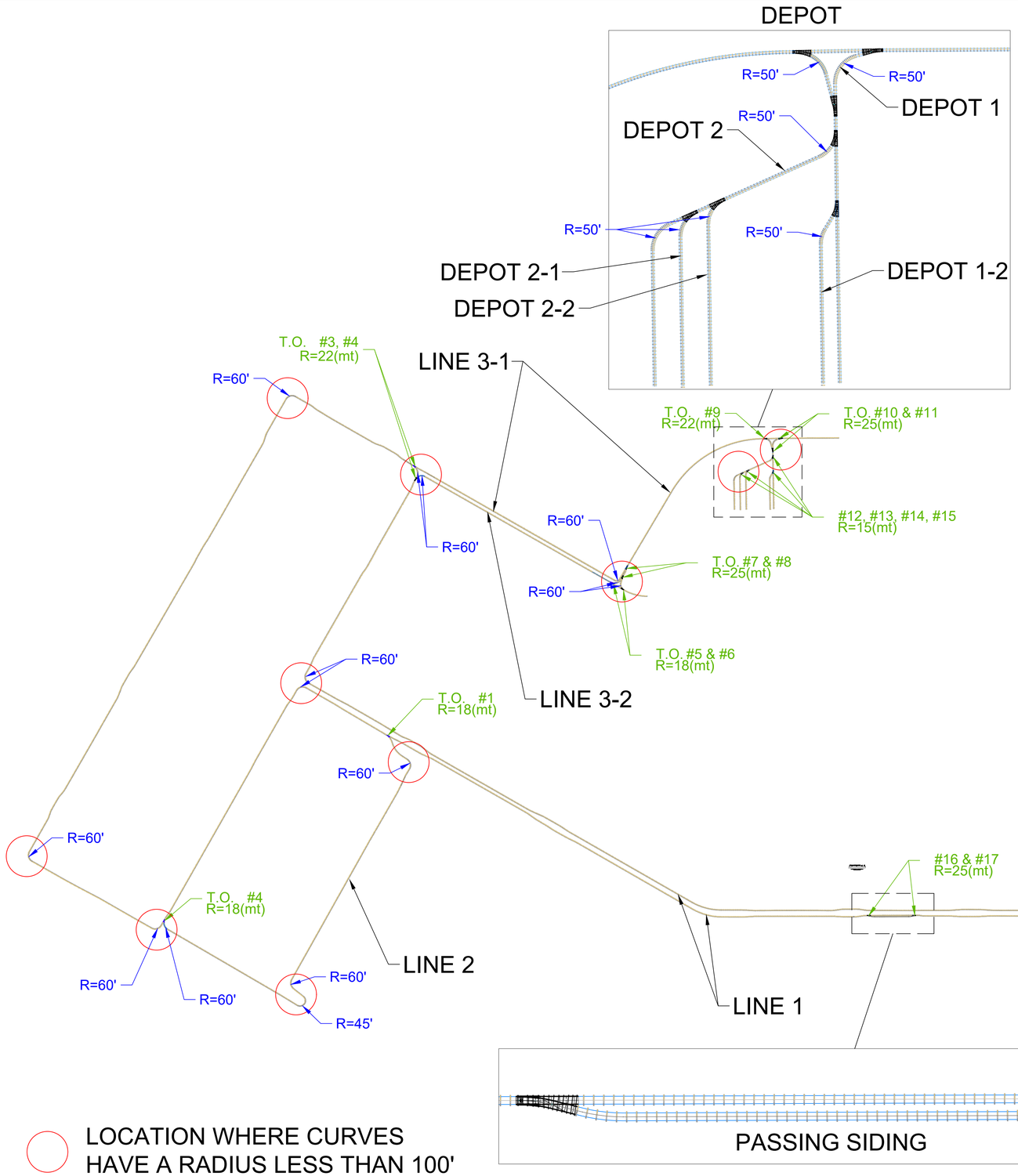


RIVERSIDE STREETCAR

	FROM STA	TO STA	TOTAL FT	TOTAL MILES
LINE 1	100+00.00	473+90.67	37,391	7.08
LINE 2	10+00.00	50+79.04	4,079	0.77
LINE 3-1	50+00.00	93+63.95	4,364	0.83
LINE 3-2	60+00.00	81+90.88	2,191	0.41
LINE 3-1-1	0+00.00	1+98.80	199	0.04
LINE 3-1-2	0+00.00	0+87.85	88	0.02
DEPOT 1	0+00.00	6+39.04	639	0.12
DEPOT 1-2	0+00.00	3+18.62	319	0.06
DEPOT 2	0+00.00	6+39.11	639	0.12
DEPOT 2-1	0+00.00	3+08.91	309	0.06
DEPOT 2-2	0+00.00	3+29.85	330	0.06
PASSING SIDING	0+00.00	3+92.74	393	0.07
TOTAL LENGTH ALONG CL			**50,939**	9.6

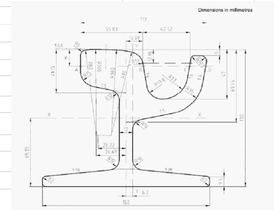
TOTAL RAIL IN TONS

		Rail Length (FT)
TOTAL RAIL	TL X 2	**101,879**

RAIL SUMMARY

TRACK LENGTH (FT)	RAIL LENGTH (FT)	RAIL COUNT (rail is delivered in 30 FT length)	RAIL WT. LBS (lbs/ft)	RAIL WT. TONS
50,939	101,879	3396.0	3,514,823	**1757**

RAIL (51R1)	51.37	KG/M
RAIL WEIGHT=	113	LBS/M
(1 YARD = 3FT)	103.5	LB/YD
RAIL (51R1) Weight	**34.5**	**LBS / FT**



TIES (EA)

	12,270
TOTAL	**12,270**

BOOT CLIPS (EA)

2 per TIE	**24,540**
TOTAL	**24,540**

BOLT

2 Per Boot Clip	**49,080**

WASHER

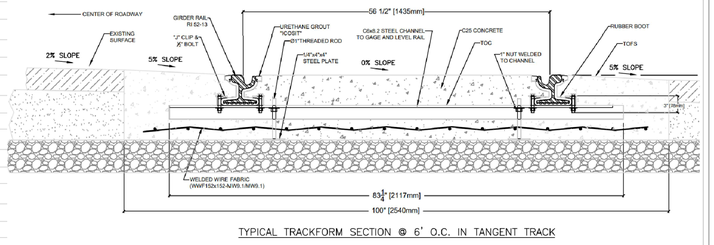
2 Per Boot Clip	**49,080**

LEVELING SCREW

2 Per TIE	**24,540**

BASE PLATE

2 Per TIE	**24,540**



TYPICAL TRACKFORM SECTION @ 6' O.C. IN TANGENT TRACK

JOINTS

	#JOINTS	
		Note : Rail is delivered in 30 FT length (joint every 30 FT)
TOTAL LENGH / 30 FT	3396	
AT END AND BEG CURVES (2 per curve)	100	
AT THE TURNOUTS (6 per T.O)	102	***Number of Turnouts:*** ***17***
	3598	

SUMMARY OF QUANTITIES

ITEM	QUANTITY	UNIT
RAIL		
RAIL (51R1) (103.5 lbs./yd)	**1,757**	TN
STEEL TIES	**12,270**	EACH
BOOT CLIPS	**24,540**	EACH
20 MM BOLTS	**49,080**	EACH
20 MM WASHER	**49,080**	EACH
LEVELING SCREW	**24,540**	EACH
BASE PLATES	**24,540**	EACH
JOINTS	**3,598**	
SPECIAL WORK		
TURNOUT S	17	EACH

Riverside Streetcar System Feasibility Study Report

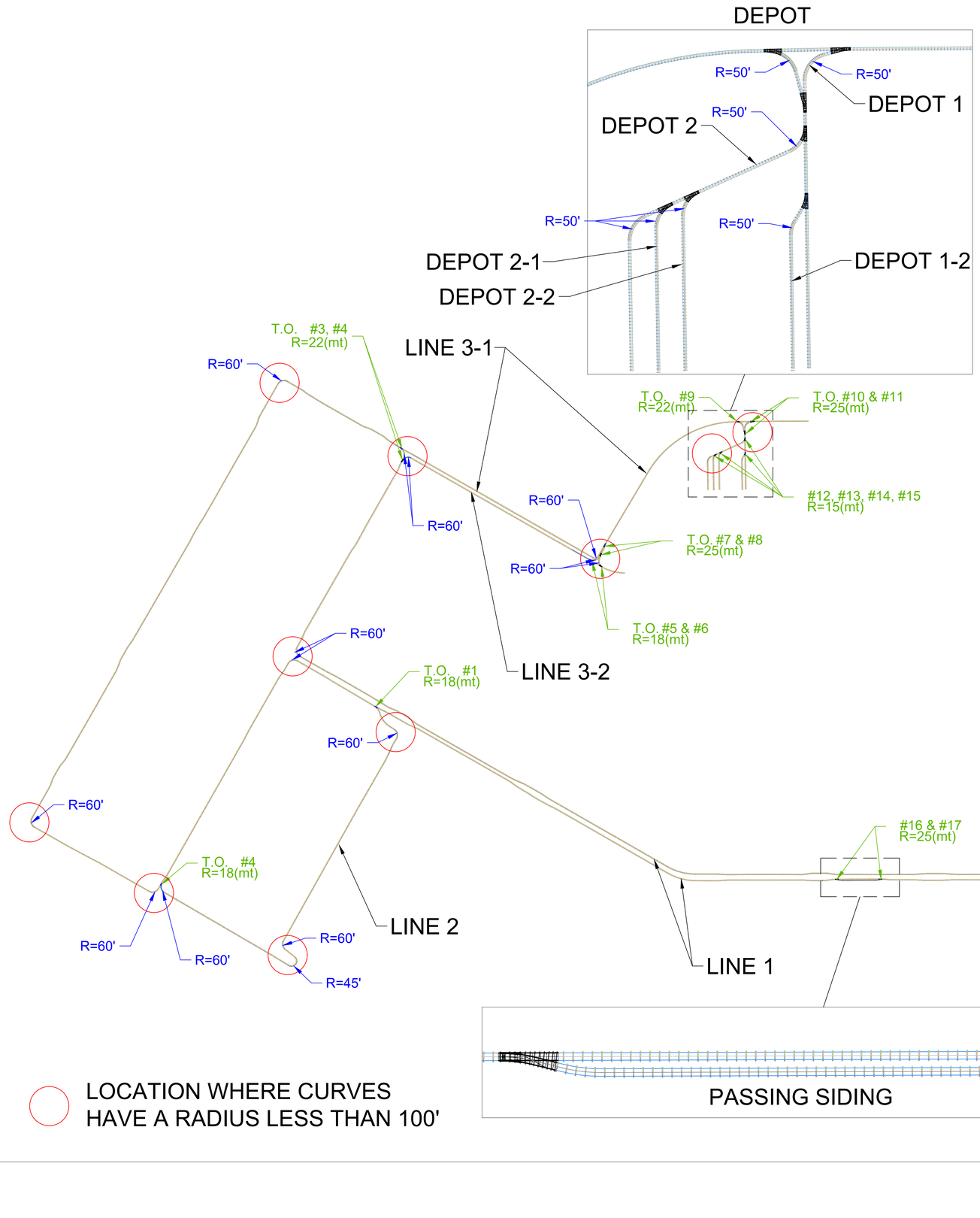
Appendix F:

Track Construction Quantities

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500



RIVERSIDE STREETCAR

	FROM STA	TO STA	TOTAL FT	TOTAL MILES
LINE 1	100+00.00	473+90.67	37,391	7.08
LINE 2	10+00.00	50+79.04	4,079	0.77
LINE 3-1	50+00.00	93+63.95	4,364	0.83
LINE 3-2	60+00.00	81+90.88	2,191	0.41
LINE 3-1-1	0+00.00	1+98.80	199	0.04
LINE 3-1-2	0+00.00	0+87.85	88	0.02
DEPOT 1	0+00.00	6+39.04	639	0.12
DEPOT 1-2	0+00.00	3+18.62	319	0.06
DEPOT 2	0+00.00	6+39.11	639	0.12
DEPOT 2-1	0+00.00	3+08.91	309	0.06
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PASSING SIDING	0+00.00	3+92.74	393	0.07
TOTAL LENGTH ALONG CL			**50,939**	9.6

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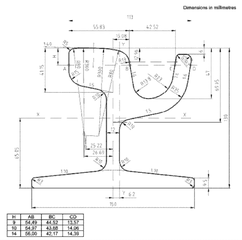


TIES (EA)

	12,270
TOTAL	**12,270**

BOOT CLIPS (EA)

2 per TIE	**24,540**
TOTAL	**24,540**

BOLT

2 Per Boot Clip	**49,080**

WASHER

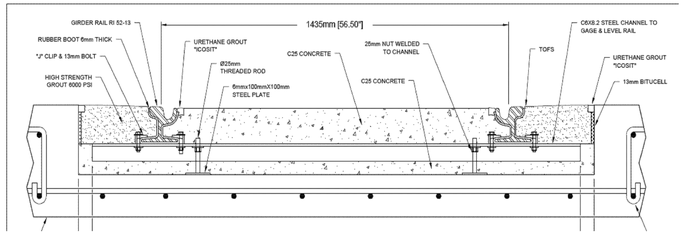
2 Per Boot Clip	**49,080**

LEVELING SCREW

2 Per TIE	**24,540**

BASE PLATE

2 Per TIE	**24,540**



JOINTS

	#JOINTS
TOTAL LENGH / 30 FT	3396
AT END AND BEG CURVES (2 per curve)	100
AT THE TURNOUTS (6 per T.O)	102
	3598

Note : Rail is delivered in 30 FT length (joint every 30 FT)

Number of Turnouts: ***17***

SUMMARY OF QUANTITIES

ITEM	QUANTITY	UNIT
RAIL		
RAIL (51R1) (103.5 lbs./yd)	**1,757**	TN
STEEL TIES	**12,270**	EACH
BOOT CLIPS	**24,540**	EACH
20 MM BOLTS	**49,080**	EACH
20 MM WASHER	**49,080**	EACH
LEVELING SCREW	**24,540**	EACH
BASE PLATES	**24,540**	EACH
JOINTS	**3,598**	
SPECIAL WORK		
TURNOUT S	17	EACH

RIVERSIDE STREETCAR SYSTEM RAIL CALCULATOR

ROM Cost Estimates for Rail Infrastructure (US$)

MATERIALS

Line	Description	Specification	Manufacturer	Unit	Unit Cost	Quantity	Extended Cost	Notes
1	Running Rail	51R1	Voestalpine	39.37 ft.	$1,820.00	2,580	4,695,600.00	Austria/Wirth Rail
2	Rail Boot/encap.	Rubber	Polycorp	Linear foot	$25.75	101,575	2,615,860.98	Canada/Skelton
3	Cross-tie Assy.	Steel	Polycorp	Assembly	$188.50	12,292	2,317,042.00	Canada/Skelton
4	Concrete/WWF	250mm x 2.4m	Local	Track foot	$178.36	50,787	9,058,369.32	Local
5	Turnouts	Double-point Flexive	DT Vyhkbharna	Assembly	$97,500.00	17	1,657,500.00	Czech/Skelton
6	Expansion Joints	Bias 75mm Compliance	DT Vyhkbharna	Assembly	$27,300.00	47	1,283,100.00	Czech/Skelton
7	Weld Kits	Thermite	Orgo	Kit	$299.00	2750	822,250.00	ORGO Thermit
8	HS Grout Curbs	6k psi	N/A	Linear foot	$7.93	0	0.00	N/A
9	Elastomeric Grout	compliance joint	Sika	Track foot	$11.90	50,787	604,111.37	Germany/Skelton
						Sub-Total	23,053,833.66	

LABOR

Line	Description	Specification	Contractor	Unit	Unit Cost	Quantity	Extended Cost	
1	Rail Installation	Steel/Concrete/Rubber	TIG/m/STECONFER	Track foot	$534.95	50,787.00	27,168,505.65	
						Sub-Total	27,168,505.65	
						TOTAL	**50,222,339.31**	

Riverside Streetcar System Feasibility Study Report

Appendix G:

Turnouts and Crossings

May 15, 2022

Prepared for:
The City of Riverside

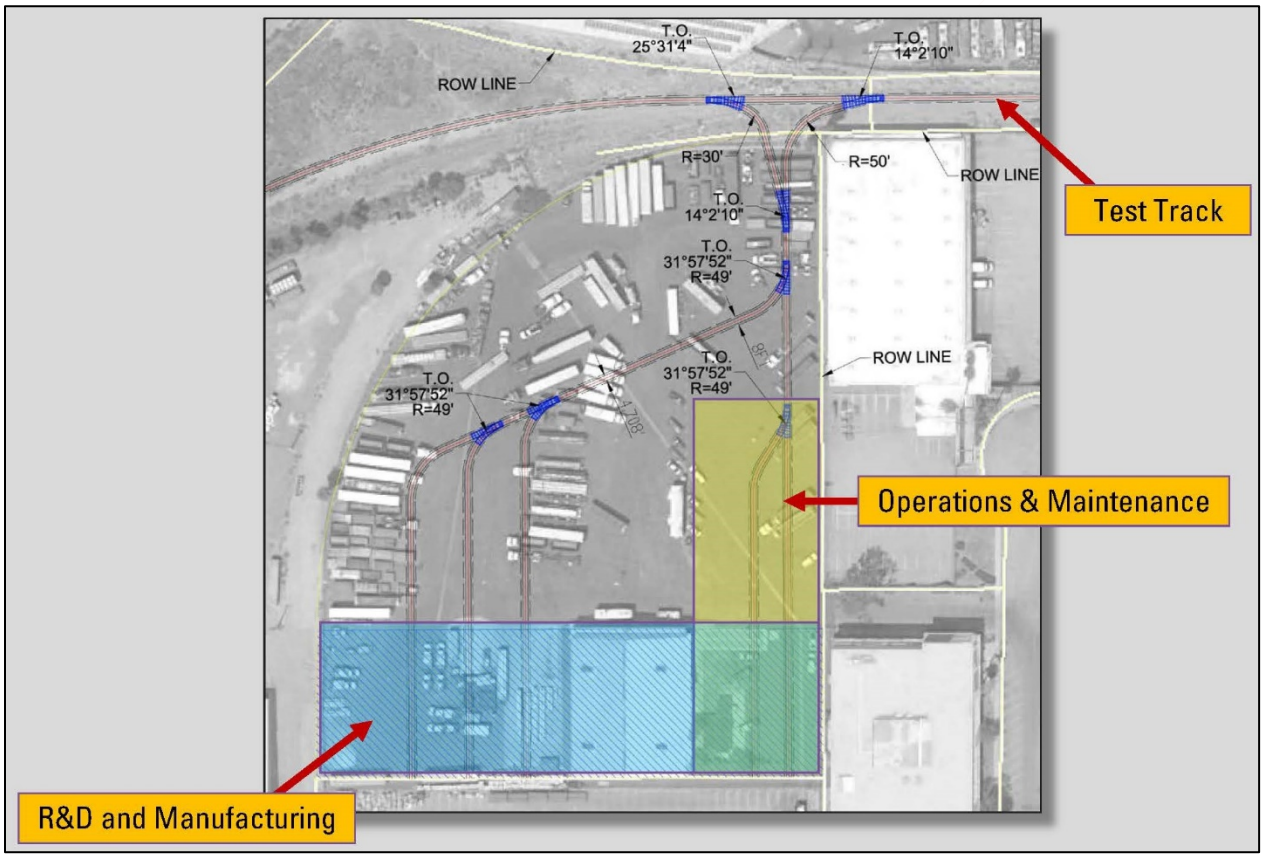
Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500

Turnouts and Crossings: Locations

The schematics shown in ***the following figures*** include the passenger service track specialwork for Phase 1, with the addition of turnouts and crossings that will anticipate subsequent phases. (Note: red lines represent Phase 1 track.).

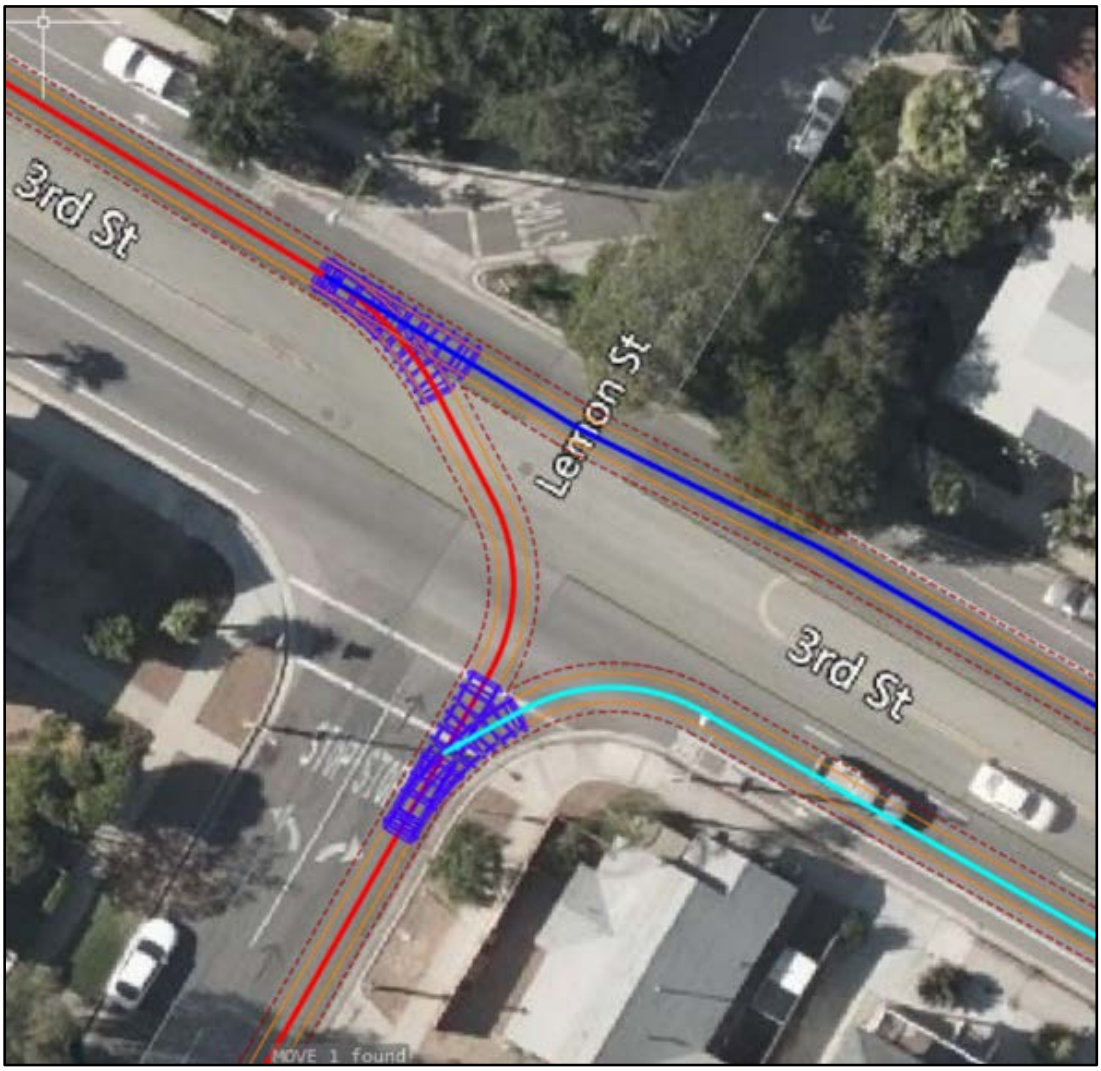
Refer to ***Appendix H: Civil Engineering Schematic Drawings*** for additional details.

Maintenance Alignment, Yard and Depot



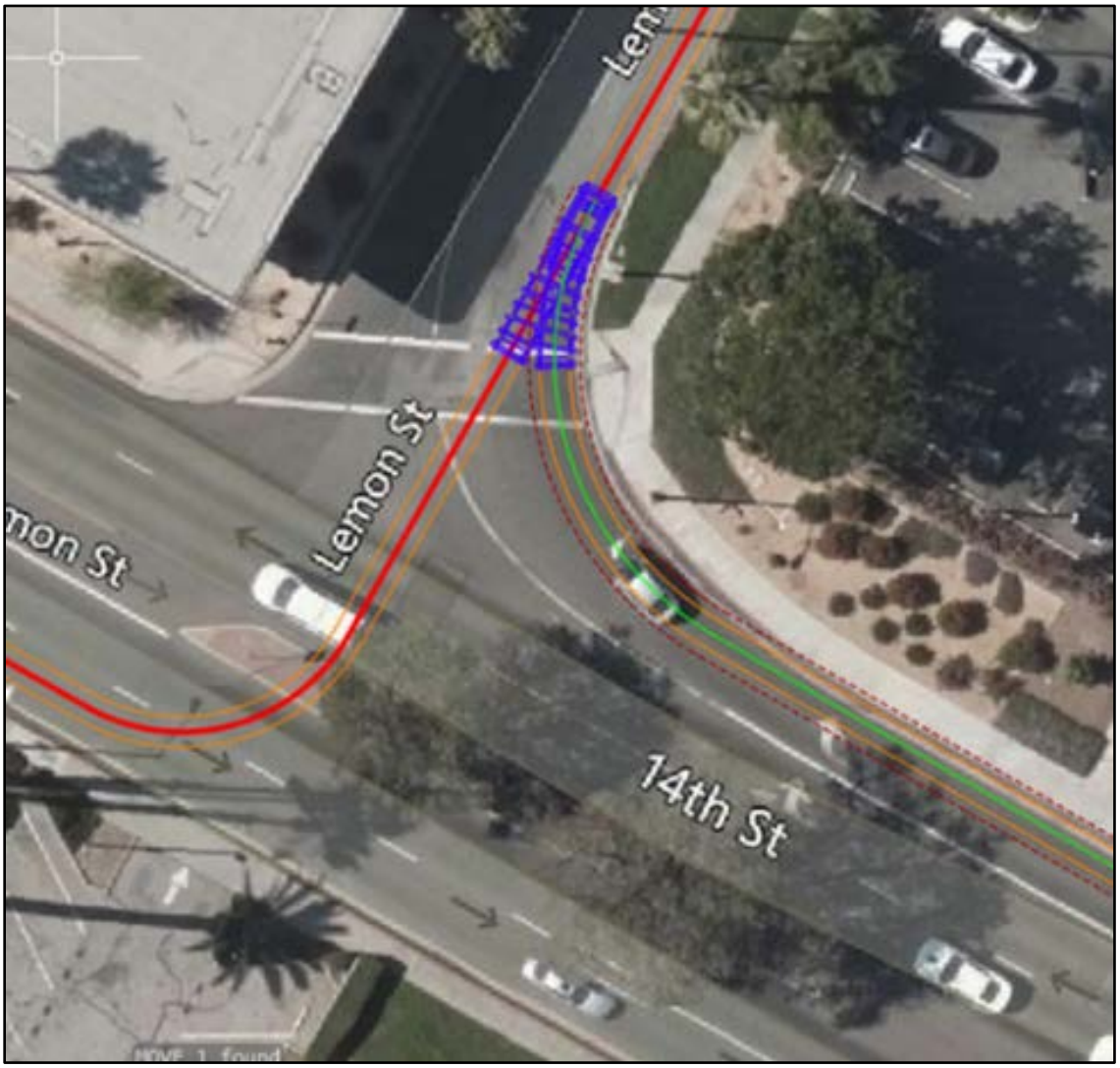
Turnouts: 3rd St. Depot & Test Track Alignment Access

Turnouts: 3rd St. at Lemon St.

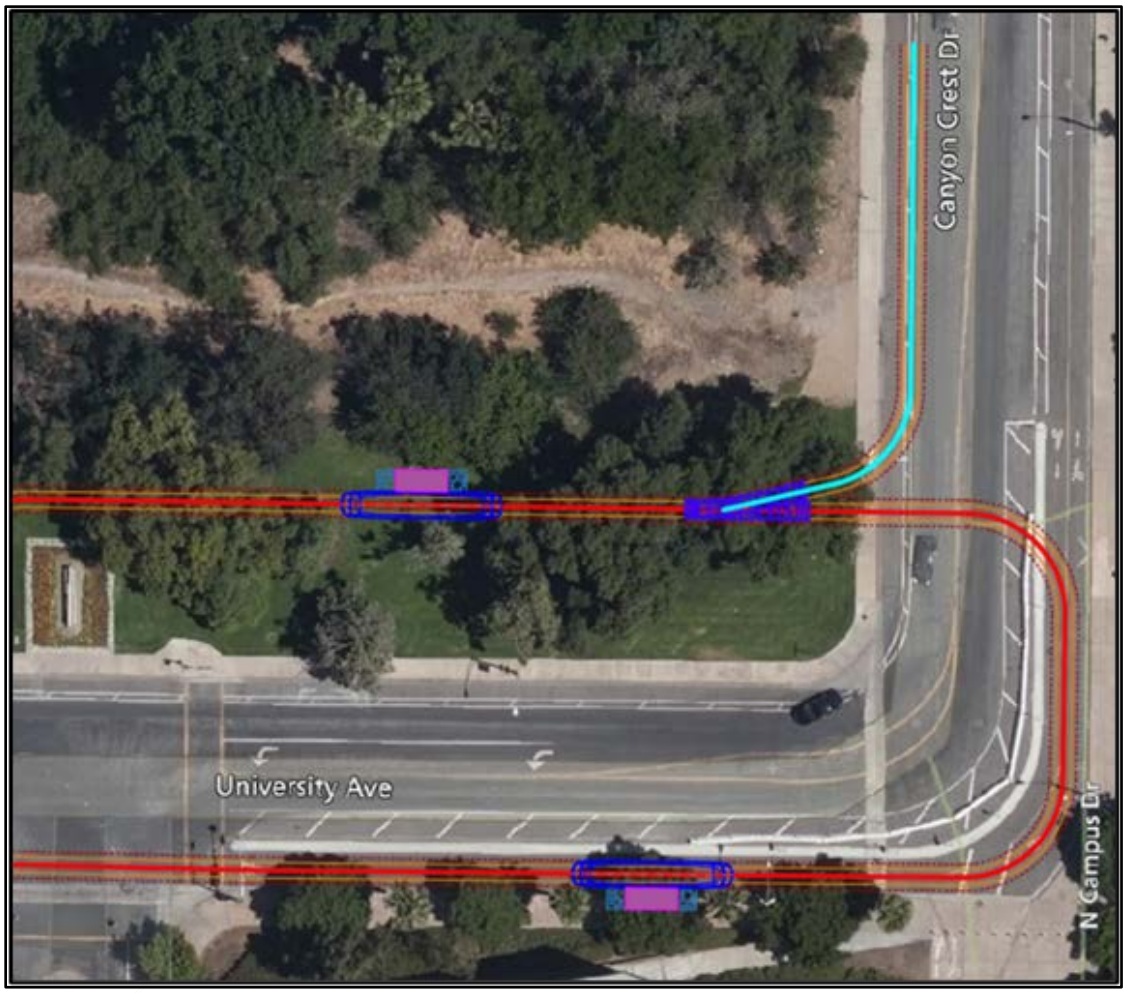


Turnout: University Ave. at Jack B. Clark Way

Turnout: 14th St. at Lemon St.



Turnout: University Ave at Canyon Crest Dr.

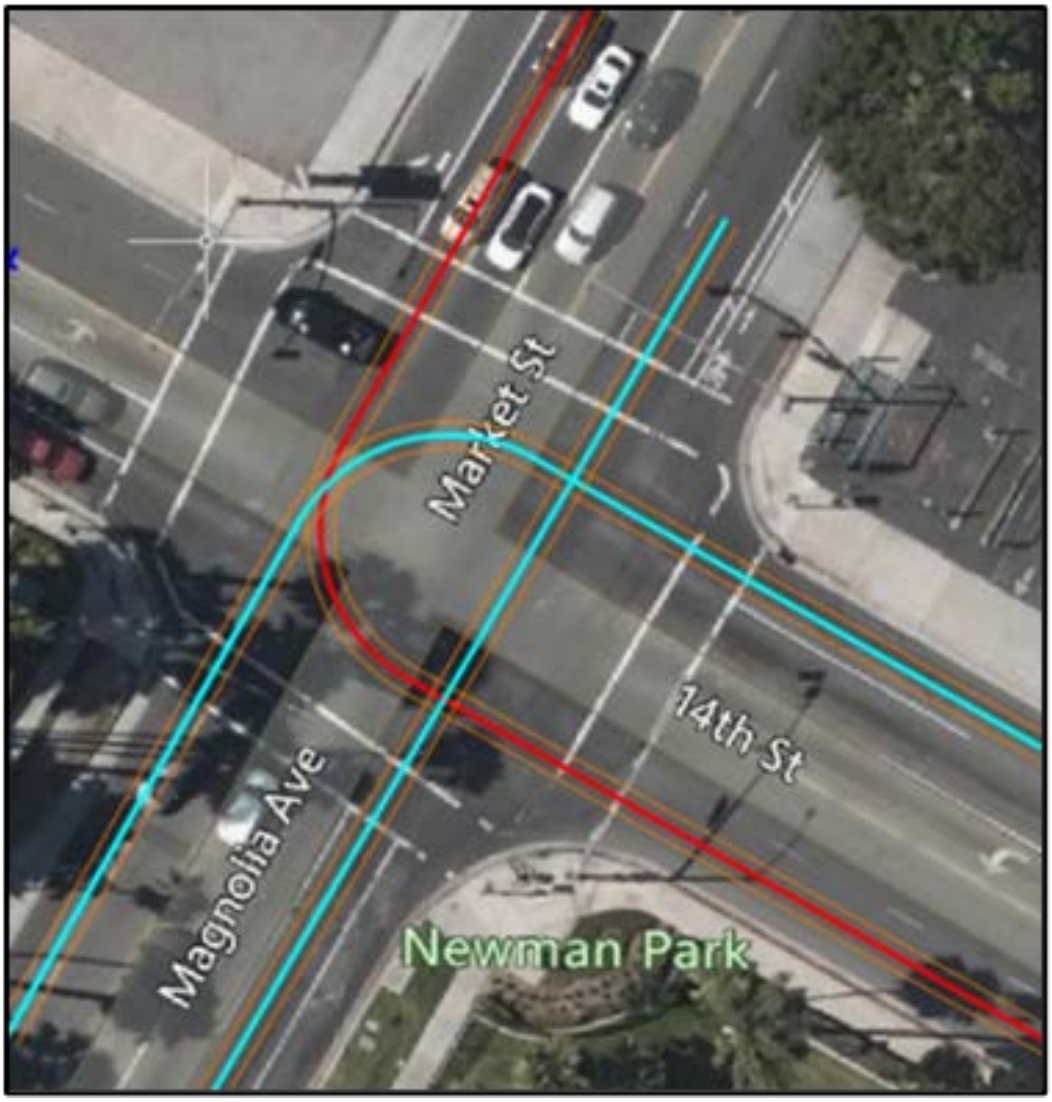


The following figure shows the conceptual location for two turnouts for entering and exiting a siding track on University Avenue.

Figure 5-27, *Turnouts: Siding Track on University Ave.*

The following figure shows the location of track crossings at 14th Street and the intersection at which Market Street becomes Magnolia Avenue. The red line represents Phase 1 track; the blue line represents Phase 2 track. TIG/m recommends that the specialwork be installed during Phase 1 infrastructure development to anticipate Phase 2, to avoid traffic disruption during its installation.

Crossings, Location: 14th St. and Market St.(Magnolia Avenue)



Riverside Streetcar System Feasibility Study Report

Appendix H:

Utilities Relocation

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500

Utilities Relocation

A detailed study of available city documents relative to sub-grade in-street utilities was undertaken to determine where utilities are placed in the streets in relation to the proposed streetcar alignment. Not all potential utilities were found; telecommunications, underground power, and sewer systems were not included in the drawings available to us. Where active utilities run parallel to, and underneath, the proposed streetcar track slab, an estimate was produced for relocating those utilities. **For water lines we used a figure of $35/inch diameter/ foot provided by the RPU.** For the gas lines, we used Unit Cost Database for Utility Relocation Projects by Kathuria. We found this system of estimation to be very well defined. The unit costs were derived by comparing RS Means Heavy Construction Costs (U.S. National Averages) with **actual contracted costs** for full scope projects performed for the Texas Department of Transportation (TxDOT). Any deficiencies in this estimation represented by conversion to California costs should be amply addressed in the 78% contingency applied to this Line Item in the CAPEX Cost Table. Kathuria, Dev Sparsh. Development of a unit cost database to estimate costs for utility relocation projects. Thesis presented to The University of Texas at Austin. 2017. https://repositories.lib.utexas.edu/handle/2152/63551

For our estimate we used Kathuria's highest unit cost given for the specified utility and pipe size, installed using the boring and casing method. Example: 4" Gas Line+ $263/foot. See the Unit Cost Database on the following page.

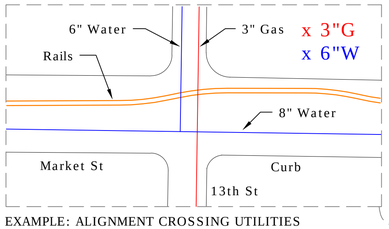
In total we have identified the relocation of approximately 9,100 linear feet of water line, and approximately 4,700 linear feet of gas line.

Final Unit Cost Dabase

Unit Cost Estimates for Utility Relocation

Facility Specifications					RS Means Cost			Agreement Cost		Reference Cost	Agreement Details
Sr. No.	Facility Type	Size	OH/UG	UG Technique (If UG)	Min	Avg	Max	Unit Cost	Reliability	Unit Cost	Agreement No.
1	Gas	2"	UG	Open Trenching	$22	$26	$38	$59	*	$95	U 111
2	Gas	2"	UG	Boring and Casing	$83	$89	$93			$170	
3	Gas	4"	UG	Open Trenching	$40	$49	$51	$95	*	$106	U 111
4	Gas	4"	UG	Boring and Casing	$134	$144	$152	$263	*	$186	U 10951
								$254			U 12557
5	Gas	6"	UG	Open Trenching	$66	$81	$96	$118	*	$111	U 111
								$130			U 11075
6	Gas	6"	UG	Boring and Casing	$193	$208	$222	$168	*	$191	U 10007
7	Gas	8"	UG	Open Trenching	$100	$121	$143			$117	
8	Gas	8"	UG	Boring and Casing	$258	$280	$302	$442		$207	U 3755
9	Gas	16"	UG	Open Trenching	$304	$372	$442			$159	
10	Gas	16"	UG	Boring and Casing	$591	$660	$729			$254	
11	Gas	24"	UG	Open Trenching	$648	$797	$945			$212	
12	Gas	24"	UG	Boring and Casing	$1,064	$1,213	$1,361			$371	
13	Waterline	4"	UG	Open Trenching	$38	$46	$54			$42	
14	Waterline	4"	UG	Boring and Casing	$108	$116	$124			$69	
15	Waterline	6"	UG	Open Trenching	$43	$53	$62			$58	
16	Waterline	6"	UG	Boring and Casing	$133	$143	$152	$104	*	$101	U 11773
17	Waterline	8"	UG	Open Trenching	$58	$71	$83	$30		$69	U 11721
18	Waterline	8"	UG	Boring and Casing	$167	$180	$193	$170		$133	U 11721
								$123	*		U 11773
19	Waterline	10"	UG	Open Trenching	$74	$91	$107	$35		$90	U 11721
20	Waterline	10"	UG	Boring and Casing	$204	$220	$298			$164	
21	Waterline	12"	UG	Open Trenching	$96	$118	$139	$279		$159	U 10306
22	Waterline	12"	UG	Boring and Casing	$245	$266	$288	$207	*	$212	U 12182
								$303			U 12574
23	Waterline	16"	UG	Open Trenching	$116	$143	$169	$393		$186	U 10306
24	Waterline	16"	UG	Boring and Casing	$304	$330	$356			$265	
25	Waterline	24"	UG	Open Trenching	$186	$228	$271			$217	
26	Waterline	24"	UG	Boring and Casing	$453	$494	$537			$408	
27	Waterline	30"	UG	Open Trenching	$227	$278	$330			$286	
28	Waterline	30"	UG	Boring and Casing	$552	$604	$655			$519	
29	Waterline	36"	UG	Open Trenching	$273	$335	$397			$345	
30	Waterline	36"	UG	Boring and Casing	$656	$719	$780			$625	
31	Wastewater	4"	UG	Open Trenching	$24	$29	$34			$80	
32	Wastewater	4"	UG	Boring and Casing	$94	$100	$104			$117	
33	Wastewater	6"	UG	Open Trenching	$26	$31	$36			$85	
34	Wastewater	6"	UG	Boring and Casing	$115	$121	$126			$143	
35	Wastewater	8"	UG	Open Trenching	$27	$32	$37	$59		$90	U 11836
36	Wastewater	8"	UG	Boring and Casing	$136	$142	$147			$164	
37	Wastewater	10"	UG	Open Trenching	$37	$44	$53	$82	*	$101	U 11773
38	Wastewater	10"	UG	Boring and Casing	$166	$174	$182			$196	
39	Wastewater	12"	UG	Open Trenching	$57	$70	$83			$111	
40	Wastewater	12"	UG	Boring and Casing	$206	$218	$231			$228	
41	Wastewater	14"	UG	Open Trenching	$77	$94	$112	$113	*	$122	

EXISTING IN STREET UTILITIES



EXAMPLE: ALIGNMENT CROSSING UTILITIES

13th St
12th St
11th St
10th St
Hidalgo Pl
Whittier Pl
University Ave
Mission Inn Ave
6th St
5th St
4th St
3rd St

x 3"G
x 6"W

x 4"G
x 4"W
x 36"W

x 6"W

x 6"G
x 10"W

x 4"W

x 4"W

x 8"G
x 6"W

x 10"W

x 6"G
x 8"W

x 4"G
x 6"W

x 3"G
x 12"W

x 4"G
x 12"W Qty 2
x 6"W

x 8"W
x 10"W

Market St

x 8"W

12" W 400 Ft

Market St

9th St

x 2"G
x 4"W

Main St

14th St

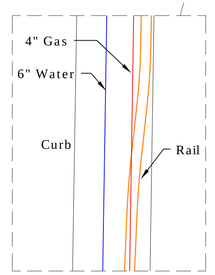
x 3"G
x 4"W

Orange St

x 3"G
x 4"W

Orange Grove Ave

DOWNTOWN RIVERSIDE



EXAMPLE: ALIGNMENT ABOVE UTILITIES

4" Gas
600 Ft

4" Gas
200 Ft

Main St

3rd St

Orange St

12" W 600 Ft

Lemon St

x 10"G
x 12"W

Lemon St

6" W 1200 Ft

x 6"G
x 10"W

x 4"W
x 36"W

x 6"G
x 10"W

x 8"W

x 6"G
x 12"W

x 18"W

x 8"G

x 4"G
x 6"W

x 3"G
x 12"W

Olivewood Ave

Lime

x 6"W

Lime

x 6"W

Lime

13th St

12th St

10th St

9th St

Mission Inn Ave

6th St

5th St

4th St

91

x G
x 12"W
x 24"W

x G
x 12"W
x 24"W

Vine St

Vine St

University Ave

12" Water
400 Ft

12" Water
300 Ft

Commerce St

4" & 8" Gas
300 Ft

91

9160 JORDAN AVE.
CHATSWORTH
CALIFORNIA 91311
PH# 818-709-8500
FAX 818-709-8508
www.tig-m.com

TIG/m
Modern Street Railways

DRAWN	BPL
CHECKED	-
APPROVED	BLR

NO	DATE	DESCRIPTION
0		

SHEET TITLE: IN STREET UTILITIES DOWNTOWN RIVERSIDE

PROJECT TITLE: TIG/m CIVIL ENGINEERING

DRAWING NO.	UT-01
DATE	22-04-20
SCALE	NTS
SHEET	1 OF 1
REVISION NO.	0

THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF SERVICE, ARE AND SHALL REMAIN THE PROPERTY OF TIG/m ENGINEERING, INC. THEY ARE NOT TO BE USED IN WHOLE OR IN PART FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF TIG/m ENGINEERING, INC.

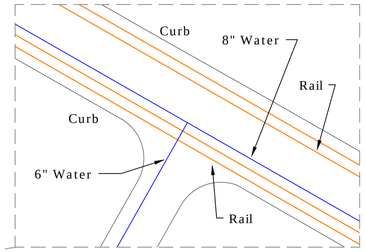
Plot Date: 2022/04/26

Z:\Riverside Feasibility Study\Work\CIVIL\Sketches\Utilities\Phase1\Alignment_Utilities.dwg

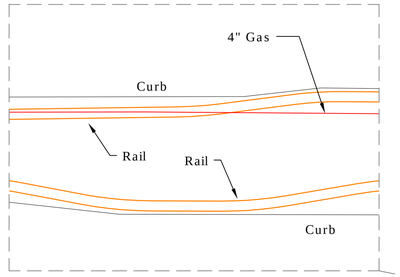
Plot Date: 2022/04/28

EXISTING IN STREET UTILITIES

UNIVERSITY AVE



EXAMPLE: ALIGNMENT CROSSING UTILITIES



EXAMPLE: ALIGNMENT ABOVE UTILITIES

TO VIEW BELOW

Commerce St

Park Ave

University Ave

x 3"G
x 6"W
x 30"W

Gas
50 Ft

x 3"G
x 6"W
x 30"W

Park Ave

x 6"W

Victoria St

Sedgwick St

x 3"G
x 6"W

8" W
50 Ft

Eucalyptus Ave

Comer Ave

x 3"G
x 4"W

3" Gas 300 Ft

x 2"G
x 8"W

Franklin Ave

x 8"W

3" Gas
100 Ft

12" W 600 Ft
x 8"W

Kansas Ave

x 3"G
x 8"W
x 12"W Qty 2

12" W 1400 Ft

x 6"G
x 8"W
x 12"W Qty 2

Douglass Ave

x 6"W
x 48"W

48" W
100 Ft

Dwight Ave

x 2"G
x 8"W

Ottawa Ave

x 3"G
x 8"W

4" Gas 1400 Ft

x 3"G
x 8"W

Mesa St

x 3"G
x 10"W
x 18"W
x 42"W

x 10"W
x 42"W

12" W
50 Ft

12" W
50 Ft

Chicago Ave

N

9160 JORDAN AVE.
CHATSWORTH
CALIFORNIA 91311
PH# 818-709-8500
FAX 818-709-8508
www.tig-m.com

TIG/m Modern Street Railways

DRAWN	BPL
CHECKED	-
APPROVED	BLR

NO	DATE	DESCRIPTION
1		

TO VIEW ABOVE

Canyon Crest Dr

215

x 8"W

x 4"G
x 12"G

4" Gas 350 Ft

x 4"G
4" Gas 500 Ft

University Ave

x 2"G
x 8"W
x 20"W

3" Gas 550 Ft

x 10"W
x 42"W

x 3"G
x 10"W
x 18"W
x 42"W

12" W
50 Ft

12" W 1000 Ft

18" W 500 Ft

x 2"G
x 8"W
x 20"W

Cranford Ave

18" W 500 Ft

12" W
550 Ft

Iowa Ave

18" W
100 Ft

x 4"G
x 12"G

12" W 1000 Ft

12" W 500 Ft

18" W 800 Ft

x 12"W

12" W
150 Ft

Chicago Ave

N

SHEET TITLE: IN STREET UTILITIES EASTSIDE RIVERSIDE

PROJECT TITLE: TIG/m CIVIL ENGINEERING

DRAWING NO.	UT-02
DATE	22-4-26
SCALE	NTS
SHEET	1 OF 1
REVISION NO.	0

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EXISTING IN STREET UTILITIES

3RD ST SPUR TO STREETCAR DEPOT AND FACTORY

Orange St

x 4"G
x 6"W Qty 2

4" Gas
200 Ft

Lime St

6" Water
1200 Ft

x 3"G
x 6"W

Mulberry St

x 3"G
x 12"W

x 3"G
x 6"W

x 2"G
x 12"W

4th St

x 2"G
x 12"W

Lemon St

3rd St

x 4"G
x 6"W

5th St

91

Vine St

x 6"W

x 12"W

12" W
400 Ft

12" W 300 Ft

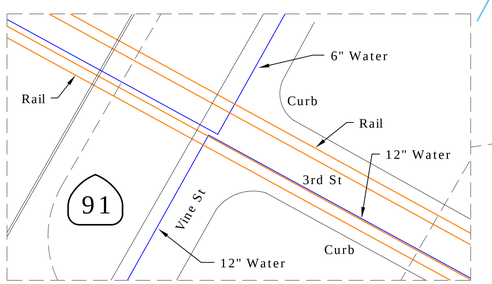
4" & 8" Gas
300 Ft

3rd St

Abandoned Right of Way

Depot & Factory

N



EXAMPLE: ALIGNMENT ABOVE AND CROSSING UTILITIES

9160 JORDAN AVE.
CHATSWORTH
CALIFORNIA 91311
PH# 818-709-8500
FAX 818-709-8508
www.tig-m.com

TIG/m Modern Street Railways

DRAWN	BPL
CHECKED	-
APPROVED	BLR

NO	DATE	DESCRIPTION
0		

SHEET TITLE: IN STREET UTILITIES DEPOT SPUR

PROJECT TITLE: TIG/m CIVIL ENGINEERING

DRAWING NO.	UT-03
DATE	22-4-29
SCALE	NTS
SHEET	1 OF 1
REVISION NO.	0

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Plot Date: 2022/04/29

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Riverside Streetcar System Feasibility Study Report

Appendix I:

Russo & Redd Consulting: "Wireless Streetcar Systems—Estimated Cost Savings"

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
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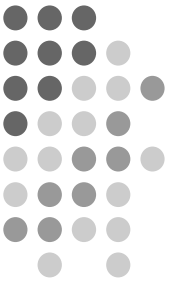
Wireless Streetcar Systems Estimated Cost Savings

20 April 2011



Russo & Redd Consulting Group LLC
Innovative Program Management Solutions

Wireless Streetcar Systems

The age of wireless streetcars has arrived. Recent advancements in battery technology have made the dream of wireless systems a reality. Storage devices are smaller, smarter and more efficient than ever before. They fit easily into modern streetcar shells and work seamlessly with the car's other systems. Car frames, trucks, motors, doors, heating and air conditioning systems remain unchanged. Pantographs and power routing systems can be totally eliminated in small systems and optimized in larger systems. And the only new addition is the battery management system. This seamless evolution in power supply provides a number of improvements while preserving the proven performance of time tested systems.

Wireless technology is most suitable for streetcar systems up to 5 miles in length, or where constraints like historic district restrictions must be considered. They are safer, cheaper to build, cheaper to operate, aesthetically more pleasing and have less environmental impact. And construction is faster and less disruptive. Wireless systems minimize property requirements, nearly eliminate the cost of electrical infrastructure, reduce the cost of bridges and tunnels, shorten construction schedules, reduce construction impacts, reduce maintenance costs, improve safety, and improve yard and shop operations. The result is a system that delivers all of the advantages of a modern streetcar without the complications and traditional clutter of poles and wires. Some of the advantages of wireless streetcar systems are:

Property: Assembling the right of way for new streetcar system is a difficult proposition. Property is always at a premium. New lines are often built in abandoned or underused freight rail corridors that were originally constructed with narrow track centers and little, if any, room for expansion. Squeezing in a modern streetcar line, complete with catenary poles and duct banks for power distribution, becomes problematic and expensive. It is not uncommon for the right of way to cost more than $2M per mile.

Pole & wire clutter in urban environment

Urban environments are even more difficult, especially in older, densely developed neighborhoods where the streets and sidewalks are narrow. Catenary poles must either occupy space between the tracks, adding as much as 3' to the width of the track system, or they must be located on narrow sidewalks where they take up precious pedestrian space and add to the urban clutter of poles. Eliminating wires and poles enhances the prospects of neighborhood acceptance and reduces the cost and time required for

environmental clearance. Catenary systems also require power distribution cables and negative return cables. That means a considerable amount of street excavation to build the duct banks, and it adds significant cost, time, and construction impacts to already expensive projects.

Traction power substation

Locating substations is a particularly difficult property issue. Streetcar systems need substations about every mile. Typically, the substation footprint is about 1,000 SF. In an urban setting, that means finding an empty lot, locating them in a park, or purchasing existing commercial or residential property and converting it to an industrial application. Needless to say, this is a difficult and expensive proposition and generally meets with considerable resistance from the neighborhood, especially in a residential area. Even in an ideal setting, the underlying substation property could cost more than $500K. Substations also need power from the local electric utility. These are generally new underground cables that also add to the cost and impact of construction.

Power Infrastructure: The savings associated with wireless technology are substantial. Overhead catenary systems are expensive. Wireless technology eliminates all of the infrastructure and hardware associated with the distribution of power. It also eliminates the long term problems of stray current, and the cost of cathodic protection for underground utilities. At a minimum, wireless streetcar technology will eliminate:

- Overhead wires
- Line poles
- Tie offs and guy wires at curves
- Tensioning devices
- Sectionalizing switches and associated hardware
- Substations and substation feeds
- Power distribution and negative return cables
- Cathodic protection for buried utilities
- Utility relocation associated with underground construction
- Electrical isolation of the rail

Duct bank construction

The cost of catenary systems in an urban environment is typically about $2.5M per mile. That includes the poles, pole foundations, wires, and hardware. Tie-offs, guy wires, tensioning devices and sectionalizing switches adds another 10%, or $250,000 per mile. The average cost of a substation is approximately $1.25M and they are located about every mile. And the average cost of a utility feed to each substation can be taken as $500,000. The excavation and duct bank construction associated with

the power distribution will cost, on average, $300,000 per mile. A major problem with "wired" systems is stray current and the resulting damage to buried utilities. Controlling stray current requires that the rails are wrapped in a special insulating material called a "boot". This is a laborious and costly element of work that is necessary to control stray currents. Wireless technology eliminates the need to "boot" the rail. Eliminating this element of work will save approximately $250,000 per mile. Stray current is also controlled through cathodic protection. Cathodic protection employs a suite of electrical devices attached to adjacent utilities and structures to counteract the effects of stray current. It is difficult to assign a cost to cathodic protection as it varies greatly from project to project. However, the cost can be substantial and it is reasonable to assign an average cost of $200,000 per mile. Lastly, utility relocation associated with the construction of the power distribution duct banks, substations, and catenary pole foundations will add another $500,000 per mile. Taken together, the capital cost savings of wireless technology is approximately $5.75M per mile. For a short urban circulator approximately 5 miles long, the total savings in capital costs is nearly $29M. These savings are substantial, and could offset nearly 100% of the cost of the vehicle fleet.

Wireless Streetcar Cost Savings:

	Cost per Mile
Poles & wires	2,500,000
Special hardware	250,000
Substations	1,250,000
Utility power feeds	500,000
Duct banks	300,000
Special rail isolation	250,000
Cathodic protection	200,000
Utility relocation	500,000
Savings per mile:	**$5,750,000**

Bridge and Tunnel Costs: There are other savings in systems with bridges and tunnels. These savings can only be quantified on a project specific basis, but they are easy to identify. Bridge widths can be reduced by 3 to 4 feet simply by eliminating the poles and wires. And accommodations for the power distribution cables are eliminated. At nearly $500 per square foot, bridge costs may be reduced by nearly $2,000 per linear foot. A wireless system also means less overhead clearance, which could eliminate the need to raise existing overhead bridges and the need for additional bridge safety and maintenance considerations.

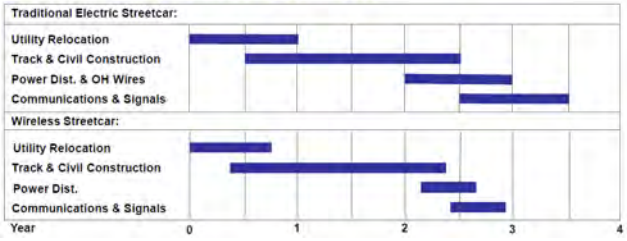
In twin bore (single track) tunnels, the tunnel diameter is generally determined by the combined height of the track, vehicle, and the overhead wire system. Eliminating the overhead wires, and the operating clearance for a raised pantograph, may allow for a smaller tunnel bore. Large bore (double track) tunnel diameters are generally dictated by the width of the track system, so tunnel bores for a wireless system may be nearly identical to a system with wires. But space in a tunnel is always at a premium and construction and maintenance in a tunnel is expensive, so eliminating the wires and power distribution cables may still result in significant savings. And locating substations in a tunnel is also expensive. They must either be housed in the passenger facilities or somewhere along the tunnel. Either way, the amount of cavern excavation required for their construction and maintenance is significant.

Construction Impacts: Wireless technology reduces construction impacts. It improves access to homes and reduces disruptions to businesses. The most disruptive elements of streetcar construction are the pole foundations, construction of the duct banks, and the

relocation of utilities. All of these require excavation. The work is time consuming, noisy, and creates a considerable amount dirt and dust. It often requires detours, including pedestrian barriers, and sometimes the work is immediately in front of homes or commercial establishments. This work is greatly reduced with wireless technology, and the quality of life within the construction corridor is easier to maintain.

Urban construction

Streetcar Construction Schedule:



Construction durations are also reduced. In general, "stringing" the wire, powering the substations, and testing the electrical systems are among the last elements of work. This work requires specialized equipment and unencumbered access to the work site. Consequently, these tasks are only started when construction of the track and stations is nearly complete. Eliminating the electrical systems would reduce construction durations, and just as importantly, greatly simplify start up and commissioning of the Streetcar. A typical streetcar construction project that normally takes more than 3 years to complete could easily be reduced by more than 6 months. This also lowers costs by reducing the expenses related to overhead and financing.

Vehicle Costs: The addition of battery equipment will result in added weight to the vehicle, resulting in added power costs. These costs, however, will be more than offset by using regenerative braking to directly recharge the batteries. Based on a fleet size of 7 cars, operating at an average of 20 hours per day and running 50,000 car miles per year, an annual savings of about $150,000 in power consumption could be realized.

eBrid Streetcar

The lithium-ion batteries and associated equipment used in Kinkisharyo's e-Brid system have proven to be very reliable and require no regular maintenance. Current life expectancy is conservatively estimated to be about 8 years. But battery technology is improving daily and batteries with a 20 year life are expected in the near future. The current cost of battery sets is approximately $240,000. If we assume changing the batteries twice in 30 years, then the annualized maintenance costs would be about $55,000 for a fleet of 7 vehicles.

A new 5 mile wireless system would require two charging stations at $500,000 each and the initial cost per vehicle will be increased by about $350,000, resulting in an added capital cost of $3,450,000.

Operations & Maintenance: Wireless technology simplifies operations and maintenance, especially in climates with inclement weather. Winter storms play havoc with overhead wire systems. Ice accumulation can cause "arcing" which damages the pantographs, and can even go as far as to cause "snags" which rip the pantograph off the roof of the car or pull down the wire. It is not uncommon for operators to schedule non-revenue "ice runs" ahead of normal service just to clear the catenary system of dangerous accumulations of ice and snow. These non-revenue runs are costly, complicate service schedules, and are not an efficient use of the revenue fleet. In older "constant length" catenary systems another problem is loose wires in the summer and wire breaks in the winter as the system tries to expand and contract with the temperature change. Even in ideal climates, catenary systems are expensive to maintain. Both the wires and the substations require regular inspection and maintenance. Substations and power feeds also require a level of security, including protective fencing and intrusion alarms, which must be inspected, tested and maintained. Wireless systems also eliminate the need for overhead wire maintenance trucks…specialized non-revenue maintenance units that are expensive to buy and can only be used efficiently on large systems. They also eliminate the spare parts and material stores of wire and catenary hardware. Even vehicle maintenance is reduced, as smooth and safe operation is dependent on the regular inspection and maintenance of the pantograph system. Wire maintenance crews are eliminated; the traditional job of "power dispatcher" is eliminated; critical safety and proficiency training associated with overhead wires is eliminated; and substation maintenance is limited to the charging station, usually located in the shop and yard area. On a small streetcar system, these improvements and efficiencies will result in operating cost savings of approximately $600,000 per year.

Overhead wire maintenance

Operating Cost Savings:	
Wire & substation maintenance	460,000
Material, parts & supplies	55,000
Special equipment & tools	15,000
Operating efficiencies	30,000
3rd party support	40,000
Annual savings:	**$600,000**

Safety: Passenger and worker safety are improved with a wireless system. In the event of a loss of power, the need for a "rescue" vehicle to ferry passengers to the nearest station is eliminated; this is especially important if power is lost to vehicles in a tunnel.

Worker safety is improved, especially in the shop and yard area where employees routinely work above the roof line of the vehicles. The vehicle maintenance shop is the most dangerous area on the system. Moving vehicles in and out of the shop can only be accomplished by powering the vehicle through overhead wires, using a "hot stick", or moving vehicles using winches or a motorized tow. Overhead wires in the shop expose employees working above the roof line to dangerous electrical

Exposed wires in shop

equipment. "Hot sticks" are even more dangerous, requiring employees to handle tools with exposed electrical contacts. Winches and tow motors are much safer, but highly inefficient. Wireless technology overcomes all of those problems safely and efficiently; improving safety for employees and reducing maintenance costs.

Wireless technology also improves safety for 3rd parties working along the line. Streetcar operators must routinely provide protective services for contractors working along the right of way. Protection is required to ensure the safety of 3rd party employees performing inspection or maintenance of bridges which cross above the wires, or to ensure the safe operation of cranes and other high mast construction equipment operating near the wires. Most of the time, this protection includes a review of the contractor's operations and equipment before work is started, and an inspector at the site to ensure compliance with safety procedures. Occasionally, contractors must work very close to the overhead wires. On those occasions the wires must be de-energized and grounds applied to protect the workers. Wireless technology will not eliminate the need to protect all work above the tracks, but it will eliminate the specialized protective services for electrical safety.

Another consideration is emergency response along the transit corridor. Responding to fires along the right of way often requires the deployment of ladders and other rescue equipment in close proximity to the wires. This requires closely coordinated and diligently rehearsed emergency procedures to ensure the safety of the emergency crews. Emergency response may also require de-energizing the wires and applying grounds, which can delay response time and further threaten life and property. Wireless technology eliminates the coordination of emergency response related to the electrified systems, and eliminates the need for rescue vehicles in the event of a total loss of traction power.

Yard Operations and Storage Tracks: The yard and shop area can also be designed more effectively, without regard to pole locations or power feeds. And track geometry can be developed independent of the complications of overhead wire geometry. Storage tracks can be closer together and save space. Yard and shop construction is easier and cheaper, and yard operations are more reliable. All of the storage is available all of the time, because shut downs for wire inspection and maintenance are eliminated.

Poles in storage yard

Summary: The advantages of a wireless system include significant savings in both the capital and operating cost, as well as potential savings associated with reduced rights of way, savings associated with civil works (especially bridges and tunnels), and with improved construction schedules. The disadvantages are limited to small increases in vehicle cost and battery maintenance.
Not accounting for the cost savings associated with right of way, shorter implementation

schedules or civil works benefits associated with smaller bridges and smaller bore tunnels (which can only be evaluated on a project specific basis), the system-wide savings for a 5 mile wireless streetcar system could easily be as much as:

- Project Capital Cost Savings **$25,300,000**
- Annual Operating Cost Savings **$695,000**

E-Brid System Cost Saving Summary:	
Capital Cost Savings (5 mile system)	28,750,000
Additional Vehicle Cost & Charging Stations	-3,450,000
Total Capital Cost Savings:	25,300,000
Vehicle Cost Savings (per year)	95,000
Maintenance Cost Savings (per year)	600,000
Total O&M Cost Savings (per year):	695,000
Present Value of O&M Savings:	10,700,000
Present Value - Total Savings: (5 mile system, 7 vehicles, 30 years)	$36,000,000

For a 5 mile streetcar system utilizing a fleet of 7 e-Brid vehicles, the estimated annual operating cost savings could be capitalized (at 5%) as $10.7 Million, and when combined on a present worth basis the total cost savings could be about $36 Million over the 30 year life of the system.

The advantages of wireless streetcars will continue to expand. Existing battery technology limits a completely wireless system to about 5 miles. But battery storage systems will get smaller and lighter even as their capacity grows, and the range of wireless systems will be extended. Construction schedule savings together with capital and operating cost savings will make streetcar systems financially more attractive, and eliminating wires and substations will make them aesthetically and environmentally more acceptable. The improvements in electrical and passenger safety are priceless, especially when they come at no cost.

Even longer streetcar lines can benefit from wireless technology. Wireless streetcars can be especially useful in cities with historic districts that prohibit the introduction of wires. They can "bridge the gap" by running conventionally outside the historic district, then lower the pantograph and operate without wires within the district. They may also be able to lower the cost of systems with tunnels by lowering the cost of tunnel construction and maintenance.

Wireless technology is no longer experimental. It is ready for commercial use now and will quickly become the preferred solution for shorter streetcar lines and downtown circulators in an urban environment. And wireless systems offer benefits that may provide value even for longer systems. Most importantly, they are faster and cheaper to build, easier and less expensive to maintain, and they result in a more aesthetically pleasing product.

Note: The information in this report was based on typical project data and from manufacturer's data provided by Kinkisharyo. Costs for a specific project may vary depending on specific project conditions.

Riverside Streetcar System Feasibility Study Report

Appendix J:

Park & Ride Concept

With Modal Shift Data

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
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Chatsworth, California 91311
+1 818 709 8500

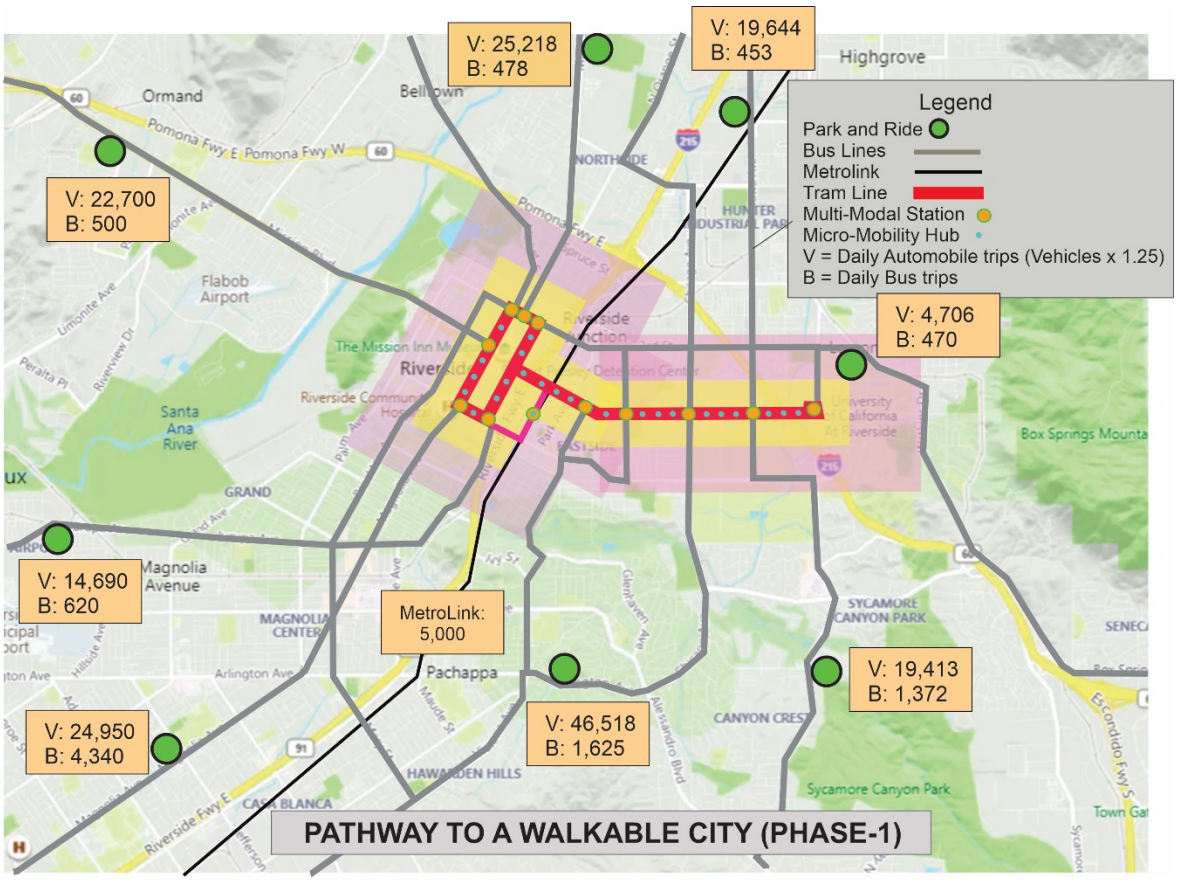
Sustainable Multi-Modal Transit: A Pathway to a Walkable City

Sustainability is defined as the capacity to endure in a relatively ongoing way across various domains of life, including social, economic, and environmental domains. James, Paul; with Magee, Liam; Scerri, Andy; Steger, Manfred B. (2015). Urban Sustainability in Theory and Practice: Circles of Sustainability. London: Routledge.; Kuhlman, Tom; Farrington, John (1 November 2010). "What is Sustainability?". Sustainability. 2 (11): 3436–3448. doi:10.3390/su2113436.
https://www.academia.edu/9294719/Urban_Sustainability_in_Theory_and_Practice_Circles_of_Sustainability_2015
https://en.wikipedia.org/wiki/Sustainability#cite_note-1

A city's walkability improves with easy access to active multi-modal public transit. The wider the variety of available transit opportunities, the likelier it is that people will start and/or finish their trips around a city on foot. These local trips may originate from Riverside homes, from available parking facilities on the city's perimeter, or via incoming Metrolink passenger rail. All of these options, when utilized, reduce the number of vehicles and VMT.

Figure 1-6, below, shows a map of Riverside with TIG/m's conceptual Phase 1 streetcar alignment, five-minute pedestrian catchment within an eight-minute micro-mobility catchment to transit stops (all placed 1,300 feet apart), as well as eight suggested intermodal Park-and-Ride (P&R) facilities on the city's perimeter at which drivers could leave their cars and hop on busses that will connect them to a multi-modal transit stop or micro-mobility hub, each with a streetcar station. The bus lines become a "feeder system" to the streetcar, and visa-versa. This, in addition to the streetcar stops at Metrolink stations, solves the "first and last mile" problem. Additionally, each 1.5-acre P&R could fit 132 cars at one time, reducing the auto-to-bus trip from 25:1 to 21:1, which translates to a local 16% increase in public transit use.

Riverside: Pathway to a Walkable City, Phase 1



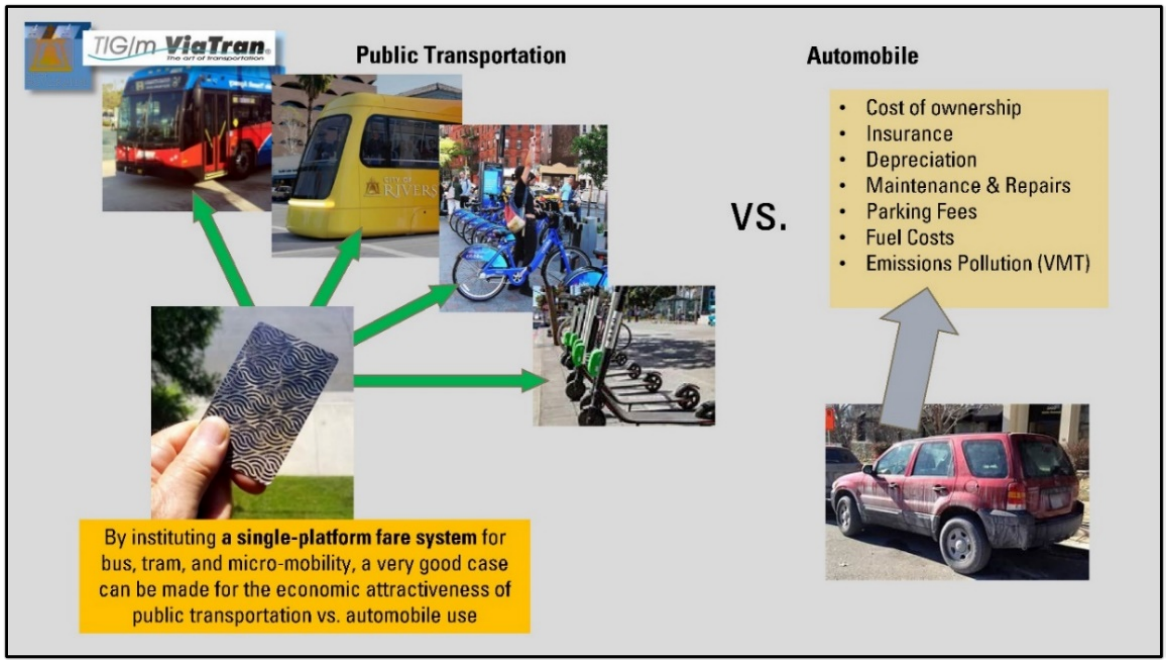
The above diagram shows the current daily bus ridership and vehicle count on the main thoroughfares adjacent to the indicated locations of potential P&R Facilities. Conceptual locations for P&Rs were developed by searching Google Earth for undeveloped land adjacent to key bus routes and approximately 4 to 5 mile from the centroid of the Phase 1 alignment. By adding 1.5-acre P&R facilities at these eight locations (each with 132 parking spaces per acre), 1,584 parking spaces could be provided.

The capacity of this P&R system is calculated at two cars per parking space, per 16 hours of public transportation service. Using the generally accepted factor of 1.25 riders per car, this system could potentially impart 3,960 daily riders into the public transportation system.

For the ridership analysis and cost modeling effort, we will be using 30% of this potential P&R contribution, equaling 1,320 passengers per day (PPD).

Single-Platform Fare System

Public Transportation vs. Personal Automobile



Park and Ride Facilities

As regards P&R, Parkhurst describes the differences between the perspective of the individual traveler and that of the policymaker. Parkhurst, G., Meek, S. (2014). The Effectiveness of Park-and-Ride as a Policy Measure for more Sustainable Mobility. Chapter 9 in Ison, S. & Mulley, C. (Eds) Parking Issues and Policies. Emerald, 185-211. https://www.semanticscholar.org/paper/The-Effectiveness-of-Park-and-Ride-as-a-Policy-for-Parkhurst-Meek/a04a46a41ba68fecff598f9392b98c24f1855211 For example, the individual traveler in a society highly oriented and accustomed to personal automobile travel, may perceive P&R as an opportunity to:

- Circumvent known or unpredictable constraints in parking opportunities near the destination in a city's central business district (scarcity or price)
- Avoid congested driving conditions en route to a destination in the central business district (CBD)
- Relieve distance fatigue (from a commute from outside the city limits) or avoid complex navigating activities to and around the CBD
- Enjoy private car usage from trip origin until public transport is accessible.

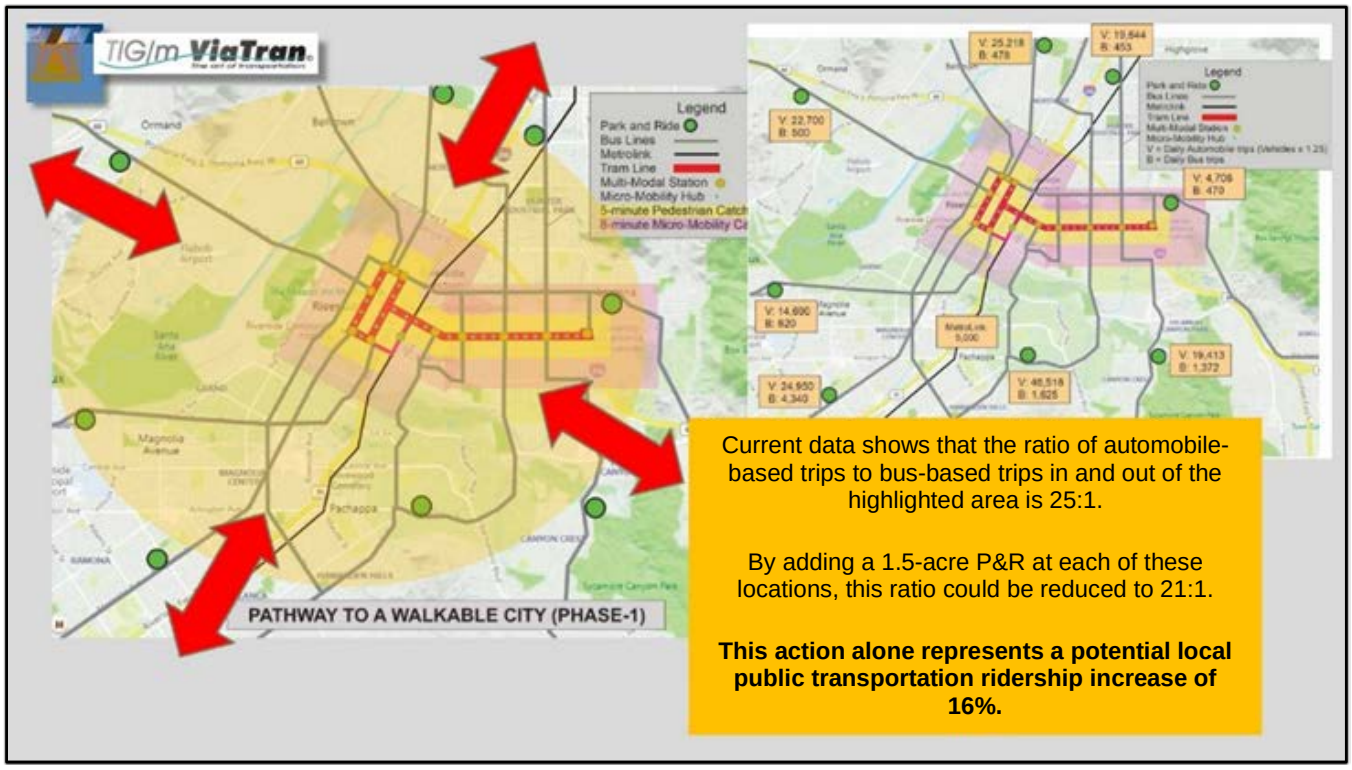
He characterizes the policymaker's perspective as multifaceted, tending to reflect professional orientation. For example:

- **Transport planners** may recognize the potential of P&R to have direct influence on traffic and/or congestion in and around a CBD, with the expectation that each of these should reduce. Indirectly, positive consequences for tailpipe and tire pollution reduction can be assumed. Traffic reduction may also consider the reallocation of roadway space and land currently used for parking to other purposes. Olowoporoku, D., Hayes, E., Longhurst, J., Parkhurst, G. (2012). The rhetoric and realities of integrating air quality into local transport planning process in English local authorities. *Journal of Environmental Management*, **101**, 23-32.

- **Economic development** professionals will likely see P&R as one way of providing, advertising, and attracting retail, consumer, and other business activities to the CBD. Parkhurst and Dudley expect that a preference for P&R capacity would be in addition to (rather than instead of) city center parking, with the understanding that city-center parking constraints would be considerably relieved. Parkhurst, G., Dudley, G. (2004). Bussing between hegemonies: the dominant frame in Oxford's transport policies. *Transport Policy*, **11** (1), 1-16.

- The **public transport operator's** perspective to the addition of P&R, noted by Parkhurst, will depend on specific regulatory administration and operations plans, but will generally be favorable where P&R is observed to simplify operations by focusing demand at specific traffic nodes, and to be an instrument of attracting or retaining transit customers. All public transport operators may expect reduced roadway traffic to improve operating conditions for all modes of transit services. Parkhurst, G., Meek, S. (2014). The Effectiveness of Park-and-Ride as a Policy Measure for more Sustainable Mobility. Chapter 9 in Ison, S. & Mulley, C. (Eds) Parking Issues and Policies. Emerald, 185-211. https://www.semanticscholar.org/paper/The-Effectiveness-of-Park-and-Ride-as-a-Policy-for-Parkhurst-Meek/a04a46a41ba68fecff598f9392b98c24f1855211

Conceptual Park-and-Ride Facilities



Reduced rates or free parking at these locations and increased parking rates and/or parking levies downtown would encourage drivers to “leave your car here and get around downtown using *the new streetcar system*”. This is how we increase ridership in all modes of public transportation, reduce VMT and congestion, improve the state of good repair of the roadways, and promote a walkable city.

It is assumed that, should the City and County approve the concept, RTA would work with the City to modify bus routes to provide bus stops at Park & Ride locations which would be finalized during a Design Phase with the input of all of the public and privates sector stakeholders in the project. The cost of the P&Rs are included in line 4.6 of the project CAPEX. A survey of current prices for undeveloped land in Riverside as well as construction costs for parking lot installation and P&R furnishings has produced an estimate of approximately $10MM for these eight P&Rs.

Modal Shift from Automobile Use

The Travel Survey questionnaires showed that a significant majority of the Riverside respondents would shift their mode of transportation to the Streetcar if they had the opportunity and it served to facilitate their journey.

Survey Question #9:
If an electric streetcar were to provide service on the routes of the normal trips you have identified in this survey, how likely would it be that you would switch from your current mode of transportation or add the new streetcar system to it? (please check only one)

Likelihood of Modal Shift; Responses from Survey Question #9

Question #9	Likelihood of Mode Shift	
Total Responses	478	
	Total	Percentage
Likely	379	79.3%
Not Likely	99	20.7%
Totals	478	100%

While it is generally accepted that there is a higher public opinion, acceptance, and therefore usage, of rail vehicles (streetcars, trams, trolleys) over rubber-tired vehicles (buses, trolley-buses, BRT), there is relatively little documented evidence of quantified modal shift from automobile usage to streetcar systems once they are installed. The main reason for this is that vehicle counts on roadways are enormous numbers that include freight as well as commuters and vary substantially from time to time and day to day due thereby resisting qualification as a baseline. As a result, data on this subject is usually carried out by interviewing existing tramway ridership to find if they have shifted modes as a result of the streetcar line being established.

Several good example of this have been carried out which will allow us to make a case for a plausible augmentation of the *base ridership total*.

Croydon London Tramlink

Steer Davies Gleave, in their 2005 report prepared for Passenger Transport Executive Group in England, monitored modal shifts after the 2000 opening of the Croydon Tramlink, a three-line network linking Beckenham, New Addington, and Wimbledon to Central Croydon. The system includes street-running, new segregated alignments, and replacement of other rail services.

Their investigation showed that nearly 20% of the system's passengers had previously made their trips using a personal automobile, and a shift from other public transport modes

accounted for approximately 75% of demand. Much of this system's early and immediate success is due to changes in bus routes and services (to work in concert with the tram system) and the tram line partially replaced a portion of the local heavy rail passenger lines. *Table 6-8* shows the primary modes used by Tramlink passengers before the implementation of the tram system.
Steer Davies Gleave. "What Light Rail Can Do For Cities: A Review of the Evidence." PTEG 2005. https://www.urbantransportgroup.org/system/files/general-docs/WhatLightRailCanDoforCitiesMainText_0218.pdf

Modal Shift Following the Opening of Tramlink

Mode	Users Surveyed	Trips Transferred
Bus	69%	9,316,271
Car (as driver)	16%	2,160,295
Car (as passenger)	3%	405,055
National Rail (heavy rail passenger service)	7%	945,129
Walking	4%	540,074
Other	1%	135,018
Total	100%	13,501,842

Source: Steer Davies Gleave. "What Light Rail Can Do For Cities: A Review of the Evidence." PTEG 2005. https://www.urbantransportgroup.org/system/files/general-docs/WhatLightRailCanDoforCitiesMainText_0218.pdf

In the year following the opening of the Croydon Tramlink system, an immediate -14% change in average daily flow of roadway traffic in Croydon was recorded. Steer Davies Gleave. "What Light Rail Can Do For Cities: A Review of the Evidence." PTEG 2005. https://www.urbantransportgroup.org/system/files/general-docs/WhatLightRailCanDoforCitiesMainText_0218.pdf.

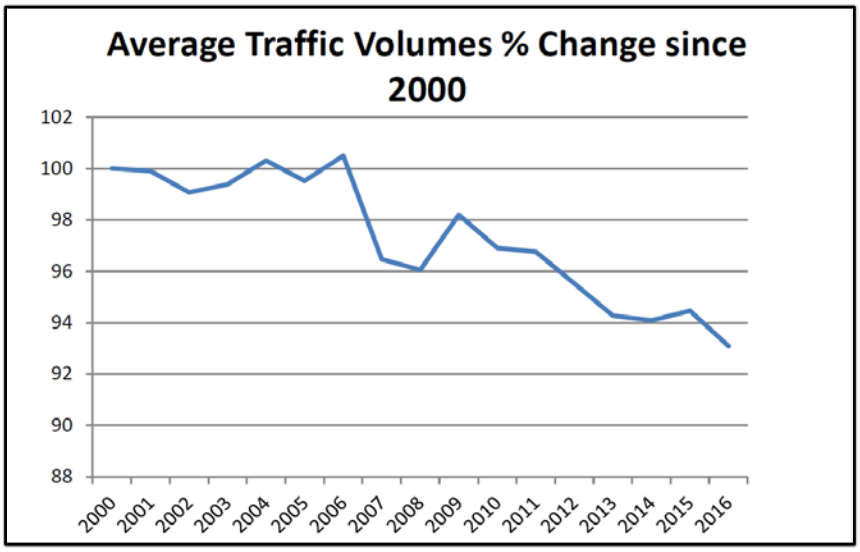
Their studies of additional U.K. cities with street-running light rail (tram) systems showed that approximately 20% of peak light rail passengers were found to have shifted from personal automobile use, and that a system operating at a theoretical rate of six trams per hour would remove c.240 cars per peak hour from the roadways. This is compared to an overall level of bus service, which their calculations determined would require 30 busses to remove c.40 cars during that same peak hour, demonstrating street rail's effectiveness in delivering a higher scale of traffic-reducing benefits. Steer Davies Gleave. "What Light Rail Can Do For Cities: A Review of the Evidence." PTEG 2005. https://www.urbantransportgroup.org/system/files/general-docs/WhatLightRailCanDoforCitiesMainText_0218.pdf.

Additionally, their report states that "integration of light [street] rail with national [commuter] rail and bus stations also encourages more use of public transport overall. Steer Davies Gleave. "What Light Rail Can Do For Cities: A Review of the Evidence." PTEG 2005. https://www.urbantransportgroup.org/system/files/general-docs/WhatLightRailCanDoforCitiesMainText_0218.pdf.

Nottingham, UK

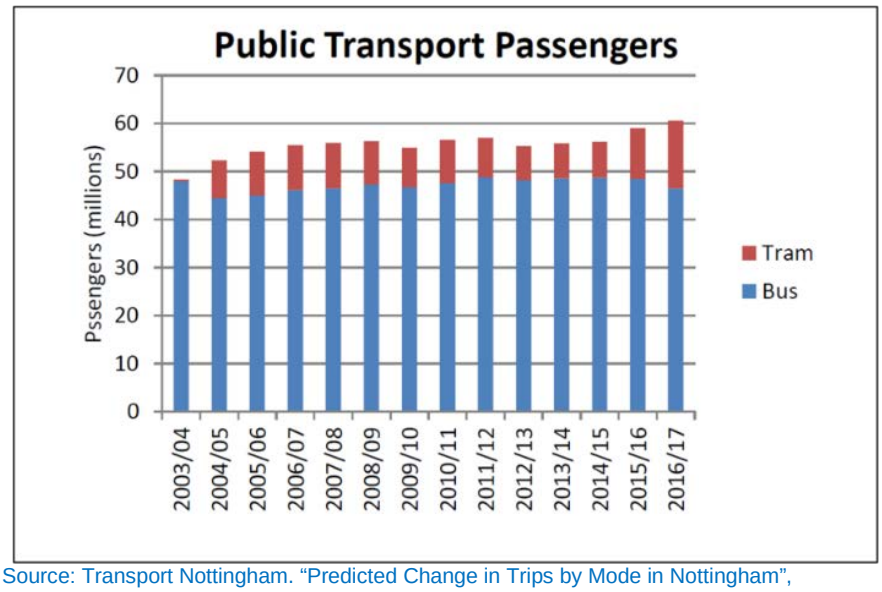
In Nottingham, UK, an 8% decrease in its AADT traffic volumes occurred between 2000 and 2018, with an increase in public transit ridership during the period from 2003 to 2017, from around 48 million passengers per year in 2003 to just over 60 million in 2016/2017.

Observed AADT Traffic Volumes in Nottingham from 2000



Source: Transport Nottingham. "Predicted Change in Trips by Mode in Nottingham", Appendix A: Traffic Growth in Nottingham. 2018. https://www.transportnottingham.com/wp-content/uploads/2018/03/Appendix-A-Traffic-Growth-in-Nottingham.pdf. Retrieved June 2021

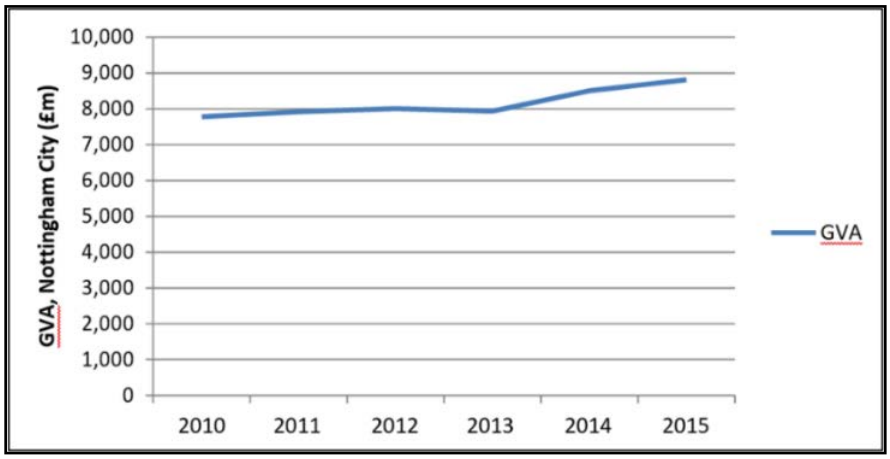
Public Transit Passenger Numbers, Nottingham, 2003-2017



Source: Transport Nottingham. "Predicted Change in Trips by Mode in Nottingham", Appendix A: Traffic Growth in Nottingham. 2018. https://www.transportnottingham.com/wp-content/uploads/2018/03/Appendix-A-Traffic-Growth-in-Nottingham.pdf. Retrieved June 2021

Additionally, Nottingham also reports economic growth, especially between 2010 and 2017.

Nottingham: Increase in Gross Value Added Between 2010 and 2017

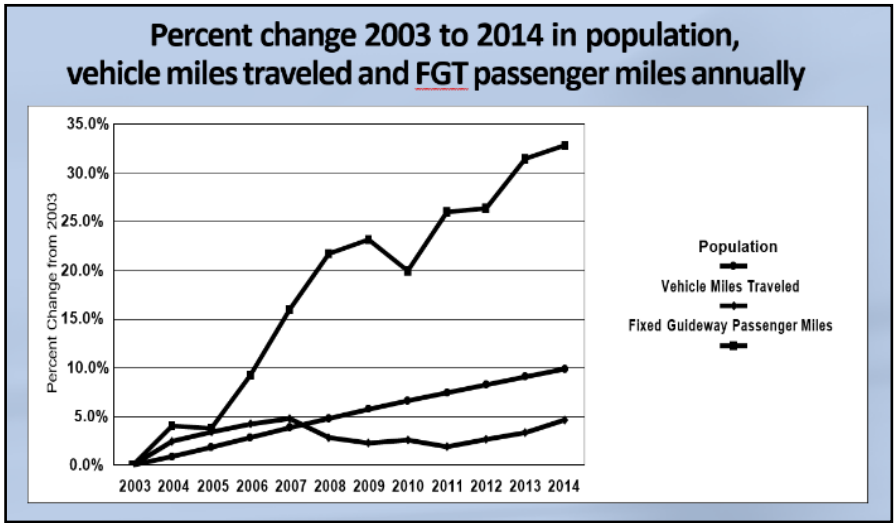


Source: Transport Nottingham. "Predicted Change in Trips by Mode in Nottingham", Appendix A: Traffic Growth in Nottingham. 2018. https://www.transportnottingham.com/wp-content/uploads/2018/03/Appendix-A-Traffic-Growth-in-Nottingham.pdf. Retrieved June 2021

Assumptions about modal shift from private vehicle use to a multimodal public transit system that includes a streetcar network can be made based upon trends recorded in cities with sustainable systems installed.

Nelson (2016) graphs associations between U.S. population growth, VMT, and fixed guideway miles traveled between 2003 and 2014, showing a dramatic shift to fixed guideway transit (FGT) passenger miles traveled in *Figure 6-32.*

Changes in Population, VMT, and FGT Passenger Miles (U.S.)



Source: Nelson, Arthur C., *"Webinar: The Association Between Light Rail Transit, Streetcars and Bus Rapid Transit on Jobs, People and Rents"* (2016). *TREC Webinar Series*. 14. https://pdxscholar.library.pdx.edu/trec_webinar/14

Riverside Streetcar System Feasibility Study Report

Appendix K:

Urban Fixed Transit Systems—Average Ridership Comparisons

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
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Revenue km/miles shown represent either track miles or corridor miles.

Urban Fixed Guideway Systems / Average Ridership Comparison

Mode / Title	Location City/State	Country	Popupation	Revenue km	Revenue miles	Avg. Daily Boardings	Avg. Daily Boardings/mi.	Latest Pre-COVID Published Reporting Year	Data Source	Additional Data Source	notes
Streetcar / Tram / Trolley											
Vienna Tram Network	Vienna	Austria	1,900,000	178	110	994,500	9,041		https://www.railway-technology.com/features/six-of-the-best-tram-systems-around-the-world/		study conducted by Eurogroup Consulting
Zurich Tram Network	Zurich	Switzerland	434,335	73	45	685,000	15,222	2019	https://www.railway-technology.com/features/six-of-the-best-tram-systems-around-the-world/		study conducted by Eurogroup Consulting
Toronto Streetcar System	Toronto, Ontario	Canada	2,600,000	83	52	530,600	10,204	2019	https://en.wikipedia.org/wiki/Toronto_streetcar_system		
Paris Tram Network T3	Paris	France	11,000,000	22	14	280,000	20,588	2019	https://www.railway-technology.com/features/six-of-the-best-tram-systems-around-the-world/		study conducted by Eurogroup Consulting
Edinburgh Trams	Edinburgh, Scotland	United Kingdom	500,000	14	8.7	205,000	23,563	2018	https://en.wikipedia.org/wiki/Edinburgh_Trams		
Oslo Tram Network	Oslo	Norway	634,300	83	53	132,000	2,491	2012	https://en.wikipedia.org/wiki/Trams_in_Oslo		
Manchester Metrolink	Manchester, England	United Kingdom	553,230	101	63	121,370	1,927	2019	https://en.wikipedia.org/wiki/Manchester_Metrolink		
San Diego Silver Trolley (incl. Silver Lir	San Diego, CA	USA	1,400,000	86	54	115,400	2,157	2018	https://en.wikipedia.org/wiki/List_of_North_American_light_rail_systems_by_ridership		
Lyon Tram Network	Lyon	France	513,300	61	38	100,000	2,632	2019	https://www.railway-technology.com/features/six-of-the-best-tram-systems-around-the-world/		study conducted by Eurogroup Consulting
Dijon Tram Lines	Dijon	France	155,114	19	12	65,753	5,572	2019	https://www.railway-technology.com/features/six-of-the-best-tram-systems-around-the-world/	"Six of the best tram systems around the world", Varsha Saraogi, Railway Technology, 12 November 2019	study conducted by Eurogroup Consulting
Nottingham Express Transit	Nottingham, England	United Kingdom	331,297	32	20	51,200	2,560	2019	https://en.wikipedia.org/wiki/Nottingham_Express_Transit	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/897339/light-rail-and-tram-statistics-england-march-2020.pdf	Retrieved 9 July 2020.
Tours Tram Network	Tours	France	136,252	15	9.3	46,575	5,008	2019	https://www.railway-technology.com/features/six-of-the-best-tram-systems-around-the-world/		study conducted by Eurogroup Consulting
Portland Streetcar	Portland, OR	USA	645,291	11.6	7.2	20,011	2,779	2018	https://en.wikipedia.org/wiki/Portland_Streetcar		
New Orleans Streetcar Lines	New Orleans, LA	USA	390,845	35.9	22.3	18,800	843	2018	https://en.wikipedia.org/wiki/List_of_North_American_light_rail_systems_by_ridership		number largely reflects local commuter trips
South Lake Union & First Hill Streetcar Lines	Seattle, WA	USA	724,305	6.1	3.8	6,000	1,579	2018	https://www.seattle.gov/transportation/getting-around/transit/streetcar/ridership-data		

Revenue km/miles shown represent either track miles or corridor miles.

Urban Fixed Guideway Systems / Average Ridership Comparison

Mode / Title	Location City/State	Country	Popupation	Revenue km	Revenue miles	Avg. Daily Boardings	Avg. Daily Boardings/mi.	Latest Pre-COVID Published Reporting Year	Data Source	Additional Data Source	notes
Cincinnati Bell Connector	Cincinnati, OH	USA	301,394	5.8	3.6	1,450	403	2019	https://www.cincinnati-oh.gov/streetcar/about-the-streetcar/ridership-and-reports/		on 10/12/19: 14,870 riders
Tempe Streetcar	Tempe, AZ	USA	187,454	4.8	3	n/a		2021	https://www.railway-technology.com/projects/tempe-streetcar-arizona/		Line not yet active
Berlin tramway	Berlin	Germany	3,645,000	190	270	n/a	n/a	n/a	https://en.wikipedia.org/wiki/Trams_in_Berlin		RIDERSHIP DATA NOT FOUND
Graz Holding Tramway Network	Graz	Austria	294,630	68	42	n/a	n/a	2012	https://en.wikipedia.org/wiki/Trams_in_Graz#cite_note-report-2	*"Dienstleister für Generationen - Geschäftsbericht der Holding Graz 2012" [Supplier for Generations - Business Report of Holding Graz 2012] (PDF) . holding-graz.at (via: http://www.holding-graz.at/holding-graz/unternehmen/geschaeftsbericht.html) (in German). Holding Graz. August 2013. p. 47. Retrieved 5 October2013.* External link in `|website=` (help)	
	Graz	Austria				n/a	n/a		https://www.holding-graz.at/graz-linien.html		
Bilbao Tram	Bilboa	Spain	345,800	5.5	3.4	8,500	2,500	2020	https://www.globalmasstransit.net/archive.php?id=38937		
Nice Tramway	Nice	France	342,500	27.5	17	100,000	5,882	2016	https://en.wikipedia.org/wiki/Nice_tramway		
TECO Streetcar Line	Tampa, FL	USA	385,000	4.34	2.7	2,500	926	2018	http://tecolinestreetcar.org/#/home		
BRT (Dedicated Bus Alignment or Guideway)											
TransMilenio	Bogotá	Colombia	7,180,000	115	71	2,470,000	34,789	2019	https://en.wikipedia.org/wiki/TransMilenio	"Transmilenio en cifras febrero 2020". TransMilenio (in Spanish). 2020-03-04. Retrieved 2020-05-15.	
G (Orange) Line Busway	Los Angeles, CA	USA	1,540,950	29	18	22,256	1,236	2020	https://en.wikipedia.org/wiki/G_Line_(Los_Angeles_Metro)	Metro Ridership". Metro.net. Los Angeles County Metropolitan Transportation Authority. February 2020. Retrieved December 1, 2020.	
Healthline	Cleveland, OH	USA	385,282	11	6.8	10,137	1,491	2018	https://en.wikipedia.org/wiki/HealthLine		
LRT											
Croydon London Tramlink	South London	UK	405,000	28	17.4	74,500	4,282	2019	https://www.plumplot.co.uk/Croydon-population.html	https://en.wikipedia.org/wiki/Tramlink	
CTrain	Calgary, Alberta	Canada	1,336,000	59.9	37.2	313,800	8,435	2019	https://en.wikipedia.org/wiki/Ctrain		
Los Angeles B (Red) Line	Los Angeles, CA	USA	340,650 Localities served along line	26.4	16.4	133,413	8,135	2019	https://en.wikipedia.org/wiki/B_Line_(Los_Angeles_Metro)#cite_note-ridership-1	"Interactive Estimated Ridership Stats". Los Angeles County Metropolitan Transit Authority. January 1, 2020.	http://maps.latimes.com/neighborhoods/

Revenue km/miles shown represent either track miles or corridor miles.

Urban Fixed Guideway Systems / Average Ridership Comparison

Mode / Title	Location City/State	Country	Popupation	Revenue km	Revenue miles	Avg. Daily Boardings	Avg. Daily Boardings/mi.	Latest Pre-COVID Published Reporting Year	Data Source	Additional Data Source	notes
Los Angeles L (Gold) Line	Los Angeles, CA	USA		50	31	50,087	1,616	2018	https://en.wikipedia.org/wiki/L_Line_(Los_Angeles_Metro)	"Ridership Statistics – Rail Ridership Estimates". LACMTA.March 8, 2016.	
TriMet Max	Portland, OR	USA	662,550	97	60	119,600	1,993	2019	https://en.wikipedia.org/wiki/List_of_North_American_light_rail_systems_by_ridership		
Guadalajara Light Rail	Guadalajara, Jalisco	Mexico	1,386.63	47	29	295,043	10,174	2018	https://en.wikipedia.org/wiki/Guadalajara_light_rail_system		
Edmonton Light Rail Transit	Edmonton, Alberta	Canada	972,223	24.3	58.5	7,335	125	2018	https://en.wikipedia.org/wiki/List_of_North_American_light_rail_systems_by_ridership		
DART Light Rail	Dallas, TX	USA	1,343,570	150	93	95,800	1,030	2018	https://en.wikipedia.org/wiki/List_of_United_States_rapid_transit_systems_by_ridership		
RTA Light Rail	Denver, CO	USA	727,211	94	8.5	101,700	11,965	2018	https://en.wikipedia.org/wiki/List_of_United_States_rapid_transit_systems_by_ridership		
Xochimilco Light Rail	Mexico City	Mexico	415,007	2.8	8	57,535	7,192	2019	https://en.wikipedia.org/wiki/List_of_North_American_light_rail_systems_by_ridership		
Link Light Rail	Tacoma/Seattle, WA	USA		32.8	21.8	77,900	3,573	2018	https://en.wikipedia.org/wiki/List_of_United_States_rapid_transit_systems_by_ridership		
MBTA (Green and M [Red] Lines only)	Boston, MA	USA		42	26	162,900	6,265	2018	https://en.wikipedia.org/wiki/List_of_North_American_light_rail_systems_by_ridership		
The Hop Streetcar	Milwaukee, WI	USA	594,548	3.4	2.1	2,191	1,043	2018	https://en.wikipedia.org/wiki/The_Hop_(streetcar)	https://www.tmj4.com/news/local-news/milwaukee-streetcar-the-hop-ridership-outpaces-estimates	
Amsterdam Metro	Amsterdam, NE	Netherlands	1,149,000	95	59	n/a	n/a	n/a	https://en.wikipedia.org/wiki/Amsterdam_Metro	RIDERSHIP DATA NOT FOUND	
SkyTrain	Vancouver, BC	Canada	2,581,000	79.6	49.5	526,400		2019	https://en.wikipedia.org/wiki/SkyTrain_(Vancouver)#cite_note-APTA-2019-1	https://www.apta.com/wp-content/uploads/2019-Q3-Ridership-APTA.pdf	"APTA Q3 2019 Ridership Report" (PDF). American Public Transportation Association. November 22, 2019. p. 37. Archived (PDF) from the original on May 8, 2019. Retrieved December 18, 2019.
Bielefeld Stadtbahn	Bieldield	Germany	333,786	37	23	89,780		2012	https://en.wikipedia.org/wiki/Bielefeld_Stadtbahn	http://www.mobiel.de/unternehme	Zahlen & Fakten" [Numbers & Facts] (in German). moBiel. May 2013.
Metro (Underground, Elevated, and Mixed Surface/Underground System)											
RER (Réseau Express Régional / Regional Express Network)	Paris, France	France	2,161,000	587	365	5,041,100	13,811	2018	https://en.wikipedia.org/wiki/R%C3%A9seau_Express_R%C3%A9gional	https://www.bloomberg.com/news/articles/2019-11-13/the-paris-metro-s-new-problem-a-ridership-boom	
London Underground	London, England	United Kingdom	9,304,000	402	250	3,717,800	14,871	2018	https://en.wikipedia.org/wiki/Londo	http://content.tfl.gov.uk/tfl-annual-report-and-statement-of-accounts-2017-18.pdf	TfL annual report 2017-18" (PDF). Transport for London. Retrieved 26 February 2019.

Revenue km/miles shown represent either track miles or corridor miles.

Urban Fixed Guideway Systems / Average Ridership Comparison

Mode / Title	Location City/State	Country	Popupation	Revenue km	Revenue miles	Avg. Daily Boardings	Avg. Daily Boardings/mi.	Latest Pre-COVID Published Reporting Year	Data Source	Additional Data Source	notes
Berlin U-Bahn	Berlin	Germany	3,645,000	152	94	1,515,342	16,121	2017/2018	https://en.wikipedia.org/wiki/Berlin_U-Bahn		
New York City Subway	New York, NY	USA	18,800,000	394	245	5,493,875	22,424	2019	https://new.mta.info/agency/new-york-city-transit/subway-bus-ridership-2019	MTA Subway (and bus ridership for 2019 Updated Apr 14, 2020	
Chicago CTA "L"	Chicago, IL	USA	2,693,976	165	103	618,890	6,009	2018	https://data.cityofchicago.org/Transportation/CTA-Ridership-Annual-Boarding-Totals/w8km-9pzd	Annual Ridership Report: Calendar Year 2018" (PDF). Transitchicago.com. Retrieved September 13, 2019	
Washington DC Metrorail	Washington, DC	USA	705,749	190	118	498,630	4,226	2019	https://en.wikipedia.org/wiki/Washington_Metro#cite_note-2019_ridership-1	https://www.wmata.com/about/news/2019-Metrorail-ridership.cfm	"Metrorail ridership grew by 20,000 trips per weekday in 2019". WMATA. January 15, 2020. Retrieved March 21, 2020.

Riverside Streetcar System Feasibility Study Report

Appendix L:

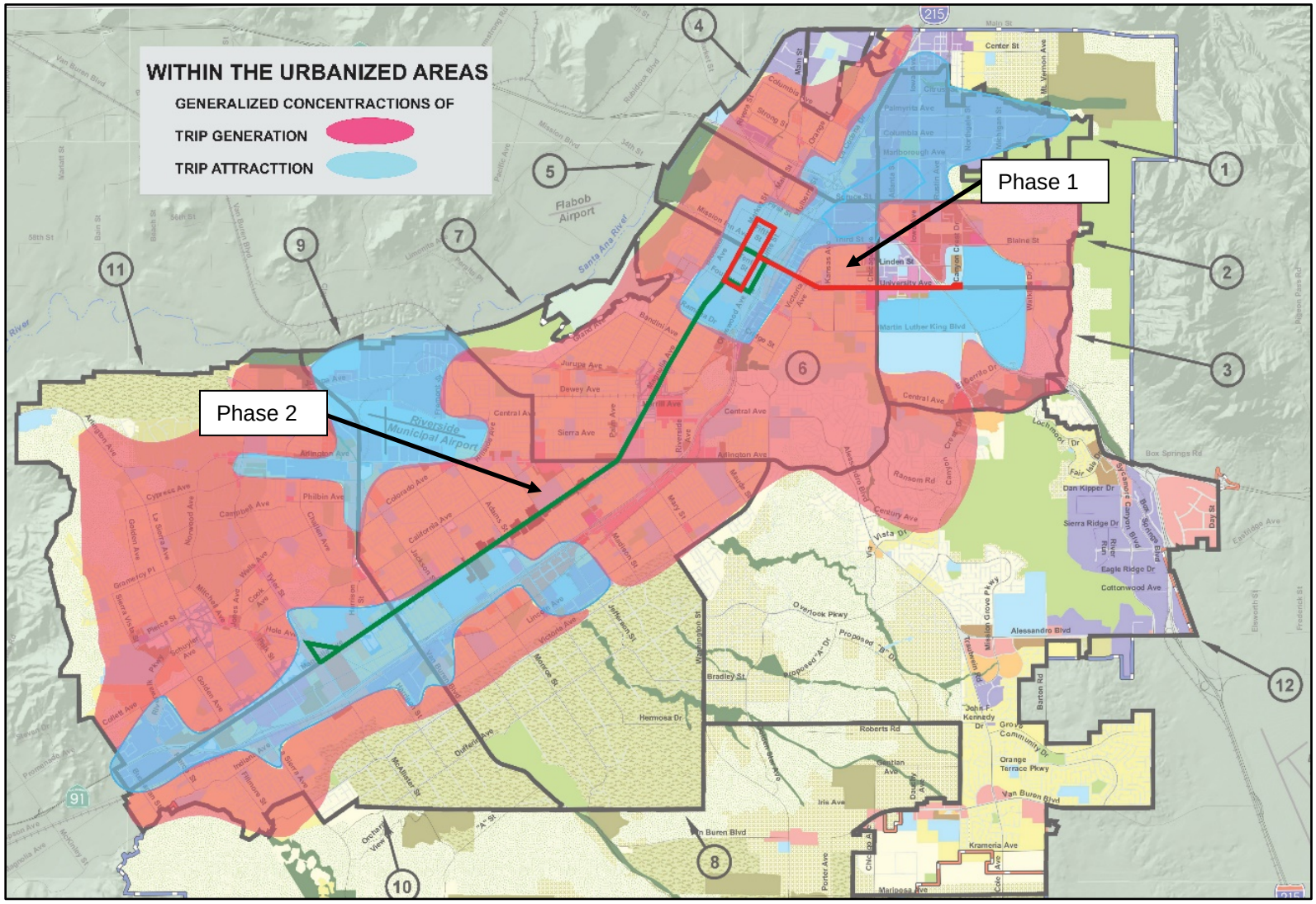
Trip Distribution Graphics

May 15, 2022

Prepared for:
The City of Riverside

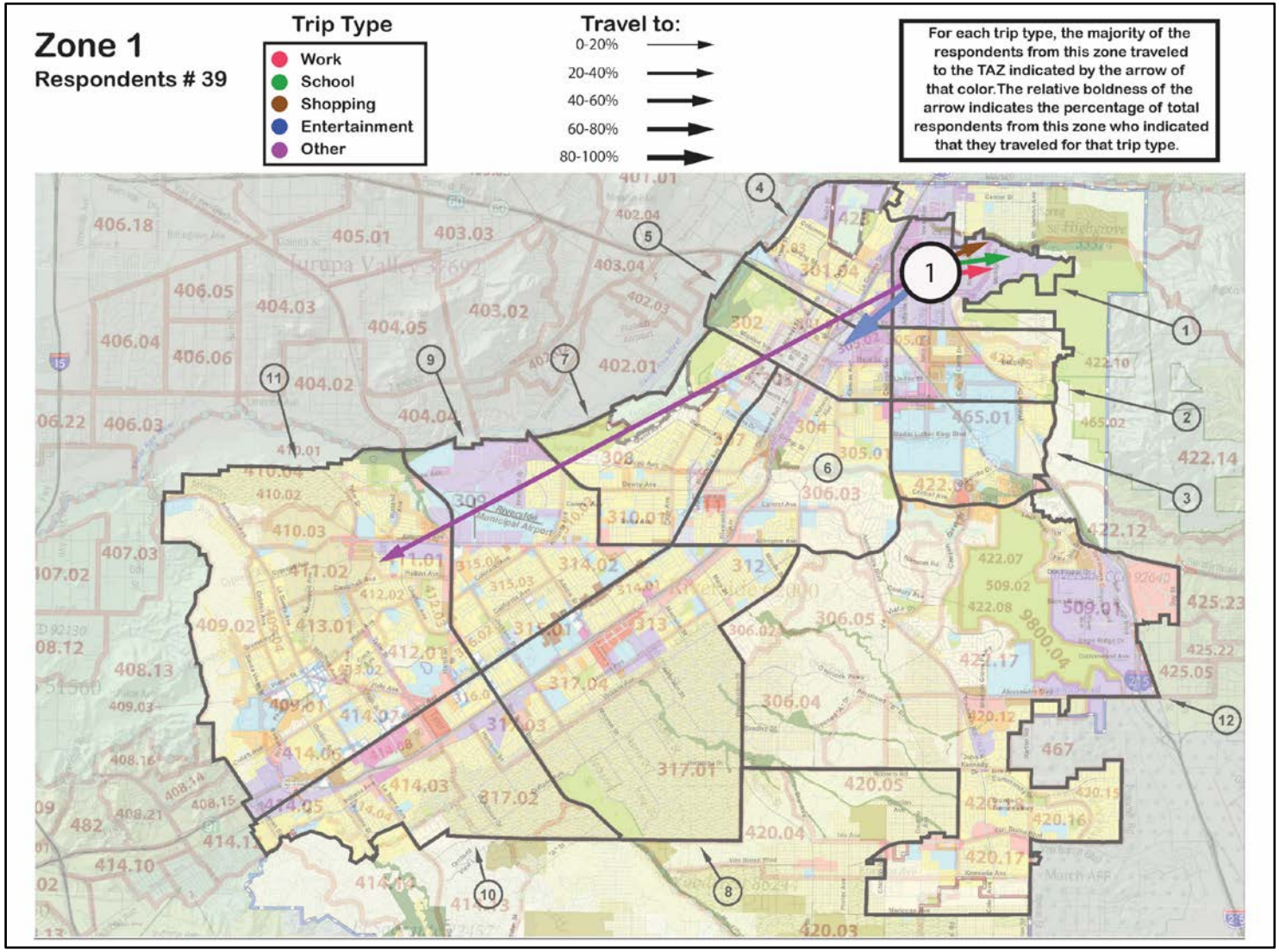
Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500

Generalized Concentrations of Trip Generation and Attraction

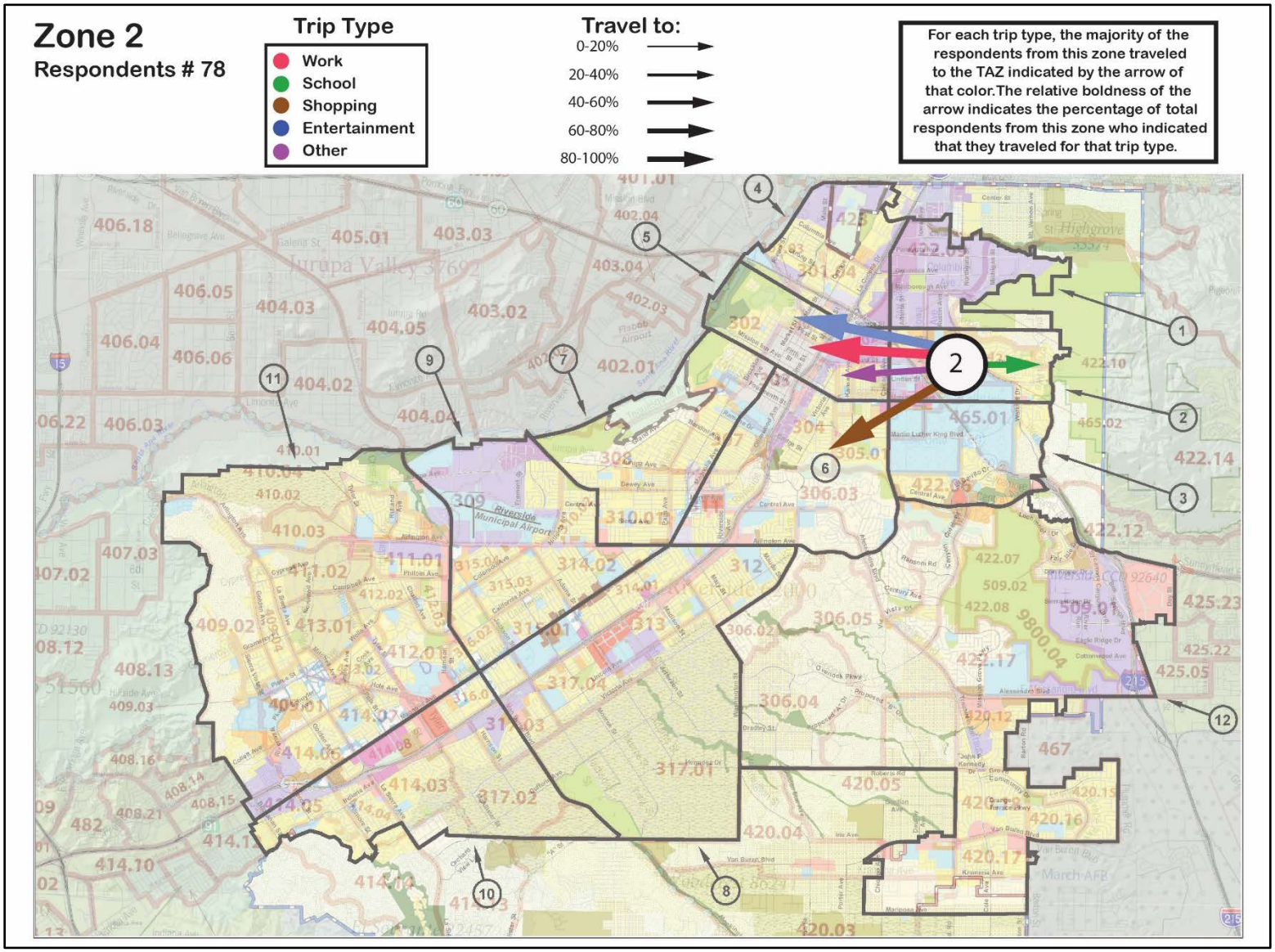


By utilizing the real-world responses from our Survey Participants, we have created a series of trip distribution maps illustrating trip origination and destinations grouped by trip types as reported by residents from each of the twelve TAZs:

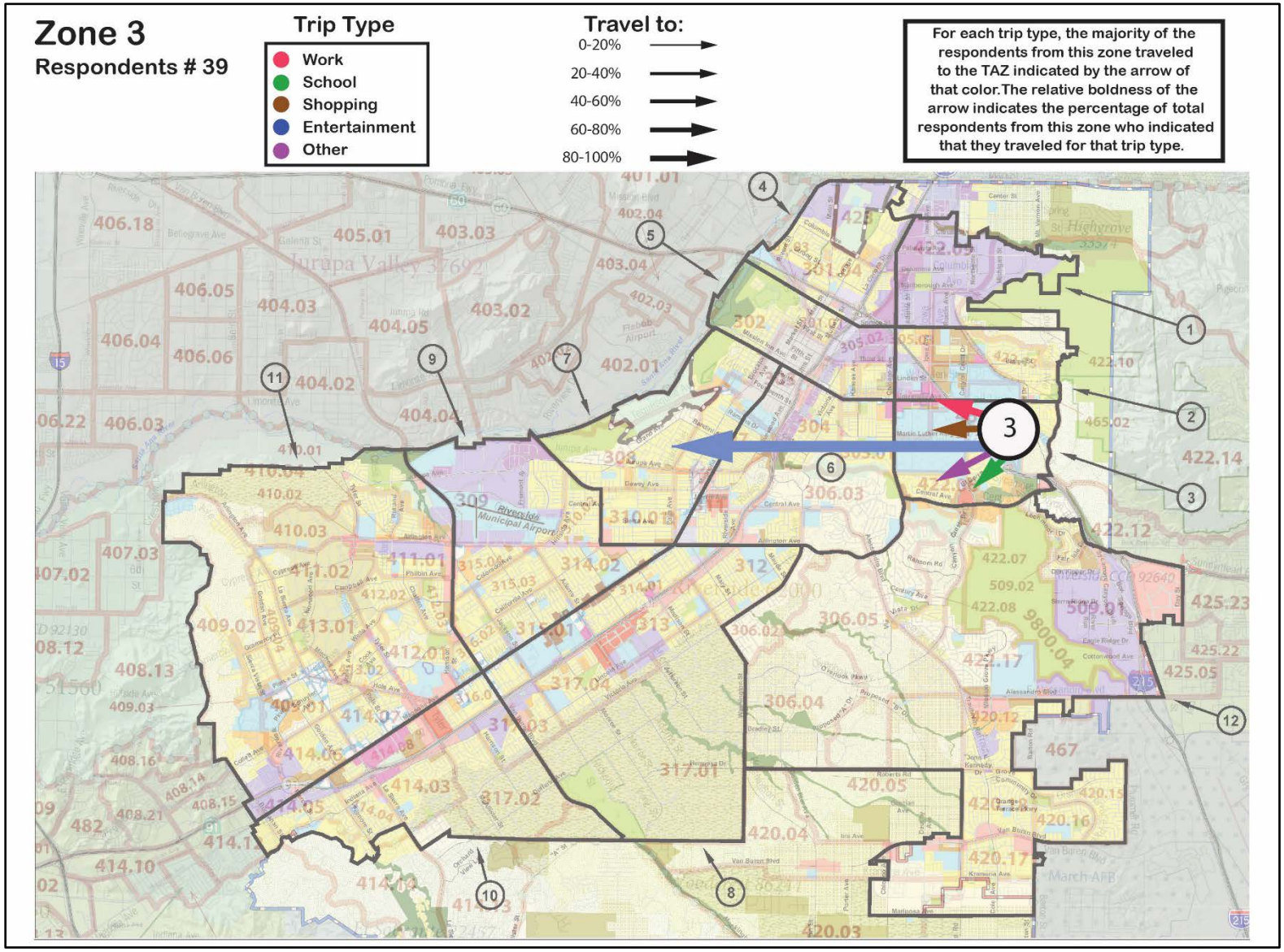
Zone 1



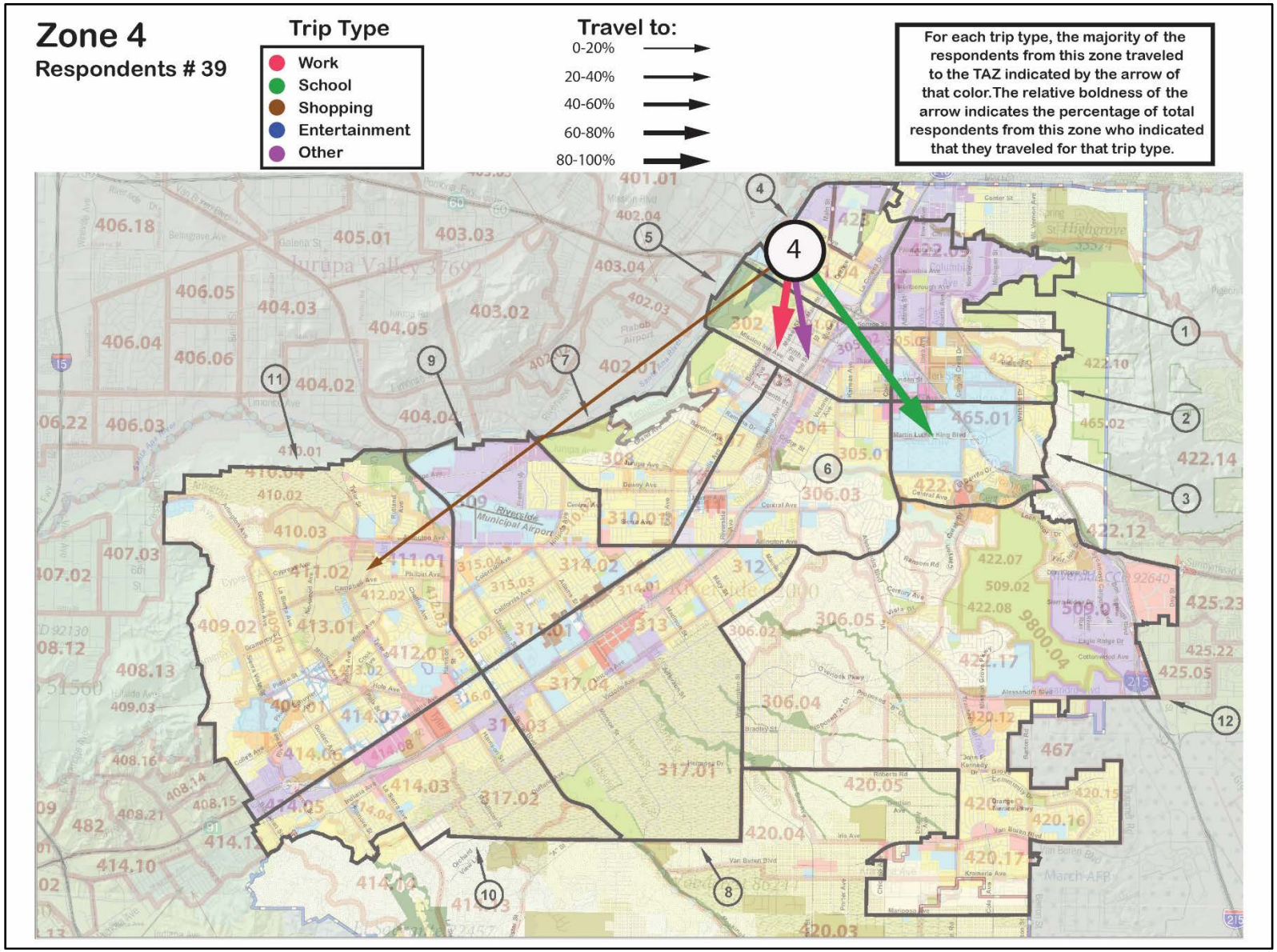
Zone 2


Zone 2
Respondents # 78
Trip Type
Work
School
Shopping
Entertainment
Other
Travel to:
0-20%
20-40%
40-60%
60-80%
80-100%
For each trip type, the majority of the respondents from this zone traveled to the TAZ indicated by the arrow of that color.The relative boldness of the arrow indicates the percentage of total respondents from this zone who indicated that they traveled for that trip type.
Riverside Municipal Airport
March AFB

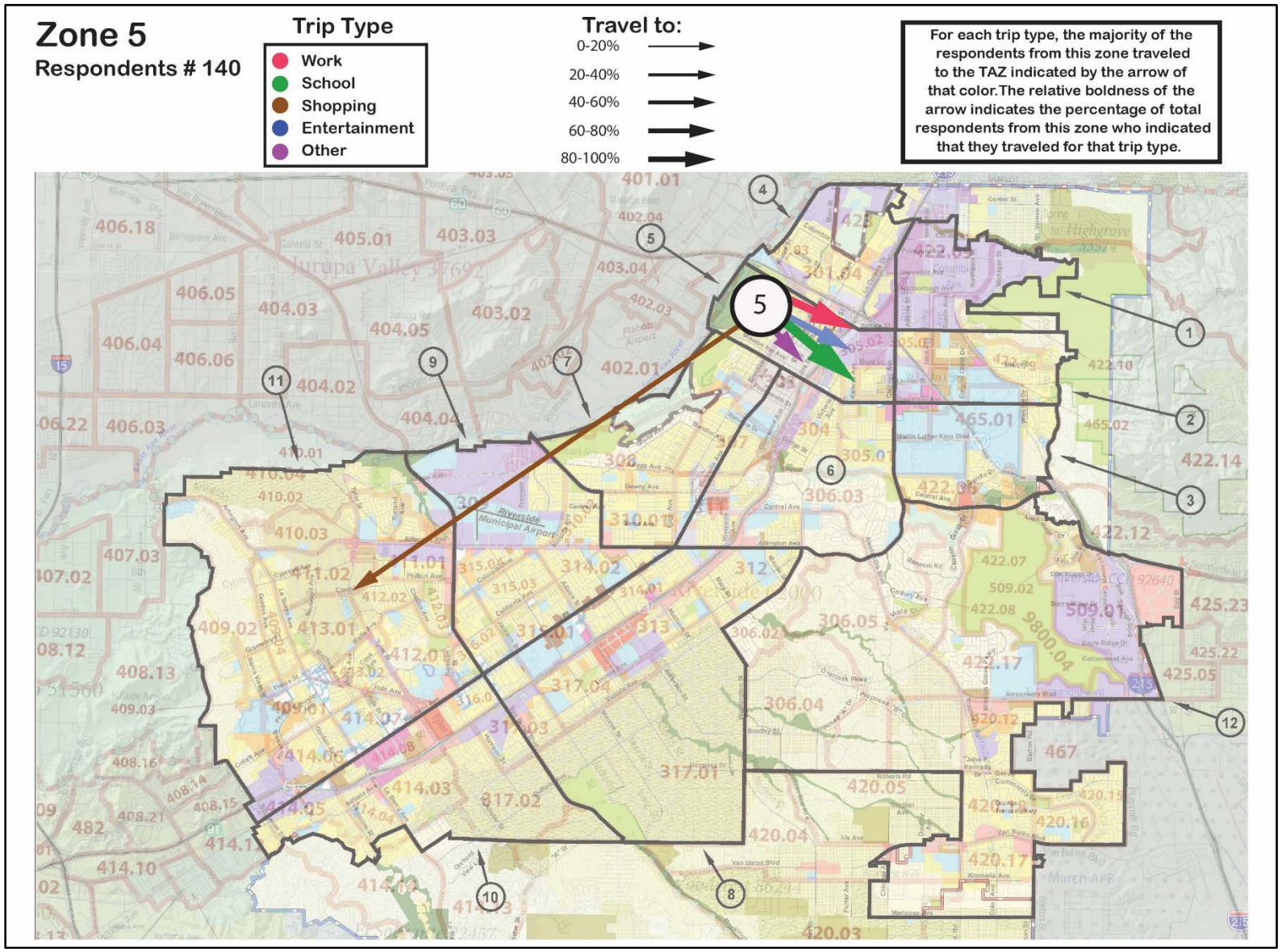
Zone 3


Zone 3
Respondents # 39
Trip Type
Work
School
Shopping
Entertainment
Other
Travel to:
0-20%
20-40%
40-60%
60-80%
80-100%
For each trip type, the majority of the respondents from this zone traveled to the TAZ indicated by the arrow of that color.The relative boldness of the arrow indicates the percentage of total respondents from this zone who indicated that they traveled for that trip type.
Riverside Municipal Airport
March AFB

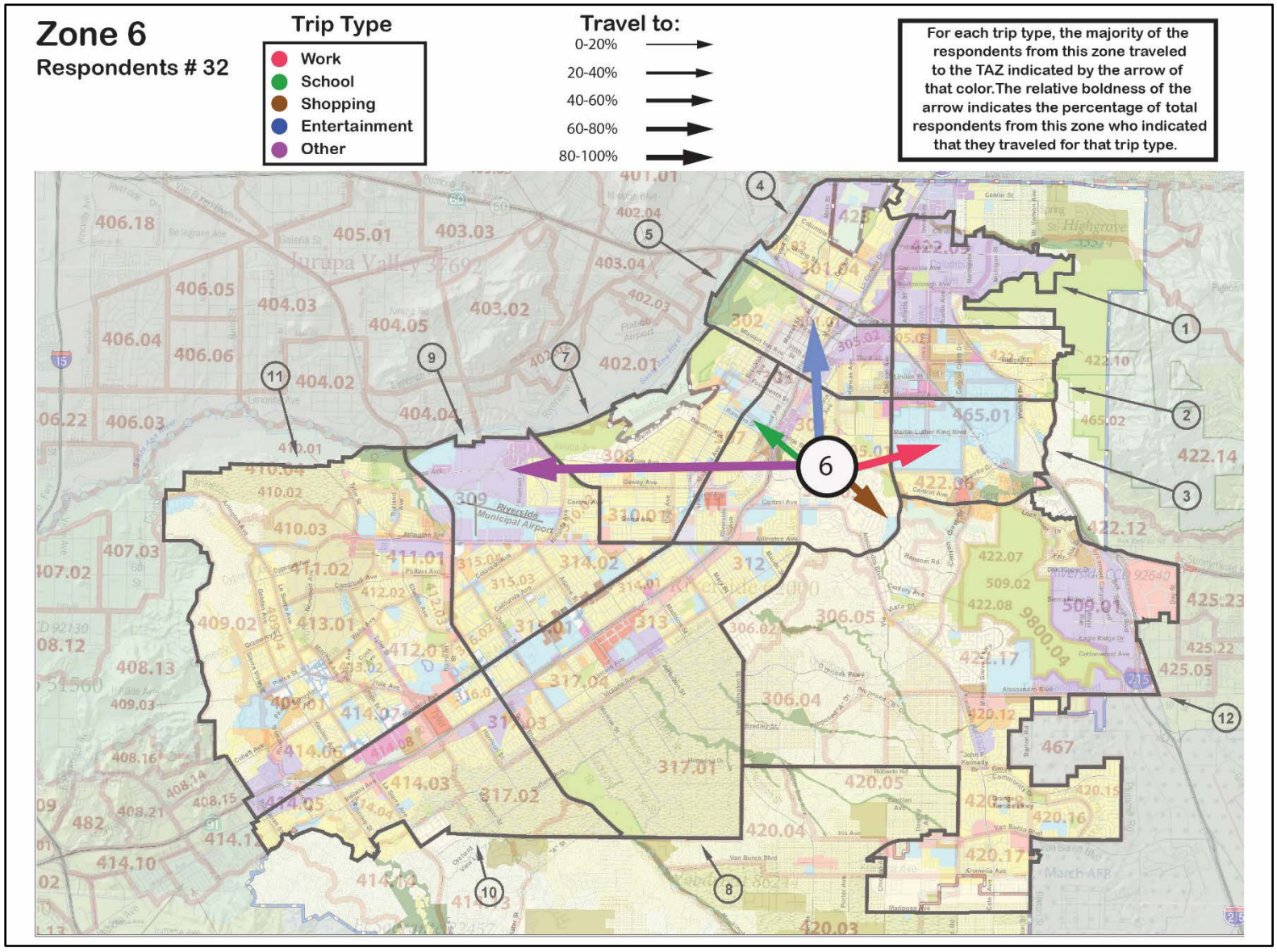
Zone 4


Zone 4
Respondents # 39
Trip Type
Work
School
Shopping
Entertainment
Other
Travel to:
0-20%
20-40%
40-60%
60-80%
80-100%
For each trip type, the majority of the respondents from this zone traveled to the TAZ indicated by the arrow of that color.The relative boldness of the arrow indicates the percentage of total respondents from this zone who indicated that they traveled for that trip type.
4
1
2
3
5
6
7
8
9
10
11
12
Riverside Municipal Airport
Jurupa Valley
March AFB

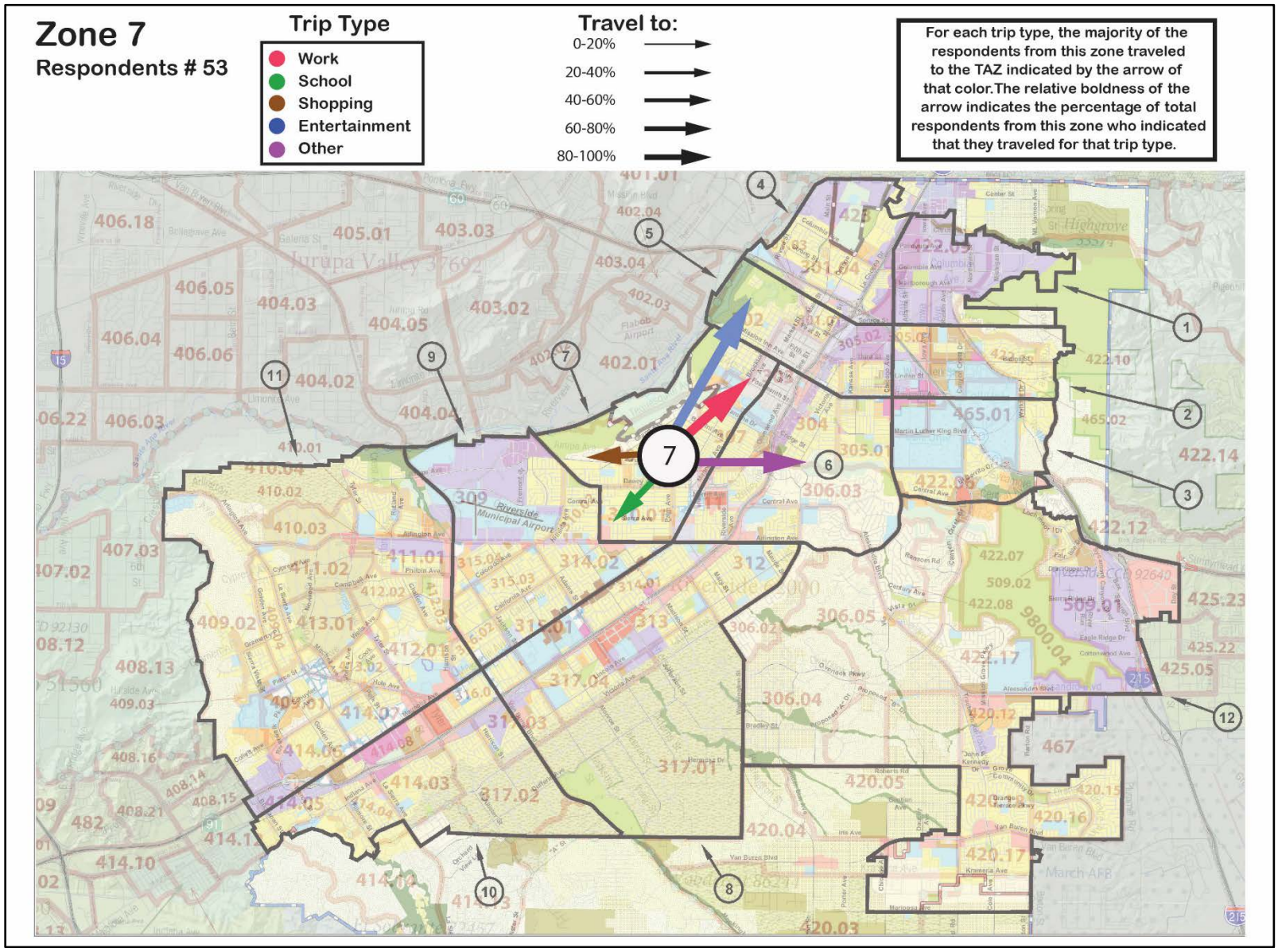
Zone 5


Zone 5
Respondents # 140
Trip Type
Work
School
Shopping
Entertainment
Other
Travel to:
0-20%
20-40%
40-60%
60-80%
80-100%
For each trip type, the majority of the respondents from this zone traveled to the TAZ indicated by the arrow of that color.The relative boldness of the arrow indicates the percentage of total respondents from this zone who indicated that they traveled for that trip type.
Riverside Municipal Airport
March ARB

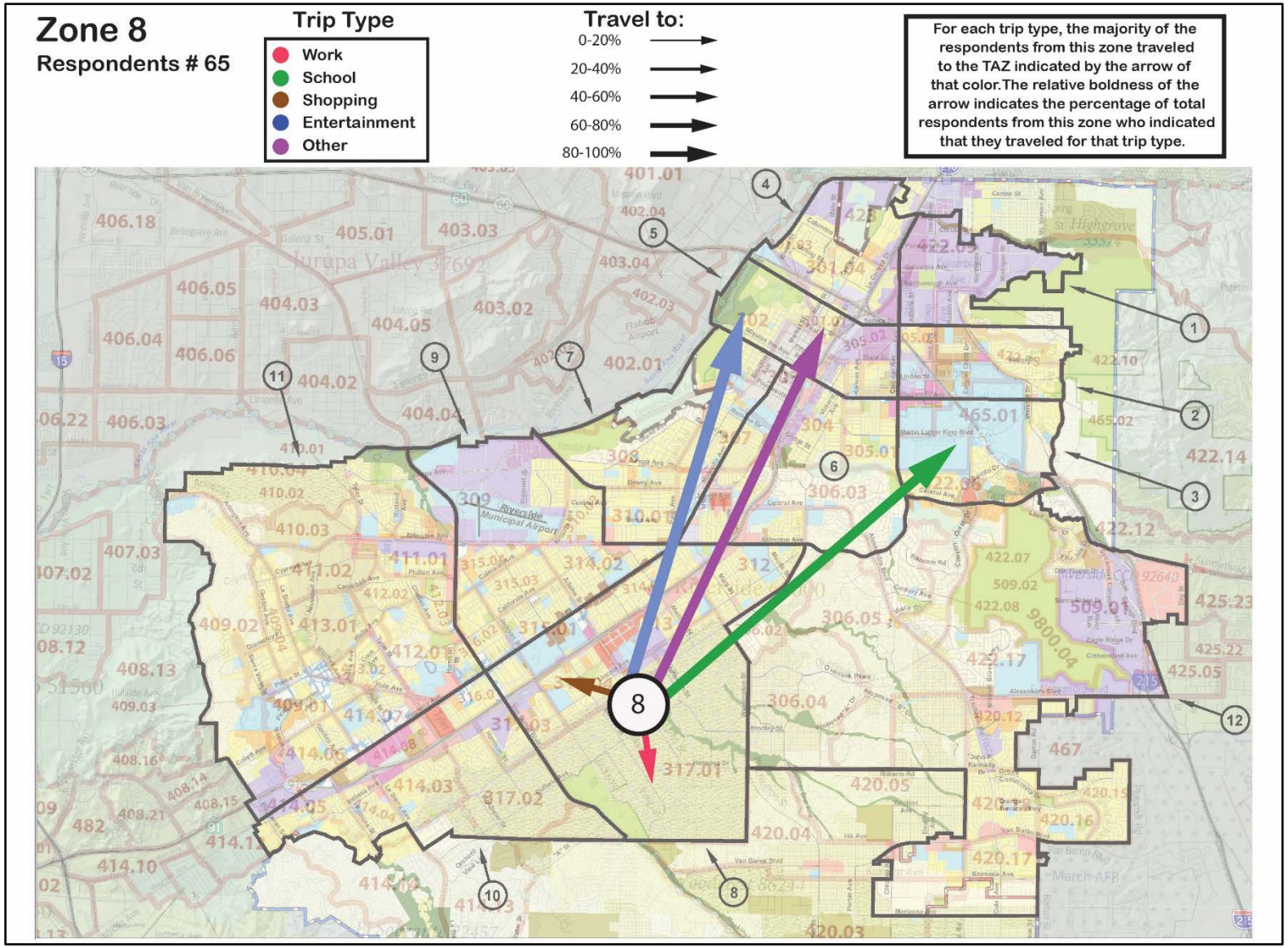
Zone 6


Zone 6
Respondents # 32
Trip Type
Work
School
Shopping
Entertainment
Other
Travel to:
0-20%
20-40%
40-60%
60-80%
80-100%
For each trip type, the majority of the respondents from this zone traveled to the TAZ indicated by the arrow of that color.The relative boldness of the arrow indicates the percentage of total respondents from this zone who indicated that they traveled for that trip type.
6
Riverside Municipal Airport
Jurupa Valley 37692
Highgrove 33524
March AFB

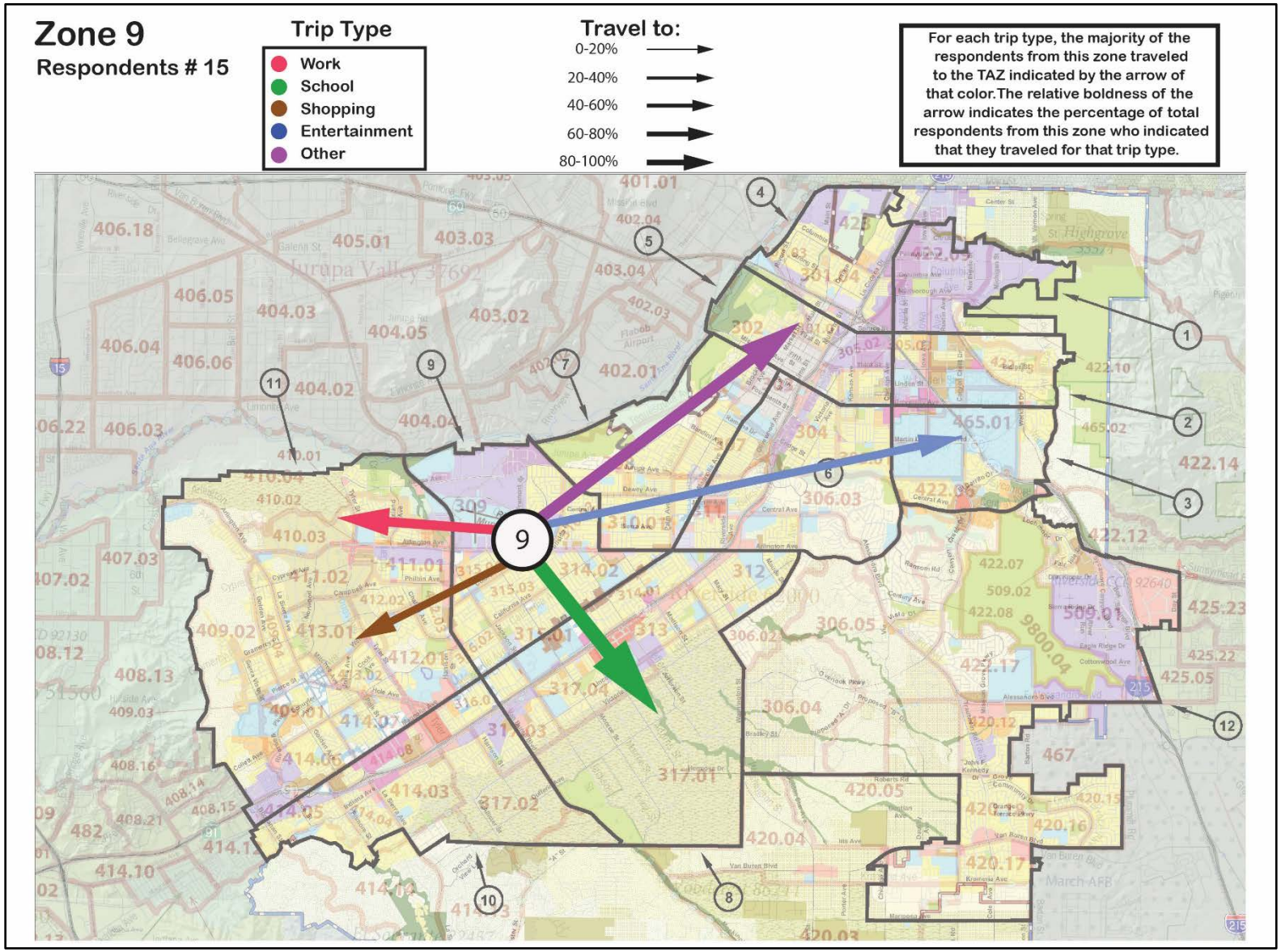
Zone 7


Zone 7
Respondents # 53
Trip Type
Work
School
Shopping
Entertainment
Other
Travel to:
0-20%
20-40%
40-60%
60-80%
80-100%
For each trip type, the majority of the respondents from this zone traveled to the TAZ indicated by the arrow of that color.The relative boldness of the arrow indicates the percentage of total respondents from this zone who indicated that they traveled for that trip type.
Riverside Municipal Airport
March AFB

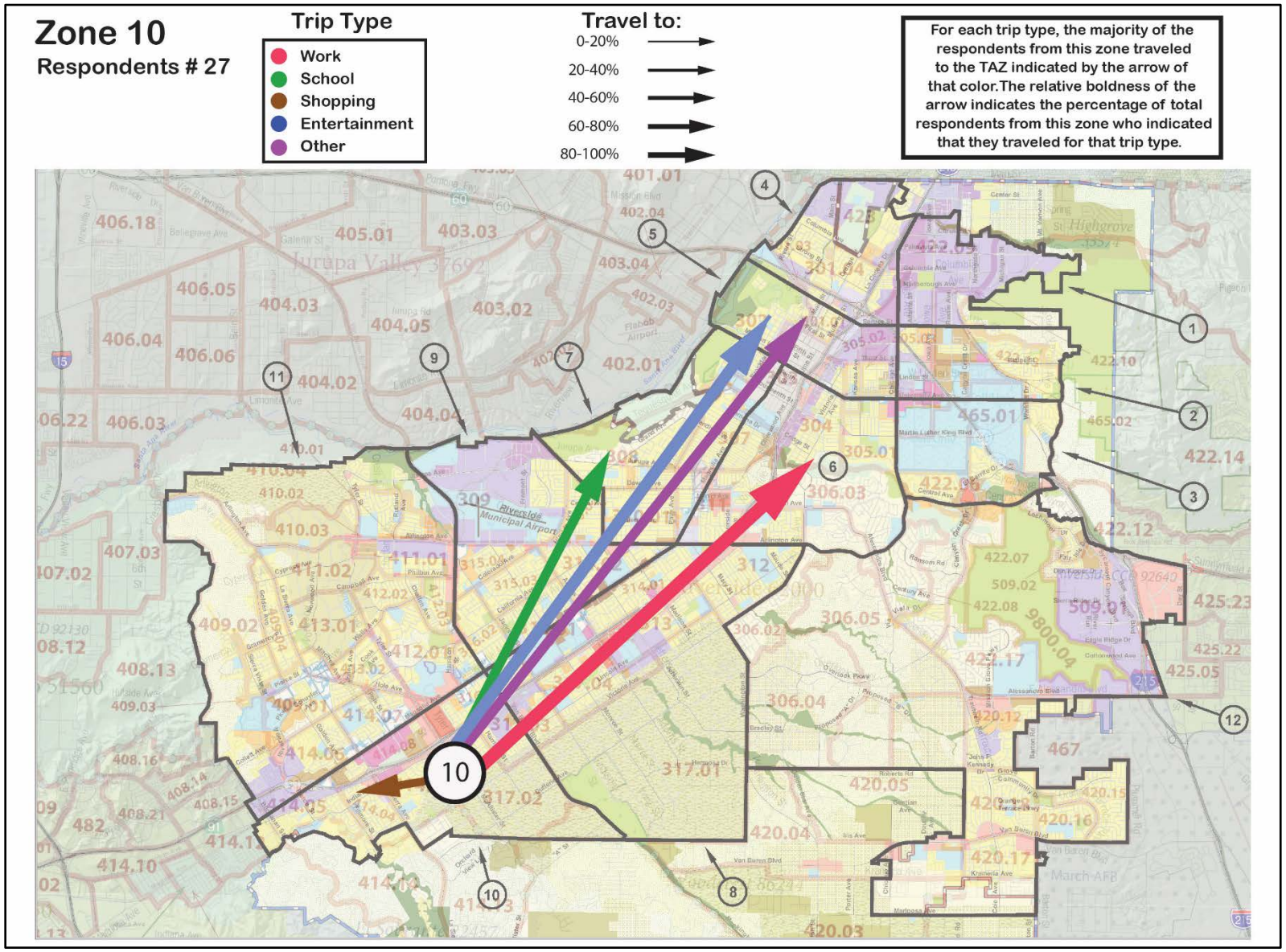
Zone 8


Zone 8
Respondents # 65
Trip Type
Work
School
Shopping
Entertainment
Other
Travel to:
0-20%
20-40%
40-60%
60-80%
80-100%
For each trip type, the majority of the respondents from this zone traveled to the TAZ indicated by the arrow of that color.The relative boldness of the arrow indicates the percentage of total respondents from this zone who indicated that they traveled for that trip type.
Riverside Municipal Airport
March AFB
1
2
3
4
5
6
7
8
9
10
11
12

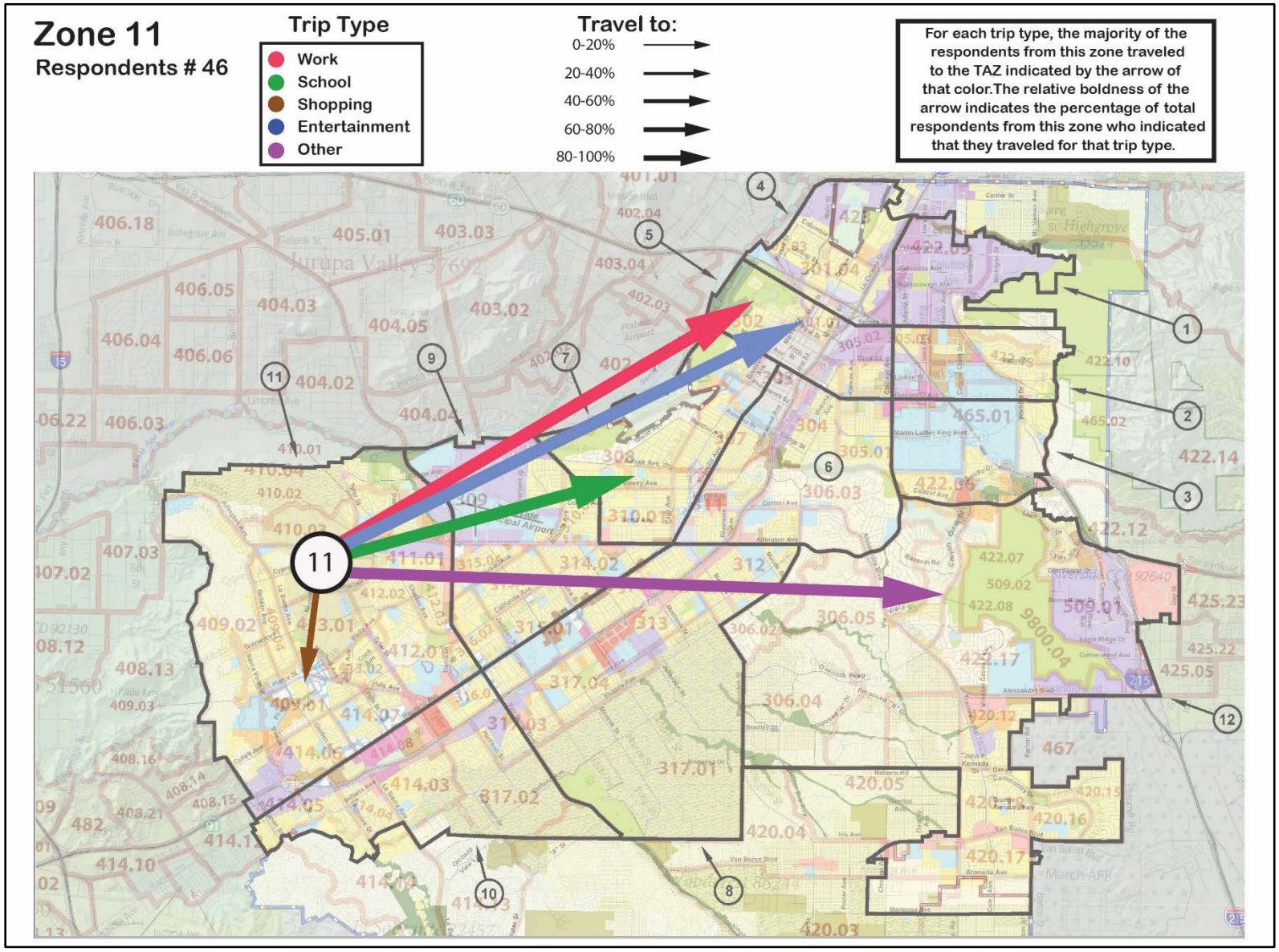
Zone 9


Zone 9
Respondents # 15
Trip Type
Work
School
Shopping
Entertainment
Other
Travel to:
0-20%
20-40%
40-60%
60-80%
80-100%
For each trip type, the majority of the respondents from this zone traveled to the TAZ indicated by the arrow of that color.The relative boldness of the arrow indicates the percentage of total respondents from this zone who indicated that they traveled for that trip type.
9
1
2
3
4
5
6
7
8
9
10
11
12

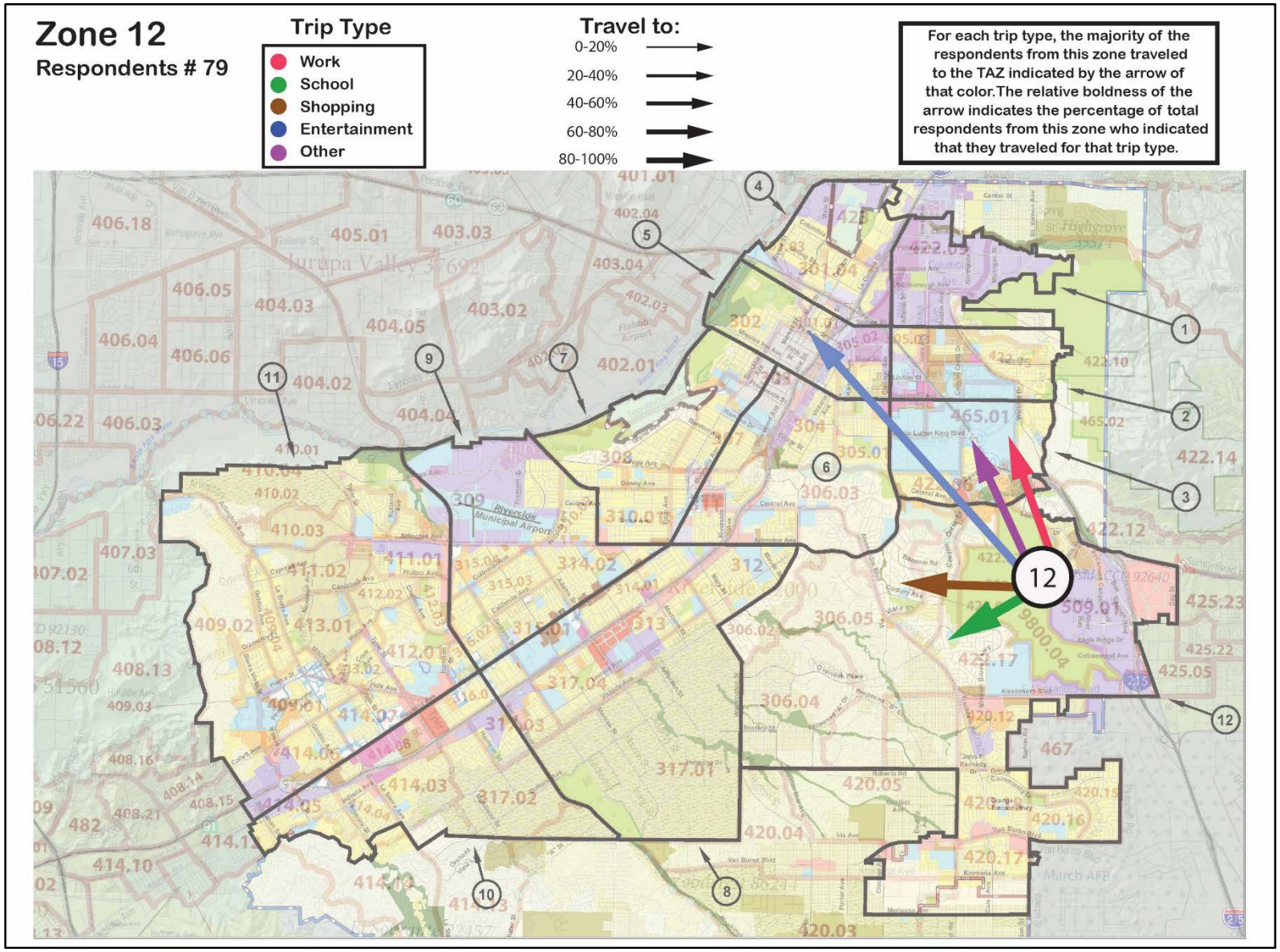
Zone 10


Zone 10
Respondents # 27
Trip Type
Work
School
Shopping
Entertainment
Other
Travel to:
0-20%
20-40%
40-60%
60-80%
80-100%
For each trip type, the majority of the respondents from this zone traveled to the TAZ indicated by the arrow of that color.The relative boldness of the arrow indicates the percentage of total respondents from this zone who indicated that they traveled for that trip type.
Riverside Municipal Airport
March AFB
1
2
3
4
5
6
7
8
9
10
11
12

Zone 11

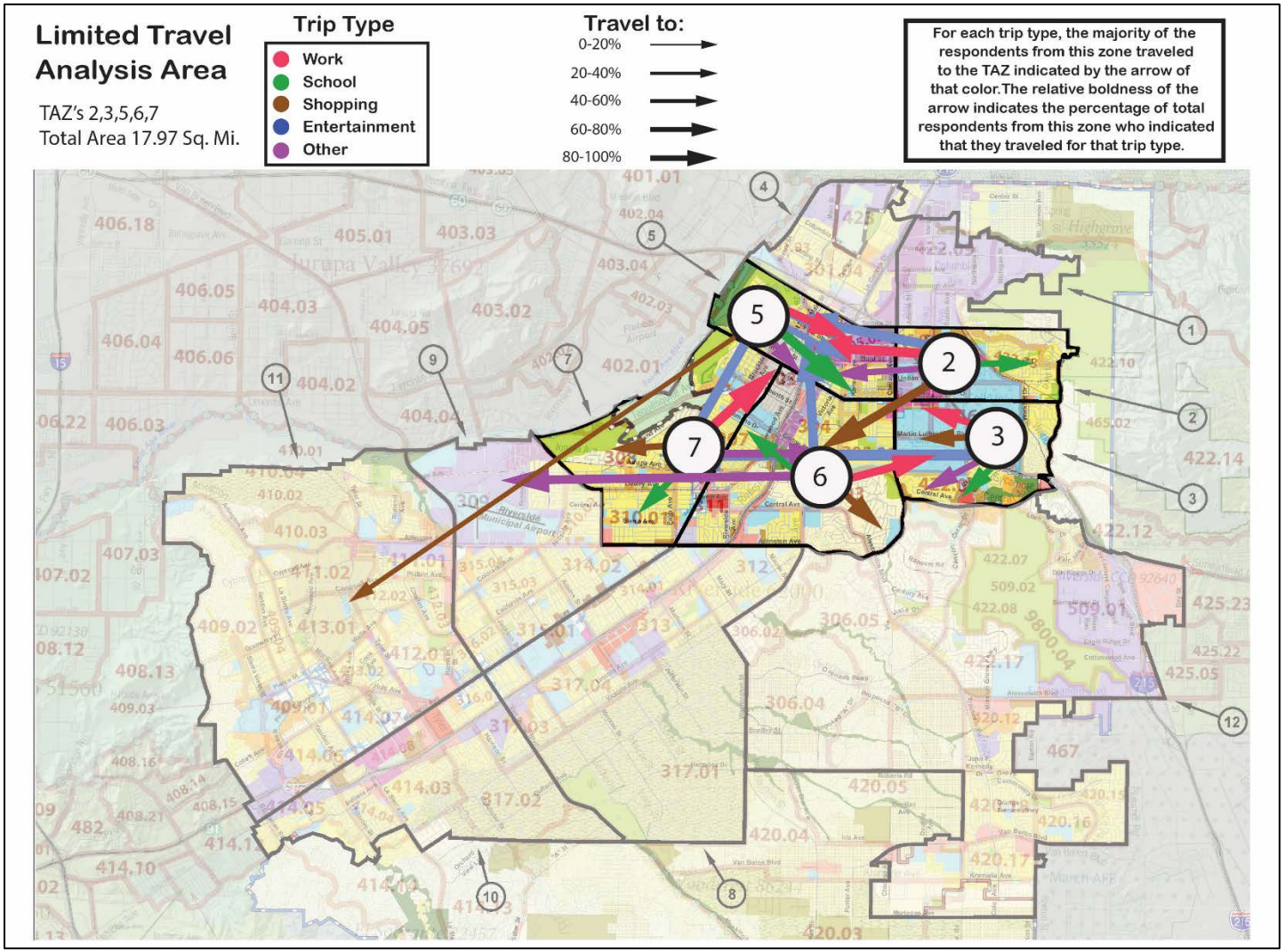

Zone 11
Respondents # 46
Trip Type
Work
School
Shopping
Entertainment
Other
Travel to:
0-20%
20-40%
40-60%
60-80%
80-100%
For each trip type, the majority of the respondents from this zone traveled to the TAZ indicated by the arrow of that color.The relative boldness of the arrow indicates the percentage of total respondents from this zone who indicated that they traveled for that trip type.
11
1
2
3
4
5
6
7
8
9
10
11
12

Zone 12


Zone 12
Respondents # 79
Trip Type
Work
School
Shopping
Entertainment
Other
Travel to:
0-20%
20-40%
40-60%
60-80%
80-100%
For each trip type, the majority of the respondents from this zone traveled to the TAZ indicated by the arrow of that color.The relative boldness of the arrow indicates the percentage of total respondents from this zone who indicated that they traveled for that trip type.
Riverside Municipal Airport
March AFB
1
2
3
4
5
6
7
8
9
10
11
12

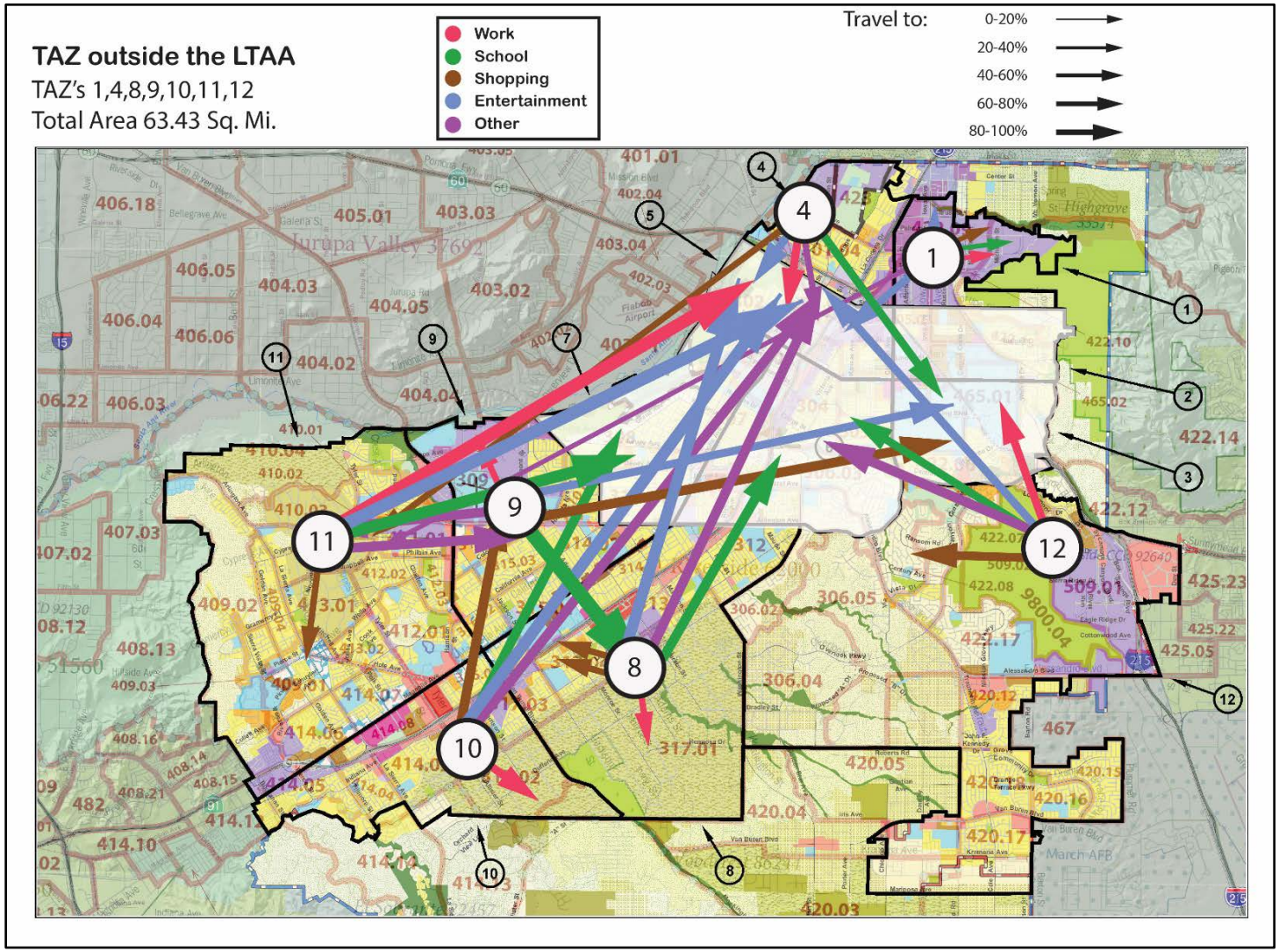
When viewing the visualizations derived directly from the Community Survey Questionnaire results, we see that relatively few of the residents reporting from the Limited Travel Analysis Area (LTAA) are travelling outside of the LTAA on a regular basis, instead reporting that most of their trips of all types are completed within that area. This observation strongly supports the theory that a more frequent, comfortable, and time-saving circulator within the Downtown to East-Side corridor will be successful as a Phase 1 Streetcar project.

Limited Travel Analysis Area (LTAA)



Alternately, TAZs from the west side show that the residents travel significantly more far afield and are predominantly traveling to Downtown and the Eastside. This conclusion supports basic premise of the TIG/m concept and the argument to continue with design and installation of Phase 2 of the Streetcar project.

TAZs Outside the Limited Travel Analysis Area (LTAA)



Riverside Streetcar System Feasibility Study Report

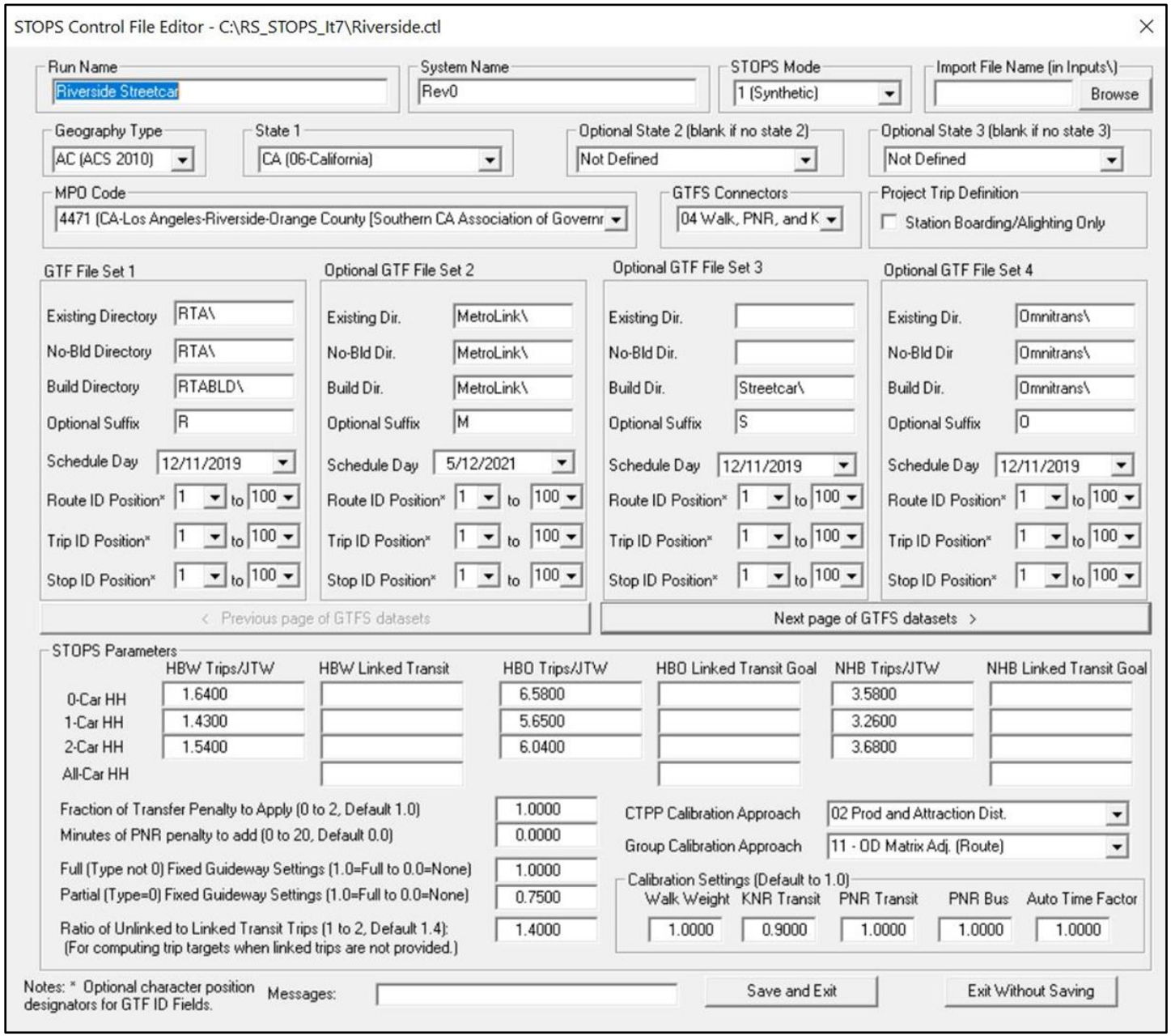
Appendix M:

STOPS Model

May 15, 2022

Prepared for:
The City of Riverside

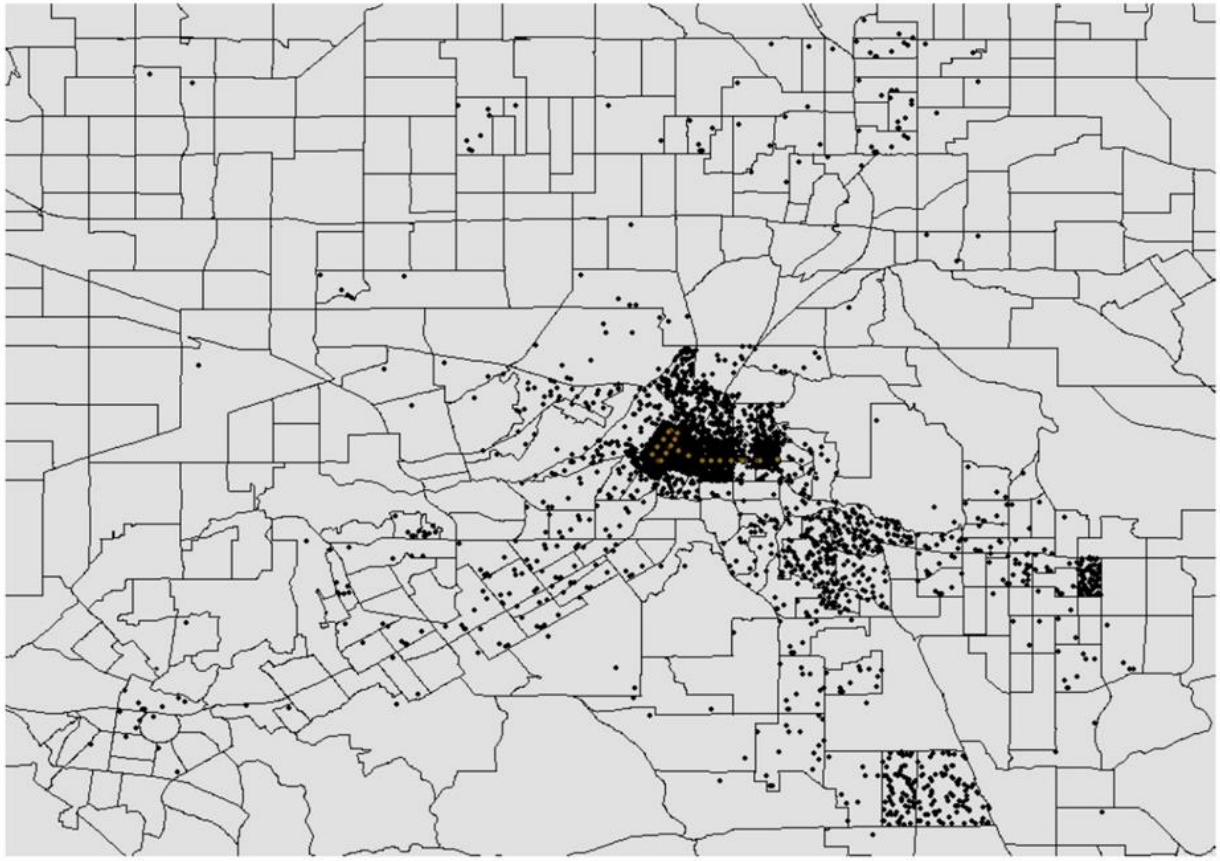
Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500


STOPS Control File Editor - C:\RS_STOPS_It7\Riverside.ctl
Run Name
Riverside Streetcar
System Name
Rev0
STOPS Mode
1 (Synthetic)
Import File Name (in Inputs\)
Browse
Geography Type
AC (ACS 2010)
State 1
CA (06-California)
Optional State 2 (blank if no state 2)
Not Defined
Optional State 3 (blank if no state 3)
Not Defined
MPO Code
4471 (CA-Los Angeles-Riverside-Orange County [Southern CA Association of Governr
GTFS Connectors
04 Walk, PNR, and K
Project Trip Definition
Station Boarding/Alighting Only
GTF File Set 1
Existing Directory RTA\
No-Bld Directory RTA\
Build Directory RTABLD\
Optional Suffix R
Schedule Day 12/11/2019
Route ID Position* 1 to 100
Trip ID Position* 1 to 100
Stop ID Position* 1 to 100
Optional GTF File Set 2
Existing Dir. MetroLink\
No-Bld Dir. MetroLink\
Build Dir. MetroLink\
Optional Suffix M
Schedule Day 5/12/2021
Route ID Position* 1 to 100
Trip ID Position* 1 to 100
Stop ID Position* 1 to 100
Optional GTF File Set 3
Existing Dir.
No-Bld Dir.
Build Dir. Streetcar\
Optional Suffix S
Schedule Day 12/11/2019
Route ID Position* 1 to 100
Trip ID Position* 1 to 100
Stop ID Position* 1 to 100
Optional GTF File Set 4
Existing Dir. Omnitrans\
No-Bld Dir Omnitrans\
Build Dir. Omnitrans\
Optional Suffix O
Schedule Day 12/11/2019
Route ID Position* 1 to 100
Trip ID Position* 1 to 100
Stop ID Position* 1 to 100
< Previous page of GTFS datasets
Next page of GTFS datasets >
STOPS Parameters
HBW Trips/JTW
HBW Linked Transit
HBO Trips/JTW
HBO Linked Transit Goal
NHB Trips/JTW
NHB Linked Transit Goal
0-Car HH 1.6400 6.5800 3.5800
1-Car HH 1.4300 5.6500 3.2600
2-Car HH 1.5400 6.0400 3.6800
All-Car HH
Fraction of Transfer Penalty to Apply (0 to 2, Default 1.0) 1.0000
Minutes of PNR penalty to add (0 to 20, Default 0.0) 0.0000
Full (Type not 0) Fixed Guideway Settings (1.0=Full to 0.0=None) 1.0000
Partial (Type=0) Fixed Guideway Settings (1.0=Full to 0.0=None) 0.7500
Ratio of Unlinked to Linked Transit Trips (1 to 2, Default 1.4):
(For computing trip targets when linked trips are not provided.) 1.4000
CTPP Calibration Approach 02 Prod and Attraction Dist.
Group Calibration Approach 11 - OD Matrix Adj. (Route)
Calibration Settings (Default to 1.0)
Walk Weight KNR Transit PNR Transit PNR Bus Auto Time Factor
1.0000 0.9000 1.0000 1.0000 1.0000
Notes: * Optional character position designators for GTF ID Fields.
Messages:
Save and Exit
Exit Without Saving

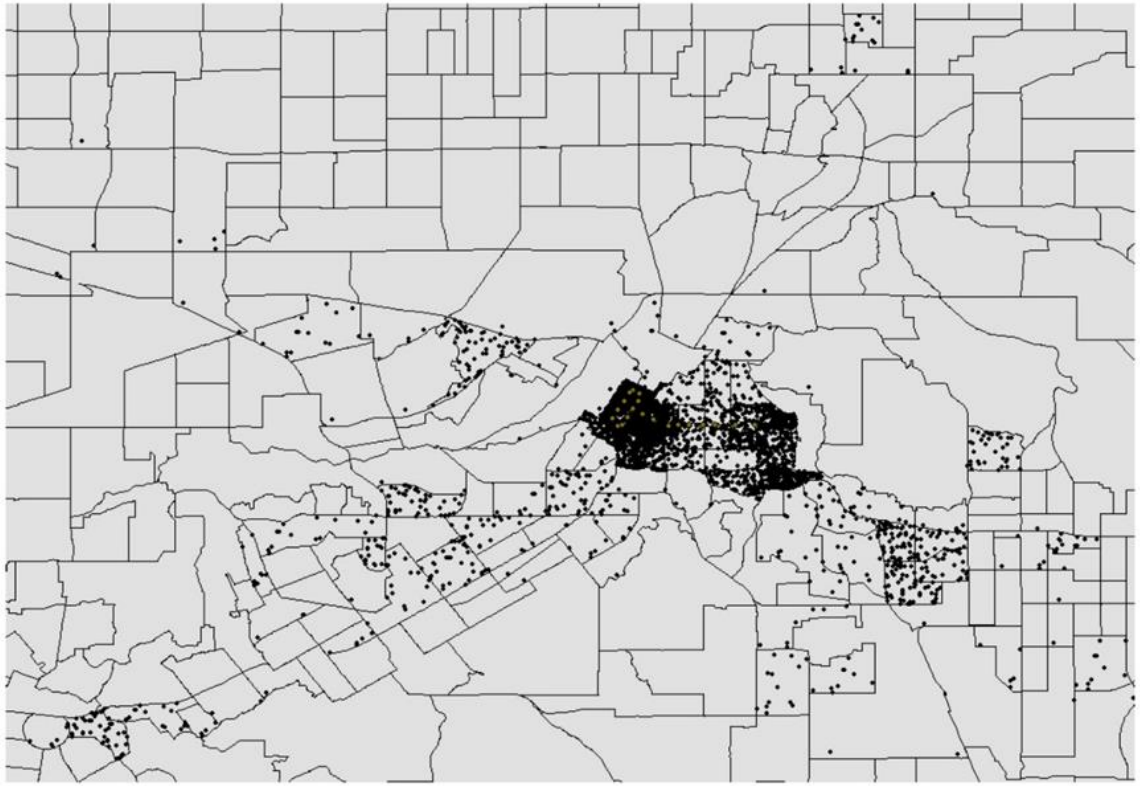
Input Data

#	Data Type	Source(s)
1	CTPP work trip data	FTA
2	Roadway travel times and distances (TAZ-to-TAZ)	SCAG's regional travel demand model
3	Current and Future Population and employment (TAZ-level)	SCAG's regional travel demand model
4	GTFS files	RTA
5	Total weekday systemwide unlinked trips	NTD 2017
6	Streetcar representation in GTFS files	Project team
7	Average weekday boardings by station/stop	Not available / Not used
8	Average weekday boardings by route	RTA board meeting package
9	Transit travel patterns stratified by trip purpose and auto ownership	Not available / Not used
10	Total transit trips, stratified by trip purpose and auto ownership	Not available / Not used
11	Walk Link shapefile	Census TIGER layer

Home End of the Streetcar Trips



Work-end or Attraction-end of the Streetcar Trips



OUTPUT DATA

SUMMARY OF TOTAL RIDERSHIP

AC_RTA-MetroLink-Omnitrans#RTA-MetroLink-Omnitrans#RTABLD-MetroLink-Streetcar-Omnitrans_STOPSY2030Results - Notepad

File Edit Format View Help

```
 FTA Simplified Trips-on-Project Software                                                    Page    49
v2.50 - 07/22/2020                                                                          9/02/2021
de Streetcar                                                                                  7:32:59



AY ROUTE UTILIZATION ZONE BY (PRODUCTION-END) ACCESS TYPE ************
oute Boardings by Scenario and Zone (Production-End) Mode-of-Access
rips
                                        Y2020 EXISTING                    Y2030 NO-BUILD                    Y2030 BUILD
                                        ================================= ================================= =================================
          --Route Name                  Count     WLK      KNR      PNR      ALL      WLK      KNR      PNR      ALL      WLK      KNR      PNR      ALL
========================================= ======== ======== ======== ======== ======== ======== ======== ======== ======== ======== ======== ======== ========
          --1-W. Corona-UC Riverside      7750     6955      795        0     7750     8218      904        0     9122     7073      707        0     7780
          --10-Riverside/Watkins-Galleri   574      519       55        0      574      604       64        0      668      634       72        0      707
          --StrC-Riverside Streetcar         0        0        0        0        0        0        0        0        0     3035      305        0     3340
          --StrCMetrolink-Riverside Stre     0        0        0        0        0        0        0        0        0      314       91        0      405
          --11-Moreno Valley-March ARB     338      315       23        0      338      389       30        0      419      391       34        0      425
          --12-Corona Hills Plaza/Rivers   745      976       41        0     1017     1137       43        0     1180     1100       44        0     1144
          --13-Hunter Park Metro-Galleri   813      761       52        0      813      877       56        0      932      958       69        0     1027
          --14-Galleria-Loma Linda VA      732      642       90        0      732      796       96        0      891      699       94        0      793
          --15-Riverside/Downtown-Merced  1624     1490      134        0     1624     1625      145        0     1770     1676      156        0     1832
          --16-UCR-Moreno Valley          2395     1834      231        0     2065     2424      275        0     2699     2707      292        0     2999
          --18-Mo Val College-Sunnymead    462      437       25        0      462      439       25        0      465      468       24        0      492
          --19-Mo Val Mall-Perris Statio  2696     2529      167        0     2696     3212      197        0     3409     3255      204        0     3460
          --20-Mo Val College-Riverside    879      757      122        0      879      893      157        0     1050      888      139        0     1027
          --200-San Bernardino - Riversi   782      547      234        0      782      680      274        0      955      679      285        0      964
          --202-Murrieta-Oceanside Expre    40       32        8        0       40       39       12        0       51       39       12        0       51
          --204-Riverside-Montclair Expr   198      102       96        0      198      112      111        0      223      110      111        0      221
          --205-Temecula-Corona-Village     98       38       60        0       98       44       67        0      111       44       67        0      111
          --206-Temecula-Corona Express    136       46       90        0      136       58      110        0      167       57      110        0      167
          --208-Temecula-Riverside Expre   202      161       41        0      202      230       47        0      276      263       50        0      313
          --21-Galleria-Country Village    353      280       73        0      353      290       77        0      367      286       77        0      363
          --210-Riverside-Beaumont Expre    20        5       20        0       25        5       21        0       26        5       21        0       26
          --217-San Jacinto-Escondido Ex   141        2        0        0        2        2        0        0        2        2        0        0        2
          --22-Riverside - Perris         1041      943       98        0     1041     1177      125        0     1302     1134       71        0     1204
          --23-Temecula - Murrieta - Wil   300      291       60        0      351      324       69        0      393      324       69        0      393
          --24-Promenade Mall - Temecula   243      240       30        0      269      257       33        0      289      257       33        0      289
          --26-Moreno Valley Mtrlnk-More    54       85       13        0       98      106       19        0      124      112       18        0      130
          --27-Galleria-Perris             664      573       91        0      664      659      108        0      767      665      112        0      776
          --28-Lincoln & Florida to Perr  1443     1340      103        0     1443     1737      134        0     1871     1736      133        0     1869
          --29-Riverside-Eastvale          538      447       91        0      538      501      100        0      601      483      101        0      585
```

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SUMMARY OF LINKED/UNLINKED TRIPS

*** WEEKDAY LINKED TRANSIT TRIPS (All Transit/All car HH) ***
District to District MODEL Summary for Scenario 3: Y2020 BUILD
All Purposes All Transit All Access All car HH

Idist	RvCBD	NUniv	SUni	UCR	WofUC	NofC	SofCB	PresP	Jurup	SoLaS	Coron	Missi	E_Riv	S_Riv	W_Riv	N_Riv	Orang	DIS18	LA_Co	San_B	Santa	Other	Total
RvCBD	57	85	61	151	10	27	12	26	384	4	47	1	117	227	0	274	0	0	0	15	0	0	1496
NUniv	304	75	59	144	38	13	28	7	51	4	39	16	53	36	0	8	7	0	2	7	7	0	896
SUni	19	2	9	28	1	1	4	1	1	0	1	1	2	19	0	1	0	0	2	0	3	0	94
UCR	12	4	0	12	60	3	0	2	10	0	14	1	0	1	1	4	2	0	0	0	0	0	127
WofUC	38	24	21	455	59	27	47	6	9	4	6	22	24	1	0	10	1	0	48	6	23	0	831
NofC	98	56	47	81	32	27	32	19	52	0	15	10	25	9	0	46	34	0	8	11	10	0	612
SofCB	129	11	5	21	4	13	89	20	79	131	228	3	4	4	1	2	10	0	0	6	0	0	758
PresP	36	10	10	29	10	7	26	45	94	17	68	13	18	57	3	3	137	0	3	5	6	0	596
Jurup	109	13	14	23	4	6	19	35	212	41	135	11	12	28	4	37	55	0	9	6	0	0	773
SoLaS	20	2	2	0	0	0	37	19	23	25	65	3	3	148	4	5	64	0	37	3	0	0	462
Coron	63	23	17	4	20	5	179	109	295	253	255	11	17	114	121	43	387	0	33	10	25	0	1984
Missi	158	10	14	115	16	4	17	14	21	7	27	41	53	7	1	5	16	0	18	10	0	0	553
E_Riv	123	22	17	100	152	15	19	16	31	37	41	168	6790	90	4	58	136	0	138	35	121	0	8111
S_Riv	140	8	9	35	11	5	19	46	53	220	144	43	743	2535	110	10	1045	0	170	12	24	0	5384
W_Riv	32	0	0	1	0	1	1	4	9	8	18	1	3	79	82	9	173	0	220	6	41	0	687
N_Riv	108	33	16	16	12	20	33	13	22	7	13	5	8	4	11	135	55	0	113	32	6	0	661
Orang	3	5	3	18	1	5	1	7	5	3	17	4	6	112	6	4	0	0	0	0	0	0	200
DIS18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA_Co	1	0	1	4	1	1	0	1	0	1	1	0	0	12	0	1	0	0	0	0	0	0	24
San_B	60	26	21	36	19	37	10	15	72	18	26	15	55	29	9	47	0	0	0	0	0	0	495
Santa	0	0	0	5	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	9
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1511	409	325	1276	451	218	573	403	1423	780	1159	369	7933	3513	356	701	2123	0	801	163	266	0	24753

Program STOPS - FTA Simplified Trips-on-Project Software Page 26
Version: STOPS-v2.50 - 07/22/2020 8/31/2021
Run: Riverside Streetcar 12:47:58

Program STOPS - FTA Simplified Trips-on-Project Software Page 25
Version: STOPS-v2.50 - 07/22/2020 8/31/2021
Run: Riverside Streetcar 0:00:03
System: Rev0
Table 4.01

*** WEEKDAY LINKED TRANSIT TRIPS (All Transit/All car HH) ***
District to District MODEL Summary for Scenario 3: Y2030 BUILD
All Purposes All Transit All Access All car HH

Idist	RvCBD	NUniv	SUni	UCR	WofUC	NofC	SofCB	PresP	Jurup	SoLaS	Coron	Missi	E_Riv	S_Riv	W_Riv	N_Riv	Orang	DIS18	LA_Co	San_B	Santa	Other	Total
RvCBD	97	186	136	174	11	32	12	30	406	4	52	2	135	271	0	378	0	0	0	16	0	0	1940
NUniv	436	116	103	147	45	12	24	6	51	6	36	18	80	33	0	8	8	0	1	7	7	0	1144
SUni	25	2	14	30	1	1	4	1	1	0	1	1	2	16	0	1	0	0	2	0	3	0	105
UCR	18	4	0	11	84	3	0	2	11	0	13	1	1	1	1	4	2	0	0	0	0	0	155
WofUC	78	38	36	621	89	42	68	8	12	7	7	35	49	2	0	14	2	0	66	9	24	0	1207
NofC	148	83	84	75	38	29	31	18	46	0	14	11	33	9	0	47	35	0	8	13	10	0	731
SofCB	161	13	8	18	5	12	83	17	70	168	244	3	5	4	1	2	10	0	0	6	0	0	829
PresP	54	14	17	28	11	7	27	42	90	20	67	16	22	54	3	3	145	0	3	6	6	0	634
Jurup	154	19	25	22	4	6	17	31	195	48	124	11	16	28	4	33	57	0	8	7	0	0	808
SoLaS	28	3	3	0	1	1	42	18	24	33	69	4	4	165	4	5	67	0	34	4	0	0	508
Coron	102	29	31	4	19	5	181	102	313	344	250	17	23	134	130	47	447	0	35	11	28	0	2251
Missi	239	15	21	104	15	4	15	12	19	7	24	48	67	7	1	5	15	0	17	10	0	0	644
E_Riv	174	31	29	94	171	16	19	15	30	51	43	206	8382	103	4	64	153	0	148	44	139	0	9916
S_Riv	230	12	15	35	15	6	20	48	59	302	151	58	1003	3215	128	11	1189	0	209	15	33	0	6755
W_Riv	46	1	1	1	0	1	1	4	8	11	19	1	3	85	91	11	191	0	211	7	47	0	738
N_Riv	178	45	29	17	14	21	36	12	23	10	14	5	11	5	14	140	62	0	113	35	7	0	793
Orang	4	6	4	18	1	5	1	7	5	3	18	4	7	124	7	4	0	0	0	0	0	0	217
DIS18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA_Co	2	1	1	4	1	1	0	1	0	1	1	0	0	12	1	1	0	0	0	0	0	0	25
San_B	84	34	36	34	21	42	9	15	71	23	26	17	68	31	10	46	0	0	0	0	0	0	567
Santa	0	0	0	6	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	11
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2256	651	592	1442	547	244	590	386	1435	1038	1174	456	9914	4300	398	824	2384	0	854	190	304	0	29979

Table 4.02

*** WEEKDAY INCREMENTAL LINKED TRANSIT TRIPS (All Transit/All car HH) (VS. NO-BUILD) ***
District to District MODEL Summary for Scenario 3: Y2020 BUILD
All Purposes All Transit All Access All car HH

Idist	RvCBD	NUniv	SUni	UCR	WofUC	NofC	SofCB	PresP	Jurup	SoLaS	Coron	Missi	E_Riv	S_Riv	W_Riv	N_Riv	Orang	DIS18	LA_Co	San_B	Santa	Other	Total
RvCBD	35	47	16	73	4	6	1	5	12	0	6	0	42	3	0	11	0	0	0	2	0	0	262
NUniv	136	39	29	66	17	7	6	1	12	1	5	6	21	0	0	2	0	0	0	1	0	0	350
SUni	4	1	0	14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19
UCR	6	0	0	3	1	1	0	0	2	0	2	0	0	0	0	2	0	0	0	0	0	0	18
WofUC	14	8	9	51	5	-1	7	1	1	0	0	2	0	0	0	3	0	0	0	1	0	0	101
NofC	15	27	8	32	3	0	0	2	12	0	1	4	6	1	0	3	0	0	0	1	0	0	115
SofCB	0	0	0	6	1	2	-3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6
PresP	0	-1	0	3	1	1	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	6
Jurup	1	-1	0	4	0	1	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	7
SoLaS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coron	0	4	0	0	1	0	0	-1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	6
Missi	54	0	1	7	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	66
E_Riv	20	7	4	1	-4	-1	0	0	1	0	3	0	-10	0	0	4	-4	0	-1	0	-5	0	15
S_Riv	8	-1	0	5	0	0	0	0	0	0	0	0	1	0	0	0	-2	0	1	0	0	0	13
W_Riv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N_Riv	3	10	0	5	5	1	-2	1	0	0	0	1	2	0	0	0	0	0	0	0	0	0	27
Orang	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DIS18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA_Co	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San_B	1	1	0	3	-1	0	0	1	0	0	0	1	4	0	0	0	0	0	0	0	0	0	12
Santa	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	298	142	67	274	34	19	9	9	42	2	18	17	70	3	0	25	-6	0	-1	6	-5	0	1023

Program STOPS - FTA Simplified Trips-on-Project Software Page 27
Version: STOPS-v2.50 - 07/22/2020 8/31/2021
Run: Riverside Streetcar 12:47:58
System: Rev0

Table 4.03

*** WEEKDAY LINKED TRANSIT TRIPS ON PROJECT (All Transit/All car HH)***
District to District MODEL Summary for Scenario 3: Y2020 BUILD
All Purposes All Transit All Access All car HH

Idist	RvCBD	NUniv	SUni	UCR	WofUC	NofC	SofCB	PresP	Jurup	SoLaS	Coron	Missi	E_Riv	S_Riv	W_Riv	N_Riv	Orang	DIS18	LA_Co	San_B	Santa	Other	Total
RvCBD	47	83	14	144	7	9	2	11	33	1	15	1	88	48	0	41	0	0	0	5	0	0	549
NUniv	274	73	39	141	33	11	17	3	39	2	28	14	45	1	0	4	2	0	0	3	0	0	731
SUni	2	1	0	24	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	30
UCR	10	2	0	3	1	2	0	1	6	0	7	0	0	0	0	3	0	0	0	0	0	0	37
WofUC	26	16	14	100	11	0	17	1	2	0	1	9	1	0	0	7	0	0	24	2	0	0	233
NofC	37	50	16	68	7	1	1	3	21	0	3	8	12	3	0	4	8	0	1	2	0	0	246
SofCB	1	3	0	13	2	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	23
PresP	1	1	0	7	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	14
Jurup	2	3	0	8	1	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	0	20
SoLaS	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Coron	0	13	0	1	3	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	21
Missi	128	5	3	13	0	2	0	0	0	0	0	0	1	0	0	3	0	0	2	4	0	0	162
E_Riv	67	17	10	2	0	5	0	1	3	3	9	0	3	0	0	6	5	0	2	5	27	0	165
S_Riv	89	2	0	11	3	1	0	0	0	0	0	1	4	0	0	2	4	0	3	0	0	0	121
W_Riv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
N_Riv	5	18	1	13	7	1	0	0	0	0	0	3	4	0	0	0	1	0	1	0	0	0	55
Orang	0	0	0	13	1	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	17
DIS18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA_Co	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
San_B	1	4	0	16	6	0	0	0	0	0	0	7	19	0	0	0	0	0	0	0	0	0	53
Santa	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	691	292	99	585	86	35	38	20	105	6	63	52	188	53	0	71	21	0	33	22	27	0	2488

Program STOPS - FTA Simplified Trips-on-Project Software Page 28
Version: STOPS-v2.50 - 07/22/2020 8/31/2021
Run: Riverside Streetcar 12:47:58
System: Rev0

Program STOPS - FTA Simplified Trips-on-Project Software Page 27
Version: STOPS-v2.50 - 07/22/2020 8/31/2021
Run: Riverside Streetcar 0:00:03
System: Rev0
Table 4.03

*** WEEKDAY LINKED TRANSIT TRIPS ON PROJECT (All Transit/All car HH)***
District to District MODEL Summary for Scenario 3: Y2030 BUILD
All Purposes All Transit All Access All car HH

Idist	RvCBD	NUniv	SUni	UCR	WofUC	NofC	SofCB	PresP	Jurup	SoLaS	Coron	Missi	E_Riv	S_Riv	W_Riv	N_Riv	Orang	DIS18	LA_Co	San_B	Santa	Other	Total
RvCBD	83	183	33	166	8	11	2	13	39	1	18	1	97	54	0	56	0	0	0	5	0	0	770
NUniv	395	113	69	144	41	9	15	2	40	2	25	15	70	3	0	4	2	0	0	3	0	0	953
SUni	3	1	0	26	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	34
UCR	16	2	0	3	2	2	0	1	6	0	6	0	0	0	0	3	1	0	0	0	0	0	42
WofUC	55	27	23	129	16	1	24	2	2	1	1	16	1	0	0	11	0	0	32	4	0	0	345
NofC	49	71	27	64	8	1	1	3	15	0	3	8	17	3	0	4	8	0	1	2	0	0	286
SofCB	2	4	0	11	2	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	23
PresP	1	1	0	7	1	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	16
Jurup	3	3	0	8	1	0	0	0	0	0	0	4	3	0	0	0	0	0	0	0	0	0	21
SoLaS	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Coron	0	13	0	1	3	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	22
Missi	197	8	5	12	0	2	0	0	0	0	0	0	1	0	0	3	0	0	2	5	0	0	237
E_Riv	100	24	17	2	0	5	0	1	2	4	10	0	6	0	0	6	5	0	2	6	31	0	222
S_Riv	152	3	0	11	4	1	0	0	0	0	0	2	7	0	0	2	4	0	4	1	0	0	190
W_Riv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
N_Riv	9	22	2	13	9	1	0	0	0	0	0	4	6	0	0	0	1	0	1	0	0	0	69
Orang	0	0	0	13	1	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	18
DIS18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA_Co	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
San_B	1	4	0	16	7	0	0	0	0	0	0	7	25	0	0	0	0	0	0	0	0	0	61
Santa	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1068	482	177	633	106	36	43	21	105	8	65	63	242	61	0	89	23	0	42	26	31	0	3320

Table 4.84

***** AVG WEEKDAY STATION UTILIZATION BY PROJECT TRIPS (All Transit/All car HH) ***********
Origin Station to Destination Station MODEL Summary for Scenario 3: Y2020 BUILD
All Purposes All Transit All Access All car HH

	101&S---	102&S---	103&S---	104&S---	105&S---	106&S---	107&S---	108&S---	109&S---	110&S---	111&S---	112&S---	113&S---	114&S---	115&S---	116&S---	117&S---	118&S---	119&S---	120&S---	121&S---	122&S---	123&S---	124&S---	125&S---	126&S---	127&S---	128&S---	129&S---	130&S---	131&S---	Other	Total
101&S---	0	0	14	6	27	8	11	2	4	3	1	10	1	2	2	3	0	5	26	0	0	0	0	1	0	0	1	0	0	0	13	0	143
102&S---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	1	0	0	0	0	0	0	0	0	0	0	0	9
103&S---	14	0	0	0	9	6	5	0	1	3	0	3	7	0	3	1	0	2	29	5	25	0	19	34	0	0	1	0	0	0	5	0	174
104&S---	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	1	0	0	0	0	12
105&S---	27	0	9	0	0	0	2	0	0	0	2	4	1	0	2	2	0	1	24	3	1	0	0	8	0	0	7	5	0	0	0	0	97
106&S---	8	0	6	0	0	0	1	0	0	1	0	1	2	0	0	2	0	1	21	1	1	0	1	2	0	0	0	0	0	0	1	0	50
107&S---	11	0	5	0	2	1	0	0	0	22	4	8	0	0	0	4	0	0	30	3	5	0	2	2	0	0	10	5	0	0	0	0	116
108&S---	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4
109&S---	4	0	1	0	0	0	0	0	0	0	5	10	2	0	0	5	0	1	44	0	0	0	0	0	0	0	0	0	0	0	0	0	72
110&S---	3	0	3	0	0	1	22	0	0	0	0	1	8	0	4	5	0	2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	76
111&S---	3	0	0	0	2	0	4	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
112&S---	10	0	3	0	4	1	8	0	10	1	0	0	8	3	4	14	0	2	59	0	0	0	0	0	0	0	0	0	0	0	0	0	128
113&S---	1	0	7	0	1	2	0	0	2	8	0	8	0	0	1	1	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	37
114&S---	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	4	0	0	11	0	0	0	0	0	0	0	0	0	0	0	2	0	24
115&S---	2	0	3	0	2	0	0	0	0	4	0	4	1	0	0	1	0	3	45	0	0	0	0	0	0	0	0	0	0	0	0	0	65
116&S---	3	0	1	0	2	2	4	0	5	5	0	14	1	4	1	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	1	0	58
117&S---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
118&S---	5	1	2	0	1	1	0	0	1	2	0	2	1	0	3	0	0	0	43	0	0	0	0	0	0	0	0	0	0	0	2	0	64
119&S---	26	4	29	2	24	21	30	2	44	25	0	59	5	11	45	14	1	43	0	0	3	1	0	1	0	0	3	1	18	14	12	0	437
120&S---	0	0	5	0	3	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	7	6	5	0	0	0	19	2	5	0	64
121&S---	0	1	25	0	1	1	5	0	0	0	0	0	0	0	0	0	0	0	3	7	0	0	0	2	3	3	6	2	18	45	0	0	123
122&S---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
123&S---	0	0	19	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	1	0	0	1	1	12	33	3	0	0	80
124&S---	1	0	34	0	8	2	2	0	0	0	0	0	0	0	0	0	0	1	6	2	0	1	0	1	1	29	7	28	57	0	0	0	180
125&S---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	0	0	1	0	0	2	1	12	1	0	0	26
126&S---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	2	1	6	0	0	0	15
127&S---	1	0	1	1	7	0	10	0	0	0	0	0	0	0	0	0	0	0	3	0	6	0	1	29	2	2	0	1	7	0	0	0	71
128&S---	0	0	0	1	5	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	1	7	1	1	1	0	12	0	0	0	37
129&S---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	19	18	0	12	28	12	6	7	12	0	0	0	0	135
130&S---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	2	45	0	33	57	1	0	0	0	0	0	0	0	153
131&S---	13	0	5	0	0	1	0	0	0	0	0	0	0	2	0	1	0	2	12	5	0	0	3	0	0	0	0	0	0	0	0	0	45
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	143	9	174	12	97	50	116	4	72	76	16	128	37	24	65	58	1	64	437	64	123	2	80	180	26	15	71	37	135	153	45	0	2516

Program STOPS - FTA Simplified Trips-on-Project Software Page 29
Version: STOPS-v2.50 - 07/22/2020 8/31/2021
Run: Riverside Streetcar 12:47:58
System: Rev0

Program STOPS - FTA Simplified Trips-on-Project Software Page 28
Version: STOPS-v2.50 - 07/22/2020 8/31/2021
Run: Riverside Streetcar 0:00:03
System: Rev0
Table 4.04

***** AVG WEEKDAY STATION UTILIZATION BY PROJECT TRIPS (All Transit/All car HH) ***********
Origin Station to Destination Station MODEL Summary for Scenario 3: Y2030 BUILD
All Purposes All Transit All Access All car HH

	101&S---	102&S---	103&S---	104&S---	105&S---	106&S---	107&S---	108&S---	109&S---	110&S---	111&S---	112&S---	113&S---	114&S---	115&S---	116&S---	117&S---	118&S---	119&S---	120&S---	121&S---	122&S---	123&S---	124&S---	125&S---	126&S---	127&S---	128&S---	129&S---	130&S---	131&S---	Other	Total
101&S---	0	0	22	7	35	10	18	4	6	3	8	21	1	2	2	4	0	6	27	0	0	0	0	1	0	0	1	0	0	0	14	0	190
102&S---	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	10
103&S---	22	0	0	0	11	7	10	0	2	5	1	7	7	0	3	2	0	2	39	7	38	0	32	52	0	0	1	0	0	0	5	0	252
104&S---	7	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	1	2	0	0	0	0	16
105&S---	35	0	11	0	0	0	3	0	0	0	4	8	1	0	2	2	0	1	28	4	1	0	0	8	0	2	9	6	1	0	0	0	125
106&S---	10	0	7	0	0	0	2	0	0	1	1	3	2	0	0	3	0	1	25	2	1	0	1	2	0	0	0	0	0	0	1	0	62
107&S---	18	1	10	1	3	2	0	0	0	30	10	18	0	0	0	5	0	0	35	5	7	0	3	3	0	0	13	6	0	0	0	0	167
108&S---	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	7
109&S---	6	0	2	0	0	0	0	0	0	0	12	21	2	0	0	6	0	1	49	0	0	0	0	0	0	0	0	0	0	0	0	0	99
110&S---	3	0	5	0	0	1	30	0	0	0	0	2	10	0	4	6	0	3	28	0	0	0	0	0	0	0	0	0	0	0	0	0	92
111&S---	8	0	1	0	4	1	10	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35
112&S---	21	1	7	0	8	3	18	0	21	2	0	0	7	1	3	15	0	2	62	0	0	0	0	0	0	0	0	0	0	0	0	0	175
113&S---	1	0	7	0	1	2	0	0	2	10	0	7	0	0	1	1	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	38
114&S---	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	4	0	0	11	0	0	0	0	0	0	0	0	0	0	0	2	0	24
115&S---	2	0	3	0	2	0	0	0	0	4	0	3	1	0	0	2	0	3	60	0	0	0	0	0	0	0	0	0	0	0	0	0	80
116&S---	4	0	2	0	2	3	5	0	6	6	0	15	1	4	2	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	2	0	65
117&S---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
118&S---	6	0	2	0	1	1	0	0	1	3	0	2	1	0	3	0	0	0	56	0	0	0	0	0	0	0	0	0	0	0	2	0	79
119&S---	27	4	39	4	28	25	35	2	49	28	0	62	5	11	60	14	1	56	0	0	4	2	0	1	0	0	7	1	21	24	13	0	523
120&S---	0	0	7	1	4	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	11	8	8	0	1	0	28	4	6	0	94
121&S---	0	1	38	0	1	1	7	0	0	0	0	0	0	0	0	0	0	0	4	9	0	0	0	2	3	3	13	3	21	71	1	0	177
122&S---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3
123&S---	0	0	32	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	1	0	0	1	2	14	57	4	0	126
124&S---	1	0	52	0	8	2	3	0	0	0	0	0	0	0	0	0	0	0	1	8	2	0	1	0	0	1	55	13	28	89	0	0	265
125&S---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	3	0	0	0	0	0	3	2	9	2	0	0	28
126&S---	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	5	2	6	0	0	0	19
127&S---	1	0	1	1	9	0	13	0	0	0	0	0	0	0	0	0	0	0	7	1	13	0	1	55	3	5	0	1	6	0	0	0	117
128&S---	0	0	0	2	6	0	6	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	2	13	2	2	1	0	13	0	0	0	52
129&S---	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	21	28	21	0	14	28	9	6	6	13	0	0	0	0	147
130&S---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	4	71	0	57	89	2	0	0	0	0	0	0	0	248
131&S---	14	0	5	0	0	1	0	0	0	0	0	0	0	2	0	2	0	2	13	6	1	0	4	0	0	0	0	0	0	0	0	0	50
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	190	10	252	16	125	62	167	7	99	92	35	175	38	24	80	65	1	79	523	94	177	3	126	265	28	19	117	52	147	248	50	0	3366

CHANGE IN VEHICLE MILES TRAVELED (VMT)

SECTION 8: SUMMARY OF IMPACTS ON AUTOMOBILE PERSON MILES OF TRIPS
Incremental District-to-District Vehicle PMT: 8.01

Table 8.01

District to District Incremental WEEKDAY AUTOMOBILE PMT Summary for Scenario 3: Y2020 BUILD
All Purposes All Transit All Access All car HH

Idist	RvCBD	NUniv	SUni	UCR	WofUC	NofC	SofCB	PresP	Jurup	SoLaS	Coron	Missi	E_Riv	S_Riv	W_Riv	N_Riv	Orang	DIS18	LA_Co	San_B	Santa	Other	Total
RvCBD	-21	-39	-12	-255	-5	-19	-2	-19	-72	-3	-56	0	-448	-35	0	-39	0	0	0	-20	0	0	-1045
NUniv	-154	-44	-29	-178	-39	-14	-14	-4	-72	-7	-47	-33	-150	-5	0	-9	10	0	0	-16	0	0	-806
SUni	-2	0	0	-40	-1	0	0	0	0	0	-1	-1	-2	0	0	0	0	0	0	0	0	0	-48
UCR	-16	-1	0	5	0	-5	0	-2	-13	0	-25	0	0	0	-3	-11	-2	0	0	-1	0	0	-74
WofUC	-37	-17	-19	-50	-5	2	-30	-4	-7	-2	-3	-16	1	3	0	-27	-2	0	29	-13	0	0	-196
NofC	-35	-63	-22	-112	2	0	-1	-14	-77	0	-8	-20	-61	-18	0	-17	-17	0	-6	-7	0	0	-476
SofCB	2	-2	0	-22	-2	-7	3	0	-1	0	0	-3	-5	-1	0	0	-11	0	0	0	0	0	-48
PresP	0	7	0	-15	-8	-7	0	0	-3	1	1	-1	-14	1	1	0	8	0	0	3	0	0	-26
Jurup	1	5	1	-24	-2	-5	0	-1	0	0	0	-19	-13	0	0	0	4	0	0	1	0	0	-52
SoLaS	0	0	0	0	0	1	0	0	0	0	0	-1	0	0	0	0	0	0	0	1	0	0	1
Coron	0	-42	0	-5	-18	-4	0	7	0	0	0	-12	12	0	0	0	0	0	0	-2	0	0	-66
Missi	-281	3	-5	-29	1	-2	0	0	1	0	-1	0	-1	7	0	-9	-1	0	13	-39	0	0	-344
E_Riv	-199	-47	-27	-23	39	9	-2	-2	-10	-8	-48	1	121	-1	0	-57	203	0	54	-6	344	0	343
S_Riv	-108	8	2	-47	-4	5	0	1	-2	0	0	-4	-27	2	0	-3	84	0	-30	5	0	0	-118
W_Riv	0	0	0	0	0	0	0	0	0	0	0	1	-3	0	0	0	0	0	0	3	0	0	0
N_Riv	1	-46	-2	-34	-30	-1	9	-7	0	0	0	-12	-25	1	0	0	-9	0	-6	-1	0	0	-162
Orang	-2	1	0	-40	-3	4	-1	-2	-2	1	-1	22	16	-2	0	0	0	0	0	0	0	0	-9
DIS18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA_Co	-1	0	0	-9	0	-1	0	0	0	-1	0	1	0	0	0	0	0	0	0	0	0	0	-10
San_B	-9	-11	1	-36	17	6	-3	-6	-5	-1	-5	-13	-86	2	0	-3	0	0	0	0	0	0	-153
Santa	0	0	0	57	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	-861	-290	-110	-857	-58	-34	-41	-53	-264	-21	-194	-110	-684	-47	-2	-175	267	0	54	-92	344	0	-3228

District to District Incremental WEEKDAY AUTOMOBILE PMT Summary for Scenario 3: Y2030 BUILD
All Purposes All Transit All Access All car HH

Idist	RvCBD	NUniv	SUni	UCR	WofUC	NofC	SofCB	PresP	Jurup	SoLaS	Coron	Missi	E_Riv	S_Riv	W_Riv	N_Riv	Orang	DIS18	LA_Co	San_B	Santa	Other	Total
RvCBD	-37	-86	-28	-294	-6	-24	-2	-22	-87	-4	-64	0	-482	-49	0	-54	0	0	0	-21	0	0	-1260
NUniv	-226	-70	-52	-182	-48	-12	-12	-2	-70	-9	-40	-35	-226	-12	0	-9	9	0	0	-16	0	0	-1013
SUni	-3	0	0	-43	-2	0	0	0	0	0	-1	-1	-2	0	0	0	0	0	0	0	0	0	-54
UCR	-24	-1	0	4	-1	-5	0	-1	-13	0	-23	0	0	0	-2	-11	-2	0	0	-1	0	0	-81
WofUC	-80	-30	-31	-67	-7	4	-42	-5	-6	-3	-3	-29	2	4	0	-40	-2	0	34	-20	0	0	-321
NofC	-50	-89	-35	-101	2	0	-1	-13	-60	0	-8	-21	-79	-17	0	-18	-21	0	-5	-8	0	0	-524
SofCB	3	-1	1	-19	-3	-6	3	0	-1	0	0	-3	-6	-1	0	0	-14	0	0	0	0	0	-47
PresP	0	9	0	-15	-7	-6	0	0	-3	1	1	-1	-17	1	1	0	8	0	0	3	0	0	-26
Jurup	1	8	1	-23	-2	-5	0	-1	0	0	0	-19	-18	0	0	0	4	0	0	1	0	0	-51
SoLaS	0	1	0	0	0	1	0	0	0	0	0	-1	1	0	0	0	0	0	0	1	0	0	3
Coron	-1	-40	1	-5	-17	-4	0	6	0	0	0	-13	4	0	0	0	0	0	0	-2	0	0	-72
Missi	-452	2	-7	-26	1	-2	0	0	1	0	-1	0	-2	7	0	-10	0	0	9	-47	0	0	-528
E_Riv	-296	-69	-45	-24	44	10	-2	-2	-5	-11	-52	2	207	-1	1	-49	214	0	66	-11	337	0	311
S_Riv	-185	10	6	-44	-7	5	0	1	-3	0	0	-6	-50	2	0	-4	91	0	-35	3	0	0	-215
W_Riv	0	-1	0	0	0	0	0	0	0	0	0	1	-3	0	0	0	0	0	0	3	0	0	0
N_Riv	2	-57	-1	-36	-36	-1	9	-8	1	0	0	-14	-38	1	0	0	-9	0	-7	-1	0	0	-197
Orang	-2	2	0	-40	-3	5	-1	-3	-2	1	-1	24	18	-2	0	0	0	0	0	0	0	0	-5
DIS18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA_Co	-1	0	0	-10	0	0	0	0	0	-1	0	1	0	0	0	0	0	0	0	0	0	0	-11
San_B	-13	-12	1	-29	23	7	-3	-6	-4	-1	-5	-13	-107	2	0	-3	0	0	0	0	0	0	-163
Santa	0	0	0	68	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	72
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	-1366	-424	-189	-884	-69	-29	-53	-56	-252	-28	-199	-129	-798	-66	-1	-196	277	0	62	-115	337	0	-4179

DAILY RIDERSHIP BY STATION

Table 9.01

***** AVG WEEKDAY STATION UTILIZATION (All Transit/All car HH) ************
Comparison of Station Boardings by Scenario for 2690 Stations
All Purposes All Transit All car HH

		Y2020 EXISTING					Y2030 NO-BUILD					Y2030 BUILD				
Stop_id1	Station Name	WLK	KNR	PNR	XFR	ALL	WLK	KNR	PNR	XFR	ALL	WLK	KNR	PNR	XFR	ALL
101&S	3rd St - Before Oran	0	0	0	0	0	0	0	0	0	0	184	6	0	0	190
102&S	3rd St - Before Mark	0	0	0	0	0	0	0	0	0	0	0	9	0	1	10
103&S	Market St (NB) - Bef	0	0	0	0	0	0	0	0	0	0	212	4	0	37	252
104&S	Market St (NB) - Bef	0	0	0	0	0	0	0	0	0	0	0	0	0	15	16
105&S	Market St (NB) - Bef	0	0	0	0	0	0	0	0	0	0	69	1	0	56	125
106&S	Market St (NB) - Bef	0	0	0	0	0	0	0	0	0	0	43	10	0	9	62
107&S	14th St (EB) - Befor	0	0	0	0	0	0	0	0	0	0	155	5	0	7	167
108&S	Lemon St - South of	0	0	0	0	0	0	0	0	0	0	4	0	0	2	7
109&S	Lemon St - South of	0	0	0	0	0	0	0	0	0	0	79	1	0	20	99
1032&R	Oceanside Transit Ce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1033&R	Town Center North (N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1034&R	Hwy 76 & I-15 Park &	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1035&R	Hwy 76 + Camino Del	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1036&R	Hwy 76 NS Olive Hill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1154&R	W. Valley Pkwy + Sig	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1155&R	Escondido Transit Ce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144&M	Oceanside Metrolink	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110&S	Lemon St - South of	0	0	0	0	0	0	0	0	0	0	0	0	0	92	92
111&S	Univ Ave (EB) - Befo	0	0	0	0	0	0	0	0	0	0	35	0	0	0	35
112&S	Univ Ave (EB) - Befo	0	0	0	0	0	0	0	0	0	0	174	1	0	0	175
113&S	Univ Ave (EB) - Befo	0	0	0	0	0	0	0	0	0	0	37	0	0	0	38
114&S	Univ Ave (EB) - Afte	0	0	0	0	0	0	0	0	0	0	24	0	0	0	24
115&S	Univ Ave (EB) - Afte	0	0	0	0	0	0	0	0	0	0	78	2	0	0	80
116&S	Univ Ave (EB) - Befo	0	0	0	0	0	0	0	0	0	0	6	0	0	60	65
117&S	Univ Ave (EB) - Afte	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
118&S	Univ Ave (EB) - Afte	0	0	0	0	0	0	0	0	0	0	76	1	0	1	79
119&S	Univ Ave (EB) - NEW	0	0	0	0	0	0	0	0	0	0	198	38	0	287	523
120&S	Univ Ave (EB) - NEW	0	0	0	0	0	0	0	0	0	0	90	2	0	2	94
121&S	Univ Ave (WB) - Afte	0	0	0	0	0	0	0	0	0	0	11	3	0	163	177
122&S	Univ Ave (WB) - Afte	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3
123&S	Univ Ave (WB) - Afte	0	0	0	0	0	0	0	0	0	0	12	0	0	114	126
124&S	Univ Ave (WB) - Afte	0	0	0	0	0	0	0	0	0	0	263	2	0	0	265
125&S	Univ Ave (WB) - Befo	0	0	0	0	0	0	0	0	0	0	28	0	0	0	28
126&S	Univ Ave (WB) - Afte	0	0	0	0	0	0	0	0	0	0	19	0	0	0	19
127&S	Univ Ave (WB) - Afte	0	0	0	0	0	0	0	0	0	0	116	1	0	1	117
128&S	Univ Ave (WB) - Afte	0	0	0	0	0	0	0	0	0	0	52	0	0	0	52
129&S	Lemon St - North of	0	0	0	0	0	0	0	0	0	0	31	0	0	116	147
130&S	Lemon St - South of	0	0	0	0	0	0	0	0	0	0	246	2	0	0	248
131&S	Strc Metrolink	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50

SYSTEM-WIDE RIDERSHIP BY MODE

System: Rev0
Table 11.04

SUMMARY OF TRIPS BY SUBMODE, ACCESS MODE, AUTO OWNERSHIP, AND SCENARIO
Purpose All Purposes
STOPS Model Application Model Application AFTER Station Boarding Calibration

HH Cars	Sub-mode	Access mode	Y2020 EXISTING Model	Y2020 EXISTING Survey	Y2030 NO-BUILD Model	Y2030 NO-BUILD Survey	Y2030 BUILD Model	Y2030 BUILD Survey	Y2030 BUILD Project	Y2030 BUILD Survey
0 car H	Fixed Guideway Only	Walk Access	125	0	138	0	577	0	462	0
0 car H	Fixed Guideway Only	KNR Access	42	0	50	0	60	0	11	0
0 car H	Fixed Guideway Only	PNR Access	0	0	0	0	0	0	0	0
0 car H	Fixed Guideway Only	All Access	167	0	188	0	637	0	472	0
0 car H	Fixed Guideway+Bus	Walk Access	230	0	250	0	720	0	518	0
0 car H	Fixed Guideway+Bus	KNR Access	18	0	21	0	30	0	10	0
0 car H	Fixed Guideway+Bus	PNR Access	0	0	0	0	0	0	0	0
0 car H	Fixed Guideway+Bus	All Access	249	0	270	0	750	0	528	0
0 car H	Bus Only	Walk Access	5872	0	7308	0	6740	0	0	0
0 car H	Bus Only	KNR Access	417	0	508	0	496	0	0	0
0 car H	Bus Only	PNR Access	0	0	0	0	0	0	0	0
0 car H	Bus Only	All Access	6288	0	7816	0	7235	0	0	0
0 car H	All Transit	Walk Access	6227	0	7696	0	8036	0	979	0
0 car H	All Transit	KNR Access	477	0	579	0	586	0	21	0
0 car H	All Transit	PNR Access	0	0	0	0	0	0	0	0
0 car H	All Transit	All Access	6704	0	8274	0	8622	0	1000	0
0 car H	All Fixed Guideway	Walk Access	355	0	388	0	1297	0	979	0
0 car H	All Fixed Guideway	KNR Access	61	0	70	0	90	0	21	0
0 car H	All Fixed Guideway	PNR Access	0	0	0	0	0	0	0	0
0 car H	All Fixed Guideway	All Access	416	0	458	0	1387	0	1000	0
1 car H	Fixed Guideway Only	Walk Access	34	0	38	0	496	0	459	0
1 car H	Fixed Guideway Only	KNR Access	168	0	179	0	267	0	87	0
1 car H	Fixed Guideway Only	PNR Access	0	0	0	0	0	0	0	0
1 car H	Fixed Guideway Only	All Access	202	0	217	0	763	0	547	0
1 car H	Fixed Guideway+Bus	Walk Access	367	0	385	0	718	0	363	0
1 car H	Fixed Guideway+Bus	KNR Access	44	0	48	0	60	0	15	0
1 car H	Fixed Guideway+Bus	PNR Access	0	0	0	0	0	0	0	0
1 car H	Fixed Guideway+Bus	All Access	411	0	433	0	778	0	378	0
1 car H	Bus Only	Walk Access	4741	0	5929	0	5528	0	0	0
1 car H	Bus Only	KNR Access	495	0	597	0	554	0	0	0
1 car H	Bus Only	PNR Access	0	0	0	0	0	0	0	0
1 car H	Bus Only	All Access	5236	0	6526	0	6082	0	0	0
1 car H	All Transit	Walk Access	5142	0	6352	0	6742	0	822	0
1 car H	All Transit	KNR Access	707	0	823	0	881	0	102	0
1 car H	All Transit	PNR Access	0	0	0	0	0	0	0	0
1 car H	All Transit	All Access	5849	0	7175	0	7623	0	924	0
1 car H	All Fixed Guideway	Walk Access	401	0	423	0	1214	0	822	0
1 car H	All Fixed Guideway	KNR Access	212	0	227	0	327	0	102	0
1 car H	All Fixed Guideway	PNR Access	0	0	0	0	0	0	0	0
1 car H	All Fixed Guideway	All Access	613	0	650	0	1541	0	924	0
2+ car	Fixed Guideway Only	Walk Access	129	0	153	0	680	0	529	0
2+ car	Fixed Guideway Only	KNR Access	951	0	1045	0	1108	0	64	0
2+ car	Fixed Guideway Only	PNR Access	0	0	0	0	0	0	0	0
2+ car	Fixed Guideway Only	All Access	1080	0	1198	0	1788	0	592	0
2+ car	Fixed Guideway+Bus	Walk Access	1237	0	1389	0	2030	0	711	0
2+ car	Fixed Guideway+Bus	KNR Access	496	0	565	0	591	0	92	0
2+ car	Fixed Guideway+Bus	PNR Access	0	0	0	0	0	0	0	0
2+ car	Fixed Guideway+Bus	All Access	1733	0	1954	0	2621	0	803	0
2+ car	Bus Only	Walk Access	7176	0	8587	0	7984	0	0	0
2+ car	Bus Only	KNR Access	1189	0	1396	0	1341	0	0	0
2+ car	Bus Only	PNR Access	0	0	0	0	0	0	0	0
2+ car	Bus Only	All Access	8364	0	9983	0	9325	0	0	0
2+ car	All Transit	Walk Access	8541	0	10129	0	10695	0	1240	0
2+ car	All Transit	KNR Access	2635	0	3006	0	3039	0	156	0
2+ car	All Transit	PNR Access	0	0	0	0	0	0	0	0
2+ car	All Transit	All Access	11177	0	13135	0	13734	0	1396	0
2+ car	All Fixed Guideway	Walk Access	1366	0	1542	0	2711	0	1240	0
2+ car	All Fixed Guideway	KNR Access	1447	0	1610	0	1699	0	156	0
2+ car	All Fixed Guideway	PNR Access	0	0	0	0	0	0	0	0
2+ car	All Fixed Guideway	All Access	2812	0	3152	0	4409	0	1396	0

DISTRICT TO DISTRICT TOTAL TRANSIT TRIPS

Table 287.01

*** WEEKDAY PERSON TRIPS (Person Trip Input to Mode Choice *Before Regional or Group Transit Factoring*) ***
District to District Person Trip Summary for Scenario 1: Y2020 EXISTING
All Purposes 0 car HH

Idist	RvCBD	NUniv	SUni	UCR	WofUC	NofC	SofCB	PresP	Jurup	SoLaS	Coron	Missi	E_Riv	S_Riv	W_Riv	N_Riv	Orang	BAS18	LA_Co	San_B	Santa	Other	Total
RvCBD	0	0	0	0	0	0	0	0	0	0	0	0	65	629	0	1404	0	0	0	0	0	0	2098
NUniv	1035	613	442	523	0	396	208	0	0	0	145	0	13	56	0	0	26	0	0	224	0	0	3681
SUni	610	337	372	715	0	295	92	0	0	0	0	0	15	92	0	0	0	0	0	134	0	0	2663
UCR	0	0	0	277	1047	0	0	119	125	0	346	0	0	0	13	0	0	0	29	6	0	0	1962
WofUC	138	0	0	4816	2212	0	0	0	22	0	0	650	0	130	0	165	0	0	0	82	0	0	8215
NofC	0	81	0	0	0	103	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	225
SofCB	373	309	0	0	0	396	1638	52	552	636	878	0	0	0	0	0	40	0	0	0	0	0	4873
PresP	193	0	0	0	0	0	323	1577	146	0	0	0	14	273	0	0	27	0	0	24	0	0	2577
Jurup	514	536	0	0	0	891	251	629	1753	0	685	0	456	0	0	763	0	0	34	175	0	0	6688
SoLaS	0	0	0	0	0	0	0	0	0	146	812	0	26	249	0	0	4	0	0	0	0	0	1237
Coron	0	0	0	0	59	0	1111	1667	485	1467	1750	0	388	384	694	0	87	0	145	178	4	0	8418
Missi	0	0	0	0	227	0	115	0	0	0	0	352	0	0	114	0	0	0	46	66	0	0	920
E_Riv	463	31	43	121	496	73	41	69	115	264	149	619	83880	327	301	431	621	0	365	2022	264	0	90693
S_Riv	552	0	0	0	25	0	14	98	0	1103	408	17	4650	20663	361	111	699	0	151	365	18	0	29235
W_Riv	355	0	0	0	0	140	0	0	202	0	0	0	250	100	4137	0	654	0	115	892	57	0	6902
N_Riv	0	0	0	0	0	182	246	0	339	0	14	0	996	0	1568	1518	0	0	34	1133	8	0	6037
Orang	0	0	0	21	34	0	26	0	0	0	0	0	0	90	65	0	0	0	0	0	0	0	237
BAS18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA_Co	12	7	12	0	27	0	0	0	0	0	0	72	73	86	17	44	0	0	0	0	0	0	350
San_B	134	20	0	40	65	644	172	0	175	0	33	0	1888	289	280	519	0	0	0	0	0	0	4259
Santa	0	0	0	2	0	0	0	0	3	0	0	0	1	5	4	0	0	0	0	0	0	0	15
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	4379	1934	869	6515	4192	3117	4237	4211	3918	3616	5220	1711	92756	23372	7554	4954	2159	0	919	5300	351	0	181284

DISTRICT TO DISTRICT TRIPS-ON-PROJECT

Table 1021.03

*** WEEKDAY LINKED TRANSIT TRIPS ON PROJECT (All Fixed Guideway/All car HH)***
District to District MODEL Summary for Scenario 3: Y2030 BUILD
All Purposes All Fixed Guideway All Access All car HH

Idist	RvCBD	NUniv	SUni	UCR	WofUC	NofC	SofCB	PresP	Jurup	SoLaS	Coron	Missi	E_Riv	S_Riv	W_Riv	N_Riv	Orang	DIS18	LA_Co	San_B	Santa	Other	Total
RvCBD	83	183	33	166	8	11	2	13	39	1	18	1	97	54	0	56	0	0	0	5	0	0	770
NUniv	395	113	69	144	41	9	15	2	40	2	25	15	70	3	0	4	2	0	0	3	0	0	953
SUni	3	1	0	26	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	34
UCR	16	2	0	3	2	2	0	1	6	0	6	0	0	0	0	3	1	0	0	0	0	0	42
WofUC	55	27	23	129	16	1	24	2	2	1	1	16	1	0	0	11	0	0	32	4	0	0	345
NofC	49	71	27	64	8	1	1	3	15	0	3	8	17	3	0	4	8	0	1	2	0	0	286
SofCB	2	4	0	11	2	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	23
PresP	1	1	0	7	1	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	16
Jurup	3	3	0	8	1	0	0	0	0	0	0	4	3	0	0	0	0	0	0	0	0	0	21
SoLaS	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Coron	0	13	0	1	3	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	22
Missi	197	8	5	12	0	2	0	0	0	0	0	0	1	0	0	3	0	0	2	5	0	0	237
E_Riv	100	24	17	2	0	5	0	1	2	4	10	0	6	0	0	6	5	0	2	6	31	0	222
S_Riv	152	3	0	11	4	1	0	0	0	0	0	2	7	0	0	2	4	0	4	1	0	0	190
W_Riv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
N_Riv	9	22	2	13	9	1	0	0	0	0	0	4	6	0	0	0	1	0	1	0	0	0	69
Orang	0	0	0	13	1	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	18
DIS18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA_Co	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
San_B	1	4	0	16	7	0	0	0	0	0	0	7	25	0	0	0	0	0	0	0	0	0	61
Santa	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1068	482	177	633	106	36	43	21	105	8	65	63	242	61	0	89	23	0	42	26	31	0	3320

Riverside Streetcar System Feasibility Study Report

Appendix N:

Modified Trackforms: Removable Panelized Track Sections

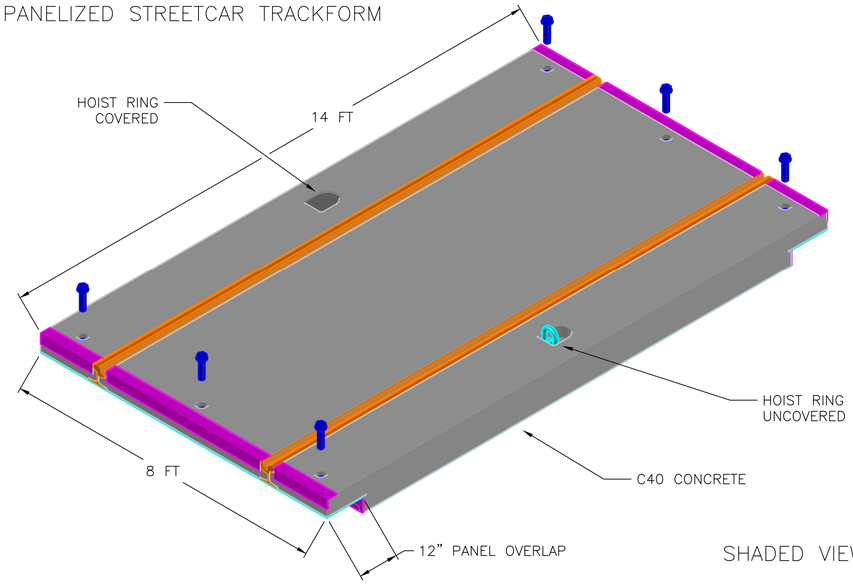
May 15, 2022

Prepared for:
The City of Riverside

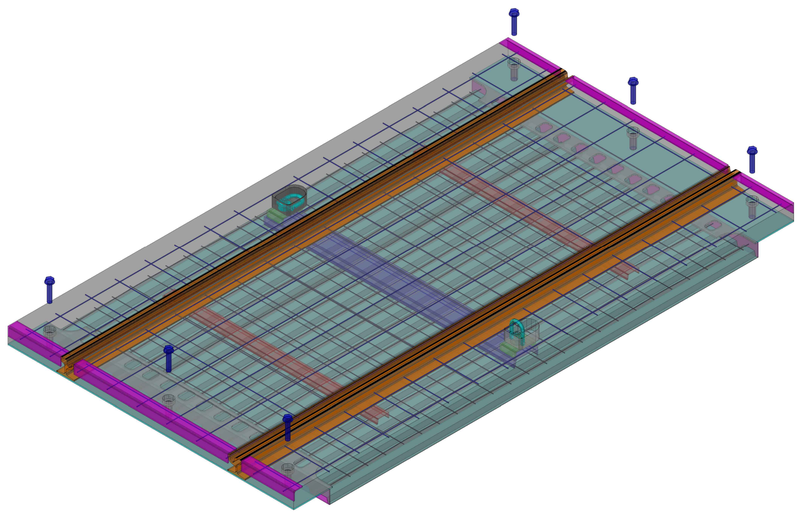
Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500

Plot Date: 2021/06/10

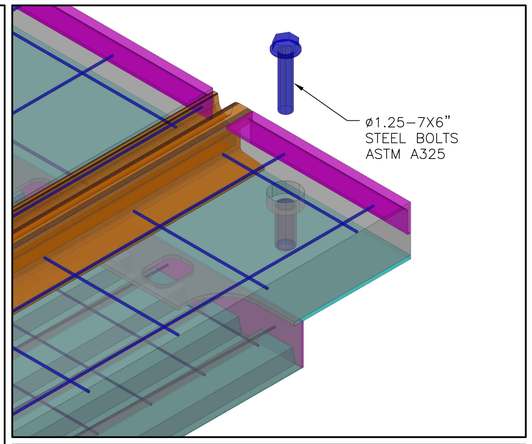
PANELIZED STREETCAR TRACKFORM

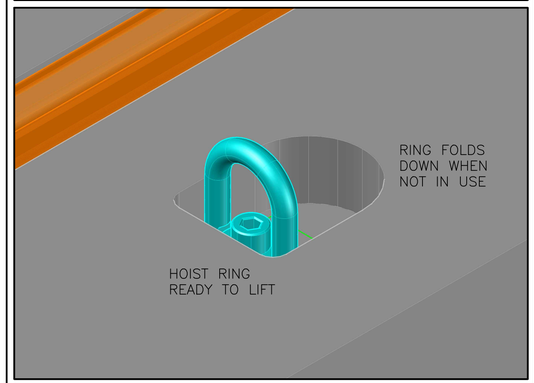


SHADED VIEW



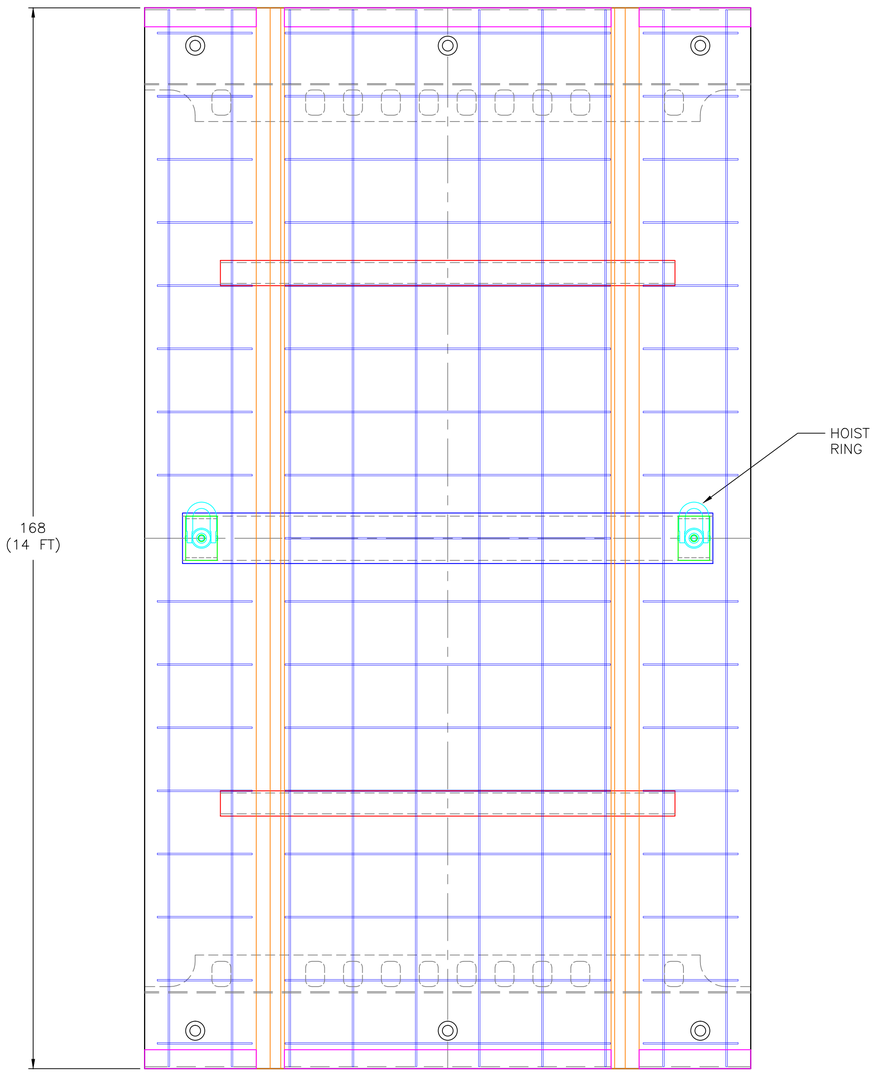
XRAY VIEW



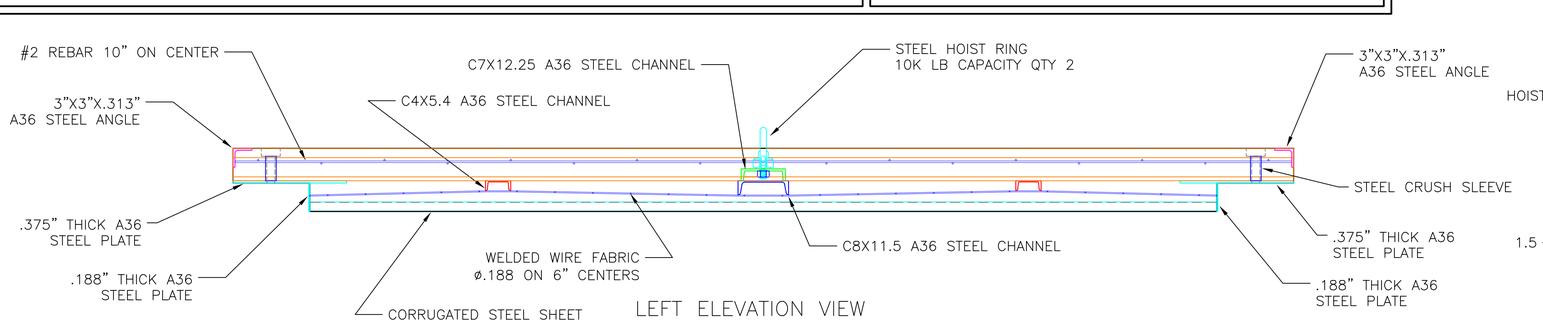


END DETAIL

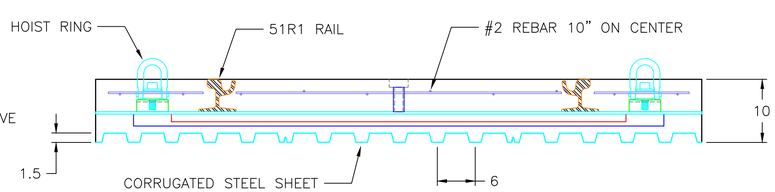
XRAY VIEWS TO SHOW INTERNAL DETAIL



PLAN VIEW



LEFT ELEVATION VIEW



FRONT ELEVATION VIEW

9160 JORDAN AVE.
CHATSWORTH
CALIFORNIA 91311
PH# 818-709-8500
FAX 818-709-8508
www.tig-m.com

TIG/m Modern Street Railways

DRAWN	BPL
CHECKED	-
APPROVED	BLR

NO	DATE	DESCRIPTION
0		

SHEET TITLE: 14 FT PANELIZED TRACKFORM DESIGN OVERVIEW

DOCUMENT CONTROL NUMBER: TIGM-4-06-DWG-143-RC-30 Rev.0 210617

PROJECT TITLE: TIG/m CIVIL ENGINEERING

DRAWING NO. RC-30

DATE	21-06-17
SCALE	NTS
SHEET	1 OF 1
REVISION NO.	0

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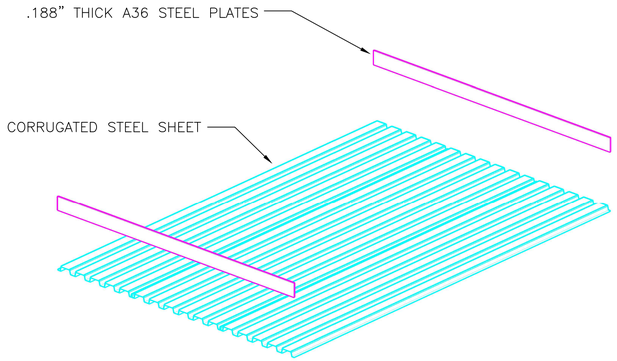
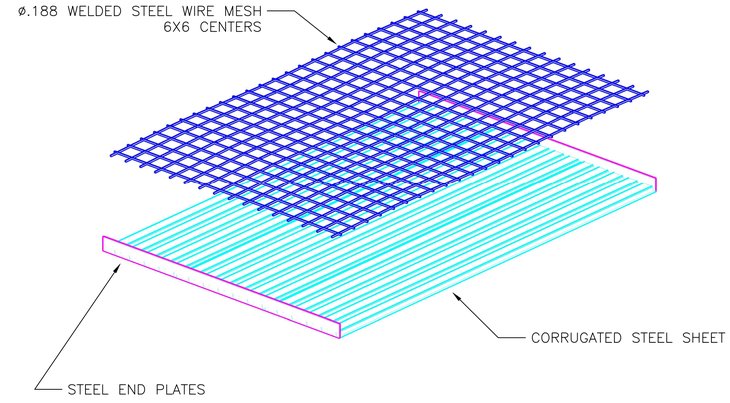
Z:\Riverside Feasibility Study\Work\CIVIL\Sketches\Panelized Track\14 Foot\RC30-RC34.dwg

Plot Date: 2021/06/10

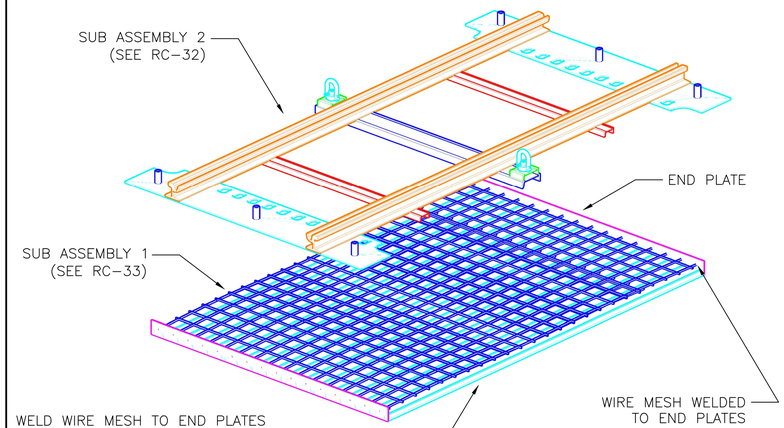


STEP 1



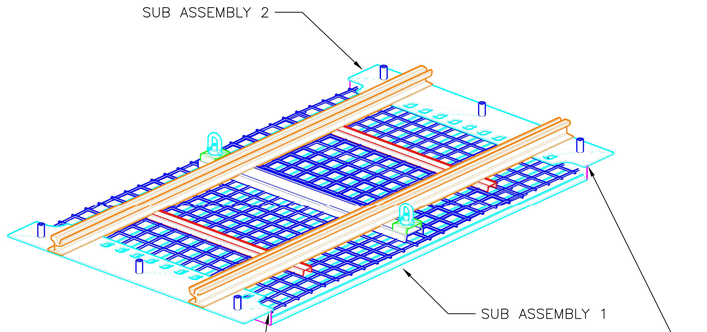
STEP 2

WELD END PLATES TO CORRUGATED SHEET



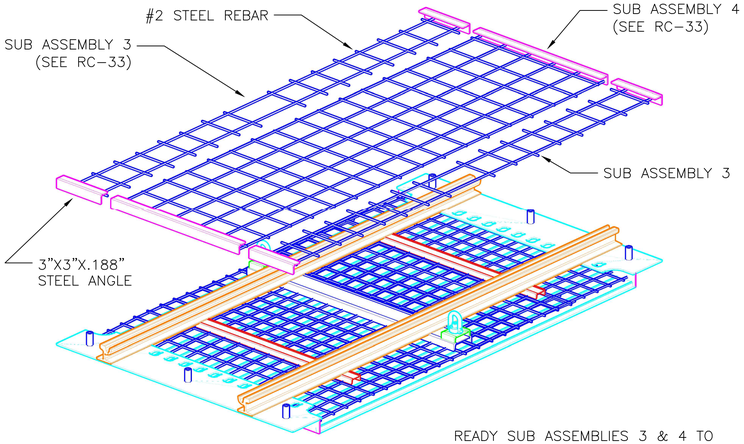
WELD WIRE MESH TO END PLATES

STEP 3



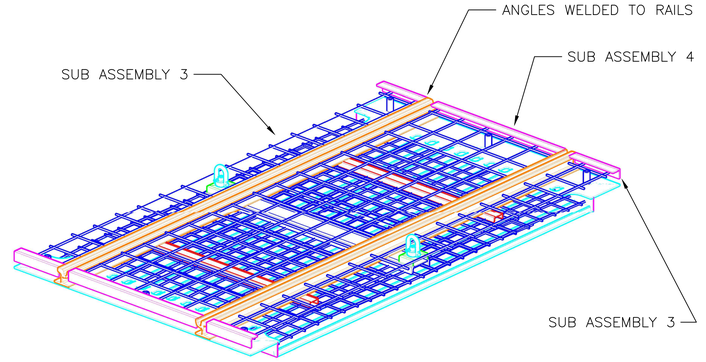
LOWER SUB ASSEMBLY 2 ONTO SUB ASSEMBLY 1 AND WELD TOGETHER

STEP 4



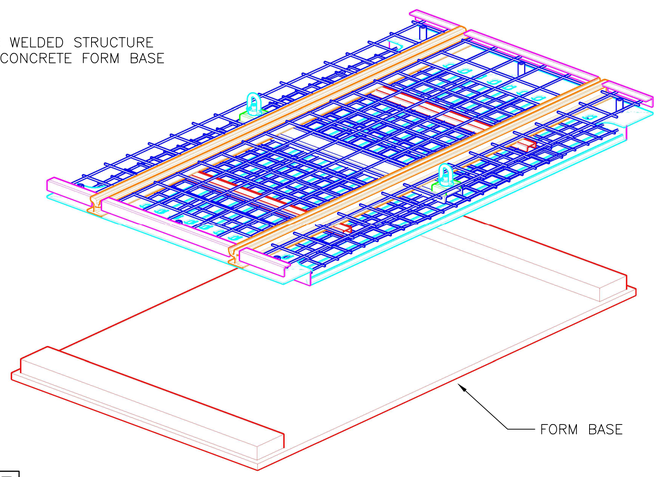
READY SUB ASSEMBLIES 3 & 4 TO
BE WELDED TO SUB ASSEMBLY 2

STEP 5

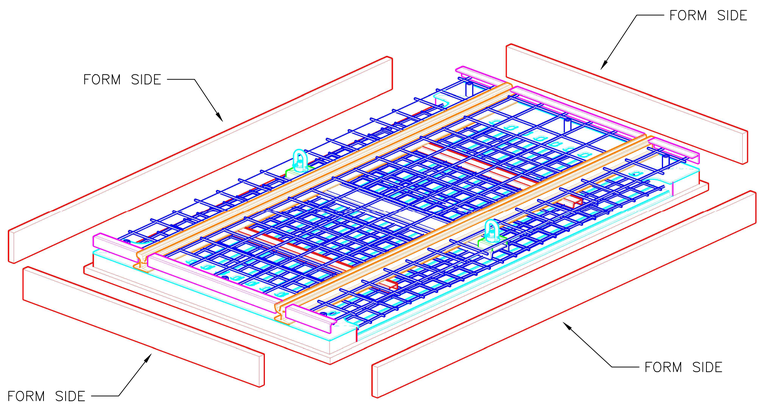


WELD SUB ASSEMBLIES 3 & 4 TO SUB ASSEMBLY 2

STEP 6

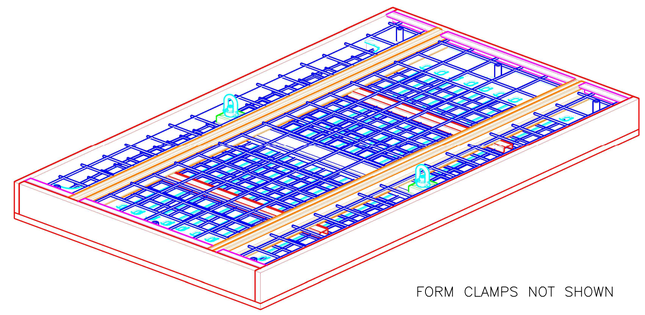


STEP 7



ADD SIDES TO CONCRETE FORM

STEP 8



FORM CLAMPS NOT SHOWN

READY FOR CONCRETE POURING

STEP 9

9160 JORDAN AVE.
CHATSWORTH
CALIFORNIA 91311
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FAX 818-709-8508
www.tig-m.com

TIG/m Modern Street Railways

DRAWN	BPL
CHECKED	-
APPROVED	BLR

NO	DATE	DESCRIPTION
0		

SHEET TITLE: ASSEMBLY PROCEDURE
14 FT PANELIZED TRACKFORM

DOCUMENT CONTROL NUMBER: TIGM-4-06-DWG-143-RC-31 Rev.0 210617

PROJECT TITLE: TIG/m CIVIL ENGINEERING

DRAWING NO. RC-31

DATE	21-06-17
SCALE	NTS
SHEET	1 OF 1
REVISION NO.	0

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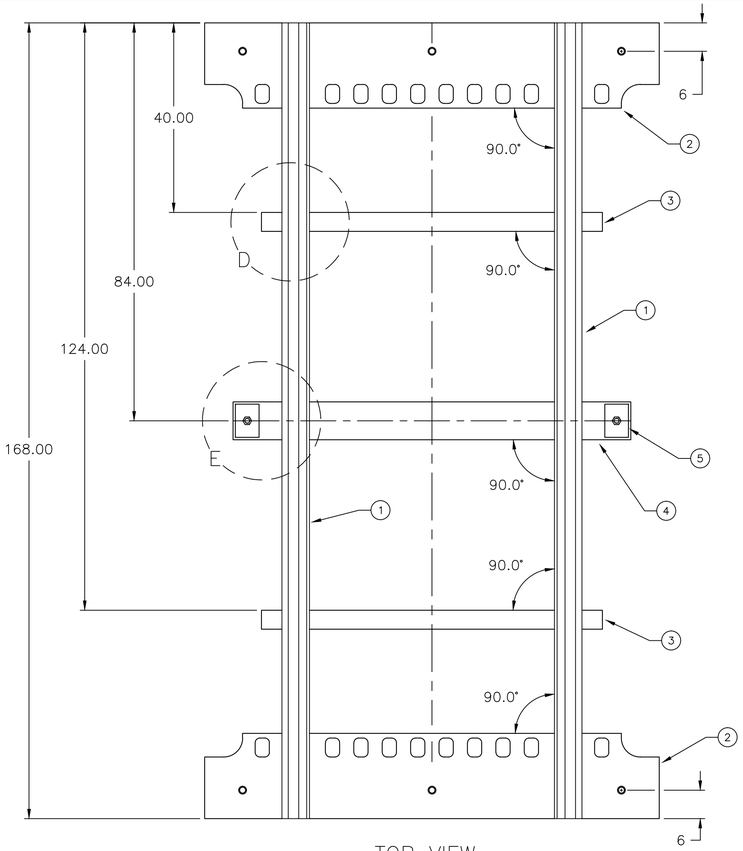
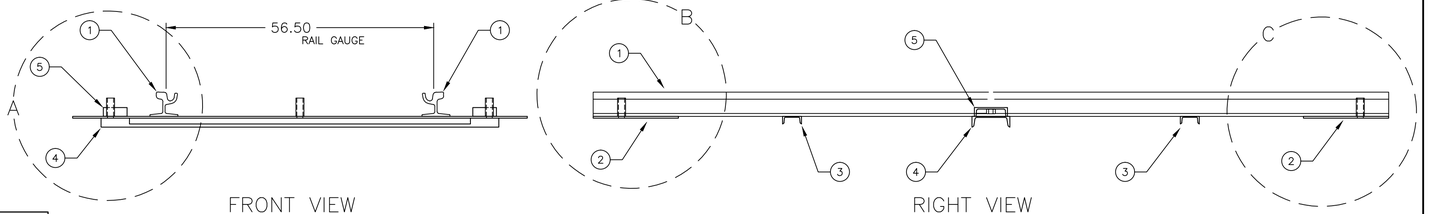
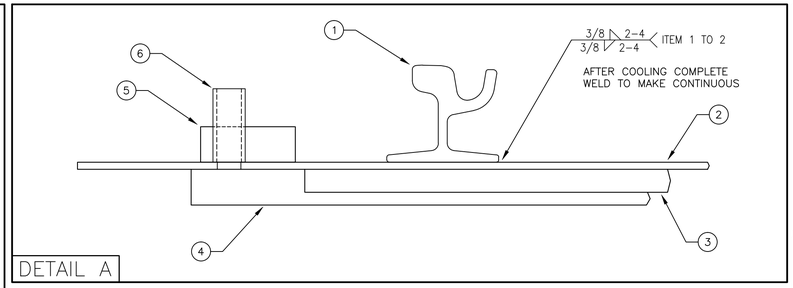
Plot Date: 2021/06/10



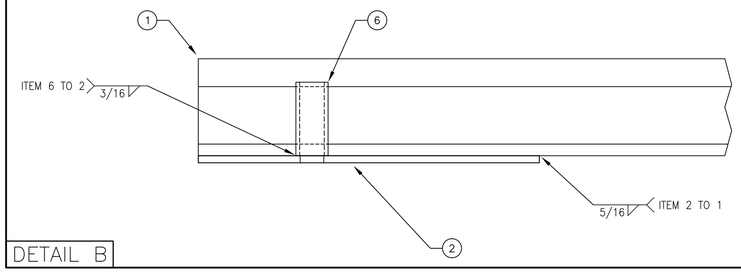
CENTER ALL PLATES AND CHANNELS
LEFT TO RIGHT TO CENTER OF RAIL GAUGE



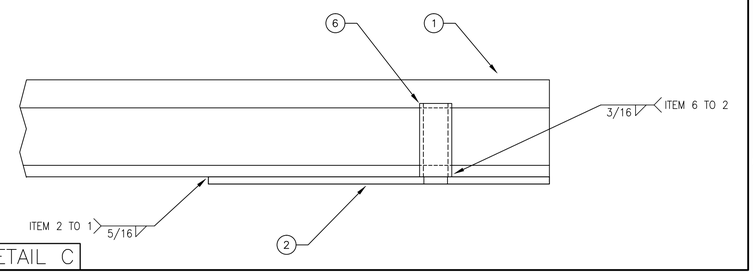
SUB ASSEMBLY 2



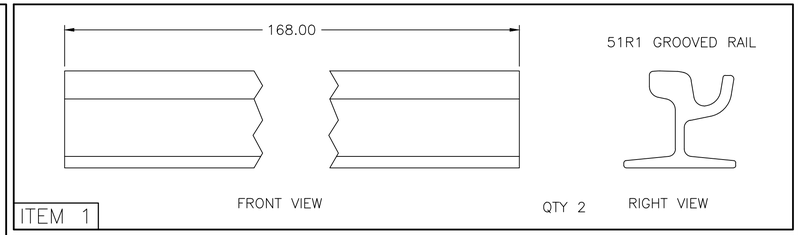
DETAIL A



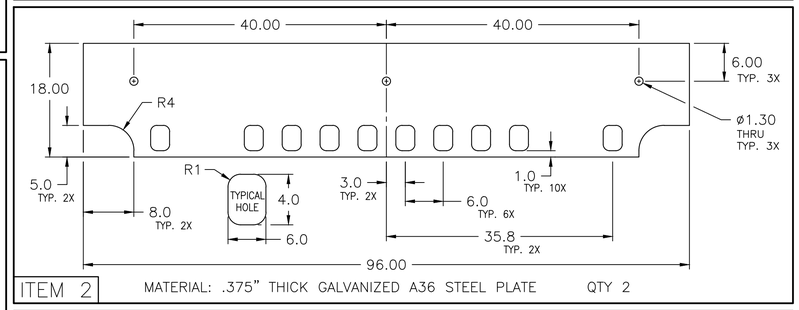
DETAIL B



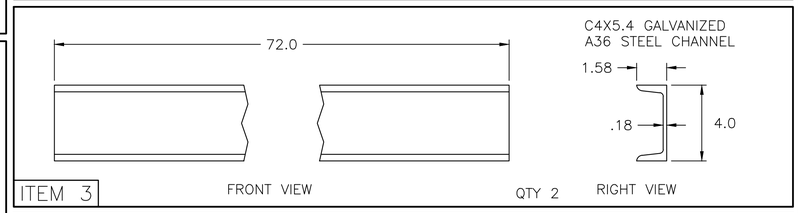
DETAIL C



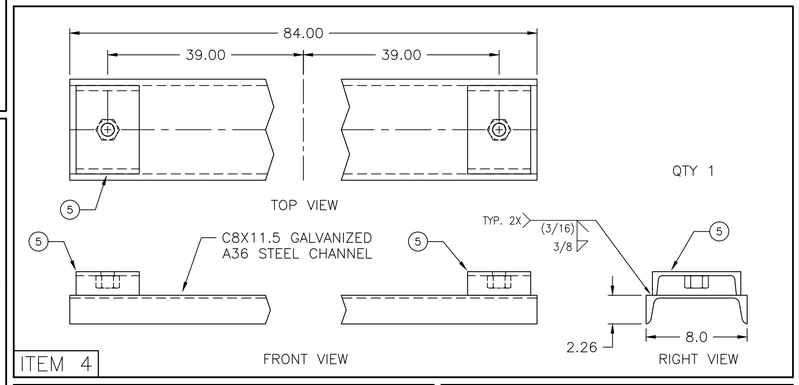
ITEM 1



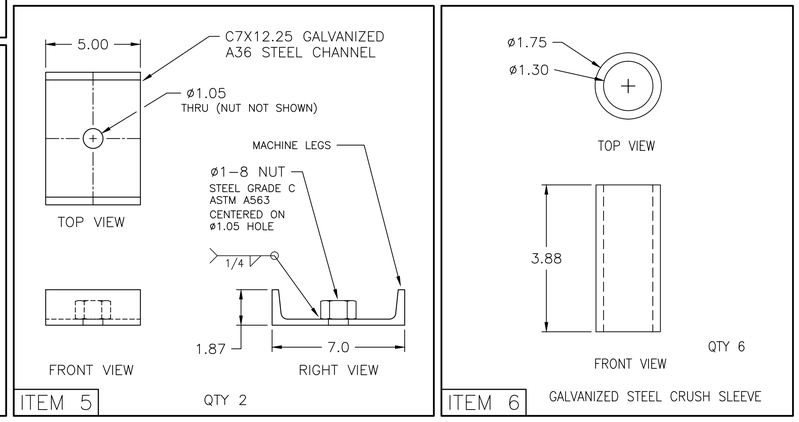
ITEM 2 MATERIAL: .375" THICK GALVANIZED A36 STEEL PLATE QTY 2



ITEM 3

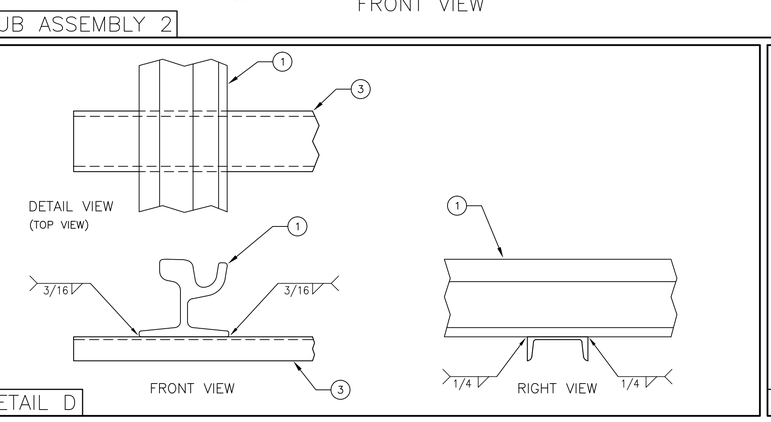


ITEM 4

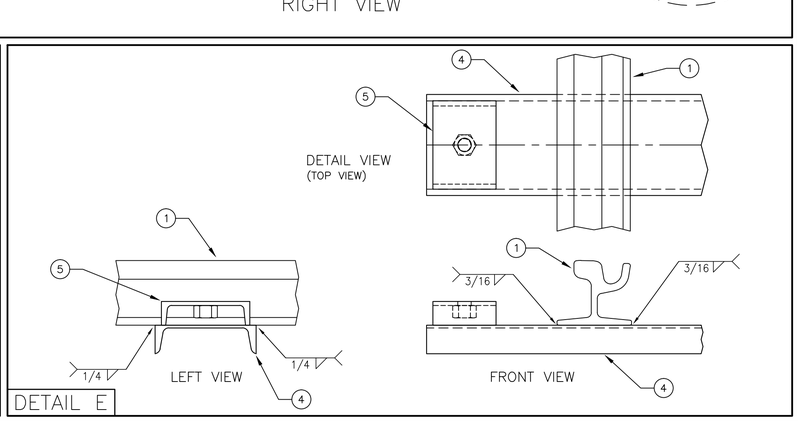


ITEM 5 QTY 2

ITEM 6 GALVANIZED STEEL CRUSH SLEEVE



DETAIL D



DETAIL E

9160 JORDAN AVE.
CHATSWORTH
CALIFORNIA 91311
PH# 818-709-8500
FAX 818-709-8508
www.tig-m.com

TIG/m Modern Street Railways

DRAWN	BPL
CHECKED	-
APPROVED	BLR

NO	DATE	DESCRIPTION
0		

SHEET TITLE: SUB ASSEMBLY 2
14 FT PANELIZED TRACKFORM

DOCUMENT CONTROL NUMBER: TIGM-4-06-DWG-143-RC-32 Rev.0 210617

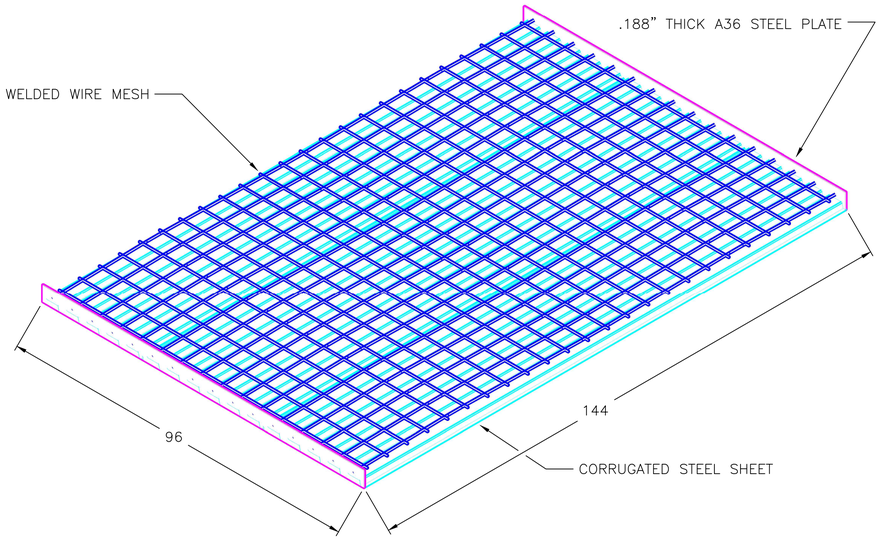
PROJECT TITLE: TIG/m CIVIL ENGINEERING

DRAWING NO.	RC-32
DATE	21-06-17
SCALE	NTS
SHEET	1 OF 1
REVISION NO.	0

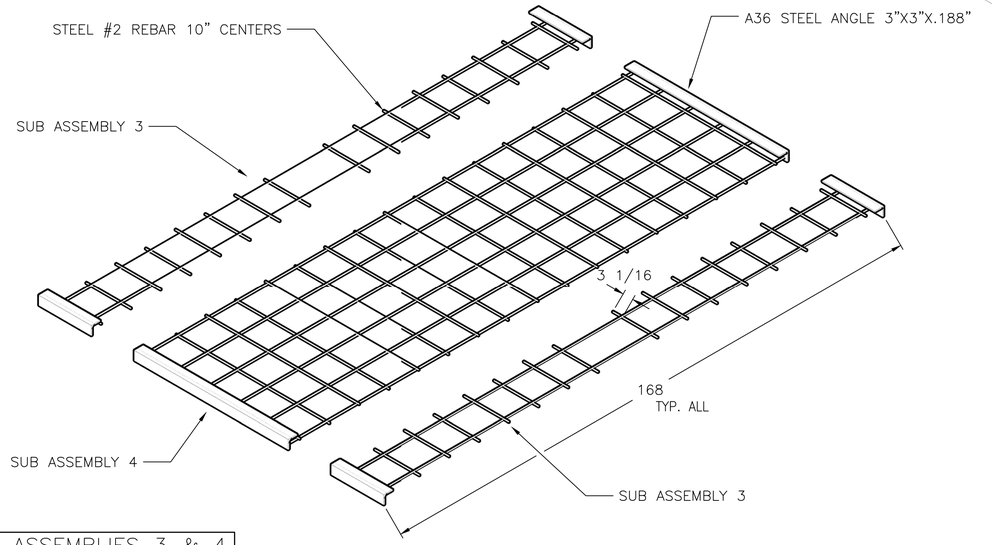
ANY USE OF PANELIZED TRACKFORM DESIGNS, TRACK SYSTEMS, AND/OR DRAWINGS BY ANY PERSON OR ENTITY FOR ANY PURPOSE OTHER THAN THE CONSTRUCTION OF THE PANELIZED TRACKFORM SYSTEM AS DESIGNED BY TIG/m CIVIL ENGINEERING IS PROHIBITED WITHOUT THE EXPRESS WRITTEN PERMISSION OF TIG/m CIVIL ENGINEERING.

Z:\Riverside Feasibility Study\Work\CIVIL\Sketches\Panelized Track\14 Foot\RC30-RC34.dwg

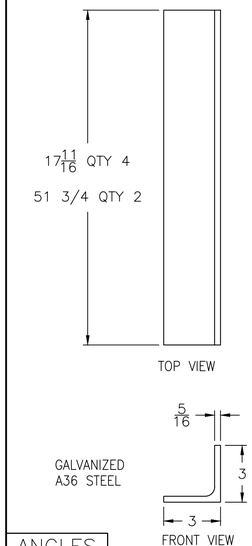
Plot Date: 2021/06/10



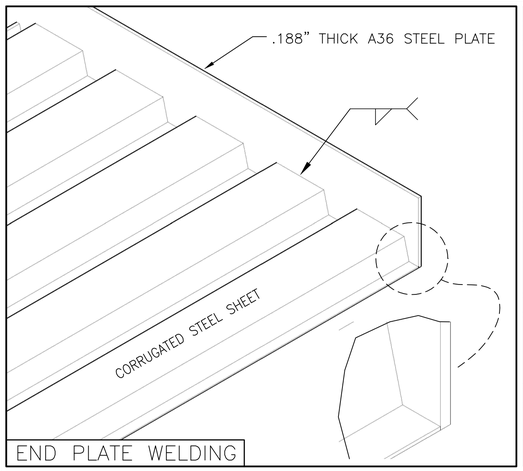
SUB ASSEMBLY 1



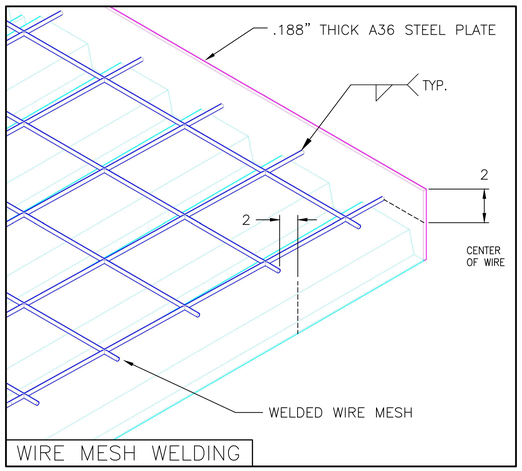
SUB ASSEMBLIES 3 & 4



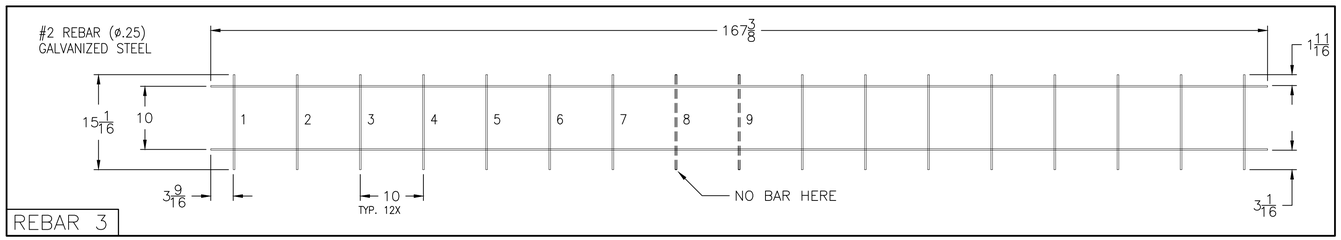
ANGLES



END PLATE WELDING



WIRE MESH WELDING



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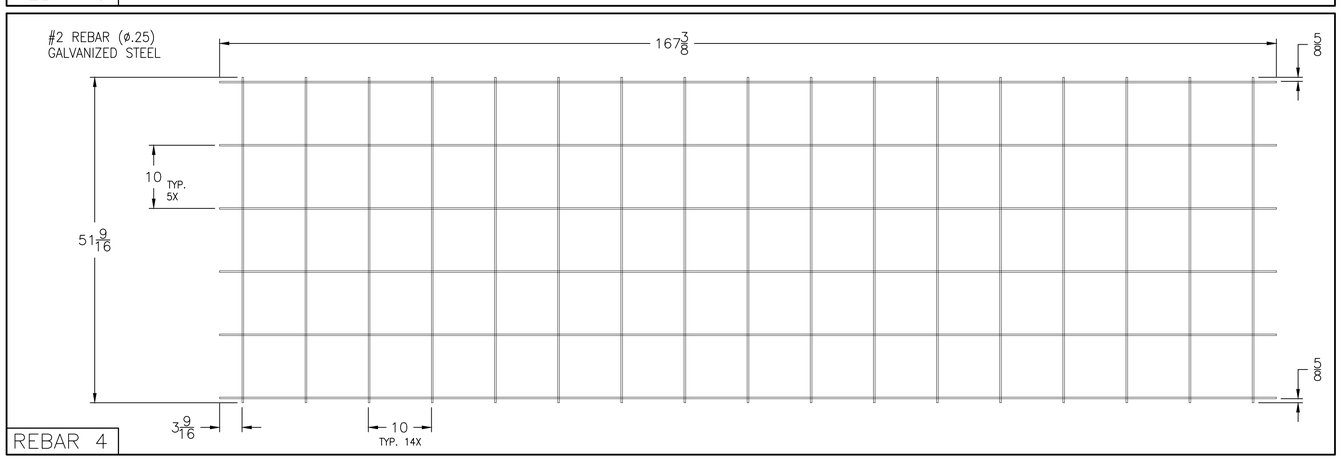

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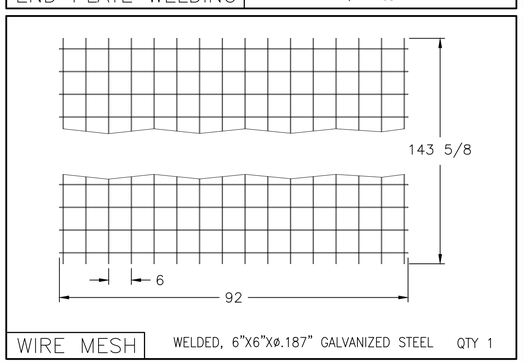
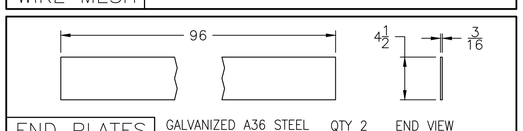
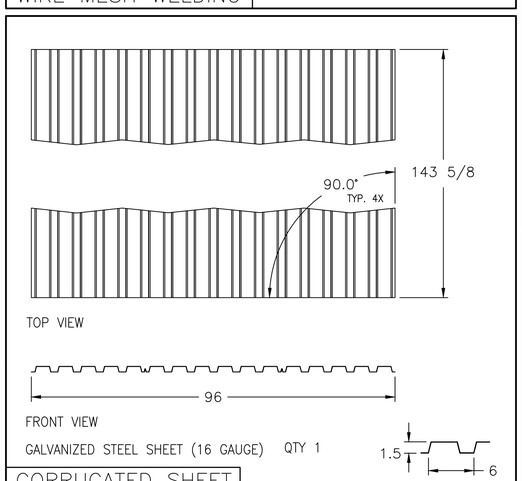


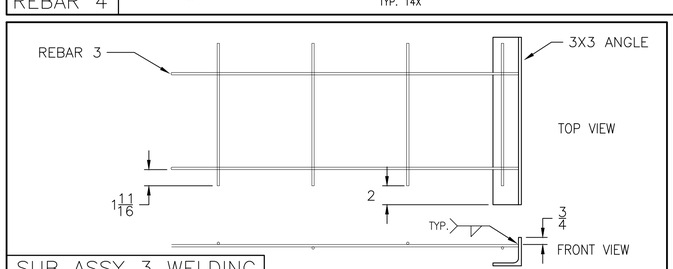
WIRE MESH WELDED, 6"X6"Xø.187" GALVANIZED STEEL QTY 1



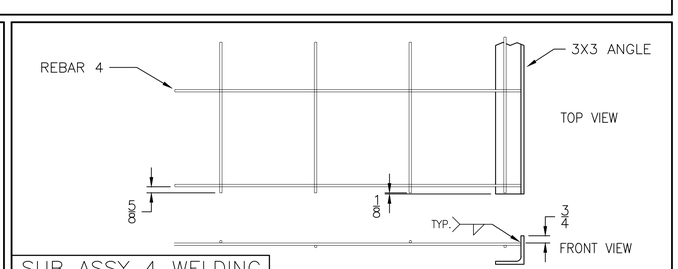
END PLATES GALVANIZED A36 STEEL QTY 2 END VIEW



CORRUGATED SHEET GALVANIZED STEEL SHEET (16 GAUGE) QTY 1



SUB ASSY 3 WELDING



SUB ASSY 4 WELDING

9160 JORDAN AVE.
CHATSWORTH
CALIFORNIA 91311
PHH 818-709-8500
FAX 818-709-8508
www.tig-m.com

TIG/m Modern Street Railways

NO	DATE	DESCRIPTION
A		
A		
A		
A		
A		
A		

DRAWN BPL
CHECKED -
APPROVED BLR

SHEET TITLE: SUB ASSEMBLIES 1,3, & 4
14 FT PANELIZED TRACKFORM

DOCUMENT CONTROL NUMBER: TIGM-4-06-DWG-143-RC-33 Rev.0 210617

PROJECT TITLE: TIG/m CIVIL ENGINEERING

DRAWING NO. RC-33
DATE 21-06-17
SCALE NTS
SHEET 1 OF 1
REVISION NO. 0

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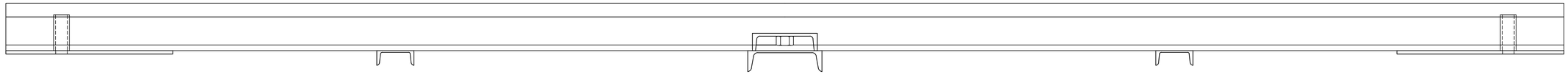
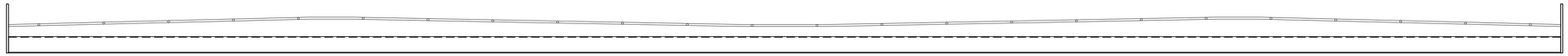
Plot Date: 2021/06/10

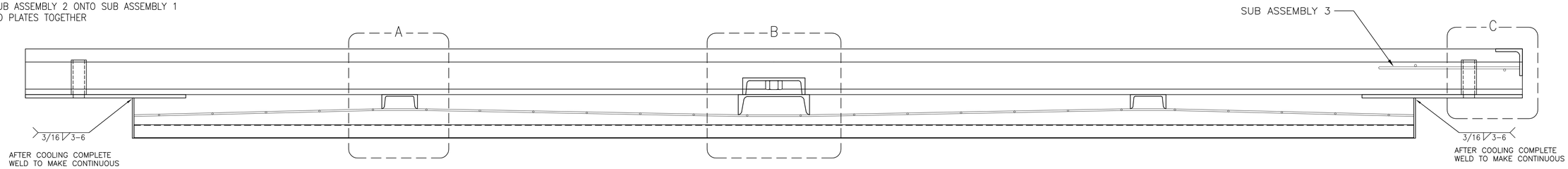


SUB ASSEMBLY 2



SUB ASSEMBLY 1

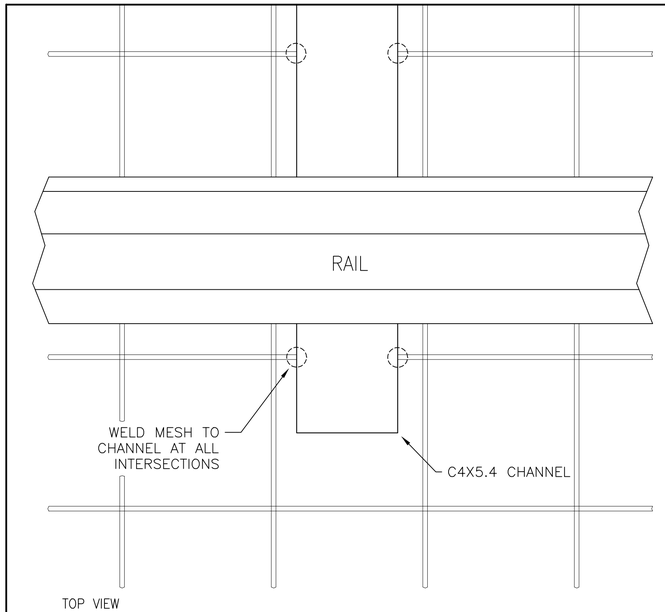
LOWER SUB ASSEMBLY 2 ONTO SUB ASSEMBLY 1
AND WELD PLATES TOGETHER



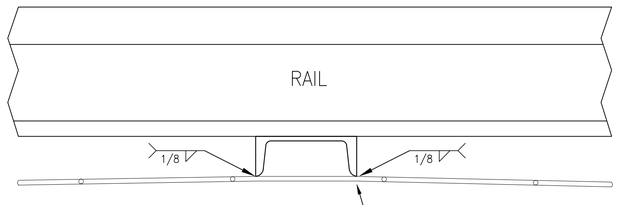
AFTER COOLING COMPLETE
WELD TO MAKE CONTINUOUS

AFTER COOLING COMPLETE
WELD TO MAKE CONTINUOUS

WELDING SUB ASSEMBLY 2 TO SUB ASSEMBLY 1



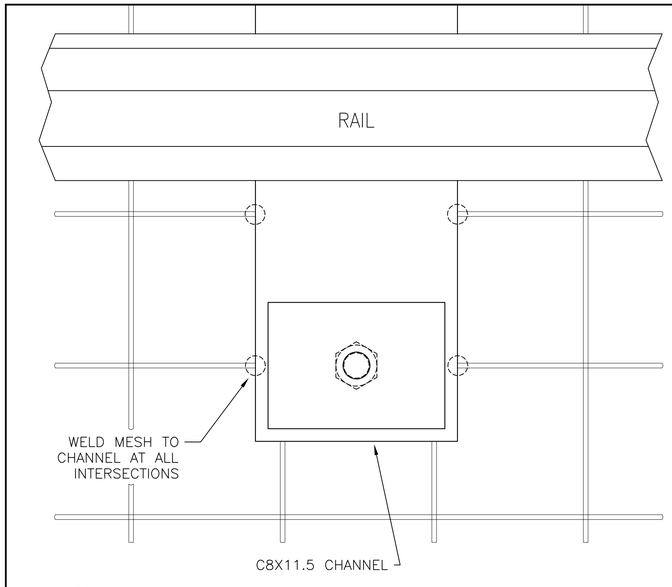
TOP VIEW



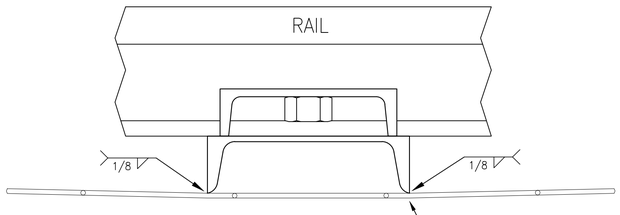
DETAIL (FRONT) VIEW

CLAMP WIRE MESH TO
CHANNEL AND WELD

DETAIL A



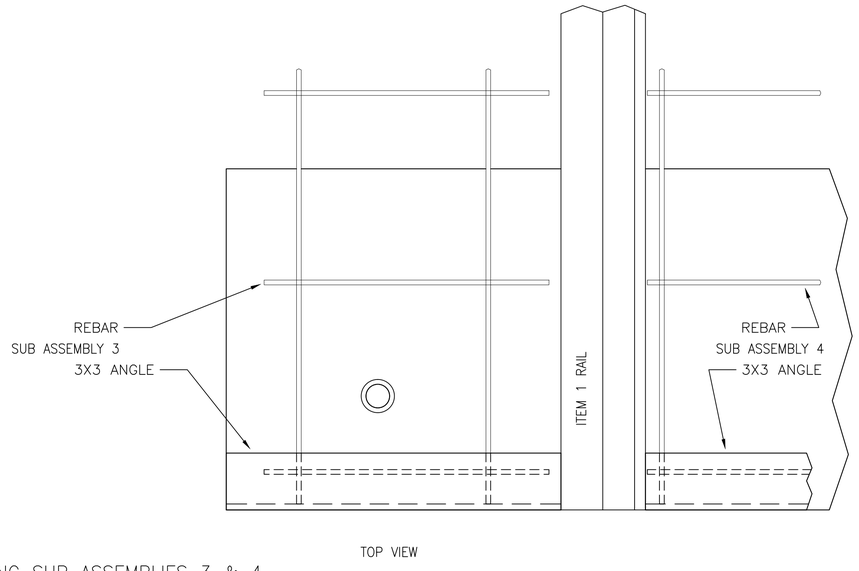
TOP VIEW



DETAIL (FRONT) VIEW

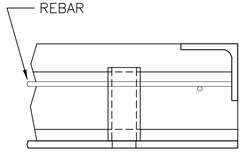
CLAMP WIRE MESH TO
CHANNEL AND WELD

DETAIL B

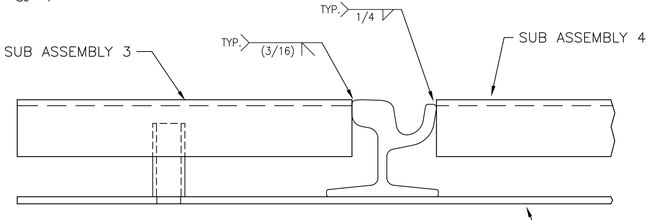


TOP VIEW

WELDING SUB ASSEMBLIES 3 & 4
TO ITEM 1 RAILS



DETAIL (FRONT) VIEW



RIGHT VIEW

ITEM 2 STEEL PLATE

DETAIL C

9160 JORDAN AVE.
CHATSWORTH
CALIFORNIA 91311
PH# 818-709-8500
FAX 818-709-8508
www.tig-m.com

TIG/m Modern Street Railways

DRAWN	BPL
CHECKED	-
APPROVED	BLR

NO	DATE	DESCRIPTION
0		

SHEET TITLE: WELDING DETAILS
14 FT PANELIZED TRACKFORM

DOCUMENT CONTROL NUMBER: TIGM-4-06-DWG-143-RC-34 Rev.0 210617

PROJECT TITLE: TIG/m CIVIL ENGINEERING

DRAWING NO. RC-34

DATE	21-06-17
SCALE	NTS
SHEET	1 OF 1
REVISION NO.	0

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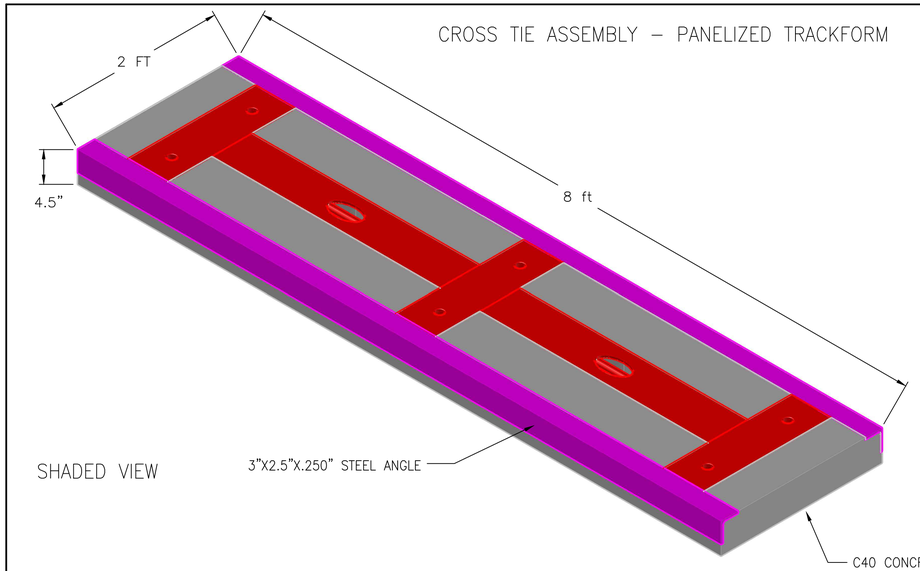
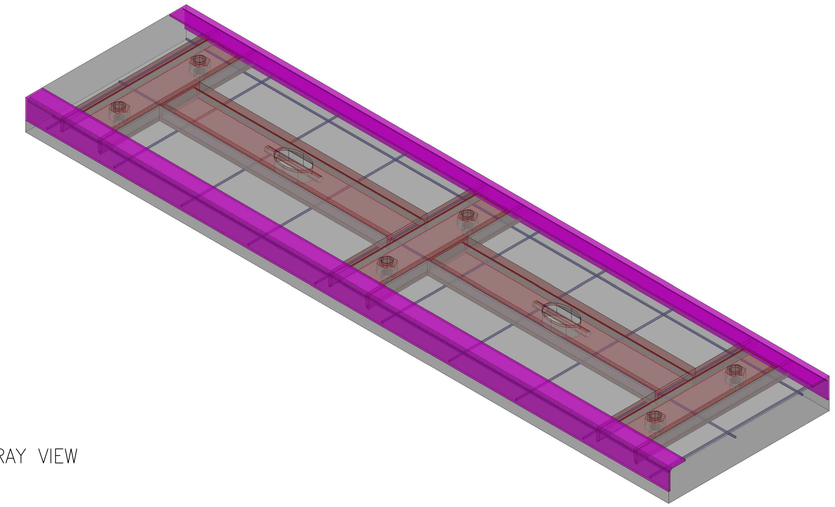
Plot Date: 2021/06/10

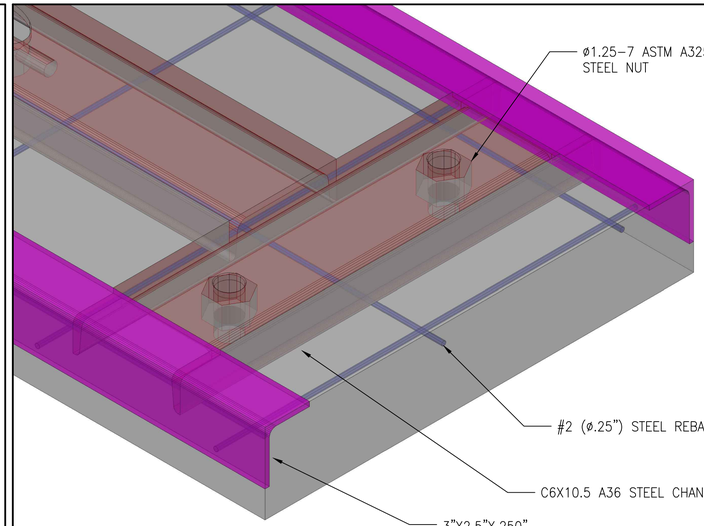
CROSS TIE ASSEMBLY – PANELIZED TRACKFORM

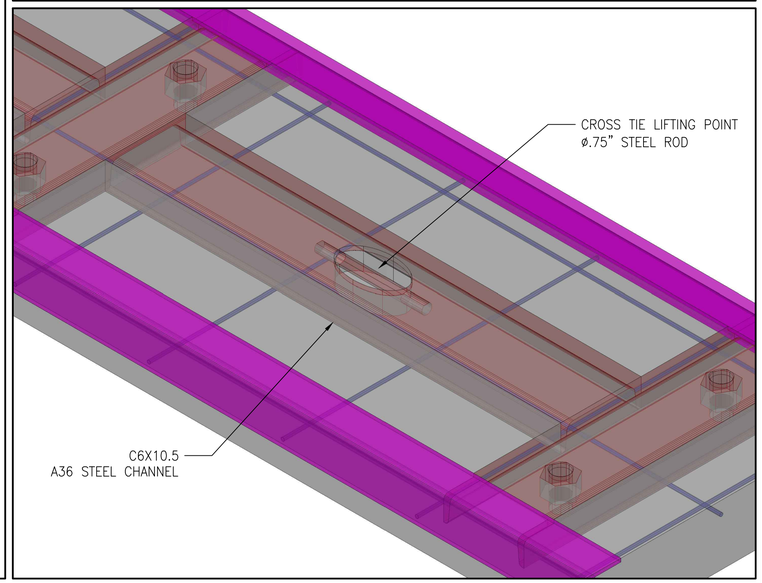


SHADED VIEW

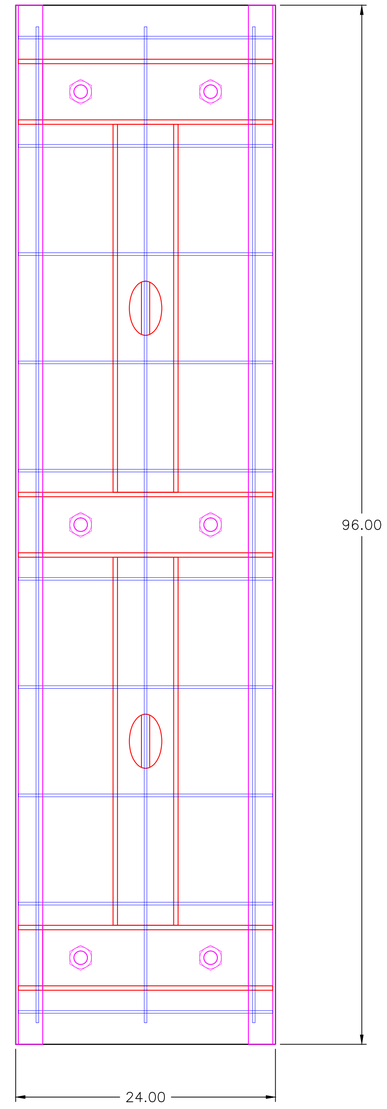


XRAY VIEW

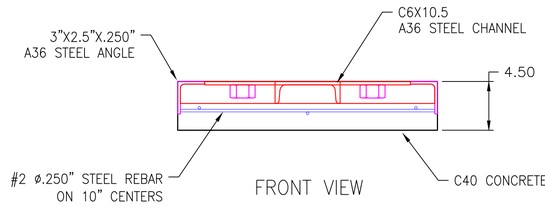




XRAY VIEWS TO SHOW INTERNAL DETAIL

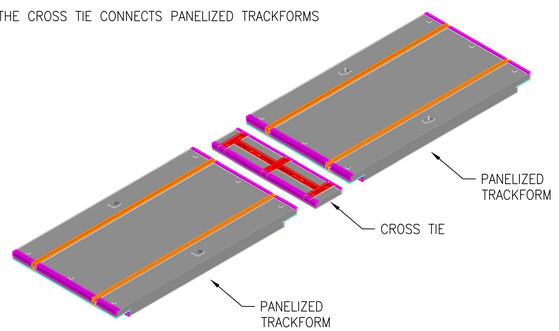


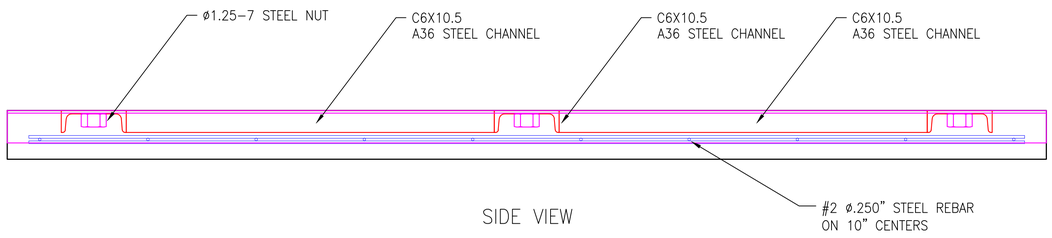
TOP VIEW



FRONT VIEW

THE CROSS TIE CONNECTS PANELIZED TRACKFORMS





SIDE VIEW

2D OVERVIEW

9160 JORDAN AVE.
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CALIFORNIA 91311
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DRAWN	BPL
CHECKED	-
APPROVED	BLR

NO	DATE	DESCRIPTION

NO	DATE	DESCRIPTION

SHEET TITLE: CROSS TIE ASSEMBLY PANELIZED TRACKFORM

DOCUMENT CONTROL NUMBER: TIGM-4-06-DWG-143-RC-40 Rev.0 210617

PROJECT TITLE: TIG/m CIVIL ENGINEERING

DRAWING NO. RC-40

DATE	21-06-17
SCALE	NTS
SHEET	1 OF 1
REVISION NO.	0

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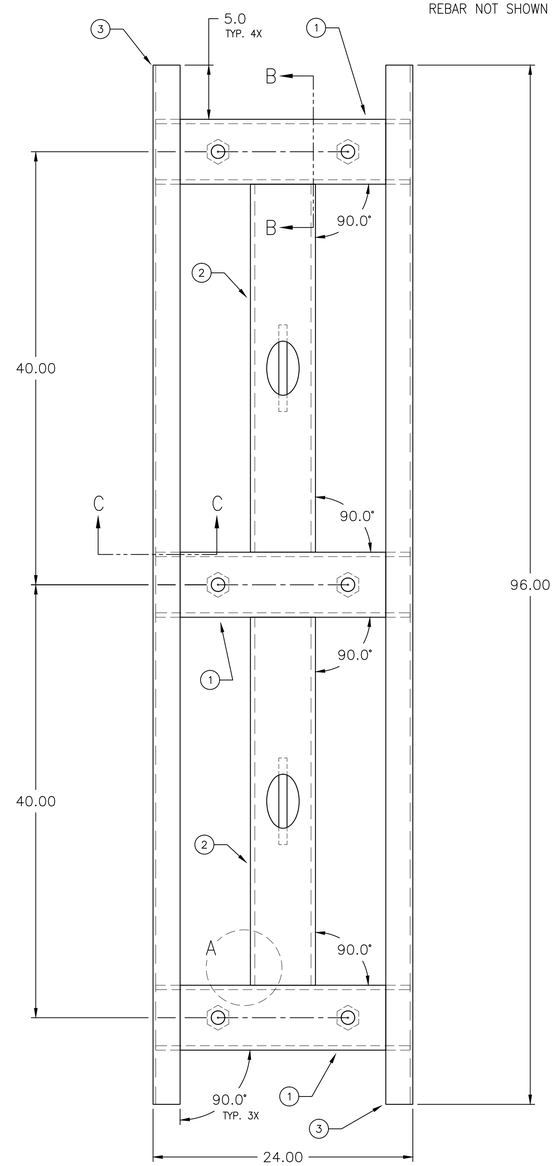
Z:\Riverside Feasibility Study\Work\CIVIL\Sketches\Panelized Track\Cross Tie\RC40-RC41.dwg

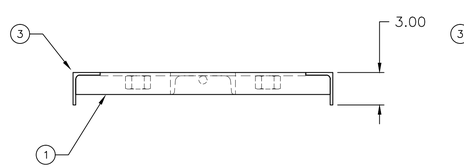
Plot Date: 2021/06/10

CROSS TIE STRUCTURE (PRIOR TO CONCRETE POUR)

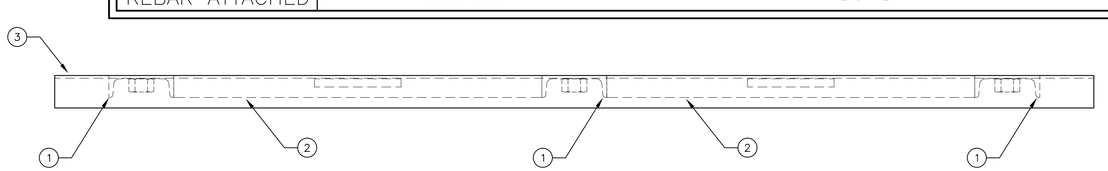
REBAR NOT SHOWN



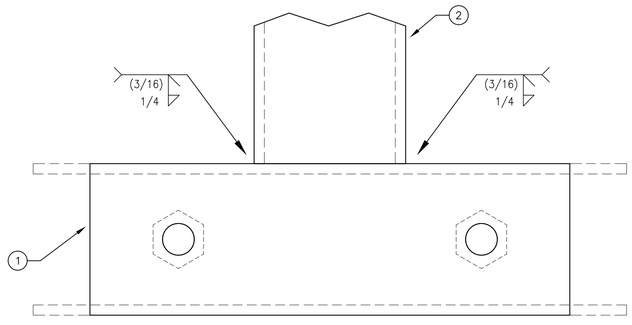
TOP VIEW



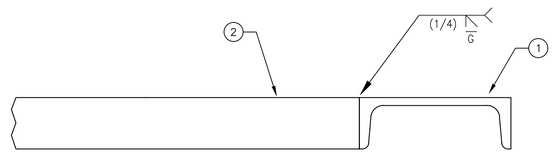
FRONT VIEW



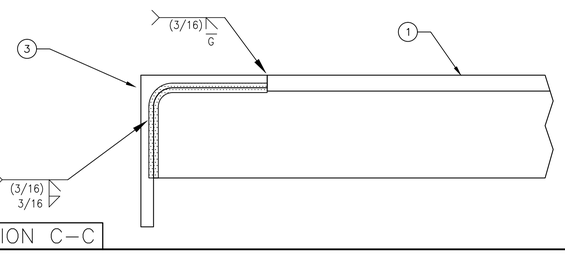
SIDE VIEW



DETAIL A



SECTION B–B



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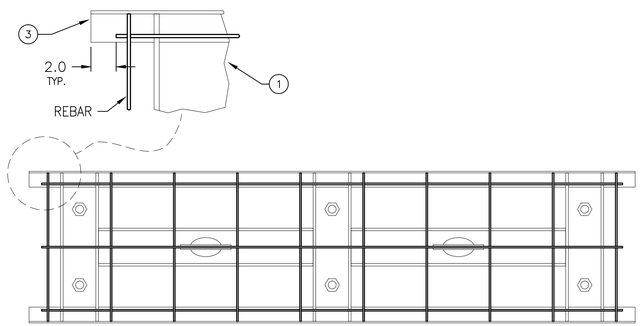
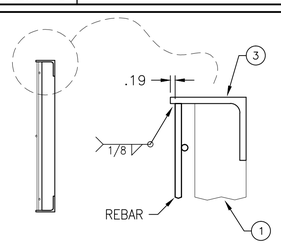
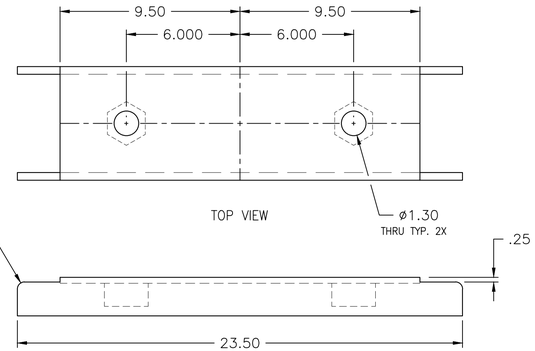


REBAR ATTACHED

BOTTOM VIEW



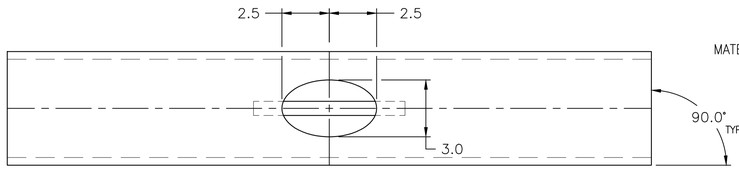
END VIEW



MATERIAL: C6X10.5 GALVANIZED
A36 STEEL CHANNEL

QTY 3

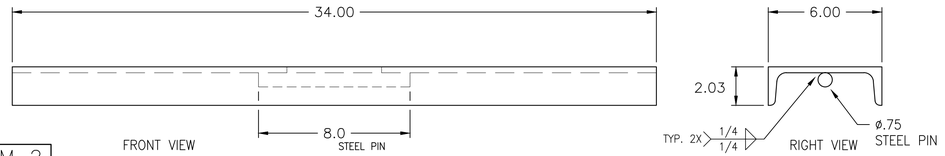
ITEM 1



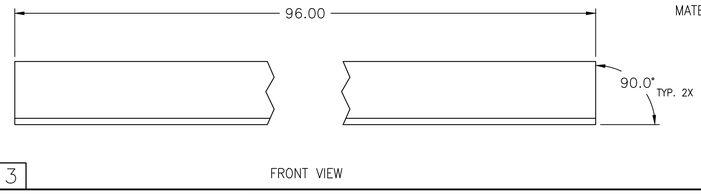
TOP VIEW

MATERIAL: C6X10.5 GALVANIZED
A36 STEEL CHANNEL

QTY 2



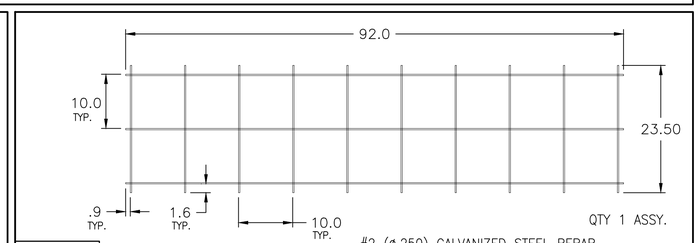
ITEM 2



MATERIAL: GALVANIZED A36 STEEL

QTY 2

ITEM 3



#2 (ø.250) GALVANIZED STEEL REBAR

REBAR

9160 JORDAN AVE.
CHATSWORTH
CALIFORNIA 91311
PH# 818-709-8500
FAX 818-709-8508
www.tig-m.com

Modern Street Railways

DRAWN	BPL
CHECKED	-
APPROVED	BLR

NO.	DATE	DESCRIPTION
A		

NO.	DATE	DESCRIPTION
A		

SHEET TITLE: CROSS TIE ASSEMBLY DETAILS PANELIZED TRACKFORM

DOCUMENT CONTROL NUMBER: TIGM-4-06-DWG-143-RC-41 Rev.0 210617

PROJECT TITLE: TIG/m CIVIL ENGINEERING

DRAWING NO.	RC-41
DATE	21-06-17
SCALE	NTS
SHEET	1 OF 1
REVISION NO.	0

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Riverside Streetcar System Feasibility Study Report

Appendix O:

Project Cost Model

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500

TIG/m ViaTran
The art of transportation

RIVERSIDE STREETCAR SYSTEM
ROM PROJECT COST MODEL (TIG/m)

YEAR	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	Total Expense	Total Revenue
CAPEX	$44,280,667	$44,280,667	$44,280,667																																$132,842,001	
OPEX				$5,067,534	$4,615,940	$4,615,940	$4,615,940	$4,615,940	$5,077,534	$5,077,534	$5,077,534	$5,077,534	$5,585,287	$5,585,287	$5,585,287	$5,585,287	$6,143,816	$6,143,816	$6,143,816	$6,143,816	$6,758,198	$6,758,198	$6,758,198	$6,758,198	$7,434,018	$7,434,018	$7,434,018	$7,434,018	$8,177,419	$8,177,419	$8,177,419	$8,177,419	$8,995,161	$8,995,161	$198,226,705	
Capacity (PPY) @AW-1 *	4,975,200	Number of Passengers/Tram		12	12	13	14	14	15	16	16	17	17	18	19	20	21	22	23	23	25	26	27	28	29	30	31	32	33	34	35	36	37	38		
% of AW-1 Capacity Used				36%	37%	39%	41%	43%	45%	47%	49%	51%	53%	55%	59%	62%	65%	68%	71%	74%	77%	80%	83%	87%	90%	93%	96%	99%	102%	105%	107%	110%	113%	116%		
Estimated Ridership (PPY)				1,814,953	1,840,824	1,940,328	2,039,832	2,139,336	2,238,840	2,338,344	2,437,848	2,537,352	2,636,856	2,736,360	2,935,368	3,084,624	3,233,880	3,383,136	3,532,392	3,681,648	3,830,904	3,980,160	4,129,416	4,328,424	4,477,680	4,626,936	4,776,192	4,925,448	5,074,704	5,223,960	5,323,464	5,472,720	5,621,976	5,771,232		
Fare Box Charge				$2.00	$2.00	$2.00	$2.00	$2.25	$2.25	$2.25	$2.25	$2.50	$2.50	$2.50	$2.50	$2.75	$2.75	$2.75	$2.75	$3.00	$3.00	$3.00	$3.00	$3.25	$3.25	$3.25	$3.25	$3.50	$3.50	$3.50	$3.50	$3.75	$3.75	$3.75		
Revenue - Fare Box				$3,629,906	$3,681,648	$3,880,656	$4,079,664	$4,813,506	$5,037,390	$5,261,274	$5,485,158	$6,343,380	$6,592,140	$6,840,900	$7,338,420	$8,482,716	$8,893,170	$9,303,624	$9,714,078	$11,044,944	$11,492,712	$11,940,480	$12,388,248	$14,067,378	$14,552,460	$15,037,542	$15,522,624	$17,239,068	$17,761,464	$18,283,860	$18,632,124	$20,522,700	$21,082,410	$21,642,120		
Revenue Advertising				$1,440,000	$1,440,000	$1,440,000	$1,440,000	$1,512,000	$1,512,000	$1,512,000	$1,512,000	$1,587,600	$1,587,600	$1,587,600	$1,587,600	$1,666,980	$1,666,980	$1,666,980	$1,666,980	$1,750,329	$1,750,329	$1,750,329	$1,750,329	$1,837,845	$1,837,845	$1,837,845	$1,837,845	$1,837,845	$1,929,737	$1,929,737	$1,929,737	$1,929,737	$2,026,223	$2,026,223	$2,026,223		
At Stations																																				
Revenue Sponsorships				$300,000	$300,000	$300,000	$300,000	$315,000	$315,000	$315,000	$315,000	$330,750	$330,750	$330,750	$330,750	$347,287	$347,287	$347,287	$347,287	$364,651	$364,651	$364,651	$364,651	$382,884	$382,884	$382,884	$382,884	$402,028	$402,028	$402,028	$402,028	$422,130	$422,130	$422,130		
of Trams																																				
Total Operational Revenue				$5,369,906	$5,421,648	$5,620,656	$5,819,664	$6,640,506	$6,864,390	$7,088,274	$7,312,158	$8,261,730	$8,510,490	$8,759,250	$9,256,770	$10,496,983	$10,907,437	$11,317,891	$11,728,345	$13,159,924	$13,607,692	$14,055,460	$14,503,228	$16,288,107	$16,773,189	$17,258,271	$17,743,353	$19,570,833	$20,093,229	$20,615,625	$20,963,889	$22,971,053	$23,530,763	$24,090,473		$404,601,187
Loan Amount**	$132,842,000	$0	$0	$128,413,933	$123,985,866	$119,557,799	$115,129,732	$110,701,665	$106,273,598	$101,845,531	$97,417,464	$92,989,397	$88,561,330	$84,133,263	$79,705,196	$75,277,129	$70,849,062	$66,420,995	$61,992,928	$57,564,861	$53,136,794	$48,708,727	$44,280,660	$39,852,593	$35,424,526	$30,996,459	$26,568,392	$22,140,325	$17,712,258	$13,284,191	$8,856,124	$4,428,057	$0	$0		
Principal Payments	$0	$0	$0	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$4,428,067	$0		
Interest Payments (@4%)	$0	$0	$0	$5,136,557	$4,959,435	$4,782,312	$4,605,189	$4,428,067	$4,250,944	$4,073,821	$3,896,699	$3,719,576	$3,542,453	$3,365,331	$3,188,208	$3,011,085	$2,833,962	$2,656,840	$2,479,717	$2,302,594	$2,125,472	$1,948,349	$1,771,226	$1,594,104	$1,416,981	$1,239,858	$1,062,736	$885,613	$708,490	$531,368	$354,245	$177,122	$0	$0	$77,048,354	
OPEX Costs (Line 7)	$0	$0	$0	$5,067,534	$4,615,940	$4,615,940	$4,615,940	$4,615,940	$5,077,534	$5,077,534	$5,077,534	$5,077,534	$5,585,287	$5,585,287	$5,585,287	$5,585,287	$6,143,816	$6,143,816	$6,143,816	$6,143,816	$6,758,198	$6,758,198	$6,758,198	$6,758,198	$7,434,018	$7,434,018	$7,434,018	$7,434,018	$8,177,419	$8,177,419	$8,177,419	$8,177,419	$8,995,161	$8,995,161		
Total Annual Expense	$0	$0	$0	$14,632,158	$14,003,442	$13,826,319	$13,649,196	$13,472,074	$13,756,545	$13,579,422	$13,402,300	$13,225,177	$13,555,808	$13,378,685	$13,201,562	$13,024,440	$13,405,846	$13,228,723	$13,051,600	$12,874,478	$13,311,737	$13,134,614	$12,957,491	$12,780,368	$13,279,066	$13,101,943	$12,924,820	$12,747,698	$13,313,977	$13,136,854	$12,959,731	$12,782,609	$13,423,228	$8,995,161		
Annual Income (TOR)	$0	$0	$0	$5,369,906	$5,421,648	$5,620,656	$5,819,664	$6,640,506	$6,864,390	$7,088,274	$7,312,158	$8,261,730	$8,510,490	$8,759,250	$9,256,770	$10,496,983	$10,907,437	$11,317,891	$11,728,345	$13,159,924	$13,607,692	$14,055,460	$14,503,228	$16,288,107	$16,773,189	$17,258,271	$17,743,353	$19,570,833	$20,093,229	$20,615,625	$20,963,889	$22,971,053	$23,530,763	$24,090,473		
Annual Net	$0	$0	$0	-$9,262,252	-$8,581,794	-$8,205,663	-$7,829,532	-$6,831,568	-$6,892,155	-$6,491,148	-$6,090,142	-$4,963,447	-$5,045,318	-$4,619,435	-$3,944,792	-$2,527,457	-$2,498,409	-$1,910,832	-$1,323,255	$285,446	$295,955	$920,846	$1,545,737	$3,507,739	$3,494,123	$4,156,328	$4,818,533	$6,823,135	$6,779,252	$7,478,771	$8,004,158	$10,188,444	$10,107,535	$15,095,312		
State and Local Funding***	$0	$0	$0	$9,262,252	$8,581,794	$8,205,663	$7,829,535	$6,831,568	$6,829,155	$6,491,148	$6,090,142	$4,963,447	$5,045,318	$4,619,435	$3,944,792	$2,527,457	$2,498,409	$1,910,832	$1,323,255	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$86,954,202
Cash Flow	$132,842,000	$88,561,333	$44,280,666	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1	$1	$0	$0	$0	$0	$0	$285,446	$581,402	$1,502,248	$3,047,985	$6,555,723	$10,049,847	$14,206,175	$19,024,708	$25,847,843	$32,627,095	$40,105,866	$48,110,024	$58,298,469	$68,406,003	$83,501,315		
																																		TOTALS	$408,117,060	$491,555,389

Total Expense	$408,117,060
Total Revenue & Grants	$491,555,389
Profit	$83,438,329

* AW-1 = Seated Passengers only, 32 passengers per Tram

**$120,331 (from Section 9.10) + 3 Yr. Prepaid Interest

***State and Local Funding Sources are Identified in Section 13.6

TIG/M, LLC
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Riverside Streetcar System Feasibility Study Report

Appendix P:

Riverside Streetcar Project Conceptual Schedule

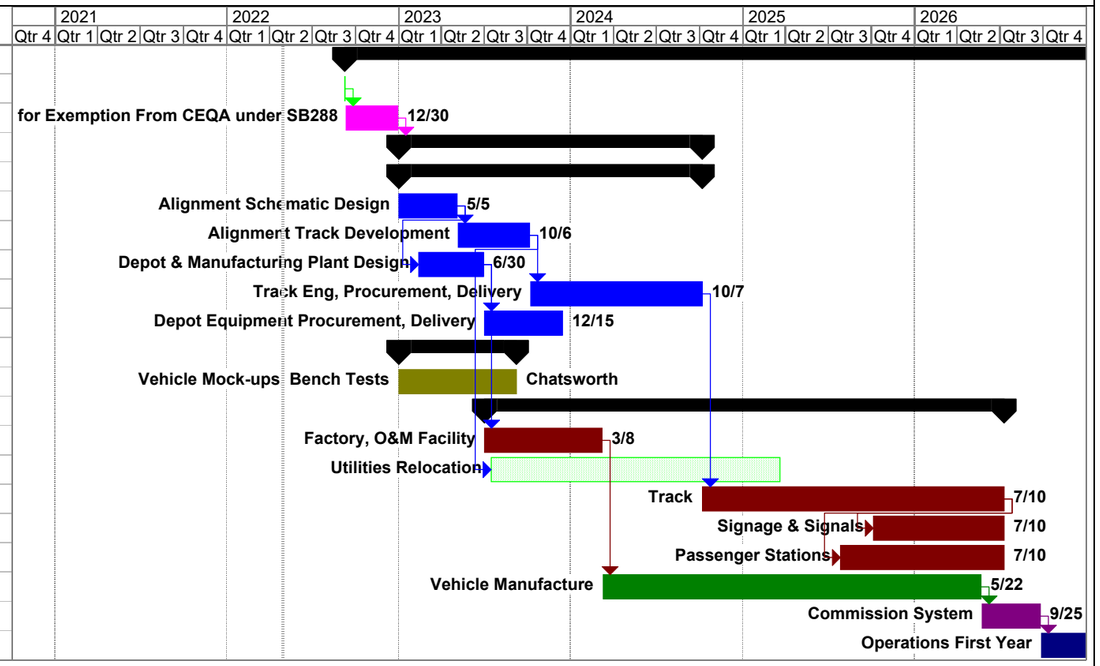
May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500

Riverside Streetcar Project Conceptual Schedule

ID	Notes	Task Name	Duration	Start	Finish	Predecessors
1		**Summary**	**1317 days?**	**Fri 9/9/22**	**Mon 9/27/27**	
2		Contract Award	1 day?	Fri 9/9/22	Fri 9/9/22	
3		Apply for Exemption From CEQA under SB288	80 days	Mon 9/12/22	Fri 12/30/22	2
4		**System Design**	**461 days**	**Mon 1/2/23**	**Mon 10/7/24**	**3**
5		**Civil Systems Design**	**461 days**	**Mon 1/2/23**	**Mon 10/7/24**	
6		Alignment Schematic Design	90 days	Mon 1/2/23	Fri 5/5/23	
7		Alignment Track Development	110 days	Mon 5/8/23	Fri 10/6/23	6
8		Depot & Manufacturing Plant Design	100 days	Mon 2/13/23	Fri 6/30/23	6FS-60 days
9		Track Eng, Procurement, Delivery	261 days	Mon 10/9/23	Mon 10/7/24	7
10		Depot Equipment Procurement, Delivery	120 days	Mon 7/3/23	Fri 12/15/23	8
11		**Vehicle Systems Design**	**180 days**	**Mon 1/2/23**	**Fri 9/8/23**	
12	Chatsworth	Vehicle Mock-ups, Bench Tests	180 days	Mon 1/2/23	Fri 9/8/23	
13		**Site Construction**	**790 days**	**Mon 7/3/23**	**Fri 7/10/26**	
14		Factory, O&M Facility	180 days	Mon 7/3/23	Fri 3/8/24	8
15		Utilities Relocation	440 days	Mon 7/17/23	Fri 3/21/25	7FS-60 days
16		Track	459 days	Tue 10/8/24	Fri 7/10/26	9
17		Signage & Signals	200 days	Mon 10/6/25	Fri 7/10/26	16FS-200 days
18		Passenger Stations	250 days	Mon 7/28/25	Fri 7/10/26	16FS-250 days
19		Vehicle Manufacture	575 days	Mon 3/11/24	Fri 5/22/26	14
20		Commission System	90 days	Mon 5/25/26	Fri 9/25/26	19
21		Operations First Year	261 days	Mon 9/28/26	Mon 9/27/27	20



Project: Riverside Streetcar Project Sc
Date: Fri 4/29/22

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

Riverside Streetcar System Feasibility Study Report

Appendix Q:

MFC Statement

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500

Private Financing/Investment Opportunities

Funding Through an Institutional Private Placement

McDonald Financial Corporation ("MFC") has entered into an agreement with TIG-m by which it will provide its knowledge and expertise to structure a very innovative proprietary funding model to finance The Riverside Streetcar Transportation System. This model allows the cars and the necessary infrastructure to repay their own investment through a non- debt funding instrument that does not encumber the City bonding capacity or Bank lines of credit. This allows for increased economic infrastructure, without the traditional corresponding liability, funded under a self-sufficient structure that is utilized as a form of credit rating enhancement.

The City would be responsible for any short fall, if one were ever to occur, under a shortfall agreement instrument. Usually, the City determines the pricing and revenues which would flow to them directly. They can either subsidize the consumers prices for below market services or allow it to repay itself to amortize the payments.

The following is MFC's summary of its capabilities and backgrounds of its team:

A Structure Finance Pioneer for Infrastructure Projects

MFC provides extensive structured finance experience combined with a long history of success. MFC possesses financial wisdom strongly focused on ethics, morals, and Christian values with the specific goal of far exceeding our client's needs each and every time.

MFC has been structuring and funding transactions as a clearing house for Life companies and pension funds since 1991. Operating as a principal, MFC has funded in excess of $20 billion in domestic and international transactions. MFC sources, qualifies transactions, structures the terms and documents, mitigates risk, employs enhancements, and secures regulatory transaction ratings through the NAIC (National Association of Insurance Commissioners) that maintains reciprocity with all rating agencies. MFC activities provide the assurance of an expedited funding, secures the lowest rate, provides optimal terms, and lowers investor risk because their regulatory agency has pre-approved the transaction.

The specific duty MFC provides is to determine the clients sophisticated financial, accounting, tax, sovereign and various strategic or economic goals and provides funds for these transactions under the most beneficial structured terms not offered through all traditional sources of funds possessing limited or no structured finance flexibilities and expertise.

MFC Operates in compliance with all regulatory rules, and possesses a detailed understanding of the useful regulatory exceptions. MFC provides clients with the optimal structure regulated institutional investors can provide, as opposed to basic departmental lending and their various restrictive requirements.

A Proprietary Technology Exclusively Developed and Utilized by MFC

Self Sufficient Investment ("SSI") is a proprietary new financing technology that resolves numerous technical problems associated with project finance and achieves off-balance sheet integrity. SSI

funds existing and to-be-constructed projects for government and corporate enterprises that do not want to incur a liability or debt or enter into a lease obligation requiring transition to debt.

By meticulously addressing numerous technical and regulatory issues, SSI allows income producing projects to be self-funding and operate on a standalone basis, thereby mitigating the need to incur indebtedness such as bonds, bank loans, institutional loans, capital leases, and other forms of debt or leases. Lease accounting rules have changed. All leases with a term exceeding one year will be capitalized as debt on the lessee's balance sheet. No lease will be grandfathered.

MFC developed SSI for governments, agencies, universities, and corporate enterprises ("Sponsor(s)") needing funds for income generating investments in infrastructure, real property and transportation such as toll roads and bridges, fiber optic cable, power plants, pipelines carrying essential products such as water, oil and gas, income producing real-estate such as hotels, convention centers, student housing, parking garages, multi-tenant office buildings and data centers, critical infrastructure such as airports and port facilities utilized by a Sponsor's client base, water and sewage treatment facilities, transportation assets such as rolling stock, aircraft, cargo ships, and many other forms of critical-use income-producing assets.

SSI provides a cost-effective all-inclusive one-step investment process. SSI also requires substantially less time and expense to implement than bonds or project finance transactions incorporating separate equity and debt components.

MFC's SSI structure can provide the following benefits:

- No indebtedness--off balance sheet integrity pursuant to regulatory, domestic, and international accounting standards
- Take owned or leased assets off balance sheet
- No encumbrance of bonding capacity or lines of credit
- Fund 100% of construction costs or acquisition costs including land
- Fund FF&E plus transactional fees and expenses
- Return all soft or hard costs incurred in the project to date
- Provide initial working capital to initiate operations, if required
- Up to three years payment deferral for project stabilization
- Fund all traditionally required debt and equity
- Provide fixed payments for 5-to-20+ year terms
- One closing for both construction and long-term facility
- Provide all the above within an estimated 30-to-60 days after reaching mutual terms
- Tailor the agreement to the specific industry and usage needs and requirements
- Total cost of funds based off comparable sponsor bond terms and rate.

Financial Options Compared to Self-Sufficient Investments

The infrastructure funding being offered to governmental entities by MFC is the most passive and least invasive form of funding available. The governmental entity can be the owner or subrogated to

ownership. The funding occurs through an instrument that MFC specifically crafts that is designed to fund **100%** of the desired infrastructure including all related soft and hard costs required to complete the transaction.

The instrument can be used to fund both the construction and the permanent term if applicable. The interest rate is a fixed interest rate based off the entities comparable bond rate and term. The institutional private funding is structured under GAAP to specifically adhere to a remote contingent support instrument designed for income producing infrastructure. The incoming producing asset or assets repays its own investment costs, or a substantial percentage under mutually agreeable terms mitigating liabilities in compliance with long established accounting rules for remote contingent liabilities.

This institutional private placement is considered as an illiquid form of structured instrument as compared to public liquid bond debt. Life Company's and pension funds utilize these to match fund or hedge their long-term annuities and policy's. This means there is no need for interest rate swaps or hedges required to lock in rates upfront. The flexibility of long-term structured private placements is ideal for funding infrastructure and reducing debt. Commonly known support instruments used are deficiency or shortfall support instruments. A provision made for a liability requires the specific amount and timing with an estimation of certainty to be in compliance with the long-standing accounting rules.

The numerous benefits in this little-known form of private funding substantially exceed what other traditional sources of funds and others can offer summarized below.

Timing to receive funding after agreeing to a proposal that outlines the terms and funding amount is as little as an expedited 30 to 60 days with reasonable cooperation. The required documents are minimal but specifically crafted to fund each situation. Estimated legal expenses is minimal and included in the total cost. No equity, grants, or out of pocket investment is required. The governmental entity can be repaid for all studies and related project costs at funding totally eliminating any cash investment.

The interest rates are currently at a 60-year low and required to increase based upon the current economic situation. The typical construction loan followed by a take-out loan commitment requirement with their related points and fees is unnecessary under this structure. The long wait for bond approval and completion is unnecessary. This preserves valuable bonding capacity and bank lines of credit allowing income producing assets to repay their own investment.

Very few financial institutions have the ability to comprehend, structure and document non-debt compliant instruments that fund income producing assets. This form of funding can help enhance credit ratings by increasing economic development and revenues without incurring the corresponding required debt. The government can control the pricing and collection of pass-through revenues therefore it can directly mitigate liabilities with full integrity. The initial payment can be deferred up to a maximum of 36 months if required to stabilize revenues and optimize remoteness.

As opposed to Public Private Partnership (P3's), the government is not required to convey long term useful life control of critical infrastructure assets or be subject to external pricing and management of public services and goods. McDonald Financial has a less invasive program providing funding for a build, own and operate program with well-known fortune 100 credit such as Jacobs and KBR.

Complex operational facilities may reasonably require a high level of specialization supported by a bonded upper investment grade rated firm insuring performance. MFC's instruments do not require private equity or grants and as opposed to P3's and are not required to focus on maximizing returns with minimum risk through concession service agreements. A typical Private P3 entity is equity based with the motivation required to be focused on returns rather than the public interest and needs provided at the lowest cost. Most P3's request long terms that typically match the assets useful economic life extracting all the usefulness. At the end of the term the government entity may be required to purchase private entity's residual interest faced with the refurbishment or replacement of the depreciated assets. Many governments continue to bail out P3's that cannot bond and guarantee their performance and are free to walk away if not economic. Unfortunately, all private entities maintain the unencumbered ability to declare bankruptcy. Typical P3's request substantial cash grants and the transfer of assets allowing them to borrow debt on a non-recourse or stand-alone basis. The government is essentially taking all the economic risk and has little control. P3's are typically viewed as either a lease or a service concession from an accounting standpoint. As discussed, all leases are required to be transitioned to debt which includes the present value stream of all payments and the estimated residual payment. Each and every P3 contract is different and therefore very expensive to document. They are therefore time consuming, complex, and expensive documents to negotiate and prepare. Many governments are now highly concerned about many private entities overcharging for the countless different services the private entity provides. Companies unable to issue a date certain cost specific contracts will walk away if things go really wrong. P3's can unfortunately not be structured to mitigate all the performance and public risks. While MFC can offer a concession agreement if so desired, our proposed structure is far less invasive and totally government controlled.

Public bonds are the most highly regarded and commonly utilized form of liquid public instruments and therefore provide the lowest stated rate. The issuance of bonds directly increases governmental debt and excessive issuance can decrease future bonding capacity or the entity's credit rating. Public bond stated rates are the most attractive while the preparation and completion can easily extend to one year or more. Unfortunately, the final bond rates are often unknown until the bond is successfully approved and placed in the future. Final rates and external costs can dramatically increase over time because no immediate closing is available. This means the effective rate, which includes all required costs, is never as low as the stated bond rate. Unfortunately, the current interest rate environment can quickly increase substantially along with other costs given the uncertain economy and world affairs.

Foreign banks and foreign funds are highly focused on control and the required employment of foreigners to complete the projects they fund, leading to diminished country control. All banks use CDs as instruments they match fund or hedge. They cannot offer long term fixed rates without requiring the purchase of cost prohibitive interest rate swaps and hedges if they are available in this low-rate environment. Bank funding is not optimally designed to accommodate long term infrastructure assets requiring fixed rates.

From a governmental financial perspective, the very best financial structure and solution would require 100% transactional funding including all the soft and hard costs at a very competitive long-term fixed rate designed to mitigate any governmental investment. The optimal form of funding is required to be expedited to quickly take advantage of the current low interest rate market and avoid cost increases. It should offer to deferral payments so the income producing assets are online and stabilized and generating revenue. It would be beneficial if the obligation instrument could be

structured so the assets can self-sufficiently pay their own cost. Lastly, a non-debt structure should not impact valuable governmental lines of credit and bonding capacity. It would therefore enhance existing governmental infrastructure and revenues benefiting the people, and the entities credit rating. The lease invasive, competitive, non-debt source of funds for income producing assets and infrastructure comes from our investor pool of the largest institutional life insurance and pension funds. These firms are the largest bond purchasers in the world.

McDonald Financial Corporation provides advisory services and has structured and funded numerous domestic and international transactions. MFC has pioneered numerous innovative financial techniques for its client's specific needs. Projects and selected transactions can be found on their website at https://mcdonaldfinancial.com/transactions/.

Riverside Streetcar System Feasibility Study Report

Appendix R:

5-Phase Concept

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
TIG/m. LLC
9160 Jordan Avenue
Chatsworth, California 91311
+1 818 709 8500

Reciprocation vs. Circulation

Two basic philosophies in streetcar operations conceptual planning are: reciprocation and circulation.

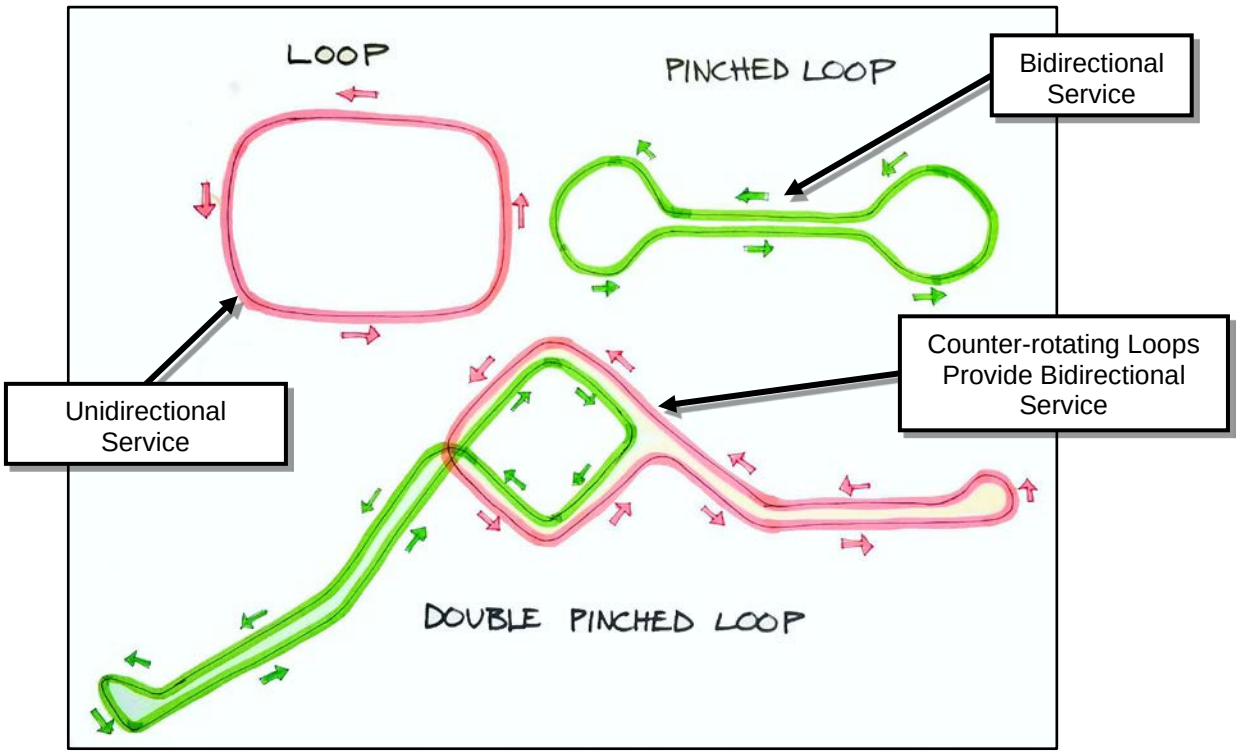
"Reciprocation" is the operation of one or more streetcars that travel back and forth on a single track or set of tracks. Vehicles need to be double ended, with an operator's console at both ends of the car. These vehicles are more complex, more expensive, have higher maintenance costs, and can carry fewer passengers because the operator's station consumes space that could otherwise be allocated to seats or standing room. Additionally, layover and recovery times at every cycle are inherent in this operation, to allow time for the operator to change positions on the streetcar to the "front-facing" direction.

"Circulation" is the operation of streetcars that travel in one direction on a continuous track. This type of system requires a turnaround (either a loop, a wye, or a mechanical turntable at each end of a track alignment) or full alignment loop configurations as described in ***Section 5.2.2***. A circulator can use single-ended cars, which are less expensive, less complex, have lower maintenance costs as well as more seats or standing room. Because layover and recovery are avoided, headways can be more symmetrical and therefore more efficient and dependable. For these reasons, TIG/m favors circulation.

Track Loops

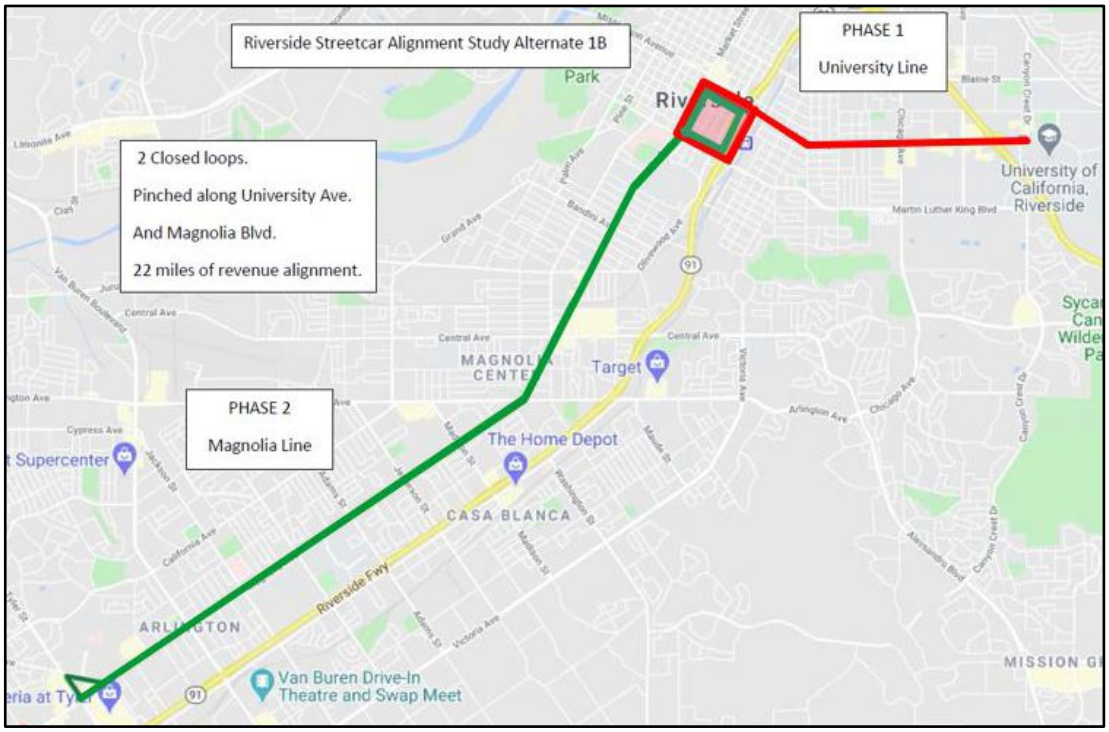
Two types of loops are considered for this study: open loops and pinched loops. An open loop allows for one-way travel on four (or more) streets. Pinching that loop for a long stretch of a main thoroughfare, for example, allows for two-way travel for the length of the pinch. This would reduce travel time for passengers, as they would not be required to ride perhaps a majority of the loop to arrive at their destination. The next Figure describes loop configuration.

Open Loop; Pinched Loop



TIG/m conceptualizes that alignment Phases 1 and 2 in this study should be double pinched loops, “overlapping” into a counter-rotational, bidirectional loops around the Downtown area and adjacent to the two spines alone the main street-level thoroughfares.

Phases 1 and 2 Form Two “Spines” of the Streetcar Network



Route Concepts

This report describes a conceptual development of a streetcar network in five phases, with the assumption that phases will be built over time. The first phase alignment track would be a single pinched loop with four open sections can serve as the spine (Phase 1) for a multiple loop system built-out over time.

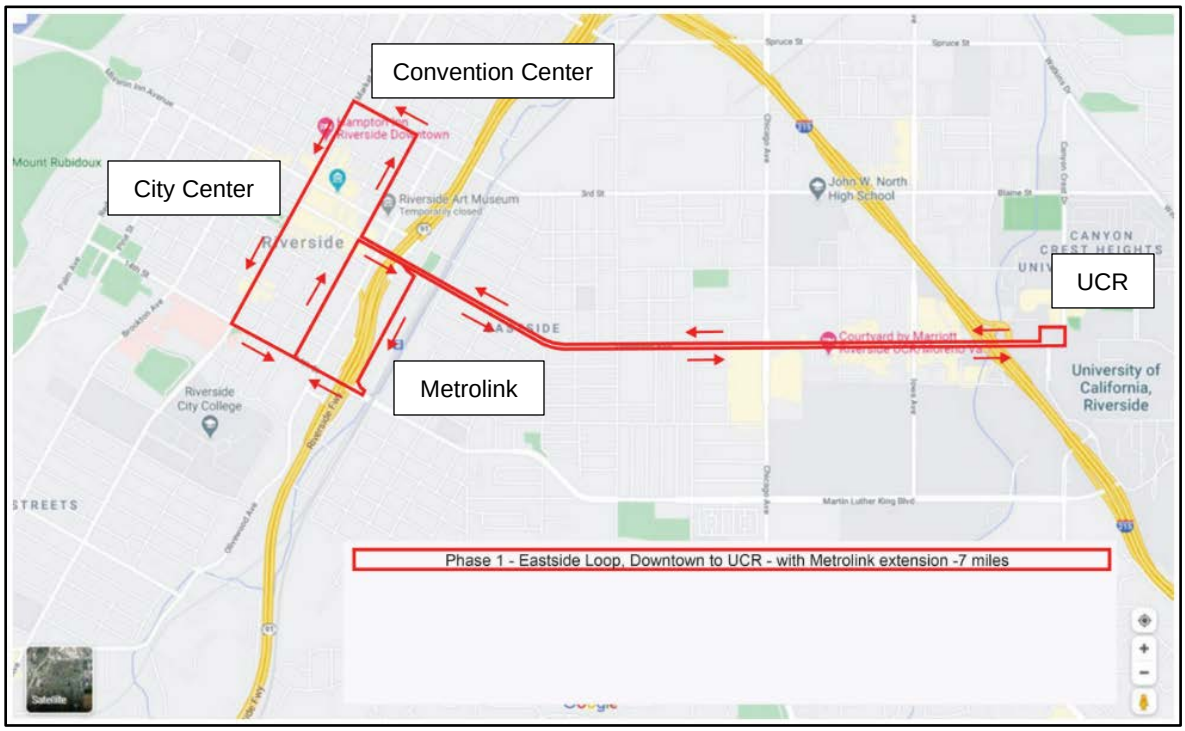
This report concentrates on Phase 1 and Phase 2 alignment concepts, with cost projections included for Phase 1 only. The conceptual five phases are described as line overlays on a local map; greater details will be provided after route decisions are made, during design phases, when contracted.

Conceptual Phase 1 and 2 are designed to serve as the network’s “spines”. Each of these two initial phases include service in both directions on University Avenue and Magnolia Avenue. These two streets are the main street-level thoroughfares in the City of Riverside.

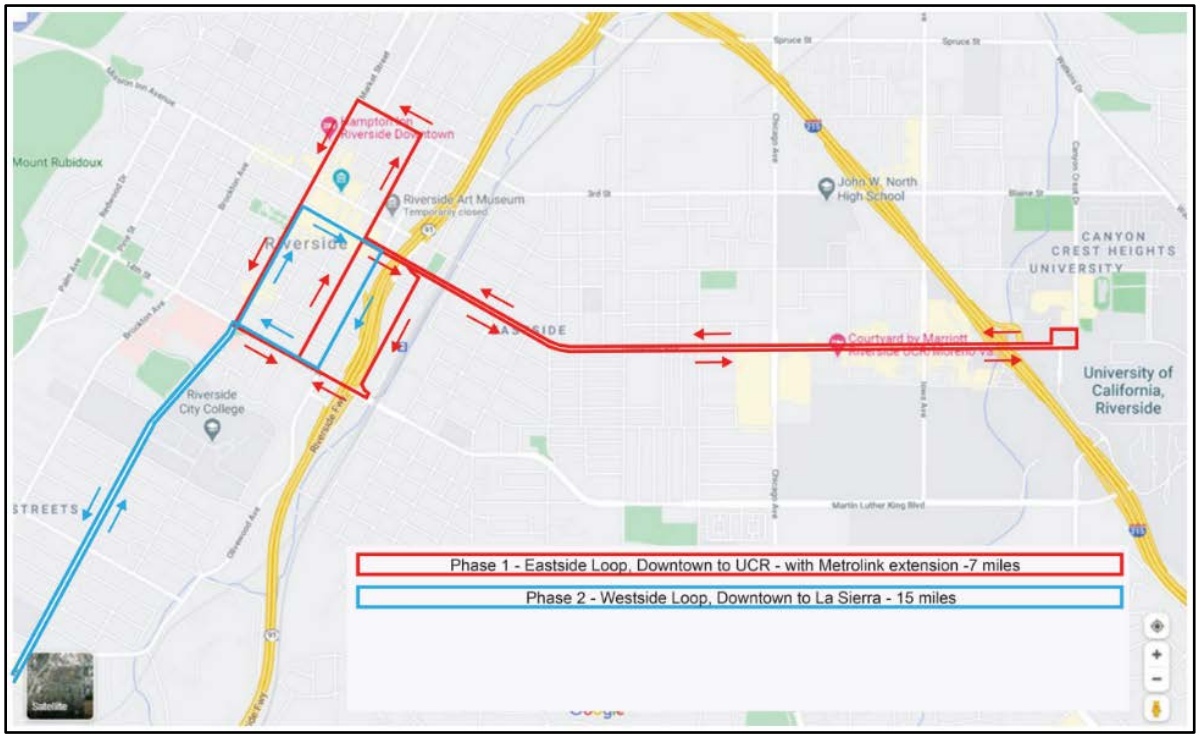
The completed system is envisioned as providing service from Downtown, east to UCR, west to La Sierra, and north to the North Specific Plan.

Each loop would operate single-ended trams on an 8-minute headway with transfer between loops at selected passenger stations.

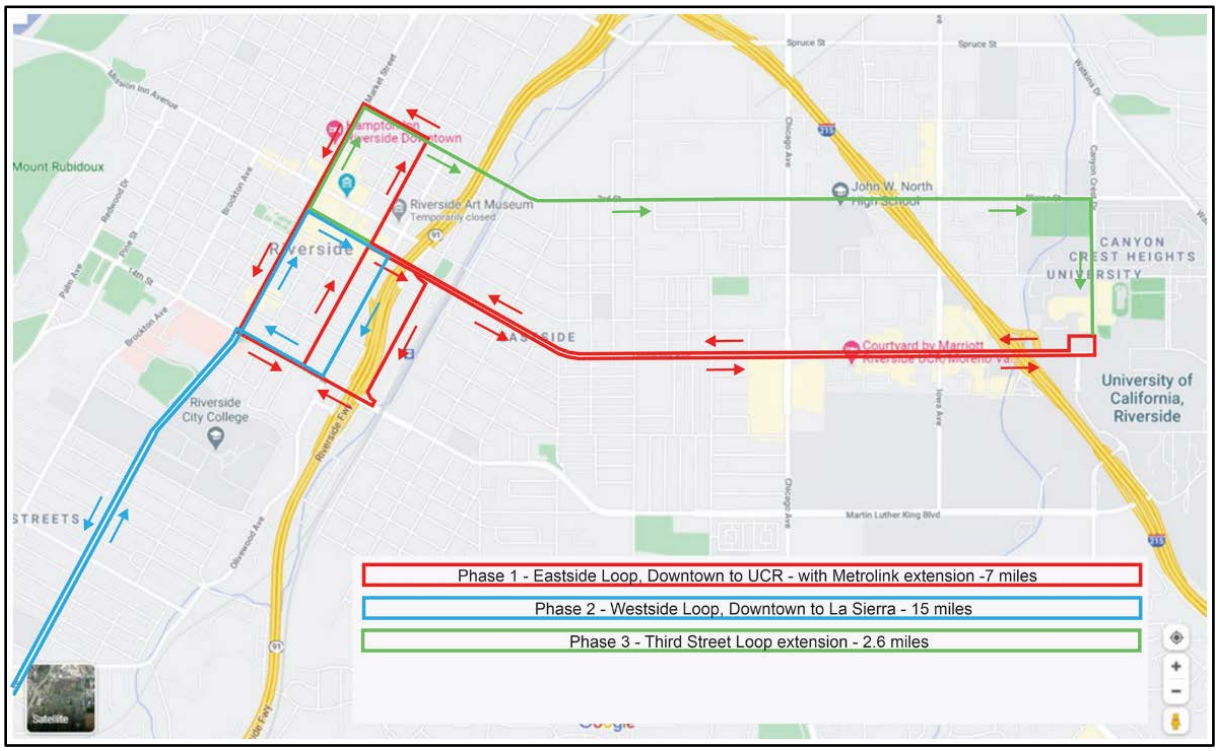
Phase 1 Alignment Concept – Red Line



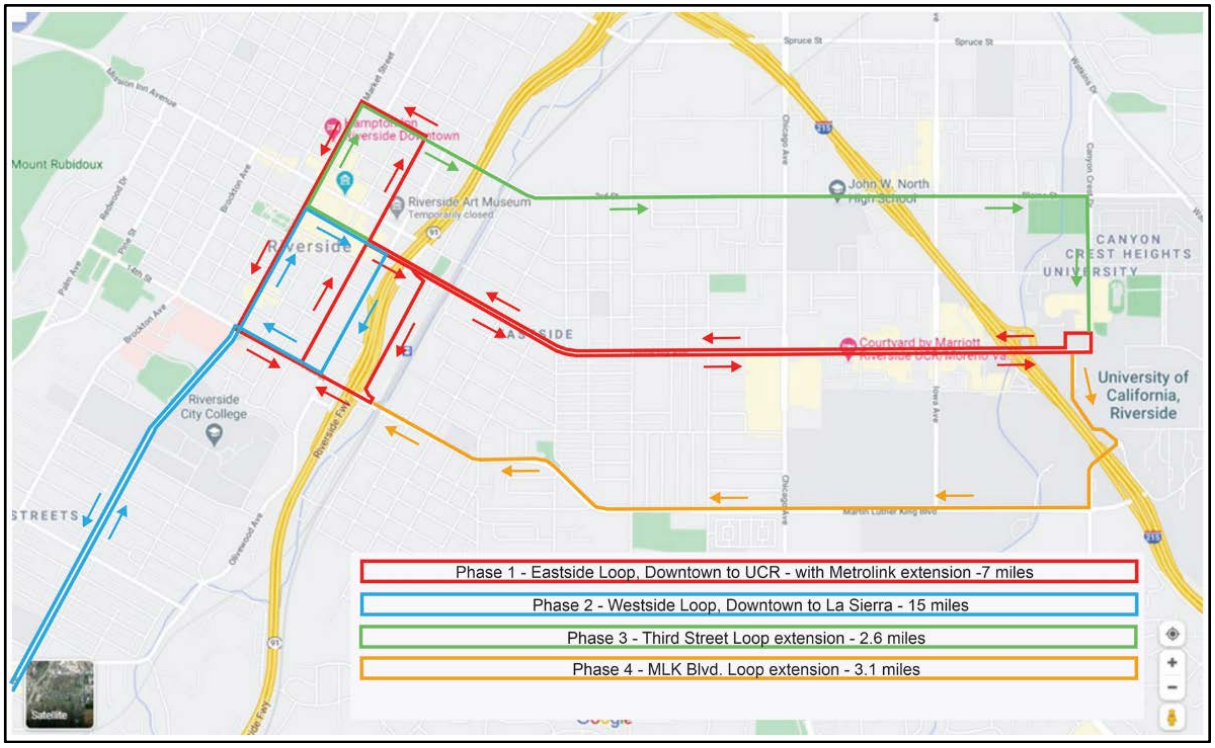
Phase 2 Alignment Concept – Blue Line



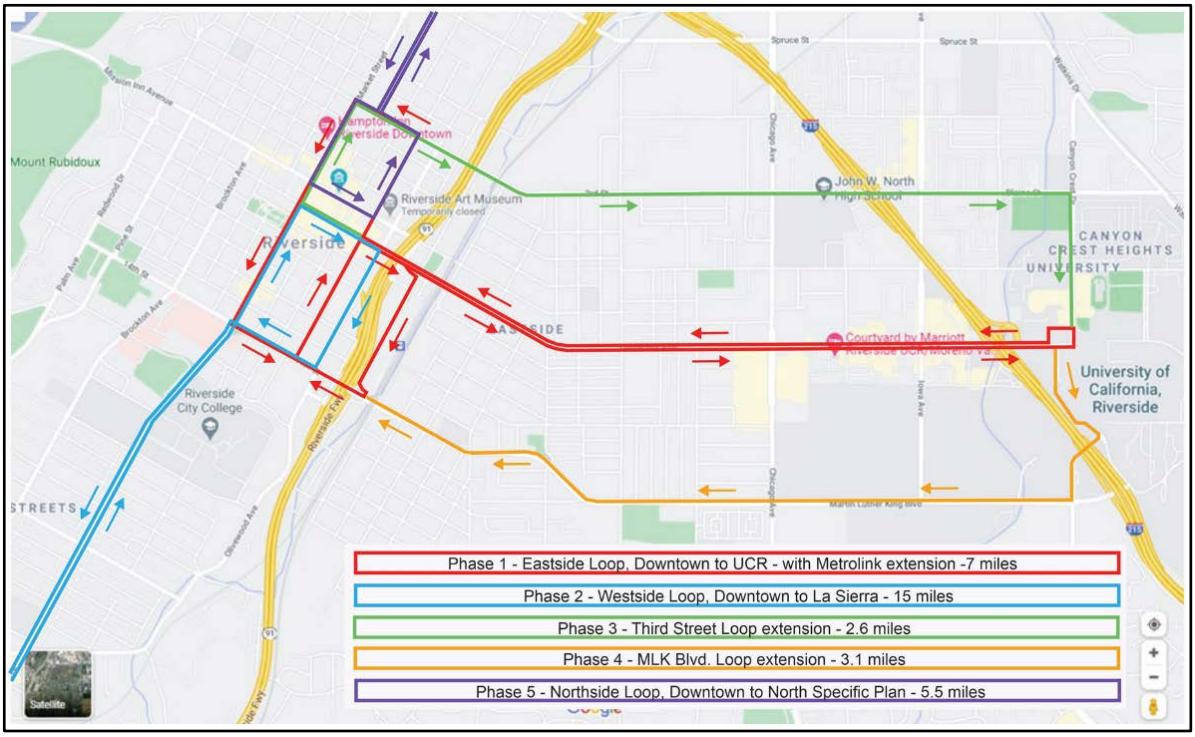
Phase 3 Alignment Concept – Green Line



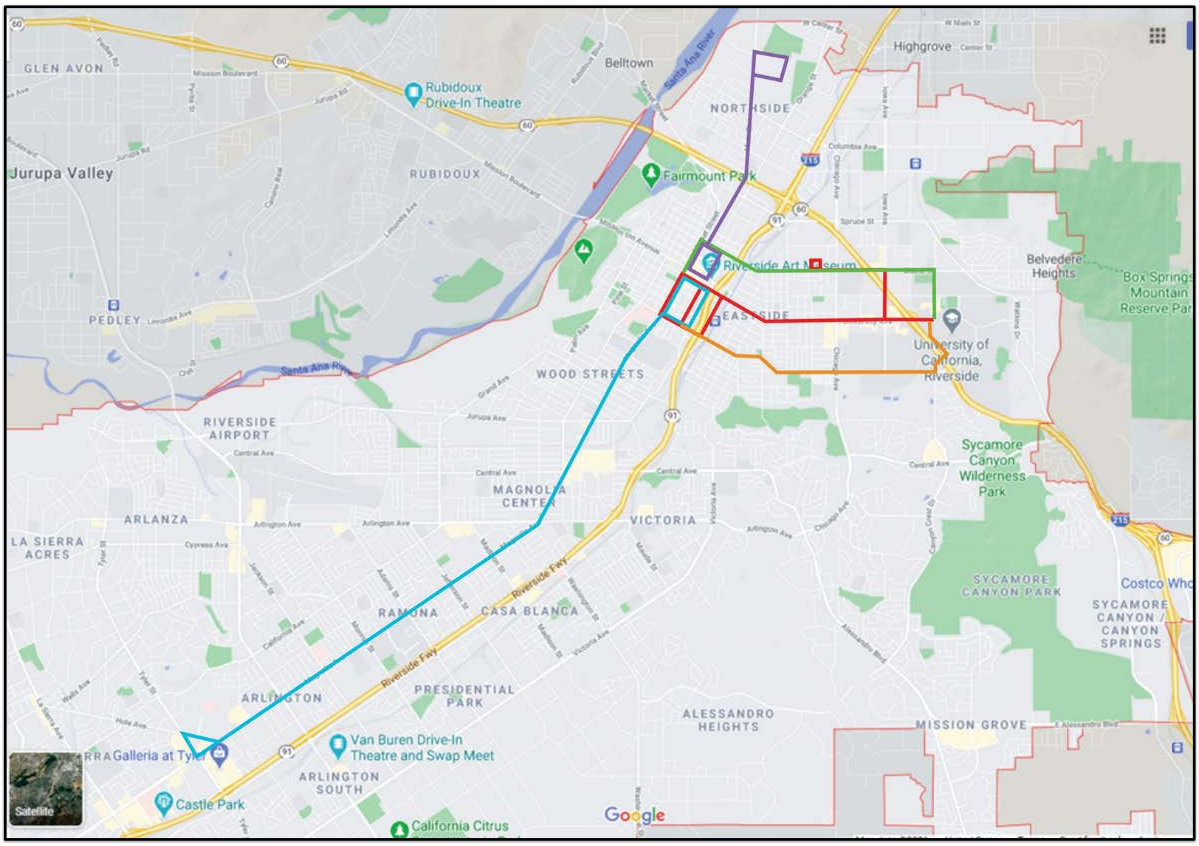
Phase 4 Alignment Concept – Yellow Line



Phase 5 Alignment Concept – Purple Line



Completed Network



Riverside Streetcar System Feasibility Study Report

Appendix S:

TIG/m Projects and References

May 15, 2022

Prepared for:
The City of Riverside

Prepared by:
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Chatsworth, CA 91311
Ph 818.709.8500 fx 818.709.8508
www.tig-m.com

Our Ref: PRL-0-01-L-129 Rev0 2200515

Project	Location	Propulsion System	Contact
Msheireb Doha Tramway	Qatar	Battery/LPG/Hydrogen	Turgay Kadioglu (+974 4000 4275)
Coast Futura Santa Cruz	USA	Battery/Hydrogen	Barry Scott (209-482-5663)
Chimelong Mountain Tramway	Guangzhou	Battery/Hydrogen	Eric Ruan (+8620 8478 0333-11653)
Downtown Dubai Trolley	UAE	Battery/Hydrogen	Tom Crute (+971 4 3673558)
Oanjetstad Streetcar System	Aruba	Battery/Hydrogen	Chris Thielman (297) 561-3930
éilan Streetcar System	USA	Battery/Solar	Carmen Cruz (914) 694-5900
Puerto Los Cabos Trrolley	Mexico	Battery/biodiesel	Jorge Buch (011-52-624-142-67-01)
Polo Square Streetcar	USA	Battery/hydrogen	Bill Swank Sr. (760-564-2068)
The Grove Trolley	USA	Battery	Rick Caruso
Maymont Peoplemover	USA	Battery	Scott Wheeler (804-788-0986)
Grand Station Trolley System	USA	Battery	Tom McWhinney ((970) 962-9990)
ZSSD Road Train	USA	Battery/biomethane	Dave Williams
Chicago Metra Locomotive	USA	Diesel/electric	CMTA
Phase I Monorail	USA	Third-rail	LVMTA

Coast Futura

مشيرب العقارية
MSHEIREB PROPERTIES

29/06/2020

OUT-MP-20-01652

Msheireb Downtown Doha,
Zone 3, Street 983, Building 4,
Sahat Ghanim Bin Ali, Doha,
State of Qatar

To Whom It May Concern,

Re: Letter of Reference for TIG/m, LLC

Msheireb Properties had the privilege to work with TIG/m to design, manufacture, and install a three-tram environmentally friendly self-powered streetcars in our pioneering and flagship project, Msheireb Downtown Doha (MDD).

As the smartest most sustainable fully-built city district in the world, we sought out the best manufacturer that could provide the highest quality and most sustainable trams. The three trams procured from TIG/m are single-deck, rigid body, self-powered vehicles requiring no overhead wires or wayside power systems of any kind. The traction power is provided by on-board batteries and ancillary power is provided by small on-board generators. The trams are fully air-conditioned and incorporate special light-filtering glass panels which inhibit over 90% of the heat from sunlight. The trams are also convertible and can be operated as open-air cars during the cooler winter months by removing the large glass panels. This feature is unique to the Msheireb Downtown Doha tramway system.

The Tram Depot, which houses the fleet of environmentally friendly self-powered trams, adheres to European standards for tramway safety. The Tram Depot recently received Platinum LEED accreditation in recognition of its advanced specifications that meet the LEED criteria – ranking it as one of the most sustainable tram depots in the world. According to a report produced by the judges, the accreditation was awarded based on excellence across multiple measures, including, design, fit-out, sustainability, and optimized energy performance.

TIG/m LLC shares a lot with our organization in terms of its commitment to environmental sustainability, reflected in the designs of their streetcars, that require no overhead wires, no wayside power, and generate zero pollutants.

We are immensely pleased with the delivery, quality, and work that was delivered by TIG/m, LLC, and our experience with them overall, and do look forward to continuing to work with them in the future.

We hope that you will give them your fullest consideration.

Sincerely,

Ali Mohammed Al-Kuwari
Acting Chief Executive Officer

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ARUTRAM

Paardenbaai Straat # 4
Oranjestad, Aruba
Tel: (00297) 5202312/5202314

January 13, 2020

Alvaro Villa, CEO

Brad Read, President

TIG/m, LLC

9160 Jordan Avenue

Chatsworth, CA 91311 USA

Dear Alvaro and Brad,

Aruba is committed to a future free from fossil fuels, and TIG/m streetcars are playing a big part in our work toward that goal. Since 2013, our fleet of your trolleys has been transporting many happy visitors from our cruise ship terminal through remodeled and now-revitalized downtown Oranjestad.

Visitors and residents alike love the vintage style of the trolleys. We have been very pleased that we can run them all day without stopping for a recharge, and have been very happy with the continually efficient and reliable performance. No overhead wires. No pollution. TIG/m delivered exactly as they promised.

With appreciation for your imagination and ingenuity,

Cris Thielman

Acting Manager

Paardenbaai Straat # 4

Oranjestad

Tel: (00297) 5202312

Email:cris.thielman@arutram.com