Santa Ana-Garden Grove Fixed Guideway Corridor

Appendix P

Drainage Technical Report

DRAINAGE TECHNICAL REPORT

in support of the

SANTA ANA AND GARDEN GROVE FIXED GUIDEWAY CORRIDOR STUDY

Santa Ana Regional Transportation Center (SARTC) to Harbor Boulevard

Prepared for
City of Santa Ana
in cooperation with
City of Garden Grove
Orange County Transportation Authority

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EXECUTIVE SUMMARY

The cities of Santa Ana and Garden Grove are considering a fixed guideway project to provide high frequency transit service between the Santa Ana Regional Transportation Center (SARTC) and a new multi-modal transportation center in the city of Garden Grove. The system would provide "last mile" transit service for commuters traveling from SARTC to employment and activity centers in the heart of Orange County, California; function as an urban circulator throughout downtown Santa Ana and the Civic Center; and serve schools, businesses, and densely populated neighborhoods throughout the study area. In addition to maximizing the effectiveness of the regional commuter rail network, the Santa Ana-Garden Grove fixed guideway system would reduce automobile trips and related greenhouse gas emissions, promote livability, and support economic development, land use, and community goals.

The Drainage Technical Report provides hydrology and hydraulic calculations for conceptual engineering of the proposed Santa Ana-Garden Grove Fixed Guideway project. The analysis is based on City of Santa Ana as-built plans, City of Santa Ana Drainage Master Plan, and field investigation. The primary objective of the drainage improvements identified as part of the fixed guideway project is to minimize the incidence of storm/drainage water accumulating within the fixed guideway track envelope.

This report identifies potential impacts of the proposed fixed guideway on the existing drainage system and recommends improvements to minimize the incidence of water accumulating within the fixed guideway track envelope. The proposed drainage improvements are within existing City right-of-way.

This report also describes the potential impacts of the proposed fixed guideway on the Santa Ana River. Both Build alternatives cross the Santa Ana River at the PE ROW, requiring replacement of the existing historic Pacific Electric Santa Ana River Bridge. Four design options were identified to provide for the river crossing. Two of the options were eliminated from further consideration because they would impact the existing historic bridge. The remaining two design options have been evaluated to determine potential impact to the hydrology and hydraulics of the Santa Ana River channel. Based on this preliminary evaluation, neither of the alternatives will significantly alter the hydraulics or hydrology of the river channel nor decrease the capacity of the channel to accommodate a 100-year flood event. Further hydraulic modeling will be required during preliminary engineering and final design.

Determination of watershed areas, and estimation of peak flows are based on a conservative approach; further investigation will be required during preliminary engineering and final design. This data combined with other design criteria stated in the report are used for the spacing of inlets and sizing of drainage facilities.

The proposed improvements are sufficient to minimize flooding within the track alignment segment, however, they will not completely eliminate flooding and/or ponding in certain areas without future drainage facility improvements per the City's Drainage Master Plan. The improvements are not intended to address current capacity deficiencies in the downtown

drainage system that result in flooded conditions during seasonal storms, only to reduce the incidence. During significant storm events, it is anticipated that even with the identified improvements, prior to the City implementing their Drainage Master Plan, flooding within the fixed guideway corridor may require substituting bus service along the corridor until the fixed guideway tracks are no longer impacted. Historically, Santa Ana averages 34 days of measureable precipitation annually, with far fewer producing sufficient rain to cause measurable accumulations along roadways for durations of a few hours.

1.0 INTRODUCTION

The cities of Santa Ana and Garden Grove are considering a fixed guideway project that would provide high frequency transit service between the Santa Ana Regional Transportation Center (SARTC) and a new multi-modal transportation center in the city of Garden Grove. A "fixed guideway" refers to any transit service that uses exclusive or controlled rights-of-way or rails. The proposed project alignments travel along a major east-west corridor through central Orange County, providing access to Santa Ana's downtown area and the Santa Ana Civic Center where city, county, state and federal government offices and courthouses are located. It will connect the historic and densely populated neighborhoods east and west of the Downtown and Civic Center with employment and educational opportunities, goods and services, and will also provide access to several redeveloping, transit-oriented areas within both cities.

1.1 General

This report describes the potential impacts of the proposed fixed guideway system on the storm drain systems within the study area, and documents the recommended improvements to the storm drain systems developed as part of conceptual design for the Project. Appendix A shows the alignment alternatives under consideration for the Santa Ana-Garden Grove Fixed Guideway Corridor.

1.2 Objective

The purpose of this technical report is to document drainage system improvements proposed as part of the fixed guideway corridor project. A drainage analysis was conducted for Streetcar Alternatives 1 and 2. The City's existing drainage systems and the drainage facilities included in the City of Santa Ana Drainage Master Plan (dated May 1994) were considered in the analysis. The drainage systems along each corridor alignment alternative were researched and documented on drainage plans. Drainage maps, analysis, and estimated quantities are presented in the appendices to this report. The objective of the drainage systems design concept for the fixed guideway corridor is to minimize the width of flooded area within the fixed guideway corridor alignment. Modifications to existing drainage systems and new drainage systems have been recommended to meet this objective. It is not anticipated that these improvements will resolve overall deficiencies in the existing drainage systems, which are to be addressed by the City through implementation of the Drainage Master Plan.

1.3 Project Study Area and Build Alternatives

The study area was defined to support the development and evaluation of a broad range of modal alternatives. It encompasses SARTC, existing and planned development surrounding the rail station; employment, government, commercial and cultural activity centers in the Civic Center and downtown Santa Ana; and, existing neighborhoods, businesses, and activity centers in central Santa Ana and east Garden Grove (see Figure 1). Planned development and areas that offer future development and redevelopment opportunities were also considered, as were planned regional transportation system improvements such as OCTA's Bus Rapid Transit (BRT) program, and Metrolink service expansions. The proposed corridor study area (see Figure 2)

Figure 1: Location Map

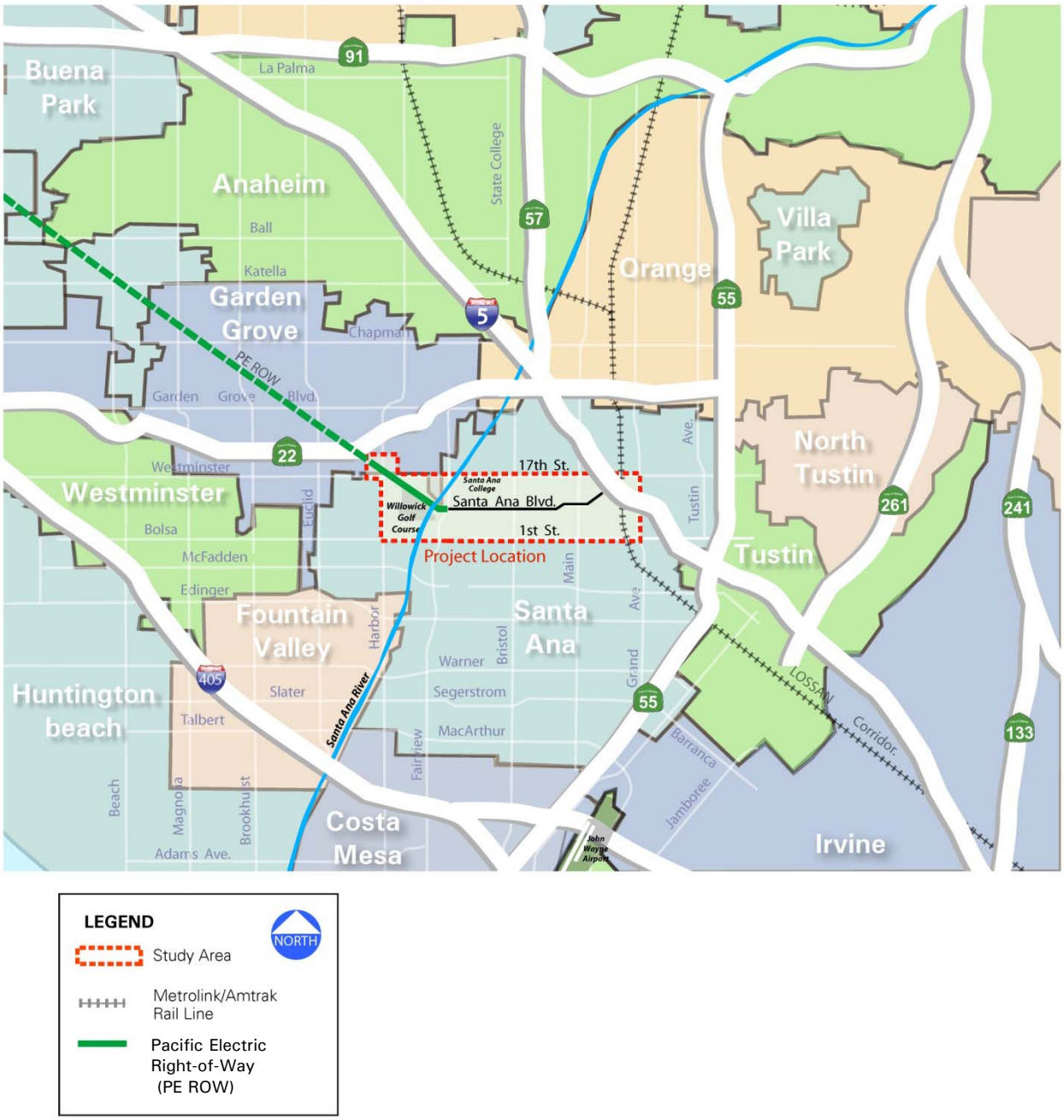
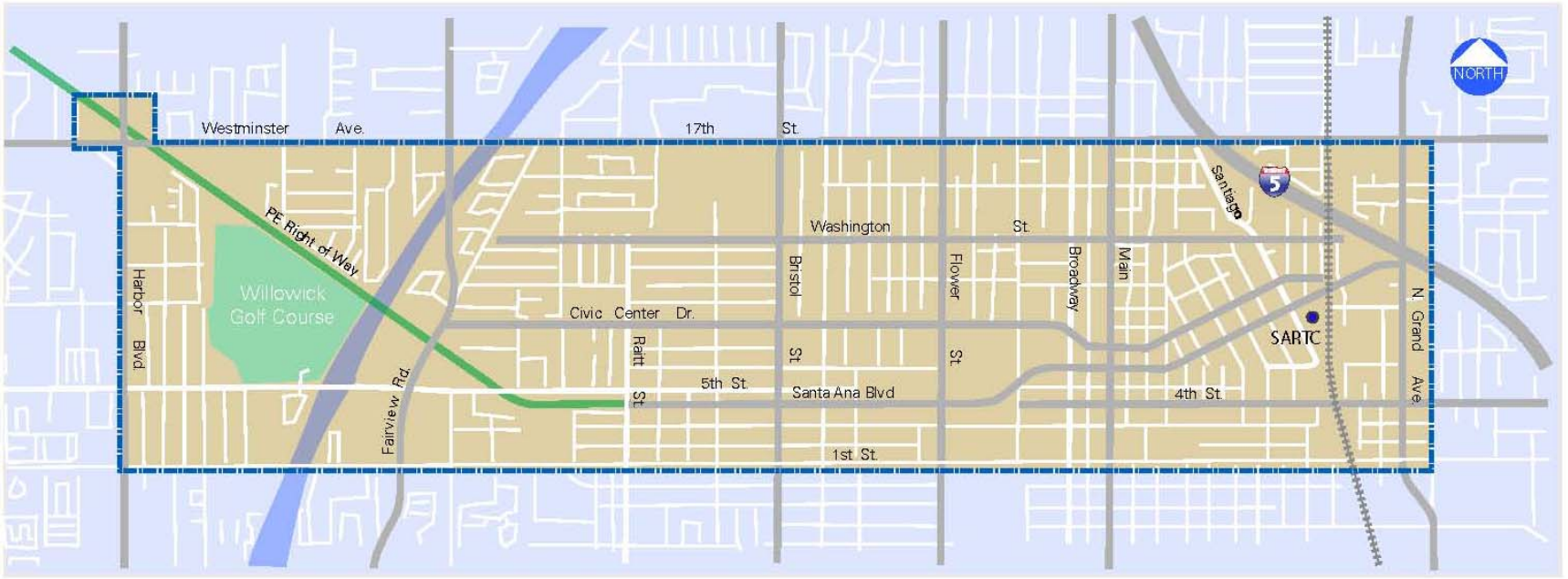


Figure 2: Project Study Area



is generally bounded by Harbor Boulevard to the west, 17th Street to the north, Grand Avenue to the east, and First Street to the south.

The Transportation System Management (TSM) Alternative provides for enhanced bus service within the study area, including a new route between SARTC and Harbor Boulevard at Westminster Avenue. Like the proposed Streetcar Alternatives, the new route is intended to serve the need to transportation identified in the Purpose and Need Statement for the project. The TSM Alternative bus element alignments are shown in Appendix A.

Two (2) "build" alternatives for the Santa Ana-Garden Grove Fixed Guideway were analyzed: Streetcar 1 and Streetcar 2. Appendix A shows the alignments of these fixed guideway alternatives. In both alternatives, modern streetcars would operate in mixed flow traffic on tracks embedded within existing city streets, except along the Pacific Electric Right-of-Way (PE ROW) segment where streetcars would operate on tracks dedicated exclusively for streetcar use.

From the western terminus at Harbor Boulevard and Westminster Avenue in the City of Garden Grove, to Flower Street, the alternatives are identical. The fixed guideway alignment runs east/west along the PE ROW across the Santa Ana River to Raitt Street and then continues on Santa Ana Boulevard to Flower Street. East of Flower Street, the alternative alignments vary through the Civic Center and downtown area.

In Streetcar 1, streetcars would travel eastbound on Santa Ana Boulevard, transitioning onto 4th Street in the vicinity of Ross Street; the streetcars would continue eastbound on 4th Street and turn north on Mortimer Avenue to Santa Ana Boulevard to Santiago Street, terminating near the Santa Ana Metrolink station (SARTC). In the westbound direction, the streetcars would travel on Santa Ana Boulevard from Santiago Street to Raitt Street, entering the PE ROW west of Raitt Street and continuing to the western terminus station near Harbor Boulevard at Westminster Avenue.

In Streetcar 2, the streetcars would travel eastbound along the PE ROW to Santa Ana Boulevard, transitioning onto Fifth Street in Downtown Santa Ana; the streetcars would turn north on Minter Street then east on Sixth Street/Brown Street to Poinsettia Street then looping to Santa Ana Boulevard and Santiago Street to access SARTC. In the westbound direction, the streetcars loop clockwise around Santiago Boulevard and Poinsettia Street to travel west along Brown Street/Sixth Street/Santa Ana Boulevard to Spurgeon Street; the streetcars turn north onto Bush Street then west onto Civic Center Drive then south onto Flower Street, returning to Santa Ana Boulevard westbound; they would enter the PE ROW west of Raitt Street and continue to Harbor Boulevard.

2.0 EXISTING DRAINAGE CONDITIONS AND FACILITIES

An inventory of the existing drainage systems within the fixed guideway corridor study area was conducted, by segment, for each of the proposed alignment alternatives. Existing drainage facilities were identified using as-built plans from the City dating back to 1950. In addition, extensive field investigations verified curb inlet openings, parkway culverts, catch basins, cross gutters, flow lines, and drainage area limits.

The City maintains approximately 1,600 storm drain inlets and 34,000 linear feet of open channels that transport urban runoff and discharge to the Lower Santa Ana River, Newport Bay, Bolsa Chica water bodies. Appendix B shows existing drainage flow patterns and facilities within the study area limits.

Santa Ana is a mature city. Based on its adopted General Plan, it is substantially urbanized. There are areas of the City in which historic development constrains opportunities to modify and improve supporting infrastructure, including the drainage systems. Past efforts to improve drainage in these areas have focused on minimizing recurring flooding and ponding without addressing the overall need for expanded system capacity. As a result, flooding occurs in certain areas during significant storm events; flooding will continue to occur in these areas until all of the improvements identified in the City of Santa Ana Drainage Master Plan have been implemented.

For the purpose of this drainage analysis, the fixed guideway corridor was divided into several segments based on existing conditions, and existing or proposed storm drain facilities identified in the City's Drainage Master Plan. The segments were defined as follows:

Downtown Segment

1. Santiago Street to French Street
2. French Street to Ross Street
3. Ross Street to Flower Street

Raitt to Flower Segment

1. Flower Street to Shelton Avenue
2. Shelton Avenue to Bristol Avenue
3. Bristol Street to Raitt Avenue

Pacific Electric ROW (PE ROW) Segment

1. Raitt Avenue to Santa Ana River
2. Santa Ana River to Harbor Blvd/Westminster Avenue

2.1 Downtown Segment

The downtown segment of the study area consists of various land uses including institutional, industrial, commercial, and residential. The area near the SARTC is considered an industrial zone. The area between SARTC and downtown Santa Ana is primarily residential with small industrial areas. Downtown Santa Ana is characterized by multi-story commercial (including

office and retail uses) buildings and residential. The Civic Center area has institutional land uses including federal, state, city, and county government offices. The topography within this segment is flat and grades towards the west and south.

2.1.1 Streetcar 1

Santa Ana Boulevard: The existing roadway conditions along Santa Ana Boulevard from Santiago Street to French Street consists of one or two travel lanes in each direction separated by a striped median; just east of French Street (at Mortimer Street, Santa Ana Boulevard converts to one-way traffic in the westbound direction. An existing 27-inch reinforced concrete pipe (RCP) runs westerly along Santa Ana Boulevard to French Street, where it turns south into a 39-inch RCP. The storm water runoff north of Santa Ana Boulevard from Washington Avenue runs southwest along the gutter and cross gutters. Existing catch basins on the northeast corners of the perpendicular streets intercept water flowing south towards Santa Ana Boulevard which tie into the existing 27-inch RCP. At the northeast corner of the French Street/Santa Ana Boulevard intersection, shallow parkway culverts (1-ft to 5-ft wide) convey water from French Street to a low point on Santa Ana Boulevard.

From French Street to Ross Street, Santa Ana Boulevard has three lanes in the westbound (one-way) direction. The roadway profile varies due to cross gutters carrying flow along the perpendicular streets from north to south especially between French Street and Broadway. Along this segment, no major existing drainage facilities exist except for a 33-inch RCP which flows south on Spurgeon Street and then turns east on Santa Ana Boulevard to tie into the junction chamber at the intersection of French Street and Santa Ana Boulevard. Parkway culverts are located at Spurgeon Street and Broadway intersecting with Santa Ana Boulevard. On Ross Street, several laterals are located between Civic Center Drive and Santa Ana Boulevard. A total of 5 catch basins are within this area. In addition, an existing 24-inch RCP crosses Santa Ana Boulevard and heads south to an existing 33-inch RCP at the intersection of 3rd Street.

Between Ross Street and Flower Street, water is conveyed along the curb and gutter with existing catch basins at the northeast corner collecting the storm runoff. Flower Street has an existing 33-inch RCP crossing Santa Ana Boulevard which runs south towards Pine Street and then turns westerly on Pine Street towards Shelton Avenue.

4th Street: Along 4th Street, the roadway profile varies especially at the intersections where cross gutters convey the runoff from north to south. Cross gutters are located on the east side of each intersection. From Ross Street to Mortimer Street, concrete V-gutters exist on both sides of the street adjacent to the parking. The runoff flows westerly and south along these existing V-gutters and cross gutters.

2.1.2 Streetcar 2

Brown and 6th Street: The runoff is conveyed along curb and gutter, and cross gutters as it flows westerly along Brown Street/6th Street, then south along Minter Street. The existing roadway conditions along Brown Street/6th Street from Poinsettia Street to French Street consist

of one lane in each direction carrying two-way traffic. At the intersection of French and 6th Street, an existing 27-inch RCP from Santa Ana Boulevard and an existing 33-inch RCP from Spurgeon Street connect to a 39-inch RCP which runs south on French Street.

Civic Center Drive: Civic Center Drive is a major east-west arterial consisting of three lanes in each direction west of Main Street. The existing drainage areas impacting Civic Center Drive along the proposed alignment extend north to Washington Avenue. The storm water runoff is collected along the existing concrete curb and gutters, and cross gutters, and then runs along the north side of Civic Center Drive. Various existing catch basins on Civic Center Drive convey the storm water runoff to existing storm drain systems. The following is a summary of existing drainage facilities:

- 24-inch RCP runs west from Broadway to Ross Street, then turns south along Ross Street
- 18-inch RCP from Main Street to Spurgeon Street
- Three (3) existing catch basins near intersection at Main Street and at Bush Street
- 21-inch RCP north-south direction on Broadway ties into 24-inch RCP on Civic Center Drive
- 18-inch RCP lateral for catch basin connects at Broadway/Civic Center Drive intersection

Flower Street: Flower Street is a major north-south arterial consisting of three lanes in each direction between Civic Center Drive and Santa Ana Boulevard. The pavement along Flower Street is concrete. Flower Street conveys the majority of storm water runoff from as far north as 17th Street. The existing parcels and streets bounded by Ross Street on the east, Flower Street on the West, 17th Street on the north, and Civic Center Drive on the south have minimal drainage facilities to convey or collect the runoff. Runoff flows westerly towards Flower Street and then south towards the intersection of Flower/Civic Center Drive. At the intersection, storm water runoff is collected by existing catch basins which connect to an existing 33-inch RCP running south along Flower Street to Pine Street. Flower Street also has existing catch basins on the west side of the street at its intersections with 6th Street and with Santa Ana Boulevard.

2.2 Raitt to Flower Segment

The Raitt to Flower Segment of the study area is a land use mixture of commercial, schools, and residential. The topography within this segment is a flat grade towards the west and south. The street segment slope varies from a 0.5% to 2.0% grade. The drainage areas for this segment are bounded by 5th Street on the north and Santa Ana Boulevard on the south. Storm water runoff from existing streets and parcel areas north of 5th Street are conveyed in existing drainage systems not impacted by the fixed guideway alignments. The eastbound side of the fixed guideway alignment has only on-site street flow, and no off-site drainage.

Along Santa Ana Boulevard between Flower Street and Shelton Avenue, storm water runoff is conveyed along concrete curb and gutter and then intercepted in a catch basin at the northeast corner of the Shelton Avenue and Santa Ana Boulevard intersection. The lateral connects to an existing north-south 27-inch drainage system. Between Shelton Avenue and Bristol Street,

storm water runoff is conveyed along concrete curb and gutter and then intercepted with parkway culverts at the intersection of Bristol Street and Santa Ana Boulevard. The runoff continues southerly along Bristol Street.

From Bristol Street to Raitt Street, Santa Ana Boulevard consists of one lane in each direction with street parking on each side. The existing streets and curbs, gutters and sidewalks are in poor condition with various cracking. The storm water runoff is conveyed along the curb and gutter with cross gutters at the intersection of perpendicular streets. The runoff flows westerly to Raitt Street and then turns southerly through existing parkway culverts.

2.3 PE ROW Segment

The PE ROW segment is an existing 100-foot ROW corridor with minimal land use. The corridor extends from Raitt Street in Santa Ana to the vicinity of the I-710 in Los Angeles County. Within Orange County, it is substantially owned by the Orange County Transportation Authority. In some areas along the PE ROW, OCTA has allowed conditional interim use of the ROW; otherwise, within the study area, the corridor is vacant. The segment is divided by the Santa Ana River. Between Raitt Street and Fairview Street, some existing tenants, mainly industrial, conditionally occupy portions of the PE ROW. The segment west of the Santa Ana River is vacant and composed of dirt and gravel. Minimal as-built plans were available within this segment. The assumption is storm water runoff flows to both sides of the right-of-way and is conveyed through natural ditches.

The historic Pacific Electric (PE) Santa Ana River Bridge is approximately centered within the PE ROW alignment, crossing the Santa Ana River. The historic bridge is inadequate to accommodate the proposed fixed guideway due to it age, size (it was constructed as a single-track bridge), disrepair, undetermined structural integrity (both superstructure and foundation) and non-compliance with current building and safety requirements.

The bridge is a Pegram Truss, built in 1907 as part of the Pacific Electric Railway route that operated between Long Beach and Santa Ana until 1950, when service was discontinued. In the early 1970's, when the PE ROW was acquired by OCTA and the tracks were removed, the bridge was fenced at each end to prevent access. The bridge has therefore been out of operations and unmaintained since 1950. Previous studies including the SR-22/West Orange County Connection FEIR/FEIS have identified the PE Santa Ana River Bridge as eligible for inclusion in the National Register of Historic Places (NRHP).

As-built plans for the Santa Ana River Bridge were unavailable. The bridge is a two-span approximately 302 feet long. The longest span is 147 feet long. The bridge foundation consists of a single pier in the Santa Ana River channel that is approximately 9 feet wide by 27 feet long. A second pier on the west embankment supports the west end of the bridge and timber supports have been used to extend the bridge from the end of the truss structure to connect at-grade with the PE ROW.

As part of the alternatives analysis, design options have been defined and evaluated to address the fixed guideway crossing of the Santa Ana River while minimizing impacts to the historic bridge.

3.0 PROPOSED DRAINAGE SYSTEMS

The City of Santa Ana Drainage Master Plan was used, as a guideline for proposing new drainage systems along the fixed guideway alignment alternatives. The City of Santa Ana's design manual and standard plans were integrated into the analysis to address the City's requirements. In addition, the proposed drainage systems comply with the requirements provided in Chapter 4.6 of the City of Santa Ana Transit Zoning Code EIR. In general, if any portion of an existing, or future storm drain system is being impacted by the fixed guideway alignment improvements, then the storm drain system was included as part of this analysis. Appendix D includes all proposed storm drain systems and facilities for each of the two fixed guideway build alternatives. Proposed storm drain systems along the fixed guideway alignments convey the runoff from the proposed and existing catch basins. Proposed catch basin location and size was determined based on minimizing the flooded width along the curbside in order to not impede into the fixed guideway track envelope.

3.1 Design Basis

Pertinent design criteria are summarized below:

- RCP will be used for all storm drain pipelines
- 18-inch RCP is the minimum pipe diameter proposed
- Rational Method per Orange County Flood Control District was adhered to
- A 10-year storm event for collectors was assumed
- A 25-year storm event for any sump (low point) condition
- Catch basins will be located so as to eliminate whenever possible open concrete cross gutters and parkway culverts
- Catch basins will be spaced to minimize flooded width within the street
- Acceptable clearances from utilities and fixed guideway track envelope will be maintained

3.2 Methodology and Assumptions

The drainage design approach was to provide the required drainage facilities to maintain existing street drainage, drain the track area, and minimize flooded width within the fixed guideway corridor alignments. The minimum open travel lane requirement is 12-feet for a 10-year storm event per City's standard. However, if the track alignment is running curbside within a 12-foot lane, then the flooded width was based on a 2-foot clearance from the track envelope.

The design utilizes as much of the existing drainage system as possible in order to minimize impacts to City streets and overall cost to the project. The preliminary design assumes upgrade of any segment of existing drainage systems where it crosses the fixed guideway alignment corridor, as well as, replacement of catch basins, if needed, based on hydrology calculations. The design is based on the City of Santa Ana Drainage Master Plan which was prepared for a 10-year storm frequency. Appendices E and F present the hydrologic and hydraulic analyses. New east-west drainage systems connect to major north-south drainage systems currently existing or proposed as part of the City's Drainage Master Plan. The major north-south

drainage systems impacted by the project are to be upgraded per the City's Master Plan, extending south, at a minimum, to 1st Street and connecting to an existing drainage facility. New drainage systems will be designed to maintain existing flow patterns. Drainage areas are based on existing street conditions since street widening is not required to accommodate the fixed guideway improvements.

3.3 Hydrologic Analysis

The methodology of hydrology calculations used in the analysis is the Rational Method based on guidelines and procedures outlined in the Orange County Hydrology Manual. Proposed catch basins are designed along the fixed guideway alignment to capture the flow of water over the pavement in order to provide safe passage of vehicles, maintain streetcar operation, prevent inconvenience or hazards to pedestrians, and hydroplaning. The allowable flooded width is based on the City's storm design frequency criteria. For 10-year storm event, the criterion is to maintain at least one travelled lane open (12 foot minimum if not determined). The size and location of the proposed catch basins are based on the spread criteria and will intercept a minimum of 10-year storm frequency. However, catch basins located at low points within the intersection (sump condition) are designed for a 25-year storm event.

The Orange County Hydrology Manual Hydrologic Soil Group Map (Appendix E) was used to obtain the hydrologic soil types for the drainage study area. The project site consisted of Soil Group B which has moderate runoff potential. The hydrologic soil B is described in the manual as follows:

- **Soil Group B:** Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderate deep to deep. Moderately well to well drained sandy-loam soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

The storm runoff discharge was calculated by the Rational Method equation. The equation is expressed as:

$$Q = CIA$$

Where:

Q = Discharge in cubic feet per second (cfs)
C = Developed runoff coefficient (dimensionless)
I = Average rainfall intensity in inches per hour (in/hr)
A = Drainage area (acres)

According with the Orange County Hydrology Manual, the rational method is used for drainage areas smaller than 1 square mile. The rational method peak flow rates were used to evaluate the proposed drainages facilities. For this drainage study, a 0.90 runoff coefficient, which is conservative in establishing peak flows, was used for all areas.

Design Approach: Utilizing the existing topography survey, proposed track alignments, and the City of Santa Ana's Drainage Master Plan, the following design elements were determined for the proposed drainage facilities:

- Drainage areas (Appendix C)
- Total peak flow to the catch basins/drainage inlets (discharge)
- Intercepted/Bypass Flow
- Depth of flow
- Flooded Width (spread)

The maximum runoff normally occurs when the runoff generated from the whole area contributes to the concentrated point. The rainfall intensities were calculated using the 10-year and 25-year "Mean Precipitation Intensities", Figure B-3 of the Orange County Hydrology Manual.

3.4 Hydraulic Analysis

Drainage design is intended to facilitate removal of storm water runoff from the roadway. The design of the drainage system will reduce the likelihood that water flows or backs up into the roadway causing flooding and hazardous conditions for drivers. Without implementing the complete Drainage Master Plan, or significantly increasing overall drainage system capacity, the drainage design is intended to minimize the water surface depth below top of curb on selected roadways and takes into consideration the maximum allowable flooded width within the roadways. The storm water runoff is conveyed within proposed curb and gutter along the street. The water surface spread is controlled by adding catch basins as necessary.

The hydraulic analyses and calculations were performed using StormCAD V. 5.6 by Bentley. The software uses the methodology of Hydraulic Engineering Circular No. 22 (HEC-22) to model, analyze, and design highway and urban drainage facilities. Refer to Appendix F for the hydrologic calculations of proposed mainline drainage systems.

Proposed drainage systems consist of reinforced concrete pipes. Each of the drainage facility reaches meet the minimum size criteria and were analyzed to determine drainage capacity and design flow rate. The drainage systems were designed with the following minimum slopes and sizes:

1. Laterals - 18" RCP / 1.0 %
2. Main Collectors - 24" / 0.5%
3. Gutters - 0.3%

Design Approach: The design approach follows the guidelines of the Orange County Hydrology Manual. In addition, the City of Santa Ana's Drainage Master Plan was used to determine ultimate drainage facilities, alignments and anticipated flow rates within the Project study area limits. The proposed drainage facilities are consistent with the City's Master Plan study dated May, 1994. For this study, lateral drainage systems were not designed, only

mainline drainage systems were analyzed. However, the drainage laterals will be analyzed during the preliminary design phase in order to establish impacts to underground utilities.

3.5 Impacts on Existing Drainage Systems

The construction of at-grade track for the fixed guideway alternatives will impact several drainage systems. The following summarizes the impacts which may be mitigated:

- Replacement of parkway culverts with proposed catch basins
- Elimination of cross gutters with proposed catch basins
- Replacement of undersized facilities
- Relocation of pipes and catch basins
- Concrete encasement of pipes if necessary
- Connection of new systems to existing ones
- Upgrade of existing drainage systems per City of Santa Ana Drainage Master Plan

3.6 Proposed Drainage Systems

The proposed drainage systems are based on the City's Drainage Master Plan and consistent with the City's future improvements. In general, new drainage systems along the fixed guideway alignments will convey runoff from proposed and existing catch basin laterals. The catch basins are proposed and spaced to minimize the flooded width in order to not impact the fixed guideway track envelope. The new drainage systems will connect to upsized north-south drainage systems along the streets perpendicular to the fixed guideway corridors. The north-south facility improvements will extend to 1st Street in order to mitigate potential flooding in the downtown area due to existing downstream facilities not being upsized with this Project. The proposed drainage systems improvements focus on minimizing flooding within the fixed guideway alignments and, specifically within the track envelope. They do not increase overall system capacity and so to the extent that flooding currently occurs within the downtown area, it will likely continue to occur (although to a lesser degree along the fixed guideway alignments). Further flooding analysis will be required during the next phase of the Project to indicate the extent of flooding and impacts to the downstream facilities due to the upgraded upstream drainage facilities. Appendix D shows the proposed drainage systems for the fixed guideway alternatives.

In addition, catch basins are proposed at street intersections to eliminate cross gutters and/or parkway culverts over the fixed guideway tracks. The proposed improvements specified are sufficient to minimize flooding within the track alignment segment. However, the drainage systems will not be able to completely eliminate flooding and/or ponding in certain areas without future drainage facility improvements per the City's Drainage Master Plan. Table 1 provides a list of intersections which will require reconstruction to eliminate cross gutters to provide for a smoother fixed guideway profile.

Table 1: List of Intersections Requiring Reconstruction to Eliminate Cross Gutters

STREET CROSSING	ALIGNMENT			
	Santa Ana Boulevard	4th Street	5th Street	6thStreet/ Brown Street
Minter Street				**X**
Garfield Street				**X**
Poinsettia Street				**X**
French Street	**X**		**X**	
Bush Street	**X**	**X**	**X**	
Main Street	**X**	**X**	**X**	
Sycamore Street	**X**	**X**	**X**	
Spurgeon Street		**X**		
Mortimer Street		**X**	**X**	
Broadway	**X**	**X**	**X**	
Bristol Street	**X**			
Raitt Street	**X**			
TOTAL	**7**	**6**	**6**	**3**

Appendix G shows typical intersection reconstruction detail with limits of work.

3.6.1 Drainage System Improvements in Streetcar 1 – Downtown Segment: Within this segment, the improvements consist of a proposed 60-inch RCP along Santa Ana Boulevard from Santiago Street to French Street. This system replaces the existing 27-inch RCP. Along French Street, the existing north-south 33-inch will be replaced with an 84-inch RCP to 3rd Street and connect to existing 39-inch at 3rd Street. Additional improvements consist of 36-inch RCP along Santa Ana Boulevard from Spurgeon Street to Broadway, then south along Broadway to 3rd Street; a 54-inch RCP along Ross Street from Santa Ana Boulevard to 3rd Street with a 36-inch RCP between Ross Street and Broadway.

Along 4th Street, the existing concrete V-gutters will be reconstructed with a ribbon gutter with slotted drain, as shown on the details in Appendix G. Due to the close proximity of the track alignment within this corridor segment, the slotted drain is proposed to rapidly convey storm water runoff in an underground system and minimize impacts to the track due to flooding.

3.6.2 Drainage System Improvements in Streetcar 2 – Downtown Segment: Within this segment, the improvements consist of a new storm drain along the eastbound alignment from Ross Street to Santiago Street. The system flows downstream beginning with a 24-inch at Santiago Street, a 33-inch along Minter, and then a 36-inch along 5th Street. The storm drain system connects to a proposed 54-inch north-south system along Ross Street which replaces the existing 24-inch RCP.

Along Civic Center Drive, a 24-inch storm drain is proposed from Main Street to Spurgeon Street which connects to an existing 33-inch drainage system. Also, a 42-inch drainage system is proposed from approximately Van Hess Street to Flower Street which connects to proposed 42-inch system that replaces the existing 24-inch storm drain along Flower Street.

3.6.3 Drainage System Improvements in Streetcar 1 and 2 – Raitt to Flower Segment: Within this segment, the lateral improvements from the proposed catch basins are conveyed within the following proposed storm drain systems:

- 24-inch RCP from approximately Olive Street to Shelton Street which connects to existing 30-inch RCP along Shelton Street
- 24-inch RCP from approximately Baker Street to Bristol Street which connects to future City improved north-south drainage system along Bristol Street.
- 36-inch RCP from Pacific Avenue to Raitt Street which connects to future City improved north-south drainage system along Raitt Street.

3.6.4 Drainage System Improvements in Streetcar 1 and 2 – PE ROW: Due to minimal drainage as-built information within the PE ROW, the assumption for this segment is drainage improvements will be required to facilitate the streetcar tracks only. The drainage system along the PE ROW will convey the runoff and exit towards the Santa Ana River. Appropriate best management practices will be determined at the preliminary and final design stages. Any future arterial or improvements, other than fixed guideway, will take into account drainage for those improvements.

3.7 Fixed Guideway Track Drainage

Track drainage includes both drainage of water from top surface of the track and the subsurface support system. The objective is avoiding accumulation of standing water or trapped water pockets along the tracks. The storm water runoff within the track envelope will be contained and collected with track drains installed at low points and in areas required to drain water from the track envelope so as not to affect the fixed guideway operation. Track drain inlets will be of sufficient size to allow water to enter without ponding. Track drains will be installed to minimize the amount of water that may enter the sub-grade of the fixed guideway envelope. Water from the surface drains will be conveyed underground to the nearest storm drain facility.

3.8 Santa Ana River Bridge

As described previously, the existing historic Santa Ana River Bridge is inadequate to accommodate the proposed fixed guideway due to it age, size (it was constructed as a single-

track bridge), disrepair, undetermined structural integrity (both superstructure and foundation) and non-compliance with current building and safety requirements.

Four design options were identified to address the fixed guideway river crossing and the historic Pacific Electric Santa Ana River Bridge:

1. Replace the historic bridge with a new bridge that includes decorative treatment to resemble the historic bridge: In Option 1, the historic PE Santa Ana River Bridge would be demolished. A new bridge would be constructed in its place. The new bridge would accommodate double tracks and would include a decorative treatment to resemble the original historic bridge. A concept drawing of Option 1 is included in Appendix A.

2. Leave the historic bridge in place and construct new single-track bridges on each side: In Option 2, the historic PE Santa Ana River Bridge would remain in its current location and condition. New single-track bridges would be constructed immediately north and south of the historic bridge to carry the fixed guideway. Although the historic bridge would remain, the view of the bridge would be obstructed by the new bridges. The concept drawing of Option 2 is included in Appendix A.

3. Relocate and repurpose the historic bridge: In Option 3, the historic PE Santa Ana River Bridge would be detached from its existing foundation and moved approximately 650 feet south of its current location. It would be positioned on a new foundation and piers providing the potential for future repurposing of the bridge for bicyclists and pedestrians. A new double-track bridge would be constructed within the PE ROW to accommodate the fixed guideway. The concept drawing of Option 3 is included in Appendix A.

4. Leave the historic bridge in place and construct a new single-track bridge immediately south: In Option 4, the historic PE Santa Ana River Bridge would remain in its current location and condition. A new single-track bridge would be constructed immediately south of the historic bridge to carry the fixed guideway. Through the use of gates and signaling, the single-track bridge would accommodate bi-directional fixed guideway operations. Although adequate for the proposed fixed guideway project, this will pose some capacity constraints for future expansion of fixed guideway operations. Although the, the view of the historic bridge would be somewhat obstructed by the new bridge when viewed from the south, the view from the north would remain unchanged. The concept drawing of Option 4 is included in Appendix A.

The four design options were evaluated based on five criteria:

1. Feasibility
2. Hydraulic impacts to the Santa Ana River
3. Constructability
4. Compatibility with future plans and improvements
5. Impact to a historical resource.

Based on the results of the evaluation, three design options were eliminated from further consideration. Design Option 1 which would demolish the existing bridge and replace it with a new bridge was eliminated due to its substantial impact to the historic bridge. Option 2 was eliminated because the construction of the two new bridges on each side of the historic bridge would impact the views of the existing bridge. In addition, Option 2 was incompatible with future plans and improvements because it would utilize as much as 63 feet of the 100-feet right-of-way, requiring that considerable additional right-of-way be acquired to accommodate the future multi-modal corridor within the right-of-way. Option 3, which would relocate and repurpose the historic bridge, was eliminated because the relocation of the bridge represented adverse effects to a Section 4(f) impacts because it creates a risk of damage to the historic bridge, and changes the historic setting and the view of the bridge.

Options 4: Leave the historic bridge in place and construct a new single-track bridge immediately south, was identified to be carried forward for further analysis through the environmental review process.

Inadequate information was available to perform hydraulic modeling at this conceptual level of analysis. The potential impacts of Option 4 on the Santa Ana River channel were evaluated based on:

1. The area of the footprint of the piers within the river channel, as a surrogate for the volume of displacement. The larger the footprint of the pier, the greater the potential for displacement and therefore the greater the impact on channel capacity.

2. The width of the pier face. The wider the pier face, the greater the potential impact to river channel hydraulics.

Table 2 shows the dimensions and areas of the piers within the Santa Ana River Channel to support each of the bridges included in the bridge deign options.

Table 2: Bridge Options' Pier Dimensions

BRIDGE SCENARIO	PIER DIMENSIONS		
	FACE (feet)	LENGTH (feet)	AREA (square feet)
Existing			
Historic Bridge	9	27	243
Option 4 - Bridge Avoidance B			
Existing bridge	9	27	243
New bridge	4	18*	72

*Includes space between the footing for the existing historical bridge and the immediately proximate new bridge.

Source: Santa Ana-Garden Grove Fixed Guideway Conceptual Design Plans, August 2012.

The area of the center pier of the existing historical bridge is approximately 243 feet with a 9-feet wide pier face. Option 4 leaves the historical bridge in place and adds a second bridge

immediately adjacent and south of the existing bridge. The result is that the area of the footprint for Option 4 is slightly larger (72 square feet larger) than with the existing bridge alone. The will result in a negligible impact to channel capacity. Because the pier face of the new bridge will be approximately 4-feet wide and tucked immediately south behind the existing 9-feet pier face, the impact to channel hydraulics is also projected to be minimal.

Option 4 is not estimated to result in significant impacts to either the 100-year flood capacity of the Santa Ana River channel or its hydraulics. Further hydraulic modeling will be required during preliminary engineering and final design.

4.0 SUMMARY

The improvements recommended in this Drainage Technical Report are all within the City of Santa Ana's right-of-way. The proposed drainage systems are adequate for the fixed guideway improvements only in coordination with the City's future drainage improvements within the Project limits. The improvements are limited to areas crossing the fixed guideway corridors to prevent operations from being disturbed in the future as the City implements the Drainage Master Plan. No offsite mitigation was considered nor was any new drainage areas introduced. However, it is anticipated that the project will slightly improve the current flooding condition in the downtown areas due to the added catch basins and additional storage in the upsized and proposed drainage facility systems. The City will need to continue construction of the Master Plan to improve the overall existing drainage conditions and avoid flooding in the study area. In addition, as the Project moves forward, the drainage system improvements will need to be consistent with the Transit Zoning Code and adhere to regulations such as NPDES, OCDAMP requirements, and City's Local Implementation Plan including mitigation measures specifically MM4.6.2 as stated in Chapter 4.6 of the "City of Santa Ana Transit Zoning Code EIR.

4.1 Quantity Estimate

Quantity take-offs were prepared, based on the improvements identified with each fixed guideway alignment alternative, for use in developing concept-level cost estimates for the project. Total quantities are summarized in Appendix H.

4.2 List of Issues

This study is part of the conceptual design phase for Santa Ana-Garden Grove Fixed Guideway Project, and therefore does not address all design issues or future proposed elements. The following additional analyses are required as the project moves through preliminary and final design:

- Water Quality Management – Runoff Treatment and Best Management Practices
- Survey information of all existing utilities
- Pothole information to accurately locate existing utilities
- Updated City of Santa Ana Drainage Master Plan
- Further hydrologic and hydraulic analyses

5.0 REFERENCES

5.1 Design Manuals

- Orange County Department of Public Works - Hydrology Manual
- City of Santa Ana Drainage Master Plan. (May, 1994)

5.2 Design Software

- Haestad Methods FlowMaster® Hydraulic Analysis
- Bentley StormCad v5.6

4.0 SUMMARY

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- City of Santa Ana Drainage Master Plan. (May, 1994)

5.2 Design Software

- Haestad Methods FlowMaster® Hydraulic Analysis
- Bentley StormCad v5.6

Appendix A:

Fixed Guideway Alternatives

Appendix A-1: Santa Ana-Garden Grove Fixed Guideway Alternatives

- **Transportation Systems Management (TSM) Alternative (Bus Elements)**
- **Streetcar Alternative1**
- **Streetcar Alternative 2**

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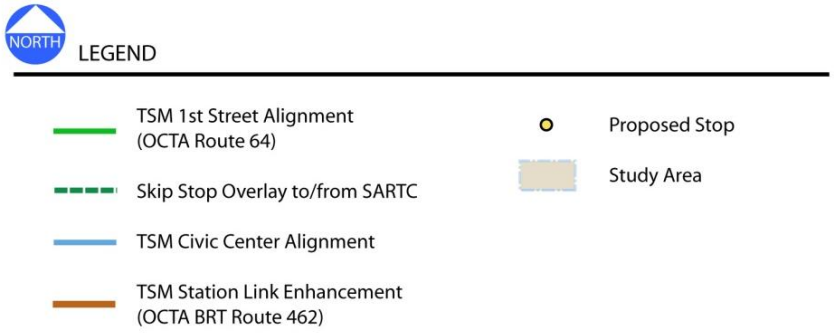
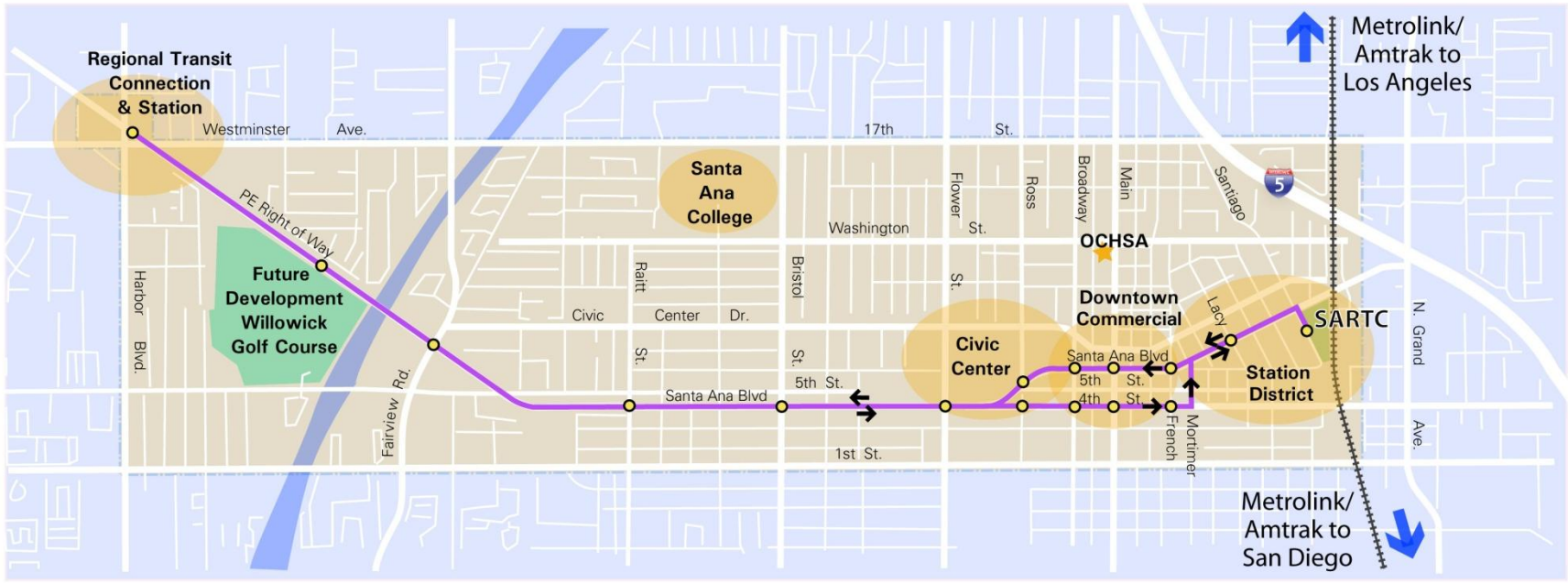
Transportation Systems Management TSM) Alternative (Bus Elements)



Streetcar Alternative 1: Santa Ana Boulevard/4th Street Couplet



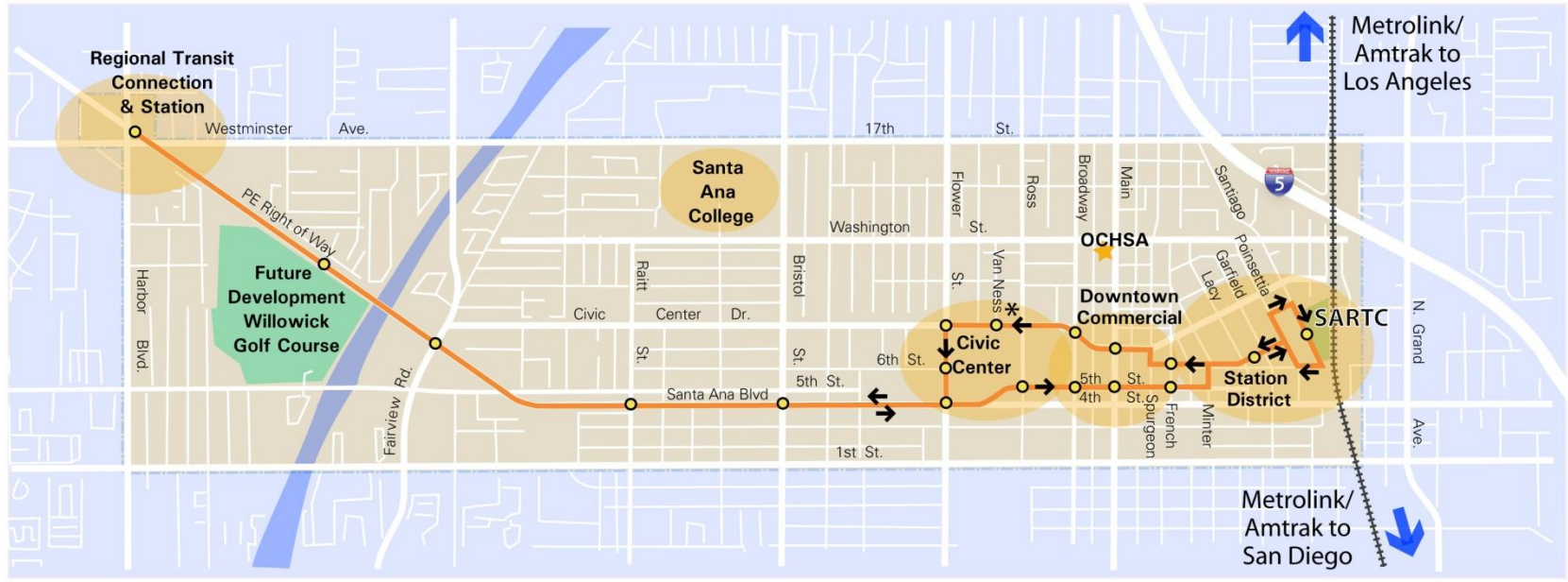
NORTH

LEGEND

- Streetcar 1
- Proposed Stop
- Future Extension to Metro East Mixed-Use Development
- Study Area

Alternative 1 Design Option 1
Sasscer Park mitigation

Streetcar Alternative 2: Santa Ana Boulevard/5th Street & Civic Center Drive Couplet



NORTH

LEGEND

- Streetcar 2
- Proposed Stop
- Future Extension to Metro East Mixed-Use Development
- Study Area
- * Civic Center station/stop on Civic Center Drive is located at Van Ness in Design Option 1 and at Ross Street in Design Option 2

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Appendix A-2: Historical Santa Ana River Bridge Design Options

- **Option 1: Bridge Replacement**
- **Option 2: Bridge Avoidance A**
- **Option 3: Bridge Relocation**
- **Option 4: Bridge Avoidance B**

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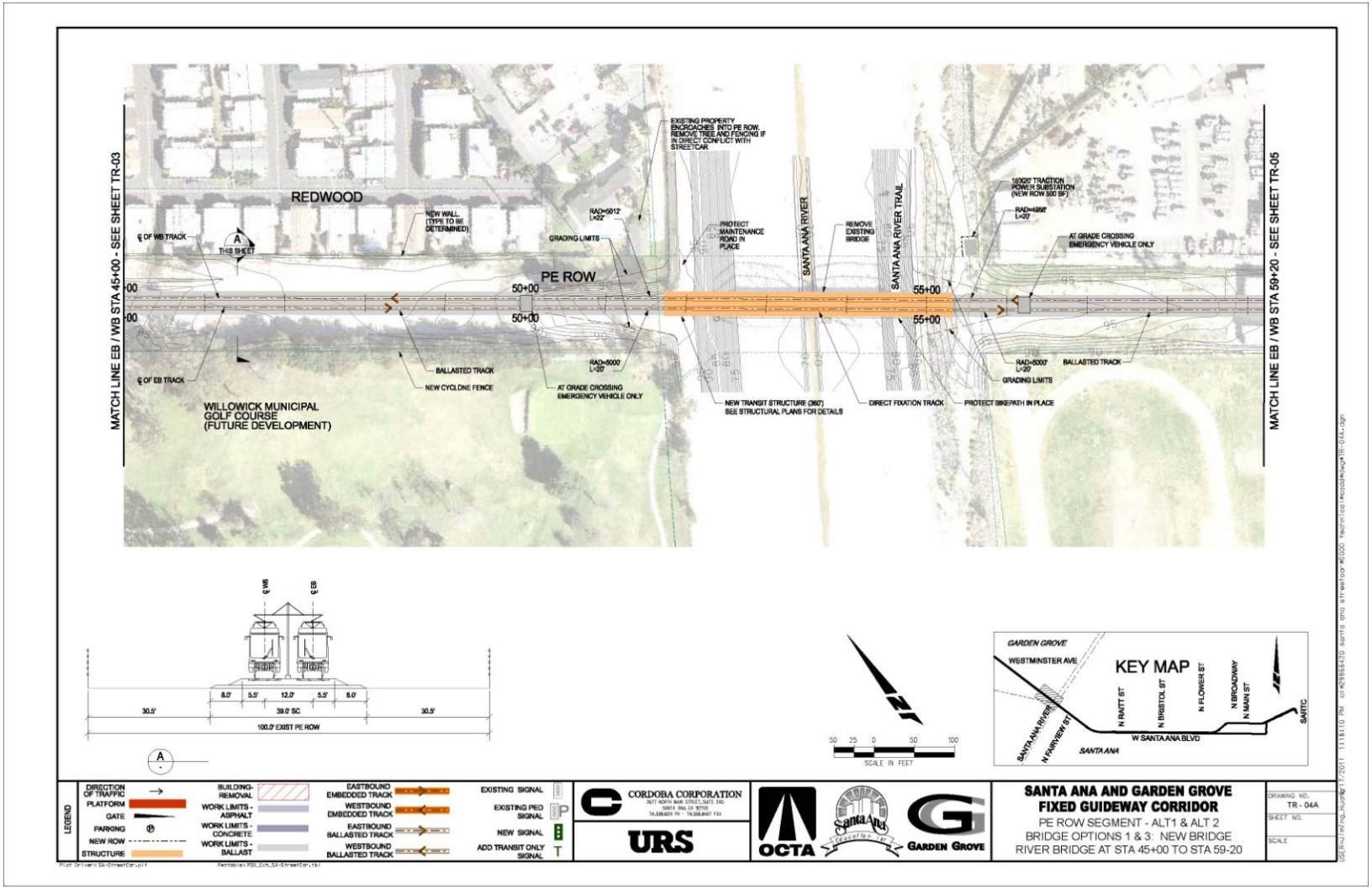
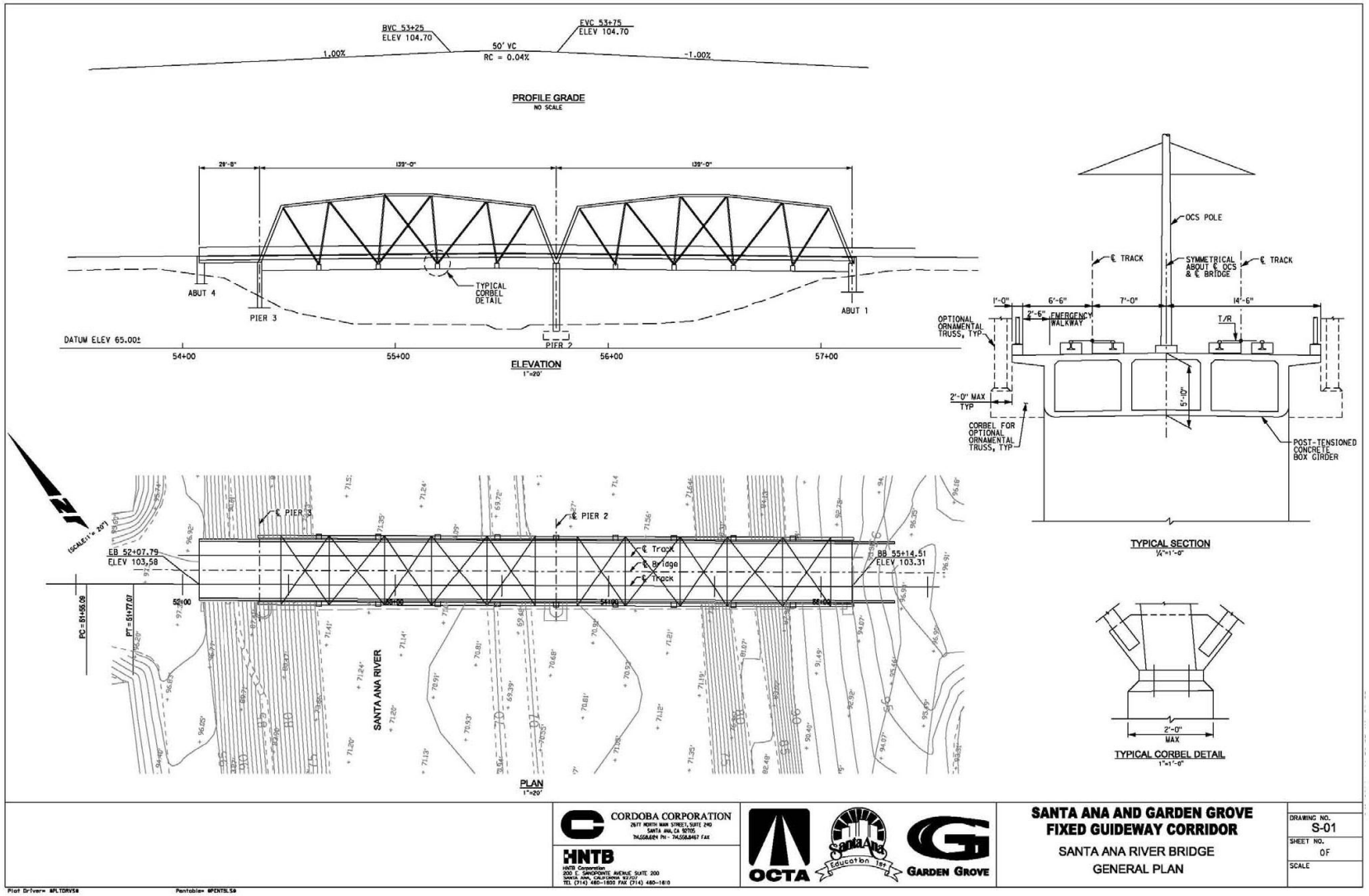
Option 1: Bridge Replacement – Demolish the existing bridge and replace with a new bridge that includes decorative treatment to provide a similar look to the existing bridge.

Alignment



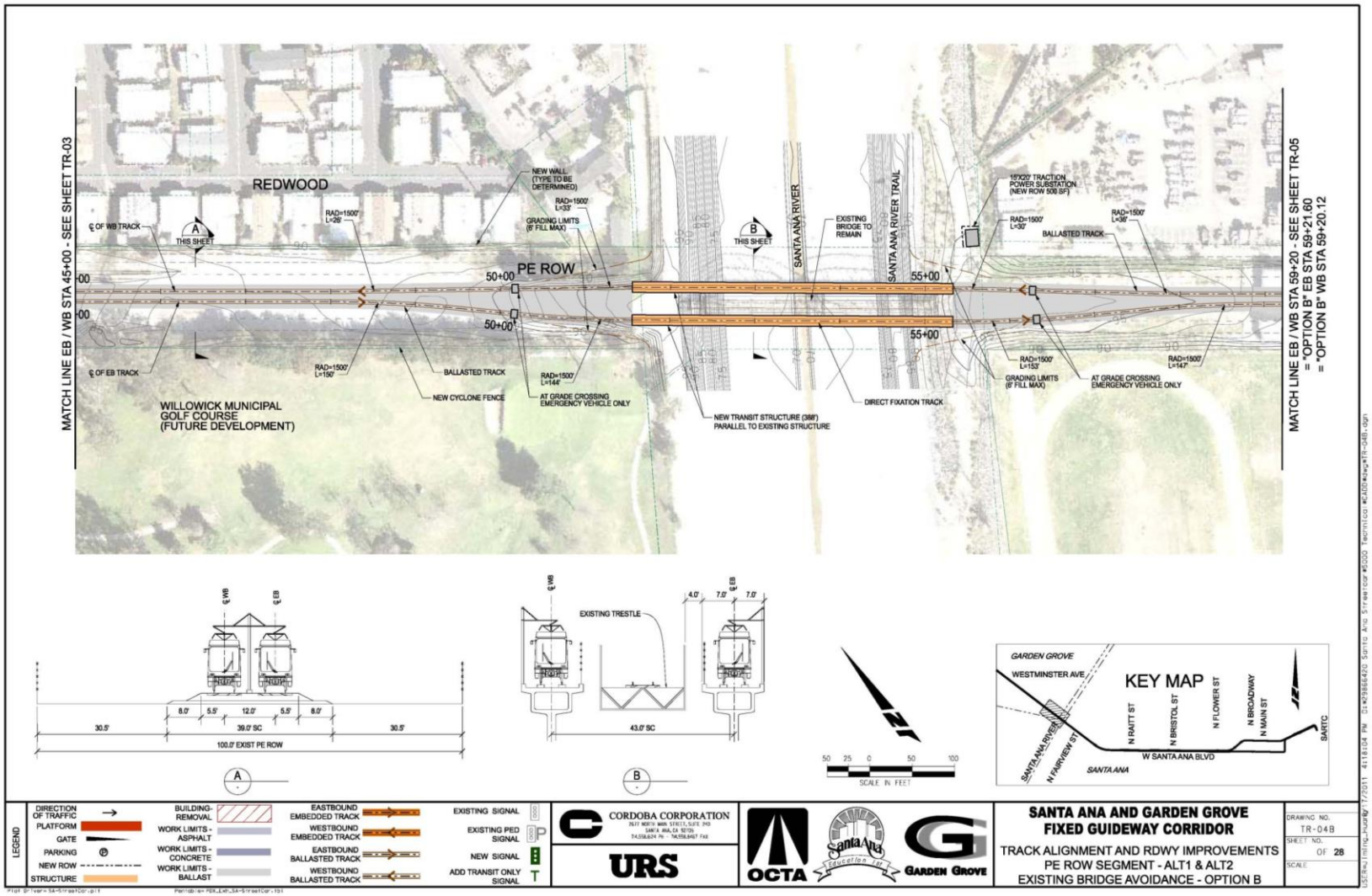
Option 1: Bridge Replacement – Demolish the existing bridge and replace with a new bridge that includes decorative treatment to provide a similar look to the existing bridge.

Plan, Profile and Typical Section



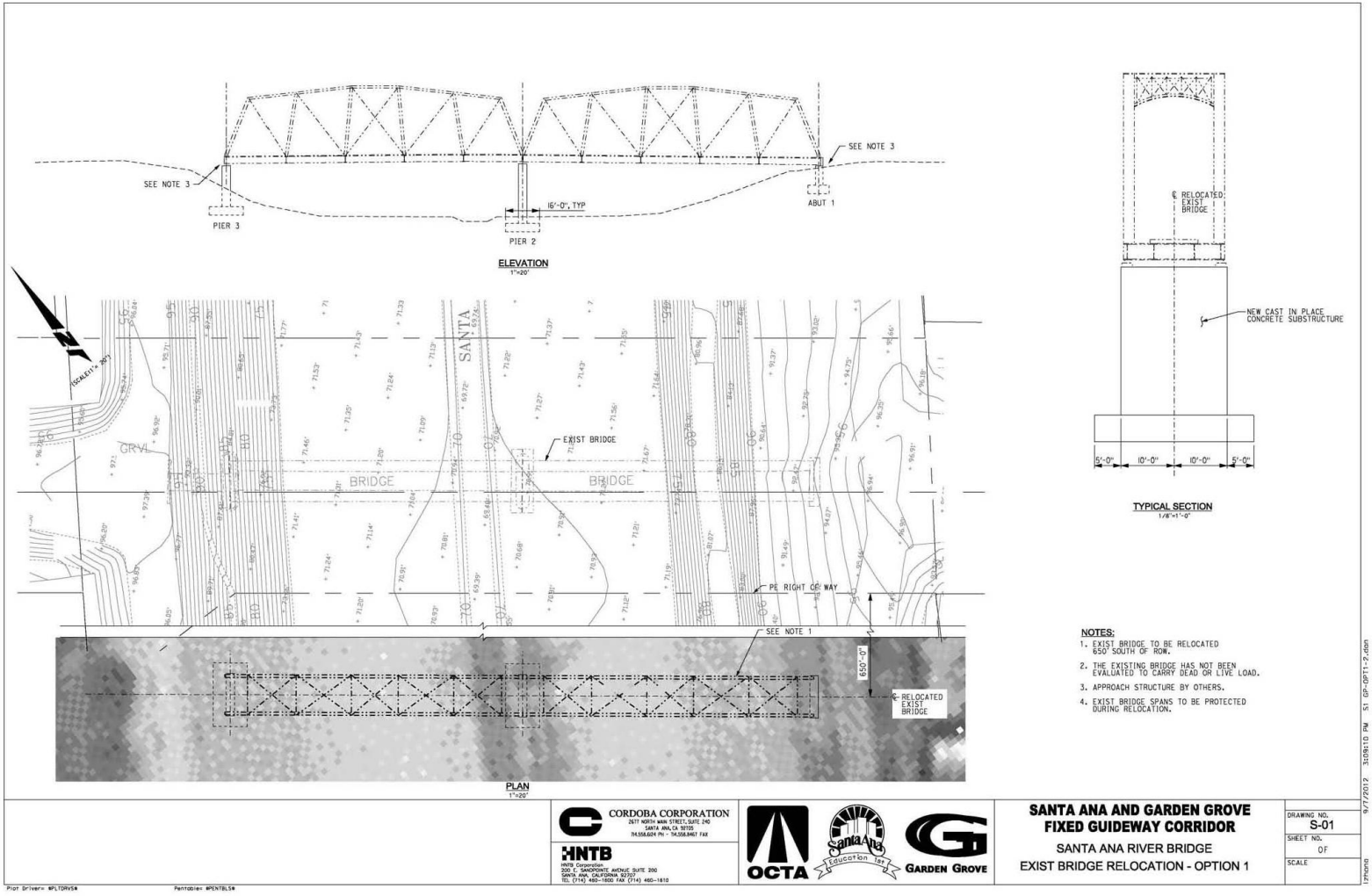
Option 2: Bridge Avoidance A: Leave the existing historic bridge in place and construct two new single-track bridges on each side of the existing bridge.

Alignment, Typical Section



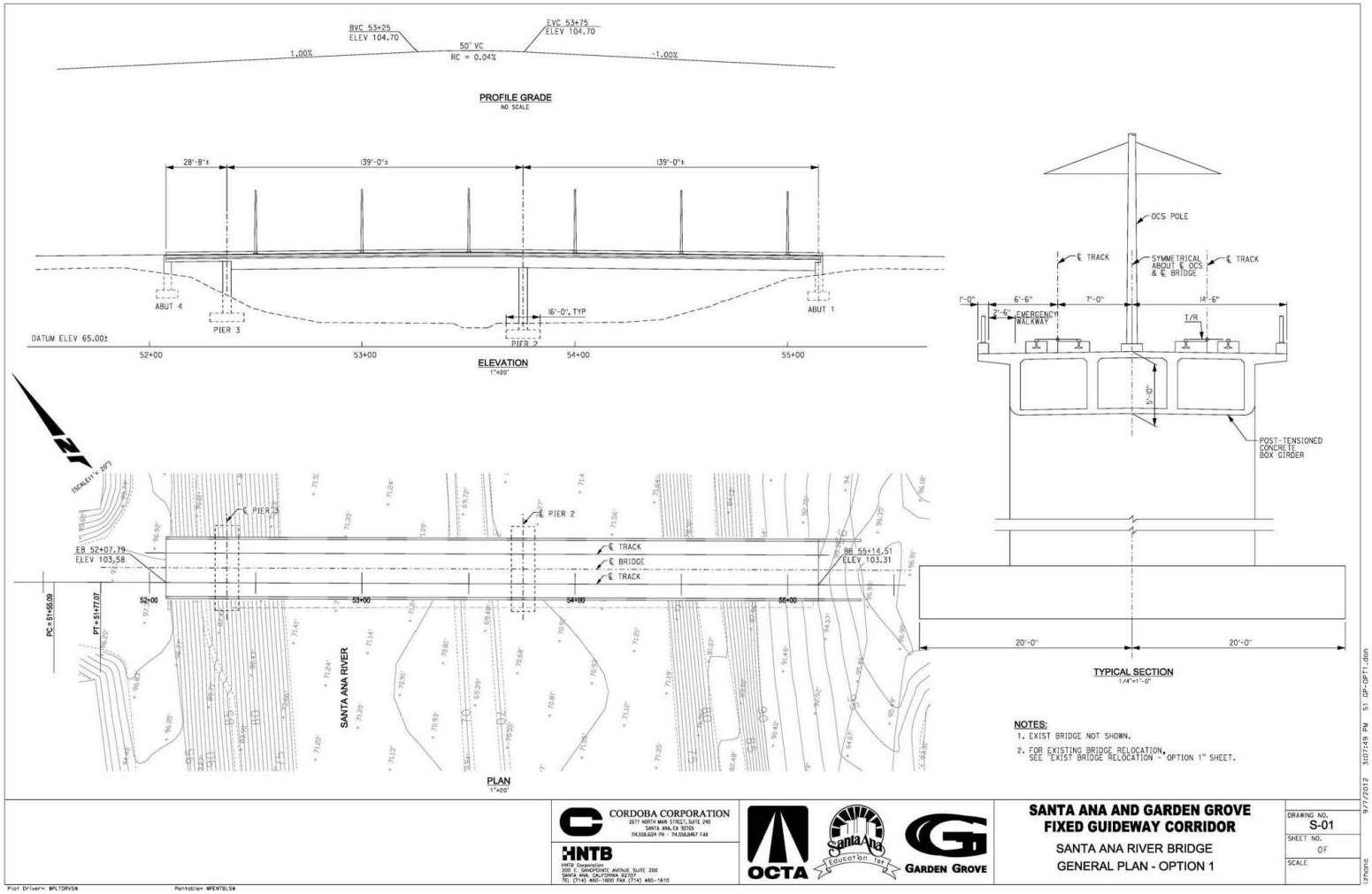
Option 3: Bridge Relocation – Relocate the existing historical bridge approximately 650 feet south of its current location and reposition on new foundation; construct new double-track bridge within the PE ROW.

Relocated Historic Bridge: Plan, Profile and Typical Section



Option 3: Bridge Relocation – Relocate the existing historical bridge approximately 650 feet south of its current location and reposition on new foundation; construct new double-track bridge within the PE ROW.

New Double-Track Bridge: Plan, Profile and Typical Section

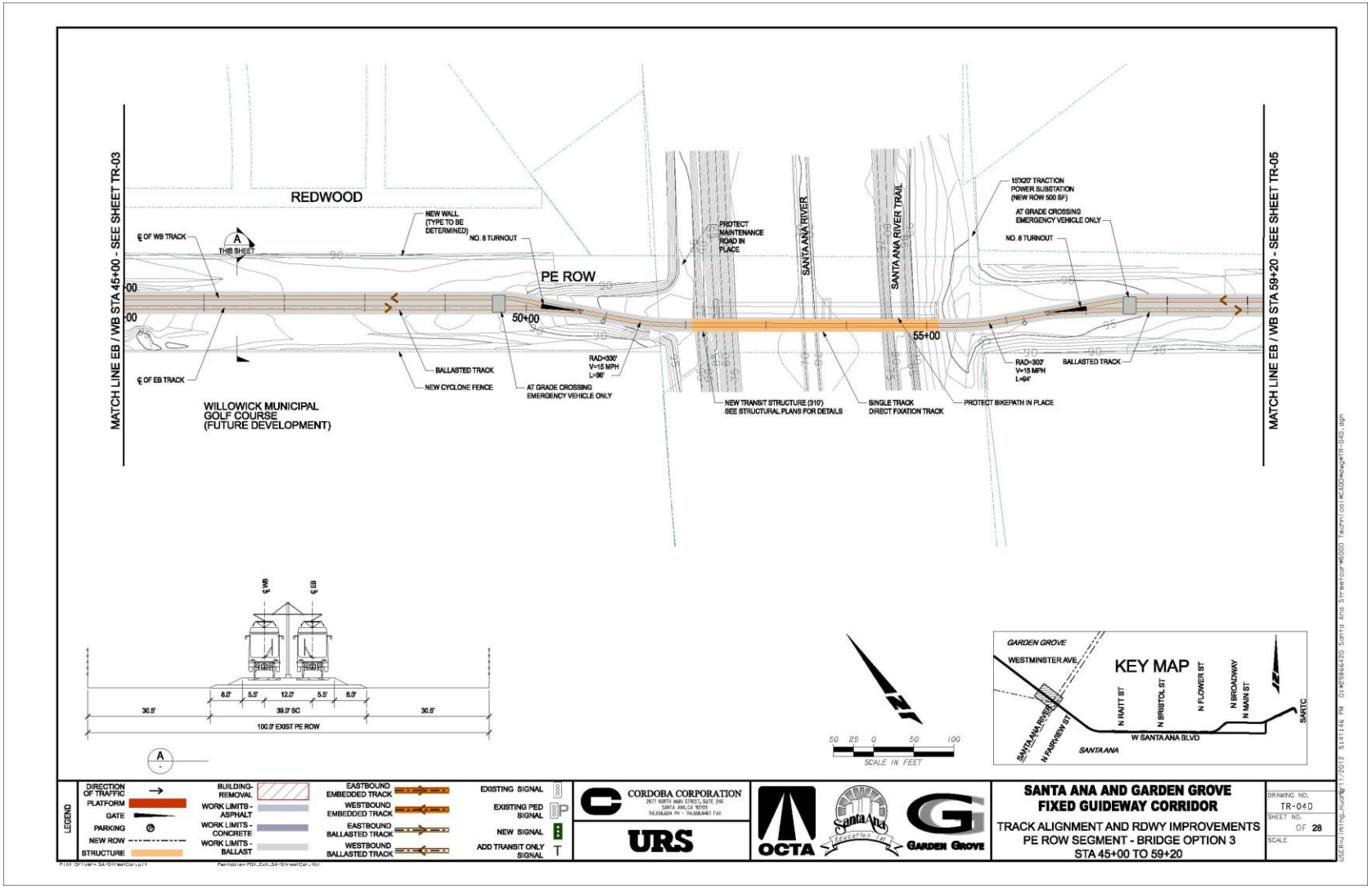


Option 3: Bridge Relocation – Relocate the existing historical bridge approximately 650 feet south of its current location and reposition on new foundation; construct new double-track bridge within the PE ROW.

Photo Simulation – From the south looking north

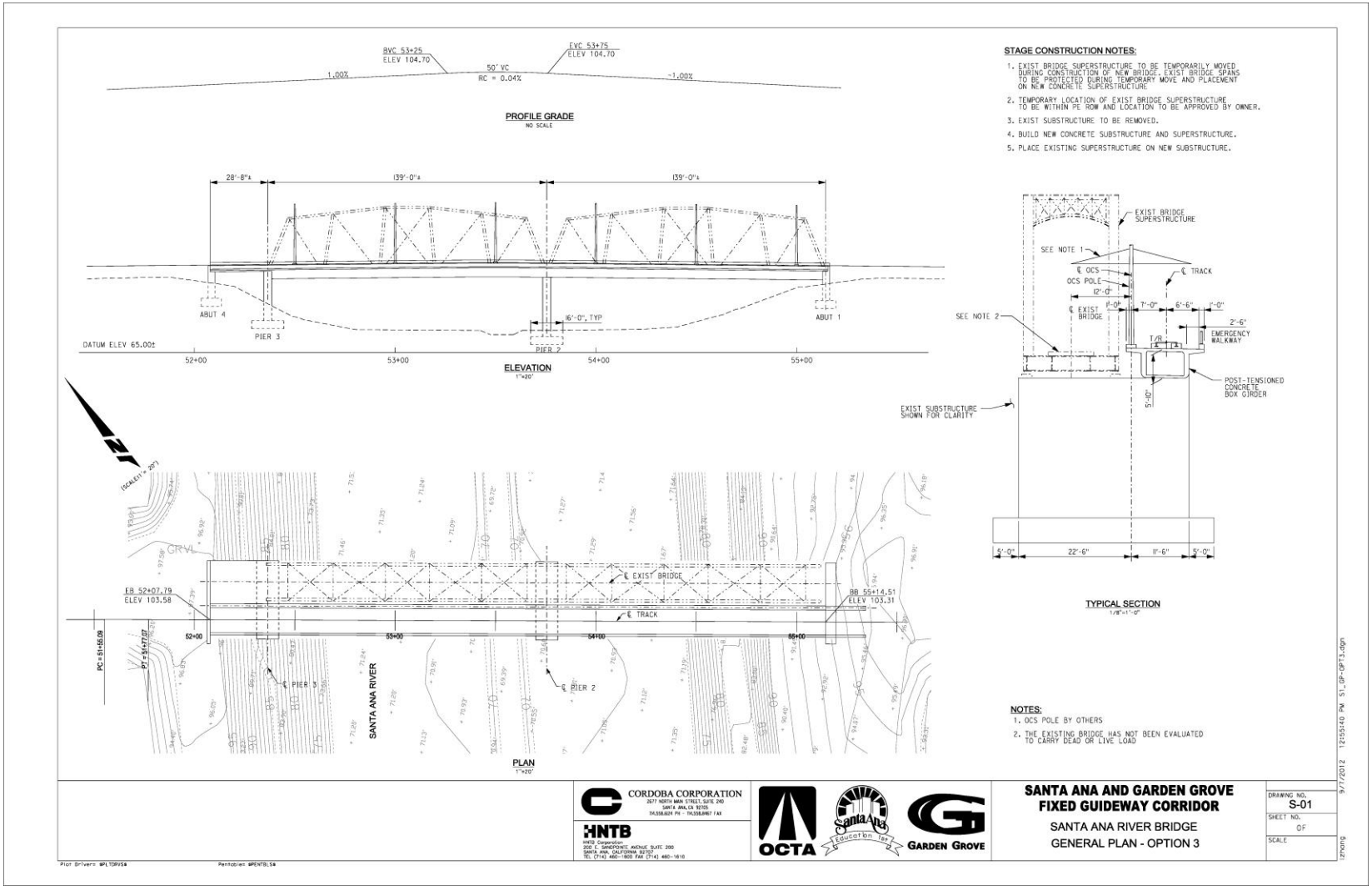
Option 4: Bridge Avoidance B: Leave the existing historic bridge in place and construct a new single-track bridge on the south side of the existing bridge.

Alignment, Typical Section



Option 4: Bridge Avoidance B: Leave the existing historic bridge in place and construct a new single-track bridge on the south side of the existing bridge.

Plan, Profile and Typical Section

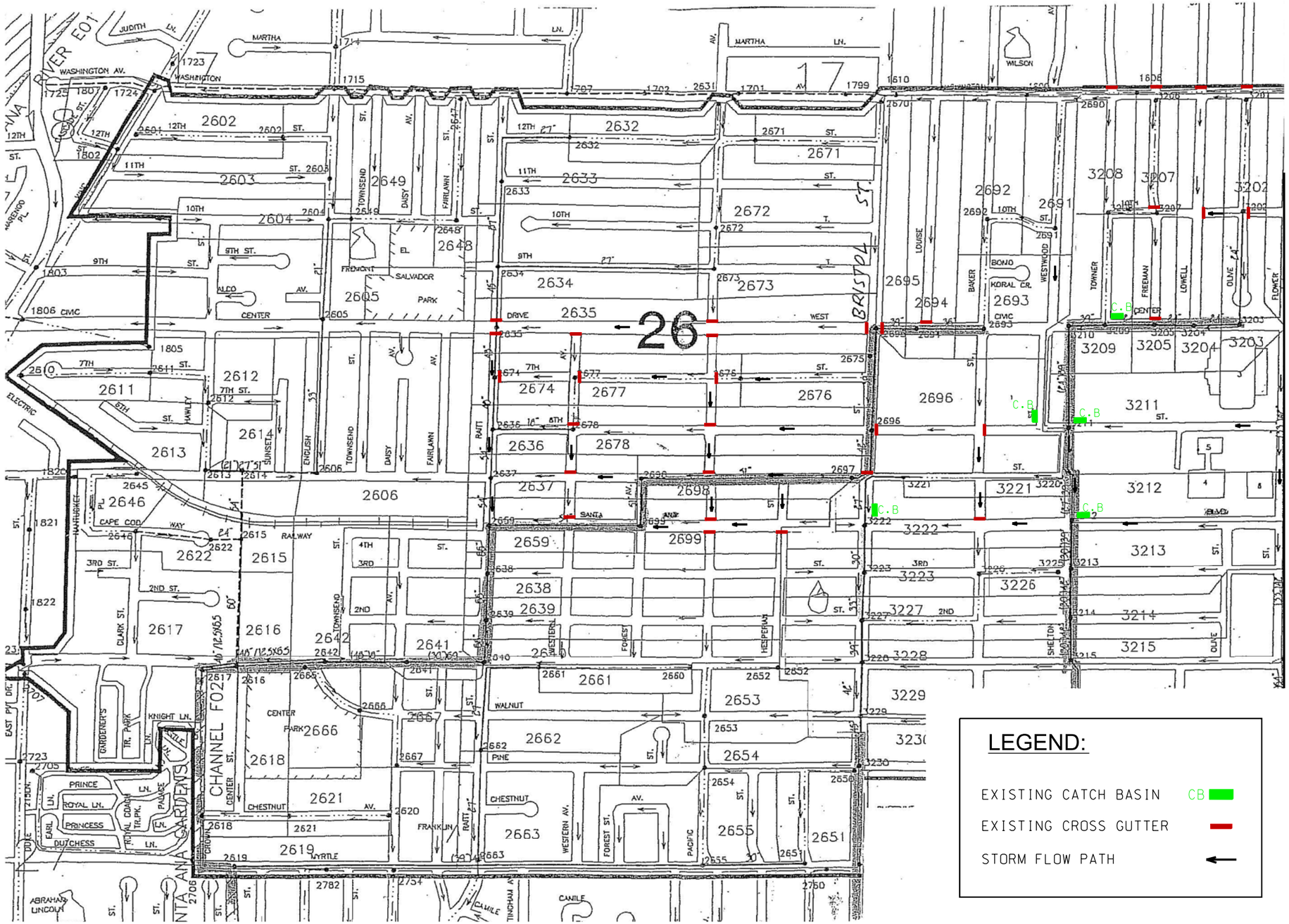


Option 4: Bridge Avoidance B: Leave the existing historic bridge in place and construct a new single-track bridge on the south side of the existing bridge.

Photo Simulation – From the south, looking north

Appendix B:

Existing Drainage Systems Map



MATCH LINE SEE SHEET D-002

LEGEND:

EXISTING CATCH BASIN	CB
EXISTING CROSS GUTTER	
STORM FLOW PATH	

REVISIONS			
NUMBER	DATE	DESCRIPTIONS	APPRVD

DESIGNED BY J.GARCIA
DRAWN BY D.SO
CHECKED BY R.RAMIREZ
APPROVED BY R.RAMIREZ
DATE 5/27/2011

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EXISTING DRAINAGE SYSTEM MAP

CONTRACT NO.
DRAWING NO. D-001
REVISION
SHEET NO. 1 OF 2
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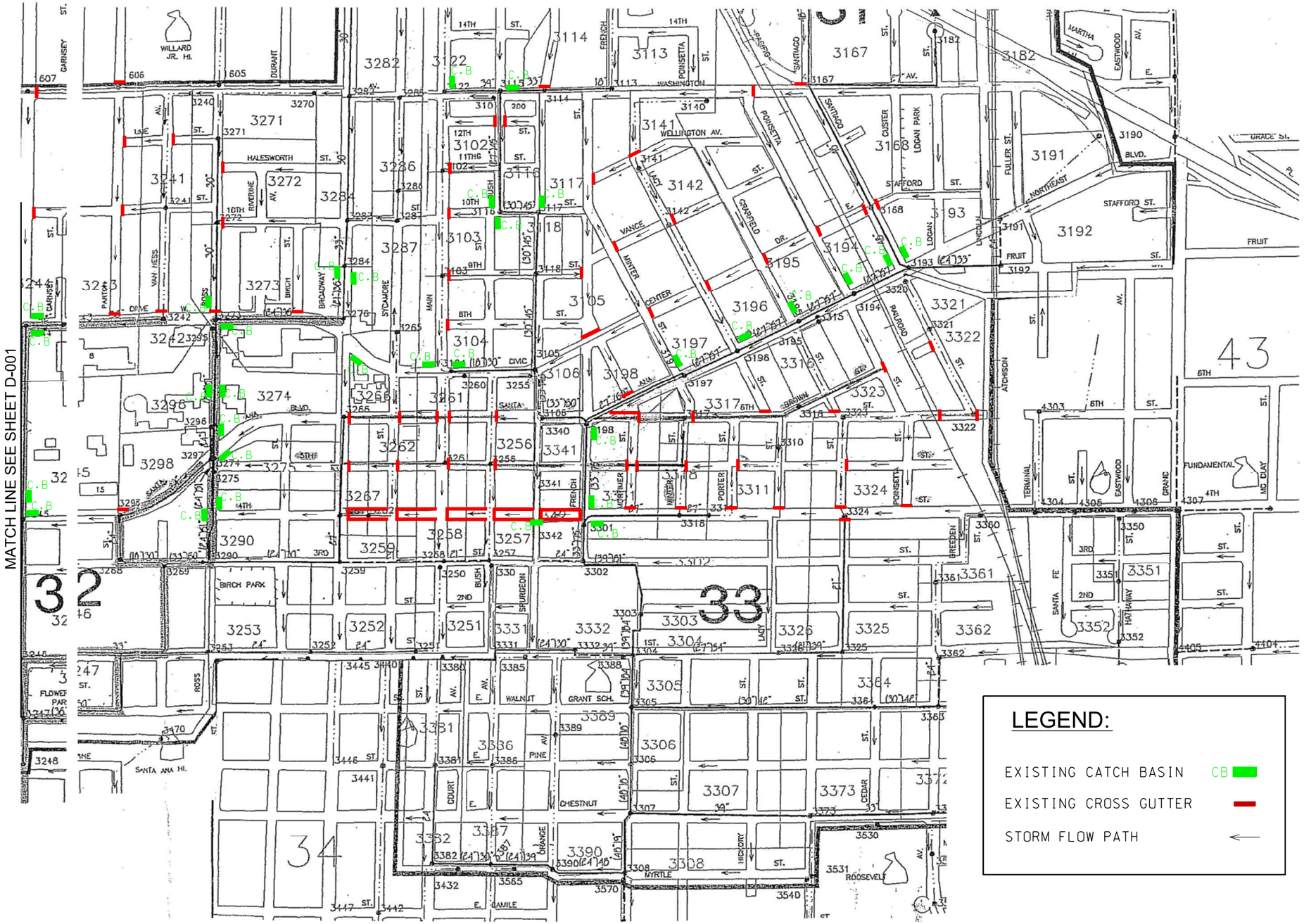

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APPROVED BY	R.RAMIREZ
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EXISTING DRAINAGE SYSTEM MAP

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REVISION	SHEET NO. 2 OF 2
SCALE	NTS

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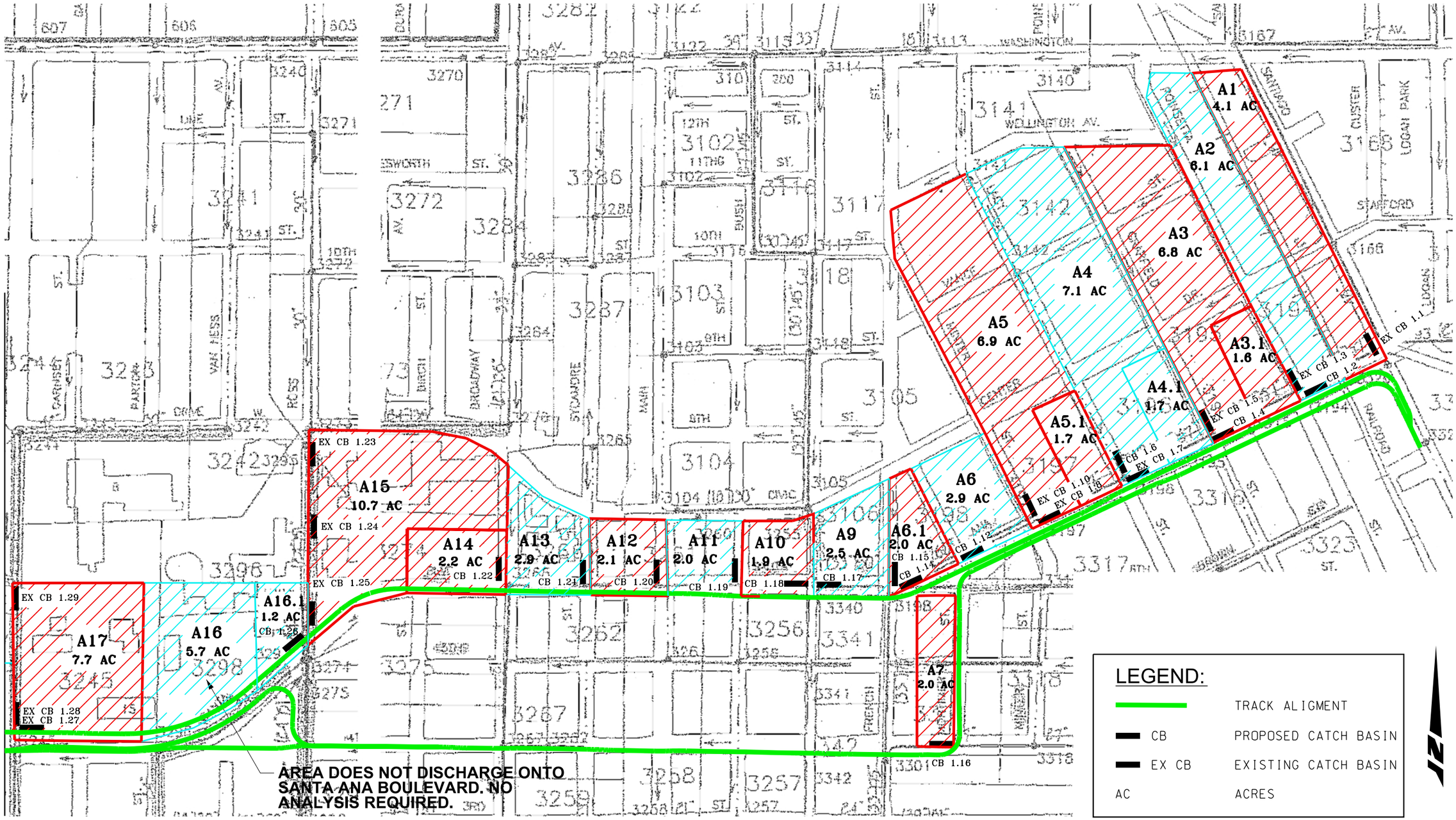
Appendix C:

Hydrology Maps



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HYDROLOGY MAP
DOWNTOWN SEGMENT
STREET CAR ALTERNATIVE 1

CONTRACT NO.	
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REVISION	SHEET NO. 1 OF 3
SCALE	NTS

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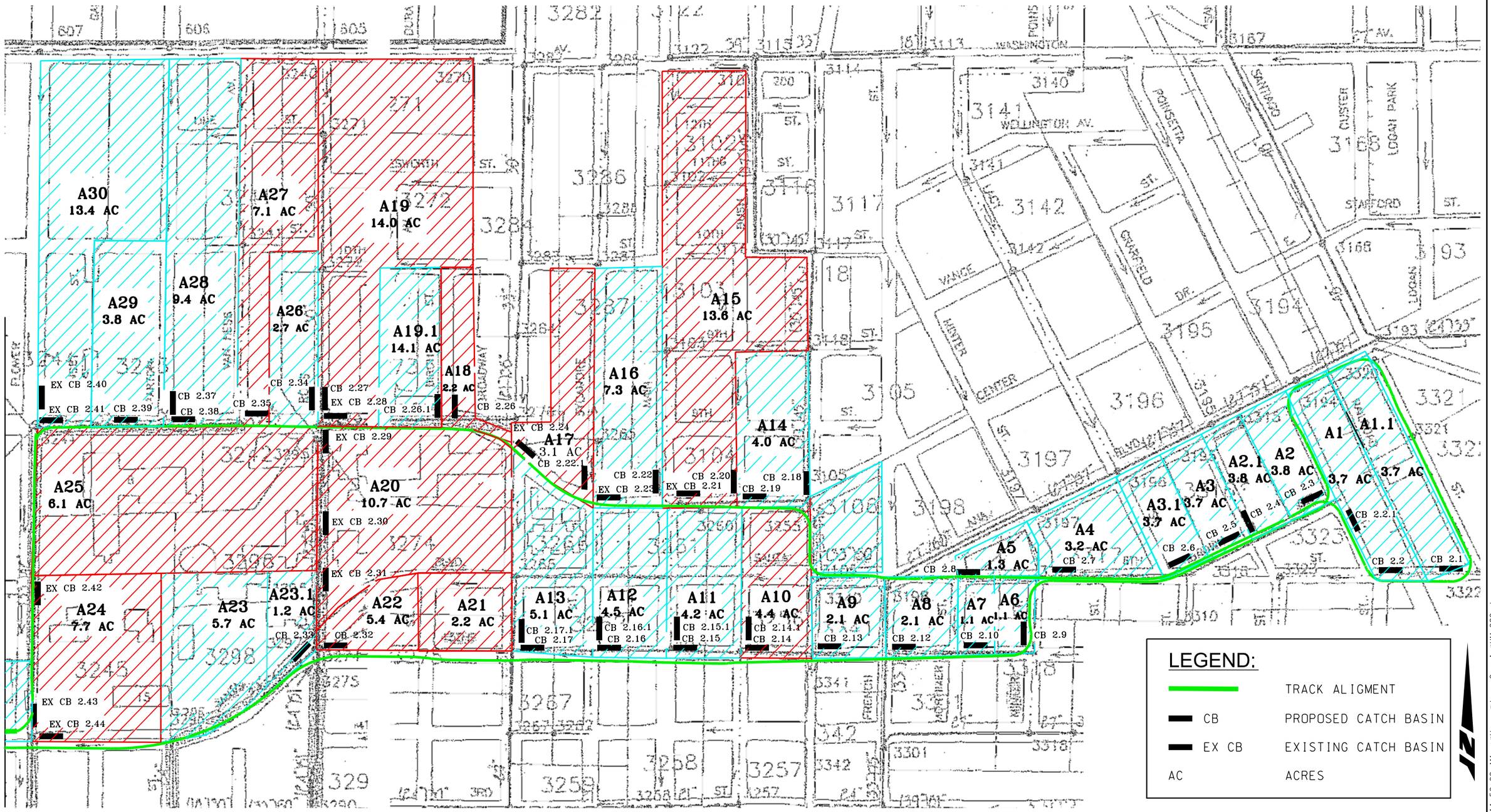

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HYDROLOGY MAP
DOWNTOWN SEGMENT
STREET CAR ALTERNATIVE 2

CONTRACT NO.	
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REVISION	SHEET NO. 2 OF 3
SCALE	NTS

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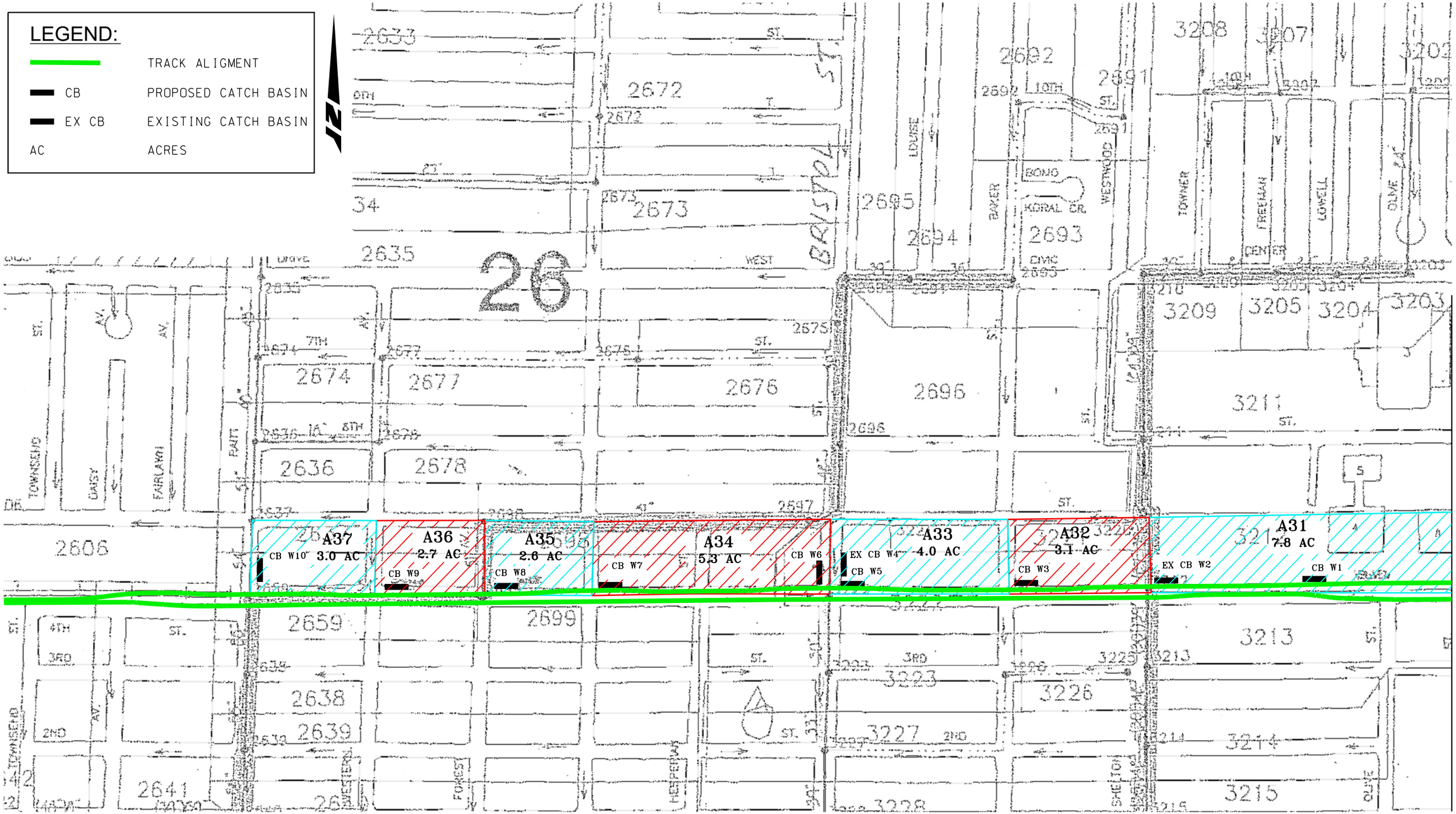
▬ EX CB	EXISTING CATCH BASIN
AC	ACRES



REVISIONS

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CHECKED BY	R.RAMIREZ
APPROVED BY	R.RAMIREZ
DATE	8/22/2011

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HYDROLOGY MAP
RAITT TO FLOWER SEGMENT
STREET CAR ALTERNATIVES 1 & 2

CONTRACT NO.	
DRAWING NO.	HM-003
REVISION	SHEET NO. 3 OF 3
SCALE	NTS

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Appendix D:

Proposed Strom Drain Systems

MATCH LINE SEE SHEET HM-006

FLOWER STREET

ROSS STREET

BROADWAY

SANTA ANA BLVD

CIVIC CENTER DR

POINSETTIA ST

SANTIAGO AVE

MORTIMER STREET

4TH STREET

3RD STREET

1ST STREET

(24")

(21")

(30")

(33")

(27")

30"

60"(27")

60"(33")

24"

54"

PROPOSED PIPE 1.1

PROPOSED PIPE 1.2

PROPOSED PIPE 1.3

PROPOSED PIPE 1.4

PROPOSED PIPE 1.5

PROPOSED PIPE 1.6

30"(18")

42"(33")

60"

33"

81"(39")

84"(39")

(39")

LEGEND:

- TRACK ALIGNMENT
- AC — ACRES
- 36" — NEW STORM DRAIN PIPE
- 36"(27") — REPLACE STORM DRAIN PIPE
- (24") — EXISTING STORM DRAIN PIPE

NOTE:

X.X
PROPOSED STREET CAR ALTERNATIVE
PROPOSED PIPE NUMBER

REVISIONS			
NUMBER	DATE	DESCRIPTIONS	APPRVD

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APPROVED BY R.RAMIREZ
DATE 7/6/2011

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PROPOSED STORM DRAIN
DOWNTOWN SEGMENT
STREET CAR ALTERNATIVE 1

CONTRACT NO.
DRAWING NO. HM-004
REVISION | SHEET NO. 1 OF 3
SCALE NTS

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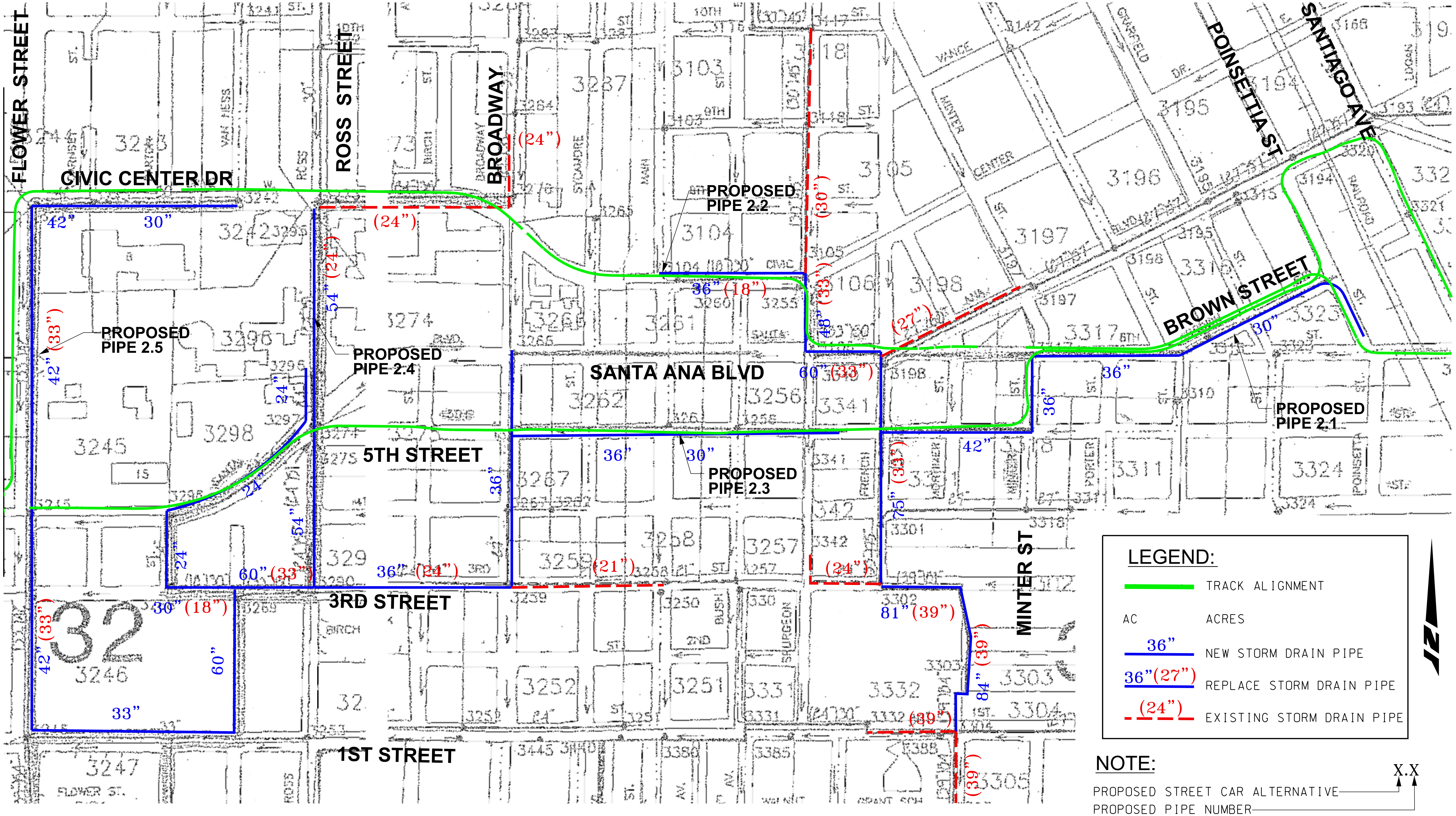

REVISIONS

NUMBER	DATE	DESCRIPTIONS	APPRVD

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FIXED GUIDEWAY CORRIDOR

PROPOSED STORM DRAIN
DOWNTOWN SEGMENT
STREET CAR ALTERNATIVE 2

CONTRACT NO.
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REVISION
SHEET NO. 2 OF 3
SCALE NTS

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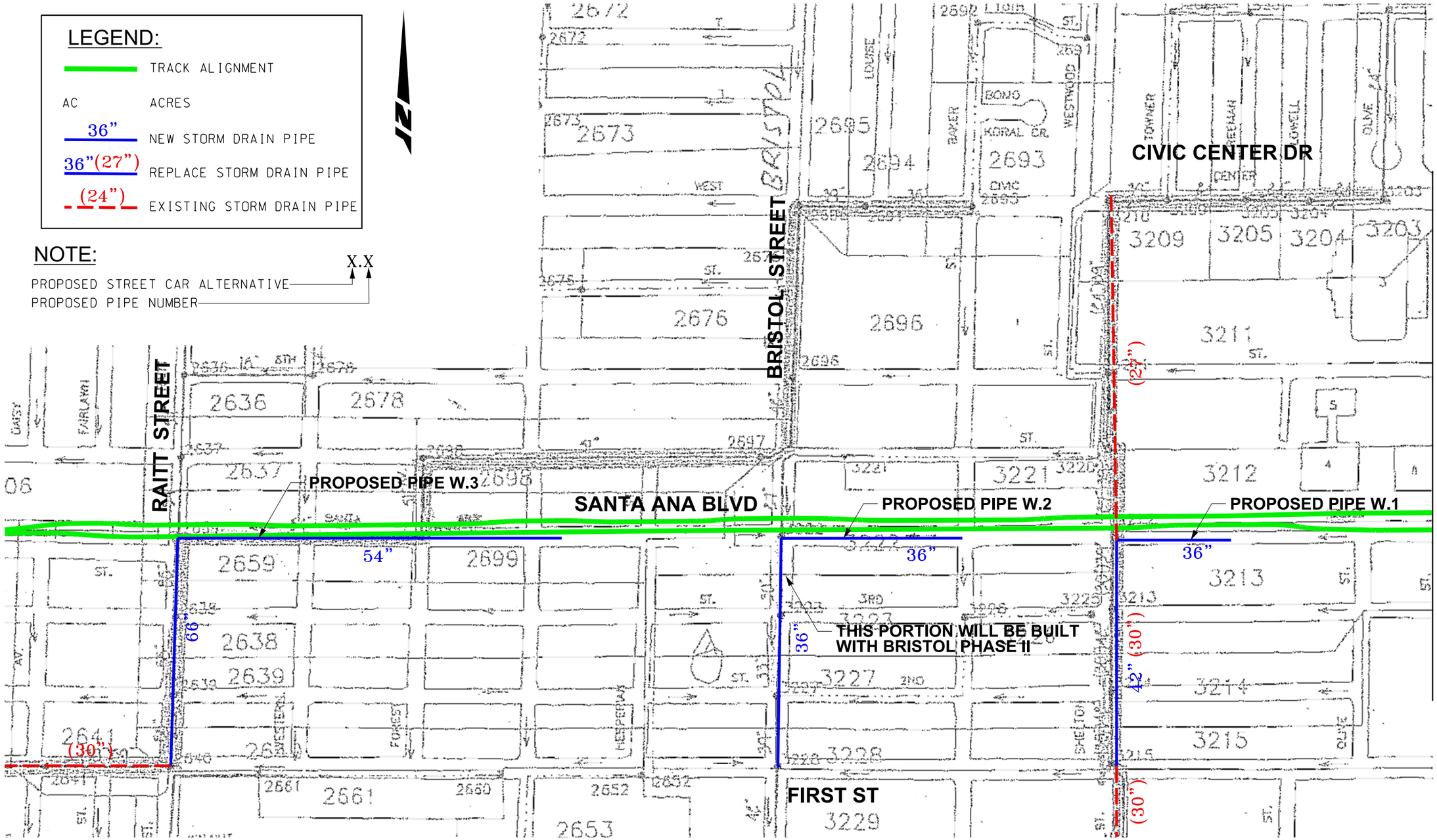
LEGEND:

- TRACK ALIGNMENT
- AC — ACRES
- 36" — NEW STORM DRAIN PIPE
- 36"(27") — REPLACE STORM DRAIN PIPE
- (24") — EXISTING STORM DRAIN PIPE

NOTE:

X.X
PROPOSED STREET CAR ALTERNATIVE
PROPOSED PIPE NUMBER



REVISIONS			
NUMBER	DATE	DESCRIPTIONS	APPRVD

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OCTA · Santa Ana Education 1st · Garden Grove

CITY OF SANTA ANA AND GARDEN GROVE FIXED GUIDEWAY CORRIDOR

PROPOSED STORM DRAIN SYSTEM
RAITT TO FLOWER SEGMENT
FOR STREET CAR ALTERNATIVES 1 & 2

CONTRACT NO.	
DRAWING NO.	HM-006
REVISION	SHEET NO. 3 OF 3
SCALE	

Plot Driver=SA-StreetCar.pltcfg Pentable=SA-STREETCAR.TBL

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Appendix E:

Hydrology Calculations

SANTA ANA FIXED GUIDEWAY

HYDROLOGY CALCULATIONS

$Q = CIA$ where,

Q = Discharge in cubic feet per second (cfs)
C = Developed runoff coefficient (dimensionless)
I = Average rainfall intensity in inches per hour (in/hr)
A = Drainage Area (acres)

STREET CAR ALTERNATIVE 1 - DOWNTOWN SEGMENT

Subarea	***Area (acres)***	***C***	***Length (ft)***	***Tc (min)***	***I* -Rainfall Intensity (in/hour) *Storm Frequency (years)***		***Flow Rate (cfs)***	
					10	***25***	***Q 10***	***Q 25***
1	4.1	0.90	1000	13.0	2.35	2.67	8.64	9.82
2	6.1	0.90	1000	13.0	2.35	2.67	12.89	14.65
3	6.8	0.90	1000	13.0	2.35	2.67	14.37	16.33
3.1	1.6	0.90	490	10.0	2.73	3.11	3.93	4.48
4	7.1	0.90	1000	13.0	2.35	2.67	15.00	17.05
4.1	1.7	0.90	480	10.0	2.73	3.11	4.18	4.76
5	6.9	0.90	1000	13.0	2.35	2.67	14.58	16.57
5.1	1.7	0.90	485	10.0	2.73	3.11	4.18	4.76
6	2.9	0.90	600	11.5	2.52	2.87	6.57	7.48
6.1	2.0	0.90	505	10.5	2.65	3.02	4.78	5.44
7	2.0	0.90	605	11.5	2.52	2.87	4.53	5.16
9	2.5	0.90	565	11.0	2.58	2.94	5.81	6.62
10	1.9	0.90	445	10.0	2.73	3.11	4.67	5.32
11	2.0	0.90	435	10.0	2.73	3.11	4.91	5.60
12	2.1	0.90	435	10.0	2.73	3.11	5.16	5.88
13	2.9	0.90	450	10.0	2.73	3.11	7.12	8.12
14	2.2	0.90	460	10.0	2.73	3.11	5.40	6.16
15	10.7	0.90	985	13.5	2.30	2.61	22.13	25.13
16	5.7	0.90	765	12.5	2.40	2.73	12.32	14.01
16.1	1.2	0.90	425	10.0	2.73	3.11	2.95	3.36
17	7.7	0.90	855	12.5	2.40	2.73	16.64	18.92

SANTA ANA FIXED GUIDEWAY

HYDROLOGY CALCULATIONS

STREET CAR ALTERNATIVE 2 - DOWNTOWN SEGMENT

Subarea	*Area (acres)*	*C*	*Length (ft)*	*Tc (min)*	**Rainfall Intensity (in/hour)** *Storm Frequency (years)* *10*	*25*	*Flow Rate (cfs)* Q_{10}	Q_{25}
1	3.7	0.90	915	13.5	2.30	2.61	7.65	8.69
1.1	3.7	0.90	1000	13.0	2.35	2.67	7.82	8.89
2	1.9	0.90	600	11.5	2.52	2.87	4.31	4.90
2.1	1.9	0.90	600	11.5	2.52	2.87	4.31	4.90
3	1.85	0.90	585	11.0	2.58	2.94	4.30	4.90
3.1	1.85	0.90	585	11.0	2.58	2.94	4.30	4.90
4	3.2	0.90	525	11.0	2.58	2.94	7.44	8.47
5	1.3	0.90	380	9.5	2.81	3.21	3.29	3.75
6	1.1	0.90	350	9.5	2.81	3.21	2.78	3.17
7	1.1	0.90	350	9.5	2.81	3.21	2.78	3.17
8	2.1	0.90	450	10.0	2.73	3.11	5.16	5.88
9	2.1	0.90	435	10.0	2.73	3.11	5.16	5.88
10	4.4	0.90	725	12.5	2.40	2.73	9.51	10.81
11	4.2	0.90	700	12.0	2.46	2.80	9.29	10.57
12	4.5	0.90	700	12.0	2.46	2.80	9.96	11.33
13	5.1	0.90	700	12.0	2.46	2.80	11.28	12.84
14	4.0	0.90	680	12.0	2.46	2.80	8.85	10.07
15	13.6	0.90	1000	13.0	2.35	2.67	28.74	32.66
16	7.3	0.90	1000	13.0	2.35	2.67	15.43	17.53
17	3.1	0.90	850	12.5	2.40	2.73	6.70	7.62
18	2.2	0.90	660	11.5	2.52	2.87	4.99	5.68
19	14.0	0.90	1000	13.0	2.35	2.67	29.54	33.57
19.1	4.1	0.90	1000	13.0	2.35	2.67	8.71	9.89
20	10.7	0.90	1000	13.0	2.35	2.67	22.61	25.70
21	2.2	0.90	465	10.0	2.73	3.11	5.40	6.16
22	5.4	0.90	915	13.5	2.30	2.61	11.17	12.68
23	5.7	0.90	900	13.0	2.35	2.67	12.05	13.69
23.1	1.2	0.90	900	13.0	2.35	2.67	2.54	2.88
24	7.7	0.90	825	12.5	2.40	2.73	16.64	18.92
25	6.1	0.90	1000	13.0	2.35	2.67	12.89	14.65
26	2.7	0.90	785	12.5	2.40	2.73	5.84	6.63
27	7.1	0.90	1000	13.0	2.35	2.67	15.00	17.05
28	9.4	0.90	1000	13.0	2.35	2.67	19.86	22.57
29	3.8	0.90	800	12.5	2.40	2.73	8.21	9.34
30	13.4	0.90	1000	13.0	2.35	2.67	28.32	32.18

SANTA ANA FIXED GUIDEWAY

HYDROLOGY CALCULATIONS

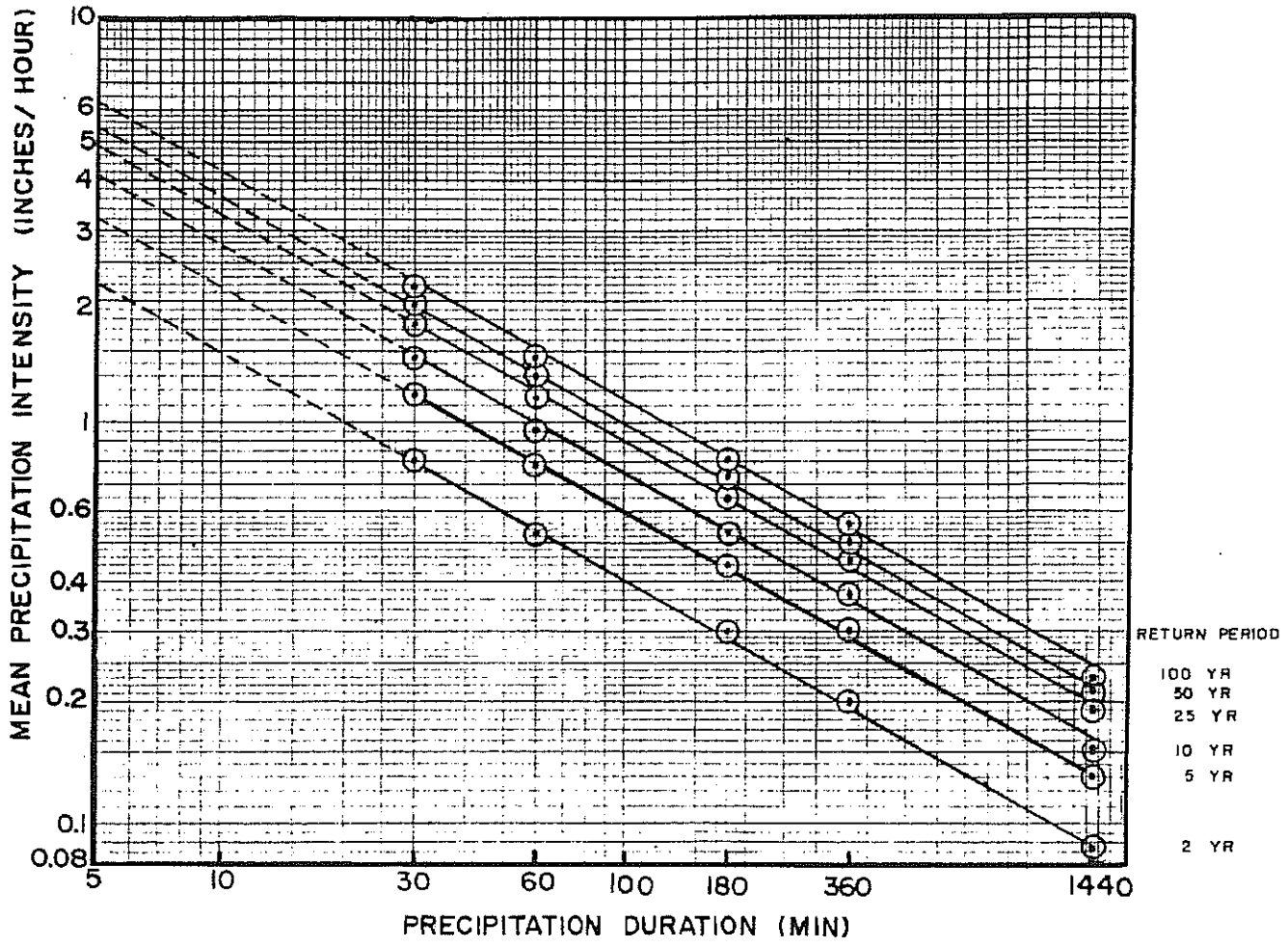
STREET CAR ALTERNATIVE 1 AND 2 - RAITT TO FLOWER SEGMENT

Subarea	*Area (acres)*	*C*	*Length (ft)*	*Tc (min)*	**Rainfall Intensity (in/hour)** *Storm Frequency (years)* *10*	*25*	*Flow Rate (cfs)* Q_{10}	Q_{25}
31	7.8	0.90	1000	13.0	2.35	2.67	16.48	18.73
32	3.1	0.90	605	11.5	2.52	2.87	7.03	8.00
33	4.0	0.90	765	12.5	2.40	2.73	8.64	9.83
34	5.3	0.90	1000	13.0	2.35	2.67	11.20	12.73
35	2.6	0.90	550	10.5	2.65	3.02	6.21	7.08
36	2.7	0.90	535	10.5	2.65	3.02	6.45	7.35
37	3.0	0.90	585	11.0	2.58	2.94	6.98	7.95

Regression Equations: $I(t) = at^b$

(I= Intensity in inches/hour, t= duration in minutes)

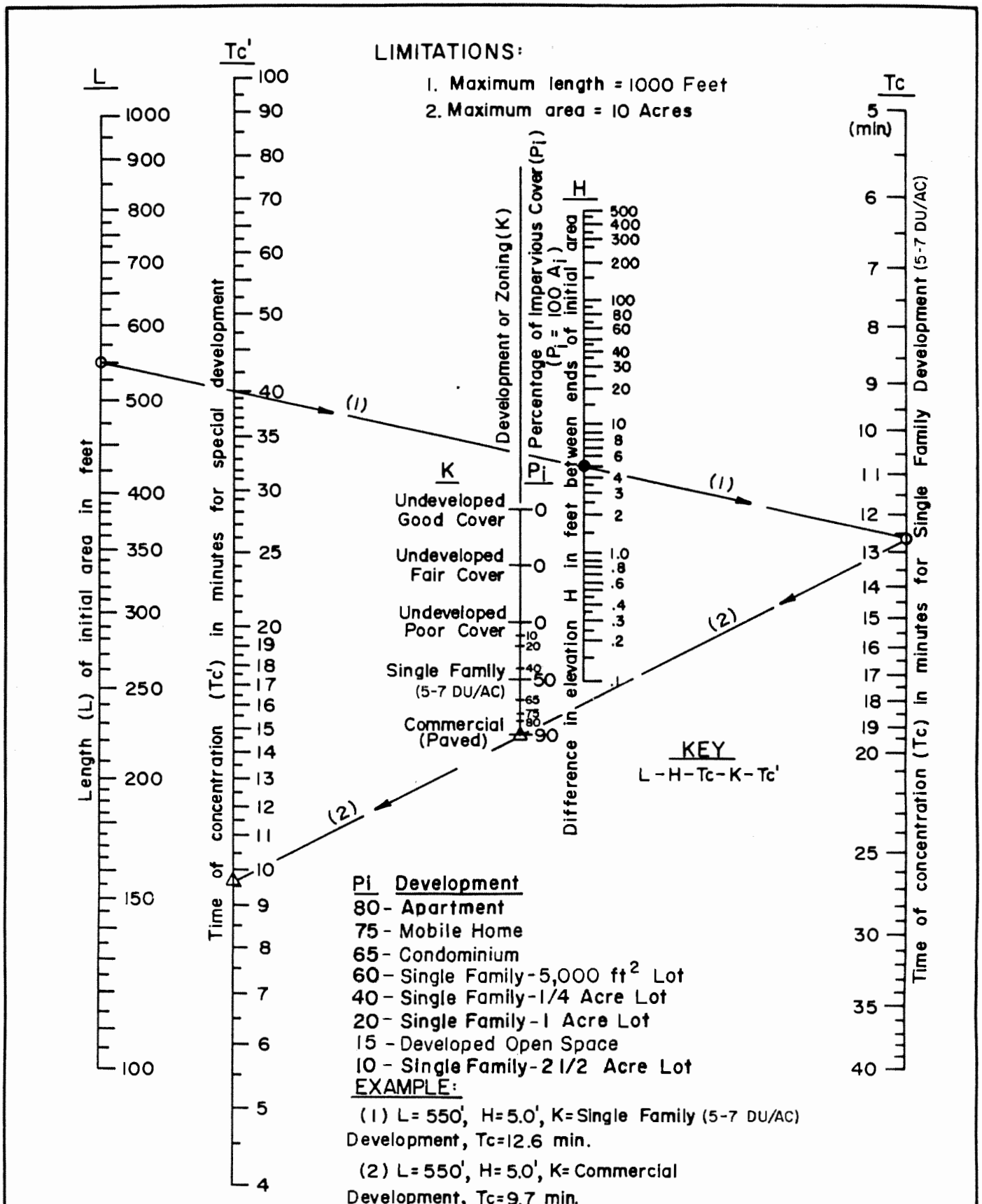
Return Frequency (years)	a	b	
2	5.702	-0.574	
5	7.870	-0.562	
10	10.209	-0.573	I(10)=10.209(10)^(-0.573)=2.75
25	11.995	-0.566	I(25)=11.995(10)^(-0.566)=3.25
50	13.521	-0.566	
100	15.560	-0.573	



ORANGE COUNTY
HYDROLOGY MANUAL

MEAN PRECIPITATION INTENSITIES FOR NONMOUNTAINOUS AREAS

Figure B-3

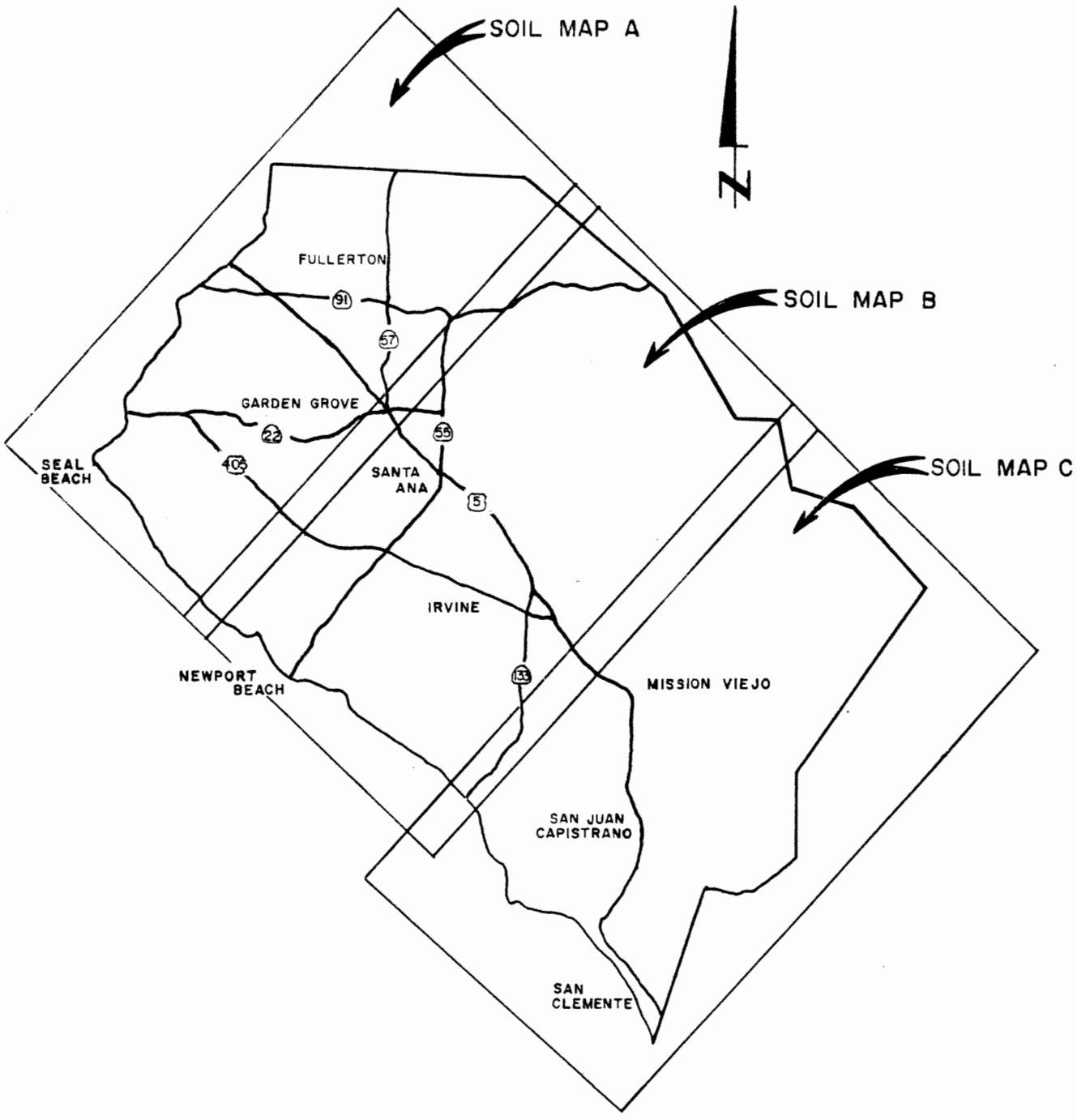


ORANGE COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1



(SEE SOIL MAPS IN POCKET)

ORANGE COUNTY
HYDROLOGY MANUAL

ORANGE COUNTY
SOIL MAP INDEX

Figure C-1

Appendix F:

Hydraulic Calculations

Worksheet for Ex. CB 1.1 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	8.64	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	82.09	%
Intercepted Flow	7.09	ft³/s
Bypass Flow	1.55	ft³/s
Spread	14.23	ft
Depth	0.41	ft
Flow Area	2.15	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.01	ft/s
Equivalent Cross Slope	0.08132	ft/ft
Length Factor	0.62	
Total Interception Length	22.75	ft

Worksheet for Proposed CB 1.2 - Curb Inlet On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	1.55	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	7.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	97.34	%
Intercepted Flow	1.51	ft³/s
Bypass Flow	0.04	ft³/s
Spread	6.31	ft
Depth	0.25	ft
Flow Area	0.52	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	2.95	ft/s
Equivalent Cross Slope	0.13727	ft/ft
Length Factor	0.87	
Total Interception Length	8.08	ft

Worksheet for Ex. CB 1.3 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	14.65	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	20.31	ft
Depth	0.53	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.4 - Curb Inlet On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	3.93	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	99.99	%
Intercepted Flow	3.93	ft³/s
Bypass Flow	0.00	ft³/s
Spread	10.11	ft
Depth	0.33	ft
Flow Area	1.15	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.42	ft/s
Equivalent Cross Slope	0.10395	ft/ft
Length Factor	0.99	
Total Interception Length	14.10	ft

Worksheet for Ex. CB 1.5 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	16.33	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	21.84	ft
Depth	0.56	ft
Gutter Depression	0.13	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.6 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	17.05	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	22.47	ft
Depth	0.57	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 1.7 On Grade

Project Description

Solve For: Efficiency

Input Data

Discharge	4.18	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	17.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	100.00	%
Intercepted Flow	4.18	ft³/s
Bypass Flow	0.00	ft³/s
Spread	10.40	ft
Depth	0.33	ft
Flow Area	1.21	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.46	ft/s
Equivalent Cross Slope	0.10196	ft/ft
Length Factor	1.16	
Total Interception Length	14.64	ft

Worksheet for Ex. CB 1.8 On Grade

Project Description

Solve For: Efficiency

Input Data

Discharge	4.18	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	99.64	%
Intercepted Flow	4.16	ft³/s
Bypass Flow	0.02	ft³/s
Spread	10.40	ft
Depth	0.33	ft
Flow Area	1.21	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.46	ft/s
Equivalent Cross Slope	0.10196	ft/ft
Length Factor	0.96	
Total Interception Length	14.64	ft

Worksheet for Ex. CB 1.10 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	16.57	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	22.05	ft
Depth	0.57	ft
Gutter Depression	0.13	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.12 - Curb Inlet On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	6.57	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	90.29	%
Intercepted Flow	5.93	ft³/s
Bypass Flow	0.64	ft³/s
Spread	12.68	ft
Depth	0.38	ft
Flow Area	1.74	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.79	ft/s
Equivalent Cross Slope	0.08850	ft/ft
Length Factor	0.73	
Total Interception Length	19.28	ft

Worksheet for Proposed CB 1.14 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	0.90	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	7.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	3.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	2.85	ft
Depth	0.22	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.15 - Curb Inlet On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	5.44	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	95.18	%
Intercepted Flow	5.18	ft³/s
Bypass Flow	0.26	ft³/s
Spread	11.69	ft
Depth	0.36	ft
Flow Area	1.49	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.64	ft/s
Equivalent Cross Slope	0.09387	ft/ft
Length Factor	0.81	
Total Interception Length	17.19	ft

Worksheet for Proposed CB 1.16 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	5.16	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	3.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	9.66	ft
Depth	0.31	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 1.17 Curb Inlet on Grade (Sag)

Project Description

Solve For	Spread

Input Data

Discharge	6.62	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.50	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	4.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.92	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.18 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	5.46	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.52	ft
Depth	0.34	ft
Gutter Depression	0.13	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.19 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	5.60	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.70	ft
Depth	0.33	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.20 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	5.88	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	11.05	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.21 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	8.12	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	3.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	13.08	ft
Depth	0.38	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.22 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	6.16	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	3.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.88	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 1.23 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	25.13	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	17.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	59.68	%
Intercepted Flow	15.00	ft³/s
Bypass Flow	10.13	ft³/s
Spread	21.87	ft
Depth	0.56	ft
Flow Area	4.91	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.12	ft/s
Equivalent Cross Slope	0.05966	ft/ft
Length Factor	0.40	
Total Interception Length	42.90	ft

Worksheet for Ex. CB 1.24 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	10.13	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	77.10	%
Intercepted Flow	7.81	ft³/s
Bypass Flow	2.32	ft³/s
Spread	15.20	ft
Depth	0.43	ft
Flow Area	2.44	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.16	ft/s
Equivalent Cross Slope	0.07748	ft/ft
Length Factor	0.56	
Total Interception Length	25.04	ft

Worksheet for Ex. CB 1.25 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	2.32	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	17.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	6.69	ft
Depth	0.26	ft
Gutter Depression	0.13	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 1.26 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	3.36	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	9.51	ft
Depth	0.31	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 1.27 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	1.19	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	17.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	4.29	ft
Depth	0.21	ft
Gutter Depression	0.13	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 1.28 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	7.88	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	84.93	%
Intercepted Flow	6.69	ft³/s
Bypass Flow	1.19	ft³/s
Spread	13.70	ft
Depth	0.40	ft
Flow Area	2.00	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.93	ft/s
Equivalent Cross Slope	0.08366	ft/ft
Length Factor	0.65	
Total Interception Length	21.52	ft

Worksheet for Ex. CB 1.29 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	18.92	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	58.36	%
Intercepted Flow	11.04	ft³/s
Bypass Flow	7.88	ft³/s
Spread	19.55	ft
Depth	0.52	ft
Flow Area	3.95	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.79	ft/s
Equivalent Cross Slope	0.06454	ft/ft
Length Factor	0.39	
Total Interception Length	36.33	ft

Worksheet for Proposed CB 2.1 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge		8.89	ft³/s
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		21.00	ft
Opening Height		0.66	ft
Curb Throat Type	Horizontal		
Local Depression		2.00	in
Local Depression Width		2.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	14.56	ft
Depth	0.41	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.2 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge		1.57	ft³/s
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		14.00	ft
Opening Height		0.66	ft
Curb Throat Type	Horizontal		
Local Depression		2.00	in
Local Depression Width		2.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	5.73	ft
Depth	0.23	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.2.1 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	8.69	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	81.91	%
Intercepted Flow	7.12	ft³/s
Bypass Flow	1.57	ft³/s
Spread	14.27	ft
Depth	0.41	ft
Flow Area	2.16	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.02	ft/s
Equivalent Cross Slope	0.08118	ft/ft
Length Factor	0.61	
Total Interception Length	22.83	ft

Worksheet for Proposed CB 2.3 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	4.90	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	97.39	%
Intercepted Flow	4.77	ft³/s
Bypass Flow	0.13	ft³/s
Spread	11.17	ft
Depth	0.35	ft
Flow Area	1.37	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.57	ft/s
Equivalent Cross Slope	0.09700	ft/ft
Length Factor	0.87	
Total Interception Length	16.13	ft

Worksheet for Proposed CB 2.4 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	5.03	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	9.96	ft
Depth	0.32	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.5 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	4.90	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	97.39	%
Intercepted Flow	4.77	ft³/s
Bypass Flow	0.13	ft³/s
Spread	11.17	ft
Depth	0.35	ft
Flow Area	1.37	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.57	ft/s
Equivalent Cross Slope	0.09700	ft/ft
Length Factor	0.87	
Total Interception Length	16.13	ft

Worksheet for Proposed CB 2.6 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	5.03	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	12.45	ft
Depth	0.37	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.7 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	8.47	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	14.10	ft
Depth	0.40	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.8 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	3.75	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.24	ft
Depth	0.32	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.9 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	2.78	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	7.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	81.83	%
Intercepted Flow	2.27	ft³/s
Bypass Flow	0.51	ft³/s
Spread	8.59	ft
Depth	0.30	ft
Flow Area	0.86	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.22	ft/s
Equivalent Cross Slope	0.11574	ft/ft
Length Factor	0.61	
Total Interception Length	11.43	ft

Worksheet for Proposed CB 2.10 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	3.68	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.11	ft
Depth	0.32	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.12 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	5.88	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	11.05	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.13 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	5.88	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	11.05	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.14 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	2.70	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	8.22	ft
Depth	0.28	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.14.1 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	10.81	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	75.06	%
Intercepted Flow	8.11	ft³/s
Bypass Flow	2.70	ft³/s
Spread	15.61	ft
Depth	0.44	ft
Flow Area	2.56	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.22	ft/s
Equivalent Cross Slope	0.07598	ft/ft
Length Factor	0.54	
Total Interception Length	26.04	ft

Worksheet for Proposed CB 2.15 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	2.56	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	7.94	ft
Depth	0.28	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.15.1 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	10.57	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	75.77	%
Intercepted Flow	8.01	ft³/s
Bypass Flow	2.56	ft³/s
Spread	15.47	ft
Depth	0.44	ft
Flow Area	2.52	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.19	ft/s
Equivalent Cross Slope	0.07650	ft/ft
Length Factor	0.55	
Total Interception Length	25.69	ft

Worksheet for Proposed CB 2.16 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	2.99	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	8.80	ft
Depth	0.30	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.16.1 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	11.33	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	73.60	%
Intercepted Flow	8.34	ft³/s
Bypass Flow	2.99	ft³/s
Spread	15.92	ft
Depth	0.44	ft
Flow Area	2.66	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.26	ft/s
Equivalent Cross Slope	0.07492	ft/ft
Length Factor	0.52	
Total Interception Length	26.78	ft

Worksheet for Proposed CB 2.17 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	3.89	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	10.49	ft
Depth	0.33	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.17.1 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	12.84	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	69.72	%
Intercepted Flow	8.95	ft³/s
Bypass Flow	3.89	ft³/s
Spread	16.74	ft
Depth	0.46	ft
Flow Area	2.93	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.38	ft/s
Equivalent Cross Slope	0.07219	ft/ft
Length Factor	0.49	
Total Interception Length	28.86	ft

Worksheet for Proposed CB 2.18 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	10.07	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	77.29	%
Intercepted Flow	7.78	ft³/s
Bypass Flow	2.29	ft³/s
Spread	15.17	ft
Depth	0.43	ft
Flow Area	2.43	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.15	ft/s
Equivalent Cross Slope	0.07762	ft/ft
Length Factor	0.56	
Total Interception Length	24.95	ft

Worksheet for Proposed CB 2.19 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	2.29	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	7.37	ft
Depth	0.27	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.20 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	32.66	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	28.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	65.32	%
Intercepted Flow	21.33	ft³/s
Bypass Flow	11.33	ft³/s
Spread	24.22	ft
Depth	0.61	ft
Flow Area	5.99	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.45	ft/s
Equivalent Cross Slope	0.03782	ft/ft
Length Factor	0.44	
Total Interception Length	62.96	ft

Worksheet for Ex. CB 2.21 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	11.33	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	17.11	ft
Depth	0.46	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.22 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	17.53	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	81.19	%
Intercepted Flow	14.23	ft³/s
Bypass Flow	3.30	ft³/s
Spread	18.97	ft
Depth	0.51	ft
Flow Area	3.73	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.71	ft/s
Equivalent Cross Slope	0.06595	ft/ft
Length Factor	0.60	
Total Interception Length	34.73	ft

Worksheet for Proposed CB 2.22.1 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	7.62	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	85.95	%
Intercepted Flow	6.55	ft³/s
Bypass Flow	1.07	ft³/s
Spread	13.51	ft
Depth	0.40	ft
Flow Area	1.95	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.91	ft/s
Equivalent Cross Slope	0.08453	ft/ft
Length Factor	0.66	
Total Interception Length	21.09	ft

Worksheet for Ex. CB 2.23 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	3.30	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	9.40	ft
Depth	0.31	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 2.24 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	1.07	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	7.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	92.40	%
Intercepted Flow	0.99	ft³/s
Bypass Flow	0.08	ft³/s
Spread	5.00	ft
Depth	0.23	ft
Flow Area	0.38	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	2.84	ft/s
Equivalent Cross Slope	0.08525	ft/ft
Length Factor	0.76	
Total Interception Length	9.20	ft

Worksheet for Proposed CB 2.26 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	5.76	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	93.80	%
Intercepted Flow	5.40	ft³/s
Bypass Flow	0.36	ft³/s
Spread	11.99	ft
Depth	0.37	ft
Flow Area	1.56	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.68	ft/s
Equivalent Cross Slope	0.09221	ft/ft
Length Factor	0.79	
Total Interception Length	17.80	ft

Worksheet for Proposed CB 2.26.1 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	9.89	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	96.75	%
Intercepted Flow	9.57	ft³/s
Bypass Flow	0.32	ft³/s
Spread	15.05	ft
Depth	0.43	ft
Flow Area	2.39	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.13	ft/s
Equivalent Cross Slope	0.07805	ft/ft
Length Factor	0.85	
Total Interception Length	24.68	ft

Worksheet for Proposed CB 2.27 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	33.57	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	61.77	%
Intercepted Flow	20.74	ft³/s
Bypass Flow	12.83	ft³/s
Spread	24.48	ft
Depth	0.62	ft
Flow Area	6.12	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.48	ft/s
Equivalent Cross Slope	0.05524	ft/ft
Length Factor	0.41	
Total Interception Length	50.74	ft

Worksheet for Ex. CB 2.28 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	13.18	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	68.92	%
Intercepted Flow	9.08	ft³/s
Bypass Flow	4.10	ft³/s
Spread	16.92	ft
Depth	0.47	ft
Flow Area	2.99	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.41	ft/s
Equivalent Cross Slope	0.07163	ft/ft
Length Factor	0.48	
Total Interception Length	29.31	ft

Worksheet for Ex. CB 2.29 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	25.70	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	57.64	%
Intercepted Flow	14.81	ft³/s
Bypass Flow	10.89	ft³/s
Spread	22.06	ft
Depth	0.57	ft
Flow Area	4.99	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.15	ft/s
Equivalent Cross Slope	0.03965	ft/ft
Length Factor	0.38	
Total Interception Length	55.34	ft

Worksheet for Ex. CB 2.30 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	10.89	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	60.90	%
Intercepted Flow	6.63	ft³/s
Bypass Flow	4.26	ft³/s
Spread	15.66	ft
Depth	0.44	ft
Flow Area	2.58	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.22	ft/s
Equivalent Cross Slope	0.04791	ft/ft
Length Factor	0.41	
Total Interception Length	34.44	ft

Worksheet for Ex. CB 2.31 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	4.26	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	11.15	ft
Depth	0.34	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.32 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge		18.84	ft³/s
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		21.00	ft
Opening Height		0.66	ft
Curb Throat Type	Horizontal		
Local Depression		2.00	in
Local Depression Width		2.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	24.02	ft
Depth	0.60	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.33 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge		2.88	ft³/s
Gutter Width		2.00	ft
Gutter Cross Slope		0.08	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		21.00	ft
Opening Height		0.66	ft
Curb Throat Type	Horizontal		
Local Depression		2.00	in
Local Depression Width		2.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	6.87	ft
Depth	0.26	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.34 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	6.63	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	14.97	ft
Depth	0.42	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB 2.35 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	15.00	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	52.65	%
Intercepted Flow	7.90	ft³/s
Bypass Flow	7.10	ft³/s
Spread	17.83	ft
Depth	0.48	ft
Flow Area	3.30	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.54	ft/s
Equivalent Cross Slope	0.04449	ft/ft
Length Factor	0.34	
Total Interception Length	41.19	ft

Worksheet for Proposed CB 2.37 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	22.57	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	73.44	%
Intercepted Flow	16.57	ft³/s
Bypass Flow	6.00	ft³/s
Spread	20.96	ft
Depth	0.55	ft
Flow Area	4.52	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.99	ft/s
Equivalent Cross Slope	0.06144	ft/ft
Length Factor	0.52	
Total Interception Length	40.29	ft

Worksheet for Proposed CB 2.38 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	13.10	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	69.11	%
Intercepted Flow	9.05	ft³/s
Bypass Flow	4.05	ft³/s
Spread	16.88	ft
Depth	0.46	ft
Flow Area	2.98	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.40	ft/s
Equivalent Cross Slope	0.07176	ft/ft
Length Factor	0.48	
Total Interception Length	29.21	ft

Worksheet for Proposed CB 2.39 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	13.39	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	19.13	ft
Depth	0.50	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 2.40 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	32.18	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	52.17	%
Intercepted Flow	16.79	ft³/s
Bypass Flow	15.39	ft³/s
Spread	24.08	ft
Depth	0.61	ft
Flow Area	5.93	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.43	ft/s
Equivalent Cross Slope	0.03793	ft/ft
Length Factor	0.34	
Total Interception Length	62.46	ft

Worksheet for Ex. CB 2.41 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	15.39	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	20.99	ft
Depth	0.54	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Ex. CB 2.42 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	14.65	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	65.73	%
Intercepted Flow	9.63	ft³/s
Bypass Flow	5.02	ft³/s
Spread	17.66	ft
Depth	0.48	ft
Flow Area	3.24	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.52	ft/s
Equivalent Cross Slope	0.06945	ft/ft
Length Factor	0.45	
Total Interception Length	31.22	ft

Worksheet for Ex. CB 2.43 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	23.94	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	14.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	52.11	%
Intercepted Flow	12.47	ft³/s
Bypass Flow	11.47	ft³/s
Spread	21.46	ft
Depth	0.56	ft
Flow Area	4.73	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	5.06	ft/s
Equivalent Cross Slope	0.06045	ft/ft
Length Factor	0.34	
Total Interception Length	41.70	ft

Worksheet for Ex. CB 2.44 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	11.47	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	21.57	ft
Depth	0.55	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W1 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	18.73	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	4.00	ft

Results

Efficiency	66.02	%
Intercepted Flow	12.36	ft³/s
Bypass Flow	6.37	ft³/s
Spread	19.48	ft
Depth	0.52	ft
Flow Area	3.92	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.78	ft/s
Equivalent Cross Slope	0.04236	ft/ft
Length Factor	0.45	
Total Interception Length	46.57	ft

Worksheet for Ex. CB W2 On Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	6.37	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	14.57	ft
Depth	0.41	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W3 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	8.00	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	99.78	%
Intercepted Flow	7.98	ft³/s
Bypass Flow	0.02	ft³/s
Spread	13.78	ft
Depth	0.40	ft
Flow Area	2.03	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.95	ft/s
Equivalent Cross Slope	0.08327	ft/ft
Length Factor	0.97	
Total Interception Length	21.72	ft

Worksheet for Ex. CB W4 On Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	9.83	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	96.87	%
Intercepted Flow	9.52	ft³/s
Bypass Flow	0.31	ft³/s
Spread	15.02	ft
Depth	0.43	ft
Flow Area	2.38	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.13	ft/s
Equivalent Cross Slope	0.07819	ft/ft
Length Factor	0.85	
Total Interception Length	24.59	ft

Worksheet for Proposed CB W5- Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	0.31	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	7.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	2.72	ft
Depth	0.17	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W6 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	12.73	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	90.61	%
Intercepted Flow	11.54	ft³/s
Bypass Flow	1.19	ft³/s
Spread	16.69	ft
Depth	0.46	ft
Flow Area	2.91	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	4.37	ft/s
Equivalent Cross Slope	0.07237	ft/ft
Length Factor	0.73	
Total Interception Length	28.71	ft

Worksheet for Proposed CB W7 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	1.19	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	14.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	4.76	ft
Depth	0.22	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W8 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	7.08	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	12.51	ft
Depth	0.37	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W9 - Curb Inlet on Grade (sag)

Project Description

Solve For	Spread

Input Data

Discharge	7.35	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	21.00	ft
Opening Height	0.66	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	12.82	ft
Depth	0.38	ft
Gutter Depression	0.12	ft
Total Depression	0.29	ft

Worksheet for Proposed CB W10 - Curb Inlet on Grade

Project Description

Solve For	Efficiency

Input Data

Discharge	7.95	ft³/s
Slope	0.01000	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.013	
Curb Opening Length	21.00	ft
Local Depression	2.00	in
Local Depression Width	2.00	ft

Results

Efficiency	99.83	%
Intercepted Flow	7.94	ft³/s
Bypass Flow	0.01	ft³/s
Spread	13.75	ft
Depth	0.40	ft
Flow Area	2.02	ft²
Gutter Depression	0.13	ft
Total Depression	0.29	ft
Velocity	3.94	ft/s
Equivalent Cross Slope	0.08343	ft/ft
Length Factor	0.97	
Total Interception Length	21.63	ft

Cross Section for Proposed Pipe 1.1 (60" RCP)

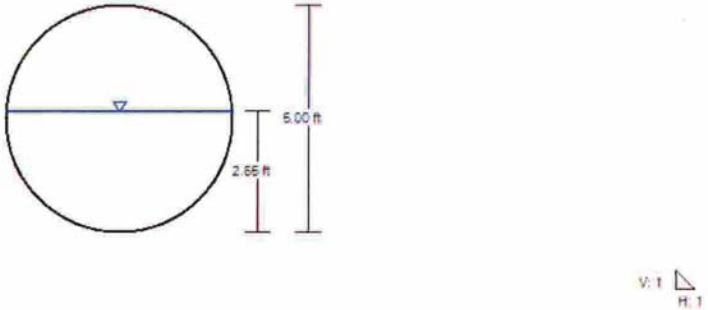
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	2.65	ft
Diameter	5.00	ft
Discharge	101.35	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 1.1 (75" RCP)

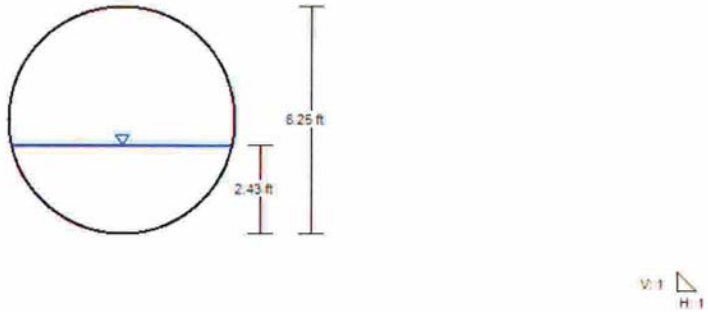
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	2.43	ft
Diameter	6.25	ft
Discharge	106.51	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 1.2 (60" RCP)

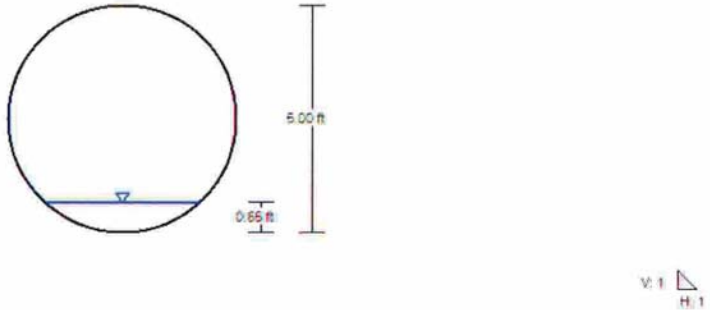
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	0.65	ft
Diameter	5.00	ft
Discharge	6.62	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 1.3 (27" RCP)

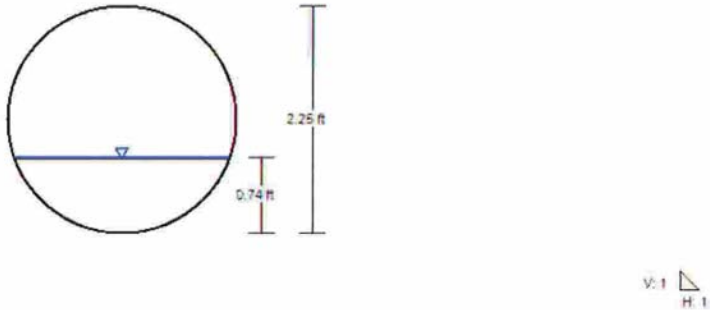
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	0.74	ft
Diameter	2.25	ft
Discharge	5.16	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 1.5 (54" RCP)

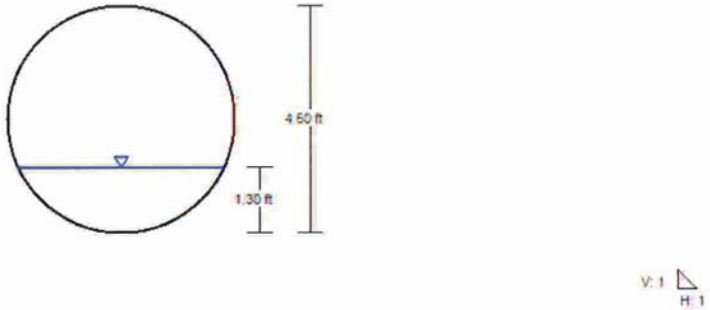
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	1.30	ft
Diameter	4.50	ft
Discharge	25.13	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 1.6 (42" RCP)

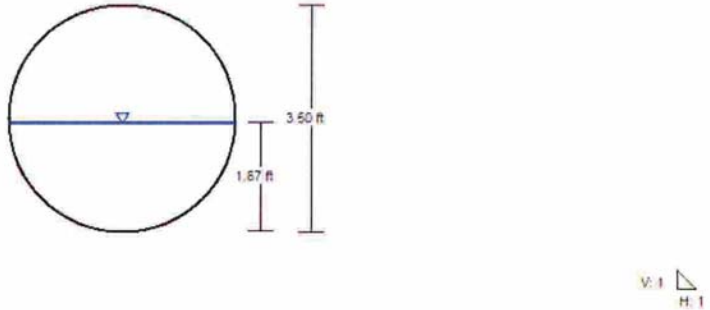
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	1.67	ft
Diameter	3.50	ft
Discharge	32.93	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 2.1 (30" RCP)

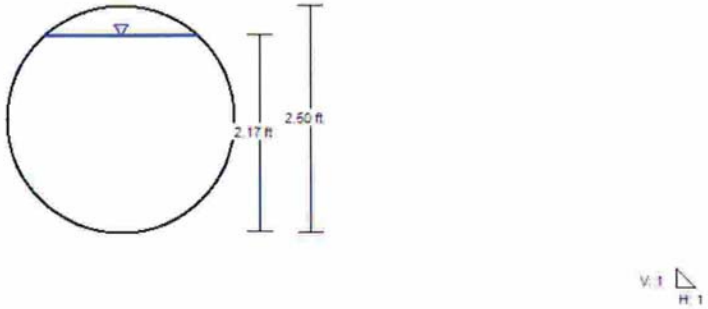
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00750	ft/ft
Normal Depth	2.17	ft
Diameter	2.50	ft
Discharge	37.18	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 2.1 (36" RCP)

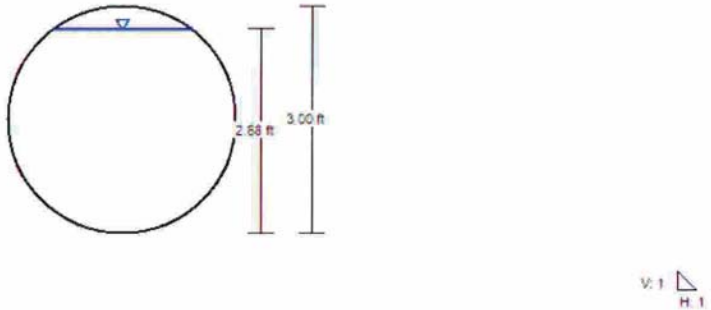
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00550	ft/ft
Normal Depth	2.68	ft
Diameter	3.00	ft
Discharge	52.58	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 2.1 (42" RCP)

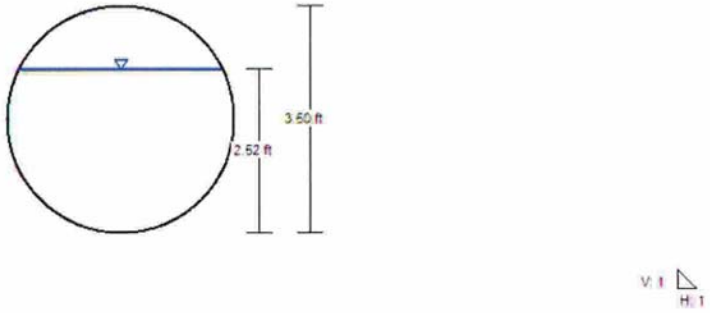
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	2.52	ft
Diameter	3.50	ft
Discharge	61.64	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 2.2 (36" RCP)

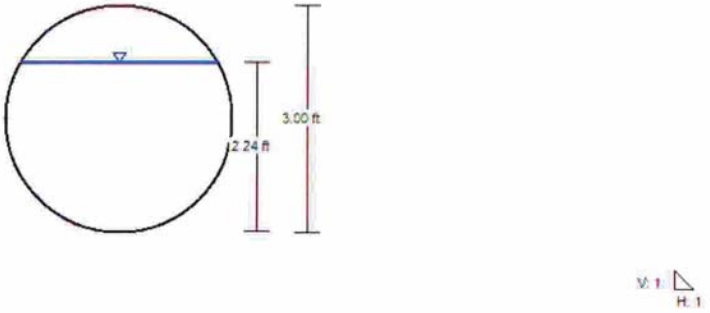
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	2.24	ft
Diameter	3.00	ft
Discharge	42.73	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 2.3 (30" RCP)

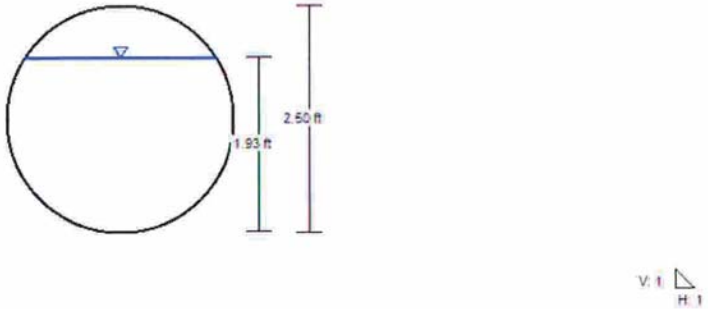
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	1.93	ft
Diameter	2.50	ft
Discharge	27.26	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 2.3 (36" RCP)

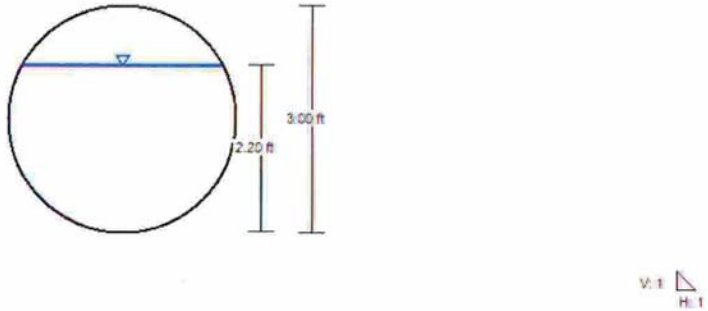
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00750	ft/ft
Normal Depth	2.20	ft
Diameter	3.00	ft
Discharge	51.42	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 2.4 (54" RCP)

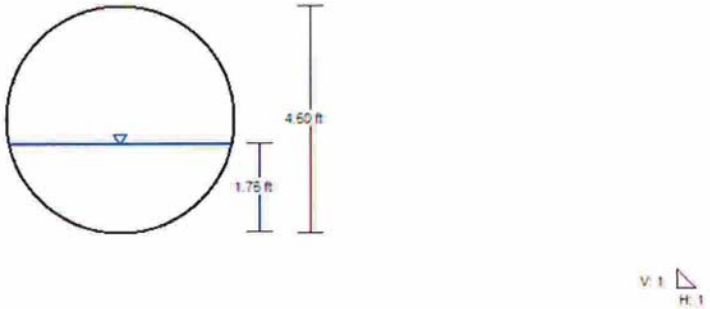
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	1.75	ft
Diameter	4.50	ft
Discharge	44.54	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 2.5 (30" RCP)

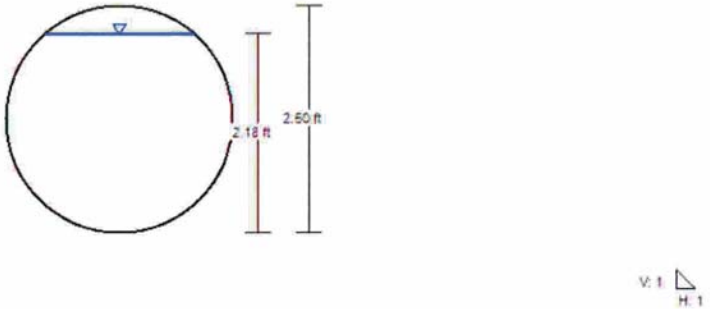
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00550	ft/ft
Normal Depth	2.18	ft
Diameter	2.50	ft
Discharge	31.91	ft³/s

Cross Section Image



Cross Section for Proposed Pipe 2.5 (42" RCP)

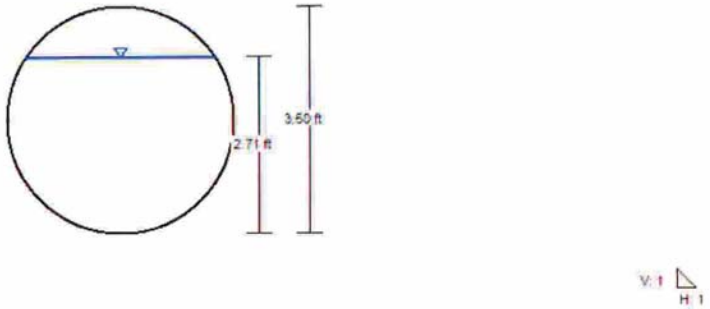
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00750	ft/ft
Normal Depth	2.71	ft
Diameter	3.50	ft
Discharge	82.31	ft³/s

Cross Section Image



Cross Section for Proposed Pipe W.1 (36" RCP)

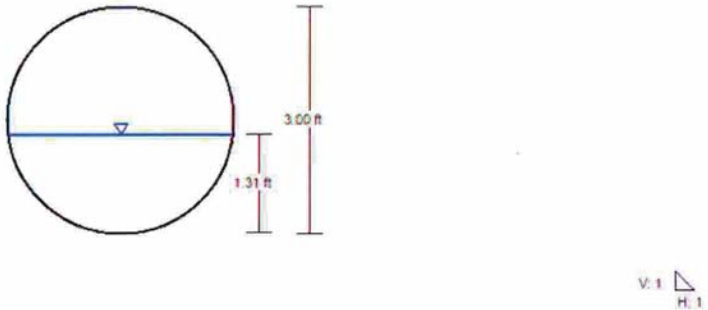
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	1.31	ft
Diameter	3.00	ft
Discharge	18.73	ft³/s

Cross Section Image



Cross Section for Proposed Pipe W.1 (42" RCP)

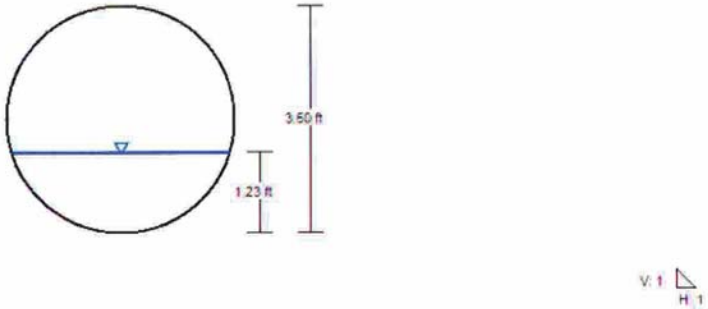
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	1.23	ft
Diameter	3.50	ft
Discharge	18.73	ft³/s

Cross Section Image



Cross Section for Proposed Pipe W.2 (36" RCP)

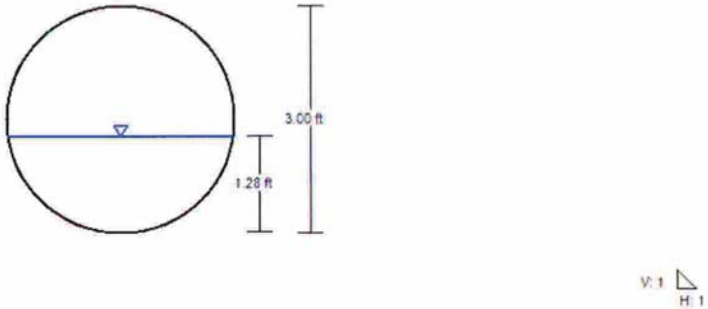
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	1.28	ft
Diameter	3.00	ft
Discharge	17.83	ft³/s

Cross Section Image



Cross Section for Proposed Pipe W.3 (54" RCP)

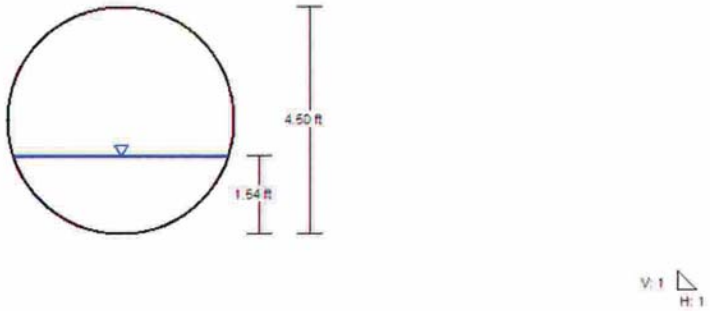
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	1.54	ft
Diameter	4.50	ft
Discharge	35.10	ft³/s

Cross Section Image



Cross Section for Proposed Pipe W.3 (66" RCP)

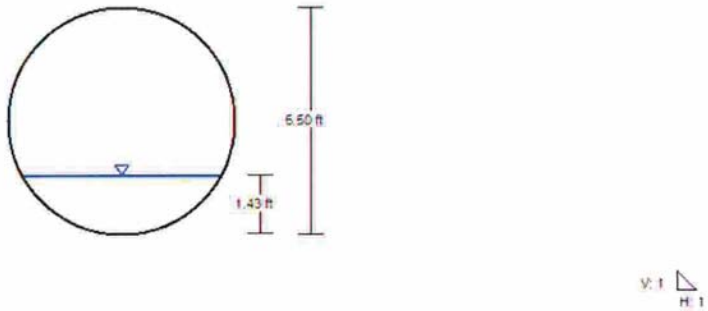
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

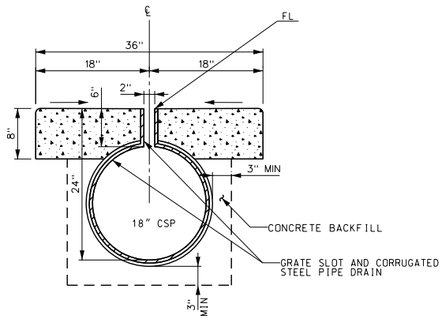
Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	1.43	ft
Diameter	5.50	ft
Discharge	35.10	ft³/s

Cross Section Image



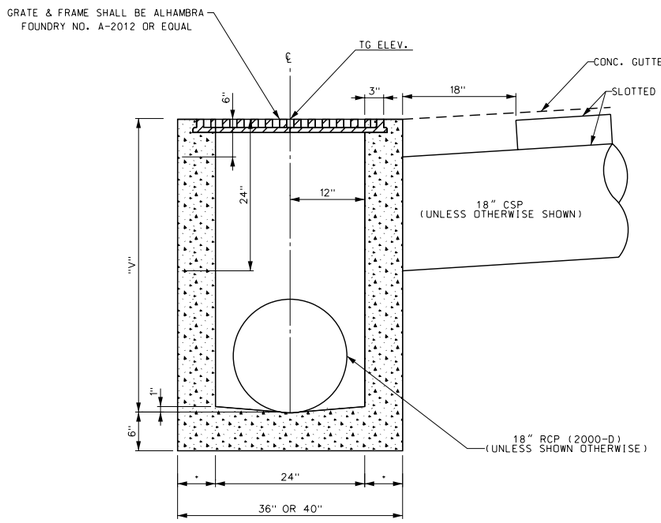
Appendix G:

Drainage Details



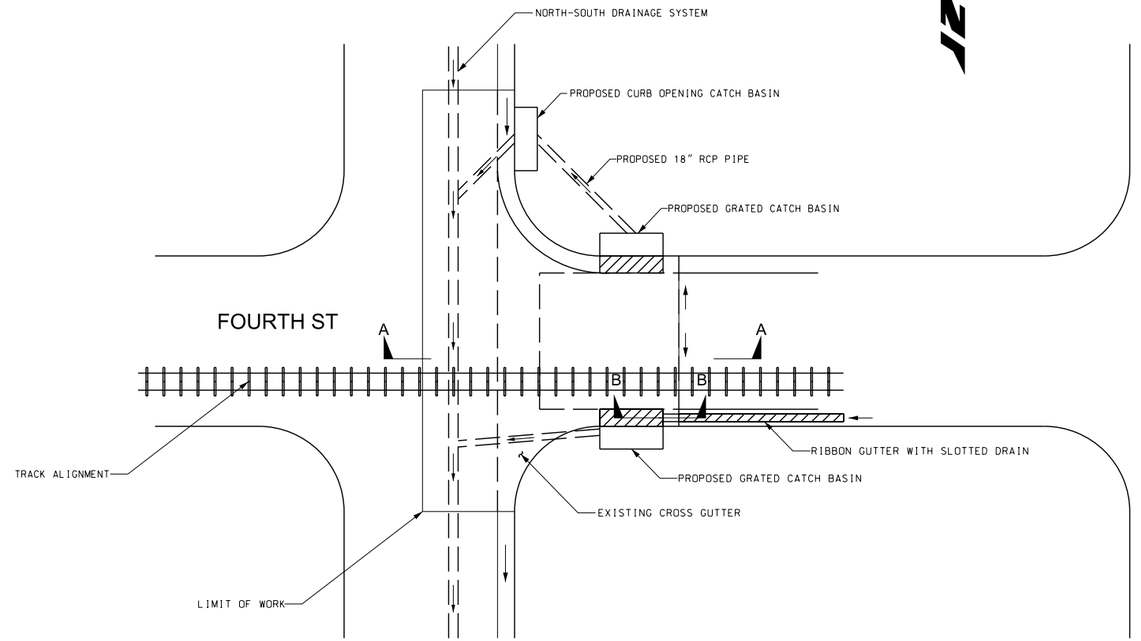
RIBBON GUTTER W/SLOTTED DRAIN

NTS

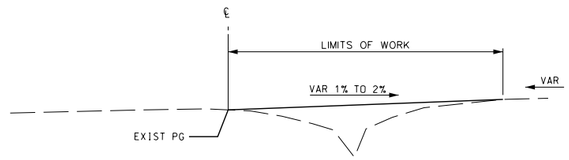


SECTION B-B

NTS



PLAN



SECTION A-A

NTS

TYPICAL INTERSECTION DETAIL

NTS

REVISIONS			
NUMBER	DATE	DESCRIPTIONS	APPRVD

INFORMATION CONFIDENTIAL:
All plans, drawings, specifications, and or information furnished herewith shall remain the property of City of Santa Ana and shall be held confidential and shall not be used for any purpose not provided for in agreements with City of Santa Ana.

DESIGNED BY	J.GARCIA
DRAWN BY	D.SO
CHECKED BY	R.RAMIREZ
APPROVED BY	R.RAMIREZ
DATE	

CORDOBA CORPORATION
2677 NORTH MAIN STREET, SUITE 240
SANTA ANA, CA 92705
714.558.6124 PH - 714.558.8467 FAX

OCTA

Santa Ana Education 1st

GARDEN GROVE

CITY OF SANTA ANA AND GARDEN GROVE FIXED GUIDEWAY CORRIDOR

DRAINAGE DETAIL

CONTRACT NO.	
DRAWING NO.	D-003
REVISION	SHEET NO. 1 OF 1
SCALE	NTS

Plot Driver=SA-StreetCar.pltcfg Pentable=SA-STREETCAR.TBL

USER=cad8 7/6/2011 4:35:26 PM z:\Users\Jose Garcia\D-003.dgn

Appendix H:

Quantity Estimates

Santa Ana Fixed Guideway Project

Drainage Infrastructure Improvements

STREET CAR ALTERNATIVE 1 (Downtown Segment)

Segment SC1-1: Santiago Street to French Street

Item Description	Unit	Quantity
27" RCP	LF	300
60" RCP	LF	2,100
84" RCP	LF	950
Catch Basin	EA	10
18" RCP (Laterals)	LF	300
Manholes/Junction Structures	EA	15

Segment SC1-2: French Street to Broadway

Item Description	Unit	Quantity
36" RCP	LF	1,800
Catch Basin	EA	6
18" RCP (Laterals)	LF	200
Manholes/Junction Structures	EA	6

Segment SC1-3: Broadway to Ross Street

Item Description	Unit	Quantity
36" RCP	LF	1,200
54" RCP	LF	400
Catch Basin	EA	4
18" RCP (Laterals)	LF	120
Manholes/Junction Structures	EA	5

Santa Ana Fixed Guideway Project

Drainage Infrastructure Improvements

STREET CAR ALTERNATIVE 2 (Downtown Segment)

Segment SC2-1: Santiago Street to French Street

Item Description	Unit	Quantity
30" RCP	LF	1,200
36" RCP	LF	600
84" RCP	LF	1,000
Catch Basin	EA	15
18" RCP (Laterals)	LF	375
Manholes/Junction Structures	EA	18

Segment SC2-2: French Street to Broadway

Item Description	Unit	Quantity
36" RCP	LF	2,000
Catch Basin	EA	10
18" RCP (Laterals)	LF	300
Manholes/Junction Structures	EA	15

Segment SC2-3: Broadway to Ross Street

Item Description	Unit	Quantity
54" RCP	LF	1,200
Catch Basin	EA	2
18" RCP (Laterals)	LF	60
Manholes/Junction Structures	EA	4

Segment SC2-4: Ross Street to Flower Street

Item Description	Unit	Quantity
36" RCP	LF	900
42" RCP	LF	1,900
Catch Basin	EA	10
18" RCP (Laterals)	LF	300
Manholes/Junction Structures	EA	12

Santa Ana Fixed Guideway Project

Drainage Infrastructure Improvements

STREET CAR ALTERNATIVES 1 & 2 (Raitt to Flower Segment)

Segment W-1: Flower Street to Shelton

Item Description	Unit	Quantity
36" RCP	LF	700
42" RCP	LF	400
Catch Basin	EA	10
18" RCP (Laterals)	LF	300
Manholes/Junction Structures	EA	13

Segment W-2: Shelton to Bristol Street

Item Description	Unit	Quantity
36" RCP	LF	1,000
Catch Basin	EA	3
18" RCP (Laterals)	LF	100
Manholes/Junction Structures	EA	6

Segment W-3: Bristol Street to Raitt Street

Item Description	Unit	Quantity
42" RCP	LF	2,200
66" RCP	LF	900
Catch Basin	EA	6
18" RCP (Laterals)	LF	200
Manholes/Junction Structures	EA	14

Segment W-4: Raitt Street to Santa Ana River

Item Description	Unit	Quantity
36" RCP	LF	2,250
42" RCP	LF	2,250
Catch Basin	EA	25
18" RCP (Laterals)	LF	800
Manholes/Junction Structures	EA	35

Segment W-5: Santa Ana River to Harbor Boulevard

Item Description	Unit	Quantity
36" RCP	LF	2,100
42" RCP	LF	2,100
Catch Basin	EA	25
18" RCP (Laterals)	LF	800
Manholes/Junction Structures	EA	35