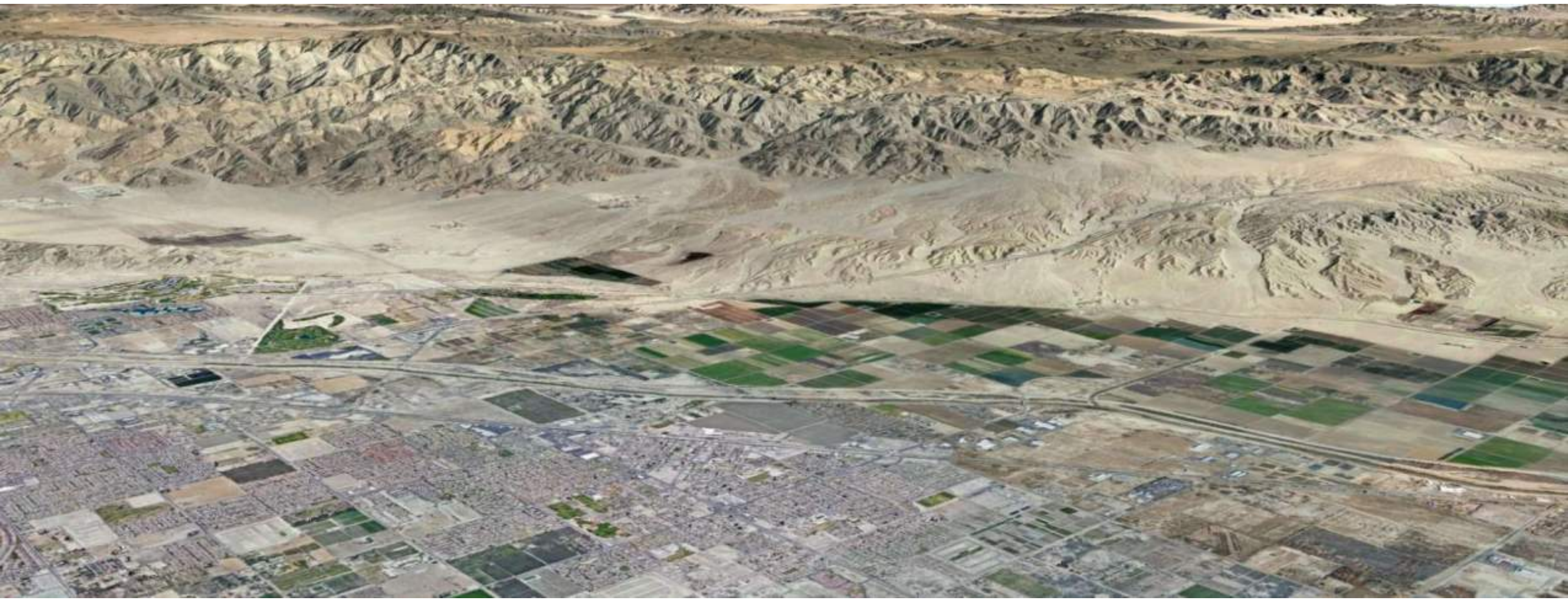


STORMWATER MASTER PLAN PROJECT

FINAL REPORT

City of Coachella
53990 Enterprise Way
Coachella, California 92236

January 2021

Prepared by:

Q3 Consulting

Executive Summary

The City has experienced substantial growth in recent decades. This increase in density and urbanization has resulted in increased quantities of stormwater runoff, yet the City currently lacks a comprehensive stormwater network to effectively convey this increase in runoff. This Stormwater Master Plan has been developed to identify current drainage deficiencies and propose facility improvements.

The City of Coachella (City), with Coachella Valley Water District (CVWD) as a local sponsor, acquired a Local Assistance grant under Proposition 1 to develop a comprehensive Stormwater Master Plan (SMP). The City, in conjunction with CVWD, hired Northwest Hydraulic Consultants (NHC) to complete the first of two phases of the project, which includes existing system identification and baseline hydrology and hydraulics to identify all deficient storm drain systems. Q3 Consulting (Q3) was hired to complete the second phase, which include developing proposed improvements to mitigate drainage deficiencies, potential for water quality and recharge opportunities, and identify potential funding sources. The results of the entire project will be documented in a city-wide Stormwater Master Plan report.

Coachella Valley has a unique climate. Desert hydrology and the design of appropriate flood protection is challenging due to the flashy nature of storm events and the relatively flat terrain in the foothills and valleys. Consequently, this study was performed using an advanced hydrologic and hydraulic model, PCSWMM. PCSWMM includes two-dimensional overland flow capabilities coupled with the industry standard EPA SWMM engine (version 5.1.013) for conduit (1-dimensional) flow. The advantage of this model allows for the development of a single City-wide model capable of running multiple alternatives simultaneously to identify the most feasible solution.

Proposed Drainage Alternatives

The region of the City that experiences the most flooding is the urbanized region, west of Grapefruit Boulevard or State Route 111 (SR-111) and bound between Avenue 48 to the north, Avenue 54 to the south and Van Buren Street to the west. Four (4) proposed storm drain lines were identified to mitigate existing and future flooding based on the 100-year design storm event.

Avenue 48 resides along the boundary between the City of Indio and Coachella. It is one of the most frequently flooded roads in the City, yet the street itself is split between the two Cities. More than 95-percent of the tributary drainage area to Avenue 48 comes from the City of Indio. Indio recently prepared a Stormwater Master Plan identifying a facility within Avenue 48 to drain the area and convey the flows to the CVSC. As a result the City has requested that this area not be included in this Stormwater Master Plan, and the assumption was made that flows tributary to Avenue 48 would be mitigated by the City of Indio.

The four alternatives include Line A, Line B, Line C, and Line D. All proposed alternatives discharge into CVSC except for Line C, which discharges into Line D. One of the main concerns in identifying proposed alternative alignments was to minimize the number of crossings, under Highway 111 and the existing railroad tracks. The two main alternative crossings were located at intersections with the idea of minimizing impacts to highway and railroad. The table below shows the overall estimate construction costs for each alternative.

Summary of Proposed Storm Drain Infrastructure

Proposed Storm Drain Line	Total Project Cost
Line "A:	$ 729,000
Line "B"	$ 7,125,000
Line "C"	$ 7,998,000
Line "D"	$ 10,795,000
Total	**$26,647,000**

A facility prioritization analysis was prepared highlighting segments of alternatives recommended to be constructed based on rank. Priority ranking was based on overall benefit for reducing areas experiencing the most problematic flooding. These areas generally fall within the downtown area and other areas of high traffic volume and areas of high risk of property damage.

Three levels of priority were identified: Priority 1 (Highest); Priority 2(High); and Priority 3(Moderate). The highest priority (Priority 1) was identified for a portion of Line B along Avenue 50. Another top priority was two sections of lines along Line C, along Shady Lane north of Avenue 52 and along Avenue 53 down to the Line D junction. For Line D, top priority was given to the section of pipe from the junction of Line C all the way to the CVSC.

Water Quality and Groundwater Recharge

Water quality treatment can be performed using regional or local facilities. Regional treatment (and recharge) facilities require large areas of available land. In reviewing City-owned land, no significant parcels were identified that would provide sufficient regional treatment. However multiple undeveloped privately owned parcels exist along all four alignments. During final preparation of plans of any of these alternatives, it is recommended that measures be taken to purchase land in these undeveloped areas.

Local water quality treatment facilities can be implemented along all four alignments. Using green infrastructure or redesign of street sections (streetscape), has become more popular for Cities wanting to reduce vehicular traffic, increase bicycle lanes, and decrease runoff. This report highlights examples for retrofitting existing street sections to include biofiltration and rainwater harvesting. From the perspective of a regional Stormwater Master Plan, it is difficult to identify all potential local sites. These should be identified and implemented on a project-by-project basis.

Grant Opportunities

As part of this SMP, several potential funding sources were researched and identified in Section 8. It is expected that no single source of revenue will be adequate to fund construction of the entire SMP, but utilization of several of these grants and funds could be used to construct portions of projects, reducing the overall costs.

Table of Contents

1 INTRODUCTION

The City of Coachella (City), with Coachella Valley Water District (CVWD) as a local sponsor, acquired a Local Assistance grant under Proposition 1 to develop a comprehensive Stormwater Master Plan (SMP). The City, in conjunction with CVWD, hired Northwest Hydraulic Consultants (NHC) to complete the first two (of eight) elements of the project, which includes existing system identification and baseline hydrology and hydraulics to identify all deficient storm drain systems.

Q3 Consulting (Q3) was hired to complete the remaining six elements, which include developing proposed improvements to mitigate drainage deficiencies, as well as identify opportunities for water quality treatment and groundwater recharge. The results of the entire project will be documented in a city-wide Stormwater Master Plan report.

The information developed by NHC in the initial study was used as the basis to develop and support the proposed improvements in this SMP. This SMP includes NHC's findings from the report titled *"City of Coachella, Stormwater Master Plan – Existing Conditions Study, DRAFT Report",* prepared October 15, 2019.

1.1 Background

The City has experienced substantial growth in recent decades. This increase in density and urbanization has resulted in increased quantities of stormwater runoff, yet the City lacks a comprehensive stormwater network to effectively convey the runoff.

Coachella Valley has a unique climate. Desert hydrology and the design of appropriate flood protection is challenging due to the flashy nature of storm events and the relatively flat terrain in the foothills and valleys. These conditions are better suited for more advanced hydrologic and hydraulic modeling techniques. This report documents the development of an advanced modeling tool that will be used to develop a Stormwater Master Plan (SMP) for the City. The SMP will provide the City a comprehensive overview of current flooding trends, and a planning tool that may be used to identify candidate drainage improvement projects.

1927 Flood, City of Coachella

1.1.1 Stormwater Master Plan Objective

The City applied for and received a Local Assistance Grant under Proposition 1 with the State of California for the development of an SMP. The Coachella Valley Water District (CVWD), the regional flood authority, is working with Coachella as a local sponsor on this project. The main objective of this SMP development project is to provide a framework for addressing the City's chronic stormwater flooding issues. Development of the SMP includes the following tasks:

1. Summary of the existing stormwater management system
2. Modeling of stormwater runoff and routing to identify existing system deficiencies
3. Development of alternatives to correct system deficiencies
4. Identification of preferred alternative(s) based on cost and non-economic factors
5. Preparation of capital cost estimates for the preferred alternative(s)
6. Preparation of a schedule for the various implementation phases of the preferred alternative(s)
7. Summary of potential funding sources for implementation of the preferred alternative(s).

NHC was retained to complete tasks 1 and 2, which generally included the research and evaluation of the City's existing infrastructure. Q3 provided work for tasks 3 through 7, which included developing proposed flood control improvements, developing cost estimates, and identifying a project priority ranking for various phases and implementation strategies.

2 PROJECT SETTING

The City is susceptible to both regional and local flooding sources. CVWD has completed several recent studies to quantify regional flooding sources. Flooding from these sources were included in the model described below where applicable, but no new analyses of regional flooding sources were conducted for this project.

Local flooding, which is the primary focus of the SMP, stems from direct rainfall within the city limits as well as in areas that drain to the City via overland, uncontained drainage pathways. The City lacks a comprehensive network of subsurface stormwater pipes, instead utilizing roadways as the primary stormwater conveyance pathways. On the west side of the Coachella Valley Storm Channel (CVSC), the predominate flow pattern is to the south and east, while on the east side of the CVSC, the predominate drainage pattern is toward the south and west.

Developments built since approximately 2006 have been required to include on-site retention facilities designed to contain site runoff from the 100-year storm. Development that occurred prior to this date was not required to provide any on-site retention. Consequently, many of the locations experiencing flooding today are in the older portions of the City.

2.1 Other Studies

A precursor study to the SMP was completed in 2006 by Dudek. This "Storm Drain Needs Analysis Report" documented the City's existing infrastructure and was a resource for the current study. The report completed an inventory and conditions analysis of the existing infrastructure, identified problem areas within the City, made recommendations for design criteria for new development, and identified potential sources of funding for stormwater improvements. The study did not include any hydrologic or hydraulic analyses. Upon completion of the study, the City implemented one of the study's key recommendations: a requirement for on-site stormwater retention for new and redevelopment.

Potential regional flooding from the Coachella Valley Stormwater Channel (CVSC) was assessed in studies for CVWD performed by NHC (2012, 2013). The findings from the studies have been mapped by FEMA and are represented in the current flood hazards for the region. CVWD commissioned the Eastern Coachella Valley Stormwater Master Plan (ECVSMP), a portion of which, The Oasis/Valley Floor Study (WEBB, 2015), looked at regional flooding in the valley and includes the south western extents of the City. The focus of that study was on sizing potential regional facilities as part of a future development plan, it did not address existing flood patterns. Regional flooding from the Mecca Hills/Little San Bernardino Mountains was assessed in a study of the East Side Dike (NHC, 2017) performed for CVWD. This study assessed conditions behind the dike and through Wasteway #2.

The City of Indio, located north and west of Coachella, is currently in the process of developing its own stormwater master plan. Indio's study is relevant to Coachella's SMP as floodwaters are known to enter Coachella from Indio along Avenue 48. A draft memorandum was obtained, outlining the Indio study's approach from Webb Consultants, who is leading Indio's study. The approach Webb has taken is to estimate representative runoff flow rates on a per acre basis, rather than building a hydraulic model. Unfortunately, Indio's approach does not provide the kind of detailed information, such as flow hydrographs of existing flooding. Consequently, a new hydraulic model had to be created for the portion of Indio that drains to Avenue 48 in order to estimate the runoff originating in Indio that flows into Coachella.

2.2 Known Flooding Issues

Dudek (2006) identified the following six flooding problem areas within the City (page 3-2):

- Avenue 48 and Harrison Street

- Avenue 50 and Kenmore Street
- Avenue 51 and Harrison Street
- Avenue 52 and Grapefruit Boulevard
- Avenue 53 and Tyler Street
- Avenue 54 and Harrison Street

Additional problem areas were identified by City staff during meetings for this project. These locations include:

- Most of Avenue 48 west of the railroad tracks
- Avenue 49 at Grapefruit Boulevard
- Avenue 50 at Frederick
- Westerfield Way at Harrison Street
- Shady Lane north of Avenue 52
- Harrison Street between Avenues 52 and 53

All of the above listed locations are indicated on the Stormwater System Map described in Section 0 and presented in Appendix A.

2.3 Existing Drainage Facilities

The City has some limited stormwater infrastructure in select locations. These facilities were identified by Dudek (2006) and confirmed during NHC's site visit. Notable facilities include:

- A "Regional Retention Area" (RRA). Located just east of Shady Lane, between Avenues 52 and 53, this facility collects runoff from nearby areas on all sides. Runoff from the north enters the RRA through culverts at the northwest and northeast corners of the intersection of Shady Lane and Avenue 52, as well as a curb inlet on the south side of Avenue 52. Runoff from the west enters the RRA via a stormwater pipe beneath Valley Rd. Runoff from the development to the east enters the RRA at various points, and runoff from Avenue 53 enters the southern end of the RRA via curb inlets.
- Avenue 52 contains a stormwater line east of approximately Education Way, continuing to the CVSC. Note the stormwater line flows the historic alignment of Avenue 52, and does not turn northeast near the CVSC along the realigned section of Avenue 52.
- There is a small local stormwater network and associated ponds along Avenue 50 between Leoco Lane and Peter Rabbit Lane. These ponds appear to collect Avenue 50 runoff only.
- There is a small local stormwater network that collects runoff from Las Flores Avenue, Calle Mendoza and adjacent residential streets, and outfalls to the CVSC.
- There are agricultural drains paralleling many of the avenues in the City on the west side of the CVSC, with outfalls to the CVSC. Knowledge of these drains is based on conversations with City staff; no maps were available, and the functional condition of these lines is largely unknown.
- All post-2006 developments have private stormwater networks and retention ponds to control runoff on-site.
- The Gateway Center has approximately two acre-feet of underground stormwater storage capacity (J. Hoy, personal communication, 10 June 2019).
- Wasteway #2 conveys runoff from the hills east of the City to the CVSC.
- The agricultural area east of the CVSC contains several drains discharging to the CVSC. These drains are typically 3 to 6 feet in diameter and flap gated.

- The numerous curb inlets located in the downtown core are dry wells, which serve to control nuisance runoff. They are not connected to a larger network and do not reduce stormwater flooding.

2.3.1 Field Inspections

NHC conducted two field inspections over the course of this study. An initial, reconnaissance-level field inspection was completed at the project outset. The purpose of this effort was to familiarize the team with the principal drainage features within the City, including the RRA, CVSC, and Wasteway #2. After preliminary model results were obtained, a second field inspection was undertaken in order to ground-truth the model results and gather data necessary to refine the model.

A field report, including notes and photographs, is found in Appendix B of this report. Shown below are sample photographs of two principal drainage features within the City. See Appendix B for a full field report.

2.3.2 Stormwater System Map

All known public stormwater infrastructure was compiled to produce a Stormwater System Map (Figure 2-1). Known problem areas as noted in Section 2.2 are also indicated on the map. As stated above, development since 2006 has included on-site retention. These developments typically have a network of stormwater pipes leading to a pond within the development. These developments are indicated as self-contained on the Stormwater System Map, but the individual catch basins, pipes, and manholes within each development are not part of the public infrastructure and are not included in the map.

Figure 2-1: Existing Facilities Map

3 HYDROLOGY

3.1 Guidelines

3.1.1 Riverside County Hydrology Manual

The City has adopted the Riverside County Hydrology Manual (RCHM) (Riverside County Flood Control and Conservation District, 1978) to guide the analysis and design of stormwater features within the City. Consequently, NHC utilized the manual to the maximum degree feasible, only deviating and relying on outside sources for information that the RCHM lacked, or when the information in the RCHM was clearly out of date. Information from the RCHM that was used for this study included runoff index numbers, infiltration rates based on those index numbers, and rainfall temporal distributions for the 3-, 6-, and 24-hour events. Antecedent Moisture Condition II was assumed when computing runoff index numbers as recommended by the RCHM for storms of 10 to 100-year magnitude.

3.1.2 NOAA Atlas 14

As alluded to above, some information in the 1978 RCHM is outdated or insufficient. Atlas 14 (National Oceanic and Atmospheric Administration (NOAA), 2014) contains spatially distributed up-to-date estimates for rainfall totals for various return period-duration combinations, as well as statistically-derived temporal distributions for these events. NHC utilized the Atlas 14 rainfall totals (though the differences from the RCHM rainfall totals were fairly minor) to leverage the spatial distribution and several decades of additional monitoring data that were used in their development. NHC also included some Atlas 14 temporal distributions in the model in addition to the RCHM distributions to investigate sensitivity to different storm patterns.

3.2 Design Storm Events

The project team, including NHC, Q3, and City staff, agreed to develop 10- and 100-year return interval design storms at 1-, 3-, 6-, and 24-hour durations for a total of eight design storms. NOAA Atlas 14 was used to determine total rainfall for each event. Rainfall totals were calculated separately for the North, West, and East models by averaging the Atlas 14 point values within each model domain. Because the model area is relatively small (less than 10 square miles), depth-area reduction factors were not applied to the Atlas 14 values.

Multiple temporal distributions were used to generate the design storm hyetographs shown in Figure 1 and Figure . The approach used varied by design storm. The first approach relied on the RCHM temporal distributions for 3-, 6-, and 24-hour events. The RCHM distributions are based on single historical events from the 1930s. These temporal patterns were coupled with the Atlas 14 rainfall totals to produce six design storms (using both 10- and 100-year return interval rain totals). These design storms utilizing the RCHM temporal distributions include “rchm” in their name, both in the model files and the figure legends below.

A second approach used temporal distributions derived from Atlas 14 frequency analyses. The Atlas 14 study considers hundreds of historical events that have occurred in southeastern California. The analyses are available for the 6- and 24-hour events and are further divided into four groups depending on which temporal quadrant contained the peak intensity. The advantage of this approach is that the patterns are based on multiple events and reflect more recent hydrologic conditions; however, it was expected, and confirmed by comparison to the RCHM design storms (Figure 1 and Figure), that aggregating events would diminish peak intensity. To combat this effect, we selected the most conservative pattern with the highest peak intensity for each design storm. Four additional design storms were created using this approach (using both 10- and 100-year return interval rain totals). The design storms developed utilizing Atlas 14 temporal distributions include the number 50 or 90 at the end of their name, both in the model files and the figure legends below. The 50/90 naming convention represents the particular statistical distribution selected from among the suite of distributions found in Atlas 14.

The third and final temporal distribution approach used a nesting method that captures short-duration intensities (e.g., 5-min, 10-min, 15-min) defined by Atlas 14 point precipitation frequency estimates. This is the only approach used to generate the 1-hour design storms. However, this method was also used to create a second set of 3-hour events as a comparison to the RCHM distribution. As Figure 1 shows, the peak intensities are more than doubled using the nesting approach. Again, the values used in the nested temporal distribution approach are based on many historical events in the region contrasted with the single event describing the RCHM distribution. The design storms developed with the nesting approach have "nest" in their name, both in the model files and the figure legends below.

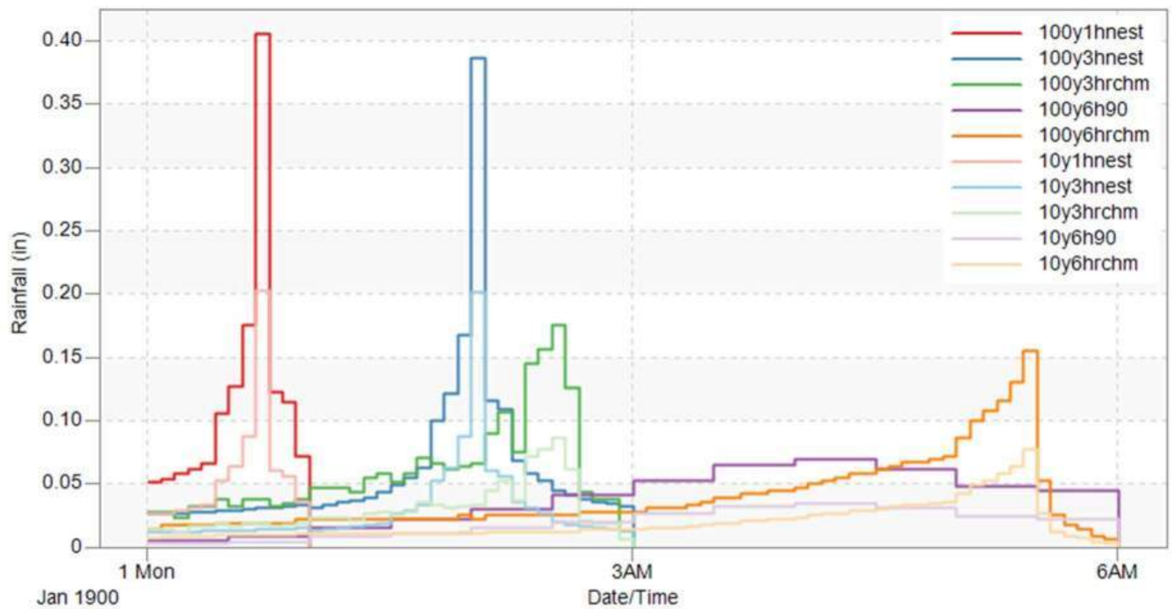


Figure 1-1: Design storm hyetographs for 1-, 3-, and 6-hour duration events (west model events)

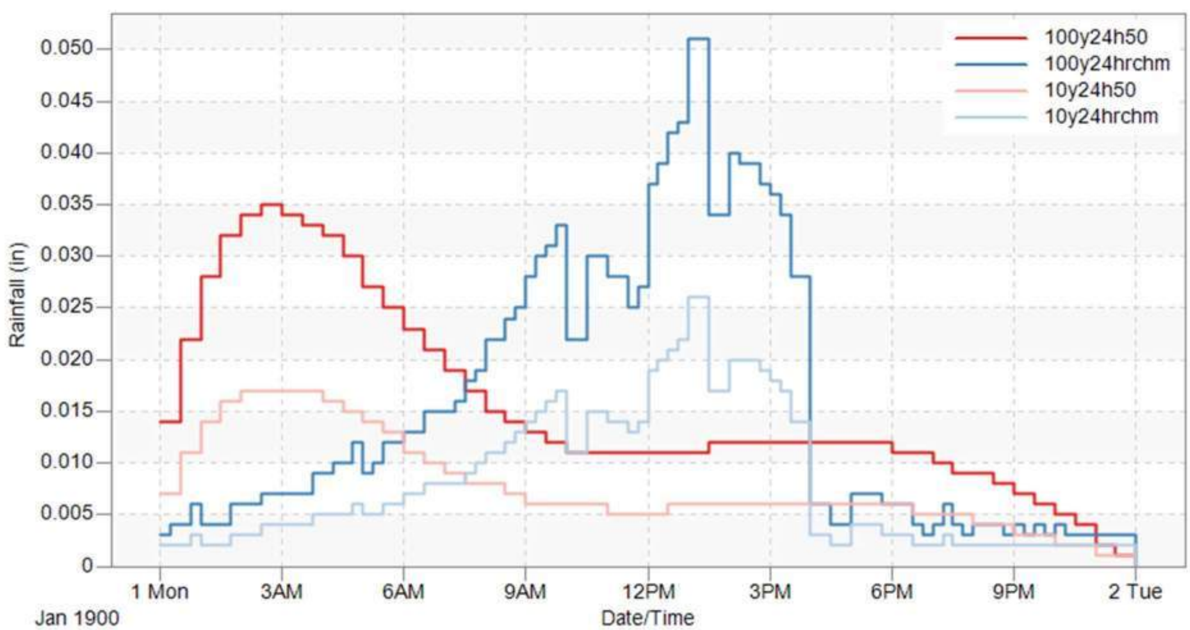
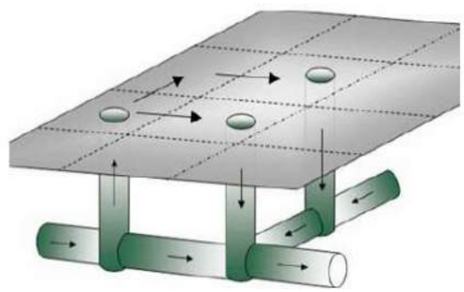


Figure 3-2: Design storm hyetographs for the 24-hour duration events (west model events)

4 Model Development

4.1 Model Selection

PCSWMM was the model selected by NHC, the City, and Q3 for this study. The model includes two-dimensional overland flow capabilities coupled with the industry standard EPA SWMM engine (version 5.1.013) for conduit (1-dimensional) flow. The advantage of this model lies in its flexibility to model a wide range of potential drainage improvement projects, from simple ponds to detention vaults to pump stations. This flexibility will allow future users the ability to use a single model to explore a full suite of alternatives in developing solutions to flooding problems. The PCSWMM model includes both hydrologic and hydraulic capabilities, each of which is described in more detail in Section 4.6.



PCSWMM Linked Surface (2-D) to Subsurface (1-D)

4.2 Model Domain

Three separate PCSWMM models were developed to encompass the study area. The three models are referred to as the east model (east of CVSC), west model (west of CVSC) and north model (portions of Indio that run-on to Coachella). The boundaries of the models are shown in 4-1. Dividing the study area into three distinct modeling regions allowed for a greater level of detail to be represented within each region, as the computational burden was spread over several models.

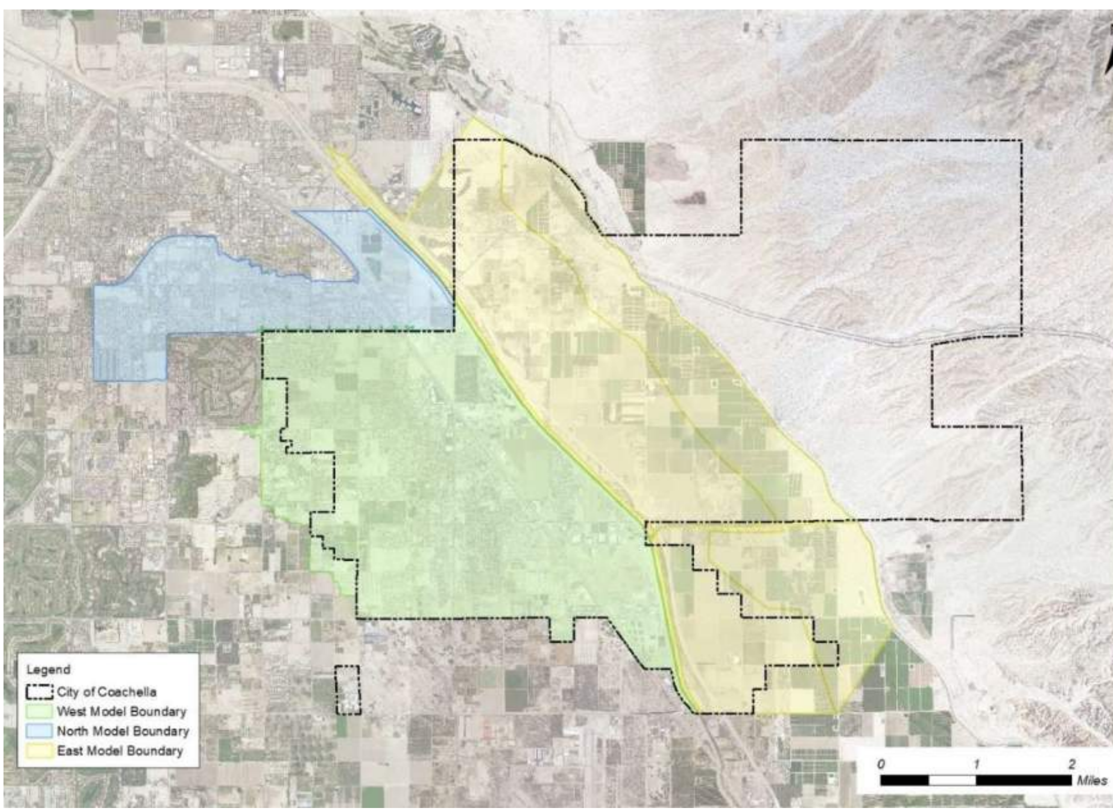


Figure 4-1: Domains of east (yellow), west (green), and north (blue) models

The model extents were defined to encompass the City and portion of Indio that would directly run-on to the City. The far eastern portion of the City, comprised of desert hills, was not included in this study as it was the subject of the East Side Dike study (NHC, 2017). The only outlets in this area are the wasteways, which are included in the east model.

Model extents for the east and west models were determined by examination of the topography; the extent of the north model was determined from both topography and a map of Indio's stormwater facilities (Webb, 2019), and the assumption that those stormwater facilities have sufficient capacity to divert flows from upstream tributary areas. If any of Indio's stormwater facilities were to be overwhelmed, it is possible that a larger area could contribute runoff to Coachella's northern border. No information on any down valley flooding from upstream communities is available at this time, however it could be added as a boundary condition to the model if it becomes available in the future.

4.3 Data Sources

4.3.1 Topography

The topography of the study area is based on the FEMA Riverside County LiDAR dataset developed for FEMA Region 9 (Digital Mapping Inc, 2011). The LiDAR data were provided in feet in the State Plane Zone VI, North American Datum of 1983 (NAD 83) and North American Vertical Datum of 1988 (NAVD 88) projections. The LiDAR data had been processed to meet FEMA standards; checkpoint surveys were completed by Summit Engineering Corporation (2011). The topographic surface for the study area was created by extracting the "bare earth" LAS Point Classification Codes from the LiDAR point cloud and then linearly interpolating to a 1-foot digital elevation model (DEM). However, in a few small areas, the FEMA LiDAR LAS Point Classification Codes were not provided, and elevations from All Returns (including vegetation and structures) are present in the topography.

Due to the fact that the LiDAR data used in this study are eight years old, it is possible that some newer features may not be reflected in the model. Every effort was made to avoid such gaps through the field inspection process, but not every location in the City could be visited.

4.3.2 Soil Type

Soil type distribution throughout the model area was derived from the Soil Survey Geographic (SSURGO) database for Riverside County, California, Coachella Valley Area (USDA, 2017). The primary use of the dataset was to determine the hydrologic soil group (A, B, etc.) for each soil type for use with the Runoff Index Number guidance provided by RCHM (see Section 4.4).

4.3.3 Aerial Imagery

United States Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) orthophotos from 2016 were used to classify land-uses within the study area. Land-use classification was conducted manually on a parcel-by-parcel basis for a large majority of the study area, but some very large parcels were subdivided into multiple different uses for increased accuracy and resolution. All land was categorized as one of the following land-uses:

- Natural (barren, chaparral, brush)
- Golf
- Agriculture
- Commercial
- Industrial
- Parks and Urban Open Spaces
- Estate Density Residential
- Low Density Residential
- Medium Density Residential

- High Density Residential
- Surface Roads (includes full ROW, typically no median and small shoulders)
- Interstate (includes full ROW, typically large median and large shoulders)
- Water

A representative sample showing the level of detail in the land-use classification is shown in 4-2.

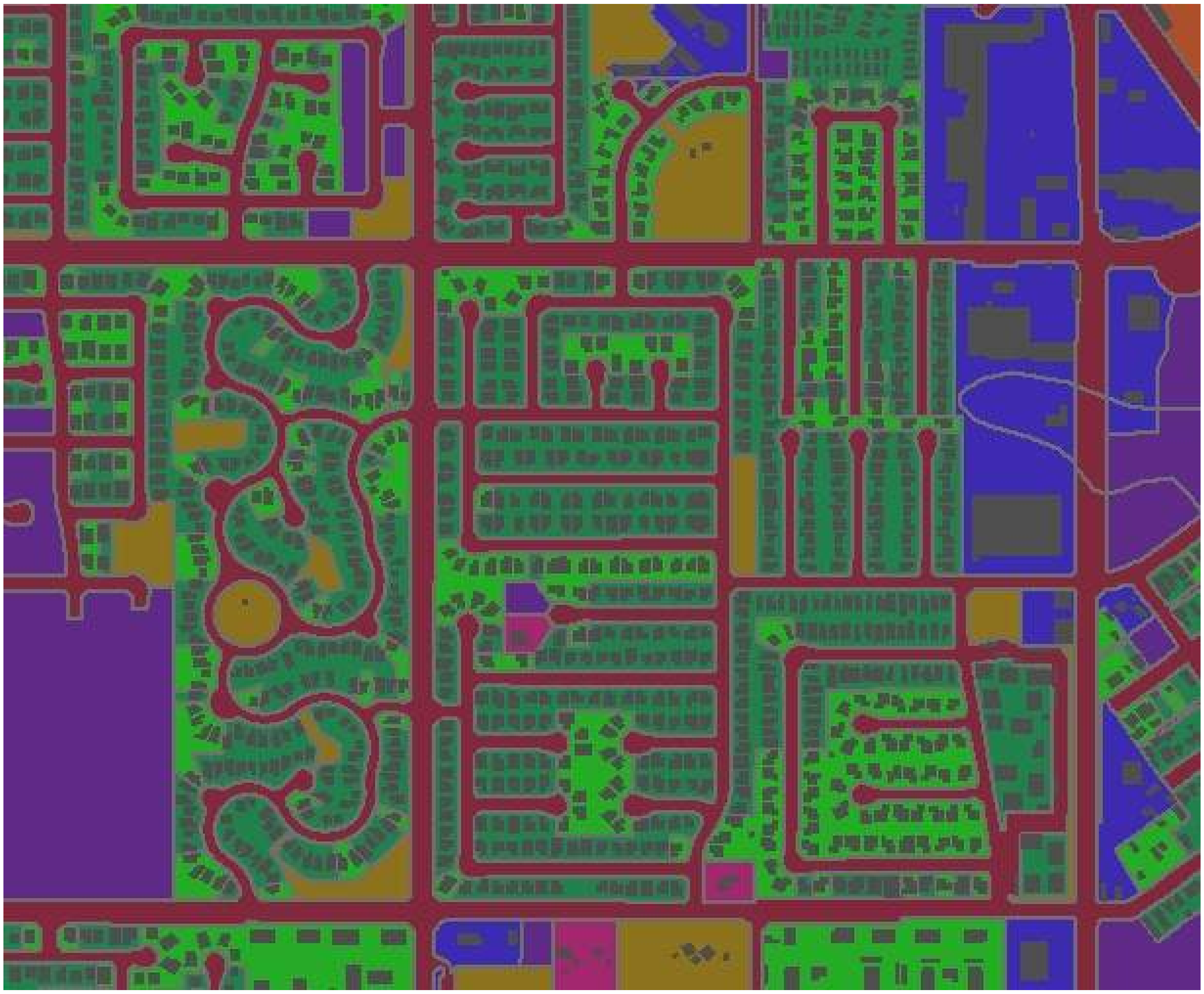


Figure 4-2: Sample of land-use classification detail, with building footprints

4.3.4 Building and Road Coverages

A building coverage layer was used to improve the accuracy of the impervious area tabulation. The building layer was developed and published by Microsoft (2018) and was generated by artificial intelligence analysis of aerial photos. The coverage includes structures as small as approximately 15 square feet and is updated regularly. Within the north, west, and east model domains the building coverage includes approximately 55,000 structures.

A roads coverage was provided to NHC by the City and likewise was used in the tabulation of impervious areas. NHC compared this coverage to recent aerial imagery (2016 NAIP imagery, as well as Google Maps images) and made changes to the coverage where necessary to reflect current conditions (e.g., some roads have been planned but not yet built; these were removed from the coverage).

4.3.4 Existing Stormwater Infrastructure

Information regarding the existing stormwater infrastructure was provided by City staff, Dudek (2006), and CVWD. CVWD provided a point shapefile of known outfalls to the CVSC, including both stormwater and agricultural outfalls. City staff verbally provided additional information regarding underground retention in the Gateway Center, agricultural drains paralleling the Avenues, and stated that curb inlets in the downtown core are dry wells only, not connected to a larger network. City staff also provided a map of newer developments that were designed to retain on-site the runoff from a 100-year storm. These developments are highlighted in orange in 4-3. The highlighted developments within Indio (blue outline) were obtained from Webb (2019).

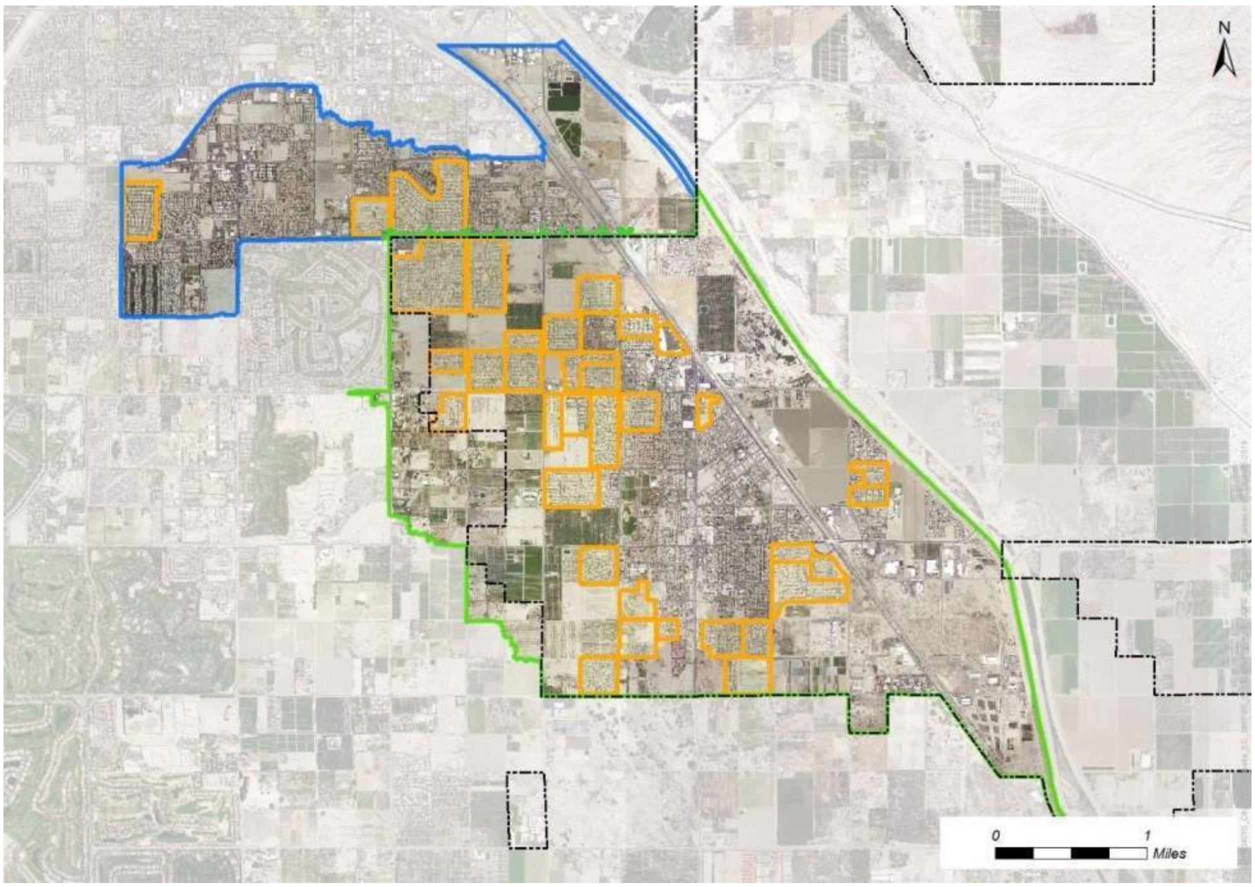


Figure 4-3: Self-contained developments in the study area (orange outline)

NHC's two field inspections, discussed in Section 4.7, confirmed much of the data provided by these sources.

4.4 Development of Land-Use Based Input Parameters

Several key model input parameters vary by land-use and soil conditions. These include roughness parameters, infiltration rates, and impervious area assumptions.

Model roughness parameters were selected from the SWMM 5 User's Manual (EPA, 2010) to the extent feasible. In land-uses with significant building footprints, the roughness values were increased further to approximate the blocking effects of the buildings.

Infiltration rates were calculated from data in the RCHM. Plate E-6.1 in the RCHM presents "runoff index numbers" based on land-use. Plate E-6.2 includes curves for translating the runoff index numbers to infiltration rates. The curve representing antecedent moisture condition II was used to determine the infiltration rate for 10- and 100-year storm events, as recommended by the RCHM. The runoff index numbers selected from Plate E-6.1 are based on the typical pervious cover found within each land-use (e.g., "res/comm landscaping" for developed areas, "irrigated turf" for golf courses and parks, etc.).

Impervious area was calculated individually for each model sub-catchment as the sum of three individual components: building coverage, road coverage, and a "characteristic" additional impervious percentage that varied by land-use. The characteristic impervious percentage represents miscellaneous impervious areas that are not captured by the buildings or road layers. These include, for example, parking lots, driveways, and walkways. The characteristic additional impervious values were calculated by manually delineating all impervious area (from NAIP 2016 imagery) at three representative locations for each land-use type, then subtracting the building coverage and roads coverage to obtain the remaining, miscellaneous impervious areas.

The final land-use/soil dependent parameters are summarized in Table 4-1.

Table 4-1: Land-Use Dependent Model Input Parameters

Land Use Classes	Overland Flow Manning n	Character-istic Additional Impervious %	Infiltration Rate: Soil Group A (in/hr)	Infiltration Rate: Soil Group B (in/hr)	Infiltration Rate Note
Natural (barren, chaparrel, brush, etc.)	0.13	1	0.52	0.34	based on runoff index for this land use
Golf	0.15	5	0.63	0.42	based on runoff index for irrigated turf
Agriculture	0.17	1	0.4	0.27	based on runoff index for this land use
Commercial	0.1	93	0.74	0.51	based on runoff index for res/comm landscaping
Industrial	0.1	34	0.74	0.51	based on runoff index for res/comm landscaping
Park / Open Urban Space	0.15	12	0.63	0.42	Based on runoff index for irrigated turf
Estate Density Residential	0.15	3	0.52	0.34	based on runoff index for res/comm landscaping
Low Density Residential	0.2	5	0.74	0.51	based on runoff index for res/comm landscaping
Medium Density Residential	0.25	14	0.74	0.51	based on runoff index for res/comm landscaping
High Density Residential	0.3	22	0.74	0.51	based on runoff index for res/comm landscaping
Road	0.011	na	0.52	0.34	based on runoff index for natural
Interstate Highway	0.011	33	0.52	0.34	based on runoff index for natural
Water	0.01	99	0	0	

Notes

1) Infiltration only applies to the pervious portion of the landuse.

2) Manning n in commercial, industrial, and residential areas increased to account for building blockage effects

3) Infiltration rates applied in subcatchment layer, as well as seepage in 2D conduits layer

4) Subcatchments covering multiple land uses or soil types were assigned weighted average properties

5) Conduits assigned average properties of two end points

4.5 Model Structure

As described in Section 4.2, three separate models were developed to cover the area of interest. The domains of each model were shown in Figure . This section describes the unique features of each model.

4.5.1 East Model

The east model extends from the CVSC (western boundary) to the Coachella Canal (eastern boundary), and from Airport Boulevard (southern boundary) to Wasteway #3 (northern boundary). This region is dominated by agriculture and features gently sloping terrain from east to west. Wasteway #2 essentially bisects this model into two regions, north and south of the Wasteway.

Because this region features significant terrain relief relative to the flatter portions of the City, an adaptive meshing algorithm was used in the east model. This process generates larger cells where the terrain is flat, and smaller cells in steeper areas. Approximately 29,100 2D model cells are included in the east model. Wasteway #2 is a highly linear feature, so it was represented with 1D cross-sections extracted from as-built drawings (USBR, 1949) rather than 2D cells. The 1D cross-sections are connected to the adjacent 2D cells using side orifices with an elevation offset equal to the elevation difference between the Wasteway and the surrounding terrain at that location, such that water may spill into or out of Wasteway #2 from surrounding areas.

Boundary conditions for the east model include an upstream inflow to Wasteway #2, a downstream free outflow boundary condition for flow entering the CVSC, and a normal depth boundary condition along the southern extent of the model for overland flow leaving the model domain. Peak discharges for the CVSC and local flooding are typically not coincident. Additional runs could be completed if an assessment of coincident water levels is needed. The inflow to Wasteway #2 was taken from NHC (2017), which estimated a 100-year peak flow of 1,740 cfs in Wasteway #2. In comparison, the capacity of Wasteway #2 is estimated to be 3,000 cfs (NHC, 2017). For the 10-year storm, an inflow to Wasteway #2 of 380 cfs was assumed. This value was determined by scaling the 100-year flow by the ratio of 10-to-100 year flows in the FEMA (2018) adopted Flood Insurance Study for Riverside County. Wasteway #3 is not represented in the model as it is outside the City boundary, does not overflow in a 100-year event (NHC 2019), and the field inspection (Section 4.7.3) confirmed no flow would enter Coachella from north of this feature.

4.5.2 West Model

The west model extents are primarily defined by the City boundary on the northern, western, and southern sides and the CVSC on the eastern side. The model boundary includes additional area outside of the City limits to capture possible run-on identified by a topographic analysis. The northern boundary was positioned along the northern side of Avenue 48, extending approximately 50 feet into Indio, to capture the conveyance of the entire street and better simulate run-on from Indio. Approximately 250 feet of the Indio streets intersecting Avenue 48 were also included in the model to achieve similar effects.

The west model's domain is substantially different in character from the east model, with little terrain relief and far more urban development. Therefore, a different meshing approach was adopted in the west model, which utilized rectangular and hexagonal mesh regions. The overriding objective in the west model mesh development process was to represent the existing primary stormwater conveyance system–the street network–in as much detail as possible. The remaining land-use classes could be represented by a coarser grid since the west model terrain is generally flat with a gentle southeast slope. Table shows the type and resolution specified for each of the land-use classes during the mesh generation process. A rectangular grid with 24-foot resolution was used to represent streets, allowing for multiple grid cells to define street cross-sections. Sufficient hydraulic behavior was captured using this approach including roadway gutter ponding in several areas. The final west model mesh contains approximately 95,000 2D cells.

Table 4-2: West and North Model 2D Mesh Type by Land-Use Classification

Land-Use Classes	Mesh Type	Mesh Resolution (ft)
Natural (barren, chaparral, brush, etc.), Agriculture, Commercial, Industrial, Park / Open Urban Space, Estate Density Residential	Hexagonal	250
Low Density Residential, Medium Density Residential, High Density Residential	Hexagonal	100
Road	Rectangular	24
Other	Hexagonal	250

Other notable model features include run-on from a separate model (north model) introduced as a northern boundary condition, gaps in the mesh representing hydraulically self-contained developments (Section 4.6.3), and existing stormwater infrastructure. Run-on from Indio was represented in the west model using flow hydrographs produced from the north model simulations. The runoff at the downstream end of the north model along Avenue 48 was divided into nine zones, splitting road and non-road flow. The hydrographs were assigned to the corresponding junctions along Avenue 48 in the west model, evenly distributing the flow among junctions within each zone. Other west model boundary conditions include normal depth outfalls along the southern boundary and free outfalls representing existing connections from the west model into the CVSC.

The 31 "self-contained" developments in the west model are represented as rating curves derived from each area's LiDAR surface. Seepage rates associated with the detention pond soil types were applied as a storage unit parameter. Routing within the self-contained developments is not simulated, apparent by the gaps in the 2D mesh. However, overflow during storm events that exceed the developments' detention capacity was allowed for by positioning conduit features with inlet invert elevations equal to the approximate lowest street crown elevation within the development plus 1.5 feet (Dudek, 2006). The overflow conduits were connected to nearby 2D junctions outside of the self-contained development.

Existing stormwater facility locations in the west model were provided by the City, identified by Dudek (2006), or identified during NHC's field inspections. Curb and grate inlets were represented in the model as orifice features, connecting the 2D junctions to stormwater facilities. Measurements were taken by NHC where feasible during site inspections and were used, and pipe diameters were reported in Dudek (2006). Reasonable assumptions had to be made in the absence of data in some cases, most notably the slope of the few trunk lines within the City, as the information in Dudek (2006) was incomplete. NHC assumed pipe slopes approximately equal to the ground surface slope. While this assumption is reasonable for a large scale planning tool, slopes should be confirmed with new as-built survey of the infrastructure surrounding any proposed improvements.

The RRA east of Harrison Street, between Avenue 52 and Avenue 53, is the most notable stormwater feature in the City. The RRA was included in the model as part of the adjacent self-contained area rating curves. Several stormwater inlets along Avenue 52 near Shady Lane were connected to this regional facility.

4.5.3 North Model (Existing Condition)

The north model covers the portion of Indio that is believed to drain directly toward Coachella. NHC examined topography and a stormwater infrastructure map of Indio (Webb, 2019) in order to determine the extents of the model. The same meshing techniques and assumptions used in the west model were applied in the north model as well. The model contains approximately 34,500 2D cells and has three self-contained developments. There are no external inflow boundary conditions—an assumption based on examination of the Webb figure. Outflow boundaries include a normal depth boundary along the interface with the west model, and free outflow into the CVSC.

There are no existing studies that quantify the potential down valley overflows from Indio and other neighboring communities into Coachella. The impact of this limitation is unknown. If such information becomes available it could be incorporated as a boundary condition to the north model.

This model is only used to identify current, or existing conditions. The recent City of Indio master plan of drainage shows a complete capture of flow from Jefferson street north, at Avenue 48 and discharges to the CVSC. The construction of this storm drain in Avenue 48 would eliminate the overflow from the north into the City of Coachella. Consequently, this portion of the model is only used for the existing conditions analysis, in addition to understanding potential phased condition, if Avenue 48 is not constructed prior to future storm drain improvements within the City of Coachella. For ultimate conditions, it is assumed that this Indio (Avenue 48) storm drain system is constructed.

4.6 Computational Methods

This section of the report documents how the various input data sources were compiled and implemented in the model environment. Details of the calculation methodologies adopted are also discussed.

4.6.1 Hydrologic Model Component

SWMM is equipped to compute infiltration using a variety of methods. Based on guidance described in the RCHM, NHC determined that a constant infiltration rate is best suited for the present model. The RCHM provides runoff index numbers by land cover type and associates them with infiltration rates typical for the local geology. Since there is no explicit constant infiltration computation method in PCSWMM, the standard Horton method was adapted to produce a constant infiltration rate by using equivalent values for minimum and maximum rates.

The infiltration rates are assigned at the subcatchment level and were computed using an area-weighting scheme based on the combined land-use/soil infiltration values listed in Table 4-1. Additional subcatchment parameters, including percent impervious and Manning n, were calculated using the same area-weighting approach. Slope for the subcatchments was calculated using a down-sampled 30-foot resolution raster in order to smooth out micro-undulations in the topography and provide a more realistic, hydrologically effective slope for the subcatchments.

4.6.2 Hydraulic Model Component

Excess rainfall from the hydrologic model's subcatchments is input to hydraulic model junctions for routing. The 2D cells used in the hydraulic model are the same size and shape as the subcatchments used in the hydrologic model. Therefore, each 2D model cell receives inflow from the hydrologic subcatchment that it overlays.

Routing is via conduits that connect the nodes found near the center of each grid cell. Conduits were included to represent both overland flow and subterranean pipes, where applicable. Parameters for the overland flow conduits are based on the land-use/soil combination where they are located. Values for Manning n and infiltration (conduit "seepage" in PCSWMM terminology) were extracted from the land-use/soil combination layer at conduit endpoints, and an average of the two endpoints was assigned to each overland flow conduit. Underground pipes have standard pipe roughness values and no seepage. Table 4-1 lists the Manning n and seepage (infiltration) values used when assigning values to the conduit end points.

Dynamic wave routing was utilized in the calculations to more accurately account for any rapid changes in hydraulic conditions that may occur over the course of the simulation. Default time steps ranged from 0.5 to 2 seconds, and the variable time step option was engaged.

4.6.3 Special Case: Self-Contained Developments

Developments identified by the City as "self-contained" were designed to retain runoff from a 100-year, 24-hour storm on-site. These developments, shown in Figure as well as the Storm System Map in Appendix A, typically have at least one retention pond and a local stormwater network to convey flows to the pond. Plans for the individual stormwater networks were not readily available, so could not be modeled explicitly.

The modeling approach for these areas was to treat them as large, single cells connected to detention ponds. This approach eliminates the need to model the details of each respective local stormwater network by routing all runoff within the development directly to the detention facility. Stage-storage curves were developed for each development from LiDAR, as discussed in Section 4.5.

Without direct knowledge of the stormwater networks within these developments, setting the elevation at which water begins to spill out of the detention pond to neighboring areas requires an assumption. This is especially true in developments that have multiple detention facilities, resulting in a stage-storage curve with numerous inflection points. A variety of possible "spill out" elevation triggers were considered and tested. The adopted approach assumes that the lowest elevation street within each self-contained development would be allowed to flood up to 1.5 feet before spilling out of the development to neighboring areas. This value was referenced as the maximum allowable ponding for new developments in Dudek (2006), and is also consistent with the RCHM, which allows the 100-year flood to inundate local streets so long as it remains in the right-of-way. This spillout elevation assumption could be refined with survey of development outlet works or procurement of as-built drawings.

4.7 Existing Conditions Model Refinement

4.7.1 General Sensitivity Tests

A wide variety of model mesh resolutions and meshing techniques (hexagonal, rectangular, directional, adaptive) were tested in order to determine optimal mesh parameters. Much of this effort revolved around determining the resolution needed to capture small-scale flooding features, while simultaneously not overburdening the computer with an unnecessarily dense mesh. This trade-off was resolved by varying the mesh parameters according to land-use, so that streets (the primary conveyance pathways in Coachella) were represented in detail, while agricultural areas were coarser in resolution. Commercial, Industrial, and Residential land-uses received an intermediate mesh resolution. The underlying assumption with this approach is that excess rainfall within a particular area is routed through one or two coarser grid cells to the nearest street, where it is then conveyed using a detailed mesh. The final selected mesh size parameters were discussed in Section 4.5.

Tests were also conducted to determine whether curbs and building blockages should be added to the model. For curbs, it was determined that the resolution of the mesh within the street right-of-way was sufficient to capture the change in elevation associated with the curb, and adding curb lines did not significantly alter results. In considering whether to include building footprints as blockages, it was determined that the mesh resolution required to accurately mesh around and in between buildings was too fine to be applied on a city-scale model. Furthermore, buildings are not considered to be major barriers to flow in the City during local runoff events.

4.7.2 Existing Conditions Preliminary Results

A preliminary model was constructed using information from available GIS data and reports, and preliminary model results indicating flooding in various areas of the City were presented to City staff on June 10, 2019. NHC and City staff together reviewed the preliminary results, and City staff provided feedback on how closely the model results matched their general observations. Overall, the preliminary results were encouraging, accurately reproducing flooding in most known problem areas. An example of the level of detail included in the preliminary results is shown below in Figure 4-4.

Figure 4-4: 100-Year Existing Condition Model. The corner of Cesar Chavez and Westerfield Way, near the center of the image, is a known frequent flooding area.

While the preliminary model reasonably reproduced flooding in known problem locations, it also indicated flooding in areas with no history of flooding. Discussion with the City resulted in clarifications with staff, indicating the presence of curb inlets that connect to a nearby ponds or drainage lines. Each of the discrepancy locations were field-verified to ensure the type and location of the infrastructure.

4.7.3 Post Field Visit Refinements

As described above, following the presentation and discussion of preliminary model results, sites were visited at locations where preliminary results were not in accordance with City staff experience, and areas where City staff described infrastructure (curb inlets) not reflected in the preliminary model. Subsequently, the model mesh was further refined and these drainage features were added to the model, significantly improving the model results compared to City descriptions of flooding locations. A comparison of preliminary model results and refined results is shown below in Figure 4-5.

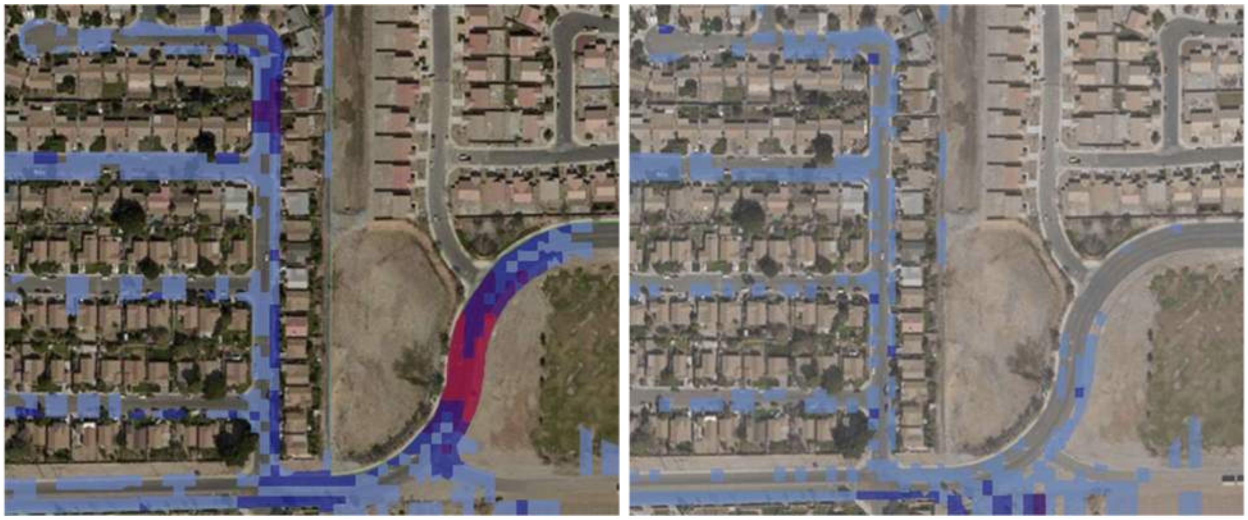


Figure 4-5: Comparison of preliminary (left) and post (right) field visit refined model results

In addition to adding curb inlets that were missing from the preliminary model, the interface between the north (Indio) and west (Coachella) models was refined to better represent observed flooding along Avenue 48 to more accurately predict current conditions. The boundary between the two models was shifted north of Avenue 48 in order to avoid a model boundary interface occurring in an area of interest. The run-on from the north (Indio) model to the west model was also further subdivided into eight separate run-on locations, each with their own hydrograph, as described in Section 4.5.

4.7.4 Existing Condition Model Results

Each of the models (east, west, north) were run for 14 different design storms, as detailed in Section 3.2. No historical events were simulated; therefore, no direct comparison between model results and observed conditions for a specific event is possible. The highly localized nature of severe storms in this region, coupled with a relatively sparse rainfall gauge network, would lead to a high degree of uncertainty in any such historical event comparison.

A qualitative assessment of model performance was completed during meetings with City staff, wherein City staff confirmed frequent flooding in many locations the model indicated drainage problems. After implementing the findings from the second field investigation, the agreement between model flooding patterns and City staff descriptions of flooding was considered good. Avenue 48, the boundary between Coachella and Indio and between the north and west models is an area of interest for the City, as substantial flow has been observed from Indio onto the Avenue. The model results for the 3-hour nested hydrograph simulations indicate peak runoff of 42 and 174 cfs (10- and 100-year, respectively) exiting the north (Indio) model and entering the west (Coachella) model along this boundary. Avenue 48 average flood depths in the outer travel lanes for these two events are approximately 0.25 and 0.5 feet (10- and 100-year, respectively), with maximum depths of 0.6 and 0.75 feet. These are average values over a 24-ft grid cell with elevation sampled near the centroid. Depths at the road shoulder would be around 0.2 feet greater, or near 1-foot in the 100-year case. This matches reasonably well with video evidence presented by the City of a severe storm in August 2013.

Another indication of model accuracy was obtained by examination of the self-contained regions during 100-year, 24-hour events. As noted above, these developments were designed to retain the anticipated runoff from such a storm on-site. In examining the model results, four of the 31 self-contained regions in the west model have spillout in this event, with a maximum spillout flow rate of approximately 6 cfs. This result is considered verification of the model approach and assumptions, since it indicates that runoff volumes computed with the PCSWMM model are in close agreement with runoff volumes anticipated by the designers of these developments. It would be cause for skepticism if no self-contained developments had spillout, or if a large number of them did.

4.7.5 Existing Condition Discussion

A PCSWMM model of the City, as well as the areas that drain onto it, was developed as a planning tool to inform the City's Stormwater Master Plan. Design storms (10- and 100-year, 1-, 3-, 6-, and 24-hour duration) were developed using the RCHM and NOAA Atlas 14. Physical features were included from various GIS data sources, prior studies (Dudek, 2006), and communication with City staff. The model utilizes a distributed subcatchment approach wherein hydrologic computations (rainfall, infiltration, runoff) occur on the same scale as the hydraulic computations.

4.8 Proposed Condition Models

4.8.1 Design Criteria

In agreement with the City and CVWD, the hydrology prepared for this study included the 1-percent annual chance (100-year) and 10-percent annual chance (10-year) storm events. The 100-year annual chance event represents the minimum typical design standard for flood protection within the City. The study criteria used this storm event to evaluate the minimum level of flood protection, with the goal of identifying proposed improvements to maintain one dry lane in each direction within major street arterials for emergency vehicle access.

The majority of the streets and storm drain systems within the focused study area drain directly to storm water retention basins or are allowed to spread over natural areas and sumps. City standards indicate that street sections should be design for the 1-percent annual chance, 24-hour storm event. However, retention basins are designed based on the worst case of the 1-percent annual chance event for the 1-, 3-, 6-, or 24-hour durations.

Due to the flat grades in the study area and the influence of the retention basins on the flood protection in the street sections, it was determined that the street sections and associated storm drain systems should also be evaluated and designed for the worst case of the 1-, 3-, and 6-hour duration events.

The goal for the general drainage path of the City was to discharge flows into the CVWC. Due to size of the overall CVWC watershed, it was assumed that the timing of the peak runoff from the City would commence prior to the peak of the CVWC. The tailwater condition for the PCSWMM models was allowed to "free flow" at the outfall. It is recommended that each of the main outlets into the CVWC be flap gated, to restrict flows surcharging into the proposed storm drain pipes.

4.8.2 Proposed Condition Modeling Process

Storm Drain Main Lines

Using the guidelines identified in Section 4.8.1, drainage improvement concepts were identified to alleviate existing flood hazard areas that did not meet City criteria using PCSWMM. Preliminary alignments and sizes for conceptual improvement alternatives were estimated, and the concepts incorporated into the baseline exiting condition models. The models were re-run with the proposed improvements and the results were evaluated to determine the benefits of the conceptual alternative. Facility sizes and alignments were refined and re-run as necessary to optimize the flood hazard reduction associated with each alternative. The performance for each of the potential alternatives was tested for the 100-Year storm events. The results of the proposed condition analyses and a discussion of the conceptual alternatives identified for each sub-area are discussed in below.

Tailwater Conditions

The outfall of each major line terminates in the CVSC. Channel hydraulics for the CVSC were acquired from the Oasis/Valley Floor Area Stormwater Master Plan, prepared by Webb and Associates in April 2015.

A subsequent HEC-RAS analysis was provided by CVWD that updated the maximum 100-year water surface elevations. Due to the large variation in tributary drainage sizes between the CVSC watershed and the City outfall watersheds, this study assumed normal depth at the outfall. The outfalls do, however, will need to be flap-gated to eliminate surcharging when the CVSC peak stage occurs. Invert elevations for the proposed outfalls will be located above the channel inverts (as listed in the latest HEC-RAS model run), and verified with aerial topography to ensure the flap gates do not become obstructed by sediment as the channel invert changes over time.

Catch Basin Inlets

In PCSWMM, locations for flow capture are identified to reduce localized flooding at targeted locations. In this model, flows are intercepted by allowing flows on the surface to communicate directly with the subsurface (storm drain) at given junctions using an "full interception" technique. All flows that cross this node will be intercepted and conveyed to the subsurface storm drain. If the storm drain can handle the flow, it passes it downstream. If the intercepted flow is greater than the capacity of that storm drain, flows are restricted, and passed back to the surface. This is considered downstream or (outlet) control, which entails the storm drain mainline itself controls the water surface elevation. The next step is to size catch basin inlets capable of intercepting this calculated flow from PCSWMM. Standard catch basin sizing software, using FHWA criteria and guidelines. Proposed catch basins were located at PCSWMM junctions based on direction of surface flow, at low points, or where flows would congregate based on topography.

4.8.3 Facility Priority Evaluations

A priority ranking has been developed based on the projects of greatest importance. A process has been prepared to determine which projects should be constructed first when funding becomes available. The three priorities are summarized below: Refer to Figure 5-10 for a map containing priority storm drains.

- **Priority 1 (*highest priority*)**
  - *Local Streets* – Existing streets and storm drain systems where flood depth is above the right-of-way in the 10-year storm event.
  - *Arterial Streets* - Existing streets and storm drain systems where flood depth is above the right-of-way in the 10-year storm event.
  - *Frequent Flooded Locations* – Areas of known frequent flooding that produce recurring property damage of critical facilities or major roadways.
- **Priority 2**
  - *Local Streets* **–** Existing streets and storm drain systems where flood depth is above top-of curb in 10-year event or right-of-way in the 100-year storm event.
  - *Arterial Streets* **-** Existing streets and storm drain systems where flood depth is above the top of curb in 10-year event or right-of-way in the 100-year storm event.
  - *Frequent Flooded Locations* – Areas of known frequent flooding that produce recurring property damage of local facilities or roadways.
- **Priority 3**
  - *Arterial Streets* **-** Existing streets and storm drain systems where flooded width is greater than 17 feet in the 10-year storm event.
  - *Frequent Flooded Locations –* Areas of known recurring flooding within roadways for 100-year storm events.

4.8.4 Cost Estimates

Cost estimates were created for each of the conceptual alternatives. The unit prices were developed in cooperation with the City and current market values. The cost includes proposed main line facilities, catch basin inlet estimates, junction structures, outlet structures, and asphalt removals and replacement costs. The costs for the actual facilities described above are used to establish a project subtotal. Additional project contingency costs are added based on this subtotal price.

Pipe costs are calculated based on linear foot and include costs for excavation, shoring, bedding, backfill, compaction, removal of excess material, and trench resurfacing. Reinforced concrete box (RCB) facility costs were calculated based on a unit price of reinforced concrete (per cubic yard). This value was then converted into a linear foot price.

The project contingency costs were based on a percentage of project subtotal cost and varied based on the size and location of each project. The following values were assigned as follows:

- Mobilization, Bonds, Insurance & Permits = 10-25%;

- Engineering, Survey, Soils, and Staking = 15-20%;

- Utility Relocation = 5-10%; and

- Construction Contingency = 20%.

These values are only planning level estimates and may vary per project. Utility relocations can vary greatly depending on quantity and complexity of utility. These true costs will become better known during the final design phase of each specific project as more detailed site-specific subsurface investigations are undertaken. A detailed cost analysis is presented in Section 5.

5 Drainage Area Results

Four main storm drain alignments were identified to improve the drainage issues within the urbanized areas of the City of Coachella. The area east of the CVSC were evaluated and no major drainage issues identified. Future development of this area should require development to mitigate runoff to existing conditions. Below are detailed proposed project descriptions. For full watershed map, refer to Exhibit A.

5.1 Line A

Line A is the smallest of four (4) proposed main storm drain lines in this study. It is located along Avenue 48, just west of the CVWC and is proposed to mitigate the known flooded area at the corner of Avenue 48/Harrison Street. This system is part of a solution proposed by both City of Coachella and City of Indio.

The City of Coachella Master Plan covers the east portion of Avenue 48, east of Highway 111. Line A is the northernmost facility proposed for the SMP and generally drains the area bound by Avenue 48 and Dillon Street. The tributary drainage area for Line A is approximately 90 acres, bound by Grapefruit Boulevard to the east, Dillon Road to the north and Avenue 48 to the south. See Figure 5.1.

Currently, extensive flooding occurs along a majority of Avenue 48, both east and west of Highway 111. To the west of Highway 111, almost all of the tributary drainage area is within the City of Indio, to the north. The City of Indio recently completed a drainage master plan that included areas tributary to Avenue 48 and proposed a storm drain within Avenue 48 that extends from west to east, discharging into the CVWC at Dillon Road. This proposed line along Avenue 48 was assumed to be a part of the Ultimate Condition drainage plan for the City of Coachella. Consequently, no storm drain system is proposed west of Highway 111 as part of this Master Plan. Until the City of Indio constructs this line, runoff from the City of Indio will continue to cause flooding issues at Avenue 48 and potentially continue south into the City of Coachella.

5.1.1 Proposed Alternative

The proposed system includes a 1,600 linear foot 24-inch RCP pipe that captures flows near the intersection of Avenue 48 and Harrison Street and discharges into the CVSD channel. This system mitigates an area of known and recurring flooding along the eastern portion of Avenue 48. A system of 5 catch basins will capture a total peak flowrate of approximately 8.5 cfs (100-year storm). Figure 5.2 shows the proposed alignment.

Although this system is small, the ponding that currently occur at the eastern portion of Avenue 48 has no outlet, as the CVSWC is leveed. The maximum water surface in the CVSWC is low enough to allow for gravity flow from the proposed catch basin inlets, without surcharging.

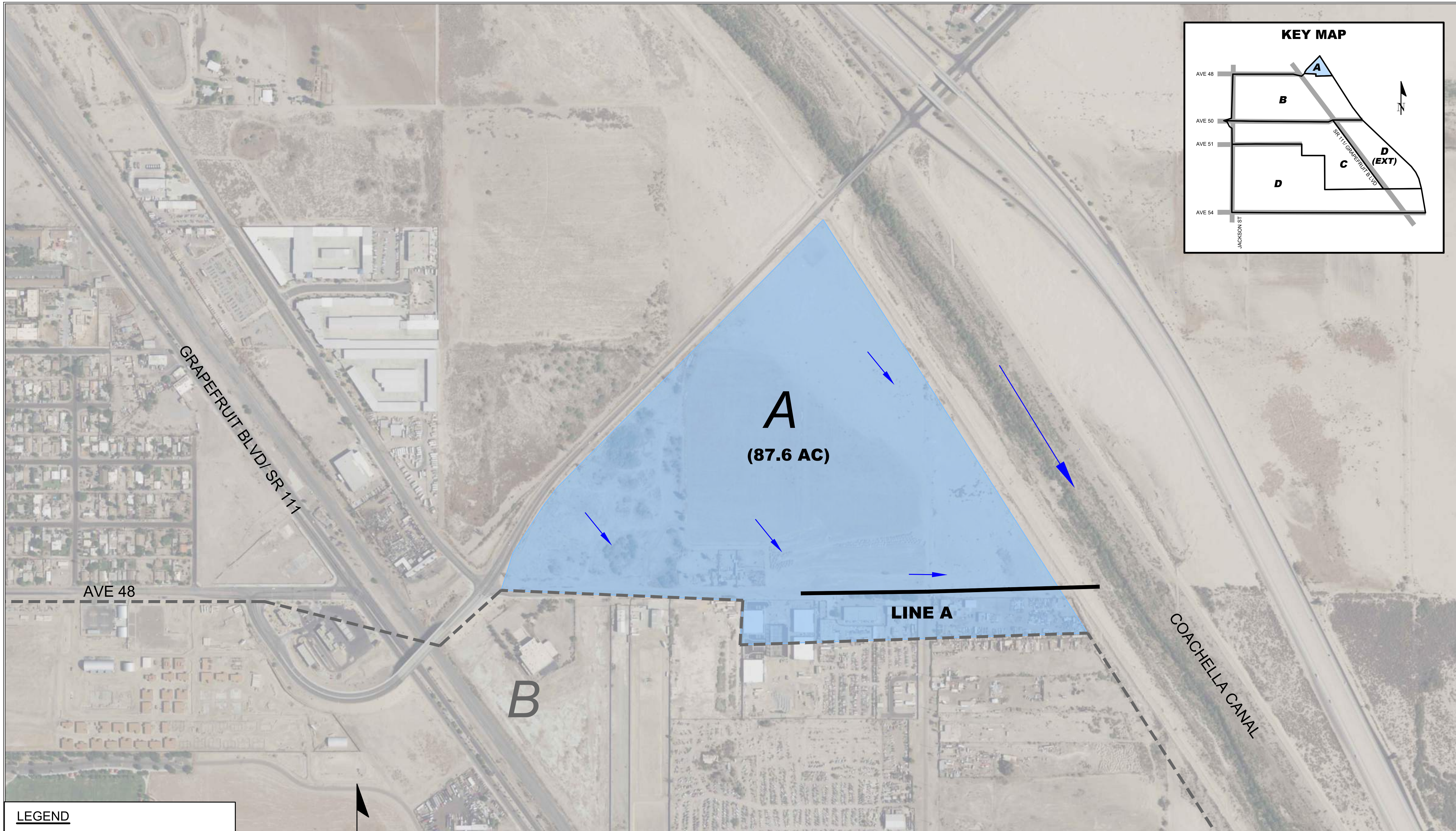
The outfall discharges into the CVSC at an invert elevation of -69.8. Based on our topographic data, the invert of the channel at this location is -71.4. According to CVWD's latest HEC-RAS analysis, this location at approximate channel station 86+782 has an invert of -80.1, with a maximum 100-year water surface elevation of approximately – 62.8. This outfall should be equipped with a flap-gate and final invert should be established during final design.

5.1.2 Cost Estimate

For the system, the Q3 team has provided a recommendation constructing storm drain facilities. Table 5-1 gives a summary of the construction cost estimates and the recommended system within the Line "A" area. See Appendix C for detailed cost estimates.

Table 5-1: Line "A" Cost Estimate Summary

Item	Type/Quantity	Total Project Cost (2020 $)
Storm Drain Mainline	24-Inch RCP (1,630 LF)	$204,000
Inlets	4' Curb-Opening Catch Basins (5)	$75,000
Junction Structures	2	$15,000
Outlet Structure	(1) CVSD Outlet Facility	$20,000
Remove & Replace AC	16,330 SF	$82,000
Traffic Control	Lump Sum	$20,000
	Subtotal	**$416,000**
Mobilization, Bonds, Insurance & Permits	LS (25%)	$104,000
Engineering, Survey, Soils, and Staking	LS (20%)	$84,000
Utility Relocation	LS (10%)	$42,000
Contingency	LS (20%)	$83,000
	LINE "A" TOTAL COST	**$729,000**



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City of COACHELLA

STORM WATER MASTER PLAN

WATERSHED A

Figure 5-1

FOR CITY OF COACHELLA

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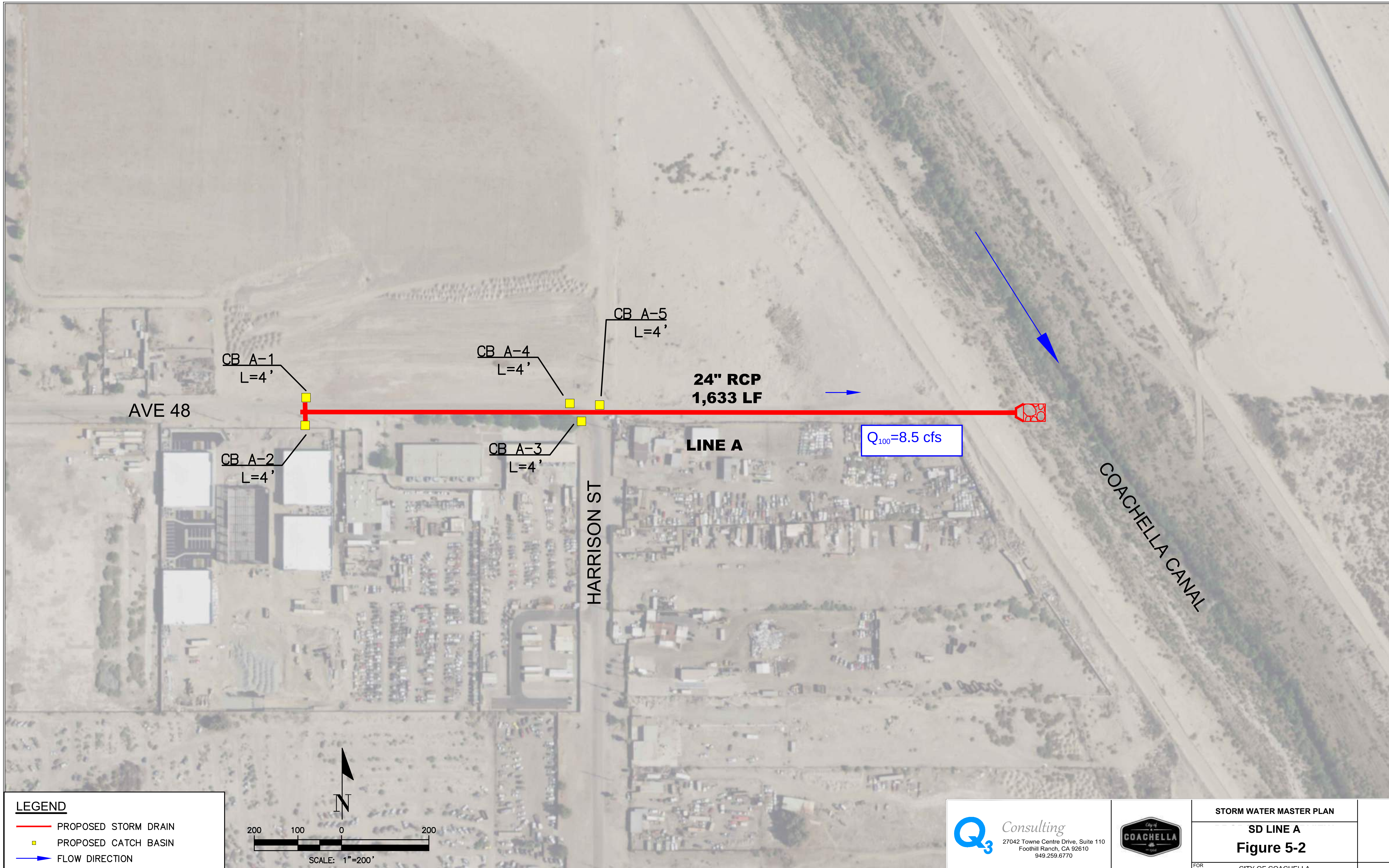

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5.2 Line B

Line B's tributary drainage area is approximately 1,600 acres generally bound by Avenue 48 to the north, Avenue 50 to the south, Jackson Street to the west, and the CVSC to the east. The general flow path is from northwest to southeast, where currently, surface runoff is conveyed via surface to Avenue 50 towards the CVSC. Known flooding locations exist at Avenue 50 and Frederick Street, Avenue 50 and Kenmore Street, and Avenue 49 and Grapefruit Blvd (Highway 111). See Figure 5.3.

The proposed Line B begins on Avenue 50 at Frederick Street and extends eastward along Avenue 50 to Grapefruit Blvd., where it joins Lateral B-1 under the overpass. Lateral B-1 begins at the Highway 111/Avenue 49 intersection and flows south along Grapefruit Blvd. to the Line B junction. From the junction, Line B extends eastward to CVSC where it is discharged.

5.2.1 Proposed Alternative

The proposed system includes a 3,600 linear foot 48-inch RCP pipe that captures flows at the intersection of Avenue 50 and Frederick Street to the intersection of Avenue 50 and Highway 111, where the Lateral B-1 junction exists. From this junction to the CVSC, 3,950 linear feet of 3-foot high by 5-feet wide reinforced concrete box (RCB) is proposed, discharging flows to CVSC. The proposed facility (Line B) includes 3,455 linear feet of 48-inch diameter RCP. Figure 5.4 shows the estimated pipe sizes and lengths associate with this alternative alignment.

Line B contains multiple proposed inlets along Avenue 50. Improved inlets are proposed at Frederick Street, Avenida De Oro, near Avenida De Plata, Harrison Street, Highway 111 and at Tyler Street. A total of thirteen (13) inlets are proposed along Line B. Along Lateral B-1, three inlets are proposed at 49th Avenue and one at Park Lane. Two more inlets are located along Grapefruit Blvd. Prior to the junction of Line B with Lateral B-1, Line B has a maximum 100-year peak flowrate of 67.7 cfs. Lateral B-1 has a maximum peak flowrate of 14.5 cfs. Line B downstream of the junction contains a maximum peak 100-year flowrate of 82.9 cfs.

The outfall discharges into the CVSC at an invert elevation of -86. Based on our topographic data, the invert of the channel at this location is -95. According to CVWD's latest HEC-RAS analysis, this location at approximate channel station 82+386 has an invert of -91.0, with a maximum 100-year water surface elevation of approximately – 72. This outfall should be equipped with a flap-gate and final invert should be established during final design.

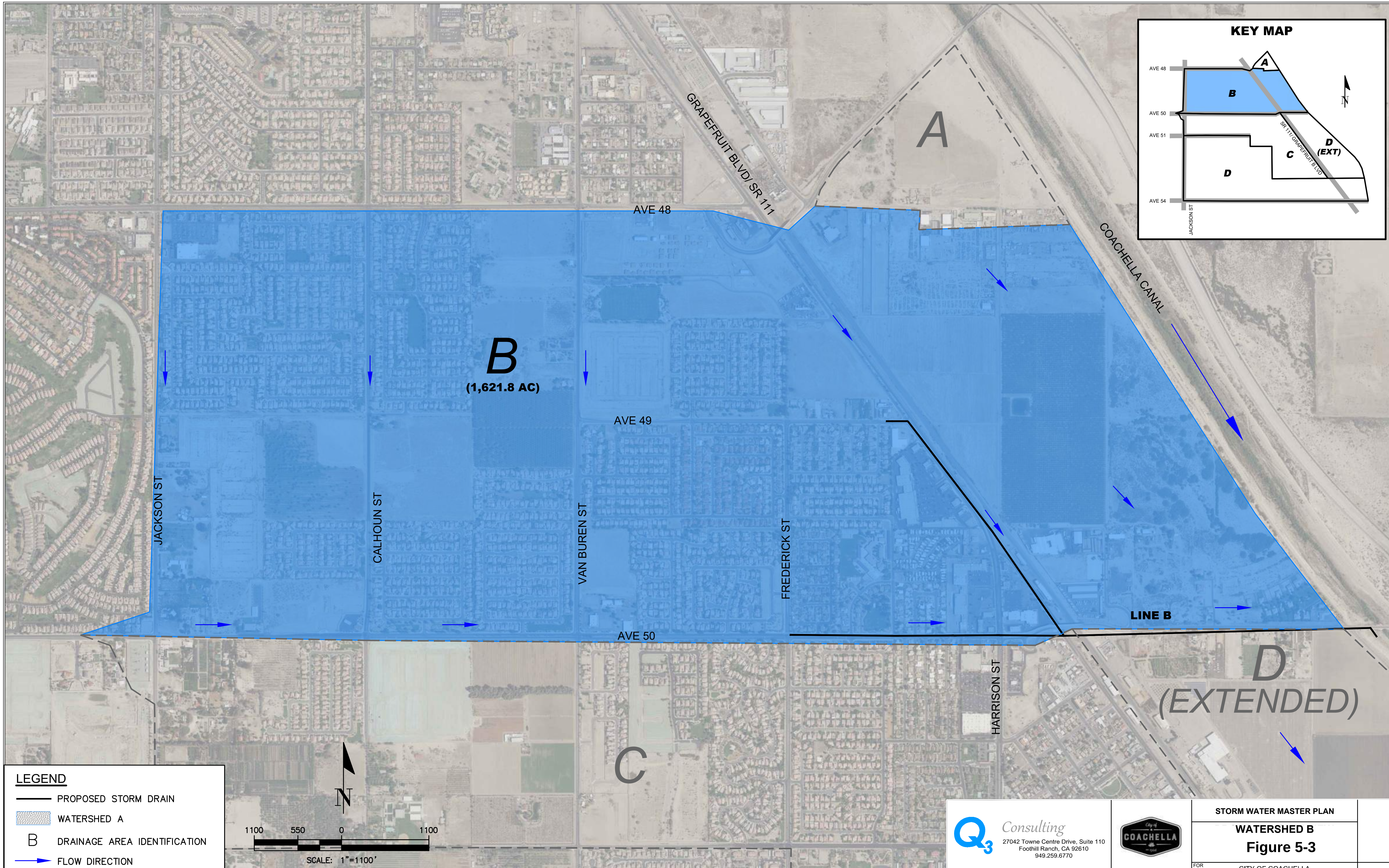
Construction issues associated with this alignment will include coordination with landowners along the easterly leg of the alignment and Caltrans as the alignment crosses the Highway 111 right-of-way. The alignment also traverses under the Union Pacific railroad, which will require special design and construction considerations. East of the railroad, the current land use is open space with a future land use designation of light industrial. The City will have to coordinate with landowners to establish a drainage easement.

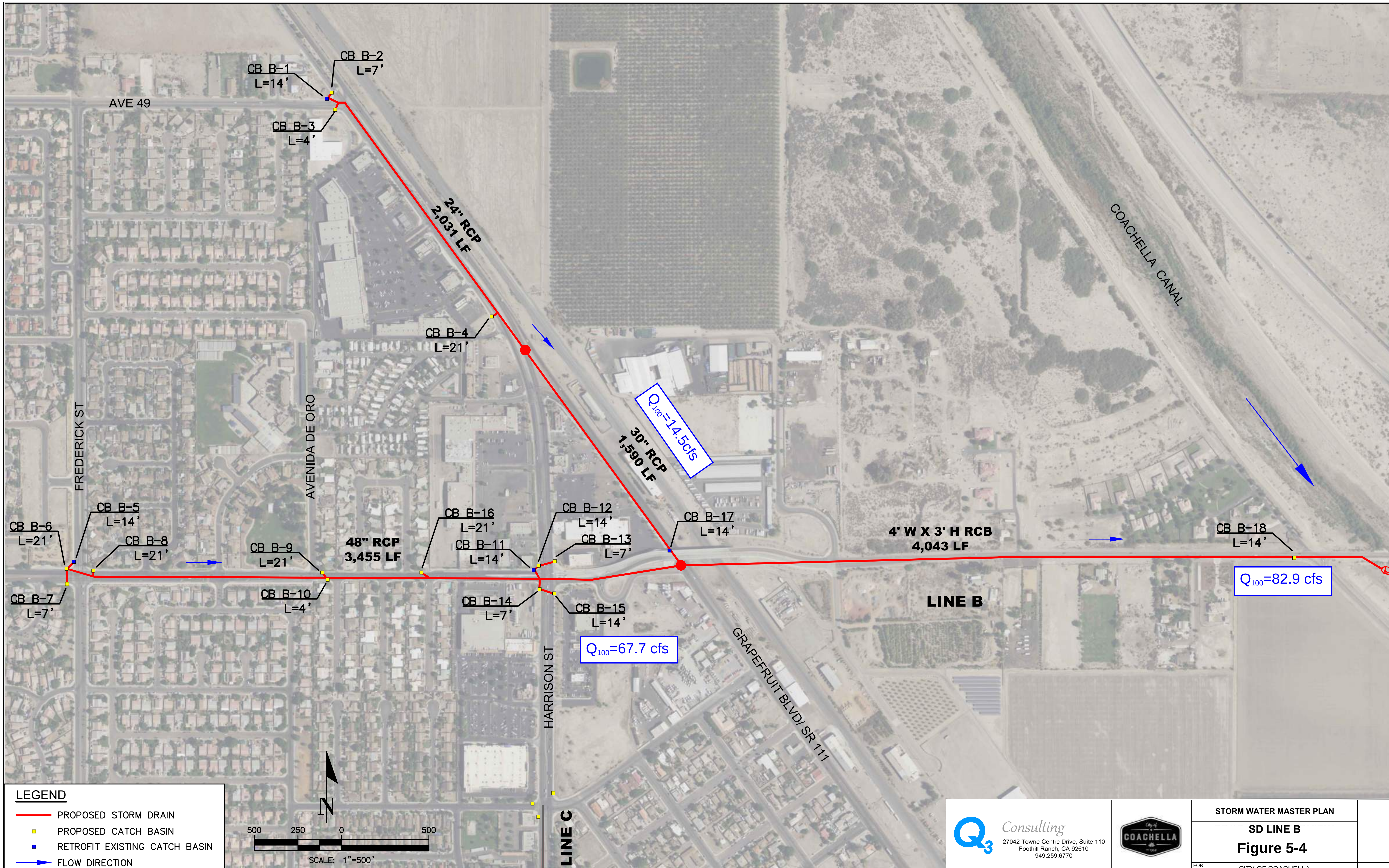
5.2.2 Cost Estimate

For the system, the Q3 team has provided a recommendation constructing storm drain facilities. Table 5-2 gives a summary of the construction cost estimates and the recommended system within the Line "B" area. See Appendix C for detailed cost estimates.

Table 5-2: Line "B" Cost Estimate Summary

Item	Type/Quantity	Total Project Cost (2020 $)
Storm Drain Mainline	24-Inch RCP (2,031 LF)	$254,000
Storm Drain Mainline	30-Inch RCP (1,590 LF)	$278,000
Storm Drain Mainline	48-Inch RCP (3,455 LF)	$777,000
Storm Drain Mainline	3'H x 4'W RCB (4,043 LF)	$1,274,000
Inlets	4' Curb-Opening Catch Basins (2)	$30,000
Inlets	7' Curb-Opening Catch Basins (4)	$72,000
Inlets	14' Curb-Opening Catch Basins (7)	$175,000
Inlets	21' Curb-Opening Catch Basins (1)	$175,000
Junction Structures	4	$30,000
Outlet Structure	CVSD Outlet Facility	$75,000
Tunnel Under Railroad	Lump Sum	$750,000
Remove & Replace AC	111,190 SF	$778,000
Traffic Control	Lump Sum	$75,000
	Subtotal	**$4,743,000**
Mobilization, Bonds, Insurance & Permits	LS (10%)	$474,000
Engineering, Survey, Soils, and Staking	LS (15%)	$712,000
Utility Relocation	LS (5%)	$237,000
Contingency	LS (20%)	$949,000
	LINE "B" TOTAL COST	**$7,115,000**


KEY MAP
AVE 48
AVE 50
AVE 51
AVE 54
JACKSON ST
SR 111/ GRAPEFRUIT BLVD
A
B
C
D
D
(EXT)
A
B
(1,621.8 AC)
C
D
(EXTENDED)
AVE 48
AVE 49
AVE 50
JACKSON ST
CALHOUN ST
VAN BUREN ST
FREDERICK ST
HARRISON ST
GRAPEFRUIT BLVD/ SR 111
COACHELLA CANAL
LINE B
LEGEND
PROPOSED STORM DRAIN
WATERSHED A
B DRAINAGE AREA IDENTIFICATION
FLOW DIRECTION
1100 550 0 1100
SCALE: 1"=1100'
N
Consulting
27042 Towne Centre Drive, Suite 110
Foothill Ranch, CA 92610
949.259.6770
COACHELLA
STORM WATER MASTER PLAN
WATERSHED B
Figure 5-3
FOR
CITY OF COACHELLA



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5.3 Line C

Line C is one of the largest of the proposed drainage systems routing the stormwater runoff from approximately 2,060 acres of tributary drainage area. The general drainage watershed tributary to Line C can be seen in Figure 5.5, capturing runoff south of Avenue 50, and north Avenue 53. To the west, the drainage area is shared with Line D drainage.

The headworks of proposed Line C begins along Harrison Street at the Westerfield Way intersection. The proposed main line traverses east and south along City streets, utilizing existing facilities where possible. Line C eventually discharges into Line D at Avenue 54.

Since Line C proposes to join Line D, the portion of Line D downstream of the Line C intersection must be constructed first, prior to construction of Line C. The benefit of joining these two lines is mainly due to the constructability issues with conveying flows east, under both Highway 111 and the railroad tracks. By minimizing these crossings, costs savings are captured also by minimizing the pipe needed to discharge to the east in the CVSC.

5.3.1 Proposed Alternative

Line C includes a 36-inch RCP that extends south along Harrison to Bagdad Avenue where it transitions into a 48-inch RCP and jogs east to Shady Lane where it joins Lateral C1 from the north at the Shady Lane intersection. After the junction, a 60-inch Line C continues south along Shady Lane to Avenue 52, where it discharges into the existing basins. A series of four existing linear detention basins have been constructed to attenuate low flows and allow large flows to overtop. At the end of three linked basins, a fourth basin captures flows and infiltrates. Currently, large flows discharge over the Avenue 53 roadway. The proposed Line C will capture these large flows in this fourth basin, and route them east to Tyler Street. At Tyler Street, flows will be conveyed south to confluence with Line D at Avenue 54.

Line C contains multiple proposed inlets along Harrison Street. Improved inlets are proposed along Harrison Street at Westerfield Way, Avenue 51, and Bagdad Avenue. Multiple inlets are proposed along Shady Lane at 9th Street, Bagdad Avenue, Cairo Street, Araby Avenue, Avenue 52 and along the easterly leg of the Line C alignment east of Shady Lane. A total of thirteen (19) inlets are proposed along Line C.

The peak 100-year flowrate in upper Line C (upstream of the existing basins) was found to be 116.6 cfs. Downstream of the basins a peak flowrate was found to be 119.1 cfs.

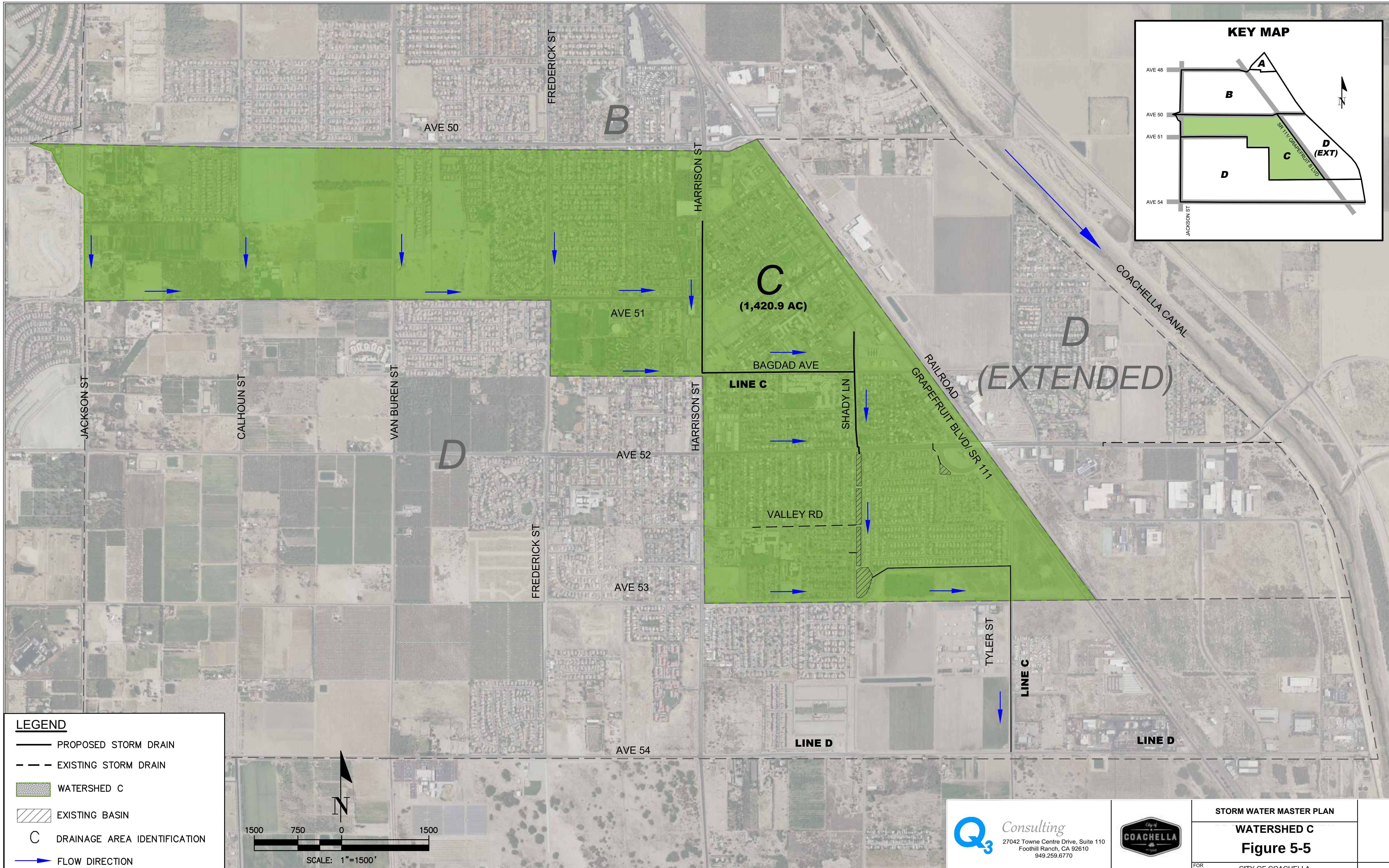
Construction issues associated with this alignment are constrained to City right-of-way. By taking flows down Tyler Street and joining Line D, no crossing of Highway 111 and railroad are needed.

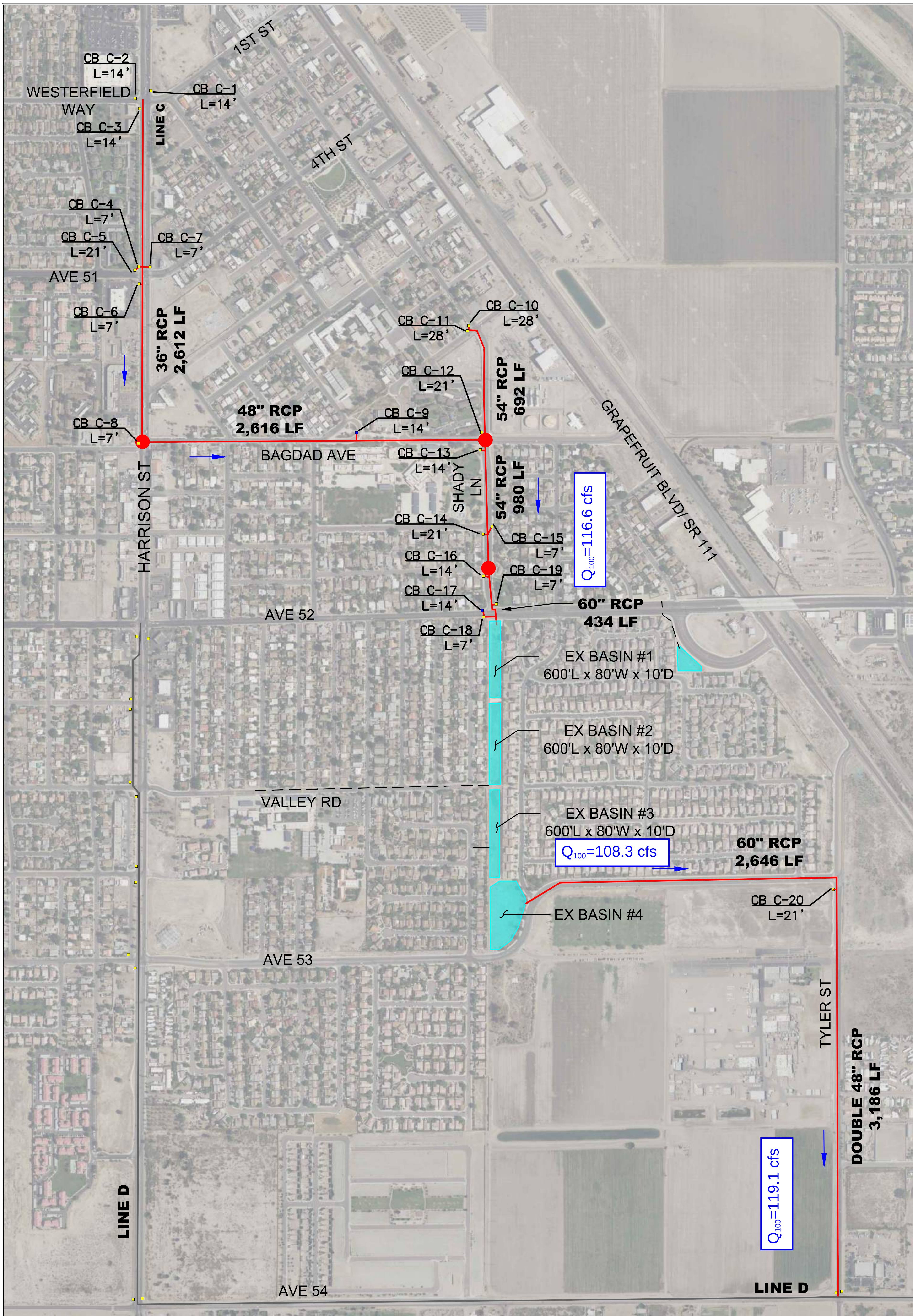
5.3.2 Cost Estimate

For the system, the Q3 team has provided a recommendation constructing storm drain facilities. Table 5-3 gives a summary of the construction cost estimates and the recommended system within the Line "C" area. See Appendix C for detailed cost estimates.

Table 5-3: Line "C" Cost Estimate Summary

Item	Type/Quantity	Total Project Cost (2020 $)
Storm Drain Mainline	36-Inch RCP (2,612 LF)	$522,000
Storm Drain Mainline	48-Inch RCP (2,616 LF)	$589,000
Storm Drain Mainline	54-Inch RCP (1,672 LF)	$460,000
Storm Drain Mainline	60-Inch RCP (3,080 LF)	$924,000
Storm Drain Mainline	Double 48-Inch RCP (3,186 LF)	$1,274,000
Inlets	7' Curb-Opening Catch Basins (7)	$126,000
Inlets	14' Curb-Opening Catch Basins (6)	$150,000
Inlets	21' Curb-Opening Catch Basins (4)	$140,000
Inlets	28' Curb-Opening Catch Basins (2)	$90,000
Junction Structures	5	$37,000
Line C/D Junction Structure	1	$48,000
Remove & Replace AC	131,660 SF	$922,000
Traffic Control	Lump Sum	$50,000
	Subtotal	**$5,332,000**
Mobilization, Bonds, Insurance & Permits	LS (10%)	$533,000
Engineering, Survey, Soils, and Staking	LS (15%)	$800,000
Utility Relocation	LS (5%)	$267,000
Contingency	LS (20%)	$1,066,000
	LINE "C" TOTAL COST	**$7,998,000**


KEY MAP
AVE 48
AVE 50
AVE 51
AVE 54
JACKSON ST
A
B
C
D
D (EXT)
SR 111/ GRAPEFRUIT BLVD
AVE 50
FREDERICK ST
B
HARRISON ST
C
(1,420.9 AC)
AVE 51
BAGDAD AVE
LINE C
SHADY LN
RAILROAD
GRAPEFRUIT BLVD/ SR 111
D
(EXTENDED)
COACHELLA CANAL
JACKSON ST
CALHOUN ST
VAN BUREN ST
D
AVE 52
HARRISON ST
VALLEY RD
FREDERICK ST
AVE 53
TYLER ST
LINE C
AVE 54
LINE D
LINE D
LEGEND
PROPOSED STORM DRAIN
EXISTING STORM DRAIN
WATERSHED C
EXISTING BASIN
C DRAINAGE AREA IDENTIFICATION
FLOW DIRECTION
N
1500 750 0 1500
SCALE: 1"=1500'
Q3 Consulting
27042 Towne Centre Drive, Suite 110
Foothill Ranch, CA 92610
949.259.6770
City of COACHELLA
STORM WATER MASTER PLAN
WATERSHED C
Figure 5-5
FOR
CITY OF COACHELLA



LEGEND

- PROPOSED STORM DRAIN
- EXISTING STORM DRAIN
- EXISTING BASIN
- PROPOSED CATCH BASIN
- RETROFIT EXISTING CATCH BASIN
- FLOW DIRECTION

N

700 4350 0 700

SCALE: 1"=700'

Q3 Consulting
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Foothill Ranch, CA 92610
949.259.6770

City of COACHELLA

STORM WATER MASTER PLAN

SD LINE C

Figure 5-6

FOR CITY OF COACHELLA

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5.4 Line D

Line D captures flows in the southernmost section of the City. The general alignment of Line D is located west of Line C and runs parallel with Line C from Avenue 52 south to Avenue 54. At the intersection of Harrison Street and Avenue 54, Line D runs east along Avenue 54 to Tyler Street, where it captures the flows from Line C. From Tyler Street, flows are routed east to CVSC.

5.4.1 Proposed Alternative

Line D includes a proposed 36-inch RCP that extends from Avenue 52 south to Avenue 53, where it transitions to a 42-inch RCP down to Avenue 54. At Avenue 54, Line D travels east to Tyler Street, where it captures flows from Line C. At this junction, Line D transitions into a double 48-inch RCP where it discharges into the CVSC. Due to the potential utility conflicts at Highway 111 and the railroad tracks, it was proposed to use a dual pipe system to decrease the proposed facility height.

Line D contains twelve (12) proposed inlets along Harrison Street. These inlets will capture most of the flows located within the Line D watershed. Twelve (12) additional inlets are proposed along Avenue 54, in addition to the junction with Line C at Tyler Street. One minor lateral (24-inch RCP) is proposed east of Highway 111. Lateral D-1 is a 900 linear foot 24-inch that extends up Enterprise Way. This lateral is proposed to drain a low point within this area.

A maximum peak 100-year flowrate at the Harrison Street/Avenue 54 intersection was found to be 41.9 cfs. After confluence with Line C at Tyler Street and capture of flows along Avenue 54 (east of Tyler Street), Line D has a peak flowrate of 153.3 cfs.

The area east of Highway 111, bound by Avenue 54 to the south, CVSC to the east and Avenue 50 to the north is technically tributary to Line D. The 100-year model results showed little in the way of runoff or major ponding within the City streets. As a result, it will be proposed that future light industry (or future construction in general) be required to maintain existing condition discharge characteristics. Consequently, it is not expected that future development will create a need for additional storm drain infrastructure. Construction issues associated with this alignment will include coordination with landowners along the easterly leg of the alignment and Caltrans as the alignment crosses the Highway 111 right-of-way. The alignment also traverses under the Union Pacific railroad, which will require special design and construction considerations. East of the railroad, the current land use is open space with a future land use designation of light industrial. The City will have to coordinate with landowners to establish a drainage easement.

An additional catch basin inlet is proposed along Line D between the railroad tracks and Highway 111. This area shows ponding in the existing condition models. Since this is not City right-of-way, inlets were proposed to drain it into Line D, with the intent that a potential future system could tie into Line D. This was done to ensure that Line D could accept these future flows without causing adverse effects on the system.

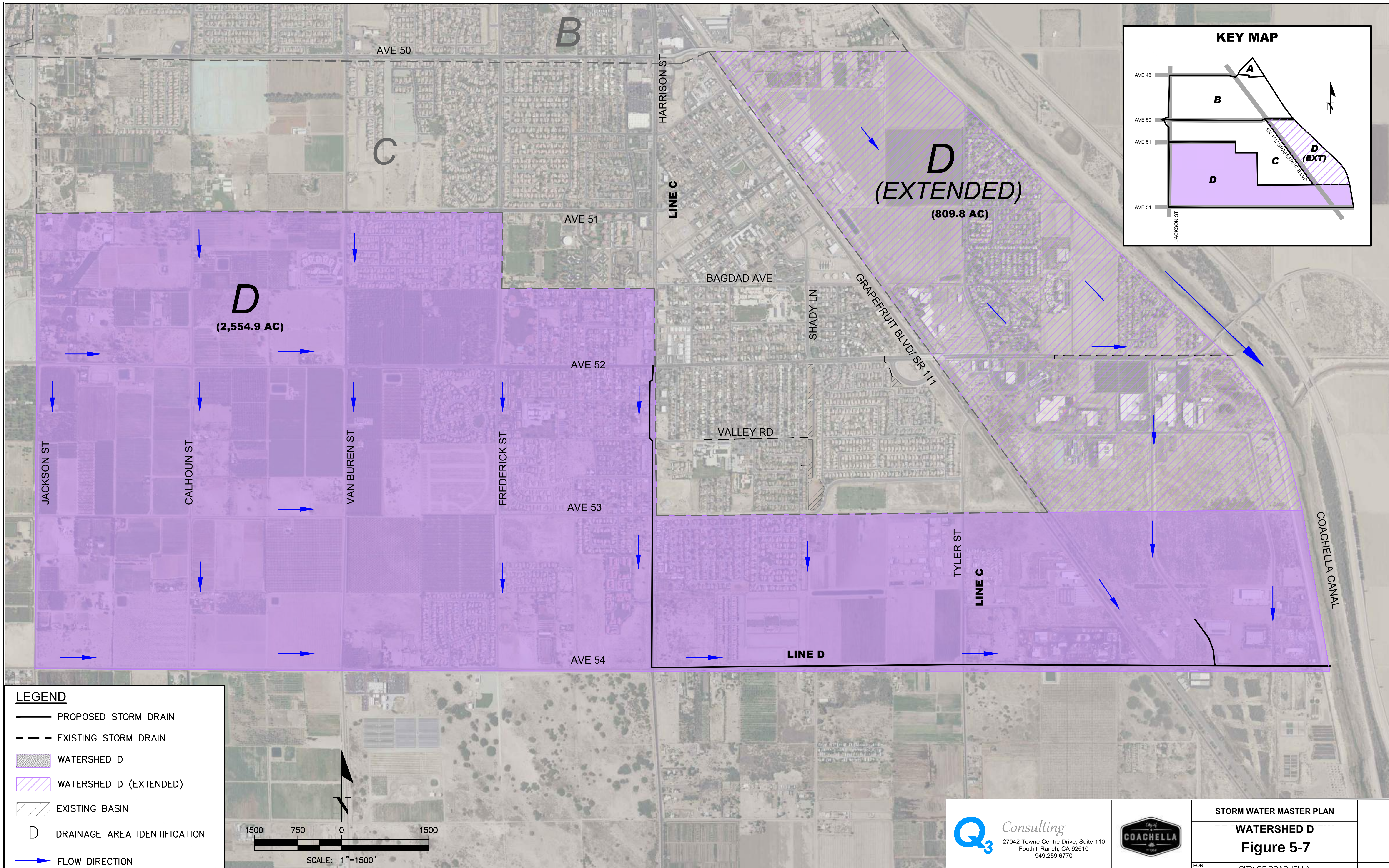
The outfall discharges into the CVSC at an invert elevation of -119. Based on our topographic data, the invert of the channel at this location is -120. According to CVWD's latest HEC-RAS analysis, this location at approximate channel station 64+618 has an invert of -132.4, with a maximum 100-year water surface elevation of approximately – 112. This outfall should be equipped with a flap-gate and final invert should be established during final design.

5.4.2 Cost Estimate

For the system, the Q3 team has provided a recommendation constructing storm drain facilities. Table 5-4 gives a summary of the construction cost estimates and the recommended system within the Line "D" area. See Appendix C for detailed cost estimates.

Table 5-4: Line "D" Cost Estimate Summary

Item	Type/Quantity	Total Project Cost (2020 $)
Storm Drain Mainline	24-Inch RCP (900 LF)	$113,000
Storm Drain Mainline	36-Inch RCP (1,265 LF)	$253,000
Storm Drain Mainline	42-Inch RCP (9,316 LF)	$1,956,000
Storm Drain Mainline	Double 48-Inch RCP (6,326 LF)	$2,530,000
Inlets	4' Curb-Opening Catch Basins (5)	$75,000
Inlets	7' Curb-Opening Catch Basins (16)	$288,000
Inlets	14' Curb-Opening Catch Basins (2)	$50,000
Inlets	21' Curb-Opening Catch Basins (1)	$35,000
Junction Structures	10	$75,000
Outlet Structure	1	$125,000
Remove & Replace AC	178,070 SF	$1,246,000
Traffic Control	Lump Sum	$100,000
	Subtotal	**$7,196,000**
Mobilization, Bonds, Insurance & Permits	LS (10%)	$720,000
Engineering, Survey, Soils, and Staking	LS (15%)	$1,080,000
Utility Relocation	LS (5%)	$360,000
Contingency	LS (20%)	$1,439,000
	LINE "D" TOTAL COST	**$10,795,000**



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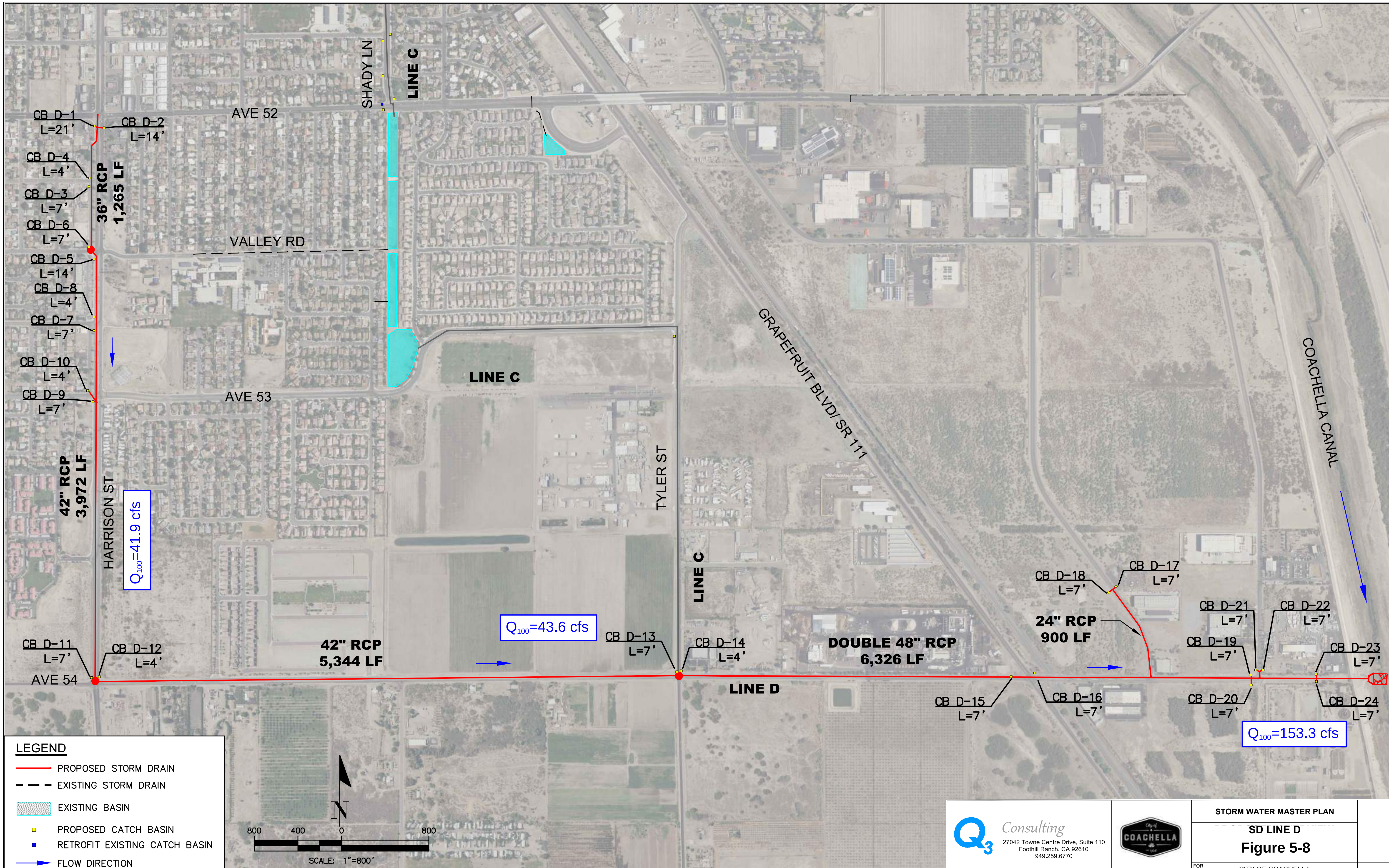

AVE 52
SHADY LN
LINE C
CB D-1
L=21'
CB D-2
L=14'
CB D-4
L=4'
CB D-3
L=7'
CB D-6
L=7'
36" RCP
1,265 LF
VALLEY RD
CB D-5
L=14'
CB D-8
L=4'
CB D-7
L=7'
CB D-10
L=4'
CB D-9
L=7'
LINE C
AVE 53
42" RCP
3,972 LF
HARRISON ST
Q100=41.9 cfs
TYLER ST
GRAPEFRUIT BLVD/ SR 111
COACHELLA CANAL
LINE C
Q100=43.6 cfs
CB D-11
L=7'
CB D-12
L=4'
AVE 54
42" RCP
5,344 LF
CB D-13
L=7'
CB D-14
L=4'
DOUBLE 48" RCP
6,326 LF
LINE D
CB D-18
L=7'
CB D-17
L=7'
24" RCP
900 LF
CB D-21
L=7'
CB D-22
L=7'
CB D-19
L=7'
CB D-23
L=7'
CB D-15
L=7'
CB D-16
L=7'
CB D-20
L=7'
CB D-24
L=7'
Q100=153.3 cfs
LEGEND
PROPOSED STORM DRAIN
EXISTING STORM DRAIN
EXISTING BASIN
PROPOSED CATCH BASIN
RETROFIT EXISTING CATCH BASIN
FLOW DIRECTION
N
800 400 0 800
SCALE: 1"=800'
Q3 Consulting
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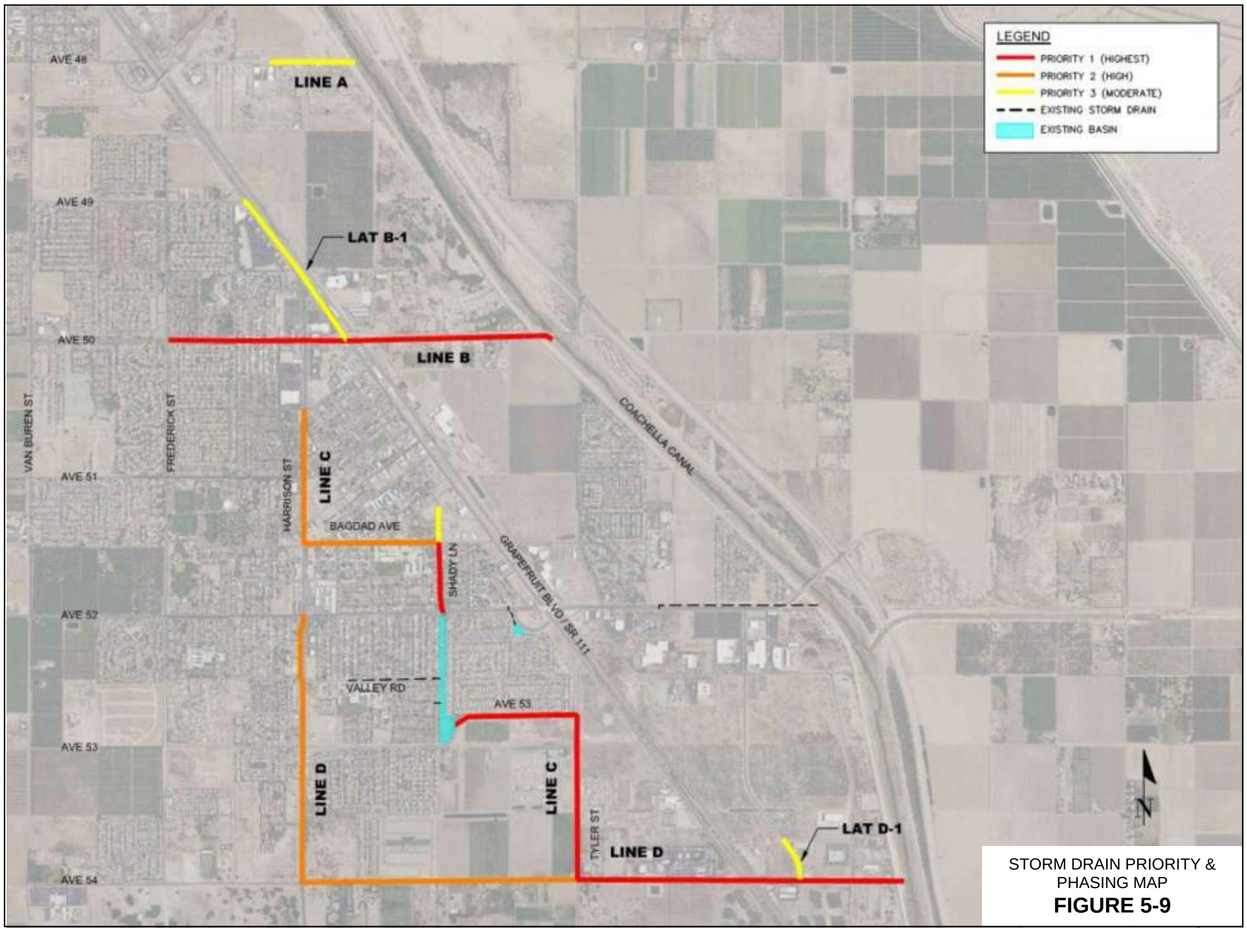
Foothill Ranch, CA 92610
949.259.6770
COACHELLA
STORM WATER MASTER PLAN
SD LINE D
Figure 5-8
FOR
CITY OF COACHELLA

5.5 Project Prioritization & Phasing

A priority ranking has been developed based on levels of system deficiencies per Section 2.3. The goal of the priority ranking system is to determine the projects of the greatest importance and determine which projects should be constructed first when funding becomes available. Note that in situations where portions within a pipe segment consisted of multiple priorities, the ultimate priority assigned to a particular segment defaulted to the highest priority on that segment. Detailed calculations can be found in Appendix D.

Since Line “C” discharges into Line “D”, a portion of Line “D” must be constructed prior to improvements made along Line “C”. For this reason, it is recommended that, at a minimum, the portion of Line “D” downstream of Tyler Street be constructed prior to any portion of Line “C” or upstream Line “D”. Figure 5.9 show the project prioritization for the stormwater master plan facility implementation based on importance. Figure 5.10 shows the construction phasing recommended for future improvements.



STORM DRAIN PRIORITY & PHASING MAP
FIGURE 5-9

6 Green Infrastructure

As part of this project, locations were to be evaluated for potential ground water percolation, regional water quality treatment, and flood control mitigation. Much of the Coachella Valley, including the City, resides near the bottom of a large valley. As such, ground water table elevations can be high, especially during the wet season. Several City owned parcels were identified for potential retention/detention locations but very few were along the proposed storm drain alignments.

With respect to peak flood mitigation, the benefit of utilizing detention basins is reducing proposed pipe sizes downstream of the facility. Much of the City's urbanized area is west of Highway 111 and the railroad tracks. To be beneficial for pipe size reduction, a basin would need to be identified west of Highway 111 and the railroad tracks. The primary construction impacts for the SMP is the proposed crossing of Highway 111 and the railroad tracks. The area east of the Highway and the railroad is primarily agricultural, with no known flooding issues. A basin on the east of the Highway would not provide any substantial economic benefit with regards to reducing storm drain facility sizes but could potentially provide benefit for ground water replenishment and water quality.

Ground water replenishment is a viable option for diverting stormwater runoff, capturing, and percolating. These facilities also require relatively large footprints and can be used throughout the watershed and or alignment of the storm drain system. Currently, the City has some locations where urban stormwater has been directed to in-line basins for retention and percolation. It is recommended that this process be further vetted along the new proposed alignments. Not many City owned lots reside adjacent to the proposed storm drain alignments, but there may be potential to purchase private land. Areas east of the railroad should also be considered for purchase.

Figure 6-1: Example of rainwater harvesting in arid regions (Brad Lancaster, 2008)

Similar to groundwater replenishment, water quality facilities can be implemented throughout the City. Small, local facilities can be incorporated into streetscape-type projects utilizing biotreatment and media filters. These types of facilities are also referred to as rainwater harvesting and are becoming more commonly used in urban areas. Typical locations for rainwater harvesting include along shoulders of streets, within center medians, within landscaped areas and low points within parking lots or adjacent to buildings. These facilities are easy to implement during the planning process of new construction but more difficult to retrofit existing facilities.

Retrofitting existing watersheds (or sub-watersheds) typically involves modifying the current drainage system or flow paths. Figure 6.1 shows how a residential street could be retrofitted by breaking the curb to allow flows to inundate biofilter areas behind the curb. Large flows would fill these pockets and continue down the street to the current drainage inlets.

Regional water quality treatment facilities would require, in most cases purchase of private property. This could be further evaluated as the proposed storm drain system is constructed and during final design phases. Open space areas owned by the City are favorable, but rare along the proposed alignments. Future purchases of private land (currently undeveloped) would provide the best option for potential regional retention/recharge and water quality treatment. Figure 6.2 shows the potential locations for regional recharge based on City-owned land. As can be seen, there are not many locations that provide major benefits along the proposed storm drain alignments.

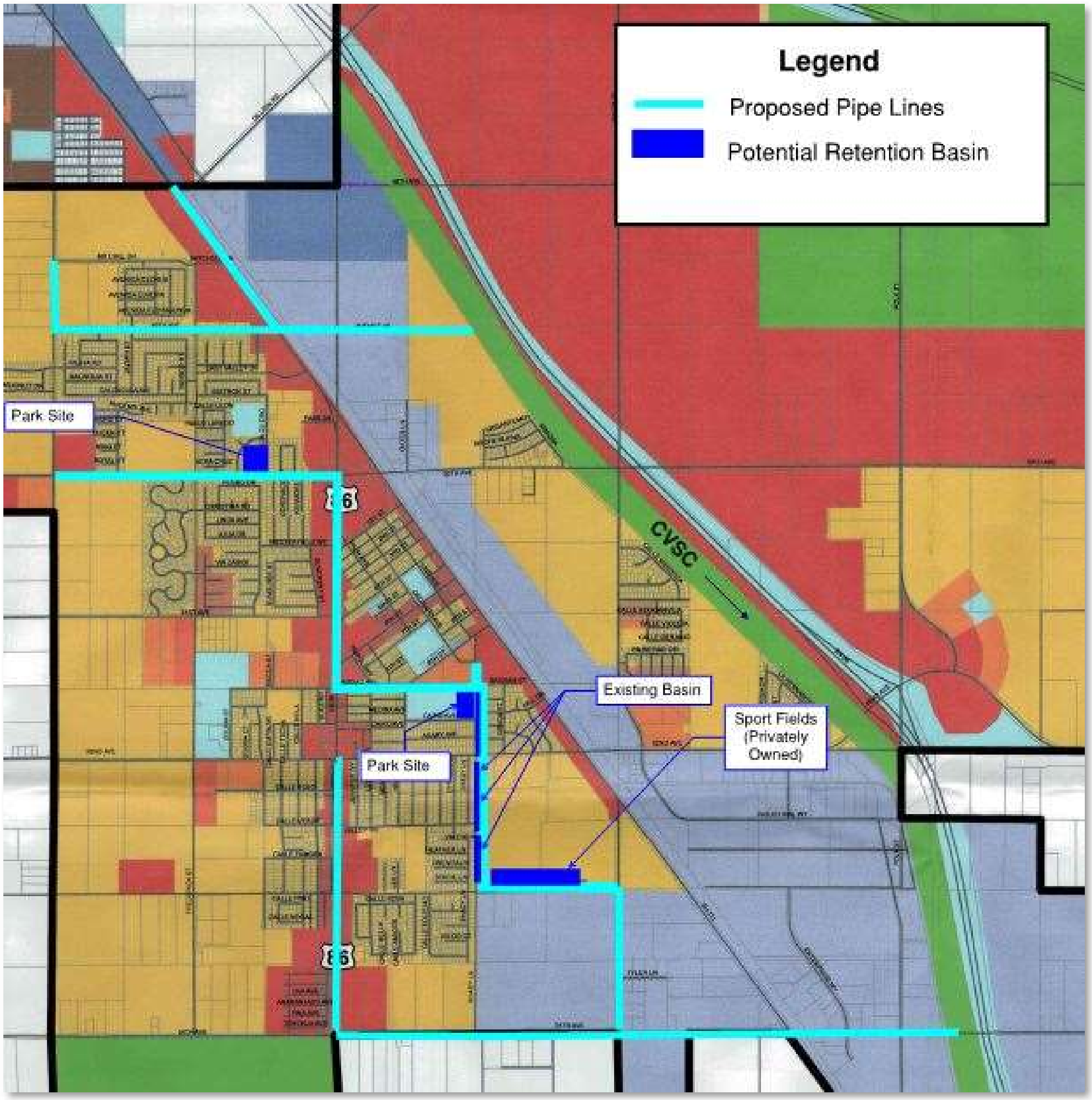


Figure 6-2: Potential Locations for Regional Retention and Water Quality Treatment

7 Final Considerations

Proposed storm drain facilities have been recommended focusing on mitigating known areas of frequent flooding using an advanced hydrologic and hydraulic software program (PCSWMM). The benefit of this software is a single comprehensive drainage model can be developed for the entire City. This provides immediate impact analyses to be completed for every proposed drainage alignment. Proposed improvements can be tracked to identify how they impact downstream areas. In other words, improving flood conditions upstream can sometimes cause flooding downstream. Comprehensive models such as PCWMM will identify these issues and allow the modeler to properly identify an appropriate solution.

Multiple storm drain alignments were evaluated to identified based on feasibility and constructability. One of the main hurdles for identifying a comprehensive drainage plan is the location of the outlet, the Coachella Valley Storm Channel. Flows captured within the urbanized area of the City have to be routed over a mile along flat terrain, crossing under Highway 111 and the railroad. One of the primary goals for storm drain alignment selection was to minimize the number of outlets or main line crossings, while minimizing the main storm drain sizes.

By having the urbanized area located within the upstream subareas of the watershed (west of Highway 111), opportunities for flood control retention and/or attenuation are minimal. Providing flood control mitigation in the downstream watershed subareas (east of the railroad tracks) does not provide much benefit for reducing the overall storm drain costs.

However, identification of retention (recharge) or regional water quality treatment opportunities east of the railroad tracks are optimal. Future studies and coordination with land owners adjacent to the proposed main storm drain alignments would be ideal for potential future project and potential grant applications.

The proposed alignments have been presented in a phased approach. This approach was based on constructing segments of storm drain that would provide the greatest incremental benefit, while not creating adverse flood impacts downstream. Local water quality and minor recharge opportunities can be implemented with the implementation of these projects using green infrastructure and potentially purchasing of privately owned land, which can be converted to regional facilities.

The alignments identified in this SMP are based on topography and regional hydrology. It is expected that during Final Design of any of these projects will go through a more rigorous vetting process with respect to utility locations and final hydrology and hydraulics. These proposed projects are just the first phase of design. Alignment modifications, introduction of laterals and/or water quality and recharge facilities is suggested.

8 Funding Opportunities

Potential funding sources that may become available and instrumental for implementation of the City's Storm Water Master Plan have been evaluated. It is expected that no single source of revenue will be adequate to fund implementation of the entire Storm Water Master Plan, so multiple funding options are deemed necessary to carry out the plan. This section provides a summary of various options, primarily in the form of grants and loans, evaluated as part of the Storm Water Master Plan preparation. It is worth noting that the availability of programs and grants to which the project may be eligible can potentially change over the years. For each source, the content consists of a program summary and link to the program web site. The listed options provided in this document are not presented in an order of priority or importance. Detailed analysis of the grant programs and eligibility is suited for a grant writer's expertise in this field.

8.1 Funding Propositions and Grants

8.1.1 Proposition 1 Water Quality Supply and Infrastructure Improvement Act

Proposition 1, the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Assembly Bill 1471, Rendon) authorized $7.545 billion in general obligation bonds for water projects, including surface and groundwater storage, ecosystem and watershed protection and restoration, and drinking water protection. Proposition 1 funds are administered by the State Water Resources Control Board (State Water Board) under five relevant programs: 1) Small Community Wastewater; 2) Clean, Safe & Reliable Drinking Water; 3) Integrated Regional Water Management; 4) Stormwater; and 5) Water Recycling. In this context, stormwater resource management refers to projects aimed at reducing, managing, treating, or capturing rainwater or stormwater.

Portions of the proposed MDP may be eligible for funding under Proposition 1 by following a competitive grant application process. For additional Proposition information:

- https://www.waterboards.ca.gov/water_issues/programs/grants_loans/proposition1/

Additional Proposition 1 Bond Accountability information:

- http://bondaccountability.resources.ca.gov/p1.aspx

8.1.2 Storm Water Grant Program (Proposition 1 SWGP)

Under the Proposition 1 SWGP, eligible applicants include public agencies, nonprofit organizations, public utilities, federally recognized Indian tribes, state Indian tribes listed on Native American Heritage Commission's California Tribal Consultation List, and mutual water companies.

Eligible project types fall into two categories:

1. Planning: Development of Storm Water Resource Plans (SWRPs) that meet the requirements of Water Code section 10562 and the SWRP Guidelines, and project-specific planning projects. Applications for SWRPs and project-specific planning projects were only solicited for Round 1.

2. Implementation: Multi-benefit storm water management projects which may include, but shall not be limited to, green infrastructure, rainwater and storm water capture projects and storm water treatment facilities.

For additional Proposition 1 SWGP Information:

- https://www.waterboards.ca.gov/water_issues/programs/grants_loans/swgp/prop1/

8.1.3 Clean Water State Revolving Fund

The federal Clean Water Act (CWA) established the Clean Water State Revolving Fund (CWSRF) program to finance the protection and improvement of water quality. The CWSRF program has protected and promoted the health, safety, and welfare of Californians since 1989. Many of the projects funded by the CWSRF program address wastewater discharge violations or enforcement orders issued by the Regional Water Boards. The State of California also periodically allocates funding to the State Water Board for financing programs that help protect and improve water quality.

Additional CWSRF information can be found below:

- https://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/

8.1.4 Small Community Clean Water/Wastewater (SCWW) Funding

The purpose of wastewater planning funding is to provide low-interest loans, grants, and principal forgiveness to small disadvantaged communities for planning/design and construction of projects that restore and maintain water quality in the state.

The SCWW Funding Program provides low-interest loans and other financing mechanism, such as grants or principal forgiveness using federal and state fund for the planning/design and construction of publicly owned facilities including wastewater treatment plants, sewer collectors and interceptors, combined sewers, septic to sewer conversions, regionalization, landfill leachate treatment, storm water reduction and treatment, and water reclamation facilities.

Office of Sustainable Water Solution (Office) was created within the State Water Resources Control Board to promote permanent and sustainable drinking water and wastewater treatment solutions to ensure effective and efficient provision of safe, clean, affordable, and reliable drinking water and wastewater treatment services. The Office is focused on addressing financial and technical assistance needs, particularly for small, disadvantaged communities through the Small Community Funding Program.

Clean Water State Revolving Fund (CWSRF) loan and principal forgiveness Small community grant (SCG) provided through CWSRF repayments Proposition 1 - Water Quality, Supply, and Infrastructure Improvement Act of 2014

For additional SCWW Information, refer to link below:

- https://www.grants.ca.gov/grants/small-community-clean-water-wastewater-scww-funding/

8.1.5 U.S. Department of Agriculture Rural Development, OneRD Guarantee Loan Initiative: Water and Waste Disposal Loan Guarantees

This program helps private lenders provide affordable financing to qualified borrowers to improve access to clean, reliable water and waste disposal systems for households and businesses in rural areas. Affordable terms and good practices can save tax dollars, improve the natural environment and may be necessary for manufacturers and other types of businesses to locate or expand operations.

Lenders need the legal authority, financial strength and sufficient experience to operate a successful lending program. This includes lenders that are subject to supervision and credit examination by the applicable agency of the United States or a State including:

- Federal and State-chartered banks
- Savings and loans
- Farm Credit Banks with direct lending authority
- Credit unions

Eligible borrowers include public bodies in rural areas with populations of 50,000 residents or less. Funds may be used to construct or improve facilities for storm water disposal facilities, drinking water, sanitary sewers, and solid waste disposal

Additional OneRD information can be found below:

- https://www.rd.usda.gov/onerdguarantee

8.1.6 FEMA Flood Mitigation Assistance (FMA) Grant

The Flood Mitigation Assistance Program is a competitive grant program that provides funding to states, local communities, federally recognized tribes and territories. Funds can be used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the National Flood Insurance Program. FEMA chooses recipients based on the applicant's ranking of the project and the eligibility and cost-effectiveness of the project. FEMA requires state, local, tribal and territorial governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance, including funding for hazard mitigation assistance projects.

Additional FMA information can be found below:

- https://www.fema.gov/grants/mitigation/floods

8.1.7 USDA Watershed and Flood Prevention Operations Program

The Watershed Protection and Flood Prevention Program helps units of federal, state, local and tribal of government (project sponsors) protect and restore watersheds up to 250,000 acres. This program provides for cooperation between the Federal government and the states and their political subdivisions to work together to prevent erosion; floodwater and sediment damage; to further the conservation development, use and disposal of water; and to further the conservation and proper use of land in authorized watersheds. There are 2,100 active or completed watershed projects in the 50 states, the Commonwealth of Puerto Rico and the Pacific Basin. Dams are included in 1,271 of those projects. USDA's Natural Resources Conservation Service (NRCS) offers financial and technical assistance through this program for the following purposes:

- Erosion and sediment control
- Watershed protection
- Flood prevention
- Water quality Improvements
- Rural, municipal and industrial water supply
- Water management
- Fish and wildlife habitat enhancement
- Hydropower sources

Additional WFPO information can be found below:

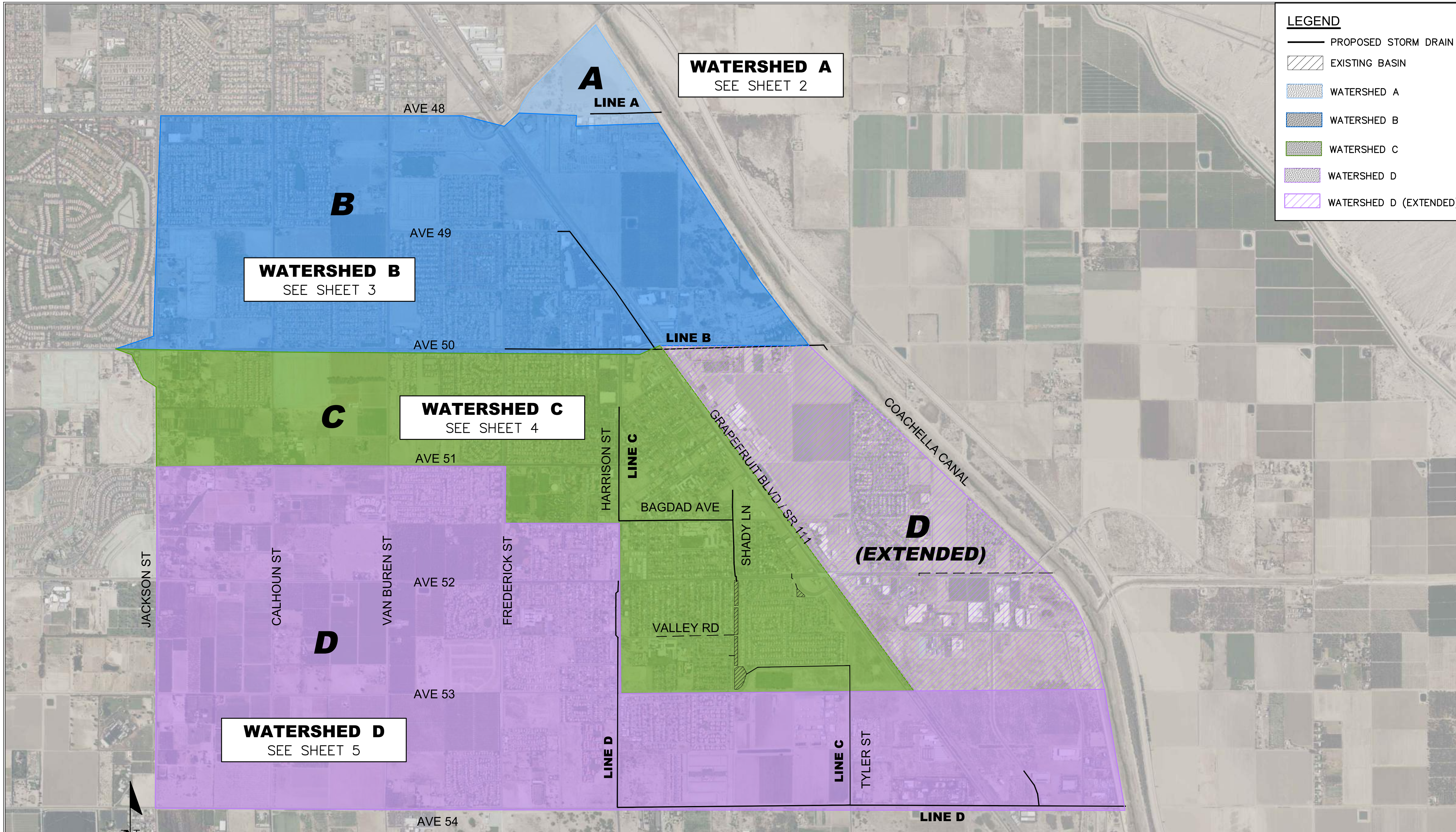
- https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/landscape/wfpo/?cid=nrcs143_008271

8.1.8 Benefit Assessment and Community Facilities Districts

Local governments can levy benefit assessments on property owners to pay for public improvements and services that specifically benefit their properties. The amount of the assessment is directly related to the amount of benefit the property receives. For example, all property owners in a drainage area could be assessed to fund stormwater runoff management programs that provide direct benefit to properties within that zone. Assessments are not taxes or fees, and must be approved by more than 50 percent of the affected property owners.

Many municipalities currently have localized special tax and assessment districts that fund the maintenance and operations of various types of local infrastructure, including Community Facilities Districts (CFDs), "Mello-Roos Districts," and Landscaping and Lighting Assessment Districts. Both CFDs and benefit assessments are very effective and manageable but are primarily a tool for new development and are commonly used for larger residential developments throughout California. The viability of these funding mechanisms depends on the level of remaining potential development or redevelopment in the City. The City may consider a benefit assessment or community facility district as a potential mechanism for funding storm water facility construction and/or maintenance.

EXHIBITS



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949.259.6770

STORM WATER MASTER PLAN

WATERSHED OVERVIEW

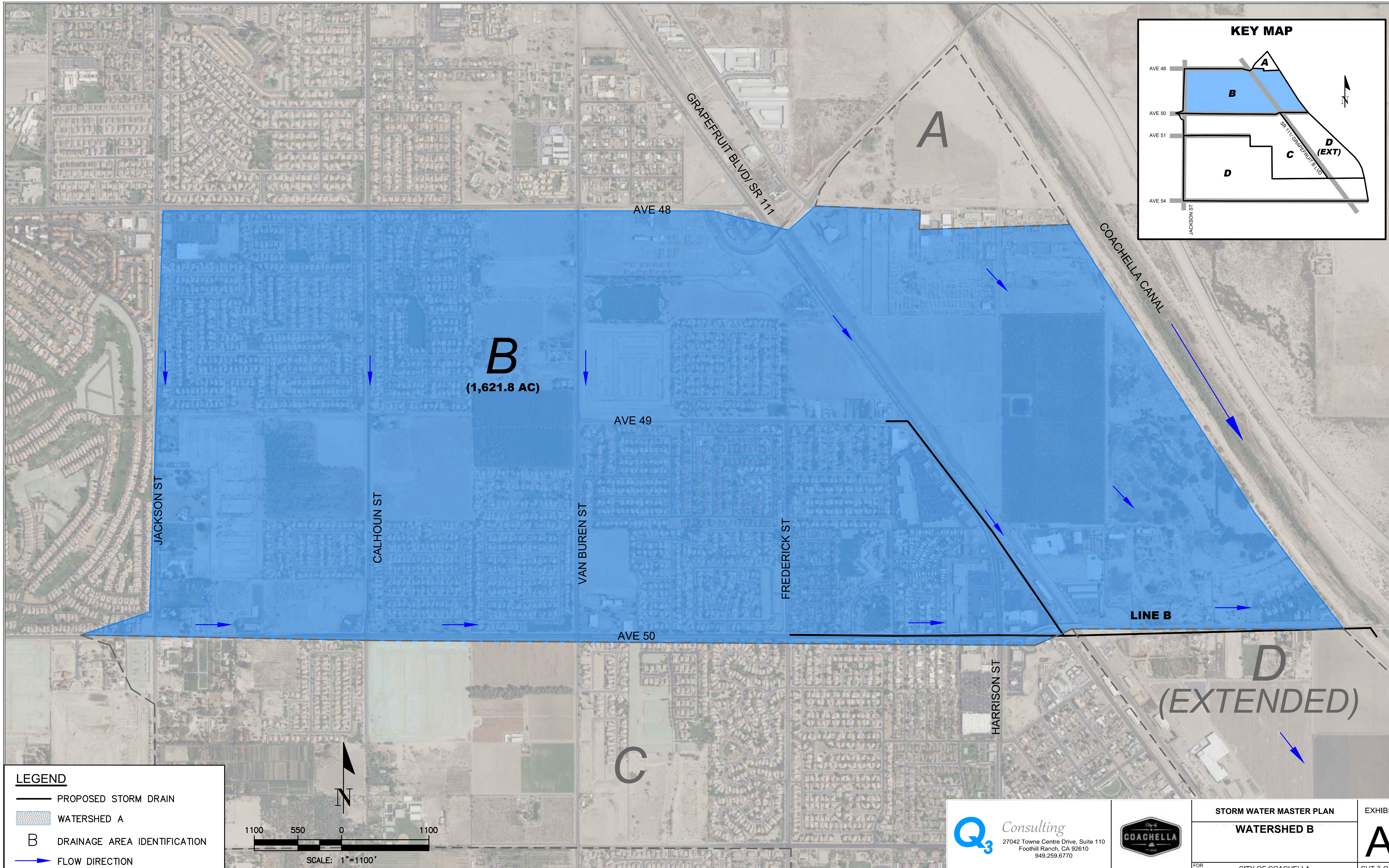
FOR CITY OF COACHELLA

EXHIBIT A

SHT 1 OF 5

N:\40.023.000\DLV\PLANS\EXH\EX001-Watersheds PLOTTED: 12/2/2020 11:00:03 AM

KEY MAP
AVE 48
AVE 50
AVE 51
AVE 54
JACKSON ST
SR 111/ GRAPEFRUIT BLVD
A
B
C
D
D (EXT)
N
A
(87.6 AC)
LINE A
B
GRAPEFRUIT BLVD/ SR 111
AVE 48
COACHELLA CANAL
LEGEND
PROPOSED STORM DRAIN
WATERSHED A
A DRAINAGE AREA IDENTIFICATION
FLOW DIRECTION
500 250 0 500
SCALE: 1"=500'
Q3 Consulting
27042 Towne Centre Drive, Suite 110
Foothill Ranch, CA 92610
949.259.6770
COACHELLA
STORM WATER MASTER PLAN
WATERSHED A
FOR
CITY OF COACHELLA
EXHIBIT
A
SHT 2 OF 5



LEGEND

- PROPOSED STORM DRAIN
- WATERSHED A
- B DRAINAGE AREA IDENTIFICATION
- FLOW DIRECTION

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Foothill Ranch, CA 92610
949.259.6770

City of COACHELLA

STORM WATER MASTER PLAN

WATERSHED B

FOR CITY OF COACHELLA

EXHIBIT A

SHT 3 OF 5

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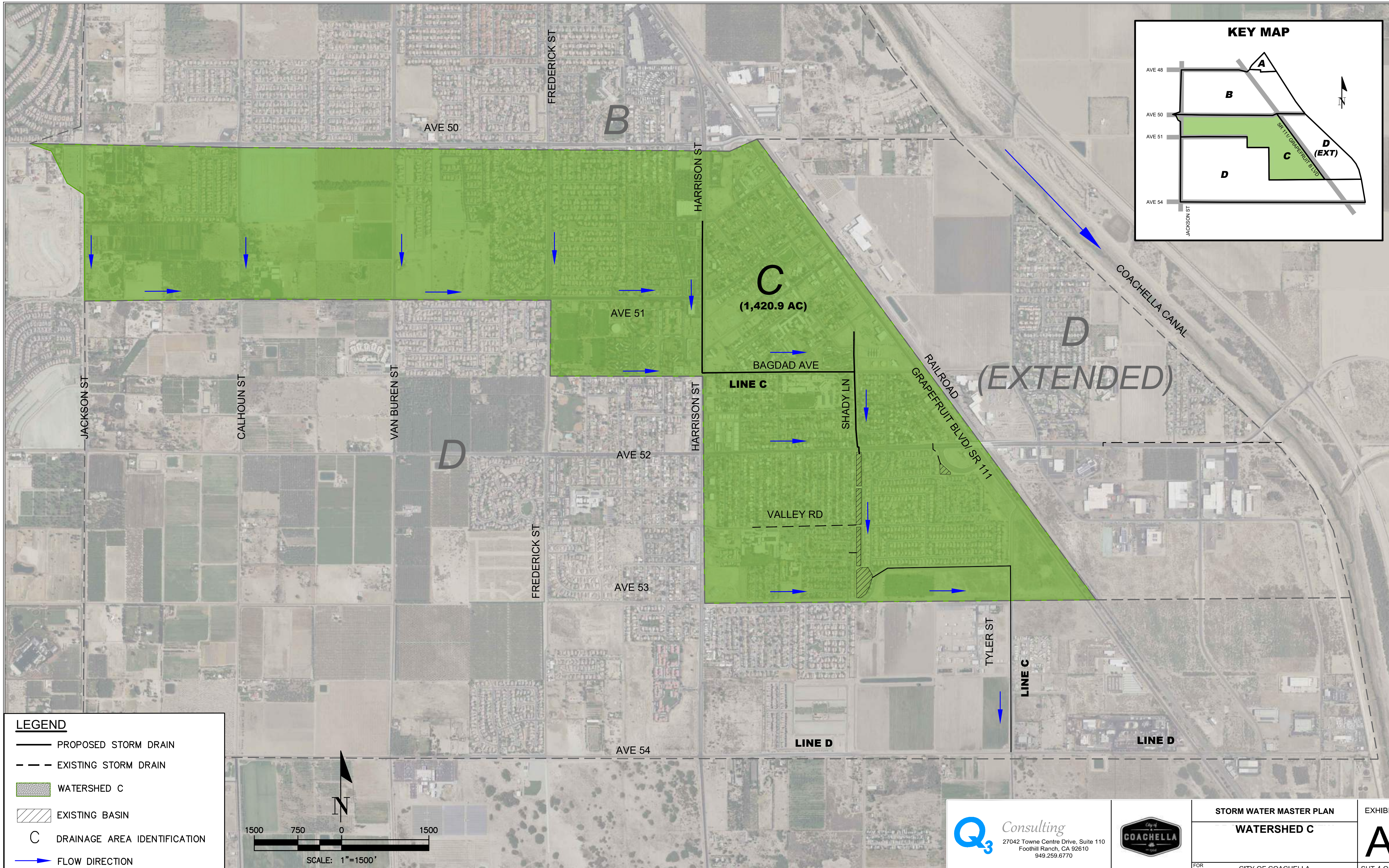

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Foothill Ranch, CA 92610
949.259.6770

City of COACHELLA

STORM WATER MASTER PLAN

WATERSHED C

FOR CITY OF COACHELLA

EXHIBIT A

SHT 4 OF 5

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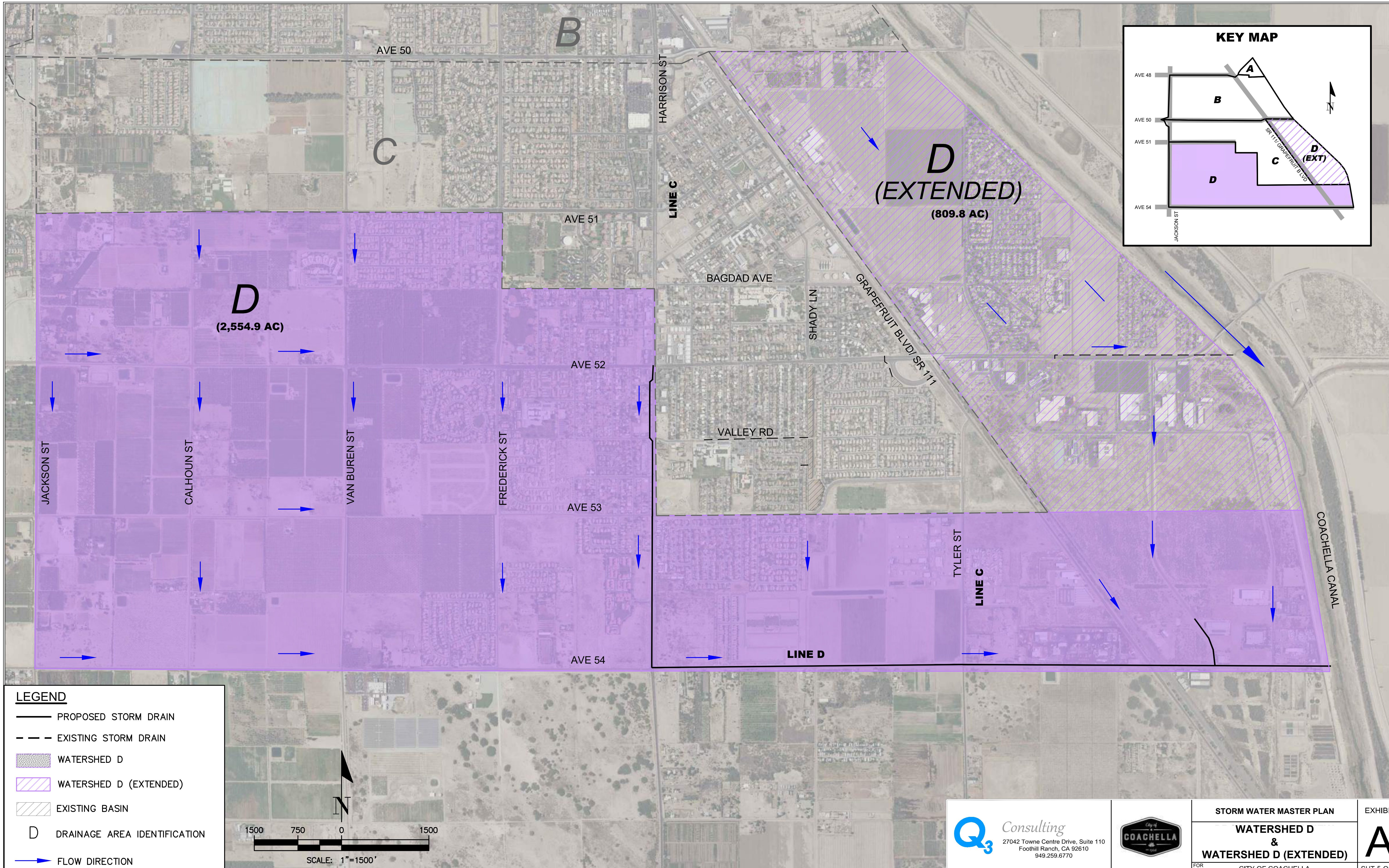

KEY MAP
AVE 48
AVE 50
AVE 51
AVE 54
JACKSON ST
A
B
C
D
D (EXT)
SR 111/ GRAPEFRUIT BLVD
B
C
D
(2,554.9 AC)
D
(EXTENDED)
(809.8 AC)
AVE 50
AVE 51
AVE 52
AVE 53
AVE 54
HARRISON ST
LINE C
BAGDAD AVE
SHADY LN
GRAPEFRUIT BLVD/ SR 111
VALLEY RD
JACKSON ST
CALHOUN ST
VAN BUREN ST
FREDERICK ST
TYLER ST
LINE C
LINE D
COACHELLA CANAL
LEGEND
PROPOSED STORM DRAIN
EXISTING STORM DRAIN
WATERSHED D
WATERSHED D (EXTENDED)
EXISTING BASIN
D DRAINAGE AREA IDENTIFICATION
FLOW DIRECTION
N
1500 750 0 1500
SCALE: 1"=1500'
Q3 Consulting
27042 Towne Centre Drive, Suite 110
Foothill Ranch, CA 92610
949.259.6770
City of COACHELLA
STORM WATER MASTER PLAN
WATERSHED D
&
WATERSHED D (EXTENDED)
FOR
CITY OF COACHELLA
EXHIBIT
A
SHT 5 OF 5
PLOTTED: 12/2/2020 11:00:22 AM

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Foothill Ranch, CA 92610
949.259.6770

STORM WATER MASTER PLAN

STORM DRAIN ALIGNMENTS OVERVIEW

FOR CITY OF COACHELLA

EXHIBIT B

SHT 1 OF 5

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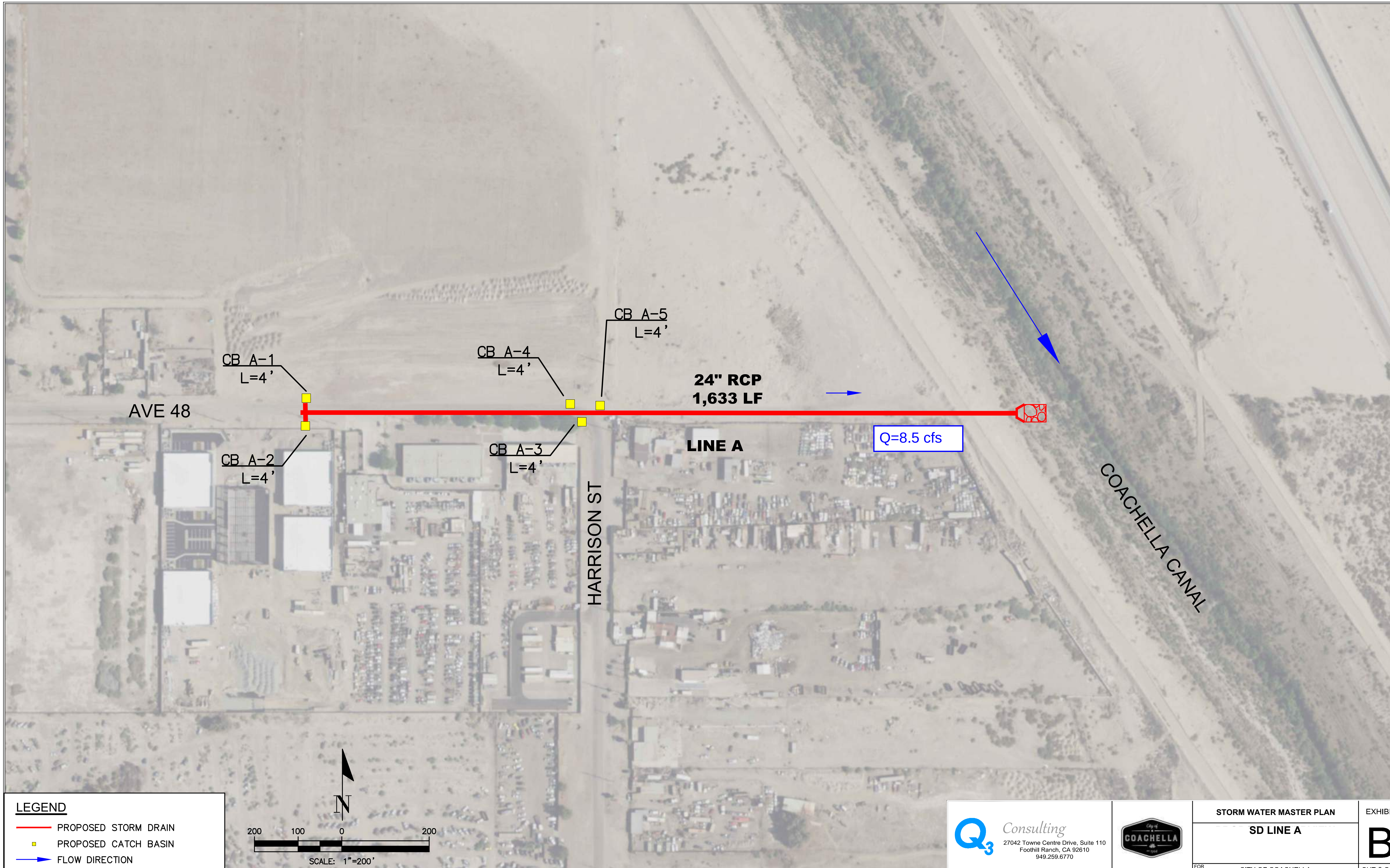

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STORM WATER MASTER PLAN

SD LINE A

FOR CITY OF COACHELLA

EXHIBIT B

SHT 2 OF 5

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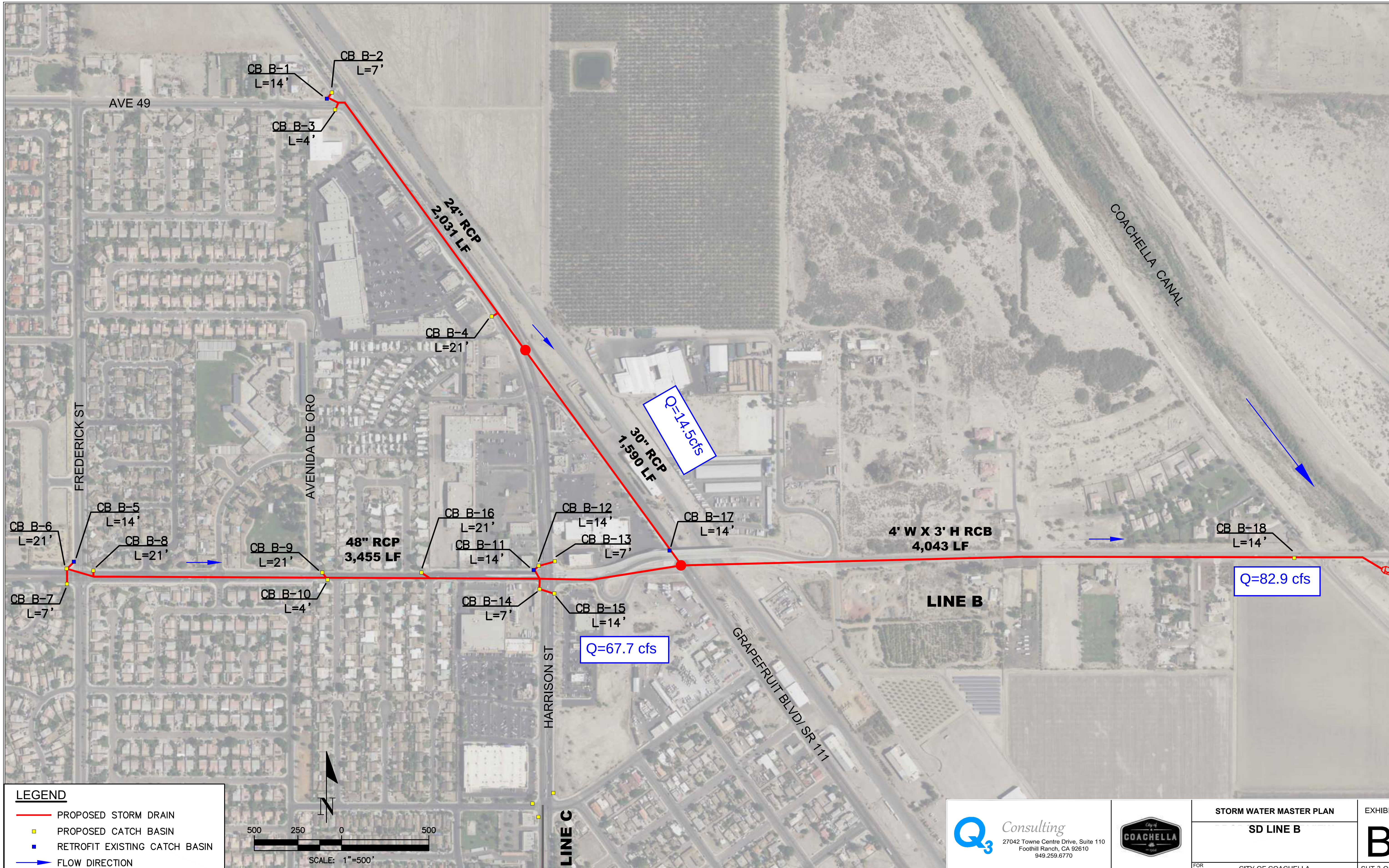

CB B-1
L=14'
CB B-2
L=7'
AVE 49
CB B-3
L=4'
24" RCP
2,031 LF
CB B-4
L=21'
COACHELLA CANAL
Q=14.5cfs
30" RCP
1,590 LF
FREDERICK ST
AVENIDA DE ORO
CB B-5
L=14'
CB B-6
L=21'
CB B-8
L=21'
CB B-9
L=21'
48" RCP
3,455 LF
CB B-16
L=21'
CB B-12
L=14'
CB B-11
L=14'
CB B-13
L=7'
CB B-17
L=14'
4' W X 3' H RCB
4,043 LF
CB B-18
L=14'
Q=82.9 cfs
CB B-7
L=7'
CB B-10
L=4'
CB B-14
L=7'
CB B-15
L=14'
LINE B
Q=67.7 cfs
HARRISON ST
GRAPEFRUIT BLVD/ SR 111
LINE C
N
500 250 0 500
SCALE: 1"=500'
LEGEND
PROPOSED STORM DRAIN
PROPOSED CATCH BASIN
RETROFIT EXISTING CATCH BASIN
FLOW DIRECTION
Q3 Consulting
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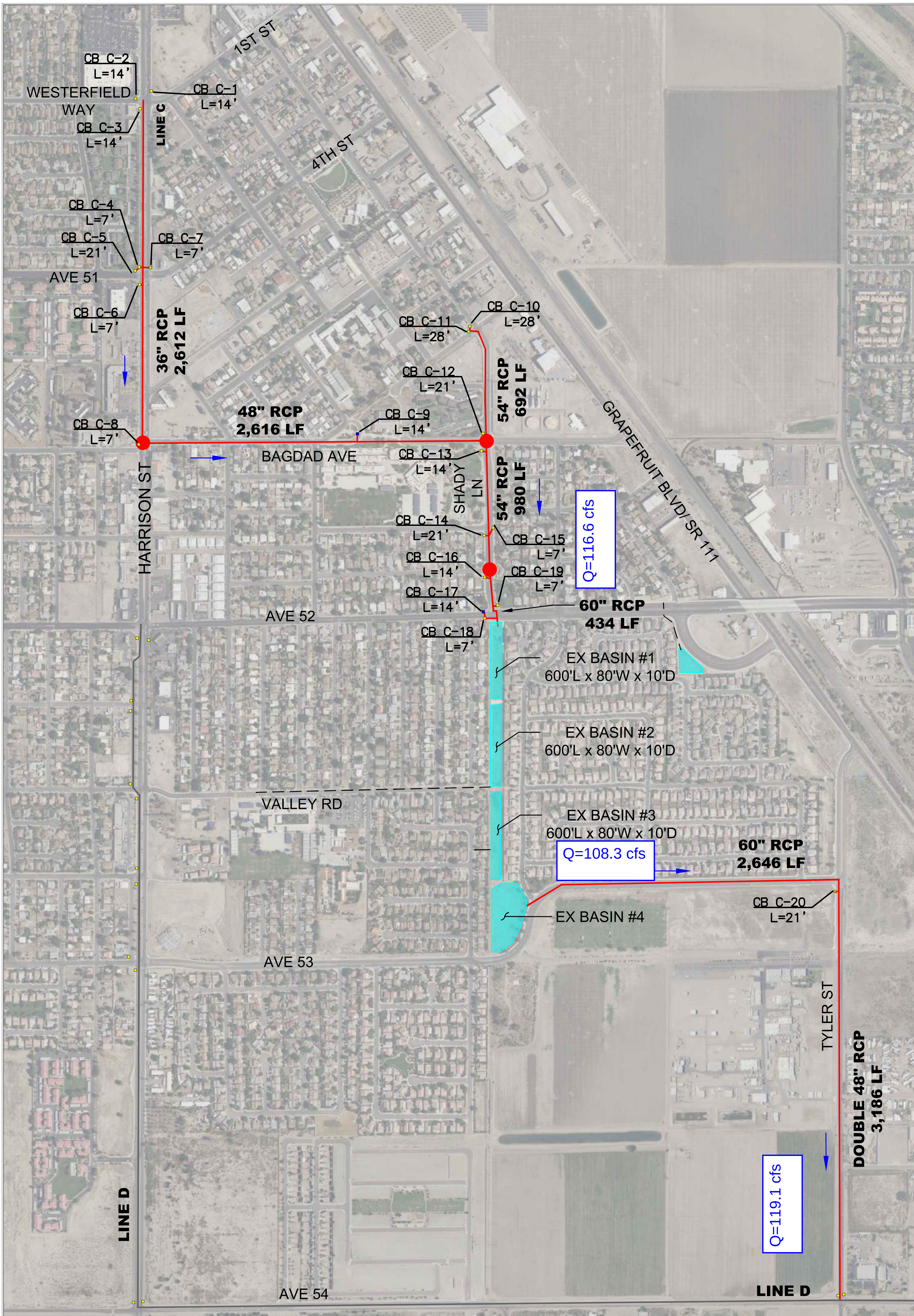
949.259.6770
COACHELLA
STORM WATER MASTER PLAN
SD LINE B
FOR
CITY OF COACHELLA
EXHIBIT
B
SHT 3 OF 5



LEGEND

- PROPOSED STORM DRAIN
- EXISTING STORM DRAIN
- EXISTING BASIN
- PROPOSED CATCH BASIN
- RETROFIT EXISTING CATCH BASIN
- FLOW DIRECTION

N

700 4350 0 700

SCALE: 1"=700'

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City of COACHELLA

STORM WATER MASTER PLAN	EXHIBIT
SD LINE C	B
FOR CITY OF COACHELLA	SHT 4 OF 5

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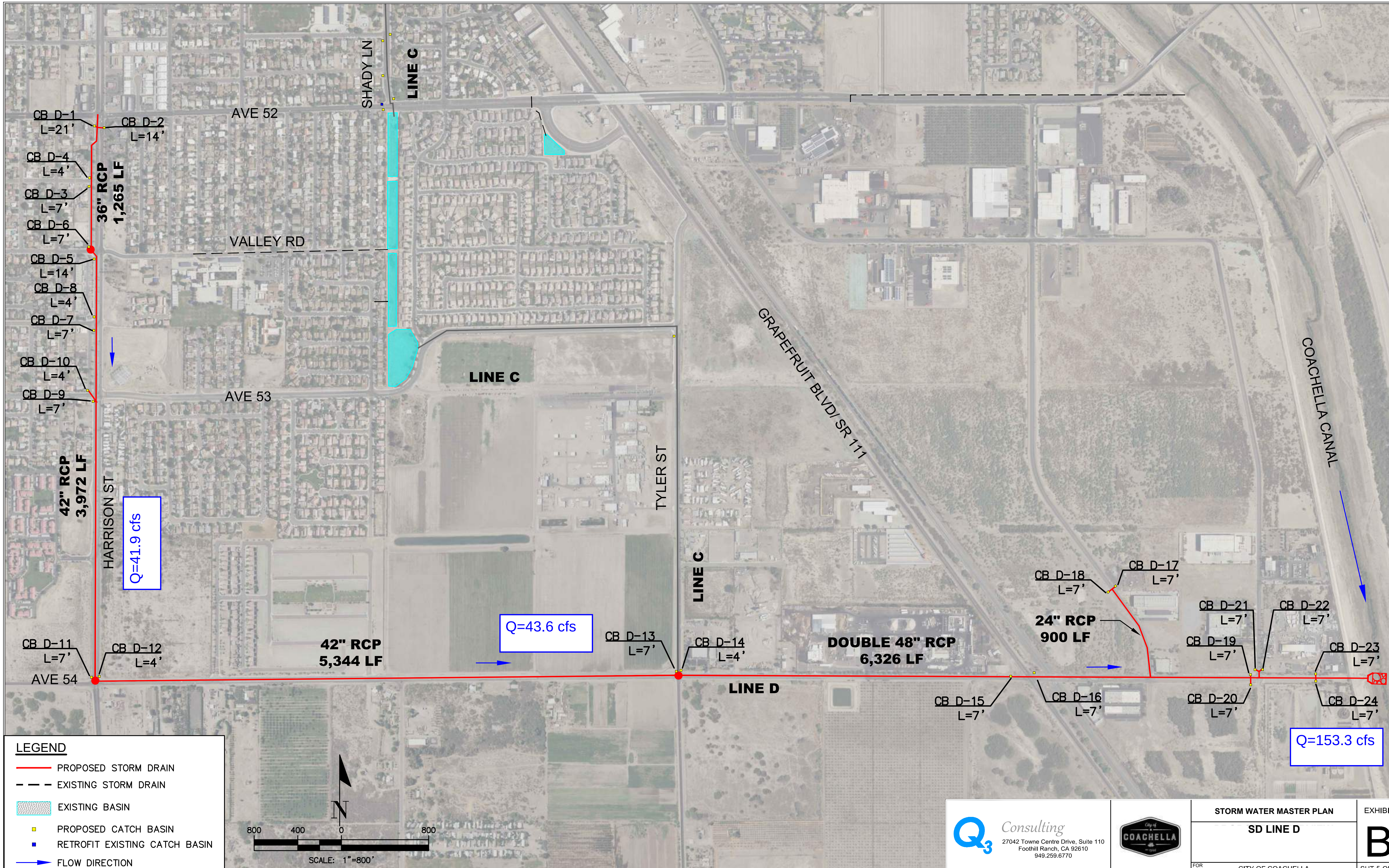
AVE 52
SHADY LN
LINE C
CB D-1
L=21'
CB D-2
L=14'
CB D-4
L=4'
CB D-3
L=7'
36" RCP
1,265 LF
CB D-6
L=7'
VALLEY RD
CB D-5
L=14'
CB D-8
L=4'
CB D-7
L=7'
CB D-10
L=4'
CB D-9
L=7'
AVE 53
LINE C
42" RCP
3,972 LF
HARRISON ST
Q=41.9 cfs
TYLER ST
GRAPEFRUIT BLVD/ SR 111
COACHELLA CANAL
LINE C
CB D-18
L=7'
CB D-17
L=7'
24" RCP
900 LF
CB D-21
L=7'
CB D-22
L=7'
CB D-19
L=7'
CB D-23
L=7'
Q=43.6 cfs
CB D-11
L=7'
CB D-12
L=4'
AVE 54
42" RCP
5,344 LF
CB D-13
L=7'
CB D-14
L=4'
DOUBLE 48" RCP
6,326 LF
LINE D
CB D-15
L=7'
CB D-16
L=7'
CB D-20
L=7'
CB D-24
L=7'
Q=153.3 cfs
LEGEND
PROPOSED STORM DRAIN
EXISTING STORM DRAIN
EXISTING BASIN
PROPOSED CATCH BASIN
RETROFIT EXISTING CATCH BASIN
FLOW DIRECTION
N
800 400 0 800
SCALE: 1"=800'
Q3 Consulting
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Foothill Ranch, CA 92610
949.259.6770
City of COACHELLA
STORM WATER MASTER PLAN
SD LINE D
FOR
CITY OF COACHELLA
EXHIBIT
B
SHT 5 OF 5

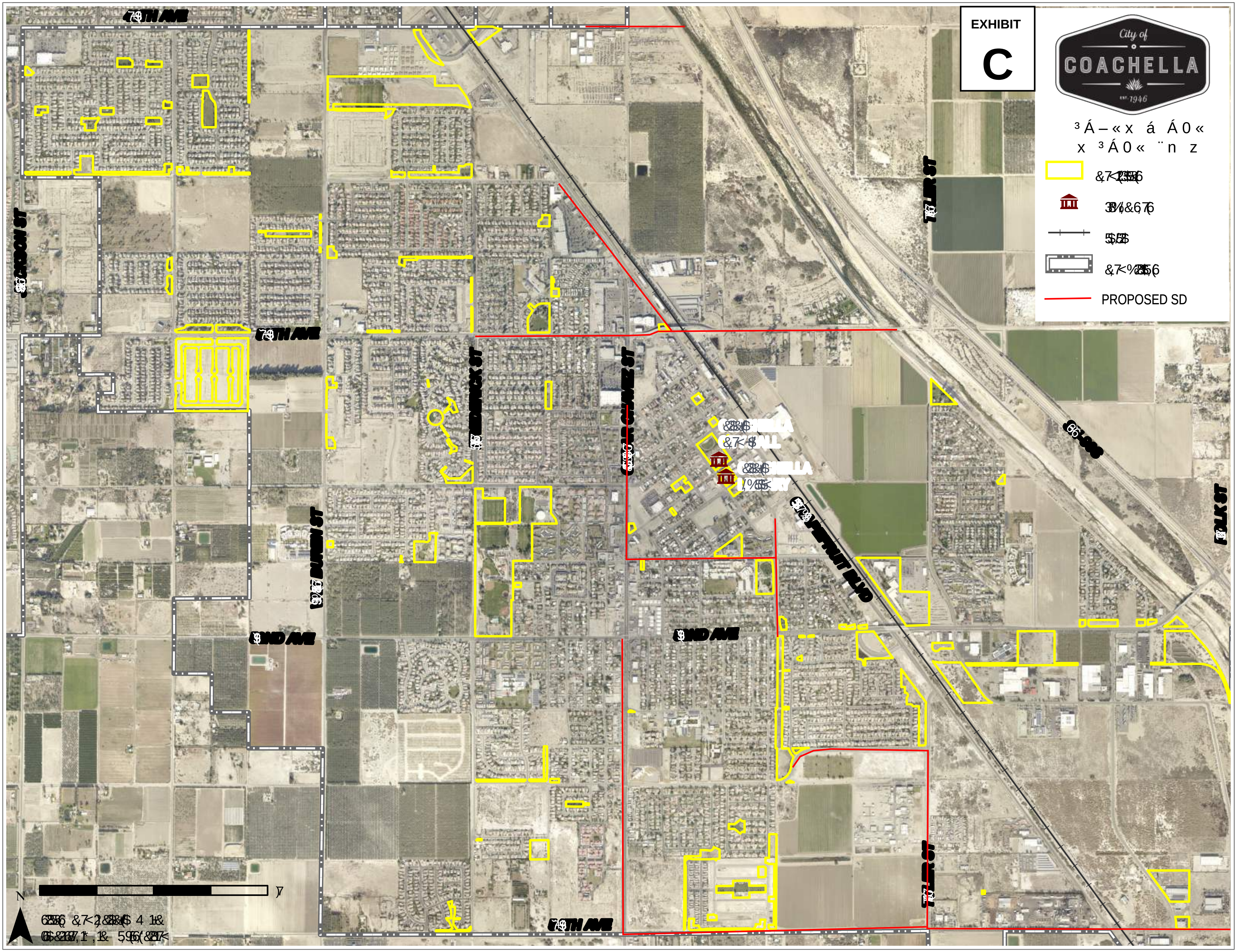

EXHIBIT
C
City of
COACHELLA
EST. 1946
PROPOSED SD

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