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CITY OF
STOCKTON

City of Stockton, California Stormwater Master Plan

Final Report
January 2023

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List of Acronyms

Abbreviation	Definition
AACE	Association for Advancement of Cost Engineering
ARPA	American Rescue Plan Act
BIL	Bipartisan Infrastructure Legislation
BMP	Best Management Practice
CAFR	Comprehensive Annual Financial Report
CCTV	Closed Circuit Television
CDBG	Community Development Block Grant
cfs	Cubic Feet per Second
CHI	Computational Hydraulic International
CIP	Capital Improvement Plan
CWSRF	Clean Water State Revolving Fund
DEM	Digital Elevation Model
DUC	Disadvantaged Urban Community
DWR	Department of Water Resources
FEMA	Federal Emergency Management Association
FIRM	Flood Insurance Rate Map
FY	Fiscal Year
GIS	Geographic Information System
GPM	Gallons per Minute
H&H	Hydrologic & Hydraulic
HGL	Hydraulic Gradeline
HP	Horsepower
IRWM	Integrated Regional Water Management Program
LID	Low Impacts Development
LiDAR	Light Detection and Ranging
MEP	Maximum Extent Practicable
MHI	Median Household Income
MS4	Municipal Separate Storm Sewer System

Abbreviation	Definition
MUD	Municipal Utilities Department
NOA	Notice of Authorization
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge and Elimination System
OPCC	Opinion of Probably Construction Cost
PBI	Peterson, Brustad, Inc.
PS	Pump Station
RPM	Revolutions per Minute
SB	Senate Bill
SCFRR	Small Community Flood Risk Reduction
SJAFCA	San Joaquin Area Flood Control Agency
SRF	State Revolving Fund
SUD	Stormwater Utility Division
SWGP	Stormwater Grant Program
SWMM	Stormwater Management Model
SWMP	Stormwater Master Plan
SWQCCP	Stormwater Quality Control Plan
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WIFIA	Water Infrastructure Innovation Act
WLA	Waste Load Allocation
WQBEL	Water Quality Based Effluent Limitations
WSE	Water Surface Elevation

Executive Summary

The City of Stockton Stormwater Master Plan (SWMP) was developed with the primary purpose of identifying the extent and nature of flooding under existing and future conditions and developing Capital Improvement Plan (CIP) projects that could be implemented to alleviate this flooding. The City is situated on the eastern boundary of the Sacramento-San Joaquin River Delta, with stormwater drainage provided by open (channels) and closed (pipes) conveyance infrastructure. Portions of the City are protected by levees, with pump stations serving a key role in stormwater conveyance throughout the City to discharge runoff collected behind these levees and support drainage relief in low-lying areas.

PCSWMM (PC-Stormwater Management Model) was utilized to model the hydrology and hydraulics of the City’s stormwater infrastructure. The modeling efforts focused on the 10-yr, 24-hr design storm event, consistent with existing City standards. Management of flooding for larger events, such as the 200-yr flood, are typically provided by improvements to levees, larger channels and infrastructure managed by Municipal Utility Department’s (MUD) partner agencies. The focus of this stormwater master plan is urban stormwater conveyance infrastructure like inlets, pipes, and pump stations which are rarely themselves sized for the 200-yr event but could be affected by levee and channel improvements. Long-term coordination is expected to be beneficial in ensuring stormwater improvements outlined within this master plan are compatible with levees and other flood infrastructure improvements developed by others. Modeling efforts presented herein examined existing conditions in addition to future anticipated development identified by City staff and the 2040 General Plan. The location and extent of areas of study for H&H modeling were established and prioritized in coordination with City staff to evaluate areas of known flooding concerns and areas of anticipated future development. H&H model results were used to identify concern areas based upon modeled surface inundation.

A limited elevation survey effort was undertaken to assess the accuracy of existing stormwater inventory data. This effort supported the use of LiDAR to establish structure rim elevations; however, pipe depths and geometries were sometimes missing or inconsistent. Standard assumptions were applied to stormwater infrastructure data to address apparent gaps and inconsistencies. Additional data during future details design phase efforts should be collected to evaluate the suitability of these assumptions and refine model results accordingly.

Improvement concepts to address flooding in concern areas were developed utilizing the PCSWMM model to determine infrastructure improvements that would alleviate modelled flooding. Potential stormwater improvements generally involved multiple typologies, including:

- Upsizing gravity conveyance infrastructure
- Pump station improvements
- Detention facilities

A total of 12 improvement concepts were developed, with costs ranging from under $5 million to over $75 million. These improvement concepts were grouped into high, medium, and low priority categories based upon stakeholder coordination efforts. Substantial costs of these identified improvements can be attributed to the nature of flooding concerns, depth of existing infrastructure, and need for pump station improvements. In addition to these larger CIP projects, opportunities exist to address smaller-scale drainage deficiencies and maintenance needs throughout the City, such as pump station rehabilitation and localized pipe and inlet replacement.

Project	Cost	Priority
Boggs Tract	$17,144,585	High
Bonnie Brook	$11,547,232	High
Hwy 4 and San Joaquin	$24,902,729	High
Walker Turnpike Alt 1 *	$46,204,468	High
Walker Turnpike Alt 2 + Eighth St and San Joaquin *	$75,142,267	High
Bianchi and Calaveras	$30,682,180	Medium
Duck Creek	$12,061,203	Medium
Legion Park and Smith Canal	$50,864,178	Medium
Deep Water	$10,229,853	Low
Little Johns	$4,552,126	Low
Mormon Slough	$27,524,026	Low
Sutter and Calaveras River	$13,710,877	Low
West Lane and Calaveras River	$6,517,147	Low

** Denoted projects are alternatives and would not both be implemented*

An assessment of the Stormwater Utility Division's baseline financials indicates that expenditures are projected to increase at a higher rate than revenues, which only considers operational costs and excludes capital investments to improve stormwater infrastructure. Multiple funding mechanisms available to the City were evaluated and would be necessary to support ongoing operations and any future capital investments. Implementation of a reliable and predictable stream of revenues sufficient to cover Stockton's long-term operation expenditures and the capital costs of the SWMP's high and medium priority projects is recommended.

1. Introduction and Background

The City of Stockton Municipal Utilities Department (MUD) retained Hazen and Sawyer (Hazen) to develop a Stormwater Master Plan (SWMP) for the City. Building upon past stormwater planning efforts and the City's most recent General Plan update, Envision 2040, this SWMP is the first of its kind for the City to consider detailed hydrologic and hydraulic (H&H) evaluations at a large scale throughout the City.

1.1 Overview of Stockton's Stormwater Infrastructure

The City of Stockton is served by open conveyance systems, including ditches, channels, sloughs, and rivers, closed conveyance systems, including pipes and culverts, and pump stations (Table 1-1, Figure 1-1). The City is situated on the eastern boundary of the Sacramento-San Joaquin River Delta. The City's topography is relatively flat with a network of creeks, smaller rivers, and sloughs, which carry water to the San Joaquin River. Drainage characteristics differ for the northern and southern portions of the City. Main drainage corridors in the northern portion of the City are generally contained within levees, with pump stations used to discharge runoff from catchment areas. The southern portion of the City has fewer levees and more natural drainage corridors; however, pump stations are still used to supplement drainage in low-lying areas.

Table 1-1 - Stockton Stormwater Overview

Total Area	65 square miles
Impervious Coverage	51%
Elevation Range	-10 to 50 feet
Mapped Stormwater Pipes	620 miles
Stormwater Pump Stations	77
10-yr, 24-hr Storm Volume	1.4 billion gallons

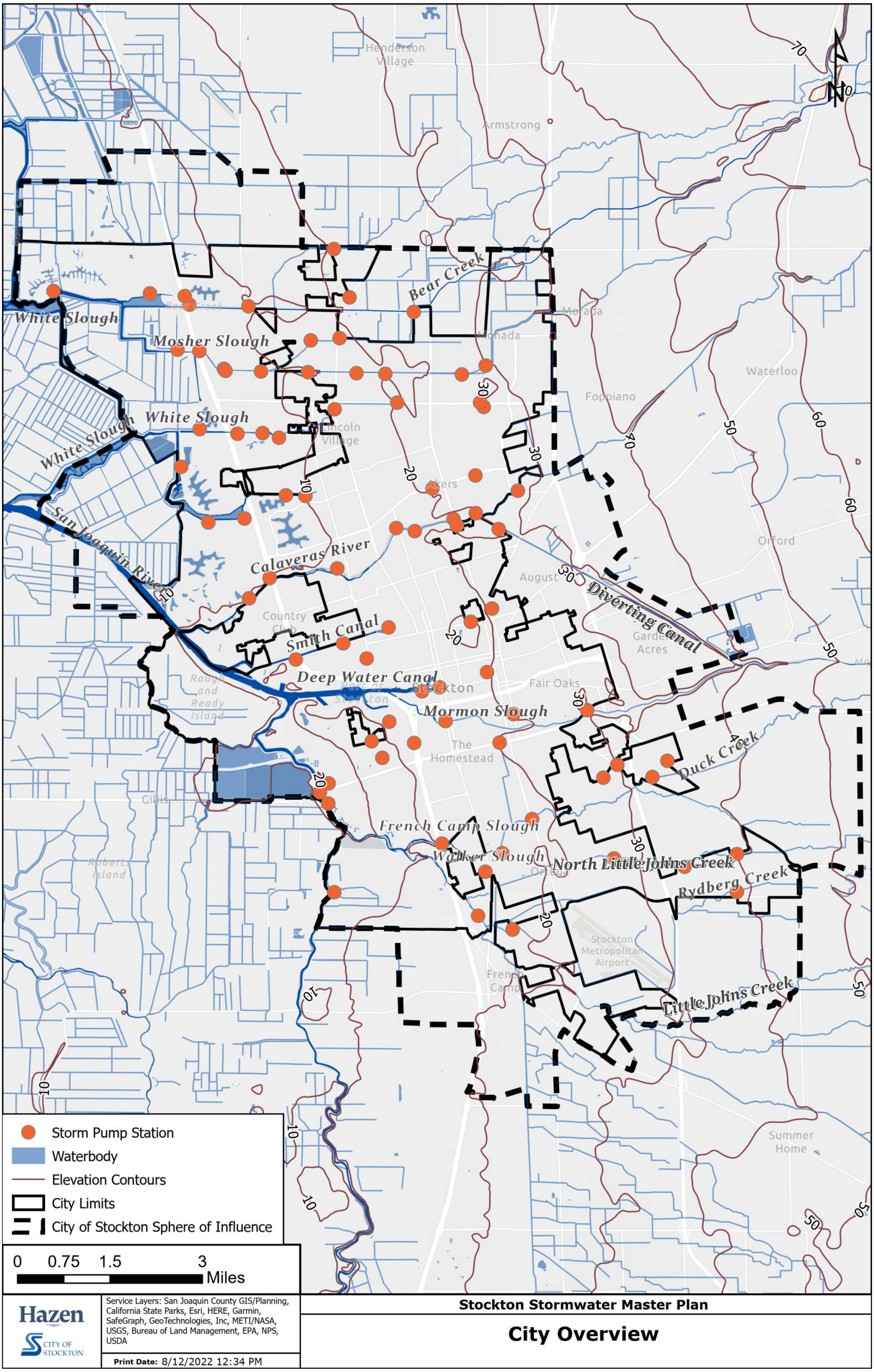


Figure 1-1: City Overview

1.2 Stormwater Master Plan Purpose

By its nature, a SWMP can consider a wide array of stormwater quantity and quality issues and seek to achieve varied objectives. Coordination efforts at the outset of master planning efforts sought to establish a clear understanding of goals, objectives, strategies, and priorities to effectively address the concerns of key stakeholders and provide lasting value. Based upon a review of past planning efforts and existing documentation, discussion with MUD staff, and input from other key stakeholders identified by MUD, the Stockton SWMP was developed to accomplish multiple objectives:

- Evaluate drainage infrastructure performance using current design standards to identify undersized systems and areas of surface flooding
- Evaluate potential impacts of future development on drainage infrastructure performance
- Identify and prioritize capital improvement projects (CIPs) to improve drainage infrastructure and reduce the frequency and severity of flooding
- Establish funding needs and strategies

This SWMP is expected to guide future improvements to Stockton's stormwater infrastructure and inform future development activities. When conducting stormwater analysis at the scale of this SWMP, there are inherent limitations on the level of detail and accuracy of results, which can be exacerbated by limited or poor-quality data. As with any master plan, additional analysis will be required for individual improvements to validate master plan assessments and support the development of design details.

1.3 Existing Standards, Regulations, and Policies

The City of Stockton Standard Specifications governs stormwater conveyance and control requirements for new development, which also serves as the level of service for evaluation of existing stormwater infrastructure. These standards provide consistency across stormwater infrastructure and help mitigate flooding associated with the proposed development and downstream areas.

As is common throughout the United States, California state standards and regulations pertaining to stormwater focus primarily on water quality and floodplain management. Stormwater quality regulations are covered by Stockton's stormwater National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer Systems (MS4) permit that seeks to limit the impact of stormwater pollutants associated with development on receiving waters, as discussed in Section 1.3.6. Federal Emergency Management Agency (FEMA) Floodplain management regulations restrict development in the floodplain and activities that may change flood elevations and impact other properties. Additionally, State ULDC/ULOP Floodplain Management Regulations, associated with 2007 SB 5, provides regulation in association with the 200-yr floodplain. Local drainage, the primary focus of this stormwater master plan, is primarily governed by local policies and practices rather than statewide or regional standards.

1.3.1 Conveyance Standards

Existing City standards specify that stormwater pipes shall be sized to convey the 10-yr instantaneous peak flow rate based upon the Rational Method of peak flow calculation. The peak rainfall intensity presented in the Standard Specifications is 1.3 in/hr. The Standard Specifications require the hydraulic grade line (HGL) to remain 1'-0" below the top of curb for this 10-yr storm. Some localities apply a more conservative standard, requiring the HGL to remain below the crown of the pipe. A similar level of service definition is assumed to apply to open conveyance infrastructure, with the 10-yr HGL remaining below the top of bank for the channel or related feature.

1.3.2 Detention Basin Standards

The Standard Specifications present guidelines for detention basin design associated with new developments, including direction that detention basins be utilized if the downstream conveyance is undersized and improvements are impractical. Detention basins are identified in association with CIPs with this SWMP as a means of mitigating downstream flooding for existing and anticipated development where other conveyance improvements are impractical or not cost-effective. Because the detention basins are retrofits, their design is based upon hydrologic and hydraulic modeling results and may not always meet all detention basin design criteria in the Standard Specifications.

Detention Basins with No Discharge Limitations

Detention basin volume shall equal the runoff volume from the tributary area for the 10-yr, 48-hr event, equivalent to 3.12-in. The hydraulic grade for the tributary collection system shall not exceed one foot below the top of curb.

Detention Basins with Discharge Limitations

Detention basin volume shall equal 150% of the runoff volume from the tributary area for the 10-yr, 48-hr event, equivalent to 3.12-in. The hydraulic grade for the tributary collection system shall not exceed one foot below the top of curb.

Retention Basins

Retention basins are intended to store stormwater for an indefinite period without a defined outlet, primarily relying upon infiltration and the associated volume reduction in surface water. Retention basins are discouraged in Stockton's Standard Specifications and require approval by the City Engineer for implementation and are therefore used less often.

1.3.3 California Senate Bill No. 5 (2007)

California Senate Bill No. 5 (SB-5 2007), titled Flood Management and passed in 2007, provided for the development of Best Available Maps (BAM) to be prepared by the California Department of Water Resources (DWR) for the Sacramento-San Joaquin Valley. These maps determine floodplain elevations and extents for the 100-year, 200-year, and 500-year flood events and are distinct from the FEMA Flood

Insurance Rate Maps (FIRM) which are used to establish flood insurance rates and other regulatory policies.

For much of Stockton, the BAM provides little information regarding floodplain extents beyond what is covered by the FEMA FIRM. The 2012 DWR Awareness Study and 2008 Regional / Special Studies do not cover areas within the City limits. The 2002 USACE Sacramento and San Joaquin River Basins Comprehensive Study designates the area generally bound by the Burlington Northern Santa Fe railroad, Interstate 5 (I-5), Walker Slough, and the San Joaquin River and the Port of Stockton as being within the 100-yr floodplain, although these areas are not included in the FEMA 100-yr floodplain (Figure 1-2).

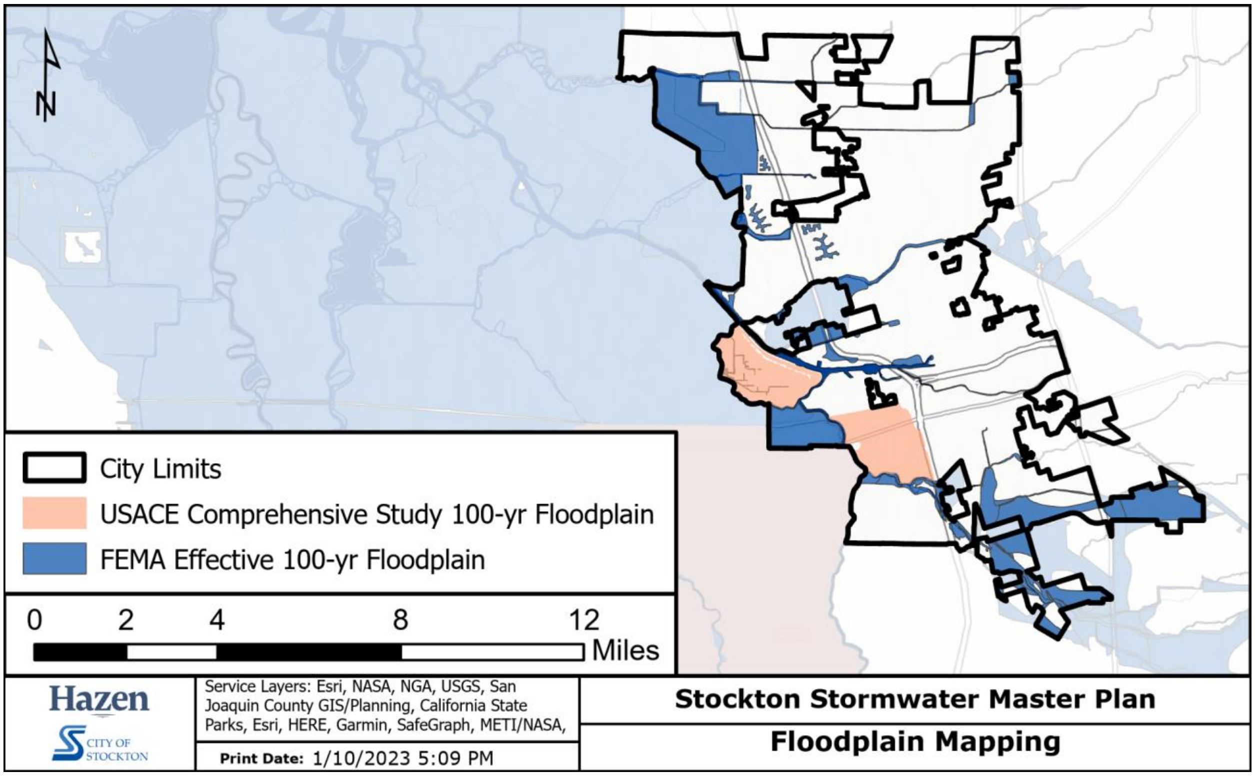


Figure 1-2 - Floodplain extents from the BAM

SB-5 2007 and related legislation requires that local jurisdictions in the Central Valley understand the Urban Level of Flood Protection (ULOP) before approving land use changes and approving certain development activities. San Joaquin County provides 200-yr flood depth mapping associated with DWR's CVFED program. This flood mapping shows some level of inundation for existing conditions throughout much of Stockton for the 200-yr flood. Management of flooding for the 200-yr flood and similar events that are the focus of SB-5 2007 is typically provided by improvements to levees, larger channels and infrastructure managed by MUD's partner agencies. The focus of this stormwater master plan is urban stormwater conveyance infrastructure like inlets, pipes, and pump stations which are rarely themselves sized for the 200-yr event but could be affected by levee and channel improvements. Long-term coordination is expected to be beneficial in ensuring stormwater improvements outlined within this master plan are compatible with levees and other flood infrastructure improvements developed by others.

1.3.4 California Senate Bill No. 5 (2018)

California Senate Bill No. 5 (SB-5 2018), titled California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for all Act of 2018 established the framework for a $4 billion bond for voter approval to support parks and climate priorities, among other objectives. Public approval of SB-5 2018 was obtained in June of 2018 through Proposition 68, titled the State of California Parks & Water Bond 2018, with 58% of voters supporting the proposition.

This law provides an outline of areas to receive funding, with areas of particular relevance to Stockton including:

- $443 million for climate adaptation and resiliency projects
- $550 million for flood protection and repair, including $350 million for flood protection, levee improvements and damage repairs in the Central Valley
- $50 million for levee repairs and restoration in the Sacramento-San Joaquin Delta

1.3.5 Receiving Water Discharge Capacity Limitations

For the purposes of this Plan, the receiving waters throughout Stockton have been generally characterized below as to their conveyance capacity and ability to accommodate additional stormwater discharge (Figure 1-3). The capacity of some of these receiving waters was considered in the 2008 Conceptual Storm Drain Master Plan, with the discharge limitations from that study presented in Table A3-3 of Appendix E. Currently, further analyses are needed in order to discretely define or update discharge limitation requirements. Such efforts would further require coordination with multiple stakeholders. A significant amount of hydrological and hydraulic modeling has already been set up and performed that can provide the groundwork for further analyses in order to make informed decisions regarding stormwater discharge limitations at receiving waters.

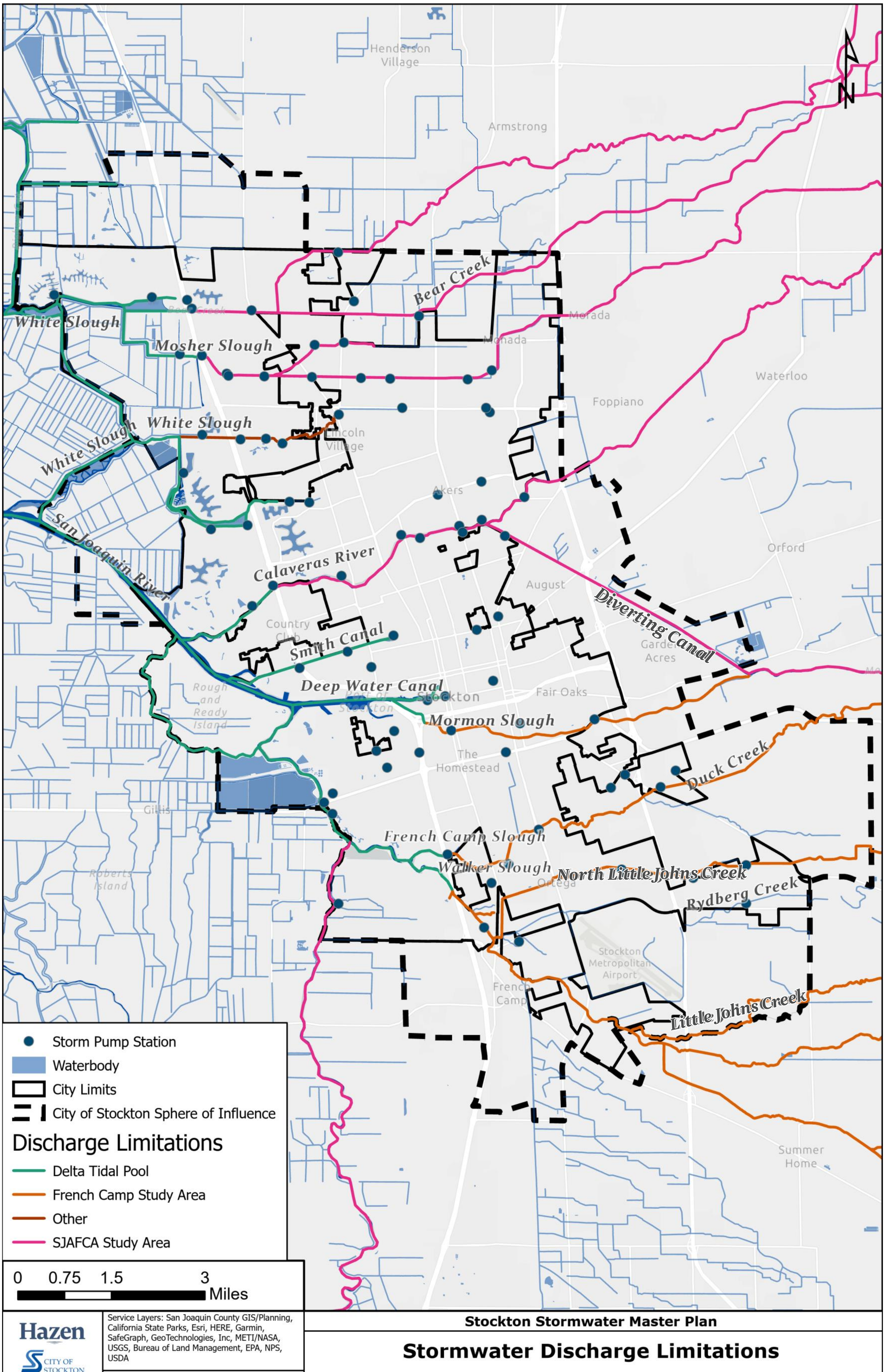


Figure 1-3 - Stormwater Discharge Limitations

Delta Tidal Pool (Western Stockton)

Waterways located west of Interstate 5 are generally in the Sacramento-San Joaquin Delta tidal pool. The water surface elevation (WSE) within the Delta tidal pool is predominantly controlled by tidal fluctuations connecting to the Pacific Ocean. As such, riverine flow into the Delta tidal pool from any one adjacent river or stream has minimal effect on the WSE since the water is dispersed over such an immense area. Therefore, stormwater discharge limitations are generally not required.

SJAFCA Study Area (Northern and Central Stockton)

There have been many hydrological and hydraulic studies performed to date by Peterson, Brustad, Inc. (PBI) on behalf of the San Joaquin Area Flood Control Agency (SJAFCA) for the waterways located in the northern and central portions of Stockton. This generally pertains to the rivers and streams from the Calaveras River northward. These studies predominantly focus on 100-year and 200-year storm events. A summary of the waterways that have previously been modeled on behalf of SJAFCA are as follows:

- Bear Creek
- Calaveras River
- Mosher Slough
- Pixley Slough
- Stockton Diverting Canal

The levees and floodwalls along most of these waterways are currently accredited by FEMA as providing a 100-year level of flood protection including minimum freeboard. As such, these waterways generally have the capacity for conveying relatively high river flows. Therefore, it is anticipated that reasonable stormwater discharge limitations could be established.

French Camp Study Area (Southern Stockton)

There is another hydrological and hydraulic study that was performed by PBI on behalf of San Joaquin County for the community of French Camp, located immediately south of Stockton. This study is part of the ongoing Small Community Flood Risk Reduction (SCFRR) program that is administered by California DWR. This generally pertains to rivers and streams in the southern portion of Stockton, located south of the Calaveras River. This study predominantly focuses on 100-year and 500-year storm events. A summary of the waterways that have previously been modeled on behalf of San Joaquin County are as follows:

- Duck Creek
- Branch Creek
- French Camp Slough
- Lone Tree Creek
- Mormon Slough
- North Little Johns Creek
- North Fork of South Little Johns Creek
- South Fork of South Little Johns Creek

- Walker Slough
- Weber Slough

The levees along the vast majority of these waterways are provisionally accredited by FEMA as providing a 100-year level of flood protection and have very little if any freeboard. The study predicts levee or streambank overtopping is likely to occur at a large number of locations along these waterways as a result of a 100-year storm event. As such, these waterways generally have very little available capacity, and additional discharges would likely have a significant impact on conveyance. Therefore, it is anticipated that very strict stormwater discharge limitations will need to be established, including capped discharge rates or requirements for 100 percent on-site retention.

Five Mile Slough

Five Mile Slough is a waterway located in North Stockton that historically flowed into Fourteen Mile Slough at its west end. Currently, Five Mile Slough is separated from Fourteen Mile Slough by an earthen dam. Therefore, Five Mile Slough does not have a direct connection to the Delta. The water surface elevation for the majority of the slough is controlled by a pump station located at the dam that is operated by the San Joaquin County Flood Control and Water Conservation District. Existing urban development covers the vast majority of the sub-watersheds that currently discharge into Five Mile Slough. Therefore, future development is not likely a factor that would significantly increase stormwater runoff. However, it has been indicated that current pumping deficiencies may exist at one of the pump stations that discharges into Five Mile Slough.

There is the potential that adjustments to the operation of the pump station located at the dam may allow an increased discharge rate into Five Mile Slough. Additional analysis of the hydraulics, pumping capacity, and available storage within Five Mile Slough and the pump station would be needed to evaluate the pump station.

1.3.6 NPDES Requirements

The Clean Water Act prohibits the discharge of pollutants through a point source, including municipal separate storm sewer systems (MS4s or storm drain systems), into the surface waters of the United States without a permit. The NPDES Permit program limits pollutant discharges, and establishes monitoring and reporting requirements, as well as other provisions to ensure that discharges do not degrade water quality or present a risk to human health. The City of Stockton and the County of San Joaquin are regulated by the Central Valley Region-wide municipal stormwater permit, which is admistered and enforced by the Central Valley Regional Water Quality Control Board (Central Valley Water Board). The Central Valley Water Board has developed a single Region-wide MS4 Permit (Order R5-2016-0040) that promotes watershed and drainage-shed coordination, water quality measure protections, and program implementation efficiencies. This Order, which serves as a municipal stormwater permit for discharges from MS4s to surface waters, was adopted on June 23, 2016, became effective on October 1, 2016, and was set to expire on September 30, 2021, but has been administratively extended.

This Region-wide permit focuses on identifying outcomes to be achieved by specific actions instead of focusing on merely identifying actions to be implemented. The objectives of this permitting approach, referred to as a stormwater management framework, encourages a consistent set of MS4 permit conditions within the Regional Jurisdictional Runoff Area and allows for permittees to focus efforts and resources on achieving goals instead of implementing prescriptive actions. A critical part of this approach is the requirement for the City to follow a Pollutant Prioritization approach to implement its Storm Water Management Program, as described further in the Storm Water Management Plan.

The Pollutant Prioritization approach focuses on identifying and prioritizing water quality impairments and implementing actions to effectively and timely address these priority impairments, balancing the need to address water quality conditions with permittee resources. These priority impairments are informed by assessments completed by the City and must comply with other compliance dates specified in the Order. The Order identifies four applicable water quality Total Maximum Daily Loads (TMDLs)[1] as summarized in Table 1-2 below. In addition to the TMDLs, the City must also comply with the Amendment to the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries that added “Final Part 1 Trash Provisions” (the Trash Amendments).

In addition to pollutant discharge requirements, the Order includes requirements for the City to minimize adverse effects of hydromodification, or the modification of a watershed’s natural hydrograph, on water quality. Hydromodification is typically due to increases in impervious surfaces, increasing the flow of stormwater runoff to the MS4 and receiving waters during storm events. Common measures to combat hydromodification include Low Impact Development (LID) measures. The City proposes to address these hydromodification requirements through guidance on new development and redevelopment, as further described in the Stormwater Quality Control Criteria Plan.

Similar to previous NPDES permits issued to the City of Stockton, the Order also requires monitoring and reporting to evaluate the effectiveness of controls and activities to improve water quality and address pollutant prioritization.

[1] TMDLs are numerical calculations of the maximum amount of pollutant that a water body can assimilate and still meet water quality standards. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point sources and non-point sources, background contribution, plus a margin of safety. (NPDES No. CAS0085324)

Table 1-2 - Specific Provisions for Total Maximum Daily Loads (Per Attachment G of Order No R5-2016-0040, NPDES No. CAS0085324)

<table>
<tr><th>TMDL / Effective Date</th><th>Deliverables / Actions Required / Water Quality Based Effluent Limitations[2]</th></tr>
<tr><td>Pathogens – E. coli and fecal coliform

Effective Date: 13 May 2008</td><td>Water Quality Based Effluent Limitations (WQBELs):
City of Stockton and County of San Joaquin (collectively, “Permittees”) shall implement BMPs that will attain applicable WLAs by the Final Compliance Deadline and maintain such attainment thereafter.

Waste Load Allocations (WLAs)
<table>
<tr><th>Fecal Coliform Allocation</th><th>E.Coli Allocation</th></tr>
<tr><td>200/100 mL Geometric Mean[1],
nor 400/100 mL for 10% of samples[2]</td><td>126/100 mL Geometric Mean[3],
and 235/100 mL single sample maximum</td></tr>
<tr><td colspan="2">[1] Geometric mean concentration of not less than five samples for any 30-day period
[2] During any 30-day period
[3] Geometric mean concentration of a statistically sufficient number of samples (generally not less than five samples equally spaced over a 30-day period)</td></tr>
</table>

Deadline for Attainment of WLAs:
30 June 2018 (“Final Compliance Deadline”)

Monitoring Provisions and Provisions for Implementing the Control Program:
The following provisions apply to the City of Stockton and County of San Joaquin MS4 Permittees upon Central Valley Water Board issuance of NOAs:

1. The Permittees shall continue to implement the Pathogen Plan or other monitoring and implementation activities consistent with the Stockton Urban Water Bodies Pathogen Control Program. If necessary, additional controls and regulatory options will be identified by the Central Valley Water Board with assistance by the Permittees to address the impairment.

2. The Permittees shall document in Mid-Term and End-Term Reports the implementation of BMPs to control the discharge of pathogens in their urban discharge.

3. The Permittees shall complete and submit program effectiveness assessments in their Mid-Term and End-Term Reports as specified in Part V.E.5 of the Order that includes assessment of the effectiveness of the BMPs implemented to control the discharge of pathogens in their urban discharge.</td></tr>
</table>

[2] As MS4 discharges contribute pollutants to waterbodies, federal regulations require that NPDES permit conditions require water quality based effluent limitations (WQBEL) that are consistent with the requirements and assumptions of any applicable waste load allocations (WLAs) and/or as a BMP program of expanded or better-tailored BMPs. This MS4 permit implements TMDLs as water quality based effluent limitations (WQBELs); the WQBELs implementing these TMDLs result in numeric limitations that are more stringent than the requirements in the previous MS4 permit.

TMDL / Effective Date	Deliverables / Actions Required / Water Quality Based Effluent Limitations[2]
	4. The Permittees shall use the information gained from the program effectiveness assessments to improve their SWMPs and identify new BMPs or modifications of existing BMPs to ensure that they are meeting applicable WQBELs. 5. Monitoring and assessment information may come from the Permittees' monitoring efforts; monitoring programs conducted by State or federal agencies or collaborative watershed efforts; or from special studies that evaluate the effectiveness of management practices. 6. With Executive Officer approval, the Permittees may participate in the Delta Regional Monitoring Program or other collective monitoring efforts in lieu of some or all of the individual monitoring requirements required by the Pathogens Plan. **Demonstration of Compliance with WQBELs** Compliance with the effluent limitations in Part III.B of this Order associated with applicable WLAs for fecal coliform and E. coli may be demonstrated by any one of the following methods: 1. Prior to the Final Compliance Deadline, implementation of the BMPs consistent with an approved SWMP that outlines a schedule of BMPs to reduce discharges of fecal coliform and E. coli that are capable of achieving compliance with applicable WLAs by the Final Compliance Deadline. 2. Receiving water monitoring and/or other information, as authorized by the Executive Officer, that reasonably demonstrates attainment of applicable WLAs in the Applicable Water Bodies. 3. Attainment of applicable WLAs within the discharge. 4. No discharges from the Permittee's MS4s to the Applicable Water Bodies. 5. After the Final Compliance Deadline, timely implementation of a Central Valley Water Board-approved compliance schedule for meeting applicable fecal coliform and E. coli WLAs.
Methylmercury	**Water Quality Based Effluent Limitations (WQBELs):** Permittees listed under "Municipality" for this TMDL (left) shall implement BMPs that will attain the applicable WLAs by the Final Compliance Deadline and maintain such attainment thereafter. **Waste Load Allocations (WLAs):** Stockton Area MS4 (Central Delta subarea): 3.5 grams/year **Deadline for Attainment of WLAs:** Methylmercury waste load allocations for MS4 dischargers in the Delta and Yolo Bypass shall be met as soon as possible, but no later than 31 December 2030 ("Final Compliance Deadline"), unless the Central Valley Water Board modifies the implementation schedule and final compliance date. **Provisions for Implementing the Control Program:** 1. The MS4 Permittees shall implement best management practices (BMPs) to control erosion and sediment discharges with the goal of reducing mercury discharges. This will be implemented through compliance with requirements in this Order.

TMDL / Effective Date	Deliverables / Actions Required / Water Quality Based Effluent Limitations[2]
	2. Phase 1 of the Delta Mercury Control Program. The Sacramento MS4, Contra Costa County MS4, and Stockton MS4 shall implement the mercury control studies required by the Delta Mercury Control Program. The permittees shall continue to conduct mercury control studies to monitor and evaluate the effectiveness of existing BMPs and develop and evaluate additional BMPs as needed to reduce their mercury and methylmercury discharges into the Delta and Yolo Bypass. Per the Delta Mercury Control Program, by 20 October 2018, the Sacramento MS4, Contra Costa County MS4, and Stockton MS4 shall complete their control studies and submit final reports to the Central Valley Water Board. The final reports shall present the results of methylmercury control studies, options for methylmercury controls, and proposed methylmercury management plan(s) (including implementation schedules) for achieving methylmercury allocations. 3. During Phase 1 of the Delta Mercury Control Program, the Phase II MS4 Permittees listed above should implement methylmercury management practices identified by the large MS4 Permittees or other management practices identified by the Delta Mercury Control Program studies that are reasonable and feasible. 4. Phase 2 of the Delta Mercury Control Program. Phase 2 begins after the Central Valley Water Board's review of Phase I of the Delta Mercury Control Program, or 20 October 2022, whichever occurs first. During Phase 2, the MS4s will implement methylmercury management plans. Within two years after the start of Phase 2, the MS4s shall submit a Mercury/Methylmercury Management Plan or revised SWMP, which describes the actions that will be taken to comply with this TMDL. The Mercury/Methylmercury Management Plan or revised SWMP shall be submitted to the Central Valley Water Board for approval. The Permittees shall implement the Mercury/Methylmercury Management Plan six months after approval. Progress toward compliance with the WLAs shall be documented in the Permittee's Work Plan, Mid-Term and End-Term Reports. 5. All MS4 Permittees listed above shall implement the Delta Mercury Exposure Reduction Program (see Water Quality Control Plan for the Sacramento River and San Joaquin River Basins, Chapter IV). This requirement may be met by ongoing participation in the collective Mercury Exposure Reduction Program work plan, dated October 2013 (available at http://waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/hg_exposure_reduction/2013oct_merp_wrkpln.pdf). Participation can include financial contributions and in-kind services that directly support exposure reduction activities. 6. The MS4 Permittees shall document in their Mid-Term and End-Term Reports, compliance with erosion and sediment control requirements, including a discussion of effectiveness of BMPs. The Permittees shall submit a program effectiveness assessment as specified in Part V.E.5 of the Order. 7. As specified in subsection 4, above, the MS4 Permittees shall document implementation of any methylmercury controls or best management practices in their Mid-Term and End-Term Reports. **Monitoring Provisions:** The following monitoring requirements apply during Phase 2 of the Delta Mercury Control Program. 1. The MS4 Permittees listed above shall begin monitoring methylmercury loads and concentrations in storm water discharges to assess compliance with the TMDL allocations. Within one year of the Delta Mercury Control Program review, (or 20 October 2022, whichever date occurs first), the MS4 Permittees shall submit a plan, for Executive Officer approval, describing the locations and frequency of methylmercury

TMDL / Effective Date	Deliverables / Actions Required / Water Quality Based Effluent Limitations[2]
	monitoring. The plan shall be representative of the MS4 service area. The sampling locations, frequencies, and reporting may be the same as the requirements in the main permit. The Permittees shall implement the monitoring plan within six months of Executive Officer approval 2. With Executive Officer approval, the MS4 Permittees may participate in the Delta Regional Monitoring Program or other collective monitoring efforts in lieu of some or all of the individual monitoring requirements required by this section. 3. Progress toward attainment of the waste load allocations shall be documented in the Mid-Term and End-Term Reports by monitoring methylmercury loads from the MS4 or by quantifying the annual average methylmercury load reduced by implementing pollution prevention activities and source and treatment controls. The Delta Mercury Control Program (see Water Quality Control Plan for the Sacramento River and San Joaquin River Basins, Chapter IV) provides guidance for the calculation of methylmercury loading from urban areas and determination of attainment. The assessment information may come from the Permittee's monitoring efforts, monitoring programs conducted by State or federal agencies or collaborative watershed efforts, or from special studies that evaluate the effectiveness of management practices, as approved by the Executive Officer. **Demonstration of Compliance with WQBELs:** Compliance with the effluent limitations in Part III.B of this Order associated with applicable methylmercury WLAs may be demonstrated by any one of the following methods: 1. Prior to the Final Compliance Deadline, implementation of the BMPs consistent with an approved SWMP that outlines a schedule of BMPs to reduce discharges of methylmercury that are capable of achieving compliance with applicable WLAs by the Final Compliance Deadline. 2. Receiving water monitoring and/or other information, as authorized by the Executive Officer, that reasonably demonstrates attainment of applicable WLAs. 3. Attainment of applicable WLAs within the discharge. 4. No discharges from the Permittee's MS4 to Applicable Water Bodies. 5. After the Final Compliance Deadline, timely implementation of a Central Valley Water Board-approved compliance schedule for meeting applicable methylmercury WLAs.
Pesticides - Diazinon & Chlorpyrifos Effective Date: 10 October 2006	**Water Quality Based Effluent Limitations (WQBELs):** Permittees listed under "Municipality" for this TMDL (left) shall implement BMPs that will attain and maintain applicable WLAs. **Waste Load Allocations (WLAs):** The waste load allocations for NPDES permitted municipal storm water Permittees shall not exceed the sum (S) of one (1) as defined below: $S = \frac{C_D}{WQO_D} + \frac{C_C}{WQO_C} \leq 1.0$ Where:

TMDL / Effective Date	Deliverables / Actions Required / Water Quality Based Effluent Limitations[2]
	C_D = diazinon concentration in ug/L of point source discharge C_C = chlorpyrifos concentration in ug/L of point source discharge WQO_D = acute or chronic diazinon water quality objective (0.160 and 0.100 ug/L, respectively) WQO_C = acute or chronic chlorpyrifos water quality objective. (0.025 and 0.015 ug/L, respectively) For the purpose of calculating the sum (S) above, non-detectable concentrations are considered to be zero. In determining compliance with permit requirements related to attainment of these waste load allocations, the Central Valley Water Board will consider data or information submitted by the Permittee regarding diazinon and chlorpyrifos inputs from sources that are outside of the jurisdiction of the permitted discharge, and any applicable provisions in the Permittee's NPDES permit requiring the Permittee to reduce the discharge of pollutants to the maximum extent practicable. **Deadline for Attainment of WLAs:** 01 December 2011 ("Final Compliance Deadline") **Provisions for Monitoring and Implementing the Control Program:** 1.a. Conduct an assessment: Within one year of receipt of the NOA for this permit, Permittees shall complete and submit to the Executive Officer an assessment to, at a minimum: determine the diazinon and chlorpyrifos levels and attainment of waste load allocations in urban discharge; evaluate attainment of established water quality objectives applicable to diazinon and chlorpyrifos for the receiving water. Assessment monitoring may be done in coordination or conjunction with other municipalities and/or Permittees. Permittees listed in this Attachment G for this are responsible for providing the assessment and necessary information related to the assessment to the Executive Officer for review and approval. The assessment information may come from the Permittee's monitoring efforts, monitoring programs conducted by State or federal agencies or collaborative watershed efforts, or from special studies that evaluate the effectiveness of management practices. 1.b. With Executive Officer approval, the MS4 Permittees may participate in the Delta Regional Monitoring Program or other collective monitoring efforts in lieu of some or all of the individual monitoring requirements required by this section. 2. SWMP Pesticide Management Plans: Unless Permittees can demonstrate attainment of the waste load allocations, permittees shall include in their SWMP a description of actions that will be taken to reduce diazinon and chlorpyrifos discharges to meet the applicable allocations. SWMP provisions addressing diazinon and chlorpyrifos can be included in pesticide management plans covering current use pesticides with the goal of reducing the discharge of pesticides from municipal storm water to receiving water. SWMP pesticide management plans shall address the Permittee's own use of pesticides, and to the extent authorized by law, the use of such pesticides by other sources within their jurisdictions. Pesticide management plans shall include identifying and promoting, within the context of IPM programs, the use of pest management practices that minimize the risk of pesticide impacts on surface water quality resulting from urban runoff discharges. Additionally, the plan shall include the integration of IPM into the Permittee's municipal operations and be promoted to residents, businesses, and public agencies within each Permittee's jurisdiction through public outreach. The Executive Officer may require revisions to the SWMP if the waste load allocations are not attained or the SWMP is not likely to attain the waste load allocations. SWMP pesticide management plans may refer to actions required by other agencies or actions required elsewhere in this permit. SWMP pesticide management plans may include actions to reduce MS4 pesticide discharges through participation or support of a regional or statewide pesticide reduction programs. To receive credit toward compliance for such participation, the MS4 Permittees must

TMDL / Effective Date	Deliverables / Actions Required / Water Quality Based Effluent Limitations[2]
	demonstrate that they have participated in the implementation of the program (i.e., contributing materially and in proportion in the size of a MS4 Permittee's service area, including, but not limited to, implementation of reduction program measures, membership, contribution of resources, etc.). Examples of programs that could be eligible include Our Water Our World (outreach), a recognized regional monitoring program, and CASQA's pesticide regulatory initiative. In developing the monitoring and reporting programs for specific Permittees, the Central Valley Water Board will, in coordination with DPR, assist the Permittee in identifying diazinon and chlorpyrifos alternatives for which monitoring may be necessary. **Demonstration of Compliance with WQBELs** Compliance with the effluent limitations in Part III.B of this Order associated with applicable diazinon and chlorpyrifos WLAs may be demonstrated by any one of the following methods: 1. Submission of receiving water monitoring and/or other information, as authorized by the Executive Officer, that reasonably demonstrates attainment of applicable WLAs. 2. Attainment of applicable WLAs within the discharge. 3. No discharges from the Permittee's MS4 to the Applicable Water Bodies. 4. Timely implementation of a Central Valley Water Board-approved compliance schedule for meeting applicable diazinon and chlorpyrifos WLAs.
Organic Enrichment and Low Dissolved Oxygen (DO) Effective Date: 27 February 2007	**Water Quality Based Effluent Limitations (WQBELs):** Permittees listed under "Municipality" for this TMDL (left) shall implement BMPs that will attain and maintain applicable WLAs. **Waste Load Allocations (WLAs):** The Basin Plan Amendment establishing this TMDL set the initial waste load allocations for NPDES-permitted discharges of oxygen demanding substances and their precursors as the effluent limitations that were applicable on 28 January 2005. Waste load allocations and permit conditions for new or expanded point source discharges in the SJR Basin upstream of the SDWSC, including NPDES and storm water, are based on the discharger demonstrating that the discharge will have no reasonable potential to cause or contribute to a negative impact on the dissolved oxygen impairment in the SDWSC. In lieu of numeric effluent limitations, this Order requires the implementation of BMPs identified in the Permittees' SWMP to control and abate the discharge of pollutants in storm water discharges. **Deadline for Attainment of WLAs:** 31 December 2011 ("Final Compliance Deadline") **Monitoring Provisions and Provisions for Implementing the Control Program:** The following provisions apply to Phase I and Phase II Permittees identified in the column to the left to which the Central Valley Water Board has issued NOAs:

TMDL / Effective Date	Deliverables / Actions Required / Water Quality Based Effluent Limitations[2]
	1. The Phase I and Phase II Permittees shall implement BMPs to control the discharge of oxygen demanding substances and their precursors in their urban discharge. These will be implemented through compliance with requirements in this Order. 2. The Phase I and Phase II Permittees shall document in their Work Plan, Mid-Term and End-Term Reports the implementation of BMPs to control the discharge of oxygen demanding substances and precursors in their urban discharge. 3. The Phase I and Phase II Permittees shall complete and submit program effectiveness assessments in their Mid-Term and End-Term Reports as specified in Part V.E.5 of the Permit that include assessment of the effectiveness of the BMPs implemented to control the discharge of oxygen demanding substances and precursors in their urban discharge. 4. The Permittees shall use the information gained from the program effectiveness assessments to improve their SWMPs and identify new BMPs or modifications of existing BMPs to ensure that they are meeting applicable WLAs. 5. Monitoring and assessment information may come from the Permittees' monitoring efforts; monitoring programs conducted by State or federal agencies or collaborative watershed efforts; or from special studies that evaluate the effectiveness of management practices. 6. The Phase I and Phase II Permittees shall incorporate a monitoring and reporting plan into their respective SWMPs. 7. With Executive Officer approval, the Phase I and II Permittees may participate in the Delta Regional Monitoring Program or other collective monitoring efforts in lieu of some or all of the individual monitoring requirements required by this section. 8. Stockton Urbanized Area MS4 Permittees shall continue to implement the Low Dissolved Oxygen Plan or other monitoring and BMPs consistent with the San Joaquin Dissolved Oxygen Control Program and its associated WLAs. See Fact Sheet Part B.1 (Attachment F) for a description of the Low Dissolved Oxygen Plan. If necessary, additional controls and regulatory options will be identified by the Central Valley Water Board with assistance by the Permittees to address the impairment. 9. It is anticipated, but not required under this Order, that the Port of Stockton MS4 will continue to implement the following elements of the Low Dissolved Oxygen Plan: Monitor dissolved oxygen in the SDWSC, provide operations and maintenance services for multiple aeration devices in the SDWSC, and participate in the aerator operations and maintenance agreement that is maintained among the stakeholders of the San Joaquin River Dissolved Oxygen Control Program. **Demonstration of Compliance with WQBELs** Compliance with the effluent limitations in Part III.B of this Order associated with applicable WLAs for oxygen demanding substances and their precursors may be demonstrated by any one of the following methods: 1. Receiving water monitoring and/or other information, as authorized by the Executive Officer, that reasonably demonstrates attainment of applicable WLAs. 2. Attainment of applicable WLAs within the discharge. 3. No discharges from the Permittee's MS4 to the Applicable Water Body or its tributaries. 4. Timely implementation of a Central Valley Water Board-approved compliance schedule for meeting applicable WLAs for oxygen demanding substances.

Stormwater Management Plan

Stockton's MS4 Storm Water Management Plan (Management Plan) was last updated in 2009. The Management Plan describes the strategy for controlling the discharge of pollutants from the municipal storm drain system to the maximum extent practicable (MEP). Core objectives of the Management Plan are to identify and control pollutants in urban runoff of concern, comply with federal regulations to eliminate or control the discharge of pollutants, achieve compliance with water quality standards, develop a cost-effective program for pollution prevention of stormwater, seek alternative solutions where prevention is not practical, and coordinate implementation of control measures with other agencies. The Management Plan was structured to include relevant Total Maximum Daily Load (TMDL) requirements and address specific pollutants of concern that impact or potentially impact local receiving water quality in the Stockton Urbanized Area. The Management Plan is currently being updated to integrate milestones and a revised implementation plan to align with the MS4 Permit and the *2020 Stormwater Quality Control Criteria Plan.*

Stormwater Quality Control Criteria Plan

The *2020 Stormwater Quality Control Criteria Plan* (*2020 SWQCCP*) for the City of Stockton and the County of San Joaquin is an update of the 2009 plan and provides clear development standards to use in the selection and implementation of appropriate control measures, emphasizes LID-based strategies, and provides maintenance procedures to ensure long-term pollutant control. The 2020 SWQCCP reflects the most recent MS4 Permit requirements and new statewide trash control requirements (Trash Amendments).

The *2020 SWQCCP* introduces new standards and categories for both Priority New Development and Redevelopment Projects and Priority Land Use projects. Volume Reduction Requirements specify that post-project runoff volumes are reduced to meet pre-project levels for the average 85th percentile/24-hr storm depth estimated for the Stockton Area (0.51-in storm depth). The *2020 SWQCCP* specifies categories of stormwater pollution control measures, including site design controls, source controls, volume reduction measures, and treatment controls that could be applied to meet the volume reduction requirements, depending on the type of development.

1.4 Existing Data Sources

The hydraulic models supporting SWMP development are data-intensive and require significant infrastructure information such as conduit connectivity, diameters, elevations, and other key parameters. At the onset of the project, Hazen requested and obtained relevant information from the City as well as data from other public sources. Existing data sources include GIS information, pump station characteristics, prior reports and plans, institutional knowledge from the City, and more. Additional GIS information was gathered from San Joaquin County and the San Joaquin Area Flood Control Agency (SJAFCA).

1.4.1 GIS Data

GIS data serve as the primary source of information for H&H model development due to their extent, characteristics, and format (Table 1-3). Assessments of GIS data quality and implications for H&H modeling and SWMP development are discussed in Section 2.1.

Table 1-3 - Summary of Existing GIS Data

GIS Feature	Source	Description	Notes
Stormwater Infrastructure			
StormLines_arc	City of Stockton	Stormwater conduits with size, pipe invert elevations, type, data, etc.	Pipe elevations may be of varying quality
StormPoints_point	City of Stockton	Stormwater features for catch basins, outfalls, vaults, etc.	Feature does not contain elevations
StormPumpPoints_point	City of Stockton	Stormwater pump features includes pump name and data	--
DrainageBasin_polygon	City of Stockton	Major stormwater drainage areas	--
Hydrography			
WaterLines	City of Stockton	Lines for area streams, rivers, and sloughs	--
Ponds	City of Stockton	Polygon layer for ponds, reservoirs, and storm drainage ponds	--
FEMA Flood Zones	San Joaquin County	Special Flood Hazard Area for San Joaquin County	--
Planimetric / Impervious			
BuildingFootprints	City of Stockton	Footprints of all buildings and structures	--
MajorStreets	San Joaquin County	Street centerline of major streets within County	--
GeneralPlan2040	City of Stockton	Land use designation from City's 2040 General Plan	--
Impervious Surface	EarthDefine	Impervious surface raster	--
Elevation			
2017 Delta LiDAR DEM	DWR	LiDAR covering all extents of City	1.6-foot cell size resolution
2009 Delta LiDAR DEM	City of Stockton	LiDAR over I-5 corridor	1.6-foot cell size resolution

1.4.2 Pump Station Characteristics

Based upon topography, hydraulics, tailwater conditions, and other factors, stormwater pump stations represent an important element of Stockton's stormwater infrastructure. City staff provided Hazen with some information for 77 pump stations. The availability of information for individual pump stations varied, which is not uncommon for infrastructure that has been installed over the course of decades. Some of the information available for Stockton's stormwater pump stations included:

- Station Name / ID
- Station Location
- Number of Pumps

- Installation Year
- Manufacturer / Model
- Pump Types (i.e. propeller, mixed flow, etc.)
- Basic Pump Performance (RPM, HP, GPM, and Total Dynamic Head)
- Wet Well Shape and Dimensions

Additionally, information on pump station discharge lines was provided for many of the City's pump stations, covering:

- Number and size of discharge lines
- Spacing of discharge lines
- Manhole or box size
- Pipe depth

Design or as-built drawings along with site photos were available for some pump stations, which provided additional context to support incorporation of the pump stations into hydraulic modeling efforts. Pump curves and operational details were not commonly available for stormwater pump stations, resulting in the need to develop some modeling assumptions discussed in Section 2.4.6.

1.4.3 Prior Reports and Plans

City of Stockton Conceptual Storm Drain Master Plan,
Peterson, Brustad, Inc, October 2008

The purpose of this report was to develop policies and design parameters for future development of the storm drain infrastructure within the City of Stockton's 2035 general boundary. The report also provides:

1. A review of the existing City Storm Drain Standards
2. Defines the receiving water discharge capacity constraints
3. Summarizes the discharge water quality constraints
4. Develops guidelines for Sub-watershed Storm Drain Master Planning

The report describes various watersheds in the City, potential developments, flow limitations, and other considerations for future growth. This report is referenced herein as Appendix E.

Stockton General Plan Update - Stormwater Master Plan Supplement,
West Yost Associates, December 2017

This Technical Memorandum supplements the Stockton General Plan Update. The Supplement describes the infrastructure necessary to manage stormwater flows from the General Plan Study Areas and the required detention volume and pumping capacity needed. Because the General Plan focuses solely on those Study Areas there is little useful information for this effort. The primary goal of the 2017 Supplement was to quantify the capital cost needed to accommodate development in the Study Areas.

1.4.4 Institutional Knowledge

MUD staff and other key stakeholders possess knowledge about existing drainage concerns, future development plans, and stormwater infrastructure details that may not be captured in existing documentation. Regular progress meetings throughout the duration of SWMP development were utilized to capture some of this institutional knowledge and vet assumptions and preliminary results with MUD staff. Additionally, Hazen set up an interactive online mapping tool to identify areas of known flooding (Figure 1-4). Through this application, City staff identified pumps that may be undersized or failing, areas without drainage infrastructure, and locations with insufficient drainage infrastructure prone to flooding.

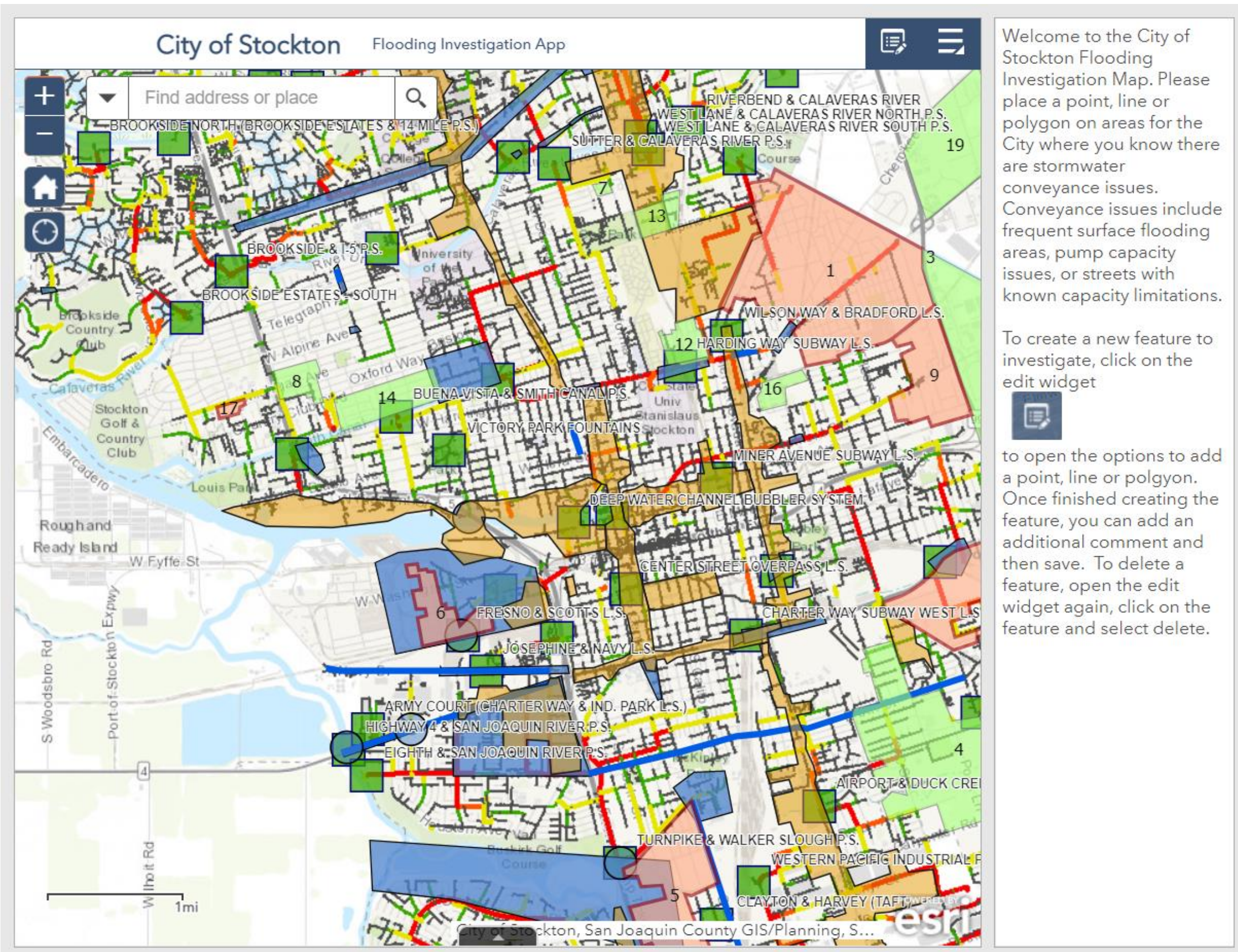


Figure 1-4 - Screenshot of Flooding Investigation Application

Additionally, a survey was distributed to stakeholders identified in coordination with MUD staff to assess overall existing conditions and build consensus around SWMP goals and priorities. A total of nine survey responses were received for the 9 questions posed, which are included in Appendix A.

Stormwater Challenges within the City

When asked about the state of stormwater challenges within Stockton, most survey respondents indicated stormwater issues are becoming more challenging (Figure 1-5). This viewpoint is common across many localities throughout the United States. Aging infrastructure, increasing development, and changing storm characteristics all contribute to stormwater management challenges. This viewpoint supports the value of developing a SWMP to better understand existing conditions in the City and plan improvements.

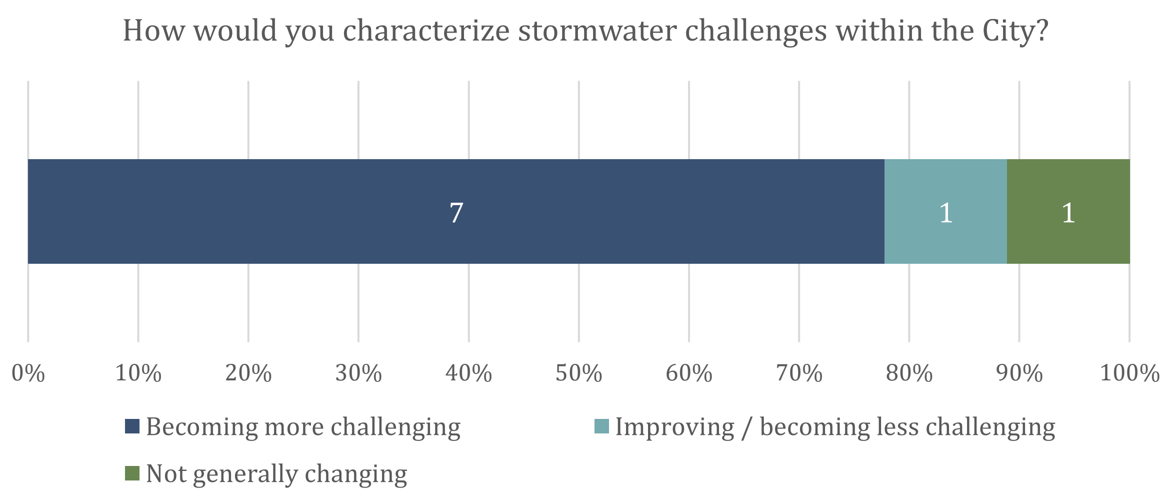


Figure 1-5 - Survey respondent perspectives on Stockton's stormwater challenges

Existing Data Quality

SWMP development is dependent upon the extent and quality of data available to support analysis and planning efforts. With stormwater infrastructure inherently distributed throughout the City and constructed through a combination of public and private efforts over the course of decades, Stockton, like many cities, relies on a variety of sources for stormwater infrastructure data which may have variable content and quality. For example, stormwater drainage infrastructure for a neighborhood may have been recorded based upon some local vertical datum that is inconsistent with other connected infrastructure. Survey respondents largely viewed the quality of existing stormwater infrastructure information as poor or did not have an opinion (Figure 1-6). More detailed assessments of data quality and procedures for addressing data gaps are discussed in Section 2.1.

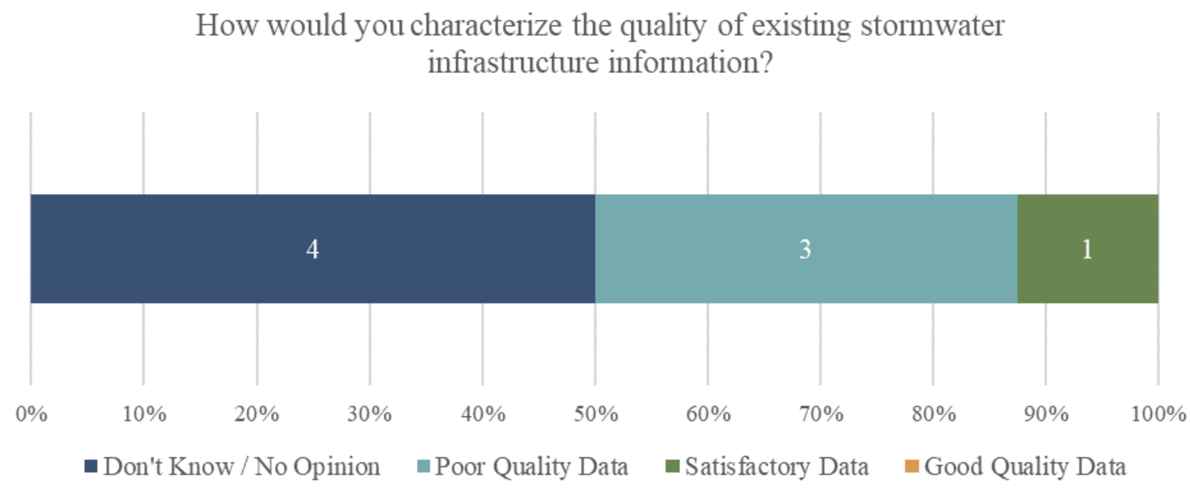


Figure 1-6 - Survey respondent perspectives on quality of stormwater infrastructure data

1.5 Goals and Priorities

Survey respondents were asked to rank a list of SWMP objectives and provide input on desired objectives not included in that list. The resultant ranking of SWMP objectives was:

1. **Develop planning and design criteria to guide existing system improvements and future development activity**
2. **Restore / improve deteriorating infrastructure**
3. **Improve understanding of existing conditions / problem areas**
4. Improve water quality
5. Address areas of deficiencies, specifically in disadvantaged communities
6. Address riverine flooding from larger events (> 10-yr event)
7. Provide a robust financial basis for stormwater investments
8. Address localized flooding from frequent events (1-yr storm or less)
9. Provide climate resiliency
10. Reduce stormwater volumes / utilize LID

Other noted objectives not included in the ranked options were:

- Comply with SB5 and have needed infrastructure funded
- Create off-the-shelf solutions for mid-size development projects to use for achieving stormwater compliance to avoid unnecessary delays in reviewing and approving development in building permit process
- Guidelines / discussion for discharge outfall structure into rivers, creeks, and sloughs
- Develop a list of recommended CIP Projects based on a comprehensive assessment of the existing stormwater system, consistent with the 2040 General Plan
- Study of system efficiencies – pipes, pumps, processes, equipment facilities. Update stormwater drainage models. Evaluate current system performance.

Although the individual order varied, the first three objectives (highlighted in orange above) were among the top three choices for most respondents, with more varied opinions on the other objectives. These three priority objectives speak to the need to address existing concerns while also preparing for the future and guiding SWMP development and deliverables. Ongoing coordination with MUD staff continued to guide SWMP content and focus over the duration of development.

1.6 Report Organization and Use

This report is organized into five main sections:

1. Introduction and Background
    - Overview of Stockton's stormwater infrastructure and general needs
    - Summary of relevant existing information, policies, and regulations
2. Approach
    - Overview of how areas were prioritized for analysis
    - Description of modeling approach and assumptions
    - Discussion of how improvement concepts were developed and prioritized
3. Analysis Results
    - Simulated flooding of existing stormwater infrastructure
    - Improvement concepts and associated flooding relief
4. Implementation Recommendations
    - Discussion of how improvements could be implemented
    - Guidance on how master plan and modeling efforts can support future development and City initiatives
5. Financial Evaluation
    - Review of historical stormwater expenditures and revenues
    - Resource prioritization and forecast revenue needs
    - Evaluation of funding alternatives

The use of this stormwater master plan is expected to vary for different audiences. A summary of potential uses for some key user groups follows.

Stockton MUD Staff

MUD staff has served a key role in development of this Master Plan. This Master Plan serves to document those efforts such that it provides a framework and support for future implementation efforts, including procurement of funding needed for stormwater improvements.

Stormwater Planning and Design Professionals

Implementation of the recommendations and improvement concepts within this Master Plan is likely to be supported by planning and design professionals working directly for the City or as consultants. Beyond the use of improvement concepts as a basis for future designs, understanding the approach to analyses and improvement concept development should streamline future efforts and result in more robust stormwater improvements.

Stockton Residents

This Master Plan provides an overview of stormwater needs throughout Stockton and potential infrastructure improvements to address those needs. Mapping of existing flooding and summaries of proposed improvements are likely to be of primary interest to Stockton residents, helping them understand the nature of stormwater concerns and what is needed to mitigate those concerns.

1.7 Acknowledgements

The preparation of this SWMP has been a collaborative effort, with key input from many stakeholders and project partners. Hazen and Sawyer would like to broadly thank the City of Stockton MUD staff for their valuable input and partnership through this effort. Specific individuals and groups with notable contributions to SWMP development include:

- Gemma Biscocho
- Ali Gharegozloo
- Ann Okubo
- Mel Lytle
- Jeff Marasovich
- Dagmara Saini
- Eric Johnson
- Nancy Xiong
- KSN Civil Engineers & Land Surveyors

2. Approach

2.1 Existing Infrastructure Network Review

Data regarding City stormwater infrastructure and the associated network of inlets, manholes, pipes, channels, and pump stations form the basis of hydraulic modeling efforts. As a precursor to hydraulic model development, Hazen reviewed existing infrastructure data available in GIS format to assess its coverage, quality, and general utility for hydraulic model development.

2.1.1 Analysis Procedure

An initial screening of the stormwater network was performed in order to identify missing or potentially erroneous data. This screening focused on the following elements:

- Negative pipe slopes
- Absence of pipe invert elevations
- Structure rim elevations inconsistent with LiDAR
- Missing pipe shape and/or diameter
- Channel inverts higher than upstream pipe/structure

An increase in pipe invert elevations when moving downstream, resulting in a negative slope, is uncommon for installed stormwater conveyance infrastructure. Typical causes include inadvertent switching of upstream and downstream invert elevations, an incorrect elevation for a structure or pipe segment, and datum shifts over the span of a stormwater network. This initial screening found that 9% of conduits had negative slopes, and an additional 16% lacked pipe invert elevations.

2.1.2 Assumptions

Multiple assumptions (described in Table 2-1) were utilized to address negative slopes, missing elevations, and associated discontinuities within the stormwater network, with the approach generally based upon the likely reason for the discontinuity, when that was apparent. In general, stormwater network elements where data were modified were flagged in the geodatabase such that assumptions could be confirmed as needed through future efforts.

Table 2-1 - Assumptions made to address data inconsistencies

Issue / Indicator	Remedy / Assumption
Upstream and downstream inverts align with adjacent structures and pipes if switched	Switch upstream and downstream invert elevations
Isolated structure or pipe at a higher elevation than adjacent structures and pipes	Lower pipe invert elevations to match adjacent structures / pipes
Pipe lacking invert elevation information	Pipe invert elevations set based on elevations and/or slopes of adjacent pipes
Open channels with LiDAR-based invert elevations higher than upstream pipes, perhaps caused by vegetation obscuring LiDAR	Shift channel invert elevations to match invert of upstream pipe / structure
Missing pipe shape and/or diameter	Assume shape and diameter are consistent with the next downstream segment

These adjustments and assumptions regarding stormwater network elevations are critical to the development of a functional hydraulic model. Without these adjustments, overestimates of flooding would be almost certain, as the hydraulic grade line would be heavily influenced by elevations in the network that are too high. There is also a risk that elevation adjustments to the stormwater network could overlook actual increases in elevations and thereby underestimate flooding. The overestimation of flooding is generally expected to be more likely and problematic, resulting in adjustments being made to address these apparent issues where possible. It will be important to validate stormwater network characteristics in the future as part of more detailed planning and design efforts that originate from this Master Plan.

2.2 Field Data Collection and Assessment

2.2.1 Stormwater Inventory

A limited elevation survey effort was undertaken in November 2020 to assess the accuracy of GIS pipe and manhole elevations in two areas of the City (locations shown in Figure 2-1. The manhole rim and pipe invert elevations were surveyed for approximately 40 structures. Results showed that the average difference between GIS and surveyed invert elevations was 2.6-ft, which is equivalent to the difference between two datums, NAVD88 and NGVD29. The conversion from NGVD29 to NAVD88 is 2.6-ft. The average difference between LiDAR and surveyed rim elevations was only 0.03-ft. Although these results were for a limited survey area, the survey effort confirmed that the difference in pipe elevations could be attributed to a datum shift and that LiDAR was a reliable source for rim elevations.

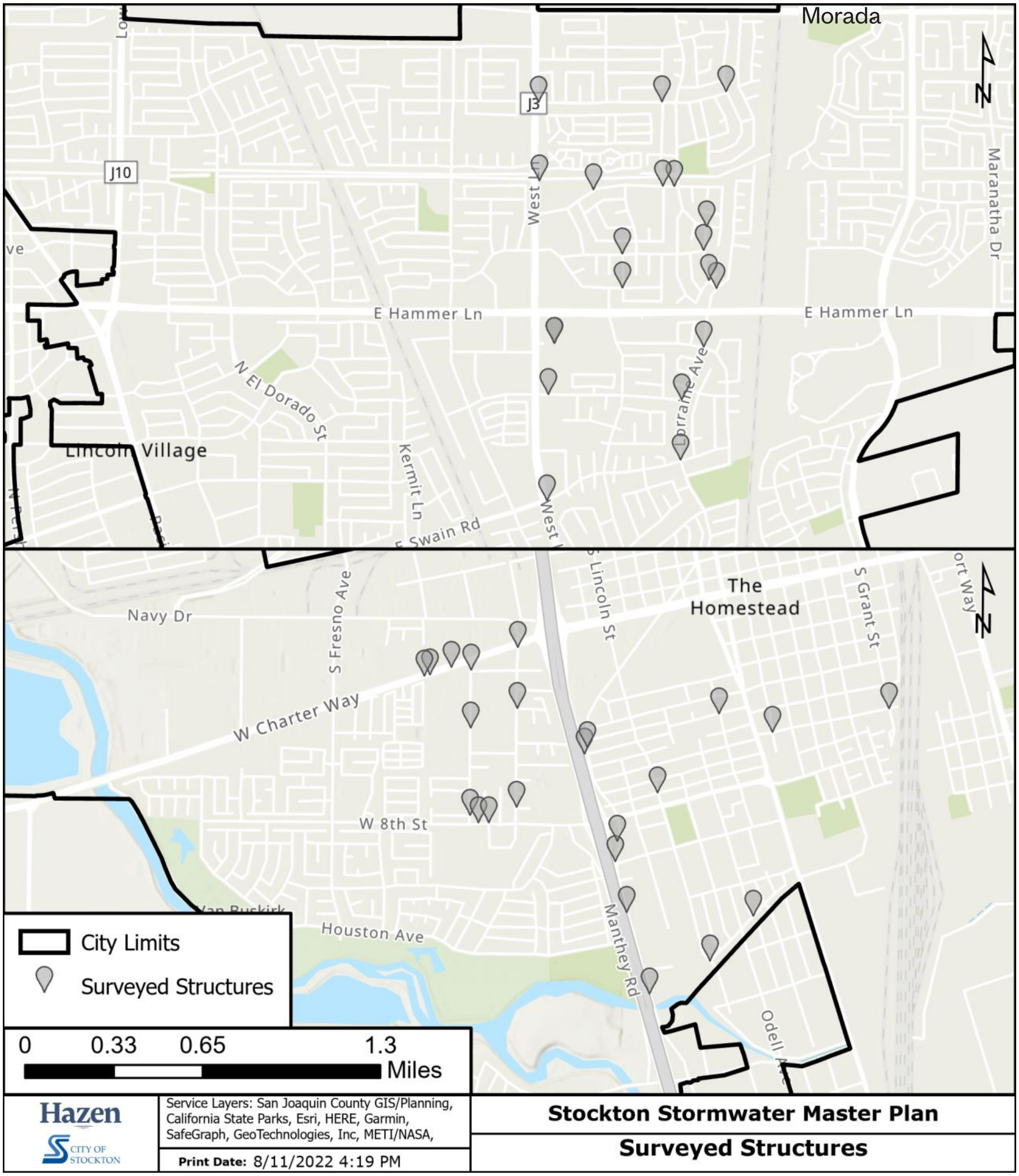


Figure 2-1 - Location of Surveyed Structures

2.2.2 Pump Station Condition Assessment

Pump stations serve as key elements of Stockton's stormwater infrastructure. Given the City's topography and depth of stormwater conveyance infrastructure relative to receiving waters, pumps are often necessary to overcome hydraulic grade differences and discharge collected runoff to receiving waters. Due to the high importance of such infrastructure, Level 1 (visual) condition assessments were conducted at five representative, high-priority pump stations. The five pump stations listed in Table 2-2 were selected based upon input from MUD staff regarding the relative importance and potential of rehabilitation needs.

Table 2-2 - Assets Inspected per Pump Station

Lift Station	Number of Assets Scored
Bonniebrook Stormwater Pump Station	26
Fresno Avenue Storm Water Pump Station	23
Grupe Business Park Pump Station	21
Highway 4 & San Joaquin River Pump Station	13
Turnpike and Walker Slough Pump Station	30

Prior to the field inspection, an asset inventory was compiled using pump station record drawings provided by MUD. Each asset identified during the inventory was then verified, inspected, and assigned a condition score in the field. Asset condition was determined via visual inspection only, with no physical or performance testing. Field observations were recorded with mobile devices utilizing customized condition assessment forms. The condition scoring system utilized mobile devices with electronic forms is presented in Figure 2-2. The condition assessment team assigned condition scores based on the International Infrastructure Management Manual with a rating range from 1 (Excellent condition) to 5 (Poor condition, recommended for replacement). Data collected for each asset included photographs, inspectors' notes, condition scores for specific attributes, and inspection checklists. Results of the pump station condition assessments are presented in **Section 3.**

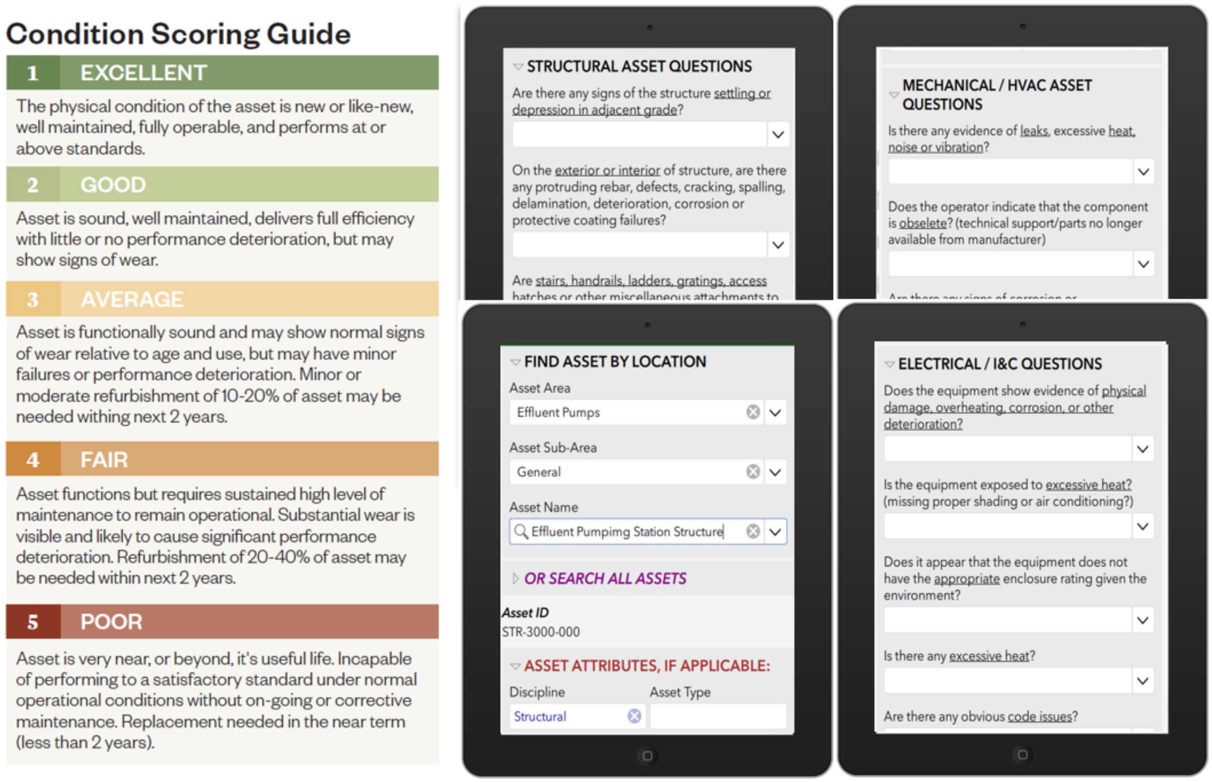


Figure 2-2 - Mobile Collection Tools and Condition Scoring Guide

2.3 Watershed Prioritization

In order to determine which watersheds warranted hydrologic and hydraulic analysis, a number of priorities were identified. The highest priority was watersheds identified as having significant conveyance and pumping capacity limitations. Additionally, City staff identified locations of known flood problems in the Flood Investigation Map, which helped to further identify priority areas. Beyond flooding and conveyance limitations, the City's 2040 General Plan identified Disadvantaged Urban Communities (DUCs) which lack sufficient stormwater drainage. The General Plan also recommended Study Areas where anticipated development would occur. Both of these areas were considered high priority for evaluation. Finally, City staff identified several locations where development is expected, and these too were evaluated. All of these factors influenced which areas of the City were the highest (and lowest) priority for detailed hydraulic modeling. A map of the modeled areas is provided in Figure 2-3.

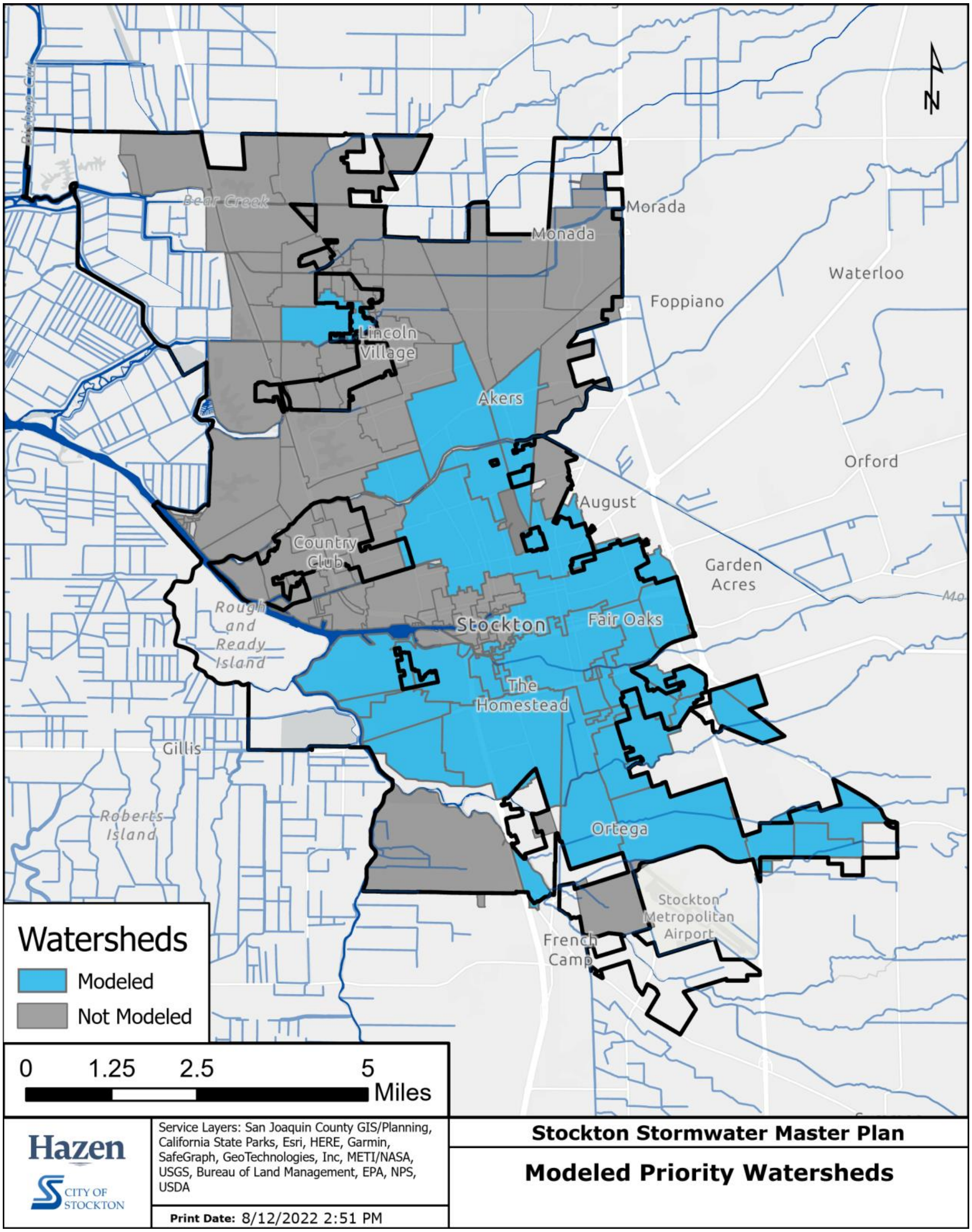


Figure 2-3 - Areas of the City covered by H&H modeling efforts

2.4 Hydrologic and Hydraulic Analyses

2.4.1 Rainfall Data and Storm Analyses

Synthetic design storms were used as the basis of H&H analyses. The 24-hr storm depths were derived from NOAA Atlas 14. Peak rainfall intensities for the 10-yr event reported in NOAA Atlas 14 generally agreed with those presented in the 2002 Stockton Standards (Figure 2-4). Total rainfall depths were fit to a NOAA California Type II distribution, which is specific to the Central Valley, as shown in Figure 2-5. Rainfall characteristics were assumed to be spatially uniform across the City.

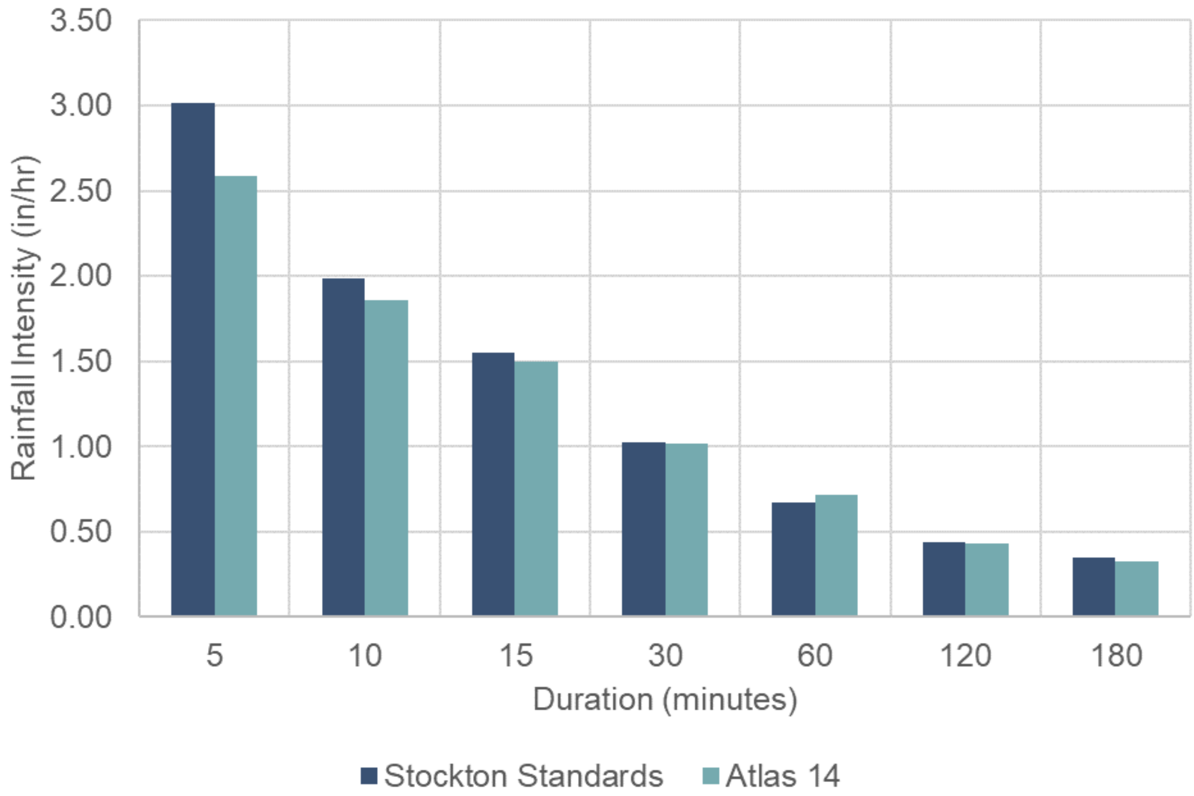


Figure 2-4 - 10-yr peak storm intensities from Stockton Standards and Atlas 14

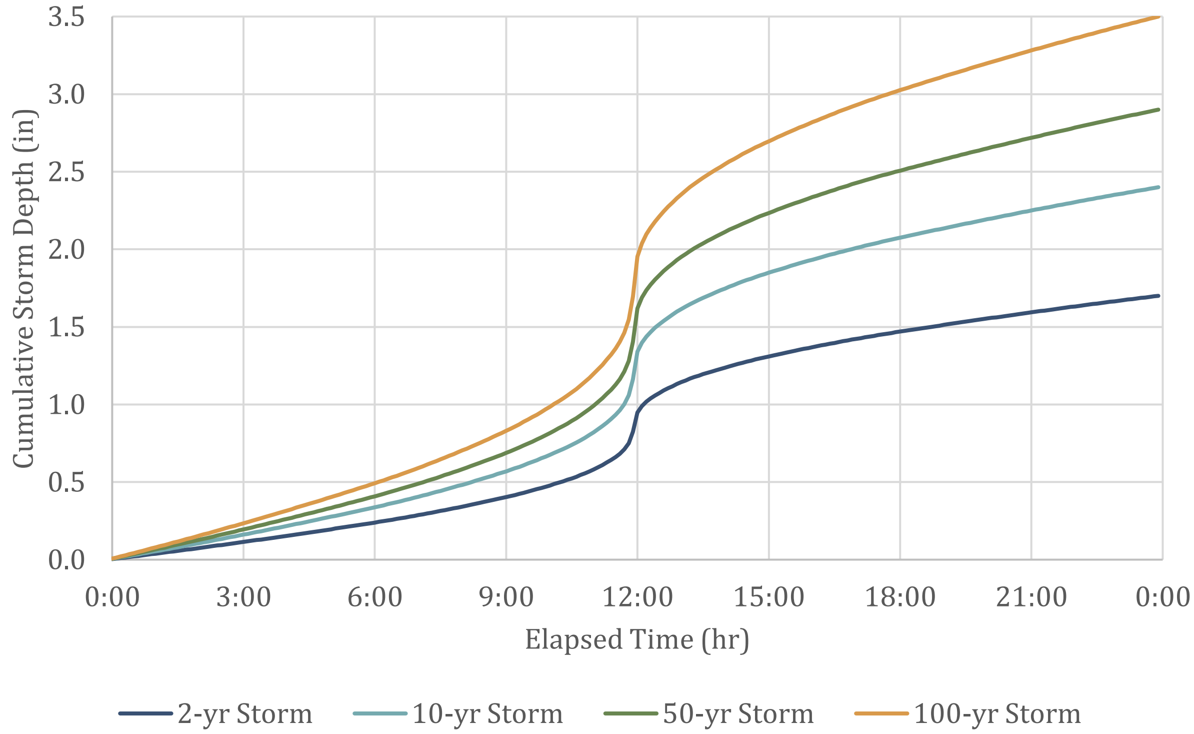


Figure 2-5 - Time distribution of cumulative design storm rainfall used for H&H analyses

Measured rainfall at the Stockton Metropolitan Airport rain gage was compared to NOAA Atlas 14 expectations using the Hazen StormSight tool. This tool compiles hourly rainfall observations into discrete storm events over a period of record, in this case, 11 years of rainfall data. For each specified duration, the most intense portion of the storm is compared to the depth specified by Atlas 14 for that duration and recurrence interval. The result is a comparison of the average expected occurrence of storms of the analyzed period to what was observed. This analysis for the Stockton Metropolitan Airport indicated general agreement between Atlas 14 expectations and measured rainfall, supporting the use of Atlas 14 data for H&H model analysis (Figure 2-6). The largest overall storm recorded over the period 2010-2020 was a 2.35-inch event lasting 21 hours on December 11, 2014, which was characterized as a 10-yr, 12-hr event and 5-yr, 24-hr event. The most intense, short-duration event occurred on October 3, 2018, with a peak one-hour intensity of 1.04 in/hr, equating to a 50-yr, 1-hr event.

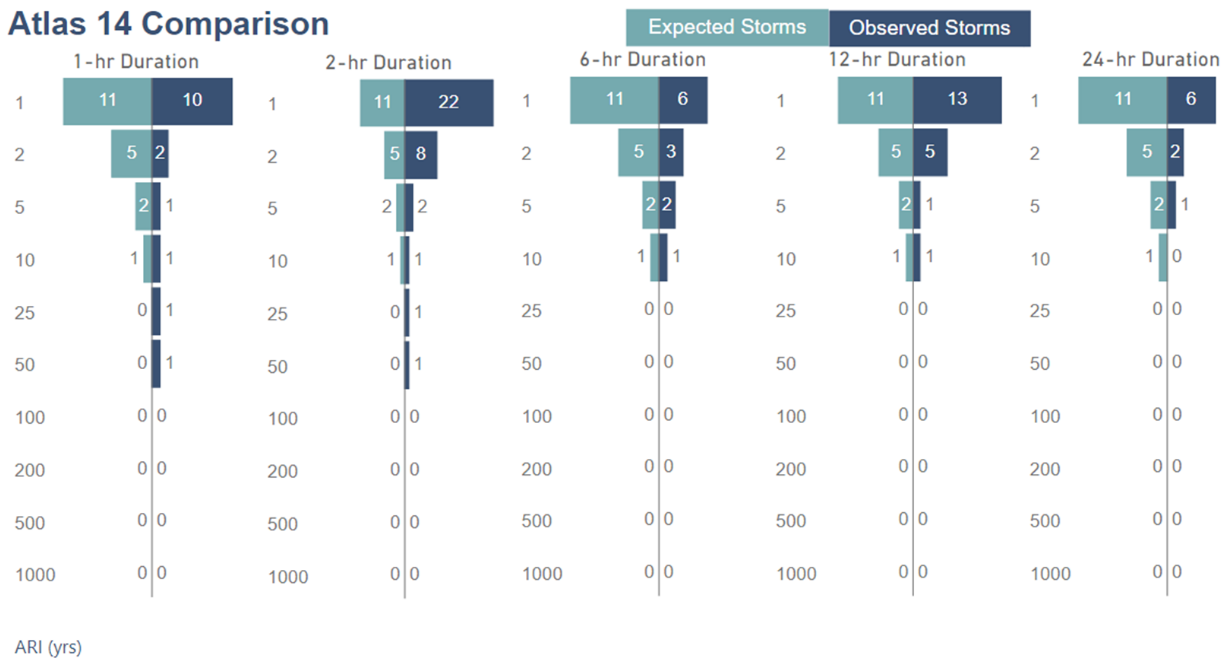


Figure 2-6 - StormSight comparison of Atlas 14 to measured rainfall at the Stockton Metropolitan Airport (2010-2020)

2.4.2 Drainage Area Delineation

Drainage areas were delineated within GIS based upon available LiDAR elevation data, stormwater conveyance infrastructure locations, and street and parcel geometry. The City's existing watershed boundaries were used as a starting point for the delineations. The resolution of the drainage areas ultimately depended on the level of detail in the hydraulic model. For some areas of the City, the primary concern was assessing the capacity of the pump and not the upstream collection system. For these areas, delineations were not as refined since the main goal was estimating flows to the pump. For watersheds with significant conveyance concerns, the watersheds were more refined. The following general assumptions and guidelines were used when delineating drainage areas:

1. Drainage area delineations were predominantly drawn based on contours and the stormwater network
2. Drainage area boundaries were snapped to the edge of parcel boundaries, especially in residential areas where fence lines and physical features divert flow
3. Delineations reflect the crown of the road if present

2.4.3 Watershed Parameterization

Watershed parameters, such as the percent impervious and drainage area, determine the runoff peak flow and volume for each watershed. Following is a list of the watershed parameters and how they were determined.

Flow Length – Length of overland sheet flow. For modeled areas with refined drainage areas, the shape of the watershed was assumed to be a square and the flow length is equal to the flow width.

Average Surface Slope – The surface slope for a watershed is calculated using the City's digital elevation model (DEM).

Impervious Percentage – Impervious percentage for each watershed is determined using the impervious surface raster acquired from Earth Define. This raster has a 5-feet cell resolution.

Land Use Dependent Parameters – There are several parameters which are dependent on the land use (Table 2-3). The City's Zoning GIS layer was used to define the land use for the watershed, and the weighted average was used for watersheds with multiple land uses. The parameters and associated descriptions are provided below.

- **Surface Roughness** – The Manning's "n" roughness coefficient along the representative overland flow path for both pervious and impervious surfaces. The surface roughness represents the composite roughness of rooftops, sidewalks, streets, gutters, inlets, and collector pipes, if these are not modeled explicitly in the hydraulic model. The pervious roughness is the composite roughness of sheet flow over pervious surfaces such as lawns and open areas.

- **Depression Storage** – Depression storage is the amount of rainfall at the beginning of a precipitation event that is trapped within areas (usually small) and does not become surface runoff. This parameter is defined for both impervious and pervious surface. In EPA-SWMM (Stormwater Management Model), water that ponds in these depression areas is assumed to be infiltrated or evaporated. Section 2.4.5 will discuss the use of EPA-SWMM.

- **Percent Routed** – This variable is used to represent the percent of impervious areas routed to pervious areas. This includes roof surfaces that are routed to pervious yards as opposed to a direct connection to the stormwater system.

Table 2-3 - Land use dependent modeling parameters

City Zoning Classification	Surface Roughness (Impervious n)	Surface Roughness (Pervious n)	Impervious Depression storage (in)	Pervious Depression storage (in)	Percentage Routed (%)
Commercial	0.015	0.25	0.1	0.25	0.1
Industrial	0.015	0.25	0.1	0.25	0.1
Mixed Use	0.015	0.25	0.1	0.25	0.1
Open Space	0.015	0.4	0.1	0.25	0.8
Public Facilities	0.015	0.25	0.1	0.25	0.1
Port	0.015	0.25	0.1	0.25	0.1
Residential, High Density	0.015	0.25	0.1	0.25	0.21
Residential, Low Density	0.015	0.25	0.1	0.25	0.34
Residential, Medium Density	0.015	0.25	0.1	0.25	0.34
Unzoned	0.015	0.25	0.1	0.25	0.1

Infiltration Parameters – The Modified Green-Ampt infiltration model was used to characterize soil infiltration. This model requires three parameters: soil capillary suction head (in), soil saturated conductivity (in/hr), and initial moisture deficit (fraction). All of these parameters are based on the soil surface texture from the USDA Soil Survey. Soil parameters for each soil surface texture are provided in Table 2-4.

Table 2-4 - Soil Infiltration Parameters

Surface Texture	Conductivity (in/hr)	Suction Head (in)	Initial Deficit (fraction)
Gravelly clay	12.60	0.01	0.21
Fine sandy loam	4.33	0.43	0.37
Gravelly loam	3.50	0.13	0.347
Loamy coarse sand	2.40	1.18	0.39
Muck	12.60	0.01	0.21
Mucky clay loam	8.27	0.04	0.28
Sand	4.74	1.90	0.34
Loamy sand	1.18	2.40	0.33
Sandy loam	0.43	4.30	0.33
Loam	0.13	3.50	0.31
Silt loam	0.26	6.70	0.32
Sandy clay loam	0.06	8.70	0.26
Clay loam	0.04	8.30	0.24
Silty clay loam	0.04	10.60	0.26
Sandy clay	0.02	9.50	0.22
Silty clay	0.02	11.40	0.22
Clay	0.01	12.60	0.21

2.4.4 Hydrologic Model Assumptions for Existing and Anticipated Development

Existing and anticipated development identified by City staff was added to the hydraulic model when possible. The objective was to determine how these developments would affect conveyance and hydraulics upstream and downstream of the development. The information available on the developments varied from very preliminary understanding of which parcels were to be developed with no site plans, to advanced plans with site layouts.

Using the available plans, the design features were reflected in the model, including the proposed drainage areas (and parameters) and the hydraulic elements such as stormwater pipes and storage ponds. For developments with basic information, the hydrologic and hydraulic features were estimated to conservatively reflect the developments.

2.4.5 PCSWMM Analysis Methodology

PCSWMM was selected as the H&H modeling software for SWMP development. PCSWMM is based upon the public domain EPA-SWMM engine, which was first developed in 1971 and has been used throughout the world to support a wide range of H&H analyses for stormwater, sanitary, and combined sewer systems. PCSWMM is a proprietary H&H modeling software developed by Computational Hydraulics International (CHI) that provides improved functionality and performance over the public domain SWMM, while using open standard data formats to support compatibility with other modeling frameworks.

2.4.6 Hydraulic Model Assumptions

A description of assumptions made to adjust the stormwater pipe attributes in PCSWMM is described in Table 2-1. Much of the additional effort was focused on accounting for the pump stations and storage basins. For pump stations with known deficiencies, the goal was to model the pumps with as much information as possible. For these pumps, engineering design plans were used to find pump curves, on/off points, wet well volume, and discharge piping conditions to dynamically simulate the pumps. If this information was not available, ideal pumps were modeled to approximate performance. An ideal pump is a pump with unlimited capacity.

2.4.7 Model Boundary Conditions

Outfalls represent the terminal ends of the drainage system and PCSWMM provides several options to define the boundary conditions at these locations. Boundary conditions are used so that the model can accurately reflect the influence of backwater or downstream constraints within the system. If a free outfall boundary condition is defined, then discharge can occur freely without the influence of any downstream constraints.

Several of the modeled areas discharge to outfalls along the San Joaquin River. River stage information from the United States Geological Survey's (USGS's) National Water Information System was obtained and reviewed to develop a representation of the San Joaquin River as a boundary condition. Gauge data was available for two locations along the San Joaquin and was assessed for a period of about one month. Since the models were primarily evaluated for design storm conditions, which do not occur during a specific point in time, a fixed boundary condition was considered adequate to determine the influence of the San Joaquin on the outfalls' capacity. For these outfalls, a fixed boundary condition of 4.75-ft NAVD88 were applied. This value represents the average observed gauge height, according to the USGS data.

For locations where receiving water data was not available or could not be obtained at this point, multiple outfall boundary conditions were applied to assess potential effects. This included evaluating free outfalls, fixed elevations to reflect a tailwater in the receiving waterbody, and normal flow depth in the connecting conduit.

2.4.8 Model Verification

A general lack of quantitative data for H&H model verification is common for stormwater modeling efforts, especially in regions where rainfall is infrequent. As such, model verification efforts were generally qualitative in nature. The primary means of model verification was checking whether modeling efforts replicated flooding in areas with known drainage complaints or observed flooding. Additional model verification associated with detailed design and implementation efforts in the future could be conducted by deployment of targeted water level loggers in the conveyance system, particularly near terminal pump stations and in areas known to flood.

2.5 Discharge Water Quality Constraints

The primary focus of this SWMP is stormwater conveyance and quantity control; however, Stockton is also subject to regulatory requirements related to stormwater runoff quality, in particular requirements for discharges to impaired waters or waters with TMDLs. Opportunistic water quality improvements were considered as part of improvement concept development, as presented in Section 3.

2.6 Identification of Concern Areas

H&H model results were utilized to identify concern areas for existing conditions and future development. Concern areas are defined as locations where the model predicts surface flooding based on stormwater infrastructure limitations.

2.6.1 Existing Development

Surface inundation during the 10-yr, 24-hr design storm was the primary metric used to identify concern areas based upon existing development. Surface inundation was specifically identified at nodes within the PCSWMM model where the modeled water surface elevation exceeded the node rim elevation. In practice, some or all modeled surface inundation may return to the conveyance system through a nearby inlet, with only isolated flooding impacts. Details of two-dimensional surface flow patterns were not included in current modeling but could be considered as part of future detailed assessments and design efforts. Additionally, due to the center-weighted nature of synthetic design storms used for this analysis, the duration of simulated surface inundation may be relatively short and low in volume in some circumstances. For these reasons, areas where only isolated inundation was predicted were sometimes excluded from delineated concern areas. In addition to nodes with modeled surface flooding, pipes flowing full under modeled design storms were mapped to assist in understanding where conveyance capacity may be limited, even though a pipe flowing full by itself may meet level of service standards.

2.6.2 Anticipated Development

Future developments that were identified by City staff and from the 2040 General Plan were considered when evaluating the hydraulic conditions. The methodology for evaluating this information was discussed in Section 2.4.4. The development areas, shown in Figure 2-7, range from projects with site plans to potential projects that are being discussed with City staff. The 2040 General Plan Study Areas are locations where development (or re-development) may occur but there are no identified projects.

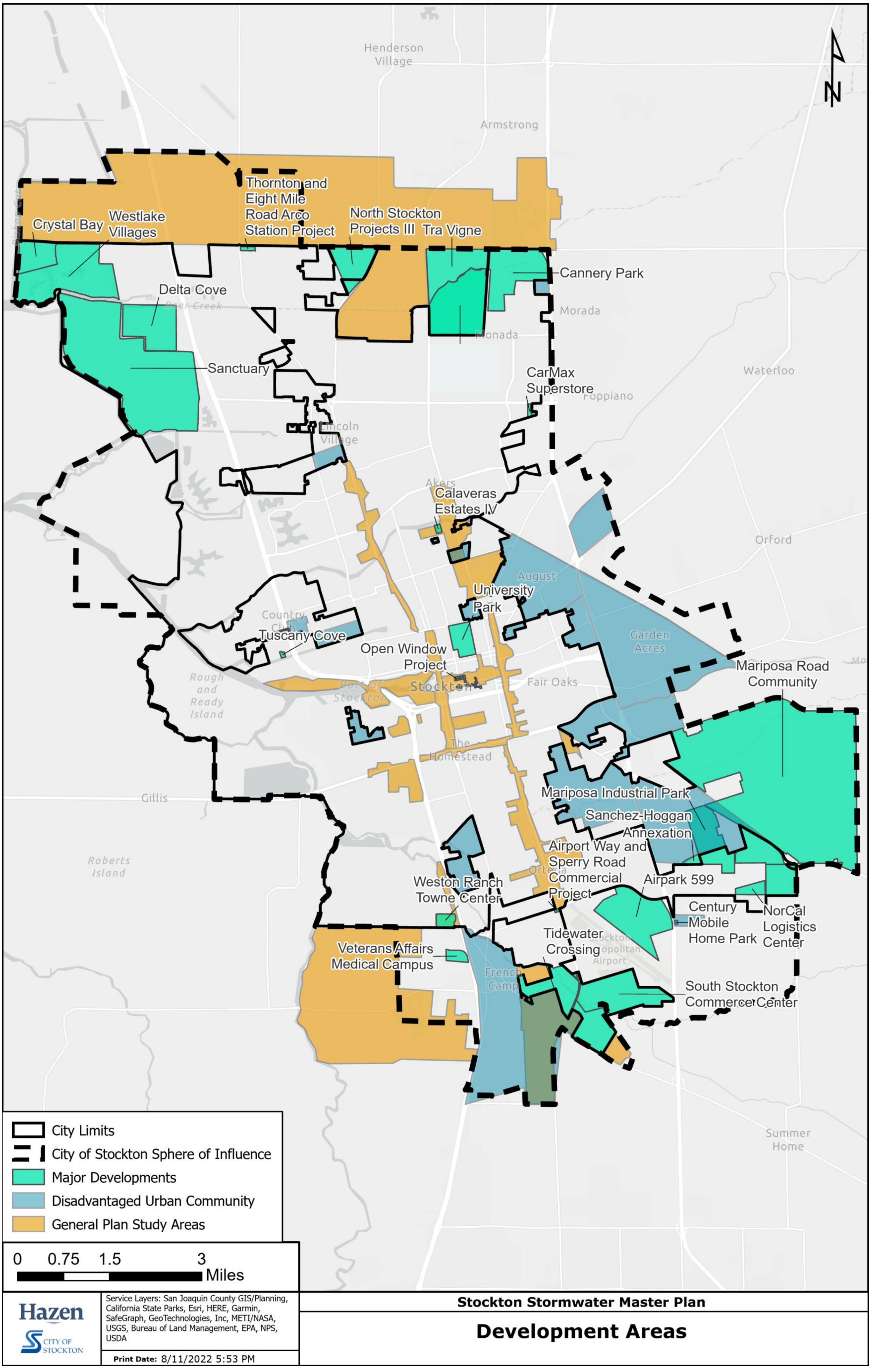


Figure 2-7 - Areas of Approved and Anticipated Development

2.7 Improvement Concept Development and Evaluation

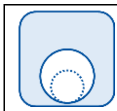
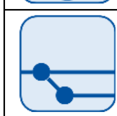
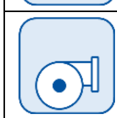
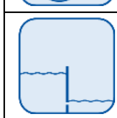
Improvement concepts to address flooding in Concern Areas were developed based upon the developed PCSWMM model and engineering judgement applied to other existing information, primarily available GIS data. The PCSWMM model was utilized to iterate through improvement alternatives to identify the most feasible means of achieving the target level of service. Full compliance with the level of service target (see Section 1.3.1) was not feasible in all concern areas, in which case improvement concepts focused on relieving flooding from as many areas as practical and noting limitations within the concept description. In areas where future development is anticipated, hydrologic inputs were adjusted to reflect that future development and conveyance infrastructure was sized to alleviate surface flooding with additional runoff from those areas. Impacts of future development were generalized and will require further analysis as proposed development details materialize.

Conceptual design efforts considered readily apparent constraints, such as existing stormwater structures and mapped utilities, but were limited in scope regarding details of improvement design, particularly related to potential vertical constraints. In general, potential conflicts and constraints associated with improvement concepts were recorded to assist in future detailed design efforts; however, consideration of design details and constraints beyond those noted herein will be required.

2.7.1 Improvement Typologies

Potential stormwater improvements were classified into four main typologies (Table 2-5). For most concern areas, a combination of multiple improvement typologies was required to achieve level of service objectives.

Table 2-5 - Stormwater Improvement Typologies

	**Upsizing existing gravity conveyance infrastructure** Removal of existing conveyance pipes and channels and replacement with larger capacity infrastructure
	**New parallel gravity conveyance infrastructure** Implementation of new conveyance pipes and channels while leaving existing infrastructure in service
	**Pump station improvements** Improvements to existing pump station capacity or implementation of new stormwater pump stations
	**Detention facilities** Addition of a detention basin to attenuate peak flows and reduce downstream hydraulic grades

2.7.2 Cost Estimation

An opinion of probable construction cost (OPCC) was developed for each proposed improvement concept. The OPCC was intended to support project prioritization, funding analyses, and future planning and design efforts. The OPCC was based upon limited site data and design details and consequently could vary substantially upon development of further detail. The cost estimate is commensurate with Class Level 4 of the Association for Advancement of Cost Engineering (AACE) which has an expected accuracy range of -15% to -30% and +20% to 50%. Cost items were grouped into the categories as shown in Table 2-6.

Table 2-6 - OPCC cost categories for conveyance projects

Cost Category	Example Costs
General / Lump Sum	• Contingency • Design and permitting • Mobilization / demobilization • Utility relocation • Traffic control
Road elements	• Pavement restoration • Curb and gutter • Aggregate base course
Pipe/Drainage elements	• Pipe • Removal of drainage structures • Catch basin and manholes

Based upon the current level of conceptual design, some cost items were generalized. For example, rather than tabulating details of utility conflicts, the degree of utility conflicts was categorized as low, medium, or high, with an associated lump sum cost. Details of unit prices and proposed improvement cost opinions can be found in Appendix D.

An OPCC was also estimated for pump stations and associated appurtenances. The level of accuracy was also commensurate with an AACE Class Level 4. Cost items for pump stations were grouped into categories as shown in Table 2-7.

Table 2-7 - OPCC cost categories for pump station

Cost Category	Example Costs
Wet Well	• Concrete • Walls • Top and bottom slab
Earthwork	• Excavation • Sheet piles • Soil • Site Civil • Dewatering
Architectural	• Concrete masonry building
Process Interconnections	• Discharge piping
Pump	• Furnish, installation, and testing
Site Civil	• Grading, yard piping
Electrical and Instrumentation and Controls	• Electrical equipment and controls

2.7.3 Basis of Improvement Recommendations

Prioritization of stormwater improvements is a necessity when improvement needs exceed available time and resources, as is typically the case. A dashboard framework was developed to support dynamic prioritization of improvement concepts using a range of factors. Improvement concepts were prioritized based upon qualitative and quantitative factors related to the nature of the existing concerns and the proposed improvement concepts (Table 2-8).

Table 2-8 - Improvement prioritization factors

Factor	Description	Qualitative Rating / Quantitative Metric
Known concern area	Has flooding been observed and documented for the subject area	• Yes • No
Extent of concerns	How widespread is the modeled flooding	• High – flooding along multiple adjacent streets • Med – flooding at multiple nodes • Low – isolated node flooding
Flood frequency	Most frequent storm recurrence interval where flooding occurs	• High – modeled flooding during 2-yr storm • Med – modeled flooding during 10-yr storm
Support of future development	To what extent is future development dependent on or supported by the proposed improvement	• High – future development dependent upon infrastructure improvement • Med – future development facilitated by infrastructure improvement • Low – future development accommodated without improvement
Confidence in data quality	To what extent are data deficiencies that might affect the need for, and details of the proposed concept, known or suspected to exist	• High – known data deficiencies • Med – suspected data deficiencies • Low – field confirmed data
Estimated construction cost	Estimated capital cost to implement the proposed improvement	• Dollars of estimated capital cost
Expected operations and maintenance requirements	To what extent will regular effort be required to ensure effective operation	• High – active system with maintenance required for mechanical elements (i.e. pump station) • Med – passive system with regular maintenance required for critical elements (i.e. detention system with outlet flow restriction) • Low – passive system with infrequent maintenance required (i.e. regular inspection and cleaning of inlets and pipes)
Co-benefits	Does the proposed improvement provide additional co-benefits	Number of co-benefits provided: • Water quality benefits • Demonstration / educational value • Potential replicability • Improvement to disadvantaged area

For the purpose of improvement prioritization, qualitative ratings were converted to a numeric score and scores for all factors were normalized. Individual factors were grouped into broader objectives, each with a fixed relative weight established in coordination with key stakeholders. The dashboard allows the user to adjust the relative weight of overall objectives and observe impacts to improvement concept scoring and ranking. This framework was intended to provide multiple benefits, including:

- Consideration of how different stakeholder priorities could affect project ranking
- Sensitivity analyses of how variable project ranking could be
- Ability to update priorities over time following feedback from implementation efforts

3. Analysis Results

This section includes discussion of the existing system performance and the identified improvement concepts. The hydraulic models contain a wealth of information that can be mined for information on individual pipe segments, watershed parameters, and dynamics between open-channel and closed-pipe systems. The following text is intended to provide a narrative description of the hydraulic modeling results. The hydraulic models provide additional detail for individual pipe segments or watershed attributes.

3.1 Existing System Performance

Hydraulic analyses of the existing system performance focused on the 10-year, 24-hour design storm. Results are summarized for each identified study area, including reasoning for performing detailed modeling for the watershed and specific locations of known flooding problems. Complimenting these narrative descriptions are the system performance maps which show the modeled hydraulic network, location of flooding junctions, and the concern areas (DUCs, General Plan Study Areas, or flooding areas). These maps are provided for the watersheds in Appendix B.

Bianchi and Calaveras River P.S.

The Bianchi and Calaveras River P.S. study area flows into the Calaveras River, which is a tributary to the San Joaquin River. This watershed is primarily residential and commercial and 70% impervious. This study area was chosen for evaluation due to reported flooding. Model predicted flooding coincided well with reported flooding areas, in particular the Bianchi underpass (El Dorado Road) and East Bianchi Road between West Lane and El Dorado Street. Flooding is primarily a result of conveyance limitations in the stormwater pipes and an undersized pump station. The existing pump station has a peak capacity of 184 cfs compared to a modeled peak inflow of approximately 230 cfs coming to the pump during the 10-year design storm. Outfall boundary conditions were modeled as normal depth in the outfall pipe.

Boggs Tract

The Boggs Tract study area is located southwest of Interstate 5 where it crosses the San Joaquin River near W. Washington Street. The watershed is 48% impervious and dominant land uses are residential and industrial. This area was selected for detailed modeling because of reported flooding issues and the presence of a DUC. The existing storm network collects flow as far west as Fresno Avenue and pumps it from the Fresno and Scott P.S. to the Orange and Sonora P.S. and then to Mormon Slough. The Fresno and Scott P.S. is at capacity. Peak flows coming to the P.S. are 41 cfs, compared to a designed capacity of 5.5 cfs. Fresno Avenue has an elevation higher than the DUC community to its west, which does not provide this community any opportunity for stormwater drainage. The primary goal of this project is to provide drainage to the DUC.

Buena Vista and Smith Canal P.S.

The Buena Vista and Smith Canal P.S study area has an overall watershed imperviousness of 59% and is predominantly residential. This area has no reports of flooding or DUCs but there is a General Plan Study Area south of I-5. There is limited available information on the existing pump station, so it was not modeled dynamically. Model results did not indicate significant flooding during the 10-year design storm, and therefore this watershed and pump station are not recommended for any improvements.

Bonniebrook (Swenson Park and 5 Mile Slough P.S.)

The Bonniebrook P.S. study area is located on the northern extent of Swenson Park Golf Course on 5 Mile Slough. The watershed has a total imperviousness of 60% and its dominant land use is residential. This area was selected for detailed modeling because of reported flooding issues and a known capacity limitation at the pump station. There are several locations of surface flooding as shown in the performance maps. Modeled flooding coincided well with locations of reported flooding, especially for major stormwater pipes along Westland Avenue and Sumac Avenue. Flooding in the watershed is a result of limited pumping capacity and conveyance restrictions throughout the watershed. The pump station has a peak pumping capacity of 74 cfs compared to modeled inflows of 132 cfs to the pump during the 10-year design storm.

Deep Water Channel

The Deep Water Channel study area, which discharges into the Deep Water Channel and Port of Stockton, is tidally influenced and the outfall is entirely submerged. The watershed is 70% impervious and the dominant land use is commercial. This area was selected for detailed modeling due to known flooding areas, the presence of General Plan Study Areas, and a DUC community bordering HWY 99. Model predicted flooding coincided well with the observed locations and flooding was observed throughout the modeled network. The main stormwater pipe, which is 72-inches at the outfall and below several buildings, is surcharged during the 10-year storm. When setting up the model, many of the elevations for this large pipe seemed inaccurate (primarily adverse slopes) and standard assumptions were made to correct these elevations. Considering the pipe's age and the lack of information on the pipe, it may be beneficial to perform a condition assessment on this pipe.

Duck Creek

The Duck Creek study area is located east of Walker Slough, along Duck Creek, and consists of several pump stations. Duck Creek is a tributary to Walker Slough. The watershed has a total imperviousness of 54% and the dominant land use is industrial. This area was selected for detailed modeling because of reported flooding issues, the presence of several DUCs, and General Plan Study Areas. This study focused on two development areas: the Casa de Esperanza P.S and future development east of Hwy 99 and south of Mariposa Road. There are several locations of surface flooding as shown in the system performance map. Model predicted flooding coincided well with locations of observed flooding, especially near the Casa de Esperanza and Somerset and Flemmons P.S. Flooding in the watershed is a result of conveyance limitations throughout the watershed.

Eighth Street and San Joaquin

The Eighth Street and San Joaquin P.S. study area is located on the west end of Eighth Street where it meets the San Joaquin River. The watershed has a total imperviousness of 64% and its dominant land use is residential. This area was selected for detailed modeling because of reported flooding in the watershed, to assess whether the pump station and pipes have the capacity to receive runoff from the Turnpike and Walker drainage area and the presence of a General Plan Study Area. There are several locations of surface flooding as shown in the performance map, which coincided well with locations of known flooding, especially along S. Fresno Avenue. Flooding in the watershed is primarily a result of conveyance limitations in the upstream portions of the watershed. The pump station is sized appropriately for the 10-year flow, the peak pumping capacity is 280 cfs and the model estimates flows of 290 cfs to the pump. The San Joaquin River water elevation was assumed to be 4.5-feet to conservatively reflect the boundary condition.

Highway 4 and San Joaquin River P.S.

The Highway 4 (Hwy 4) and San Joaquin River P.S. study area is located on the east bank of the San Joaquin River. The predominantly industrial watershed is highly impervious (71% impervious) with no significant storage to manage peak flows. This area was selected for detailed modeling because of reported flooding issues and the presence of a General Plan Study Area along Hwy 4. There are several locations of surface flooding, as shown in the performance map, the most significant being on Hwy 4 and Tillie Lewis Drive. Model-predicted flooding coincided well with locations of known flooding, especially along the major stormwater pipes along Hwy 4 and Tillie Lewis Drive. Flooding in the watershed is a result of limited pumping capacity and an undersized collection system throughout the watershed. The pump station is substantially undersized for the large drainage area, its peak pumping capacity is 10 cfs, and the peak coming flow during the 10-yr design storm is 145 cfs. The San Joaquin River water elevation was assumed to be 4.5-feet to conservatively reflect the boundary condition.

Legion Park and Smith Canal P.S.

The Legion Park and Smith Canal P.S. study area is located north of the Deep Water Channel and is a tributary to the San Joaquin River. Because of this connection, its water surface elevation is tidally influenced. The watershed has a total imperviousness of 65% and its dominant land use is residential. This area was selected for detailed modeling because of reported flooding issues along Harding Way and Tuxedo Avenue, the presence of several DUCs, and General Plan Study Areas. The model predicted flooding (shown in the system performance map) coincided well with locations of known flooding, especially along the major stormwater pipes along Harding Way, Cherokee Avenue, and northwest of the pump station. Flooding in the watershed is a result of insufficient pumping capacity and conveyance restrictions in the watershed. The pump station has a peak pumping capacity of 291 cfs and the model estimates a peak flow of 400 cfs coming to the pump during the 10-year design storm. The boundary condition at the outfall was modeled as normal depth conditions to assume a downstream restriction.

Mormon Slough

The Mormon Slough study area, which discharges into Mormon Slough and the Deep Water Channel, is tidally influenced. The watershed is 59% impervious and the dominant land use in the watershed is commercial and residential. This area was selected for detailed modeling due to known flooding areas, the presence of study areas as identified in the General Plan, and several DUC communities in the upper watershed, in particular the Garden Acres DUC which is outside the City boundary. Runoff is conveyed to Mormon Slough which is open-channel until Wilson Way, where flow enters a 7x10-foot box culvert. The quality of the GIS data was variable. The pipe elevation data in the Fair Oaks neighborhood (centered along Court and East Main Street) seemed inconsistent with downstream pipe elevations and therefore the model predicted flooding results are uncertain. The 7x10-foot box culvert is surcharged during the 10-year design storm which does cause backwater restrictions in upstream lateral pipes.

North Little Johns

The North Little Johns Creek watershed is 53% impervious and includes residential and many large industrial/warehouse facilities. While there is no city-reported flooding, significant portions of the watershed are General Plan Study Areas and DUCs. The DUC is located east of Hwy 99 and west of Mariposa Road and there are no known specific development plans. There are several existing detention ponds throughout the watershed. The model predicts flooding mostly in the residential neighborhood which ultimately drains to North Little Johns Creek via the Airport Business Center P.S. and a large stormwater pond. The Airport Business Center P.S has a peak capacity of 72 cfs and the Arch Road Industrial Park P.S. has a capacity of 40 cfs. Both pump stations pull water from large stormwater ponds, the size of which prevents the relatively small pump stations from being overwhelmed by large peak flows. The runoff from this watershed eventually enters French Camp Slough.

Sutter and Calaveras River P.S.

The Sutter and Calaveras River P.S. watershed collects runoff from Sutter Street and California Street and discharges into the Calaveras River, a tributary of the San Joaquin River. The watershed is primarily residential and is 44% impervious. This watershed was evaluated because of a DUC community and the presence of General Plan Study Areas. The model does predict significant flooding along N. Sutter Street and California Street due to insufficient pipe capacity during the 10-year design storm. There is limited information on the pump station capacity so it was assumed to be an ideal pump, the model estimates a peak flow reaching the pump station of approximately 200 cfs during the 10-year design storm. Future testing and analysis should be considered to establish pump station capacity and revise modeling analysis accordingly if capacity is limited below the modelled 200 cfs inflow. Outfall boundary conditions were modeled as equal to normal pipe flow in the outfall pipe.

Turnpike and Walker Slough

The Turnpike and Walker Slough P.S. is located on French Camp Turnpike, north of Walker Slough. The watershed has a total imperviousness of 59% and is mostly residential and commercial land use. The watershed was selected for detailed modeling because of multiple flooding locations and pump station limitations. Currently, development in the watershed is being limited because of pump station capacity limitations. Model results of the existing system and flooding locations matched well with known locations. The pump station set points were not well described in the available documentation which has the greatest impact in the lower portion of the watershed. These set points were set conservatively in the model based on available information and operations of similar pumps. The pump station has a peak pumping capacity of 152 cfs and the model estimates a peak inflow of 350 cfs to the pump during the 10-year design storm.

West Lane and Calaveras River South P.S.

The West Lane and Calaveras River South P.S. watershed is 63% impervious and comprised of commercial and residential areas. Similar to the Sutter and Calaveras River P.S. watershed, there are no reported flooding issues, however much of the watershed is within a Study Area and there is a DUC community in the upper portion of the watershed. The PG&E facility and industrial/commercial area west of West Lane are heavily impervious with no apparent stormwater controls. The model predicts flooding in the upstream portion of the watershed along Stadium Drive and West Lane, primarily due to conveyance limitations. The model estimates a peak flow to the pump station of 120 cfs during a 10-year design storm. It was assumed that the tailwater elevation in the Calaveras River was 16 feet, a conservative assumption based on Calaveras River levels.

3.1.1 Hydraulic Limitations on Additional Development

The study areas presented herein generally exhibited surface flooding during the 10-yr design storm at some locations under existing conditions and therefore offered limited hydraulic capacity for additional development without infrastructure improvements. In these areas and absent improvements to existing infrastructure, detention features preventing an increase in peak flows for the 10-yr storm will be essential to avoid exacerbating existing flooding concerns. Specific areas of limited hydraulic capacity and their proximity to DUCs and other areas of anticipated development can be seen in Appendix B.

3.2 Identified Improvement Concepts

In the following section, a description of the identified improvements is discussed. The improvements are presented in Appendix B along with a basic description of the preliminary concept.

Bianchi and Calaveras River P.S.

To reduce flooding near the pump station and further into the watershed, both pipe upsizing and pump station capacity improvements are recommended. The recommended pump station capacity is 300 cfs, which was determined by iterating the pump station size in model runs. Pipe upsizing was focused along Claremont Avenue, Bianchi Road, Kentfield Road, and March Lane.

Boggs Tract

The primary improvement objective was to provide drainage to the community West of South Fresno Avenue. With the existing stormwater network, all runoff from this area would be routed to the Fresno and Scott L.S., which is undersized and at capacity. If this lift station were upsized, it’s likely that the downstream force main and gravity pipes would also need to be upsized which would be costly and challenging. With these limitations, the most feasible solution is to build a new outfall into the Port of Stockton and build a pump station on a City-owned parcel on Harbor Street. The hydraulic model was run for different scenarios to determine the ideal pipe and pump size necessary to convey the 10-year design storm. The City is unaware of any future development in the watershed so the watershed characteristics remained unchanged. The identified improvements included new and upsized stormwater pipes and pump stations.

Bonniebrook (Swenson Park and 5 Mile Slough P.S.)

The primary improvement objective was to relieve flooding along Westland Avenue, Sumac Avenue, and to upsize the pump station which is undersized according to City feedback. The hydraulic model was run for different scenarios to determine the ideal pipe and pump sizes necessary to convey the 10-year design storm. The peak inflow to the pump station is driven by the conveyance capacity of the collection system, so the pump station was sized to manage this flow. The identified improvements included upsized stormwater pipes from Bonniebrook P.S. to Tamarisk Avenue and upsizing the P.S. to a peak pumping capacity of 120 cfs.

Deep Water Channel

As mentioned previously, more information is needed on the main trunk to determine if an increase in capacity is warranted. However, given the number of utilities, a new outfall or diversion may be the best solution if upsizing is needed. To address some of the nuisance flooding locations, several small underground storage practices are recommended. If development were to occur in the DUC along Fremont Street, a drainage network which routes water to Fremont Street would be the preferred drainage solution. To accommodate this flow, a 48-inch pipe is recommended along Fremont Street.

Duck Creek

The primary improvement objective was to relieve flooding in the vicinity of the Casa de Esperanza P.S., evaluate the proposed Casa de Esperanza development west of Mariposa Road, and the DUC in the southeast portion of the watershed which does not currently have a storm drain network. For the Casa de Esperanza development area, the identified improvements consist of improving the channel downstream of the development to S.B Street where it enters a closed pipe. There was very little information on the Casa de Esperanza development so further evaluation is warranted once more information is available. For the DUC east of Highway 99, there are no identified projects along Clark Drive, Carpenter Road, or Munford Avenue. However, if development occurs, then there will be a need for a drainage system that routes flow to Duck Creek. To evaluate the needed conveyance system, it was assumed that the impervious area is 55% impervious and the required pump station and stormwater pipes were evaluated.

Eighth Street and San Joaquin River P.S.

The primary improvement objective was to relieve flooding from the Turnpike and Walker drainage area by diverting flow to the Eighth and San Joaquin P.S. The hydraulic model was run for different scenarios to determine the ideal pipe and pump size necessary to convey the 10-year design storm. It was determined that the existing P.S. has the capacity to handle additional flow from Walker and Turnpike if conveyance improvements were made along Eighth Street. The identified improvements include a parallel pipe system along Eight Street with 4-to-6-foot diameter pipes. The proposed system would be 10 feet below the ground surface, the existing system is 20 feet below the ground surface. This proposed shallower pipe provides hydraulic and cost benefits compared to adding new pipe at the same depth as the existing system. This proposed improvement would likely be paired with Walker Turnpike Alternative 2 improvement.

Highway 4 and San Joaquin River P.S.

The primary improvement objective was to relieve flooding along Hwy 4 and Tillie Lewis Drive. The hydraulic model was run for different scenarios to determine the ideal pipe and pump size necessary to convey the 10-year design storm. The peak inflow to the pump station is driven by the conveyance capacity of the collection system, so the pump station was sized to manage this flow. The watershed is very impervious and there are no large areas of open space to provide for storage. The identified improvements focused on upsized stormwater pipes along the existing alignment, converting open channels (roadway ditches) to closed conduit, and a new pump station.

Legion Park and Smith Canal

The primary objective was to mitigate flooding along Harding Way and northwest of the pump station on Middlefield Avenue and Oxford Way. To reduce the flooding, improvements were needed for both the pump station and the larger stormwater pipes. The pump station capacity was determined by modeling the peak pump capacity at different iterations to determine the optimal pump size. A direct result of pipe upsizing is more runoff coming to this pump station.

Mormon Slough

The recommended improvements for the watershed are focused on upsizing the large stormwater trunks along Wilson Way and Court Street/Diamond Street. These projects should have a lower priority because these residential/commercial areas are not known to have flooding problems. There are no recommendations to modify the box culvert that conveys water from the open channel to the outfall.

North Little Johns

The model predicts flooding mostly in the only residential area of this watershed. The conduits and pump stations in the Arch Road Industrial Park area were determined sufficient for conveying a 10-year design storm. Given the model predictions and lack of flooding reports by the city, the recommendation for this watershed is to upsize several pipes in the residential area along Gostage Way, Estrella Ave, and Togninali Lane. With all of the storage ponds in this watershed, the peak flows to the Stockton Airport Business Center P.S. are low enough to not warrant an upgrade to the pump station. If the DUC east of the residential area were to be developed, then further evaluation of pump capacity should be studied.

Sutter and Calaveras River P.S.

Despite no reports of flooding in this watershed, the model predicts significant flooding along N Sutter Street and California Street due to undersized conduits. Upsizing the conveyance pipes in these corridors is recommended to provide more conveyance capacity. Given the currently available information, it cannot be said whether pump station improvements are necessary.

Turnpike and Walker Slough

With flooding occurring in many parts of this watershed, multiple areas of improvement are recommended. Two separate alternatives are proposed as options to mitigate flooding.

Alternative 1 includes upsizing the main trunkline along I-5, West 5th Street, and West 7th Street to provide additional capacity in the upper watershed. In order to accommodate the additional flow at the pump station, a peak pump capacity of 200 cfs is recommended at the pump station. There was little benefit of a pump station greater than 200 cfs. Underground storage at several cleared parcels was evaluated and ultimately found to have negligible impact on flooding volumes. The development of storage practices in the watershed is challenging, especially in the lower portion of the watershed, because the stormwater pipes are far below grade which would require a large pumps and significant excavation.

Alternative 2 is a scenario that diverts runoff from west of I-5 west to the Eighth Street and San Joaquin River P.S. As a result of this diversion and the reduced flow, only the two east-west stormwater pipes along W 5th Street and W 7th Street need to be upsized, however, neither the pump station or the conveyance along French Camp Turnpike need to be upsized. Alternative 2 would likely be paired with the Eighth Street and San Joaquin River P.S. project to provide adequate conveyance capacity to the P.S.

West Lane and Calaveras River South P.S.

Despite no reports of flooding in this watershed, the model predicts significant flooding along Stadium Drive and West Lane in the upper part of the watershed due to undersized conduits. Similar to the Sutter and Calaveras River P.S., there is limited information on the existing pump station to represent it accurately in the model. Instead, it was modeled as an ideal pump where the pump flow rate equals the inflow flow rate. Even with an ideal pump, the model still predicts flooding in the upper part of the watershed which indicates a conveyance limitation. The recommendation is to upsize nearly the entire length of the conduit in the West Lane corridor and part of the conduit on Stadium Drive. More information on the existing pump station would be required to make a recommendation on whether the pump station needs to be upsized.

3.2.1 Hydraulic Performance

Hydraulic performance of the proposed improvements with regards to alleviating surface flooding is shown in Appendix C. Many of the proposed improvements were effective in alleviating surface flooding; however, complete mitigation of surface inundation was not practical in all cases. Details of hydraulic performance for individual catchments and pipe segments can be found in the PC-SWMM model and should be considered further during detailed design of proposed improvements.

3.3 Improvement Prioritization and CIP Recommendations

Improvement concepts were evaluated using the prioritization framework presented in Chapter 2, then grouped into an overall priority of high, medium, or low. Resultant project ranking is presented in Table 3-1.

Table 3-1 - Capital Improvement Project Ranking

Project	Cost	Priority
Boggs Tract	$17,144,585	High
Bonnie Brook	$11,547,232	High
Hwy 4 and San Joaquin	$24,902,729	High
Walker Turnpike Alt 1 *	$46,204,468	High
Walker Turnpike Alt 2 + Eighth St and San Joaquin *	$75,142,267	High
Bianchi and Calaveras	$30,682,180	Medium
Duck Creek	$12,061,203	Medium
Legion Park and Smith Canal	$50,864,178	Medium
Deep Water	$10,229,853	Low
Little Johns	$4,552,126	Low
Mormon Slough	$27,524,026	Low
Sutter and Calaveras River	$13,710,877	Low
West Lane and Calaveras River	$6,517,147	Low

** Denoted projects are alternatives and would not both be implemented*

4. Implementation Recommendations

This section provides guidance and recommendations on how this Stormwater Master Plan and the H&H model may be used moving forward to address flooding concerns and support the City's stormwater management objectives and development goals.

4.1 Potential Packaging and Sequencing of Improvements

Project Packaging

Given the nature and size of the identified CIP projects, implementation of multiple concurrent projects would be uncommon. Additionally, CIP projects are distributed throughout the City, minimizing potential efficiencies from constructing concurrent projects in proximity to one another. Each CIP project presented in this master plan effectively represents a package of localized capital improvements, which could be subdivided into smaller individual projects. This master plan includes alternative improvement options for the Walker Turnpike area, both of which would not need to be implemented together.

There may be efficiencies and benefits in packaging minor improvements and maintenance activities within localized areas or as part of larger CIP projects, as discussed in Section 4.2.

Sequencing of Improvements

With no hydrologic or hydraulic interaction between the identified CIP projects, improvements should generally be sequenced based upon their priority, as presented in Section 3. Typical design durations for identified CIP projects would be on the order of 18-24 months, with additional construction duration of 24-36 months. To make effective use of the City's time and resources, it is recommended that design of the next project initiate as construction of the previous project gets underway, such that both design and construction efforts are simultaneously underway over the duration of the CIP after initial startup. Depending upon the rate of capital expenditure, it is possible that multiple design and construction projects could be undertaken at the same time. Doing so will address the City's stormwater concerns at a faster pace but may require additional City staff capacity to manage those ongoing efforts.

Individual Project Phasing

Where individual project elements have phased implementation, project implementation should typically begin downstream and progress upstream. Implementation in this manner mitigates the risk of new flooding concern areas resulting from the efficient conveyance of runoff to downstream areas without capacity. Where pump station improvements are proposed, those improvements should be implemented in advance of upstream conveyance improvements to avoid a scenario where increased flow to the pump station causes localized flooding or damage. Details of individual project phasing are largely dependent upon the pace of future stormwater capital expenditures and detailed design characteristics.

4.2 Repairs and Minor Improvement Projects

Due to the nature of identified flooding concerns, configuration of stormwater conveyance infrastructure, and other factors, the identified projects included in this Stormwater Master Plan will address substantial flooding concerns but also have significant individual costs. In addition to major capital investments, there are opportunities to address deficiencies and improve stormwater conveyance throughout Stockton on a smaller scale. Such projects should generally be easier and quicker to implement and may go a long way to addressing localized public nuisances and concerns. These types of smaller improvements can be especially important if modifications to the City's stormwater utility fee are proposed, as they can provide near-term stormwater improvements the public can recognize without waiting for the longer design and construction durations associated with the larger CIP projects. Several examples of repairs and minor improvement projects are described below.

Added Inlet Capacity

Localized flooding at an intersection or roadway sag may be the result of limited inlet capacity. In these scenarios, existing subsurface pipe capacity may be sufficient, but conveyance of surface runoff is limited by the geometry and capacity of the surface inlet. Damage to the inlet cover or structure of the catch basin may similarly limit the geometry and capacity of the inlet. Inlet capacity concerns may be exacerbated at locations where litter and other debris accumulate.

Determining Source of the Concern

In areas subject to stormwater modeling efforts, observed surface inundation in areas where pipe surcharge is not indicated within the model may suggest inlet capacity issues. Inlet capacity concerns can be confirmed with standard inlet hydraulic and gutter spread calculations.

In areas that have not been the subject of stormwater modelling efforts where localized surface inundation is observed, monitoring water level during one or more storm events can aid in confirming inlet capacity concerns. A pressure transducer water level logger may be deployed within the inlet of concern or a nearby manhole to measure the hydraulic grade line within the subsurface system. A hydraulic grade line inconsistent with observed surface inundation would suggest inlet capacity concerns.

Designing and Implementing Improvement

The required inlet capacity and geometry for a location can be determined using standard inlet hydraulic and gutter spread calculations. In many cases, the proposed solution will consist of an additional adjacent inlet structure hydraulically connected to the existing inlet with a short pipe segment. Depending upon site specifics, it may be preferable to replace the existing inlet with a larger structure.

Failed Pipe Maintenance, Repair or Replacement

In addition to inlet capacity, another potential source of localized drainage concerns may be blocked, damaged, or deteriorating pipe infrastructure.

Determining Source of the Concern

Blocked, damaged, or failing pipe infrastructure may have several indicators, including:

- surface sinkhole formation
- recent pavement cuts or patches indicating subsurface utility work or other recent earthwork that may have damaged pipe infrastructure
- emergence of new and frequent localized flooding
- signposts or utility poles suddenly beginning to tilt due to inundation of the subsurface gravel footer
- substantial changes in water surface elevations along a pipe run

In areas subject to stormwater modeling efforts, an additional indicator may be flooding observations inconsistent with model results. The use of pole cameras or CCTV inspections can assist in determining the nature and extent of pipe failures and maintenance and repair needs.

Designing and Implementing Improvement

For pipes with accumulated sediment and debris, vacuum truck operations may be utilized to clear pipe infrastructure. It is important that such operations follow NPDES requirements, which may require water produced by pipe cleaning to be captured instead of discharged to the storm sewer. During cleaning operations, it would be beneficial to assess contributing factors to the blockage, such as a recent major storm event, large debris within the storm sewer, or signs of long-term sedimentation due to shallow pipe slope and low flow velocities.

Where stormwater pipes are exhibiting signs of structural failure, removal, and replacement via conventional means are most common. Trenchless repair methods may be considered for deep pipe systems but are not especially common for stormwater infrastructure. Prior to replacement of failing pipe infrastructure, conducting a modeling assessment of the local drainage infrastructure would be beneficial to determine whether piping should be replaced in kind or upsized to provide additional conveyance capacity.

4.3 Model Use in Support of Future Development

This stormwater master plan considers future development in a general context, as discussed in Section 2. As details of proposed future development become known, those characteristics can be incorporated directly into the H&H model. There are several criteria important to the evaluation of future development, as discussed below.

Retention vs Detention and Restriction on Capacity for Future Development

City of Stockton standards cover detention basin design but currently discourage the use of retention basins. With many DUCs located upstream of areas with hydraulic capacity limitations, the use of detention and retention basins may be the only effective means of allowing new development without improving downstream stormwater infrastructure.

Current detention basin standards require a storage volume equal to the runoff from the tributary area for the 10-yr, 48-hr event in areas without discharge limitations and 150% of that volume in areas with discharge limitations. These sizing standards should help to effectively mitigate impacts from development provided they are paired with effective discharge limits. Discharge limits should generally require the post-development peak flows do not exceed pre-development peak flows as a minimum standard; however, the H&H model could be utilized to establish location-specific discharge limits based upon the available capacity or lack thereof in downstream stormwater infrastructure and the size and nature of the proposed development.

Decentralized retention practices, including green infrastructure like bioretention and permeable pavement, may help mitigate downstream impacts for smaller storm events but are unlikely to have substantial impacts on the hydrology of the 10-yr design storm associated with the current level of service. This result is because these practices are typically sized to manage approximately 1-inch of rainfall depth, with their storage capacity exhausted before the peak of the 10-yr design storm occurs.

Larger-scale retention basins could play a key role in supporting new development in areas with limited downstream conveyance capacity by mitigating the hydraulic and hydrologic impact of new development and would generally require less site-specific analysis because they do not have substantial discharge from a defined outlet during the 10-yr design storm. The volume sizing of retention basins should match that of the current standard for detention basins. Conventional retention basin design lacks a defined outlet and primarily functions by capturing and infiltrating the entire design volume. This approach may have limited applicability in some areas of Stockton due to soil characteristics and site constraints. A low-flow drawdown could be incorporated into retention basin design in such areas. For these low-flow drawdown systems, the drawdown rate should not exceed the rate needed to drain the basin volume over a 6-day period. This rate will typically produce a flow that is insignificant during storm events in the context of downstream capacity and flooding while also making capacity available in the basin for the next storm event.

Tailwater Influence on Proposed Development

When developing stormwater conveyance designs for a proposed development, it is important to have a downstream hydraulic grade line established for any instances where a free discharge is not anticipated. The existing H&H model can be utilized to establish this boundary condition and inform the analysis and design of drainage infrastructure directly associated with the proposed development.

4.4 Other Future Model and Analysis Updates

This master plan and the associated model are expected to provide immediate support to stormwater planning and improvement efforts, while also providing a platform for future analyses and updates. Beyond the assessment of future development, the H&H model is set up and annotated with the intent that it will be utilized in the future as future updates and analyses are expected, as discussed below.

4.4.1 Model Updates with New Inventory Data

Whether through new development or assessments of existing infrastructure, new and/or revised stormwater conveyance infrastructure data are expected to be available over time. These data can be utilized to validate existing model elements, address missing or inaccurate data, provide added detail, and refine the model's predictive capacity.

4.4.2 Assessment of Downstream Impacts and Discharge Limitations

By their nature, most of the identified CIP project concepts would alleviate flooding concerns by improving conveyance efficiency. This is provided primarily through a combination of pipe upsizing and improvements to pump station capacity and reliability. These improvements reduce flooding, but in doing so effectively reduce detention capacity and convey and discharge more water downstream. Modeling assessments associated with this master plan considered and mitigated localized downstream impacts up to the point where stormwater is discharged to a receiving water; however, these efforts did not directly consider the capacity of that receiving water itself. Further analysis, conducted as part of detailed design efforts, will be needed to understand the physical and regulatory capacity of these receiving waters to accept increased runoff discharges.

The H&H model developed as part of this master plan provides information on the volume, rate, and timing of runoff discharges to receiving waters, which can inform open channel modeling of receiving water hydraulics to determine the impacts of increased flows. In some locations there are existing receiving water models to support this analysis, whereas those models will need to be developed altogether in other areas. Stakeholder and regulatory agency coordination will be essential as part of this process to establish consensus on modeling approach and the characterization of potential impacts.

4.4.3 Expansion of Model Outside Priority Areas

As discussed in Section 2.3, H&H model development for this stormwater master plan focused on areas of known flooding concerns and anticipated future development. Future modeling efforts could expand coverage beyond these priority areas, to assist in understanding and addressing smaller scale stormwater conveyance concerns. Connectivity with existing model elements will assist in establishing boundary conditions and hydrology.

5. Master Plan Financial Evaluation

5.1 Summary of Baseline Stormwater Financial Conditions

5.1.1 Overview of Stockton Stormwater Utility Organization and Services

The City of Stockton's (City) Stormwater Utility operates as a separate division within the City's MUD. The Stormwater Utility Division (SUD) is responsible for the operation and maintenance of approximately 620 miles of pipe, 77 pump stations, and more than 100 outfall pipes that collect and route runoff from the streets to the City's local rivers, creeks, and sloughs. The SUD responsibilities also include NPDES (National Pollutant Discharge Elimination System) permit management, permit negotiations, stormwater outreach, customer service, and storm drainage maintenance districts.

According to Stockton's 2020 Comprehensive Annual Financial Report (CAFR), SUD employs 4 full-time staff. Ancillary services needed to support the stormwater management program, including human resources, legal, information technology, and customer billing are supplied by other departments within the Stockton city government or are outsourced to the private sector. As described below, the support services performed by other City departments are charged to the Stormwater Utility Enterprise Fund and are budgeted on an annual basis.

5.1.2 Stormwater Fee Structure and Sources of Revenue

As a proprietary enterprise fund, the SUD's revenues are generated primarily through the collection of a stormwater fee that is billed to owners of all subject land parcels located within the City's service area. The stormwater fee is collected as a separate line item on a customer's water and sewer bill. Customers not receiving city water or sewer service receive a separate stormwater bill. All revenues collected through the stormwater fee are required to be used exclusively for the operation and maintenance of the stormwater management system.

The current stormwater monthly fee of $2.10 per Equivalent Residential Unit (ERU), has not been increased since it was first implemented in 1992. To put that value into context, if the stormwater fee had been increased only to keep pace with inflation over the last 30 years, irrespective of other changes in stormwater needs over time, the 2022 rate would need to be set at $4.23 per ERU, or more than double the current fee.

The ability of the City to increase the stormwater fee is severely constrained by the provisions of Proposition 218, which was enacted in 1996 and requires voter approval to increase the stormwater rate. The City of Stockton floated a ballot measure in 2010 to create a new Clean Water Fee to increase revenues. The Clean Water Fee was proposed as a separate charge of $2.88 in the first year, with small increases in future years. The fee was to be charged on top of the existing stormwater fee. The measure, however, was defeated by the voters in the election held that year.

It should be noted that the California legislature enacted Senate Bill 231 in September 2017 to amend the definition of "sewer" to include stormwater so that stormwater is regulated in the same way regarding setting fees as water, wastewater, and solid waste with respect to Proposition 218 requirements and exemptions. Under Proposition 218, water, wastewater, and solid waste fees may be increased unless voters voluntarily lodge substantial opposition during a public comment period, unlike stormwater where an affirmative public vote is required. Despite the legislative redefinition of stormwater under Senate Bill 231, the continued risk of legal challenges has deterred California municipalities from increasing stormwater fees without a public vote. The potential legal challenges generally allege that because Proposition 218 was an amendment to the State's constitution, another constitutional amendment would be required to modify those definitions. A determination on these issues has yet to be adjudicated in the State Courts.

These challenges have contributed to no changes in the City's stormwater fee since 1992 and significantly and adversely impacted the SUD's financial resources and its capacity to upgrade and expand the stormwater infrastructure to accommodate population growth and maintain a high Level of Service with the Stormwater Utility Enterprise Fund alone. Instead, SUD has prioritized its spending to address only the most pressing repair issues.

SUD's stormwater fee structure is based on the concept of the Equivalent Residential Unit referred to above. The Stockton SUD defines an ERU as the average amount of impervious area associated with residential dwellings, including single family residences, duplexes, triplexes, and multifamily apartments. At the time of establishment of the stormwater utility, the ERU was set at 2,347 square feet and this ratio remains in effect today. Accordingly, one ERU is assigned to each dwelling unit whether it is a single-family residence, or contained withing a duplex, triplex, or an apartment complex. Condominiums are treated the same as the other residential units. Computation of ERUs associated with non-residential parcels is accomplished using a different formula. Specifically, individual non-residential parcels are assigned an impervious area factor depending on the type of land use and that factor is multiplied by the entire parcel area to generate an estimated impervious area. The calculated impervious area is then divided by 2,347 to yield an ERU value. Table 5-1 shows the impervious area factors used by the SUD to establish the number of ERUs assigned to nonresidential properties:

Table 5-1: Impervious Factors for ERU Determination

Land Use	Impervious Area
Commercial	90%
Institutional	62%
Industrial	79%

The City recognizes that the impervious area factors might not accurately reflect the actual land use of each non-residential parcel, and hence, allows owners to provide actual impervious area information should they seek to modify the impervious area factor used to determine their stormwater fee. Only vacant and undisturbed parcels are exempted; all other land parcels, including those owned and operated by non-profit organizations and the municipal government are subject to the stormwater fee.

5.1.3 Stormwater Accounts by Customer Class and ERU

The City provided Hazen with data on the number of stormwater accounts by customer class for the period FY2017-18 through FY2019-20 as well as total billings for the evaluation and development of the financial plan for the overall Stormwater Master Plan (Master Plan). These data were then used to generate a profile of the stormwater utility district's (SUD) customer base, the relative contribution of equivalent residential units (ERU) by parcel land use (i.e., customer class) and associated revenue, and to identify short-term trends in stormwater fee account growth by customer class. The distribution of stormwater utility accounts is shown in Table 5-2.

Table 5-2: Stormwater Utility Accounts by Customer Class: FY2017-FY2019

Type	FY2017 18 Accounts	FY2018 19 Accounts	FY2019 20 Accounts
Apartments	1,954	1,947	1,943
Condo	775	775	774
Duplex	3,900	3,913	3,916
Triplex	1,513	1,510	1,515
Single Family Residence	67,317	67,582	67,912
All Residential	75,459	75,727	76,060
Non-Residential	3,906	4,058	4,214
Total All Accounts	**79,365**	**79,640**	**80,274**
*Non-Residential includes institutional, commercial, and industrial parcels. The data provided did not disaggregate non-residential accounts by customer class.			

Residential parcels comprise about 95 percent of all stormwater accounts, but as shown in Table 5-2, there has been virtually no increase in residential account growth in the two-year period for which the most recent data are available. Residential accounts encompassing all subclass types increased by just 0.8 percent, from 75,459 to 76,060. Single family residential parcels comprised 85 percent of all stormwater accounts and increased by 0.8 percent over the same period. Non-residential accounts increased much more robustly, growing by 7.9 percent from FY2017-2019.

The stormwater account and billing data allow one to estimate the total ERUs subject to the stormwater fee and the distribution of ERUs across the two main customer classes (residential and non-residential accounts). As seen in Table 5-3 and Table 5-4, although non-residential parcels comprise just 5 percent of the total number of parcels, they account for 56 percent of the impervious area and associated ERUs subject to the stormwater fee. As indicated by the data, non-residential development accounted for almost all the growth in new accounts and the associated increase in fee-generating ERUs.

Table 5-3: Number of ERUs Charged by Customer Class

Customer Class	FY2017-18 ERUs	FY2018-19 ERUs	FY2019-20 ERUs
All Residential*	98,188	96,969	98,493
Non-Residential	116,417	121,565	125,822
Total	**214,605**	**218,534**	**224,315**
*Includes SFR, Duplex, Triplex, Multifamily Apartments, and Condominiums			

Accordingly, on a per account basis, non-residential accounts are far larger in terms of impervious area. The average non-residential account is billed for approximately 30 ERUs compared to the 1 ERU assigned to single family residences. Noteworthy is that apartment complexes are billed using the same method as for single family residential units (on a per dwelling basis) and the average stormwater utility account for this customer class is approximately 10 ERUs. To put the ERUs into a more familiar land area context, Table 5-4 converts the residential and non-residential ERUs to acres.

Table 5-4: Impervious Area Subject to the Stormwater Fee by Main Customer Class and Year

Expense Category	FY2017-18 Impervious Area Acres	FY2018-19 Impervious Area Acres	FY2019-20 Impervious Area Acres
All Residential	5,290	5,225	5,307
Non-Residential ERUs	6,273	6,550	6,779
Total Acres	**11,563**	**11,775**	**12,086**

5.2 Historical and Current Stormwater Program Expenditures

The City provided annual expenditure data for the period FY2015-16 through FY019-20. This is shown in Table 5-5.

Table 5-5: Annual Stormwater Expenditures by Expenditure Category

Expense Category	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20
Administration and Policy	$2,261,992	$2,094,630	$2,017,369	$2,434,966	$2,276,864
Customer Service and Billing	$359,357	$382,792	$399,949	$376,195	$390,038
O&M (Operations & Maintenance) and Pump Stations	$2,046,838	$2,107,272	$2,228,606	$2,573,712	$2,142,552
Capital Projects	$377,400	$450,157	$156,672	$694,432	$828,309
Debt Service	-	-	-	-	-
Total Expenses	**$5,045,587**	**$5,034,851**	**$4,802,596**	**$6,079,305**	**$5,637,763**

As shown in Table 5-5, two of the expenditure categories, Administrative and Policy and Operation & Maintenance (O&M) accounted for more than 92 percent of non-capital expenditures. Administrative and Policy expenditures reflect inter-department charges for the ancillary services provided to SUD from other city government departments. For example, the Municipal Utilities Department (MUD) Administration and Finance Division allocates 7 percent of its labor cost to SUD. Utility Billing allocates 11 percent of its labor costs to SUD. In total, over the past five years, these administrative costs have comprised more than 40 percent of non-capital expenditures. The SUD has not issued any debt and therefore incurs no debt service costs. Capital improvements and rehabilitation and repair projects have been fully funded through SUD's operations budget.

Overall, SUD total expenditures have been rising continuously since FY2016, although there has been large year-to-year variability in capital expenses ranging from just $156,672 in FY 2017 to $828,309 in FY2019. Excluding capital expenditures, the average annual increase in administrative, billing, and O&M expenditures were about 3.6 percent. Overall, customer billing and O&M expenditures were the largest contributors to the program cost increases over the period FY2015 through FY2019, although capital expenditures varied the most during this period.

5.3 Historical and Current Stormwater Program Revenues

Table 5-6 presents SUD's revenues for the last 5 years for which complete data were available. On an annual basis, user service fees accounted for between 90 percent and 98 percent of all revenues generated during this period. Agency reimbursements have varied substantially during this period, but that revenue source is expected to stabilize in future years. Similarly, revenues generated from interest income varied substantially from a low of $4,647 in FY2016 to $359,000 in FY2019. These two sources are anticipated by the City to contribute less volatility and grow more slowly in future years. Revenues from administration fees for storm drains have provided a small but stable source of income over the past 5 years. Consequently, user fees will continue to serve as the major source of the program's revenues and if current trends continue, will grow slowly unless either the stormwater fee is increased, or residential and commercial development growth accelerates. User fee growth from FY2015 to FY2019 increased at an annual rate of about 1.8 percent.

Table 5-6: Annual Stormwater Utility Department Revenues FY2015-FY2019

Revenue Category	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20
User Services	$5,548,552	$5,430,117	$5,566,463	$5,970,119	$6,068,832
Administrative Fees	-	$84,500	$84,500	$84,500	$89,500
Agency Reimbursements	$24,033	$104,045	$32,345	$352,518	$258,624
Interest	$99,185	$4,647	$11,590	$324,152	$359,999
Total Revenue	**$5,671,770**	**$5,623,309**	**$5,694,898**	**$6,731,289**	**$6,776,955**

5.4 Baseline Forecast of Stormwater Expenditures and Revenues through FY2041

A baseline forecast has been prepared to estimate the SUD's future net income (i.e., total revenues minus total expenditures) assuming that the current stormwater fee remains unchanged and using City provided forecasts of annual program expenditure increases and annual account growth. The baseline forecast estimates future net annual income in the absence of capital investments.

The purpose of the baseline forecast is to provide a high-level projection of SUD's future financial capacity to cover basic administrative and operation and maintenance costs. Capital investments are included in the subsequent section using annualized cost estimates prepared for the Master Plan. It must be emphasized that the net income forecast becomes increasingly more uncertain after the first five years, especially regarding the escalation of future costs. Inflationary pressures, for example, could substantially increase labor and other operational costs beyond those assumed in the forecast. Nonetheless, the financial forecast provides a realistic evaluation of continued trends in the program's growth in revenue requirements.

The key assumptions provided by the City and used in the baseline forecast are shown in Table 5-7 and the projected revenues and expenditures and resulting net income is shown in Table 5-8. Figure 5-1 graphically depicts the projected growing deficit over the planning period.

Table 5-7: Baseline Annual Revenue and Expenditure Forecast for Stockton's Stormwater Management Program

Revenue Sources	Projected Annual Increases
User Services	1%
Agency Reimbursement	2%
Interest	1%
Expenditure Categories	**Projected Annual Increases**
Administration & Policy	2%
Customer Service /Billing	2%
Operation and Maintenance	3%

Table 5-8: Projected Net Income FY2022-FY2041

Fiscal Year	Projected Revenue	Projected Expenditures	Net Income
FY 2022-23	$6,347,703	$6,375,065	**$122,638**
FY 2023-24	$6,412,611	$6,533,117	**$29,494**
FY 2024-25	$6,478,214	$6,695,337	**-$67,123**
FY 2025-26	$6,544,521	$6,861,838	**-$167,317**
FY 2026-27	$6,611,540	$6,882,737	**-$271,197**
FY 2027-28	$6,679,277	$7,058,154	**-$378,876**
FY 2028-29	$6,747,743	$7,238,211	**-$490,468**
FY 2029-30	$6,816,944	$7,423,037	**-$606,093**
FY 2031-32	$6,957,589	$7,807,518	**-$725,871**
FY 2032-33	$7,029,050	$8,007,445	**-$849,929**
FY 2033-34	$7,101,280	$8,212,684	**-$978,395**
FY 2034-35	$7,174,290	$8,423,380	**-$1,111,403**
FY 2035-36	$7,248,087	$8,639,683	**-$1,249,090**
FY 2036-37	$7,322,682	$8,861,747	**-$1,391,596**
FY 2037- 38	$7,398,082	$9,089,731	**-$1,691,649**
FY 2038-39	$7,474,298	$9,323,797	**-$1,849,499**
FY 2039-40	$7,551,339	$9,564,113	**-$2,012,774**
FY2040-41	$7,629,214	$9,810,850	**-$2,181,636**
FY2041-42	$7,707,933	$10,064,185	**-$2,356,252**

As shown in Figure 5-1 below, SUD expenditures are projected to increase at a higher rate than revenues under the baseline forecast, which only considers operational costs and excludes capital investments to upgrade and expand the stormwater infrastructure as would be needed over the next two decades. As noted earlier, the utility's revenue growth is constrained by the challenges of raising the stormwater fee rate per ERU. Hence, user fee growth is driven by residential and commercial development.

The Stockton 2040 General Plan Update, published in 2016, projects future annual population growth to range from 0.9 to 1.3 percent through 2040. Growth in demand for commercial and industrial space is forecasted to be more robust than residential growth but would still likely constitute a small share of the total stormwater accounts and less than 50 percent of the total billings. Therefore, the City's low forecast of future growth in user fee revenue in the absence of an unexpected population and economic development spurt is conservative, but reasonable for the baseline forecast. Annual population growth averaged 0.6 percent from 2015-2019.

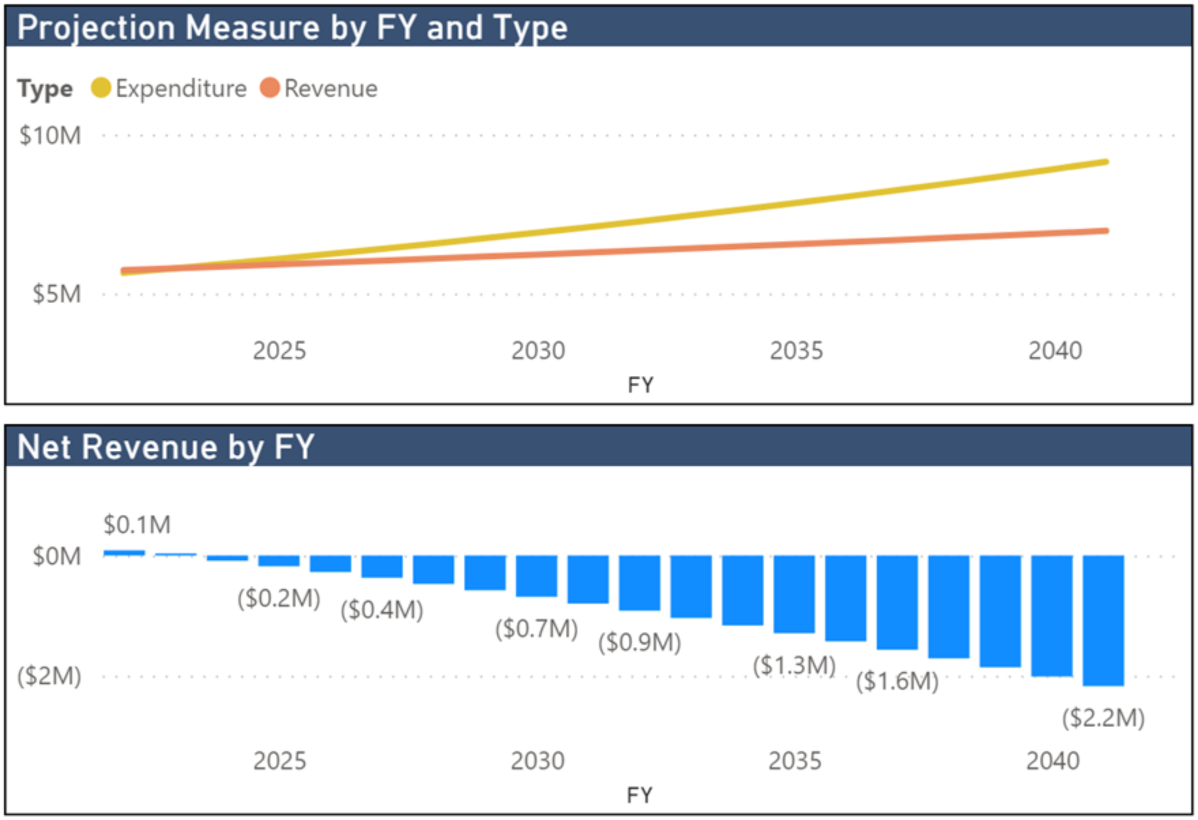


Figure 5-1: Projected Baseline SUD Net Income Deficit

The baseline forecast commences in FY2022 to avoid the anomalous and peak impacts that the COVID-19 pandemic had on user fee generated revenue. For example, in compliance with the Governor's Executive Order, the City of Stockton implemented a water shut off moratorium, which resulted in a substantial increase in payment delinquency or outright defaults. Because the stormwater fee is included in the water bill, that fee was also not paid when the water bill was delayed or defaulted. Accordingly, the City of Stockton anticipated a decrease in user fee revenue from $6,068,832 in FY 2019-20 to $5,262,888 in FY2020-21. Full revenue recovery from user fees is not anticipated until FY2023. Starting in FY2024, the projected operations budget deficit grows from a modest to $67,000 to more than $2.3 million in FY2041, with the latter deficit representing a short fall greater than 23% of total revenue requirements. If capital expenditures were included the projected deficit would be significantly larger.

5.5 Financial Evaluation of the Proposed Stormwater CIP (Capital Improvement Plans)

5.5.1 Project Cost of Master Plan CIP

The Master Plan identifies an array of capital investments needed to achieve the desired level of service objective and accommodate future growth. The Master Plan includes a total of 12 major capital projects with individual project costs ranging from $4.5 million to $75.1 million. As shown in Table 5-9, the Master Plan includes alternatives for one of the 12 projects and ranks the CIP projects into high, medium, and low priority project categories. If all the capital projects were to be implemented, the estimated cost of the Master Plan CIP would range from approximately $256 million to $285 million. However, given the magnitude of these project costs, it is anticipated that the City will focus in the near and intermediate term (e, g., the first 10 years years) on high and medium priority projects. Hence, for the purpose of the financial plan, the Master Plan CIP is projected to cost between $193 million and $223 million. This does not mean that the low priority projects are not needed and will not be implemented eventually, however, the reality of the City's budget constraints and issues of affordability will compel the SUD to focus on those projects that will address the most pressing stormwater issues first. The prioritization method is described in Chapter 2 of the Master Plan.

Table 5-9: Projected Costs of Master Plan CIP Projects

Watershed	Total Cost	Priority
Boggs Tract	$17,144,585	High
Bonnie Brook	$11,547,232	High
HWY 4 and San Joaquin	$24,902,729	High
Walker Turnpike Alt 1 *	$46,204,468	High
Walker Turnpike Alt 2 + Eighth St and San Joaquin *	$75,142,267	High
Bianchi and Calaveras	$30,682,180	Medium
Duck Creek	$12,061,203	Medium
Legion Park and Smith Canal	$50,864,178	Medium
Deep Water	$10,229,853	Low
Little Johns	$4,552,126	Low
Mormon Slough	$27,524,026	Low
Sutter and Calaveras River	$13,710,877	Low
West Lane and Calaveras River	$6,517,147	Low

** Denoted projects are alternatives and would not both be implemented*

5.5.2 Project Phasing

The Master Plan CIP annual cost impacts will depend on how quickly the projects are implemented and how they are funded. The high priority projects alone total between $99.8 million and $128.7 million. The medium priority projects add another $62 million. The Master Plan recommends a phasing in of the high and medium property projects such that they are implemented over a period of approximately 12 years. The phasing in of the projects will allow for the capital costs to be allocated over a longer period, thus mitigating the financial impacts of the CIP, but still meeting priority needs in a reasonable period.

This phased approach is not without risks. Delaying needed projects for up to 12 years could result in unexpected flood damage from inadequate or failing infrastructure that deteriorates more rapidly than projected. In addition, if construction costs escalate more rapidly than anticipated, the monetary benefits from deferring expenditures would diminish. To mitigate these risks, both the Master Plan and the financial plan should be periodically updated, and sequencing of projects reevaluated to reflect changing conditions

The proposed phasing of the high priority and medium priority CIP projects and associated annual construction expenditures is shown in Table 5-10. As seen in Table 5-10, the construction duration phase for CIP projects ranges from 2 to 5 years with most of the projects requiring about 4 years to implement. If the expenditures were equally allocated over the course of each project's construction phase and the CIP projects were phased in on a schedule as shown in Table 5-10, annual capital expenditures would be highly variable ranging from a low of $6.25 million in Year 1 to $26.4 million in Year 11. As noted earlier, implementation of the proposed CIP expenditures represents a very substantial increase in stormwater capital spending. In the previous 5 years, annual spending on capital projects has not exceeded $895,000. Also noteworthy, the capital spending would in most years outstrip the total budget for all other stormwater expenditures.

The annual impact on MUD finances will largely depend on how the City of Stockton and MUD decide to finance these capital expenditures. Using the pay as go method or "PAYGO" results in the large annual variations in revenue requirements presented in Table 5-10. Issuing debt, in contrast, would result in a gradual increase in annual revenue requirements for the CIP, but those costs would be incurred over a longer period. Of course, these considerations do not account for the source of revenues, which could range from the transferring City's general revenues to SUD's capital reserve to increasing stormwater fees, to a blend of multiple funding sources. These funding alternatives will be addressed in the next section.

Table 5-10: Annual Capital Expenditure for High and Medium Priority CIP Projects

Watershed	HWY 4 and San Joaquin	Bonnie Brook	Boggs Tract	Walker Turnpike Alt 1	Legion Park and Smith Canal	Bianchi and Calaveras	Duck Creek	Annual Cost
Total Project Cost	$24,902,729	$11,547,232	$17,144,585	$46,204,468	$50,864,178	$30,682,180	$12,061,203	
Years Construction	4	3	4	5	4	4	2	
Priority	High	High	High	High	Medium	Medium	Medium	
Year 1	$6,225,682							$6,225,682
Year 2	$6,225,682							$6,225,682
Year 3	$6,225,682	$3,849,077						$10,074,760
Year 4	$6,225,682	$3,849,077	$4,286,146	$9,240,894				$23,601,800
Year 5		$3,849,077	$4,286,146	$9,240,894				$17,376,117
Year 6			$4,286,146	$9,240,894				$13,527,040
Year 7			$4,286,146	$9,240,894				$13,527,040
Year 8				$9,240,894	$12,716,045			$21,956,938
Year 9					$12,716,045	$7,670,545		$20,386,590
Year 10					$12,716,045	$7,670,545		$20,386,590
Year 11					$12,716,045	$7,670,545	$6,030,602	$26,417,191
Year 12						$7,670,545	$6,030,602	$13,701,147
Year 10					$12,716,045	$7,670,545		$20,386,590
Year 11					$12,716,045	$7,670,545	$6,030,602	$26,417,191
* Assumes the lower cost alternative or Walker Turnpike project								

Issuing debt to fund the CIP would substantially smooth the cost curve and reduce the financial impact on any single year of the Master Plan, although the CIP costs would be extended over a much longer period. Table 5-10 presents a hypothetical cost curve for the CIP projects if they were each financed as they were implemented. As shown in the Figure 5-2, assuming a 3 percent interest rate and 20-year loans, the annual debt service cost would rise from approximately $1.6 million in 2022 to $12.4 million in 2031 and then decrease to $10.8 million in 2042. This hypothetical trajectory assumes that the project implementation follows the order shown in Table 5-10 and the first year of implementation is 2022. Consistent with Table 5-10, the projected debt service cost assumes the lower cost estimate for the Walker Turnpike Project. If the higher cost alternative were implemented instead, the debt service cost would increase to $14.3 million in 2031 and decrease to $12.7 million in 2041.

These annual outlays for the capital program during the same period would be considerably lower than would be incurred under the Paygo method where annual expenditures would range from $6.2 million to $26.4 million.

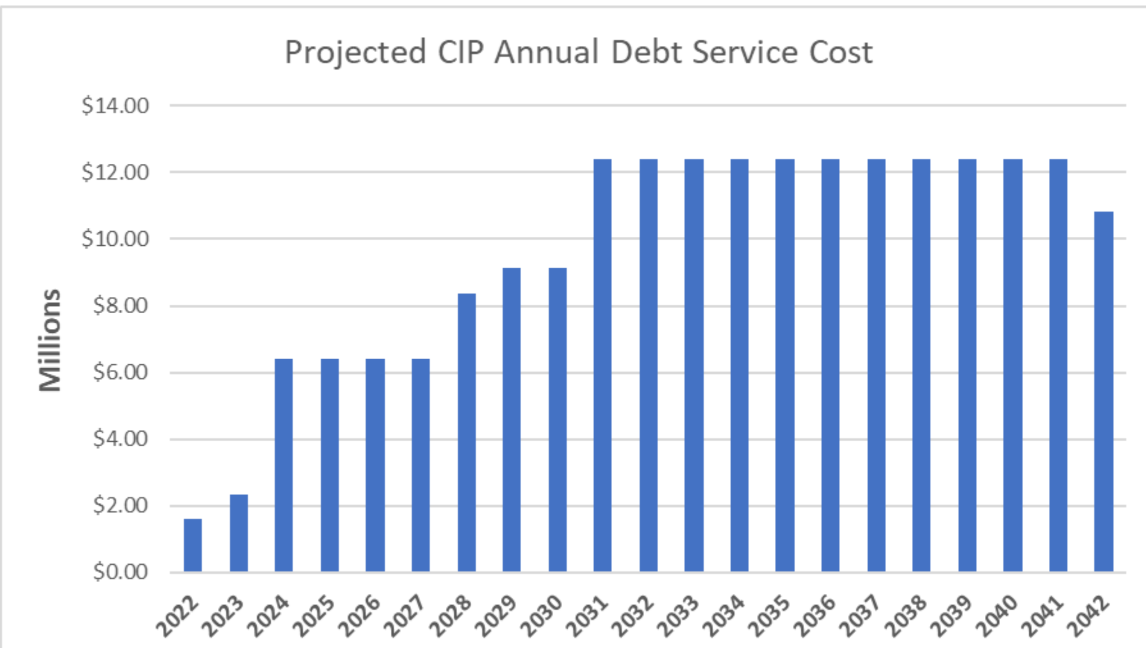


Figure 5-2: Annual CIP Dept Service Cost

5.5.3 Projected Financial Impact of CIP on SUD Net Revenues

Implementation of the CIP High and Medium priority projects, even if phased in over an extended period would have a profound impact on the budget of the SUD. Even assuming all projects are financed at 3 percent, by 2041, the annual debt service would by 2028 exceed the SUD's expenditures for all other budgetary categories. Under a PayGo scenario, in some years, the capital expenditures would be more than double all other expenses incurred by SUD and reach more than $26 million in the peak year. Figure 5-3 shows the projected SUD budget deficit through 2042 under the debt financing scenario. The scenario assumes revenue growth using the current stormwater fee rate and no supplemental funding. By 2041, the annual deficit would reach $14.5 million, but then decrease as the initial issued debt is retired. However, if the low priority projects were then initiated, the high budget deficit would persist rather than diminish. There is also potential for the need for other capital projects not envisioned in the current Master Plan that could further exacerbate the capital deficit if no additional sources of revenue are obtained.

The projected budget deficits pose a major challenge for SUD and the City of Stockton. The Master Plan has identified high and medium priority capital projects that will need to be implemented to prevent severe flooding events and their attendant damage. These projects are considered necessary to provide a high level of service. Although the cost estimates are planning-level estimates, they provide a solid basis for developing a viable financial strategy for covering these needed expenditures. Potentially exacerbating budget challenges could be a need or desire to implement smaller capital projects to address localized flooding in addition to the major capital projects outlined in the Master Plan. The following sections describe alternative funding mechanisms for meeting the revenue requirements of the Master Plan CIP.

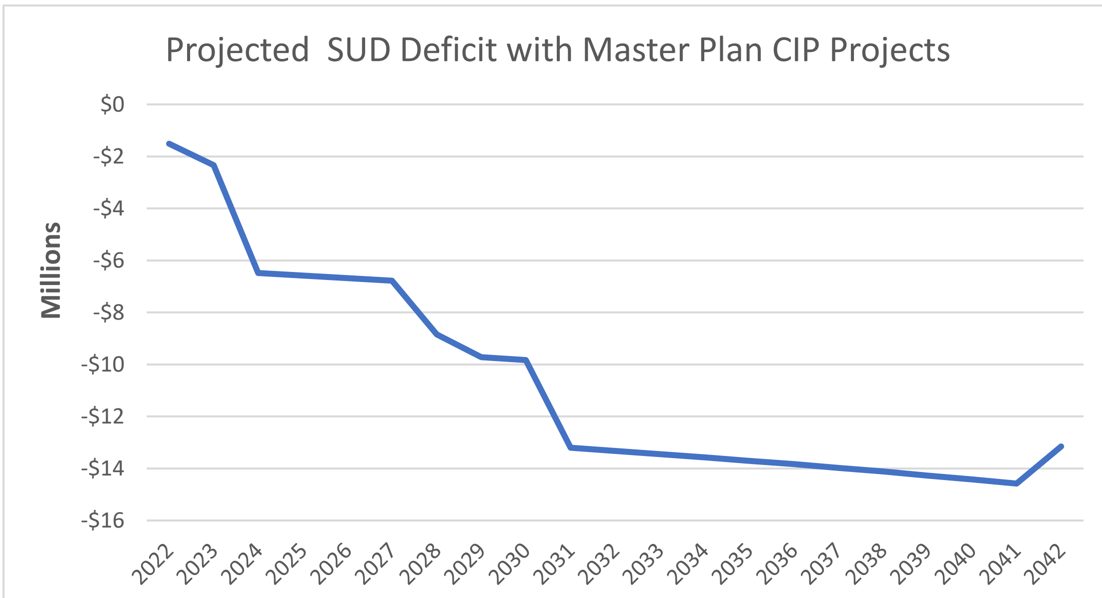


Figure 5-3: Projected Annual Deficit

5.6 Evaluation of Alternative Funding Mechanisms

The net income forecast for SUD under conservative scenarios indicates a growing and significant annual budget deficit reaching $14.5 million by 2041 under a debt financed scenario[3]. Under the current fee structure, the generated revenue will be insufficient to fund any new capital improvement projects and would fall short of covering the operation and maintenance costs of the existing stormwater infrastructure. Accordingly, the SUD will need to find alternative funding sources or increase its stormwater fees. The

[3] This scenario also assumes the SUD implements the lower cost alternative for the Walker Turnpike Project. If the higher cost alternative were selected and debt financed, the annual deficit would reach $16.4 million in 2041.

following describes the advantages and disadvantages of funding alternatives and their financial ramifications for SUD.

5.6.1 Implementing a Stormwater Fee Increase

As noted in Section 5.1.2, SUD has not raised the Stormwater Fee since it was first established almost 30 years ago. Inflation alone renders the monthly fee of $2.10 per ERU, to less than half the value it represented in 1992. Because of Proposition 218, the City has not been able to raise or supplement the fee without a voter referendum; it's one attempt to do so in 2010 failed. Meanwhile the passage of Senate Bill 231 has opened the possibility of the City raising the fee without seeking voter approval, although the constitutionality of the law has yet to be tested. To date, however, no Californian municipality has been willing to risk the likelihood of protracted litigation and for many California localities, stormwater fees remain frozen, with supplemental funds used to meet budget shortfalls.

Raising the stormwater fee, if successful, would be the most efficient and equitable approach for meeting SUD's current and future revenue requirements. An important reason for creating a stormwater utility is that it can be funded through a separate enterprise fund that generates revenues from user fees and those user fees correspond to stormwater impacts and associate costs through the ERU structure.

Stormwater Fees assessed on individual parcels are based on their contribution to stormwater management costs as determined by impervious area. Besides being equitable, stormwater fees generate a reliable and predictable stream of revenues that are not tied to the vagaries of economic conditions and the SUD does not have to compete against other City agencies to use those revenues. Furthermore, because the stormwater fee has not been increased in the past 30 years, the revenue from future development is unlikely to be sufficient to cover the costs that those developments impose on the stormwater system. Accordingly, unless the stormwater fee is increased so that a parcel's cost burden is fully covered, future development will add to the program's deficit and further reduce its financial sustainability.

Using the forecast described in detail in the above sections, the hypothetical ERU fee can be estimated for the planning period, for a scenario under which user fees generate sufficient revenue to recover both O&M and the annual debt service costs for the financed capital projects. As shown in Figure 5-4, the Stormwater Fee would need to more than triple to $6.42 by 2031 to meet SUD's projected revenue requirements, assuming that SUD fees would be used to pay the debt service cost incurred for the CIP projects. The fee would need to rise to $7.03 if the higher cost Walker Turnpike Project was implemented. It is noteworthy that if the stormwater fee had been increased simply at the rate of inflation, it would have reached $4.23 by this year (2022) and would rise to about $5.35 in 2031 assuming an average annual inflation rate of 3 percent. Hence, in real terms, the required fee increase from the 1992 levels would be rather more modest than the three-fold increase described above.

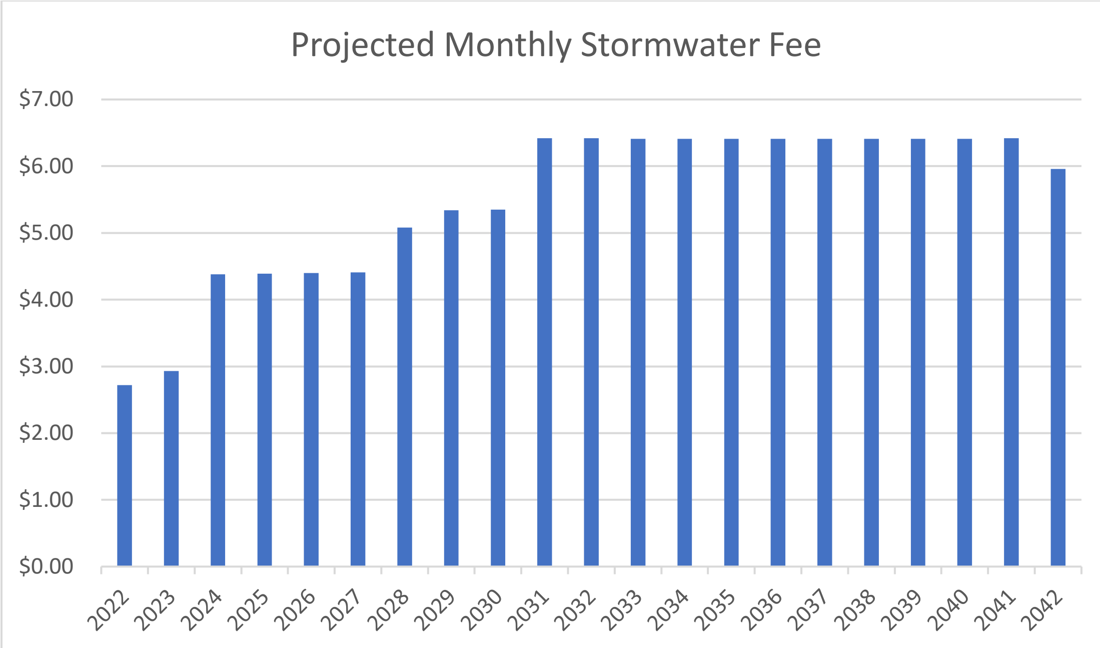


Figure 5-4: Monthly Fee Needed to Meet Projected SUD Revenue Requirements

It must be emphasized that the Stormwater Fee projections presented above are not generated by a formal stormwater rate model but are derived based on projected growth in expenditures and revenues and preliminary estimates of CIP project costs and debt service interest rates. However, the SW Fee projections provide a Stockton would a solid basis for planning the magnitude of future rate increases that would be required to meet revenue requirements for the Master Plan's Capital Program.

We note that a successful voter referendum to raise SW fees would put the SUD on solid and sustainable financial footing. Given the failure of the previous attempt to achieve voter approval, it would be advisable that the City embark on a robust voter education program well ahead of any planned vote. If pursued, key messaging should include that the citizenry will be funding the program regardless of mechanism used, but the stormwater fee is the most equitable with the largest burden falling on properties with large impervious areas and which contribute most of the stormwater runoff flowing into the system. Affordability issues could also be addressed in conjunction with the overall cost of water, sewer, and stormwater services.

5.6.2 Supplemental Financing through the City's General Fund Revenue

The constraints of Proposition 218 have compelled many California Cities to supplement their stormwater enterprise fund with revenues generated through a host of taxes and fees that go into the general fund and which are allocated through an annual budget process. General funds are typically used to cover the operational costs of running a city's government and are allocated based on the identified needs of each municipal department. Specialized enterprise funds that are self-financed are typically limited to water, sewer, stormwater services, although recreational and parking enterprise funds have been used for similar purposes.

There are substantial disadvantages to overreliance on a city's general revenue as a source of funding for a specialized enterprise such as stormwater. Most prominently, a city's general fund is subject to prevailing economic conditions and the revenues available for use by the stormwater utility could vary significantly from year to year. In periods of economic downturns, the SUD would be a candidate for budget cuts because it has an enterprise fund that could be used to finance its most critical functions. Hence, this potential revenue source is less reliable and predictable than a stormwater fee. These issues render long-term planning more difficult and pose risks to large capital projects. Finally, it should also be noted that if the MUD were use general revenues to fund the budget deficit, by 2040 about two-thirds of the Divisions budget would be derived from general revenue funds and only about one-third from user fees

5.6.3 Other Taxes and Fees

Some utilities have allocated revenues generated from other fees, assessments, and or taxes to partially fund stormwater management programs. Gas and property taxes are examples of non-stormwater fees that could potentially be used to fund SUD operations. Like general fund revenues, these revenues can vary year to year depending on prevailing economic conditions. Their allocation for stormwater management also diverts their use for other City needs. Furthermore, revenues from gas taxes are typically dedicated to maintenance of transportation infrastructure and property taxes often fund local school districts and other public services. Diversion of these funds to stormwater would reduce their available for those intended uses or would require an increase in the rates.

5.6.4 Impact Fees, Special Assessments, Bonds, Connection Fees Federal and State Grants and Loans

These potential sources of Stormwater Funding are common throughout the Uniteds State but are almost exclusively used for funding capital projects. Issuance of bonds is an effective means for amortizing capital costs over a long period; however, they must be repaid with the stormwater fee generated revenue. None of these funding methods would address operational deficits. Nonetheless, it would be prudent of SUD and the City to explore all the major public funding programs to finance the Master Plan capital program. The following sections briefly summarize the main programs available for Stormwater Capital Programs.

5.6.5 American Rescue Plan Act (ARPA) Funds

The ARPA was enacted in March 2021 and provided State, County, and local governments with more than $360 billion in grants. The ARPA allowed for grant monies to be used for water, sanitation, and broadband infrastructure projects. The final rule issued in January 2022 explicitly allows for ARPA grant monies to be used for stormwater projects. Although many jurisdictions allocated the first of the two tranches during 2021, it might be possible for SUD to obtain some ARPA funds to be dispersed by the Treasury in May 2022. The original legislation allocated a total of $27 billion to the California State government and $78.1million directly to the City of Stockton. Any project receiving ARPA funds would need to be completed by the end of 2026 and all monies allocated by the end of 2024.

5.6.6 State Revolving Fund (SRF)

Stormwater Capital projects are eligible for low interest loans through EPA's SRF program. The program is expected to grow substantially with the implementation of the Bipartisan Infrastructure Legislation (BIL). For FY2022, California alone will be allocated $600 million, the largest state recipient of the funds. Stormwater green and gray infrastructure projects are eligible for SRF loans including projects in the following categories:

Gray Infrastructure

- Traditional pipe, storage, and treatment systems;
- Real-time control systems for CSO (Combined Sewer Overflow) management; and
- Sediment controls including (e.g., filter fences, storm drain inlet protection, street sweepers, and vacuum trucks).

Green Infrastructure

- Green roofs, green streets, and green walls;
- Rainwater harvesting collection, storage, management, and distribution systems;
- Real-time control systems for harvested rainwater;
- Infiltration basins;
- Constructed wetlands, including surface flow and subsurface flow (e.g., gravel) wetlands; Bioretention/bioswales (e.g., rain gardens, tree boxes);
- Permeable pavement;
- Wetland/riparian/shoreline creation, protection, and restoration;
- Establishment/restoration of urban tree canopy; and
- Replacement of gray infrastructure with green infrastructure including purchase and demolition cost

In terms of interest rates, as required by law (California Water Code, Section 13480), the CWSRF (Clean Water State Revolving Fund) combined funding interest and loan service rate is set at a rate that does not exceed 50 percent of the interest rate paid by the State on the most recent sale of State General Obligation bonds. These low rates can provide significant savings for communities that use these funds to construct eligible projects. The SRF rate for FY2021 was 1.2 percent.

5.6.7 Water Infrastructure Innovation Act (WIFIA) State Revolving Fund (SRF)

WIFIA is a federal credit program administered by USEPA (US Environmental Protection Agency) for eligible water and wastewater infrastructure projects. WIFIA and the WIFIA implementation rule outline the eligibility and other requirements for prospective borrower. = Unlike the SRF Program, which is administered by State Governments, WIFIA is directly administered by the USEPA.

Stormwater projects that are eligible for financing under the SRF program are eligible for financing under WIFIA. Some of the key provisions under WIFIA are:

- $20 million: Minimum WIFIA project size.
- 49 percent: Maximum portion of eligible WIFIA project costs that EPA can finance.

- 35 years: Maximum final maturity date from the date of first disbursement.
- 5 years: Maximum time that repayment may be deferred after the date of first disbursement.
- Interest rate will be equal to or greater than the U.S. Treasury rate of a similar maturity at the date of closing.
- Projects must be creditworthy and have a dedicated source of revenue.
- Closed WIFIA loans during 2021 were set at interest rates as low as 1.1 percent.

Although the minimum project size is $20 million, multiple projects can be bundled such that all or some of the Master Plan CIP projects could be included in a single application. One potential obstacle for Stockton under the current program is that it would likely have to increase the stormwater fee or arrange for another dedicated source of revenue to meet the program's credit worthiness requirement.

5.6.8 California Stormwater Grant Program (SWGP)

The purpose of the SWGP is to fund stormwater and dry weather runoff projects that best advance the Water Board's policy goals of improving water quality and realizing multiple benefits from the use of storm water and dry weather runoff as a resource. Eligible stormwater infrastructure projects include 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. To date two rounds of grants have been awarded totaling $180 million. The California Water Board has not indicated when Round 3 will be announced.

5.6.9 Integrated Regional Water Management Program (IRWM) - Disadvantage Urban Communities Grants

The State of California's Integrated Regional Water Management (IRWRM) Program provides grants for projects and programs throughout the state including climate change adaptation, incentives for collaboration and setting priorities in water resource and infrastructure management, and for improving regional water self-reliance while reducing reliance on Sacramento-San Joaquin Delta. The IRWM grants are available to broad array of projects including stormwater resource and flood management projects.

The IRWM Grants program requires a 50% matching fund for awardees except for Disadvantaged Urban Communities (DUC) with an estimated Median Household Income less than 80 percent of the statewide MHI. Stockton City qualifies as a DUC with a MHI that is just 67% of the statewide MHI based on the 2019 American Community Survey 5-year data ($54,164 versus $80,440). For the upcoming round, at least 10% of the anticipated funds of $192 million (i.e., $19 million) will be reserved for projects that directly benefit Disadvantaged Urban Communities. According to the California's Grants Portal, the application period for this program is slated to commence in the Spring of 2022.

5.6.10 Community Development Block Grants (CDBG)

Although not typically perceived as a potential source of stormwater project grant money, CDBG grants can be used for projects in economically eligible areas. Stormwater project could be eligible if they potentially create jobs, increase economic activity, and increase property values. Additionally, green infrastructure can increase property values by mitigating flooding, improving neighborhood aesthetics, and providing other co-benefits.

5.7 Recommended Financial Plan

It is recommended that the City of Stockton, concurrent with the adoption of the Stormwater Master Plan, implement a strategy to generate a reliable and predictable stream of revenues sufficient to cover SUD's long-term operation expenditures and the capital costs of the Master Plan's high and medium priority projects.

The optimal financial solution to long-term funding of SUD would be to increase the stormwater fees to cover all future operational and capital costs. Increasing the fee, however, would require voter approval and that outcome is far from certain. However, because it is the most equitable and sustainable solution, this is the solution that should be aggressively pursued despite the political obstacles it would face. A voter referendum could be made successful if the City conducted a well-designed educational and outreach program.

In the absence of increased stormwater fees, SUD would need to negotiate a multiple year capital budget plan with the City to ensure that the highest priority projects are fully funded and can be completed in a reasonable timeframe. In the out years of the Master Plan, annual capital budgets can be adjusted to align with changing needs as well as unexpected changes in project costs that could require even greater future financial commitment if, for example, inflation exceeds the 3 percent rate used in the assumptions of the financial forecast. Conversely, because the City is contemplating establishing a new connection fee, it is possible that the required fee increases could be overstated when these revenues enter the enterprise fund. Similarly, if the City can successfully obtain lower cost loans and grants, the overall cost of the program will decrease.

Regardless, of how the City decides upon which source of revenues it will use to pay for the Master Plan CIP projects, it should leverage the increased availability of federal and state low-cost loans/grants. Interest rates are at historical lows both in nominal and real terms and the City would be remiss not to leverage these conditions while they persist. Most economists are forecasting increases in interest rates over the next two years and that will increase the cost of borrowing for the City and SUD. The recently enacted infrastructure bill will infuse much additional funds into the SRF programs, which will in turn increase the number of projects approved for loan interest loans.

The financial forecast including the development of alternate deficit scenarios was accomplished using the City's financial data entered into excel spreadsheets, which were then used to run the Power BI visualizations presented in the preceding sections, The Power BI Tool will be transferred to the City's Stormwater Master Plan Team and can be used by the City to continually update the information and run additional scenarios to capture the situational changes that will inevitably occur throughout the Master Plan's implementation. Finally, the financial plan provides a roadmap with alternative paths to financial sustainability and the underlying Power BI tool will assist the City in selecting the optimal path and addressing unexpected obstacles along the way.

Appendix A:
Questions from Online Stakeholder Input Survey

Stockton Stormwater Master Plan Goals, Strategies, and Priorities

Please provide input regarding your views on the goals and priorities of the Stockton Stormwater Master Plan.

6. Please enter your name / organization (Text Input)

7. How would you characterize stormwater challenges within the City? (Multiple Choice)

- Becoming more challenging
- Not generally changing
- Improving / becoming less challenging

8. How would you characterize the quality of existing information on the City's stormwater infrastructure? (Multiple Choice)

- Good Quality Data
- Satisfactory Data
- Poor Quality Data
- Don't Know / No Opinion

9. Please rank the following objectives in order of priority (Ranked List)

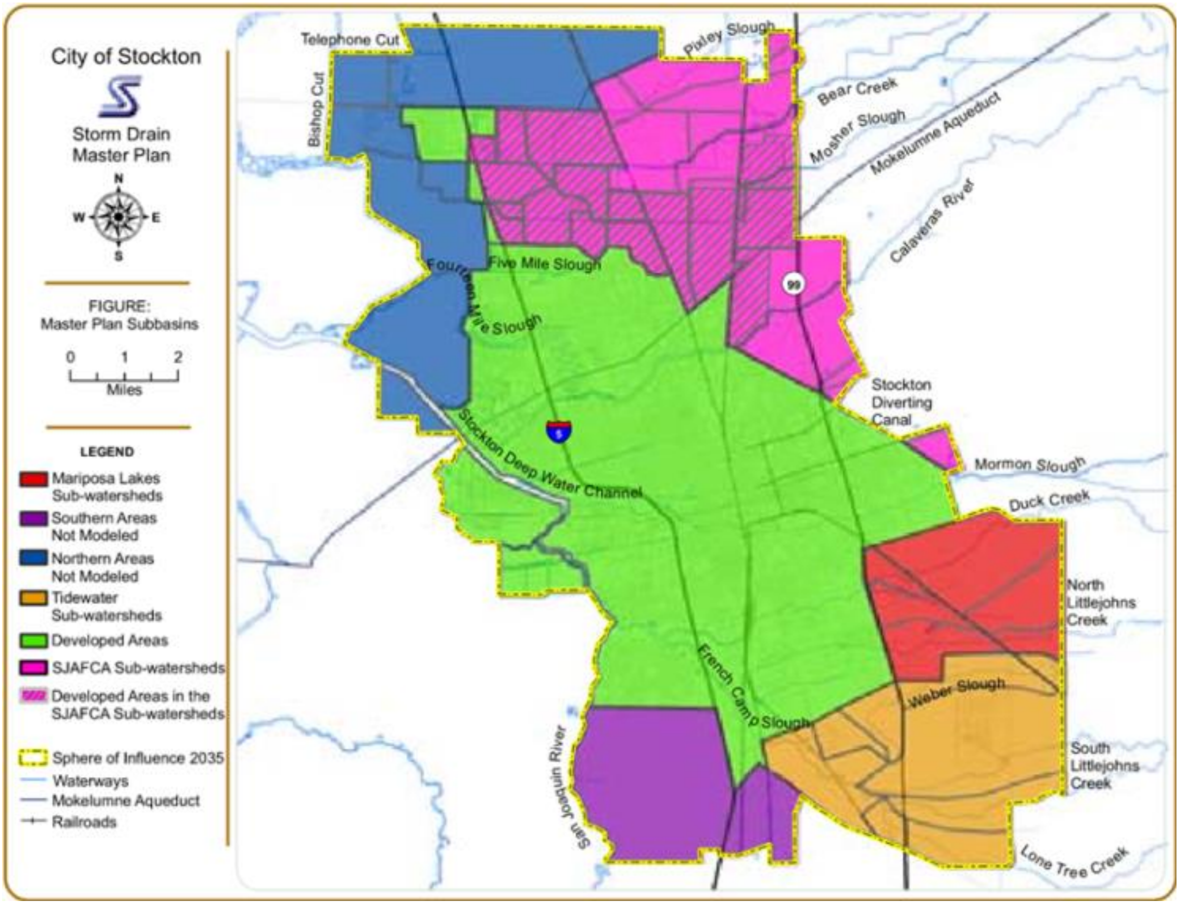
- Address localized flooding from frequent events (1-yr storm or less)
- Address riverine flooding from larger events (>10-yr event)
- Improve water quality
- Improve climate resiliency
- Restore / improve deteriorating infrastructure
- Develop planning and design criteria to guide existing system
- Provide robust financial basis for stormwater investments
- Improve understanding of existing conditions / problem area
- Reduce stormwater volumes / utilize low impacts development
- Address areas of deficiencies specifically in disadvantaged communities

10. Please add other objectives you think are important but are not listed above (Text Input)

11. Please list a minimum of three stakeholders (by name and/or entity) you think should be involved in master plan development. (Text Input)

12. What are some known problem locations you'd like the master plan to address? (Text Input)

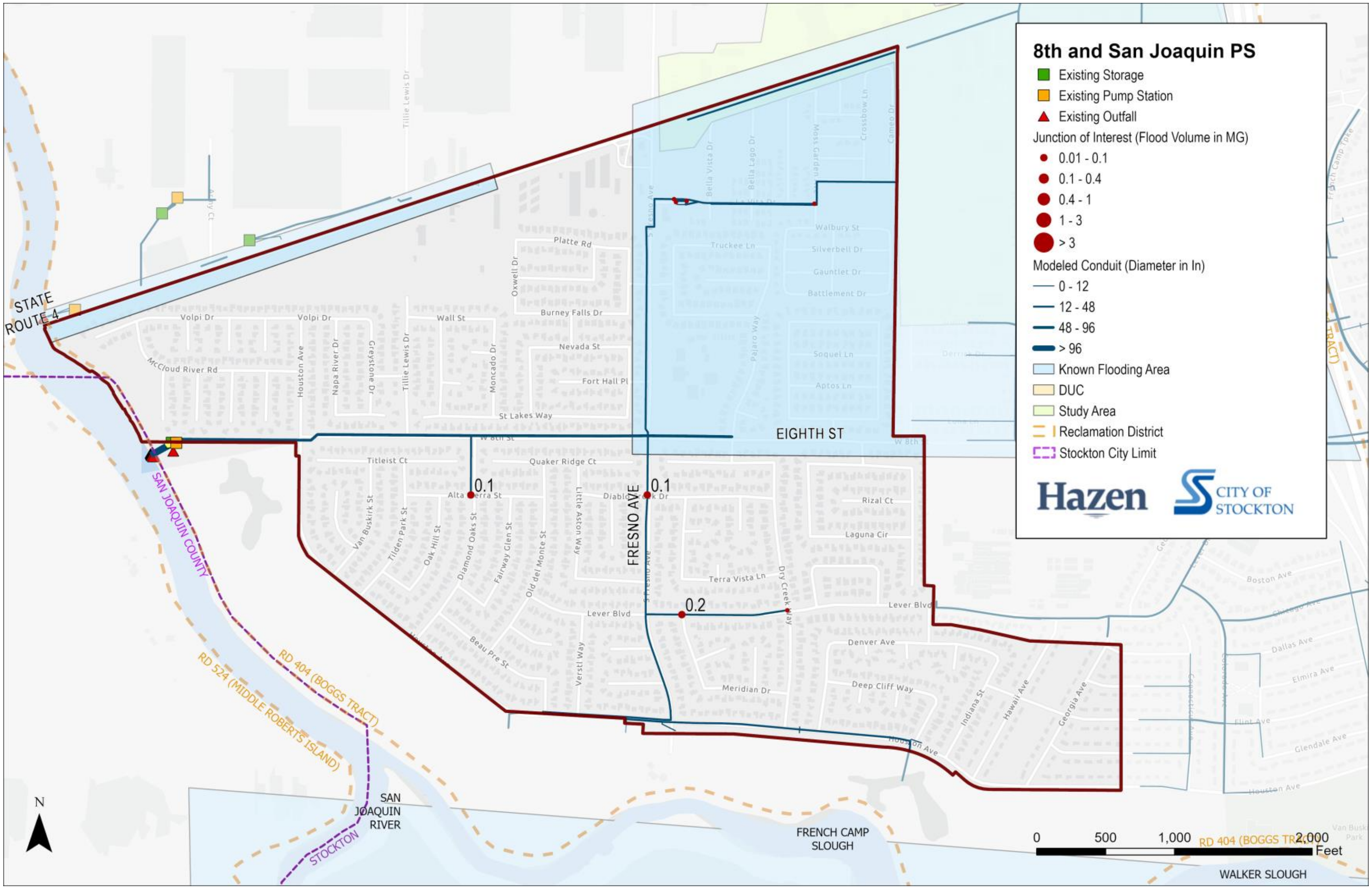
13. Please rank the 2008 sub-basins based on their priority as a focus of the current master plan effort. (Ranked List)

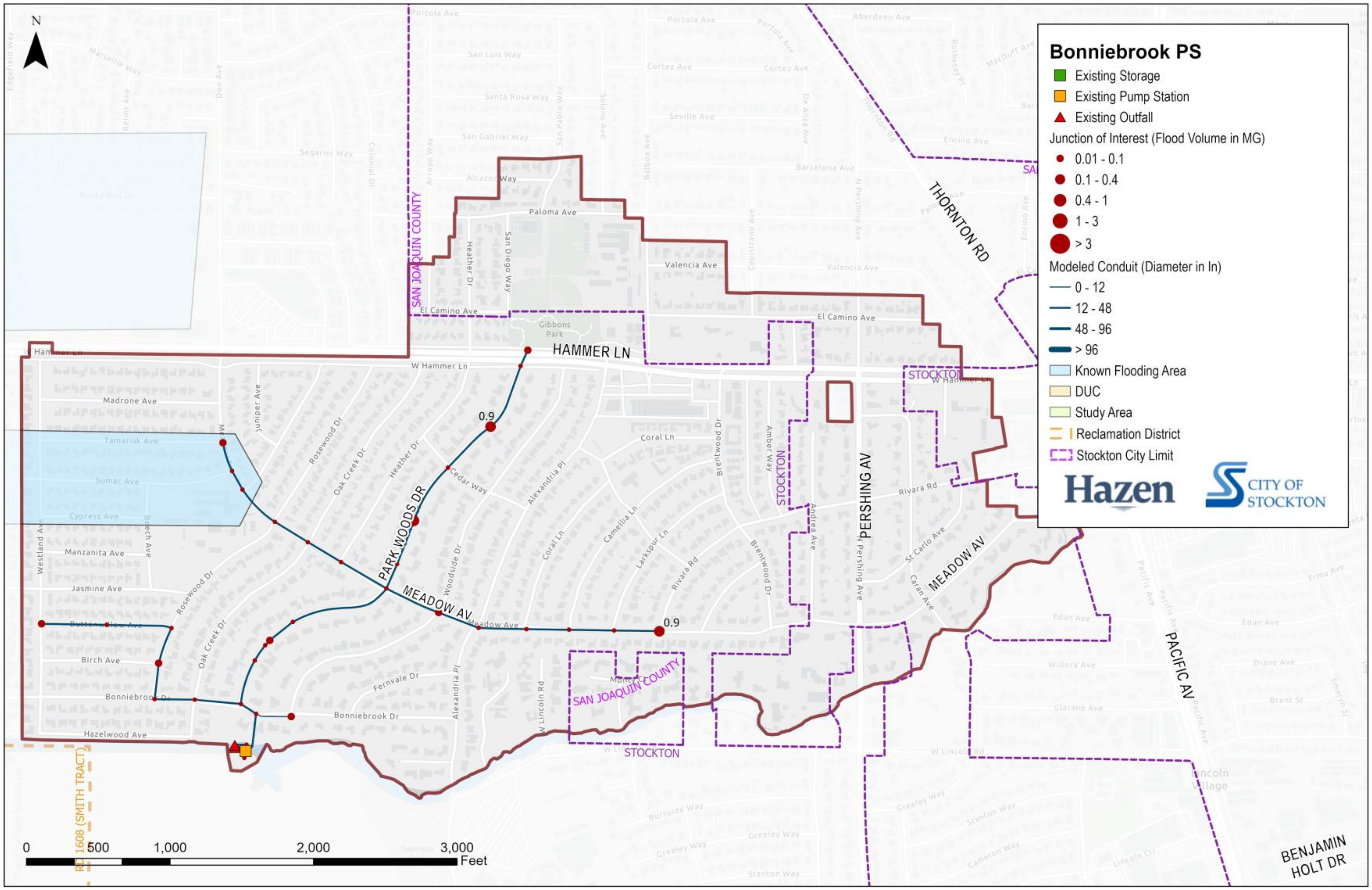


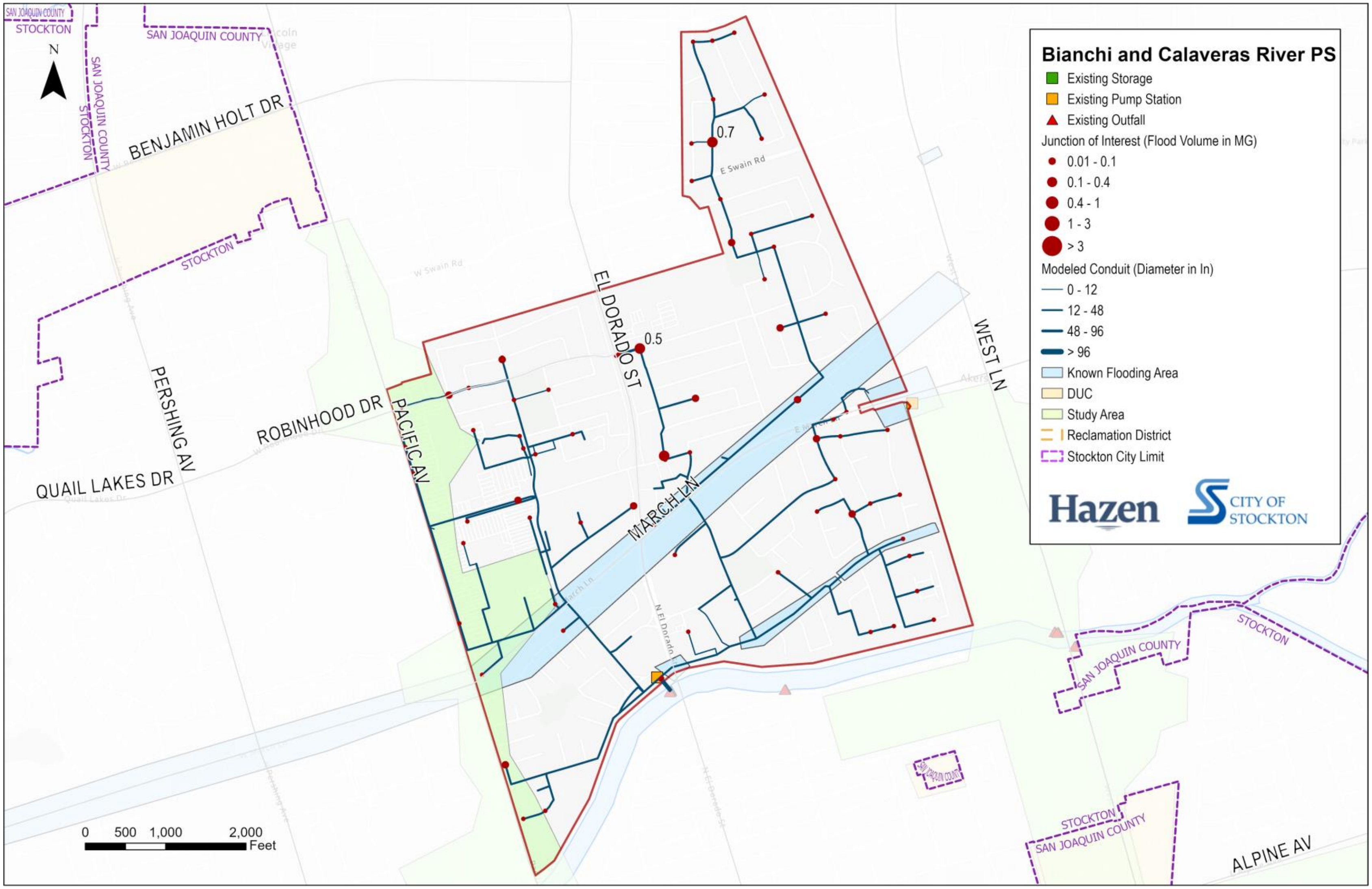
- Mariposa Lakes Sub-watersheds
- Southern Areas (Not Previously Modeled)
- Northern Areas (Not Previously Modeled)
- Tidewater Sub-watersheds
- Developed Areas
- SJAFCA Sub-watersheds
- Developed Areas in the SJAFCA Sub-Watersheds

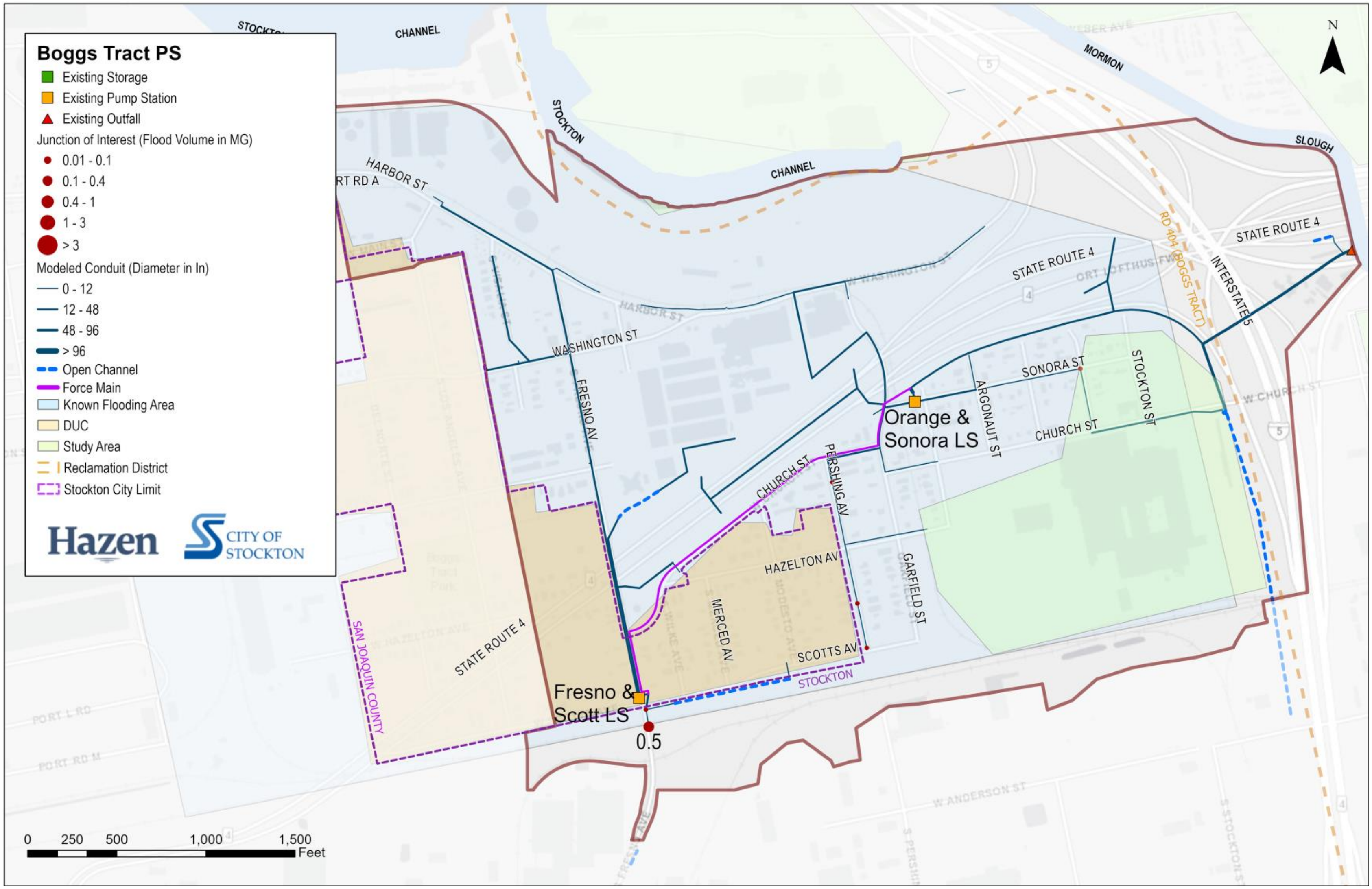
14. Please share any additional input you'd like to note as master plan efforts get underway (Text Input)

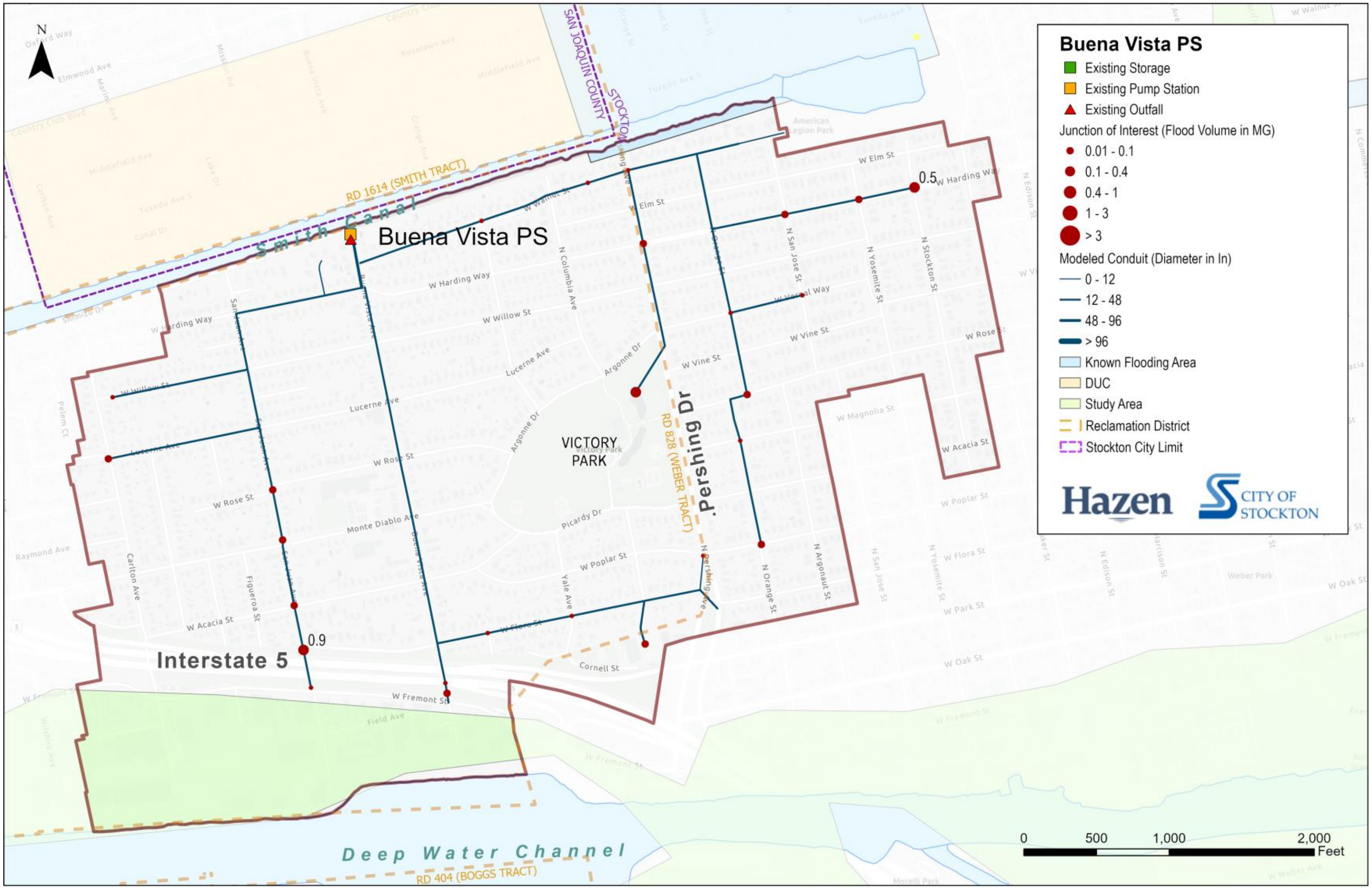
Appendix B: Existing Conditions

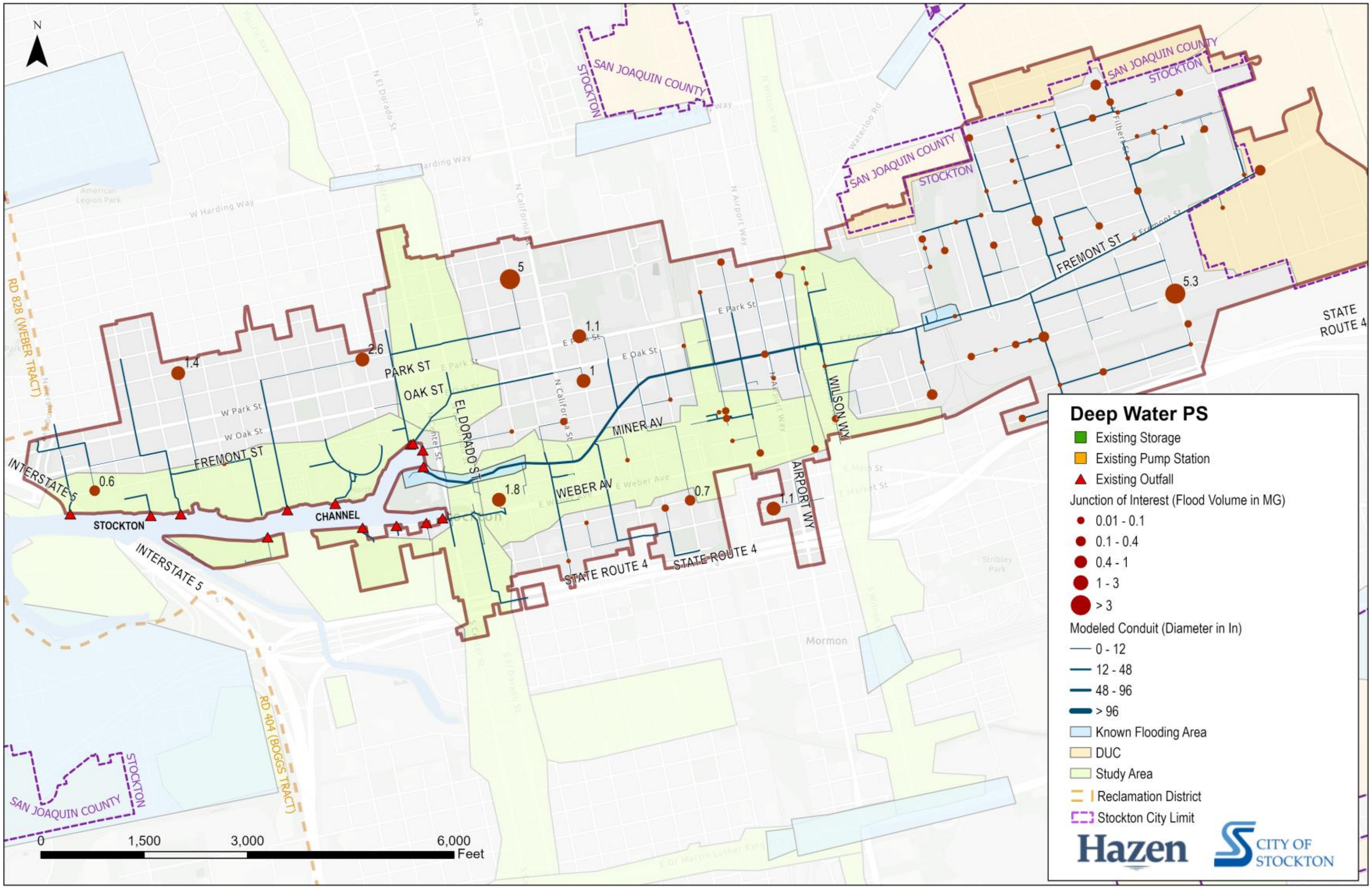

8th and San Joaquin PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
STATE ROUTE 4
EIGHTH ST
FRESNO AVE
0.1
0.1
0.1
0.2
SAN JOAQUIN COUNTY
RD 404 (BOGGS TRACT)
RD 524 (MIDDLE ROBERTS ISLAND)
SAN JOAQUIN RIVER
STOCKTON
FRENCH CAMP SLOUGH
WALKER SLOUGH
N
0
500
1,000
2,000
Feet

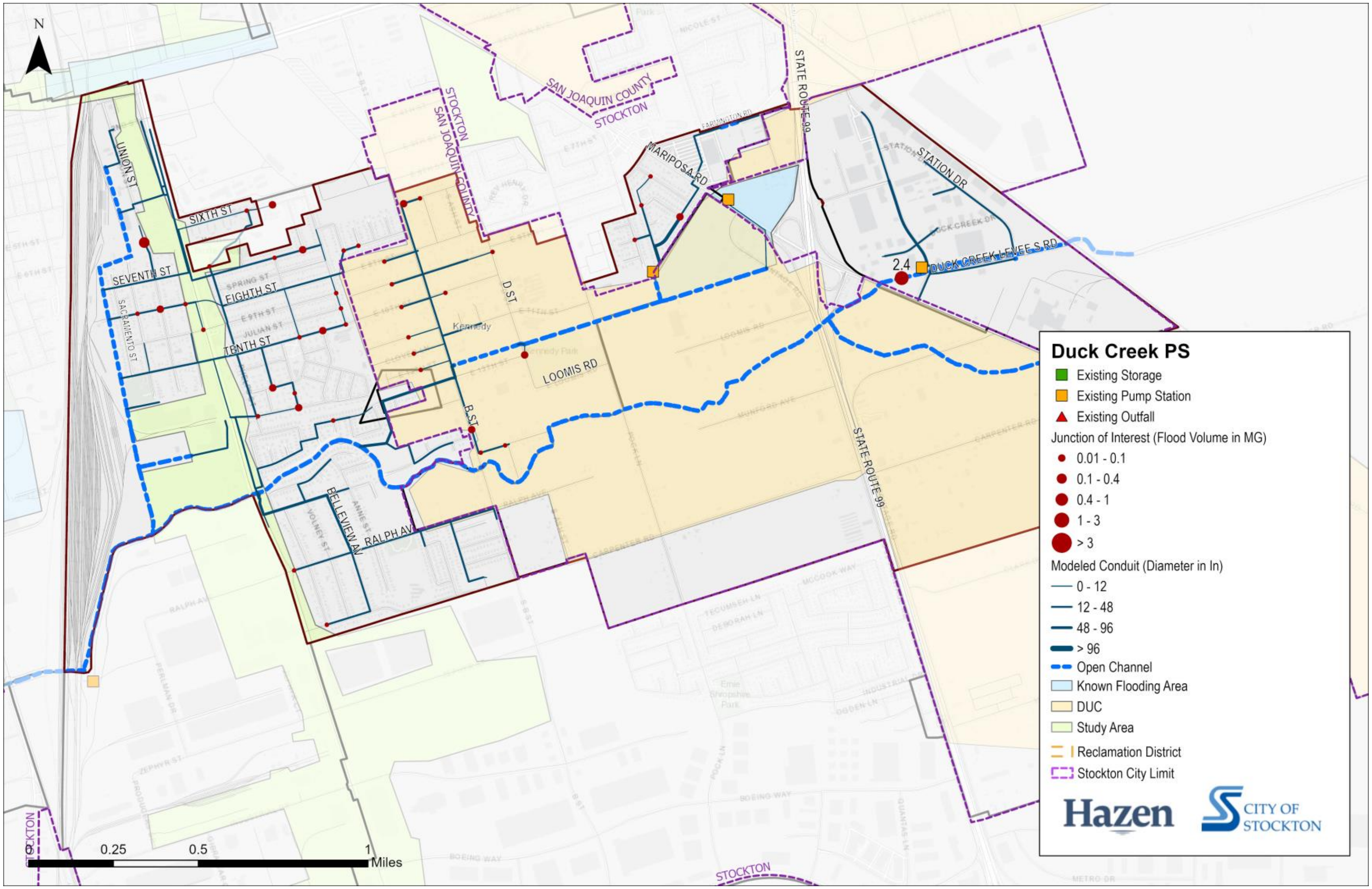

Bonniebrook PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
N
HAMMER LN
PARK WOODS DR
MEADOW AV
PERSHING AV
THORNTON RD
PACIFIC AV
BENJAMIN HOLT DR
SAN JOAQUIN COUNTY
STOCKTON
RD 1608 (SMITH TRACT)
0.9
0.9
0 500 1,000 2,000 3,000 Feet

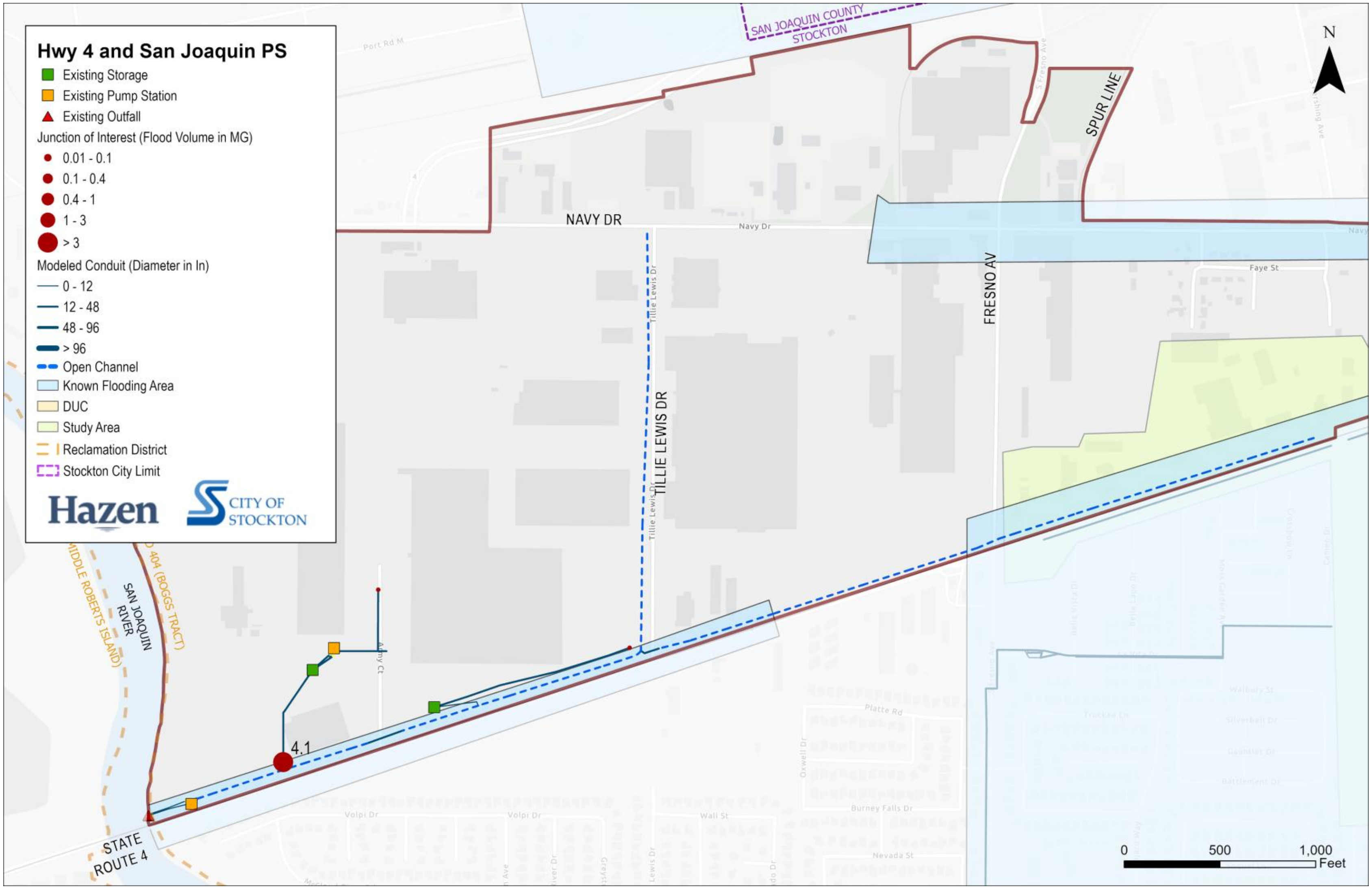

Bianchi and Calaveras River PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
N
0 500 1,000 2,000 Feet
BENJAMIN HOLT DR
ROBINHOOD DR
QUAIL LAKES DR
PERSHING AV
PACIFIC AV
EL DORADO ST
MARCH LN
WEST LN
ALPINE AV
SAN JOAQUIN COUNTY
STOCKTON
0.7
0.5

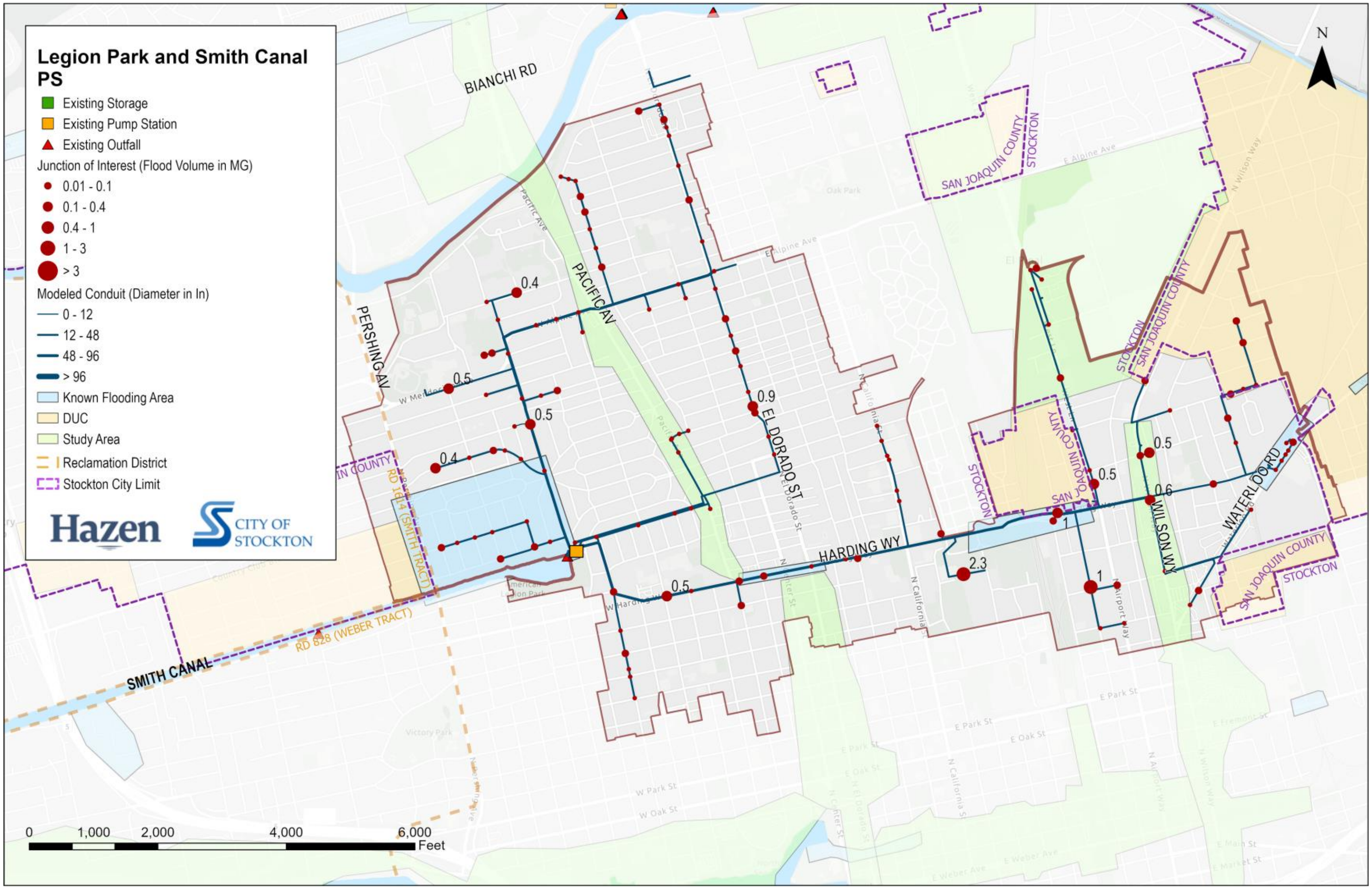

Boggs Tract PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Open Channel
Force Main
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
Orange & Sonora LS
Fresno & Scott LS
0.5
STOCKTON CHANNEL
HARBOR ST
WASHINGTON ST
FRESNO AV
CHURCH ST
PERSHING AV
ARGONAUT ST
SONORA ST
STOCKTON ST
STATE ROUTE 4
INTERSTATE 5
RD 404 (BOGGS TRACT)
HAZELTON AV
MERCED AV
GARFIELD ST
SCOTTS AV
SAN JOAQUIN COUNTY
SLOUGH
MORMON
N
0 250 500 1,000 1,500 Feet

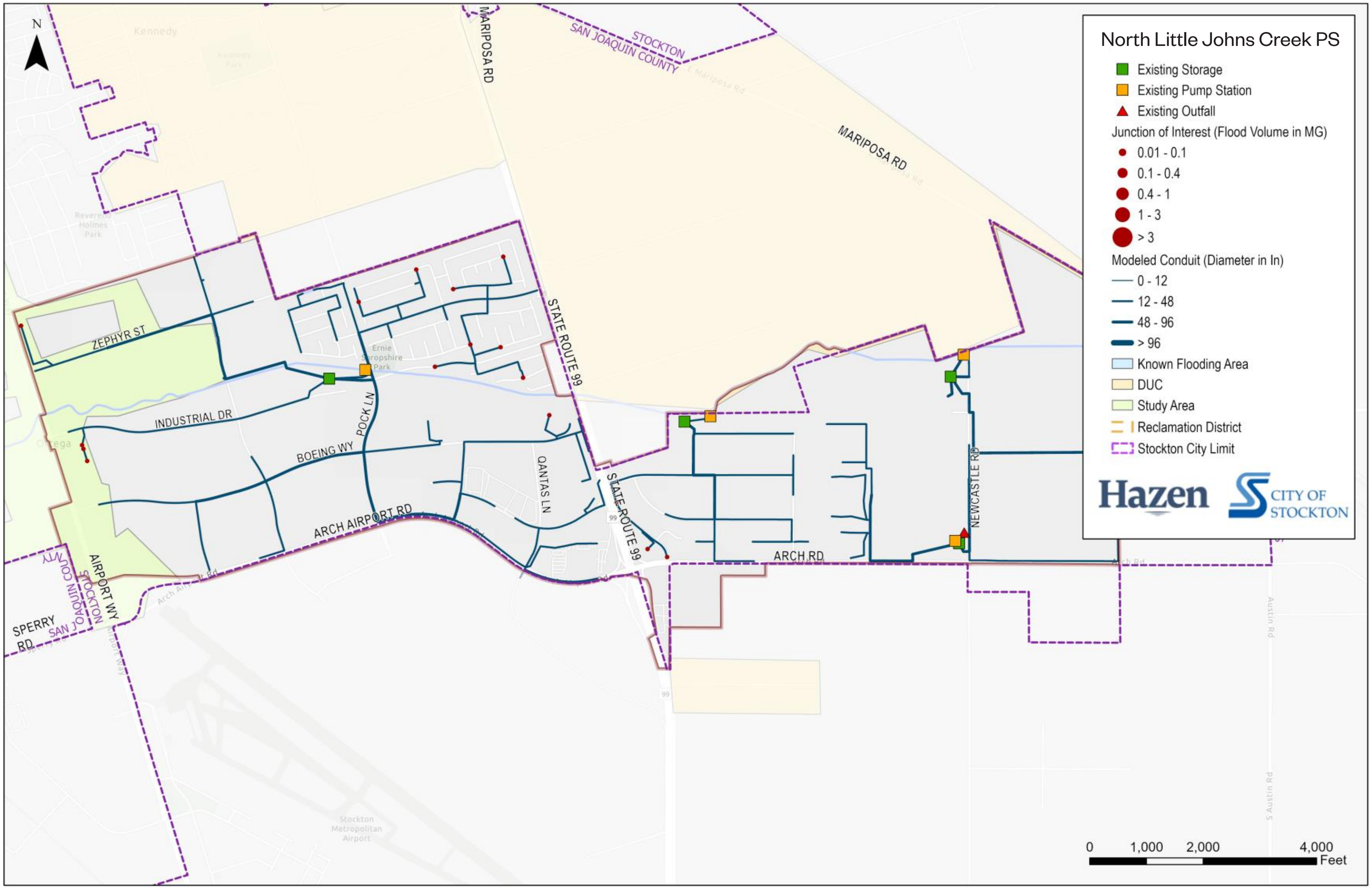

N
Buena Vista PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
Buena Vista PS
Smith Canal
RD 1614 (SMITH TRACT)
SAN JOAQUIN COUNTY
STOCKTON
VICTORY PARK
Pershing Dr
RD 828 (WEBER TRACT)
Interstate 5
Deep Water Channel
RD 404 (BOGGS TRACT)
0.5
0.9
0
500
1,000
2,000
Feet

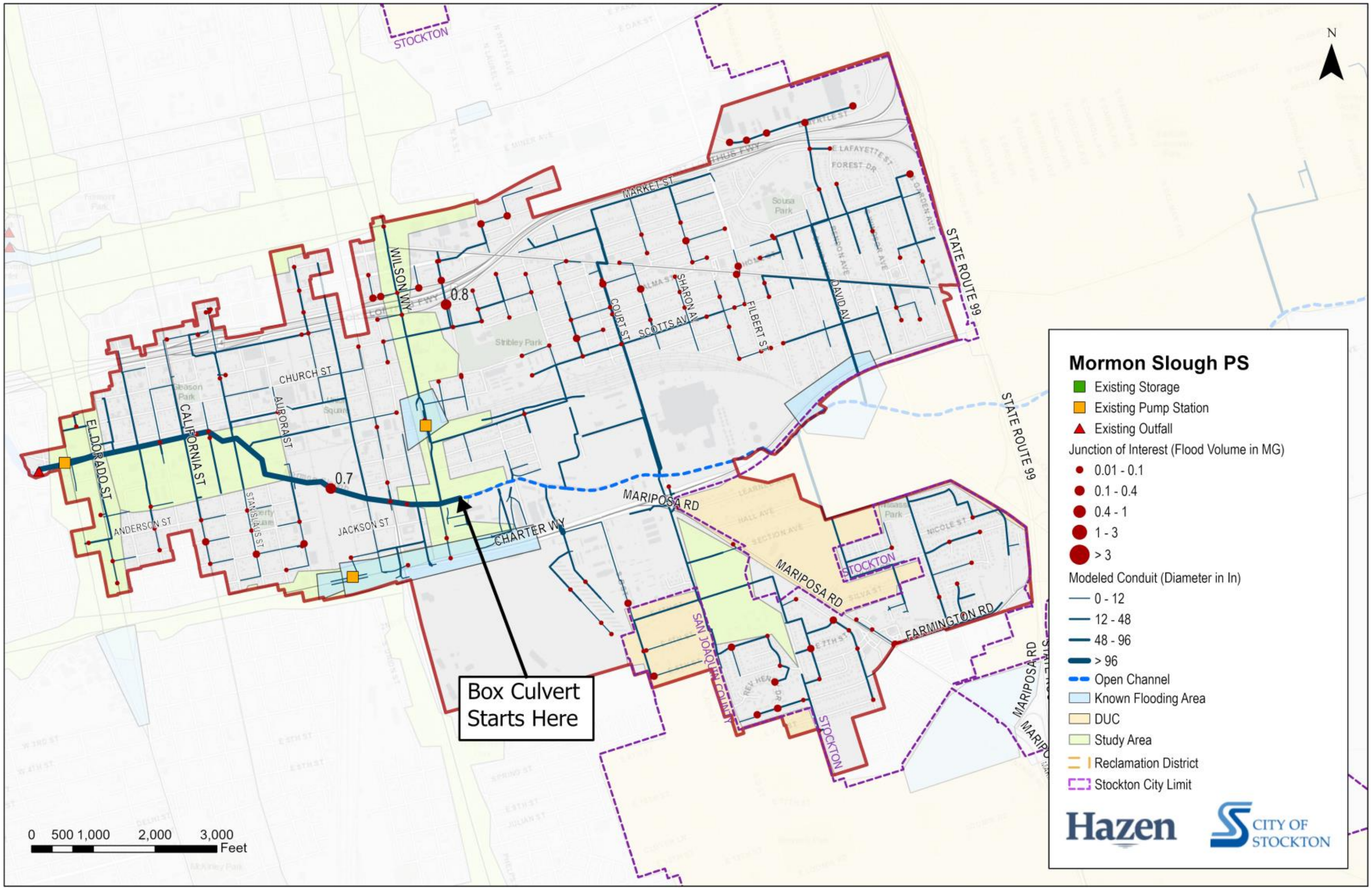

Deep Water PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
N
0
1,500
3,000
6,000
Feet
SAN JOAQUIN COUNTY
STOCKTON
RD 828 (WEBER TRACT)
RD 404 (BOGGS TRACT)
INTERSTATE 5
STOCKTON
CHANNEL
FREMONT ST
PARK ST
OAK ST
EL DORADO ST
MINER AV
WEBER AV
WILSON WY
AIRPORT WY
STATE ROUTE 4
FREMONT ST
5
1.1
1
1.4
2.6
0.6
1.8
0.7
1.1
5.3

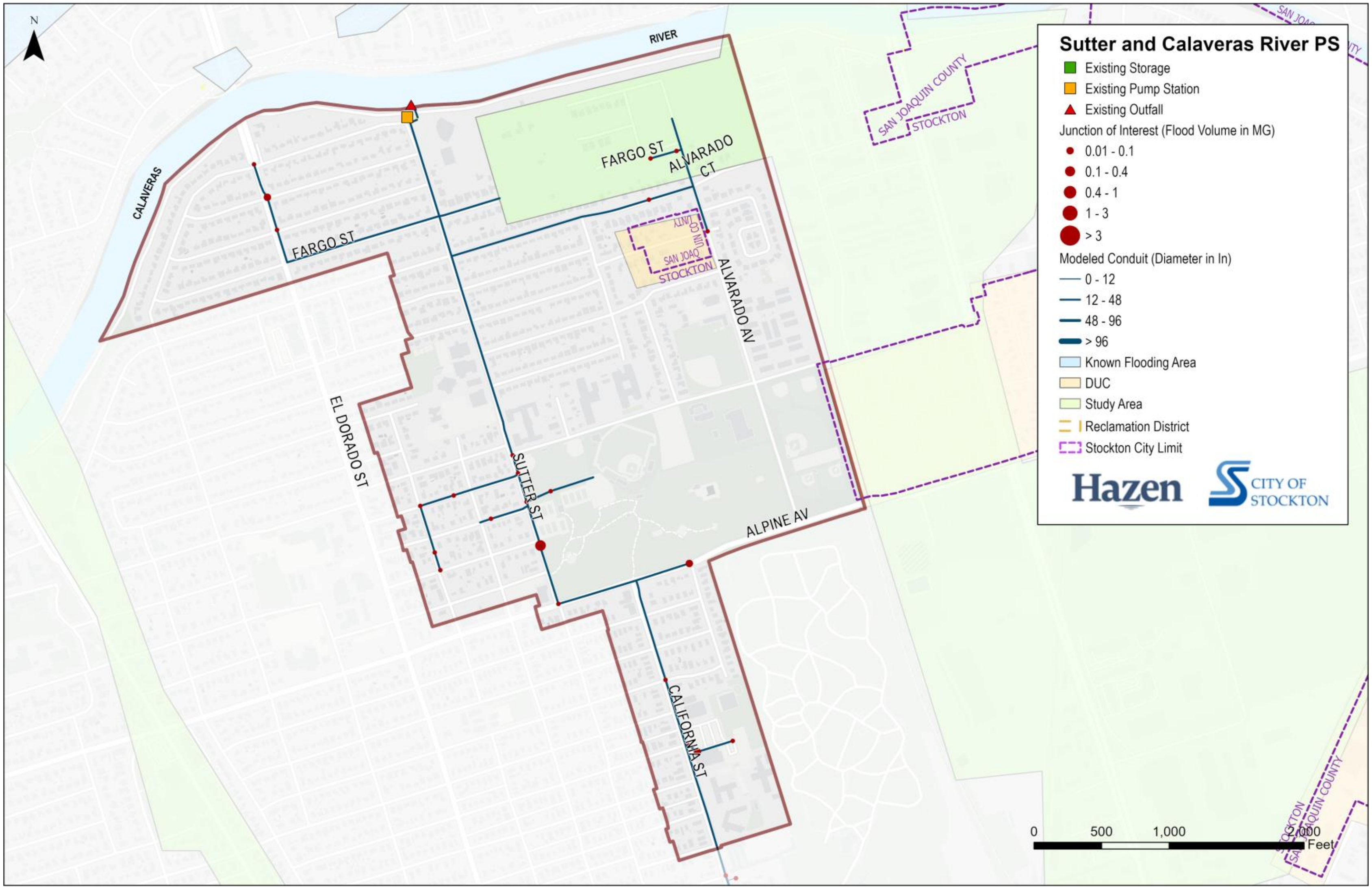

Duck Creek PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Open Channel
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
N
0 0.25 0.5 1 Miles
2.4
UNION ST
SIXTH ST
SEVENTH ST
EIGHTH ST
TENTH ST
SACRAMENTO ST
BELLEVIEW AV
RALPH AV
D ST
B ST
LOOMIS RD
MARIPOSA RD
STATION DR
DUCK CREEK LEVEE S RD
STATE ROUTE 99
SAN JOAQUIN COUNTY
STOCKTON

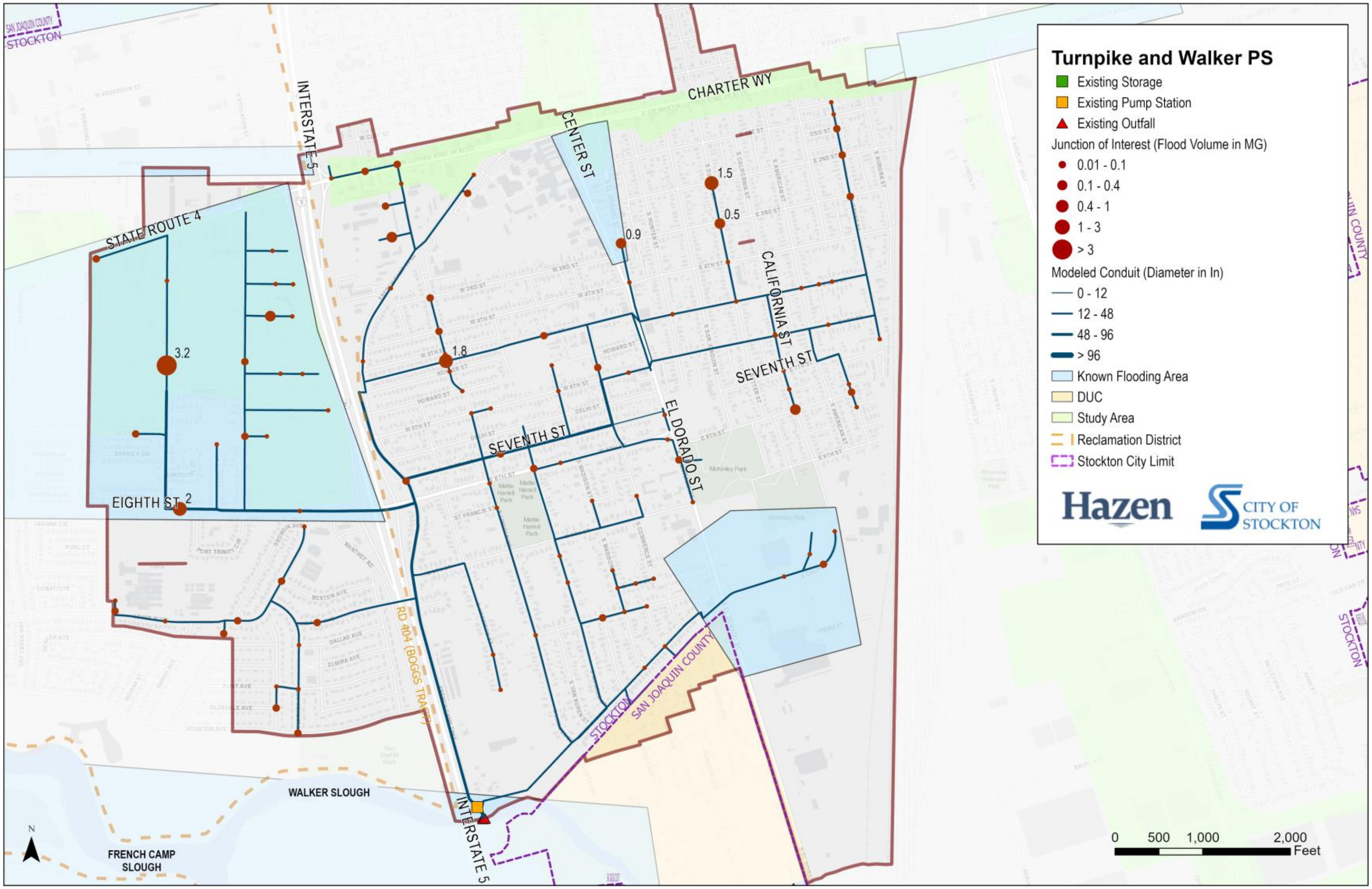

Hwy 4 and San Joaquin PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Open Channel
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
SAN JOAQUIN COUNTY
STOCKTON
NAVY DR
TILLIE LEWIS DR
FRESNO AV
SPUR LINE
SAN JOAQUIN RIVER
STATE ROUTE 4
4.1
N
0
500
1,000
Feet

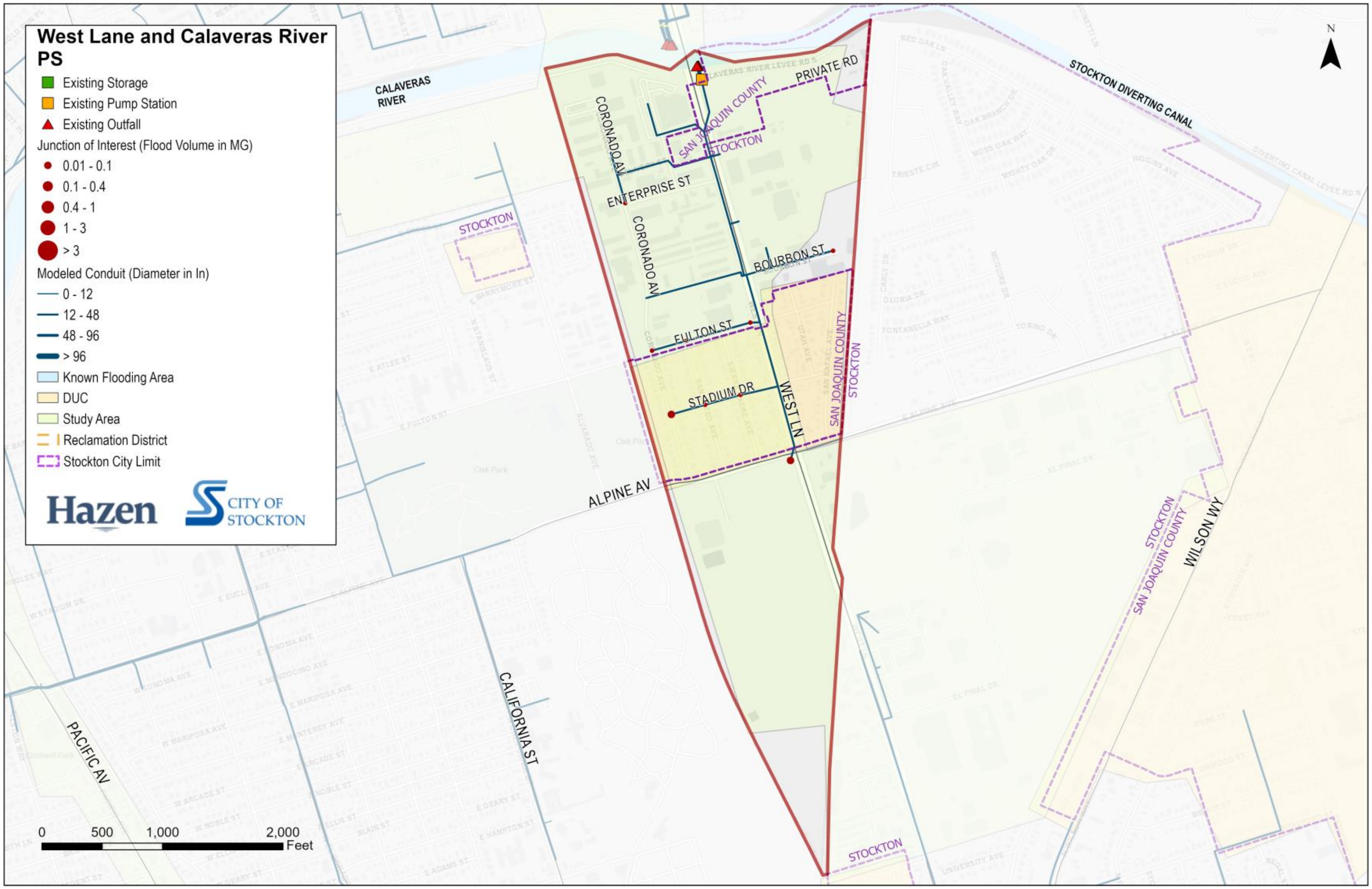

Legion Park and Smith Canal PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
BIANCHI RD
PACIFIC AV
PERSHING AV
EL DORADO ST
HARDING WY
WILSON WY
WATERLOO RD
SMITH CANAL
RD 828 (WEBER TRACT)
RD 1614 (SMITH TRACT)
SAN JOAQUIN COUNTY
STOCKTON
0.4
0.5
0.5
0.4
0.9
0.5
2.3
1
0.5
0.5
0.6
1
N
0
1,000
2,000
4,000
6,000
Feet


North Little Johns Creek PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
MARIPOSA RD
STOCKTON
SAN JOAQUIN COUNTY
STATE ROUTE 99
ZEPHYR ST
INDUSTRIAL DR
BOEING WY
POCK LN
QANTAS LN
ARCH AIRPORT RD
ARCH RD
NEWCASTLE RD
AIRPORT WY
SPERRY RD
0
1,000
2,000
4,000
Feet


Mormon Slough PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Open Channel
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Box Culvert Starts Here
0.8
0.7
MARKET ST
CHURCH ST
JACKSON ST
ANDERSON ST
CHARTER WY
MARIPOSA RD
FARMINGTON RD
STATE ROUTE 99
EL DORADO ST
CALIFORNIA ST
WILSON WY
COURT ST
SCOTTS AV
FILBERT ST
DAVID AV
STOCKTON
0 500 1,000 2,000 3,000 Feet
N
Hazen
CITY OF STOCKTON

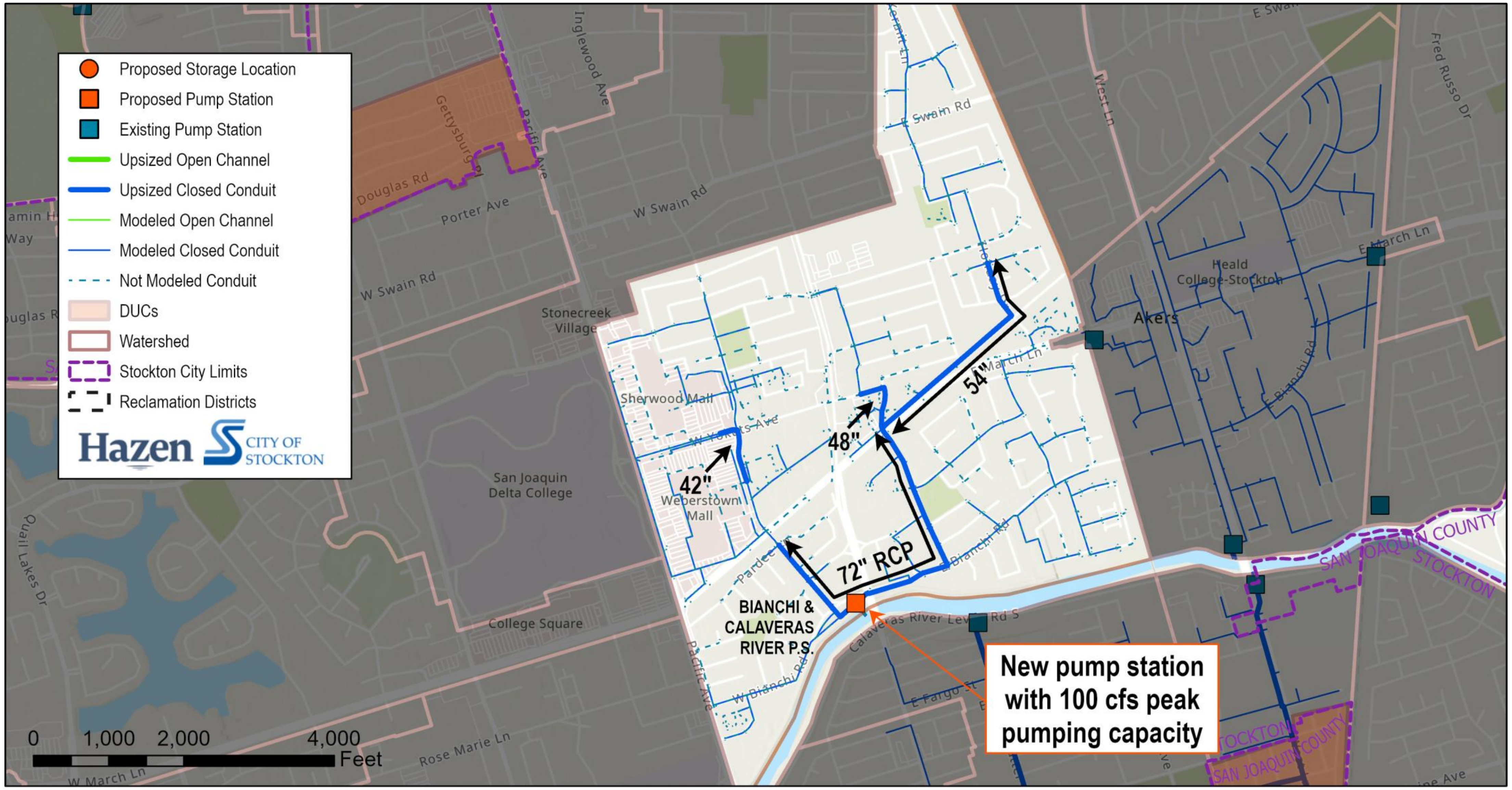

N
RIVER
CALAVERAS
FARGO ST
FARGO ST
ALVARADO
CT
SAN JOAQUIN COUNTY
STOCKTON
ALVARADO AV
EL DORADO ST
SUTTER ST
ALPINE AV
CALIFORNIA ST
Sutter and Calaveras River PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
0
500
1,000
2,000
Feet


Turnpike and Walker PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
CHARTER WY
INTERSTATE 5
CENTER ST
STATE ROUTE 4
CALIFORNIA ST
SEVENTH ST
EL DORADO ST
EIGHTH ST
RD 404 (BOGGS TRACT)
SAN JOAQUIN COUNTY
STOCKTON
WALKER SLOUGH
FRENCH CAMP SLOUGH
3.2
1.8
1.5
0.9
0.5
2
0 500 1,000 2,000
Feet


West Lane and Calaveras River PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
CALAVERAS RIVER
STOCKTON DIVERTING CANAL
PRIVATE RD
SAN JOAQUIN COUNTY
STOCKTON
CORONADO AV
ENTERPRISE ST
BOURBON ST
FULTON ST
STADIUM DR
WEST LN
ALPINE AV
WILSON WY
CALIFORNIA ST
PACIFIC AV
0
500
1,000
2,000
Feet
N

Appendix C:
Identified Improvement Concepts

Bianchi and Calaveras River P.S.



Existing Conditions

The watershed's pump station (existing peak capacity of 184 cfs) is not known to have operational problems but there are several areas in the watershed that are known to have flood problems, including Bianchi Rd, March Ln, and Camanche Ln. The existing conditions model confirmed these flooding locations; there was significant flooding along Bianchi Rd underneath the El Dorado Street underpass.

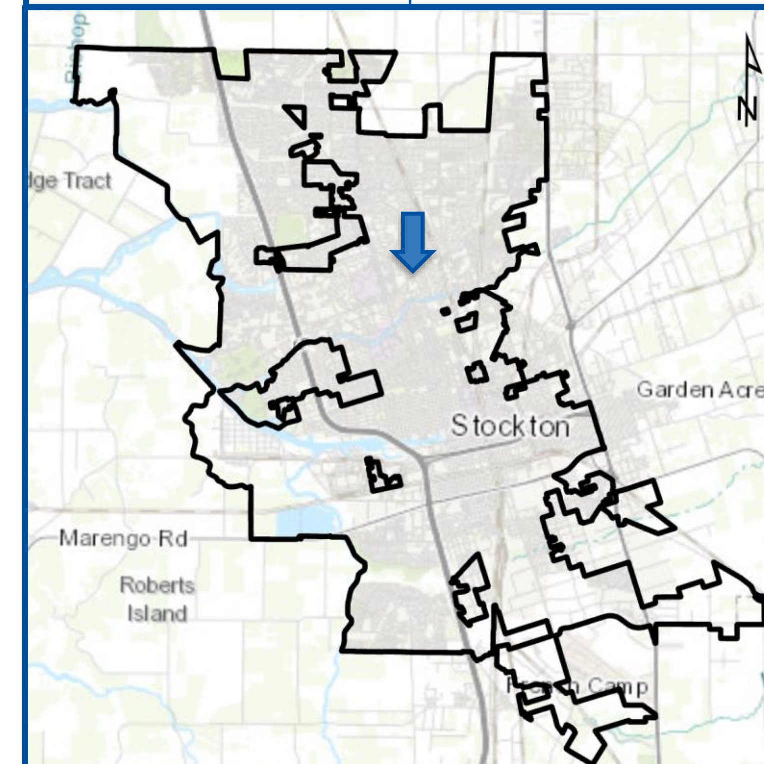
Proposed Improvement

The recommended improvements are to upsize the larger storm trunks in the watershed where the model predicted flooding occurs. The additional flow directed to the pump station as a result of pipe upsizing requires an increase of the peak capacity of the pump station to 300 cfs.

Stockton Stormwater Master Plan

CITY OF STOCKTON | Hazen

January 2022



Site Information

Drainage Basin: Bianchi and Calaveras River P.S.
Receiving Water: Calaveras River

Concern Area Characteristics

Known Concern Area	Yes	**Traffic Impacts**	Medium
Extent of Concerns	Medium	**Support for Future Dev.**	Low
Flooding Frequency	Medium	**Data Confidence**	Medium

Conceptual Level Estimates

Construction Cost: $30,682,180
Estimated O&M: Medium
Co-Benefits:
Overall Priority: Medium

Improvement Typologies

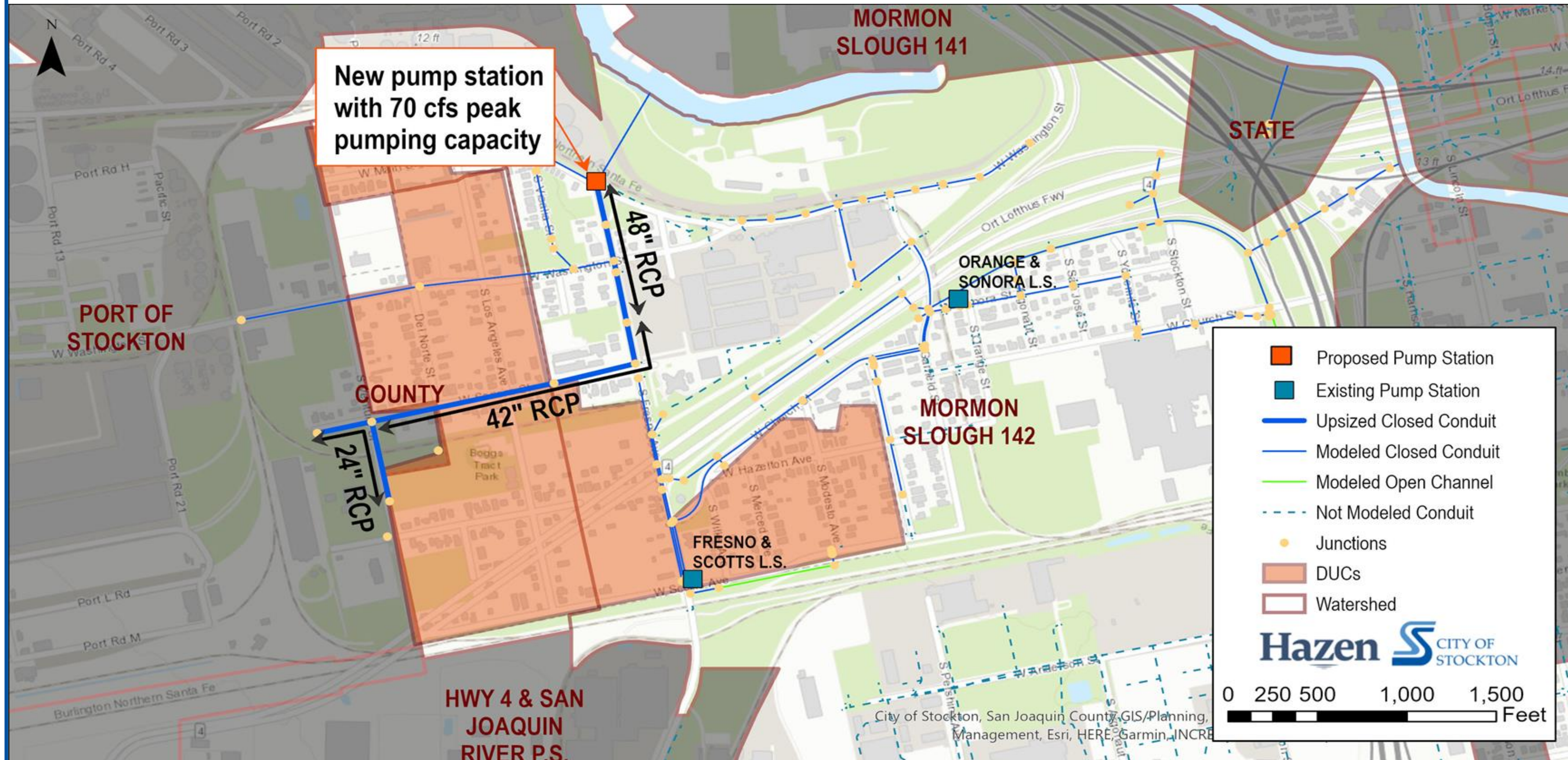
Upsized Conveyance
Pump Station Expansion

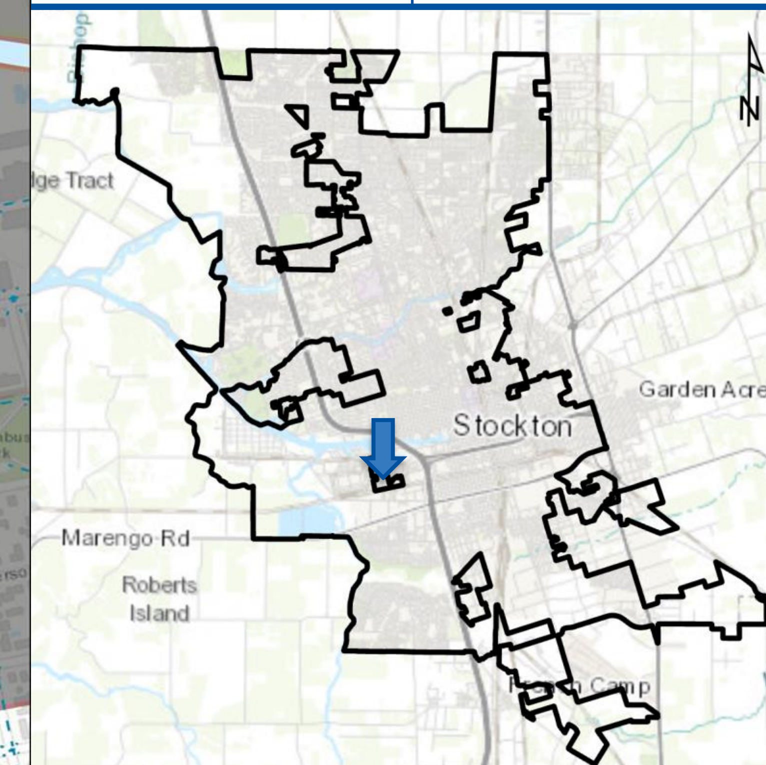
Boggs Tract

Stockton Stormwater Master Plan

CITY OF STOCKTON Hazen

January 2022





Existing Conditions

The Boggs Tract community, located West of Fresno Ave, does not have sufficient drainage and frequently floods. The primary goal of this plan is to provide drainage relief to this community. The Fresno & Scott Lift Station (LS), which is adjacent to Boggs Tract, manages runoff from a portion of the watershed north of the Crosstown Freeway, this LS is undersized and frequently causes upstream flooding. The watershed's only outfall is into Mormon Slough through a gravity pipe under I-5.

Proposed Improvement

The Fresno & Scott LS does not have capacity to accommodate runoff form Boggs Tract, upsizing this pump also requires upsizing the downstream forcemain and the gravity pipe crossing I-5. The recommendation is to install a pump station at Harbor St which discharges into a new outfall into the Port of Stockton. New storm drains along Washington St and Sonora St will route runoff to the new pump station, additional local grading and drainage will be needed to required to collect local drainage. As a result of the project, the Fresno & Scott LS will receive less runoff which will improve its operation.

Site Information

Drainage Basin: Boggs Tract
Receiving Water: Port of Stockton

Concern Area Characteristics

Known Concern Area	Yes	**Traffic Impacts**	High
Extent of Concerns	High	**Support for Future Dev.**	Low
Flooding Frequency	High	**Data Confidence**	High

Conceptual Level Estimates

Construction Cost: $ 17,144,585
Estimated O&M: High
Co-Benefits:
- Service to DUC

Overall Priority: High

Improvement Typologies

New Pump Station

Upsized Conveyance

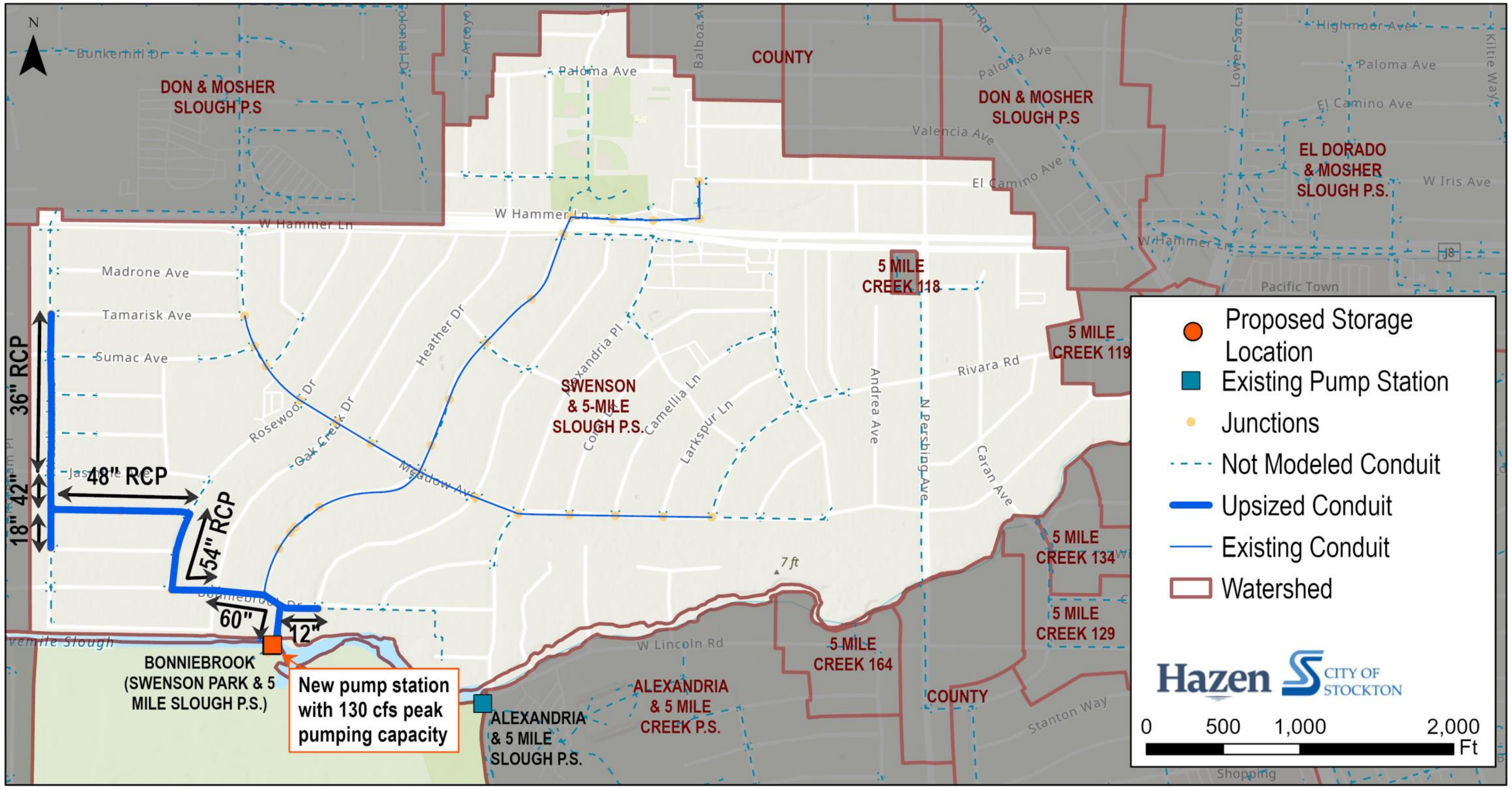
Conceptual Design – Not for Construction

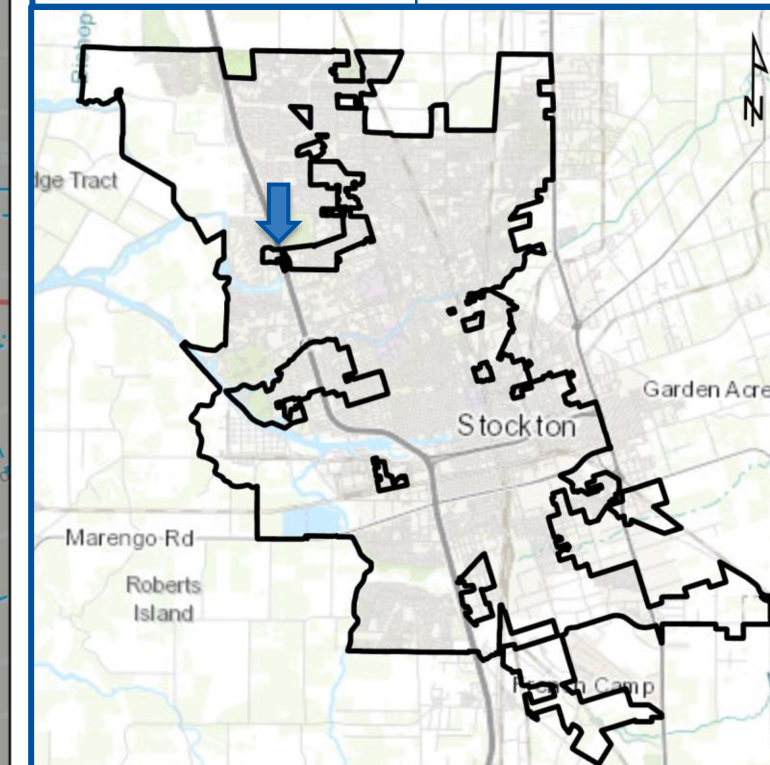
Bonniebrook (Swenson Park & 5 Mile Slough P.S.)

CITY OF STOCKTON

Hazen

January 2022





Site Information

Drainage Basin: Swenson Park & 5 Mile Slough P.S.
Receiving Water: Five Mile Slough

Existing Conditions

The goals of this plan are to address surface flooding and increase the capacity of the Bonniebrook PS. This PS has reached its maximum capacity which is a result of additional contributing area (from North of Hammer Lane) and reaching the end of its service life. The existing peak capacity of this PS is 75 cfs.. There are no known plans for significant development in this watershed.

Proposed Improvement

In order to accommodate the 10-year flow, it is recommended to increase the pump station capacity to 130 cfs. To address flooding along Westland Ave, several pipes will need to be upsized to convey the 10-year design storm.

Concern Area Characteristics

Known Concern Area	Yes	**Traffic Impacts**	Low
Extent of Concerns	Low	**Support for Future Dev.**	Low
Flooding Frequency	Low	**Data Confidence**	High

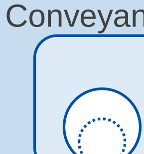
Conceptual Level Estimates

Construction Cost: $ 11,547,232
Estimated O&M: Medium
Co-Benefits:
Overall Priority: High

Improvement Typologies

Pump Station Expansion

Upsized Conveyance

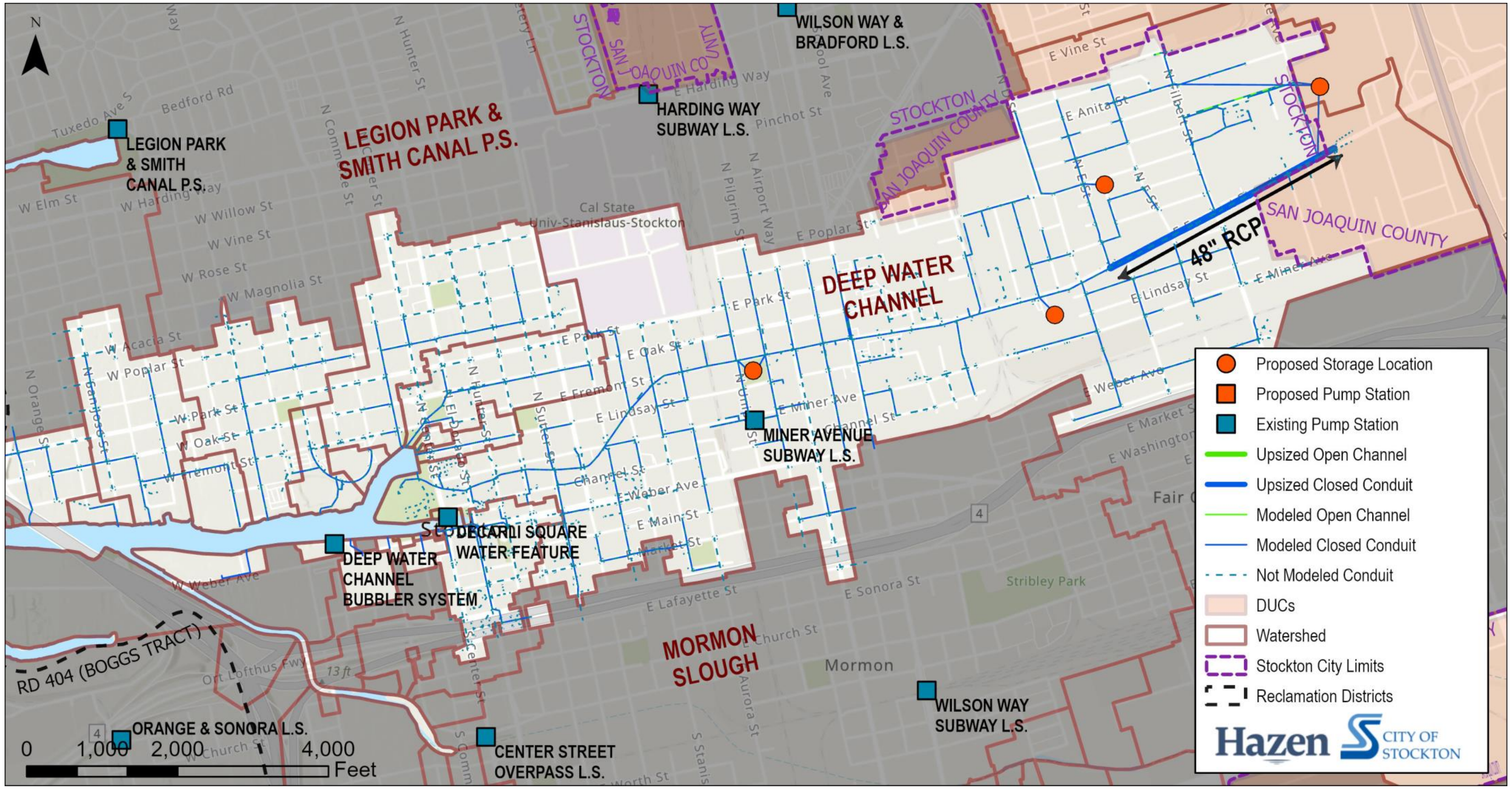


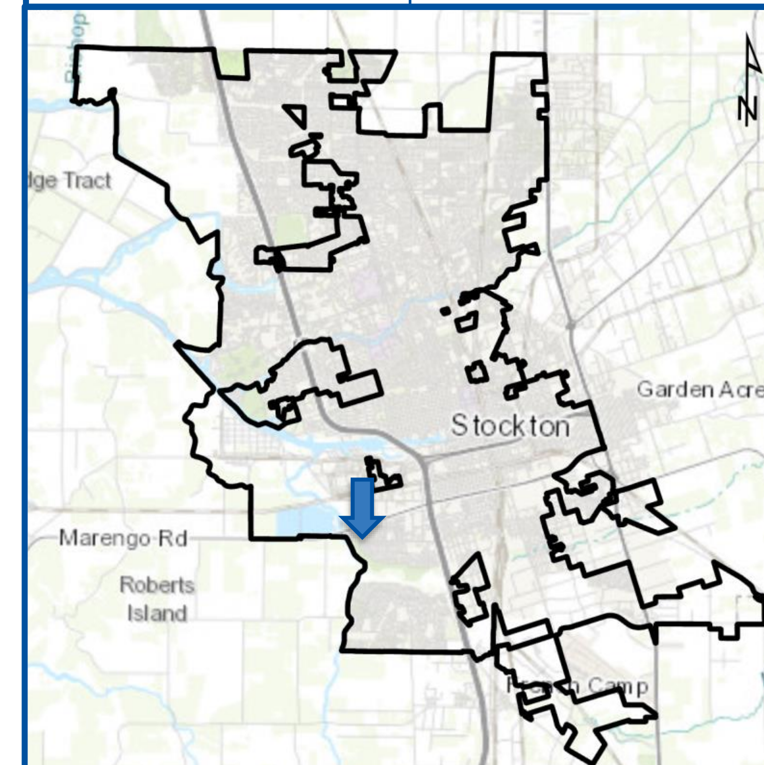
Deep Water Channel

Stockton Stormwater Master Plan

CITY OF STOCKTON | Hazen

January 2022





Existing Conditions

There are several locations within the Deep Water Channel watershed which have known flooding issues, particularly near the outfall and along Freemont Street. A large conduit (ranging from 48- to 72-inches) conveys runoff from the watershed to the outfall, which is tidally influenced. GIS elevations for this pipe may be unreliable and assumptions were made to fill in the data gaps. There is a DUC along Freemont St on the West side of Hwy 99 which has been identified for potential development.

Proposed Improvement

Additional elevation information is needed on the main trunk to determine if an increase in capacity is recommended. Given the number of utilities in this corridor, it would be significantly challenging to upsize this conveyance. Storage in the upstream portion of the watershed is proposed at three locations to reduce the flow into main trunk. If further development occurs within the DUC, the 48” conduit is recommended to convey the increased flow.

Site Information

Drainage Basin: Deep Water Channel
Receiving Water: Deep Water Channel

Concern Area Characteristics

Known Concern Area	Yes	**Traffic Impacts**	Low
Extent of Concerns	Low	**Support for Future Dev.**	Low
Flooding Frequency	Medium	**Data Confidence**	Low

Conceptual Level Estimates

Construction Cost: $ 10,229,853
Estimated O&M: Low
Co-Benefits:
- Service to DUC

Overall Priority: Low

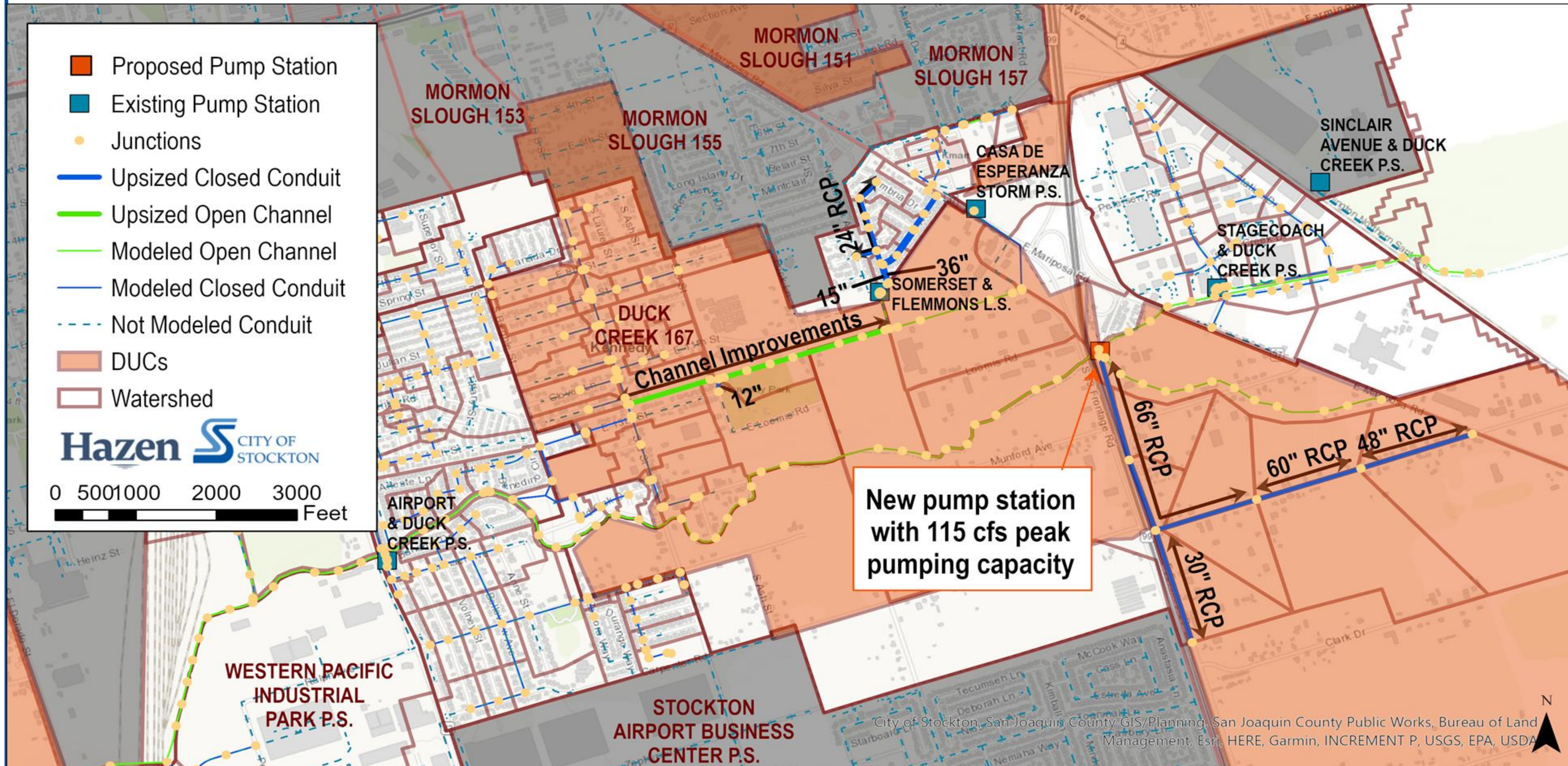
Improvement Typologies

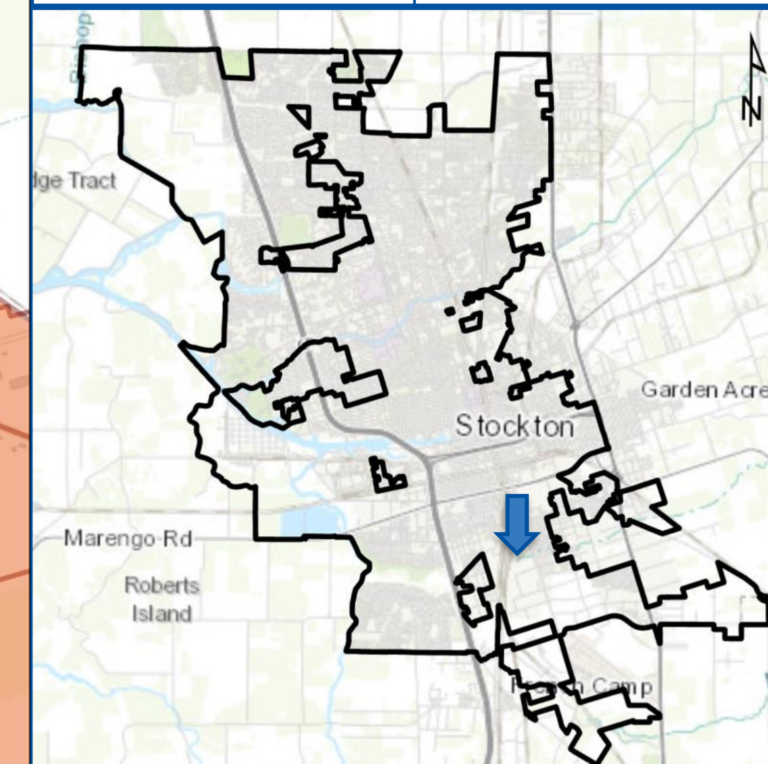
Upsized Conveyance | Detention Facilities

Duck Creek

CITY OF STOCKTON Hazen

January 2022





Site Information

Drainage Basin: Duck Creek
Receiving Water: Walker Slough

Existing Conditions

Duck Creek collects runoff from a predominantly suburban and rural watershed. There are no known flooding problems but there are several developments that may occur in the future including the Casa De Esparanza development, a DUC east of Highway 99 which has no known drainage infrastructure, and a DUC between Carpenter Road and E 11th Street which relies on a ditch to convey runoff to a collection system in D Street.

Proposed Improvement

To accommodate growth in the DUC West of HWY 99 a series of underground pipes and a pump station is recommended, these recommendations will depend on development plans and stormwater controls. The open channel that provides drainage from Casa De Esperanza and the remaining DUC needs to be cleaned out and potentially hardened to route runoff to the stormwater collection system. There is little information available on future developments, so these recommendations are preliminary and need to be evaluated with future stormwater controls.

Concern Area Characteristics

Known Concern Area	Medium	**Traffic Impacts**	Low
Extent of Concerns	Medium	**Support for Future Dev.**	Medium
Flooding Frequency	Low	**Data Confidence**	High

Conceptual Level Estimates

Construction Cost: $ 12,061,203
Estimated O&M: Low
Co-Benefits:

- Service to DUC

Overall Priority: Medium

Improvement Typologies

Upsized Conveyance

Highway 4 and San Joaquin River P.S.

Stockton Stormwater Master Plan

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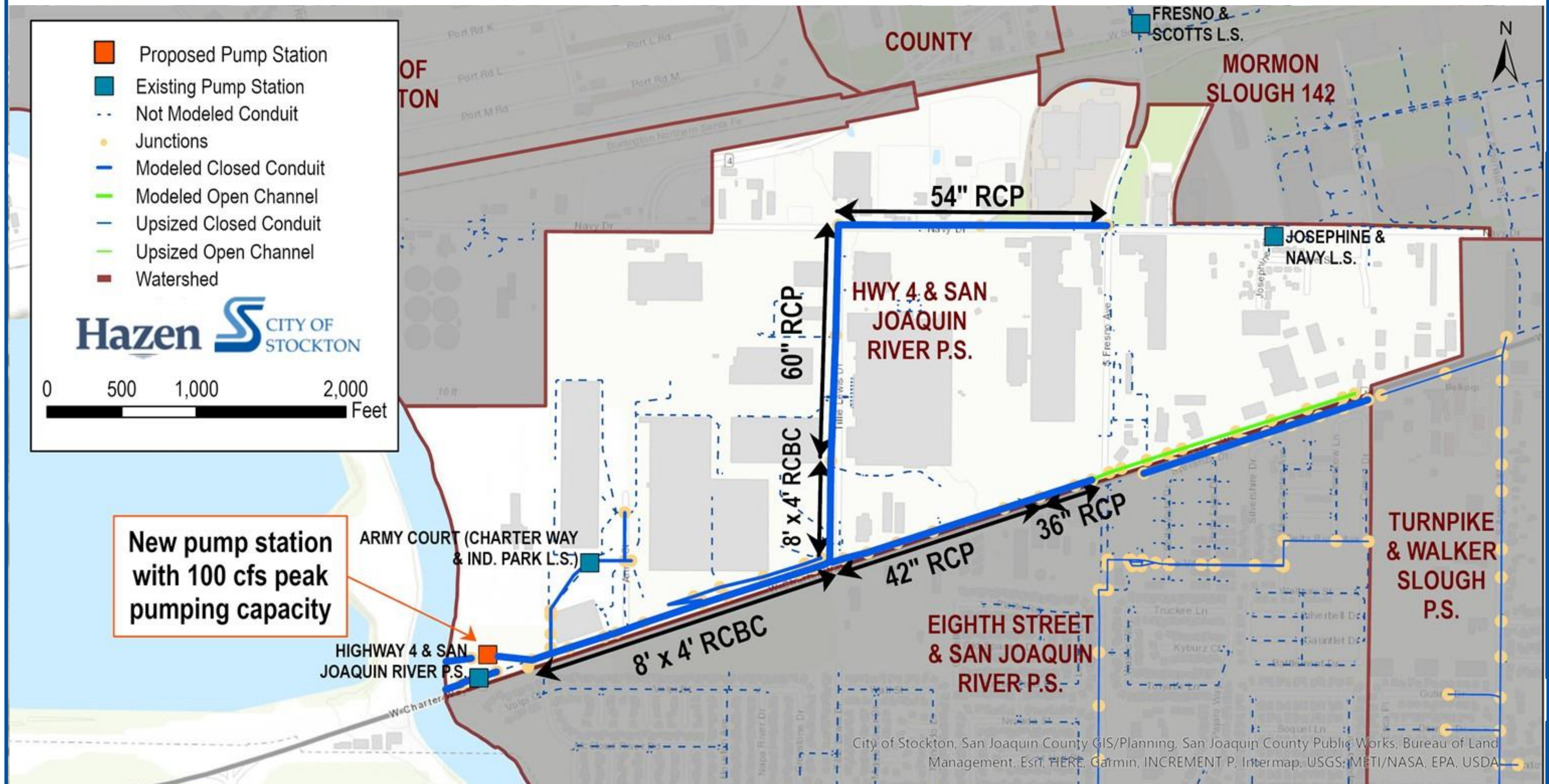
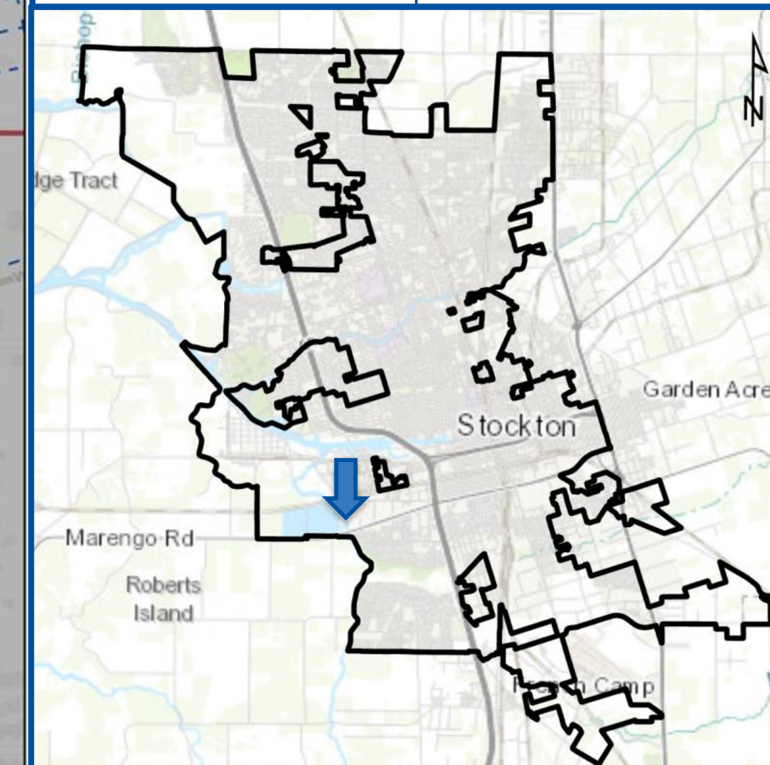




Existing Conditions

The watershed drains to the Highway 4 and San Joaquin River P.S. which has a peak capacity of 5 cfs. There are several reports of roadside flooding along W Charter Way and Tillie Lewis Drive due to small roadside ditches with minimal conveyance capacity. The watershed is highly impervious with few detention ponds or storage practices.

Proposed Improvement

In order to reduce street flooding, open channels will be replaced with closed conduits along W Charter Way and Tillie Lewis Dr to manage the 10-year design storm. There were no opportunities for detention/storage in the watershed that would provide significant peak reduction. As a result of the upsized conveyances and the resulting higher flows, the existing pump station will need to be upsized to convey up to 100 cfs.

Site Information

Drainage Basin: Highway 4 and San Joaquin River Pump Station
Receiving Water: San Joaquin River

Concern Area Characteristics

Known Concern Area	Yes	**Traffic Impacts**	High
Extent of Concerns	High	**Support for Future Dev.**	Low
Flooding Frequency	High	**Data Confidence**	High

Conceptual Level Estimates

Construction Cost: $ 24,902,729
Estimated O&M: Medium
Co-Benefits: None Identified
Overall Priority: High

Improvement Typologies

Pump Station Expansion

Upsized Conveyance

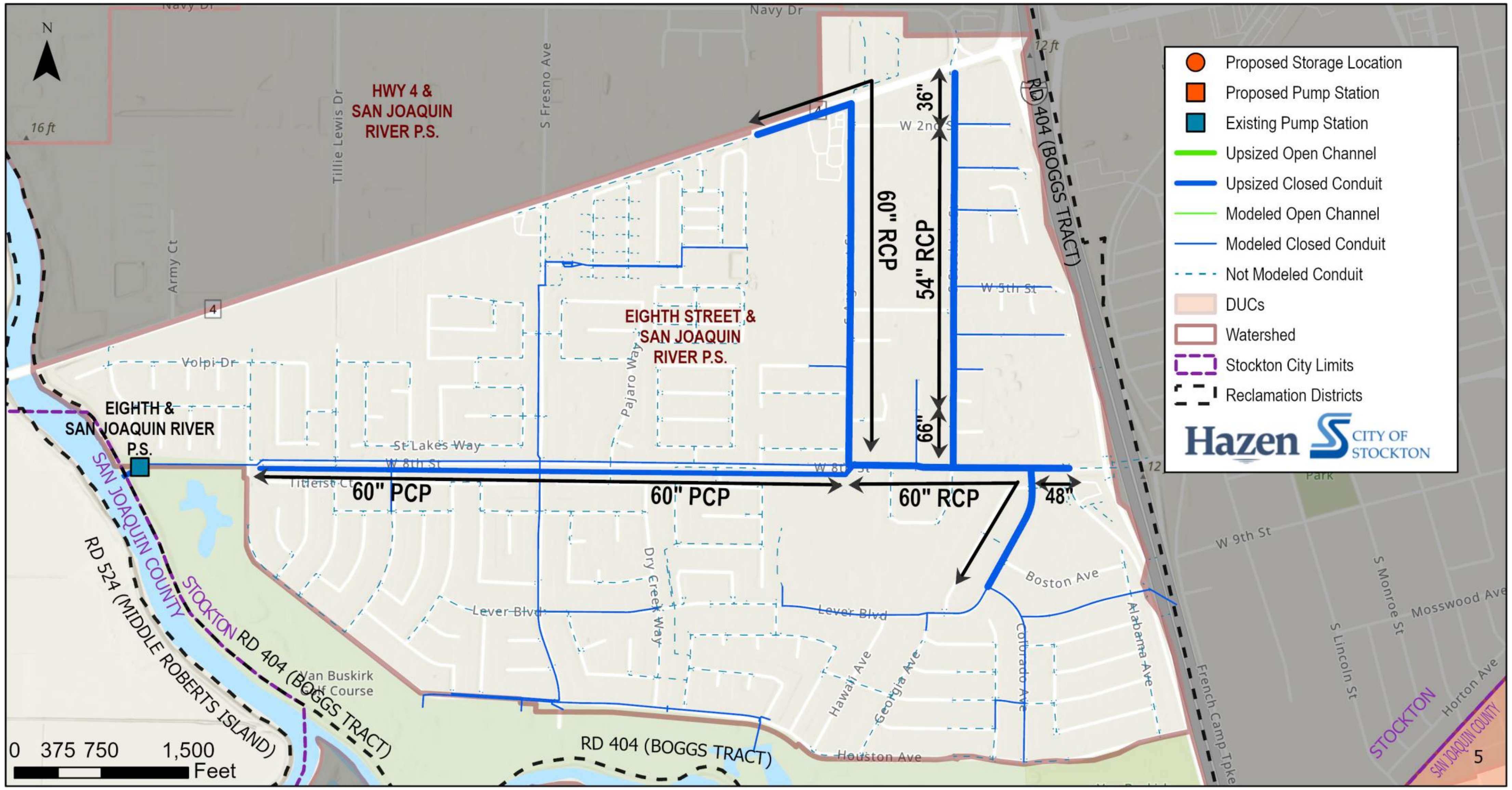
Conceptual Design – Not for Construction

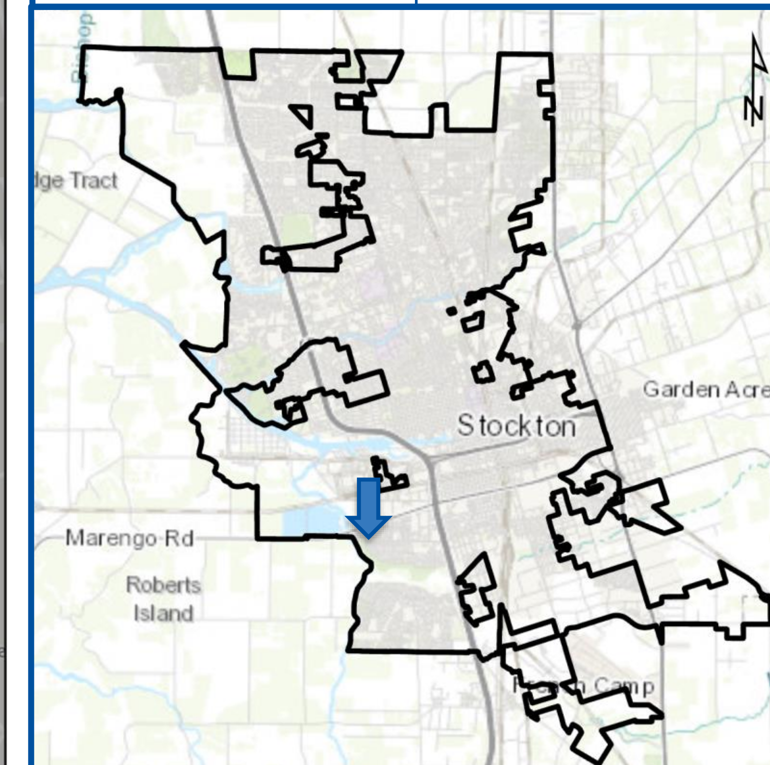
Eighth and San Joaquin River P.S.

Stockton Stormwater Master Plan

CITY OF STOCKTON Hazen

January 2022





Site Information

Drainage Basin: Eight and San Joaquin River P.S.
Receiving Water: San Joaquin River

Existing Conditions

The goals of this plan are to address conveyance limitations in the watershed and to accommodate runoff from the Turnpike and Walker Slough watershed(Walker Slough) redirection (west of I-5). The existing PS has capacity to manage the 10-year design storm, flooding in the upper watershed is due to conveyance limitations.

Proposed Improvement

The increased flow from the Walker Slough redirection will be managed by a new pipe parallel to the existing 72" pipe along Eight St. The proposed pipe is 8 to 10 feet below grade and will provide conveyance for the increased flows from Walker Slough. The existing pump station can manage the additional flow and will not require an increase in pump station capacity.

Concern Area Characteristics

Known Concern Area	Yes	**Traffic Impacts**	Low
Extent of Concerns	Low	**Support for Future Dev.**	Low
Flooding Frequency	Low	**Data Confidence**	Medium

Conceptual Level Estimates

Construction Cost: $ 75,142,267
Estimated O&M: Low
Co-Benefits: None Identified
Overall Priority: High

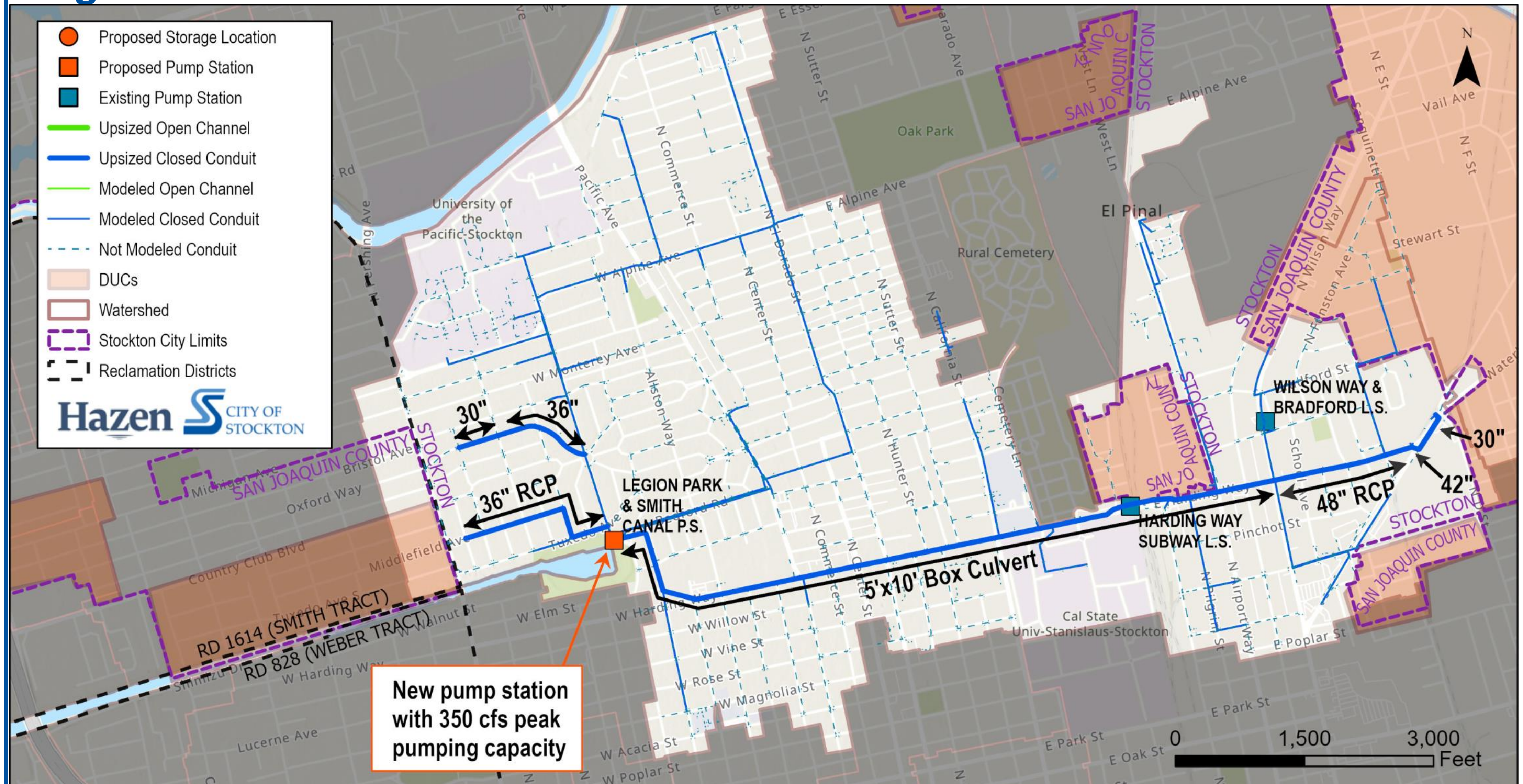
Improvement Typologies

Upsized Conveyance

Parallel Pipe

Conceptual Design – Not for Construction

Legion Park and Smith Canal P.S.

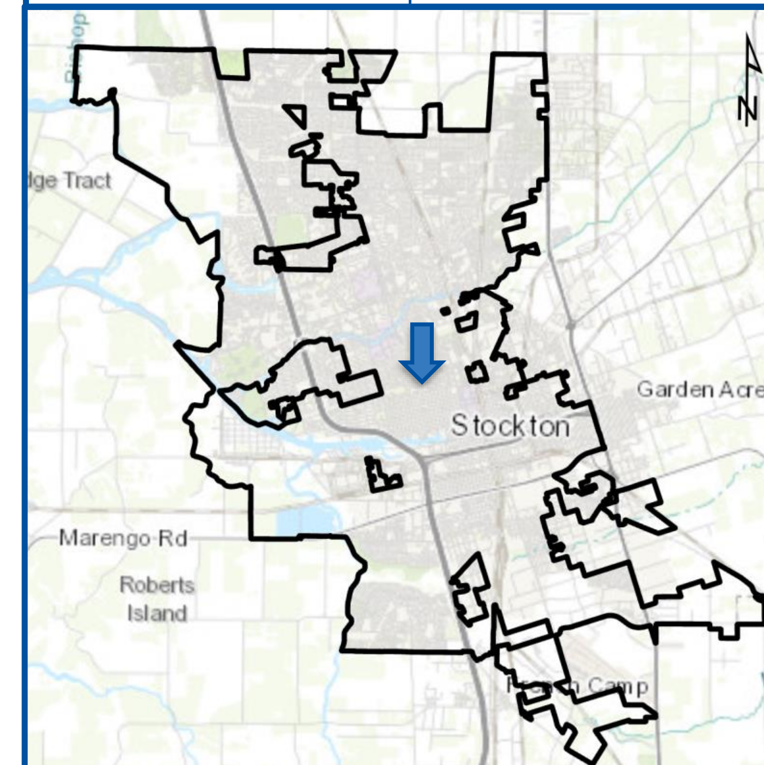


Stockton Stormwater Master Plan

CITY OF STOCKTON

Hazen

January 2022



Site Information

Drainage Basin: Legion Park and Smith Canal P.S.

Receiving Water: Smith Canal

Existing Conditions

The Legion Park and Smith Canal P.S. receives runoff from over 1900 acres of residential and commercial area. The watershed has no significant storage which acts to mitigate the peak flows. The primary flooding problems are along Harding Way and northwest of the PS along Tuxedo and Middlefield Ave. The peak capacity of the PS is 292 cfs.

Proposed Improvement

The recommended improvements are to upsize the pipe along Harding Way and in the area northwest of the PS. These projects will provide additional conveyance to the PS which requires upgrades to manage this additional flow. Several pump stations were sized to determine the most suitable size of the pump station, ultimately a 350 cfs peak capacity pump station is recommended. Discharge limits into Smith Canal need to be evaluated with this additional flow.

Concern Area Characteristics

Known Concern Area	Yes	**Traffic Impacts**	Medium
Extent of Concerns	Medium	**Support for Future Dev.**	Low
Flooding Frequency	Medium	**Data Confidence**	Medium

Conceptual Level Estimates

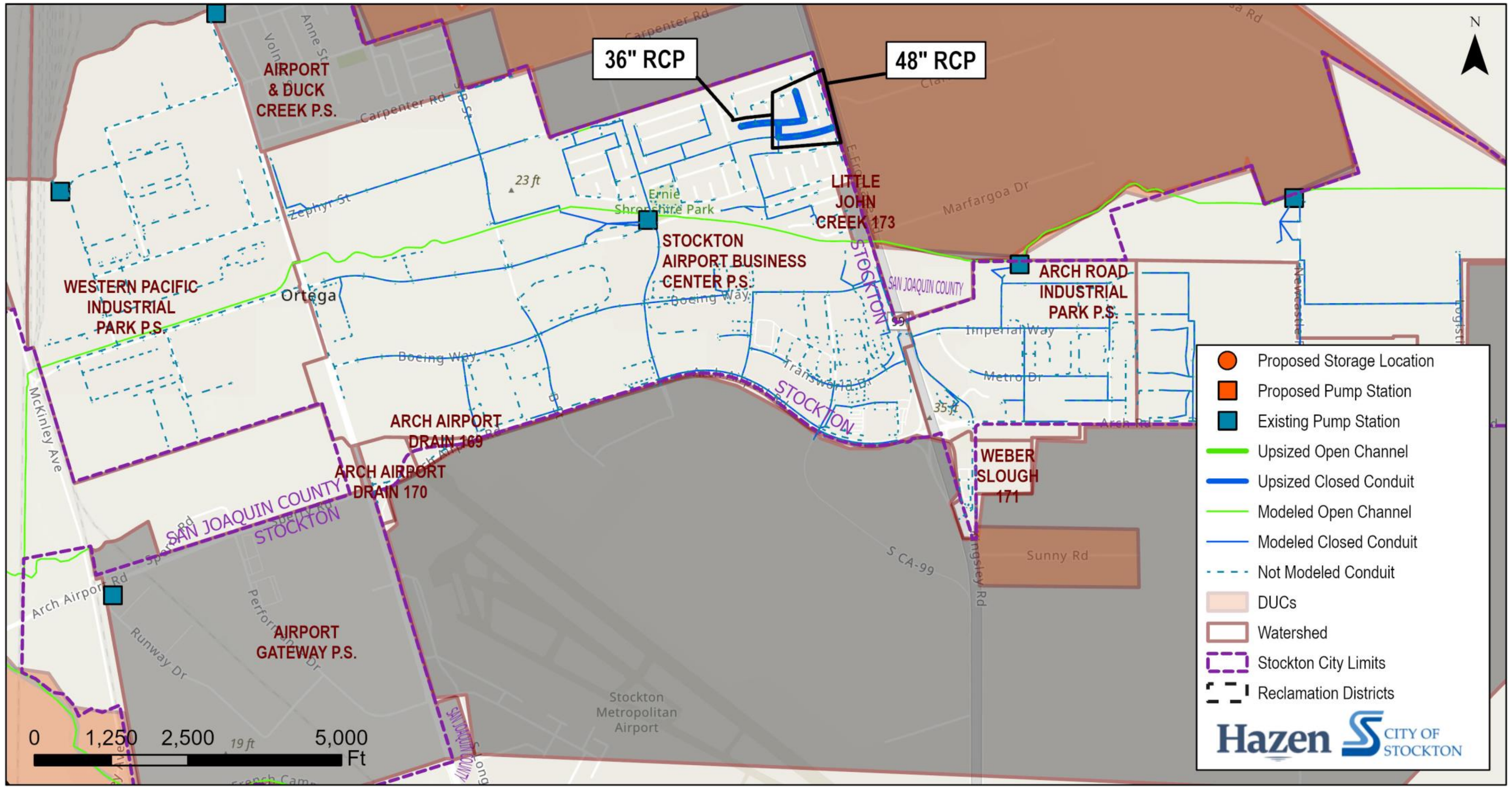
Construction Cost: $ 50,864,178
Estimated O&M: Medium
Co-Benefits: None Identified
Overall Priority: Medium

Improvement Typologies

Upsized Conveyance

Pump Station Expansion

North Little Johns Creek



Existing Conditions

North Little Johns Creek has a large contributing area which receives runoff from residential areas and industrial/warehouse facilities along Arch Airport Drive. There is a DUC east of Hwy 99 and west of Mariposa Rd which drains to North Little Johns Creek, there are no development plans for this DUC that the City is aware of.

Proposed Improvement

Improvements were focused on the residential areas north of the creek with upsizing recommended on several pipe segments. There are no recommendations to upsize conduits within the Arch Airport Drive commercial areas. If development occurs within the DUC, a new pump station and detention pond may be needed to mitigate runoff into the creek.

Stockton Stormwater Master Plan

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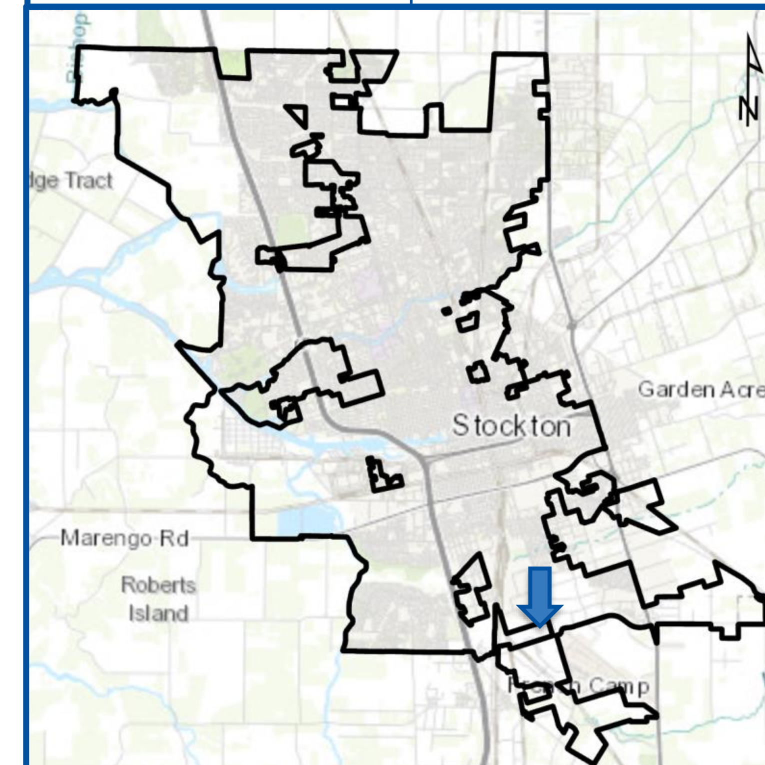


Site Information

Drainage Basin: North Little Johns
Receiving Water: French Camp Slough

Concern Area Characteristics

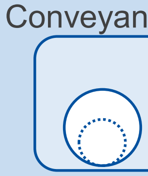
Known Concern Area	Yes	**Traffic Impacts**	Low
Extent of Concerns	Low	**Support for Future Dev.**	Medium
Flooding Frequency	Low	**Data Confidence**	Medium

Conceptual Level Estimates

Construction Cost: $ 4,552,126
Estimated O&M: Low
Co-Benefits: None Identified
Overall Priority: Low

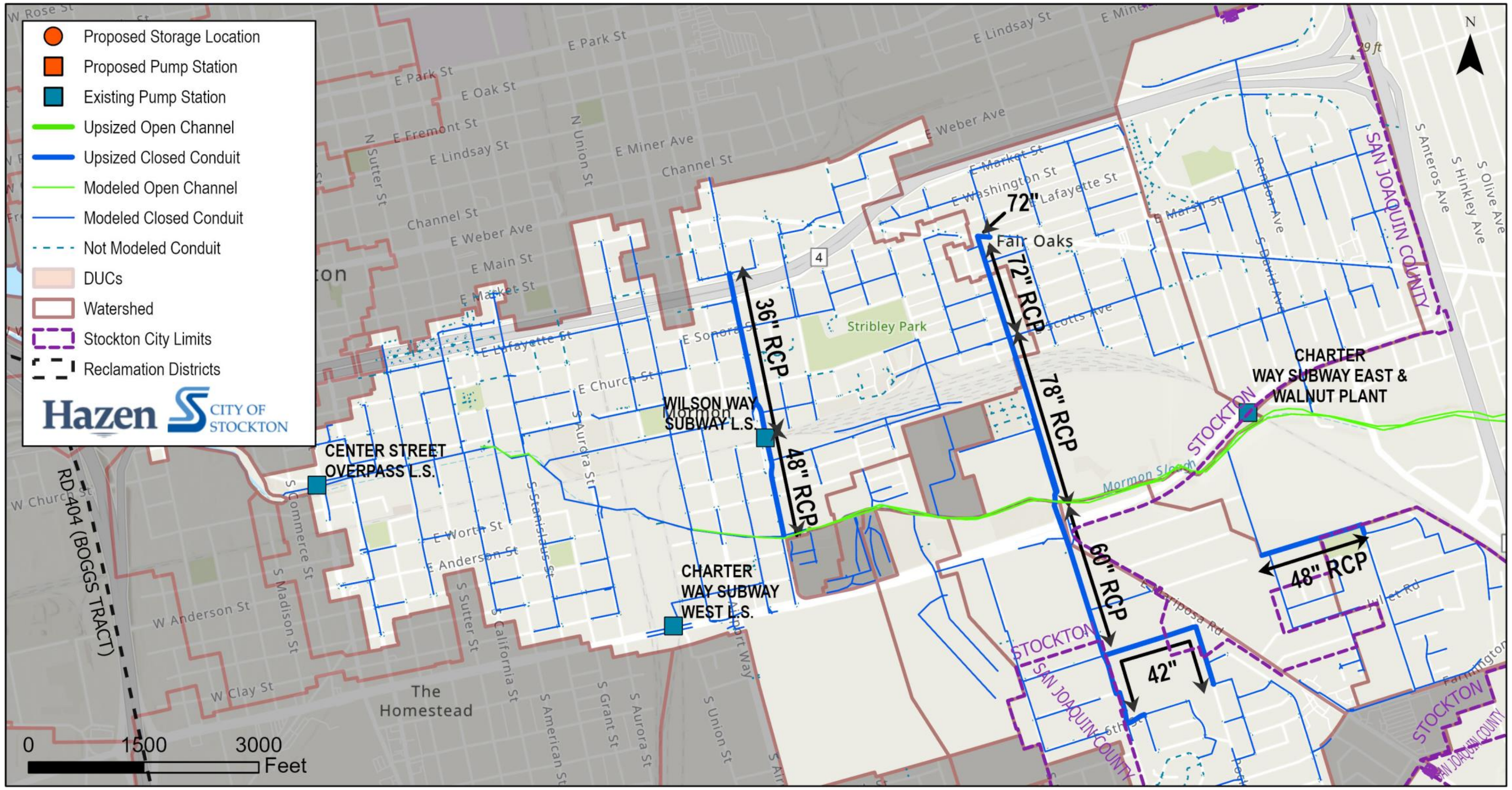
Improvement Typologies

Upsized Conveyance



Conceptual Design – Not for Construction

Mormon Slough



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CITY OF STOCKTON

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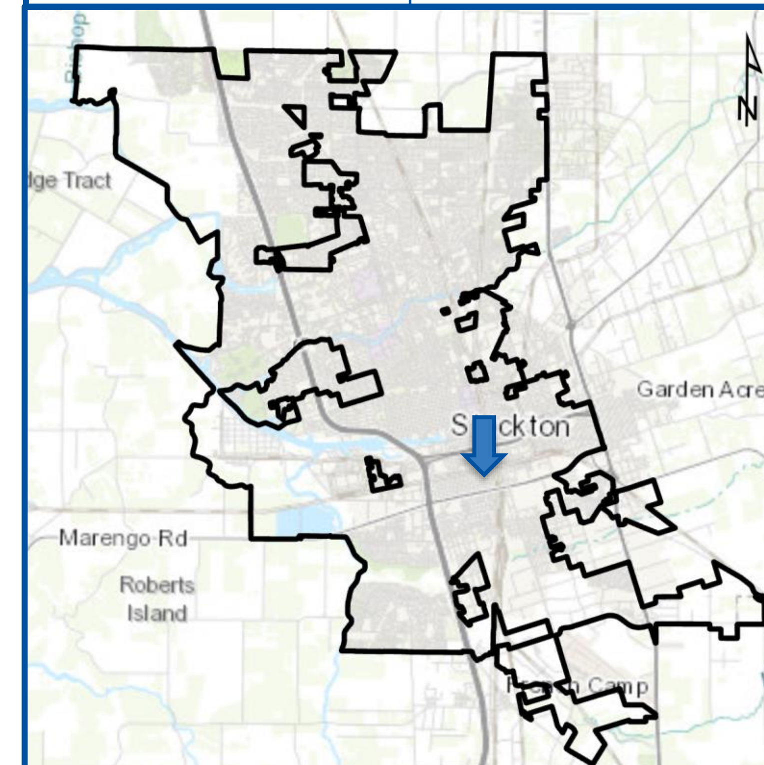


Site Information

Drainage Basin: Mormon Slough
Receiving Water: Mormon Slough/Port of Stockton

Existing Conditions

Mormon Slough's watershed includes residential, industrial, and commercial areas. It is open-channel until it reaches Wilson Way where it enters a 7x10-foot box culvert. The primary flooding is at underpasses where lift stations pump the runoff to the main trunk. There are two DUCs in the watershed East of HWY 99, Garden Acres, and between Farmington Rd and Mormon Slough. There are many model predicted flooding locations that do not correlate well to City staff observations. Data confidence in the conduit system elevations is particularly low for this watershed, especially within the Mormon Slough 159 watershed.

Proposed Improvement

The recommended improvements are to upsize the larger storm trunks in the watershed where model predicted flooding occurs. The lift stations which are reported to cause flooding will need further evaluation to determine if there are operational issues or if they need to be replaced.

Concern Area Characteristics

Known Concern Area	Yes	**Traffic Impacts**	Low
Extent of Concerns	Low	**Support for Future Dev.**	Low
Flooding Frequency	Medium	**Data Confidence**	Low

Conceptual Level Estimates

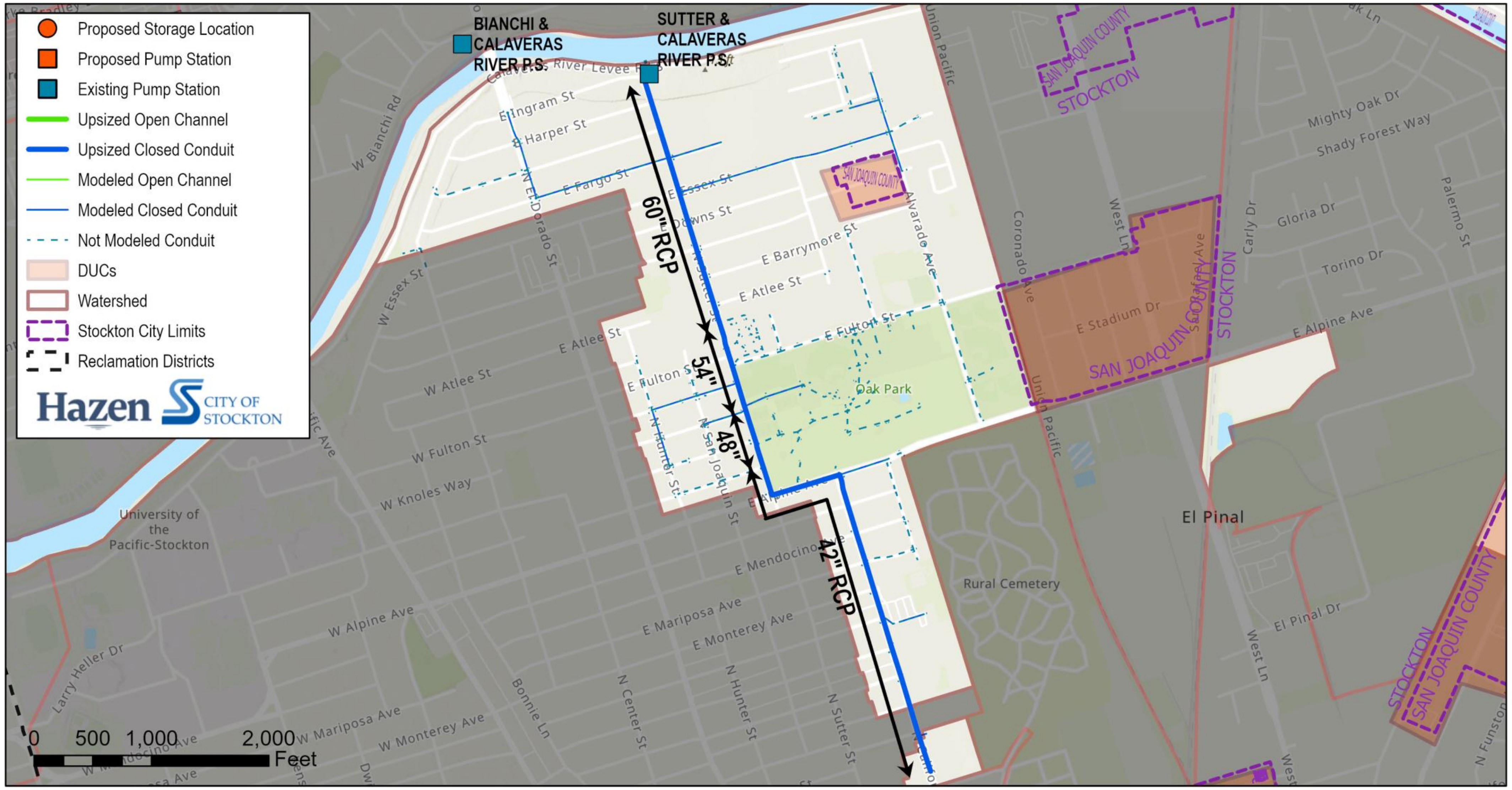
Construction Cost: $ 27,524,026
Estimated O&M: Low
Co-Benefits: None Identified
Overall Priority: Low

Improvement Typologies

Upsized Conveyance

Conceptual Design – Not for Construction

Sutter and Calaveras River P.S.



Existing Conditions

The Sutter and Calaveras River P.S. manages runoff that drains to California St and Sutter St. The City has not identified any flooding concerns along the major storm conduits and there are no DUCs or development plans within this watershed. There is model predicted flooding at several locations within the watershed. Plans for the pump station are limited and there is no information on the peak pumping capacity.

Proposed Improvement

To address the flooding, improvements are recommended along the main trunks in California and Sutter St. These improvements will reduce surcharging and flooding within the collection system. The flows to the existing pump station will increase which may require upgrades to the pump stations. More information is needed on the pumps to determine the improvements needed and these additional flows will need to be compared to the discharge limits.

Stockton Stormwater Master Plan

CITY OF STOCKTON | Hazen

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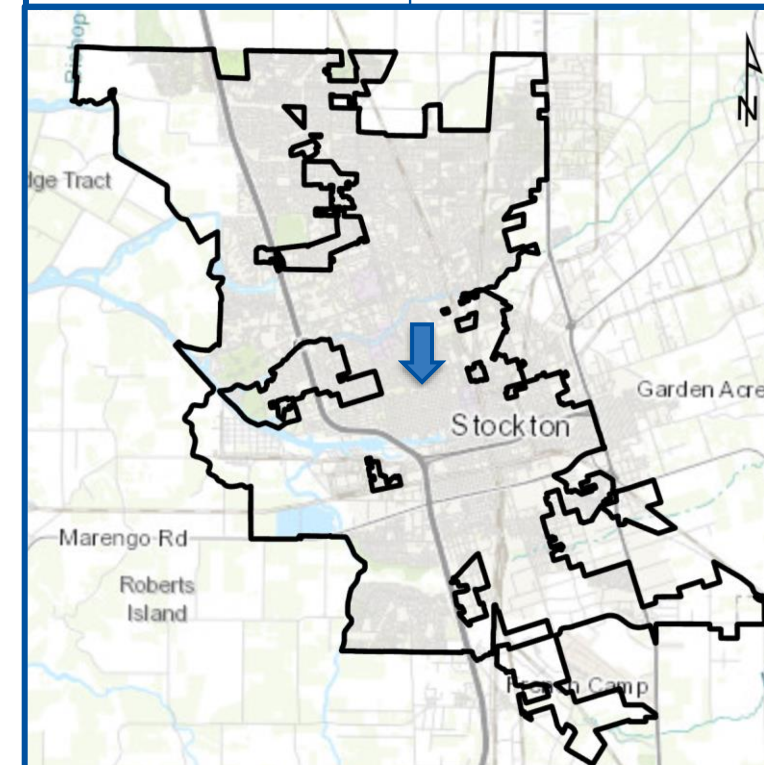


Site Information

Drainage Basin: Sutter and Calaveras River P.S.
Receiving Water: Calaveras River

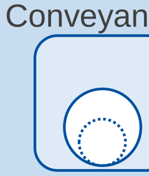
Concern Area Characteristics			
Known Concern Area	No	**Traffic Impacts**	Low
Extent of Concerns	Low	**Support for Future Dev.**	Low
Flooding Frequency	Low	**Data Confidence**	Medium

Conceptual Level Estimates

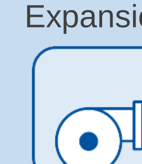
Construction Cost: $ 13,710,877
Estimated O&M: Low
Co-Benefits: None Identified
Overall Priority: Low

Improvement Typologies

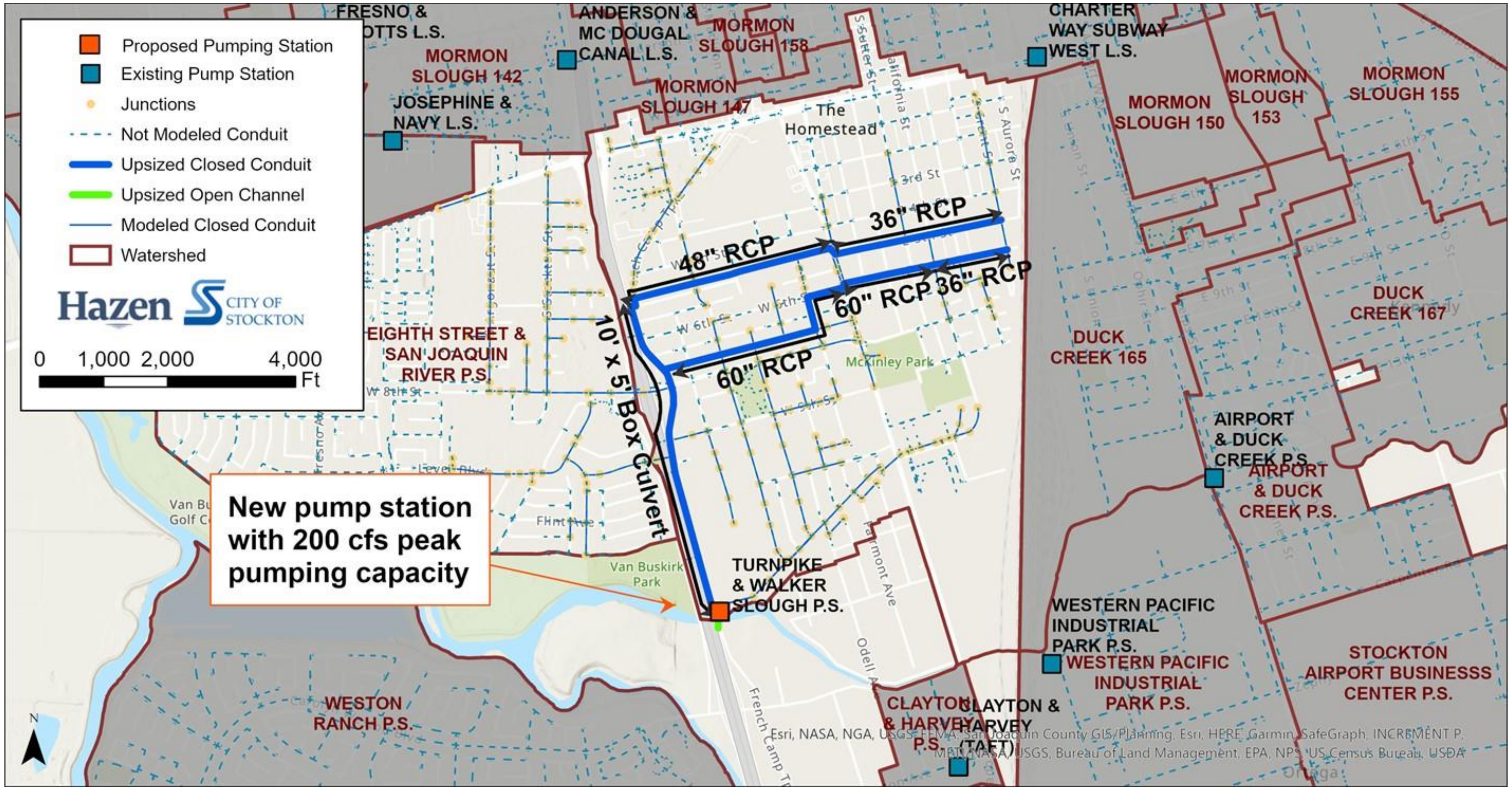
Upsized Conveyance



Pump Station Expansion



Turnpike and Walker Slough – Alternative 1



Existing Conditions

There are several known flooding locations throughout the watershed due to undersized conduits and the Turnpike and Walker Slough P.S. There are no significant detention ponds to mitigate peak runoff. The goals of this plan are to provide additional conveyance, upsize the pump station, and reduce flooding

Proposed Improvement

Pipe upsizing east of I-5 along the primary stormwater trunks is recommended to reduce flooding in the upstream portion of the watershed. The capacity of the Turnpike and Walker PS will be increased to accommodate the additional flow. Underground storage at several cleared parcels were evaluated but was found to have minimal impact on mitigating the runoff peaks. There was no ideal suitable location for above-ground storage.

Stockton Stormwater Master Plan

CITY OF STOCKTON — Hazen

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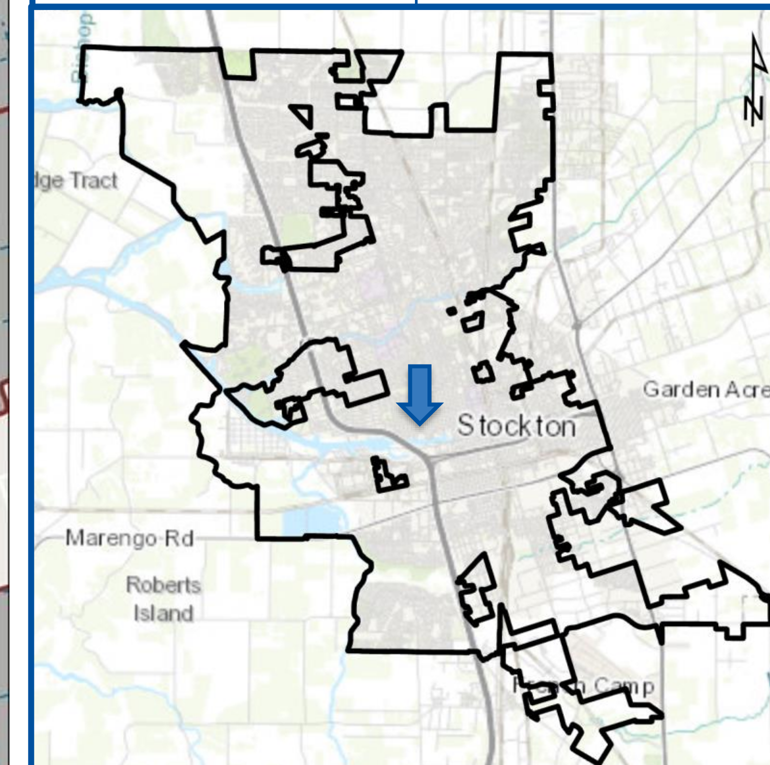

Site Information

Drainage Basin: Turnpike and Walker Slough
Receiving Water: Walker Slough

Concern Area Characteristics

Known Concern Area	Yes	**Traffic Impacts**	High
Extent of Concerns	High	**Support for Future Dev.**	Low
Flooding Frequency	High	**Data Confidence**	Medium

Conceptual Level Estimates

Construction Cost: $ 46,204,468
Estimated O&M: Medium
Co-Benefits: None Identified
Overall Priority: High

Improvement Typologies

Pump Station Expansion

Upsized Conveyance

Conceptual Design – Not for Construction

Turnpike and Walker Slough – Alternative 2

Stockton Stormwater Master Plan

CITY OF STOCKTON Hazen

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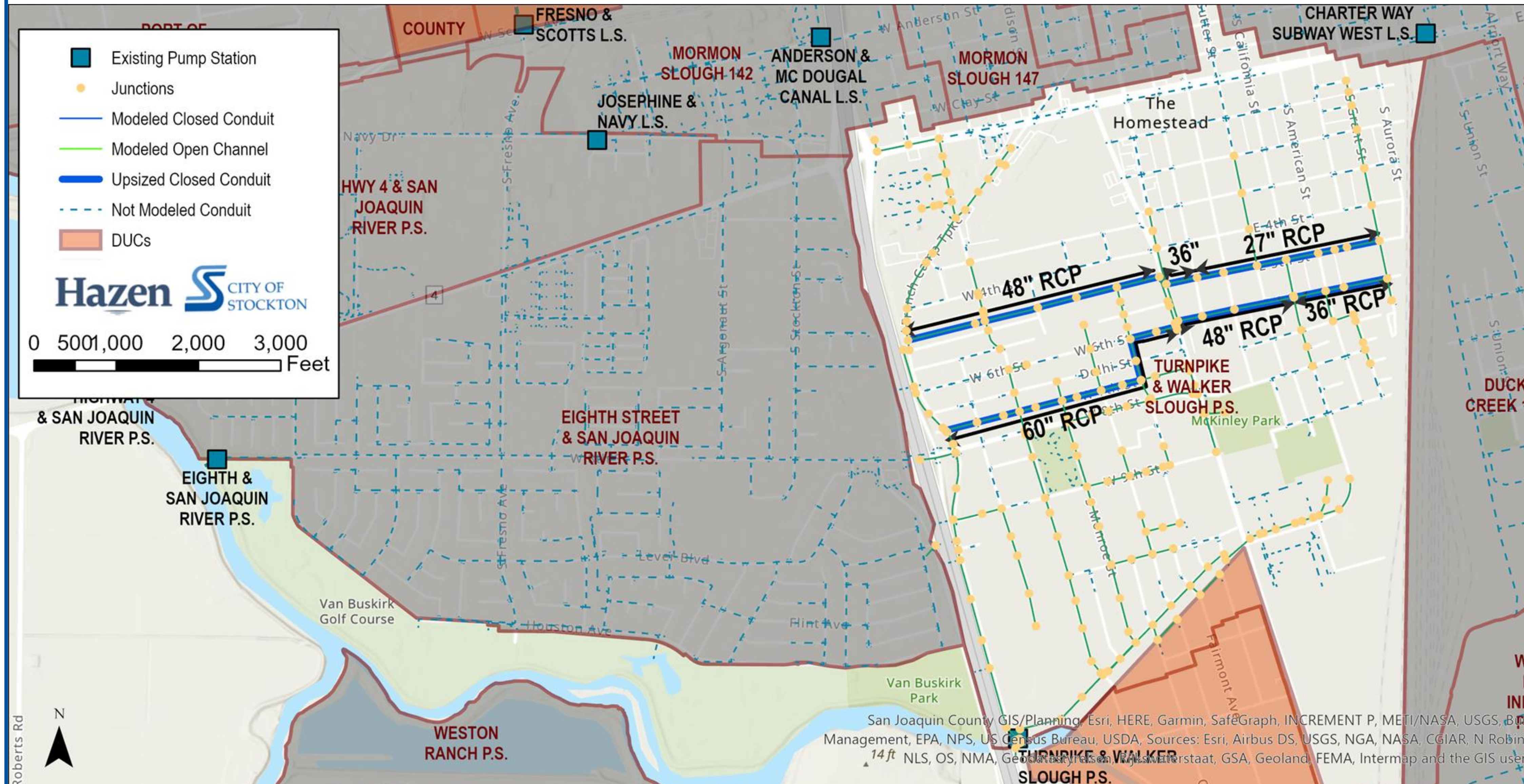
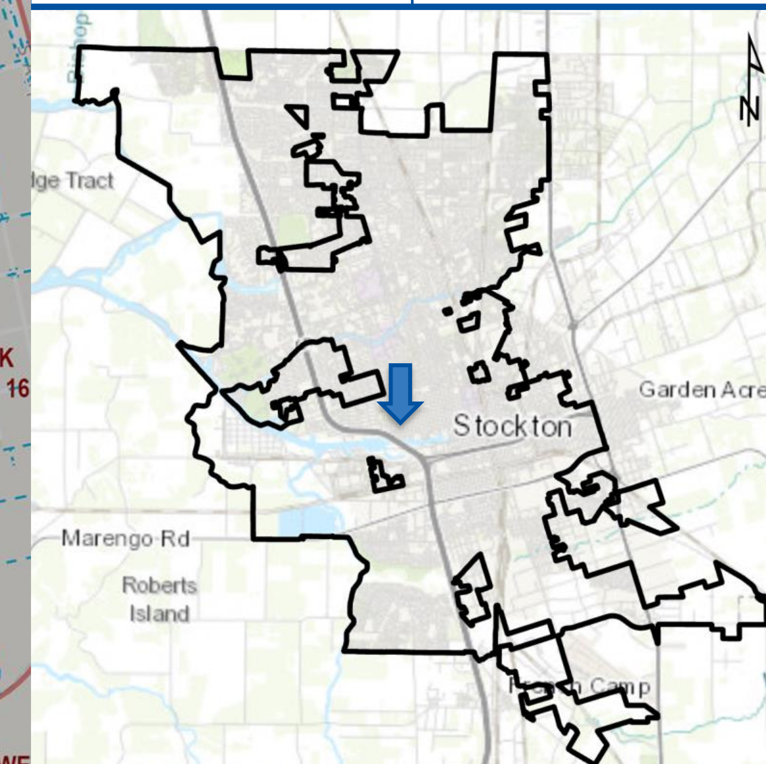




Site Information

Drainage Basin: Turnpike and Walker Slough

Receiving Water: Walker Slough

Existing Conditions

There are several known flooding locations throughout the watershed due to undersized conduits and the Turnpike and Walker Slough P.S. There are no significant detention ponds to mitigate peak runoff. The goals of this plan are to provide additional conveyance, upsize the pump station, and reduce flooding.

Proposed Improvement

This alternative diverts all flow west of I-5 to the Eight Street and San Joaquin PS. This diversion significantly reduces the amount of inflow to the Turnpike and Walker Slough PS which reduces the amount of upsizing needed. Pipe upsizing is still required east of I-5 but less than Alternative 1. No pump upsizing is needed as a result of this diversion.

Concern Area Characteristics

Known Concern Area	Yes	Traffic Impacts	High
Extent of Concerns	High	Support for Future Dev.	Low
Flooding Frequency	High	Data Confidence	Medium

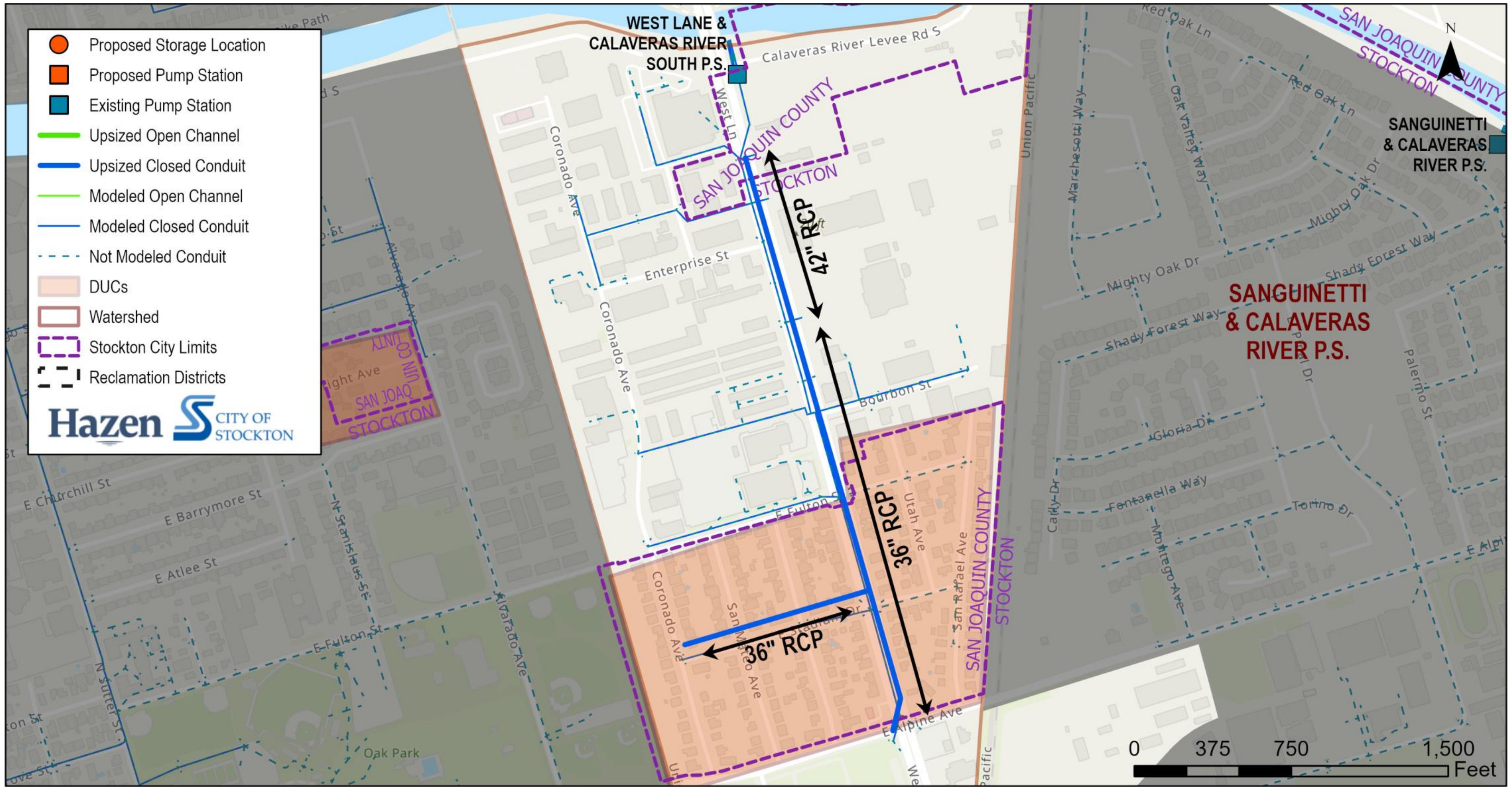
Conceptual Level Estimates

Construction Cost: $19,489,763
Estimated O&M: Medium
Co-Benefits: None Identified

Improvement Typologies

Upsized Conveyance

West Lane & Calaveras River South P.S.



Existing Conditions

The West Lane & Calaveras River South PS has a highly impervious watershed with no storage. There is very little Information on the pump station capacity but this area has been identified in the 2040 General Plan as a Study Area. The existing model shows flooding in the upstream portion of the watershed along Stadium Dr and West Ln. The existing peak flow to the pump station during the 10-yr, 24-hour design storm is 120 cfs. Because of the limited pump station data, the hydraulic model assumes an ideal pump where all incoming flow to the pump station can be pumped out at the same rate.

Proposed Improvement

The recommended improvements are to upsize the pipe along West Ln and Stadium Dr. The larger pipes send an additional 16 cfs to the pump station, a total of 136 cfs (13% increase). This increased flow may not require changes to the pump station, but this was not able to be evaluated with the given information.

Stockton Stormwater Master Plan

CITY OF STOCKTON — Hazen

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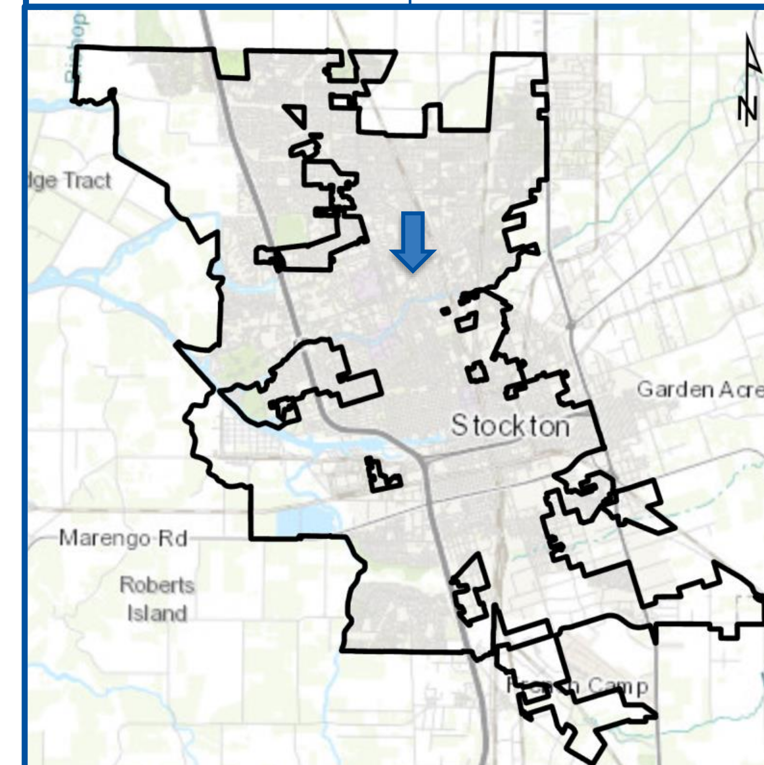

Site Information

Drainage Basin: West Lane & Calaveras River South P.S.

Receiving Water: Calaveras River

Concern Area Characteristics

Known Concern Area	No	**Traffic Impacts**	Medium
Extent of Concerns	Low	**Support for Future Dev.**	Low
Flooding Frequency	Medium	**Data Confidence**	Medium

Conceptual Level Estimates

Construction Cost: $ 6,517,147
Estimated O&M: Low
Co-Benefits: None Identified
Overall Priority: Low

Improvement Typologies

Upsized Conveyance

Appendix D:
Preliminary Opinions of Probable Construction Costs

Preliminary Opinion of Project Cost for the Walker Turnpike Alt 1 Project							
Item	Measured Quantity	Additional Quantity	Safety Factor (%)	Quantity	Unit	Unit Price	Item Cost
Mobilization / Demobiliation	1	0	-	1	LS	$1,302,000	$1,302,000
Erosion Control	1	0	-	1	LS	$635,500	$635,500
Comprehensive Grading	1	0	-	1	LS	$4,233,737	$4,233,737
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	29,390	3010	10	32,400	SY	$80	$2,591,960
Remove and Replace Concrete Curb and Gutter	15,550	1550	10	17,100	LF	$60	$1,026,000
Aggregate Base Course	4,929	471	10	5,400	CY	$65	$350,975
36" Class III RCP Above 5' Up to 10' Cover	3,900	400	10	4,300	LF	$375	$1,612,500
48" Class III RCP Above 5' Up to 10' Cover	3,150	300	10	3,450	LF	$520	$1,794,000
60" Class III RCP Above 5' Up to 10' Cover	5,000	500	10	5,500	LF	$680	$3,740,000
10' x 5' RCBC Above 5' Up to 10' Cover	5,100	500	10	5,600	LF	$880	$4,928,000
Remove Existing Drainage Structure	165	15	9	180	EA	$1,900	$342,633
Standard Catch Basin	114	11	10	125	EA	$7,300	$914,933
Standard Manhole (up to 10-ft depth)	51	4	8	55	EA	$11,500	$632,500
Pump Station Up to X-MGD			-	1	EA	$3,235,183	$3,235,183
						Subtotal	$27,339,922
						Contigency	$8,201,977
						Total Preliminary Opinion of Probable Construction Cost	$35,541,898
						Administration, Design, Permitting, Fiscal, and Legal Fees	$10,662,570
						Total Preliminary Opinion of Probable Project Cost	**$46,204,468**

The Engineer's opinions of probable costs are made on the basis of the engineer's experience and qualifications and represent the engineer's best judgement as a professional generally familiar with the construction industry. Since the engineer has no control over the cost of labor, materials, equipment, or services furnished by others, over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the engineer cannot and does not guarantee that proposal, bids, or actual construction costs will not vary from opinions of probable costs presented herein.

Preliminary Opinion of Project Cost for the Walker Turnpike Alt 2 Project							
Item	**Measured Quantity**	**Additional Quantity**	**Safety Factor (%)**	**Quantity**	**Unit**	**Unit Price**	**Item Cost**
Mobilization / Demobiliation	1	0	-	1	LS	$549,500	$549,500
Erosion Control	1	0	-	1	LS	$268,000	$268,000
Comprehensive Grading	1	0	-	1	LS	$1,785,817	$1,785,817
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	16,254	1746	11	18,000	SY	$80	$1,440,000
Remove and Replace Concrete Curb and Gutter	8,600	850	10	9,450	LF	$60	$567,000
Aggregate Base Course	2,726	274	10	3,000	CY	$65	$194,987
30" Class III RCP Above 5' Up to 10' Cover	1,500	150	10	1,650	LF	$310	$511,500
36" Class III RCP Above 5' Up to 10' Cover	1,600	160	10	1,760	LF	$375	$660,000
48" Class III RCP Above 5' Up to 10' Cover	4,600	460	10	5,060	LF	$520	$2,631,200
60" Class III RCP Above 5' Up to 10' Cover	2,500	250	10	2,750	LF	$680	$1,870,000
Remove Existing Drainage Structure	100			100	EA	$1,900	$190,000
Standard Catch Basin	68			68	EA	$7,300	$496,400
Standard Manhole (up to 10-ft depth)	32			32	EA	$11,500	$368,000
Subtotal							$11,532,404
Contigency							$3,459,721
Total Preliminary Opinion of Probable Construction Cost							$14,992,125
Administration, Design, Permitting, Fiscal, and Legal Fees							$4,497,638
Total Preliminary Opinion of Probable Project Cost							**$19,489,763**

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Item	Measured Quantity	Additional Quantity	Safety Factor (%)	Quantity	Unit	Unit Price	Item Cost
Preliminary Opinion of Project Cost for the 8th & San Joaquin Project							
Mobilization / Demobiliation	1	0	-	1	LS	$1,568,500	$1,568,500
Erosion Control	1	0	-	1	LS	$765,000	$765,000
Comprehensive Grading	1	0	-	1	LS	$5,099,496	$5,099,496
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	85,071	4429	5	89,500	SY	$80	$7,159,987
Remove and Replace Concrete Curb and Gutter	20,699	1301	6	22,000	LF	$60	$1,319,970
Aggregate Base Course	14,178	822	6	15,000	CY	$65	$975,031
60" Class III RCP Above 5' Up to 10' Cover	12,803	1197	9	14,000	LF	$680	$9,520,000
60" Class III RCP Above 5' Up to 10' Cover	318	32	10	350	LF	$680	$238,000
60" Class III RCP Up to 5' Cover	4,187	313	7	4,500	LF	$605	$2,722,500
54" Class III RCP Up to 5' Cover	1,765	235	13	2,000	LF	$515	$1,029,743
48" Class III RCP Up to 5' Cover	1,626	124	8	1,750	LF	$455	$796,250
Remove Existing Drainage Structure	165	10	6	175	EA	$1,900	$332,500
Standard Catch Basin	138	7	5	145	EA	$7,300	$1,058,500
Standard Manhole (up to 10-ft depth)	27	3	11	30	EA	$11,500	$345,000
						Subtotal	$32,930,476
						Contigency	$9,879,143
						Total Preliminary Opinion of Probable Construction Cost	$42,809,619
						Administration, Design, Permitting, Fiscal, and Legal Fees	$12,842,886
						Total Preliminary Opinion of Probable Project Cost	**$55,652,504**

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Preliminary Opinion of Project Cost for the Mormon Slough Project							
Item	Measured Quantity	Additional Quantity	Safety Factor (%)	Quantity	Unit	Unit Price	Item Cost
Mobilization / Demobiliation	1	0	-	1	LS	$776,000	$776,000
Erosion Control	1	0	-	1	LS	$378,500	$378,500
Comprehensive Grading	1	0	-	1	LS	$2,521,984	$2,521,984
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	17,822	4429	25	22,251	SY	$80	$1,780,080
Remove and Replace Concrete Curb and Gutter	7,638	1301	17	8,939	LF	$60	$536,340
Aggregate Base Course	2,970	822	28	3,792	CY	$65	$246,502
48" Class III RCP Above 5' Up to 10' Cover	3,261	239	7	3,500	LF	$520	$1,820,000
36" Class III RCP Above 5' Up to 10' Cover	1,737	163	9	1,900	LF	$375	$712,500
42" Class III RCP Above 5' Up to 10' Cover	3,274	276	8	3,550	LF	$435	$1,544,250
60" Class III RCP Above 5' Up to 10' Cover	2,108	192	9	2,300	LF	$680	$1,564,000
7' x 4' RCBC Above 5' Up to 10' Cover	1,556	144	9	1,700	LF	$630	$1,071,000
7' x 5' RCBC Above 5' Up to 10' Cover	2,227	223	10	2,450	LF	$685	$1,678,250
Remove Existing Drainage Structure	144	11	8	155	EA	$1,900	$294,500
Standard Catch Basin	94	6	6	100	EA	$7,300	$730,000
Standard Manhole (up to 10-ft depth)	50	5	10	55	EA	$11,500	$632,500
						Subtotal	$16,286,406
						Contigency	$4,885,922
						Total Preliminary Opinion of Probable Construction Cost	$21,172,328
						Administration, Design, Permitting, Fiscal, and Legal Fees	$6,351,698
						Total Preliminary Opinion of Probable Project Cost	**$27,524,026**

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Preliminary Opinion of Project Cost for the Bianchi and Calaveras Project							
Item	Measured Quantity	Additional Quantity	Safety Factor (%)	Quantity	Unit	Unit Price	Item Cost
Mobilization / Demobiliation	1	0	-	1	LS	$865,000	$865,000
Erosion Control	1	0	-	1	LS	$422,000	$422,000
Comprehensive Grading	1	0	-	1	LS	$2,811,356	$2,811,356
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	22,374	2126	10	24,500	SY	$80	$1,960,027
Remove and Replace Concrete Curb and Gutter	9,589	941	10	10,530	LF	$60	$631,800
Aggregate Base Course	3,729	401	11	4,130	CY	$65	$268,454
48" Class III RCP Above 5' Up to 10' Cover	867	83	10	950	LF	$520	$494,000
54" Class III RCP Above 5' Up to 10' Cover	3,000	300	10	3,300	LF	$585	$1,930,500
42" Class III RCP Above 5' Up to 10' Cover	927	73	8	1,000	LF	$435	$435,000
6' x 5' RCBC Above 5' Up to 10' Cover	4,795	405	8	5,200	LF	$620	$3,224,000
Remove Existing Drainage Structure	97	8	8	105	EA	$1,900	$199,500
Standard Catch Basin	64	6	9	70	EA	$7,300	$511,000
Standard Manhole (up to 10-ft depth)	33	2	6	35	EA	$11,500	$402,500
Storm Drainage Pump Stations	1						$4,000,000
						Subtotal	$18,155,136
						Contigency	$5,446,541
						Total Preliminary Opinion of Probable Construction Cost	$23,601,677
						Administration, Design, Permitting, Fiscal, and Legal Fees	$7,080,503
						Total Preliminary Opinion of Probable Project Cost	**$30,682,180**

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Preliminary Opinion of Project Cost for the West Ln+Calaveras Project							
Item	Measured Quantity	Additional Quantity	Safety Factor (%)	Quantity	Unit	Unit Price	Item Cost
Mobilization / Demobiliation	1	0	-	1	LS	$184,000	$184,000
Erosion Control	1	0	-	1	LS	$90,000	$90,000
Surveying	1	0	-	1	LS	$0	$0
Dewatering and Flow Diversion	1	0	-	1	LS	$0	$0
Comprehensive Grading	1	0	-	1	LS	$597,050	$597,050
Utility Relocation (Moderate)	1	0	-	1	LS	$0	$0
Traffic Control (Major)	1		-	1	LS	$0	$0
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	10,164	936	9	11,100	SY	$80	$888,000
Remove and Replace Concrete Curb and Gutter	3,267	303	9	3,570	LF	$60	$214,200
Aggregate Base Course	1,694	156	9	1,850	CY	$65	$120,250
36" Class III RCP Above 5' Up to 10' Cover	2,686	214	8	2,900	LF	$375	$1,087,500
42" Class III RCP Above 5' Up to 10' Cover	581	59	10	640	LF	$435	$278,400
Remove Existing Drainage Structure	34	4	12	38	EA	$1,900	$72,200
Standard Catch Basin	22	2	9	24	EA	$7,300	$175,200
Standard Manhole (up to 10-ft depth)	12	1	8	13	EA	$11,500	$149,500
						Subtotal	$3,856,300
						Contigency	$1,156,890
						Total Preliminary Opinion of Probable Construction Cost	$5,013,190
						Administration, Design, Permitting, Fiscal, and Legal Fees	$1,503,957
						Total Preliminary Opinion of Probable Project Cost	**$6,517,147**

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Preliminary Opinion of Project Cost for the Sutter+Calaveras Riv Project							
Item	Measured Quantity	Additional Quantity	Safety Factor (%)	Quantity	Unit	Unit Price	Item Cost
Mobilization / Demobiliation	1	0	-	1	LS	$386,500	$386,500
Erosion Control	1	0	-	1	LS	$188,500	$188,500
Comprehensive Grading	1	0	-	1	LS	$1,256,324	$1,256,324
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	11,125	936	8	12,061	SY	$80	$964,880
Remove and Replace Concrete Curb and Gutter	6,675	303	5	6,978	LF	$60	$418,680
Aggregate Base Course	1,854	156	8	2,010	CY	$65	$130,661
48" Class III RCP Above 5' Up to 10' Cover	360	30	8	390	LF	$520	$202,800
42" Class III RCP Above 5' Up to 10' Cover	3,680	370	10	4,050	LF	$435	$1,761,750
60" Class III RCP Above 5' Up to 10' Cover	1,842	168	9	2,010	LF	$680	$1,366,800
54" Class III RCP Above 5' Up to 10' Cover	793	77	10	870	LF	$585	$508,950
Remove Existing Drainage Structure	76	8	11	84	EA	$1,900	$159,600
Standard Catch Basin	45	5	11	50	EA	$7,300	$365,000
Standard Manhole (up to 10-ft depth)	31	4	13	35	EA	$11,500	$402,500
						Subtotal	$8,112,945
						Contigency	$2,433,884
						Total Preliminary Opinion of Probable Construction Cost	$10,546,829
						Administration, Design, Permitting, Fiscal, and Legal Fees	$3,164,049
						Total Preliminary Opinion of Probable Project Cost	**$13,710,877**

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Preliminary Opinion of Project Cost for the Legion Park+Smith Canal Project							
Item	Measured Quantity	Additional Quantity	Safety Factor (%)	Quantity	Unit	Unit Price	Item Cost
Mobilization / Demobiliation	1	0	-	1	LS	$1,433,500	$1,433,500
Erosion Control	1	0	-	1	LS	$699,500	$699,500
Comprehensive Grading	1	0	-	1	LS	$4,660,691	$4,660,691
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	42,361	936	2	43,297	SY	$80	$3,463,751
Remove and Replace Concrete Curb and Gutter	16,576	303	2	16,879	LF	$60	$1,012,740
Aggregate Base Course	7,060	156	2	7,216	CY	$65	$469,050
30" Class III RCP Above 5' Up to 10' Cover	958	30	3	988	LF	$310	$306,280
36" Class III RCP Above 5' Up to 10' Cover	3,905	370	9	4,275	LF	$375	$1,603,125
42" Class III RCP Above 5' Up to 10' Cover	222	168	76	390	LF	$435	$169,650
48" Class III RCP Above 5' Up to 10' Cover	1,716	77	4	1,793	LF	$520	$932,360
10' x 5' RCBC Above 5' Up to 10' Cover	9,775		-	9,775	LF	$880	$8,602,000
Remove Existing Drainage Structure	195	8	4	203	EA	$1,900	$385,700
Standard Catch Basin	111	5	5	116	EA	$7,300	$846,800
Standard Manhole (up to 10-ft depth)	84	4	5	88	EA	$11,500	$1,012,000
Storm Drainage Pump Stations	1						$4,500,000
						Subtotal	$30,097,147
						Contigency	$9,029,144
						Total Preliminary Opinion of Probable Construction Cost	$39,126,291
						Administration, Design, Permitting, Fiscal, and Legal Fees	$11,737,887
						Total Preliminary Opinion of Probable Project Cost	**$50,864,178**

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Preliminary Opinion of Project Cost for the HW4 and San Joaquin Project							
Item	Measured Quantity	Additional Quantity	Safety Factor (%)	Quantity	Unit	Unit Price	Item Cost
Mobilization / Demobiliation	1	0	-	1	LS	$702,000	$702,000
Erosion Control	1	0	-	1	LS	$342,500	$342,500
Comprehensive Grading	1	0	-	1	LS	$2,281,807	$2,281,807
Clearing and Grubbing	6.75	0.5	7	7	AC	$6,900	$50,025
Excavation	14222	0	-	14,222	CY	$40	$568,889
Permanent Seeding and Mulching	6.75	0	-	7	AC	$51,600	$348,300
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	16944	633	4	17,577	SY	$80	$1,406,196
Remove and Replace Concrete Curb and Gutter	2400	250	10	2,650	LF	$60	$159,000
Aggregate Base Course	2824	467	17	3,291	CY	$65	$213,920
36" Class IV RCP Up to 5' Cover	375	50	13	425	LF	$325	$138,125
42" Class IV RCP Up to 5' Cover	1500	150	10	1,650	LF	$390	$643,500
48" Class IV RCP Up to 5' Cover	850	100	12	950	LF	$440	$418,000
54" Class IV RCP Up to 5' Cover	950	100	11	1,050	LF	$525	$551,250
60" Class IV RCP Up to 5' Cover	1550	150	10	1,700	LF	$625	$1,062,500
8' x 4' RCBC Above 5' Up to 10' Cover	2400	250	10	2,650	LF	$710	$1,881,500
Remove Existing Drainage Structure	14	0	-	14	EA	$1,900	$26,600
Standard Catch Basin	51	4	8	55	EA	$7,300	$400,283
Pump Station Up to X-MGD			-	1	EA	$3,540,948	$3,540,948
						Subtotal	$14,735,343
						Contigency	$4,420,603
						Total Preliminary Opinion of Probable Construction Cost	$19,155,946
						Administration, Design, Permitting, Fiscal, and Legal Fees	$5,746,784
						Total Preliminary Opinion of Probable Project Cost	**$24,902,729**

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Preliminary Opinion of Project Cost for the Bonniebrook Project							
Item	Measured Quantity	Additional Quantity	Safety Factor (%)	Quantity	Unit	Unit Price	Item Cost
Mobilization / Demobiliation	1	0	-	1	LS	$325,500	$325,500
Erosion Control	1	0	-	1	LS	$159,000	$159,000
Comprehensive Grading	1	0	-	1	LS	$1,058,030	$1,058,030
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	2614	236	9	2,850	SY	$80	$228,036
Remove and Replace Concrete Pavement (4" Thick)	2222	78	4	2,300	SY	$100	$230,022
Remove and Replace Concrete Curb and Gutter	5000	500	10	5,500	LF	$60	$330,000
Aggregate Base Course	806	111	14	917	CY	$65	$59,612
18" Class III RCP Up to 5' Cover	500	50	10	550	LF	$145	$79,750
36" Class III RCP Up to 5' Cover	1530	170	11	1,700	LF	$320	$544,000
42" Class III RCP Up to 5' Cover	244	16	7	260	LF	$375	$97,500
48" Class III RCP Up to 5' Cover	907	93	10	1,000	LF	$455	$455,000
54" Class III RCP Up to 5' Cover	792	58	7	850	LF	$515	$437,750
60" Class III RCP Up to 5' Cover	733	67	9	800	LF	$605	$484,000
Remove Existing Drainage Structure	19	0	-	19	EA	$1,900	$36,100
Standard Catch Basin	31	0	-	31	EA	$7,300	$229,025
Pump Station Up to X-MGD		0	-	1	EA	$2,079,356	$2,079,356
						Subtotal	$6,832,682
						Contigency	$2,049,804
						Total Preliminary Opinion of Probable Construction Cost	$8,882,486
						Administration, Design, Permitting, Fiscal, and Legal Fees	$2,664,746
						Total Preliminary Opinion of Probable Project Cost	**$11,547,232**

The Engineer's opinions of probable costs are made on the basis of the engineer's experience and qualifications and represent the engineer's best judgement as a professional generally familiar with the construction industry. Since the engineer has no control over the cost of labor, materials, equipment, or services furnished by others, over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the engineer cannot and does not guarantee that proposal, bids, or actual construction costs will not vary from opinions of probable costs presented herein.

Preliminary Opinion of Project Cost for the BoggsTract Project							
Item	Measured Quantity	Additional Quantity	Safety Factor (%)	Quantity	Unit	Unit Price	Item Cost
Mobilization / Demobiliation	1	0	-	1	LS	$483,500	$483,500
Erosion Control	1	0	-	1	LS	$236,000	$236,000
Comprehensive Grading	1	0	-	1	LS	$1,570,871	$1,570,871
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	3209	91	3	3,300	SY	$80	$264,036
Remove and Replace Concrete Pavement (4" Thick)	400	25	6	425	SY	$100	$42,500
Remove and Replace Concrete Curb and Gutter	900	50	6	950	LF	$60	$57,000
Aggregate Base Course	542	45	8	587	CY	$65	$38,127
18" Class III RCP Up to 5' Cover	421	29	7	450	LF	$145	$65,250
24" Class III RCP Up to 5' Cover	57	3	5	60	LF	$185	$11,100
30" Class III RCP Up to 5' Cover	3101	199	6	3,300	LF	$255	$841,500
36" Class III RCP Up to 5' Cover	720	30	4	750	LF	$320	$240,000
42" Class III RCP Above 5' Up to 10' Cover	1266	34	3	1,300	LF	$435	$565,500
48" Class III RCP Above 5' Up to 10' Cover	854	46	5	900	LF	$520	$468,000
Remove Existing Drainage Structure	30		-	30	EA	$1,900	$57,000
Standard Catch Basin	43		-	43	EA	$7,300	$312,391
Pump Station Up to X-MGD			-	1	EA	$4,891,950	$4,891,950
						Subtotal	$10,144,725
						Contigency	$3,043,418
						Total Preliminary Opinion of Probable Construction Cost	$13,188,143
						Administration, Design, Permitting, Fiscal, and Legal Fees	$3,956,443
						Total Preliminary Opinion of Probable Project Cost	**$17,144,585**

The Engineer's opinions of probable costs are made on the basis of the engineer's experience and qualifications and represent the engineer's best judgement as a professional generally familiar with the construction industry. Since the engineer has no control over the cost of labor, materials, equipment, or services furnished by others, over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the engineer cannot and does not guarantee that proposal, bids, or actual construction costs will not vary from opinions of probable costs presented herein.

Preliminary Opinion of Project Cost for the Deep Water Project							
Item	**Measured Quantity**	**Additional Quantity**	**Safety Factor (%)**	**Quantity**	**Unit**	**Unit Price**	**Item Cost**
Mobilization / Demobiliation	1	0	-	1	LS	$288,500	$288,500
Erosion Control	1	0	-	1	LS	$141,000	$141,000
Comprehensive Grading	1	0	-	1	LS	$937,278	$937,278
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	32103	222	1	32,325	SY	$80	$2,586,000
Aggregate Base Course	5351	111	2	5,462	CY	$65	$354,998
48" Class III RCP Up to 5' Cover	3321	93	3	3,414	LF	$455	$1,553,370
Remove Existing Drainage Structure	16	0	-	16	EA	$1,900	$30,400
Standard Catch Basin	22	0	-	22	EA	$7,300	$161,622
						Subtotal	$6,053,167
						Contigency	$1,815,950
						Total Preliminary Opinion of Probable Construction Cost	$7,869,118
						Administration, Design, Permitting, Fiscal, and Legal Fees	$2,360,735
						Total Preliminary Opinion of Probable Project Cost	**$10,229,853**

The Engineer's opinions of probable costs are made on the basis of the engineer's experience and qualifications and represent the engineer's best judgement as a professional generally familiar with the construction industry. Since the engineer has no control over the cost of labor, materials, equipment, or services furnished by others, over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the engineer cannot and does not guarantee that proposal, bids, or actual construction costs will not vary from opinions of probable costs presented herein.

Preliminary Opinion of Project Cost for the Little John Project							
Item	**Measured Quantity**	**Additional Quantity**	**Safety Factor (%)**	**Quantity**	**Unit**	**Unit Price**	**Item Cost**
Mobilization / Demobiliation	1	0	-	1	LS	$128,500	$128,500
Erosion Control	1	0	-	1	LS	$63,000	$63,000
Comprehensive Grading	1	0	-	1	LS	$417,011	$417,011
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	5219	222	4	5,441	SY	$80	$435,280
Remove and Replace Concrete Curb and Gutter	2653.97	0	-	2,654	LF	$60	$159,238
Aggregate Base Course	1312	111	8	1,423	CY	$65	$92,506
48" Class III RCP Up to 5' Cover	2653.97	93	4	2,747	LF	$455	$1,249,871
Remove Existing Drainage Structure	10	0	-	10	EA	$1,900	$19,000
Standard Catch Basin	18	0	-	18	EA	$7,300	$129,160
						Subtotal	$2,693,566
						Contigency	$808,070
						Total Preliminary Opinion of Probable Construction Cost	$3,501,636
						Administration, Design, Permitting, Fiscal, and Legal Fees	$1,050,491
						Total Preliminary Opinion of Probable Project Cost	**$4,552,126**

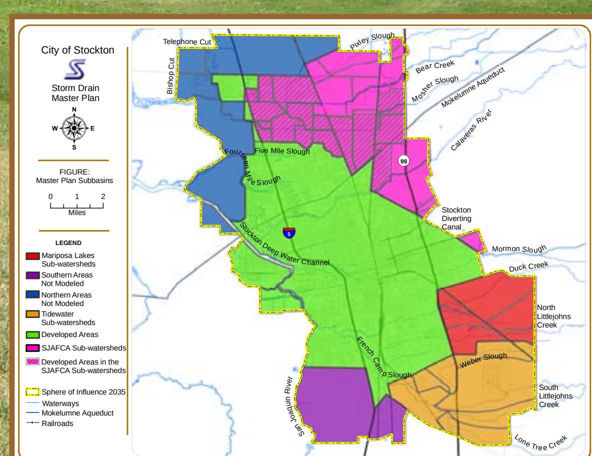
The Engineer's opinions of probable costs are made on the basis of the engineer's experience and qualifications and represent the engineer's best judgement as a professional generally familiar with the construction industry. Since the engineer has no control over the cost of labor, materials, equipment, or services furnished by others, over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the engineer cannot and does not guarantee that proposal, bids, or actual construction costs will not vary from opinions of probable costs presented herein.

Preliminary Opinion of Project Cost for the Duck Creek Project							
Item	Measured Quantity	Additional Quantity	Safety Factor (%)	Quantity	Unit	Unit Price	Item Cost
Mobilization / Demobiliation	1	0	-	1	LS	$340,000	$340,000
Erosion Control	1	0	-	1	LS	$166,000	$166,000
Comprehensive Grading	1	0	-	1	LS	$1,105,134	$1,105,134
Clearing and Grubbing	2.3	0.2	9	3	AC	$6,900	$17,537
Excavation	3333	267	8	3,600	CY	$40	$144,013
Channel Grading	8667	333	4	9,000	SY	$6	$53,998
Permanent Seeding and Mulching	2.3	0.2	9	3	AC	$51,600	$131,146
Remove and Replace Asphalt Pavement (2" SM + 6" BM)	813	37	5	850	SY	$80	$67,982
Aggregate Base Course	135	5	4	140	CY	$65	$9,130
15" Class III RCP Up to 5' Cover	550	50	9	600	LF	$130	$78,000
24" Class III RCP Up to 5' Cover	1463	87	6	1,550	LF	$185	$286,750
30" Class III RCP Up to 5' Cover	1553	47	3	1,600	LF	$255	$408,000
48" Class III RCP Up to 5' Cover	1451	49	3	1,500	LF	$455	$682,500
60" Class III RCP Up to 5' Cover	1360	90	7	1,450	LF	$605	$877,250
60" Class III RCP Up to 5' Cover	3646	354	10	4,000	LF	$605	$2,420,000
Standard Catch Basin	40		-	40	EA	$7,300	$292,365
Standard Manhole (up to 5-ft depth)	6		-	6	EA	$9,500	$57,000
						Subtotal	$7,136,807
						Contigency	$2,141,042
						Total Preliminary Opinion of Probable Construction Cost	$9,277,849
						Administration, Design, Permitting, Fiscal, and Legal Fees	$2,783,355
						Total Preliminary Opinion of Probable Project Cost	**$12,061,203**

The Engineer's opinions of probable costs are made on the basis of the engineer's experience and qualifications and represent the engineer's best judgement as a professional generally familiar with the construction industry. Since the engineer has no control over the cost of labor, materials, equipment, or services furnished by others, over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the engineer cannot and does not guarantee that proposal, bids, or actual construction costs will not vary from opinions of probable costs presented herein.

Appendix E:
City of Stockton 2008 Conceptual Storm Drain Master Plan

City of Stockton Conceptual Storm Drain Master Plan



PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

October 2008

City of Stockton Conceptual Storm Drain Master Plan

Prepared for
City of Stockton
Department of Municipal Utilities
2500 Navy Drive
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Prepared by
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1180 Iron Point Road Suite 260
Folsom, CA 95630
October 2008

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1 Executive Summary

The City of Stockton Conceptual Storm Drain Master Plan is a framework document for developers and City Staff to define a process and criteria for future detailed sub-watershed storm drain planning in growth areas of the City's General Plan Boundary. The primary purposes of this Plan include:

- Develop sub-watersheds within the 2035 General Plan Boundary
- Define receiving water quantity constraints based on previously approved hydrologic and hydraulic models.
- Review existing storm water policies and update as necessary

The area within the General Plan Boundary was divided into drainage sub-watersheds. This Plan focuses on undeveloped areas around the internal perimeter of the General Plan Boundary.

The situation arises too often in storm water planning that a conveyance system is built without fully considering the impact of upstream development and resulting changes in runoff characteristics. This Plan attempts to discourage that by implementing strategic planning measures to create an appropriate storm water system for each sub-watershed. Therefore, the entire area in each sub-watershed will be planned for storm water runoff collection, conveyance, detention and discharge prior to approval of any development within that sub-watershed. This Plan presents guidelines for developing a sub-watershed storm drain master plan.

In areas where waterway improvements are governed by hydrologic and hydraulic models, discharge limitations were refined in order to maintain a sustainable conveyance capacity. Additional limitations have been developed as safety factors and guidelines for the operation of discharge facilities including:

1. Zero discharge from the sub-watershed once the water surface elevation in the receiving water reaches 0.5-feet below the FEMA 100-year water surface profile at the discharge point.
2. At a minimum, detention basins in the sub-watershed must be sized to store at least four (4) hours of the prescribed pumping rate to accommodate a discharge shutdown.

Storm water infrastructure improvements within the City of Stockton and local urbanized areas of San Joaquin County are primarily based on hydrologic methodologies presented in two documents: the City Standards and the Draft Hydrology Manual developed by San Joaquin County. These documents will still be used and a discussion is presented on the use of these documents in conjunction with this Plan in Section 5 Hydrology Methodology.

The City's NPDES permit establishes waste discharge requirements and stipulates the City implement a Storm Water Management Plan (SWMP). The City has developed a Storm Water Management Plan and Storm Water Quality Control Criteria Plan to comply with the State Water Resources Control Board Regulations. Both of these Plans are discussed.

2 Introduction & Purpose

This Storm Drain Master Plan (Plan) establishes policies and design parameters for the future development of storm drain infrastructure in the City of Stockton's 2035 General Plan Boundary. This Plan is not intended to supersede the draft San Joaquin County Hydrology Manual or City of Stockton Storm Water Management Plan. Rather, this Plan supplements those documents and defines the process for planning and constructing storm drain facility improvements within the General Plan Boundary.

The purposes of this Plan include the following:

- Define the sub-watersheds within the 2035 General Plan Boundary. These sub-watersheds were developed with input from the City of Stockton Municipal Utilities Department and the various Developers in the region. The majority of these sub-watersheds have already been defined in the following studies:
    - Federal Emergency Management Agency, Flood Insurance Study, prepared on December 16, 2005 (revised). This study reflects hydrology and hydraulics developed by the San Joaquin Area Flood Control Agency (SJAFCA).
    - The Mariposa Lakes Development Off-Site Regional Hydrologic Investigation, prepared by Pacific Advanced Civil Engineering, Inc. on August 8, 2006.
    - The Tidewater Crossing Draft Hydrology/Hydraulic Analysis and Pre-Design Report, prepared by Domenichelli and Associates on September 15, 2006.
- Review the existing City Storm Drain Standards.
- Define receiving water quantity constraints based on previously approved hydrologic and hydraulic models.
- Summarize the discharge water quality constraints.
- Develop guidelines for Sub-watershed Storm Drain Master Planning.

3 Background

The City of Stockton is situated on the eastern boundary of the Sacramento/San Joaquin River Delta. The City is characterized by flat topography with a complex network of streams and rivers running through it. The northern portion of the City is protected by levees, and drainage is typically pumped into receiving waters. The southern portion of the City does not have many levees and is characterized by various floodplain designations. A detailed description of the area including its history, climate, various waterways, storage facilities, hydrology, principal flood problems, soil characteristics, flood protection measures, etc., is provided in the FEMA Flood Insurance Study (FIS) referenced below.

Improvements have been made on the majority of the waterways in the northern part of the City. At this time, these improvements provide 100-year flood protection to the surrounding areas. The developed portion of the City already has storm water infrastructure and it is therefore not addressed in this Plan.

Studies have been performed on the southern portion of the General Plan Boundary including the initial and subsequent revisions of the FIS. Most recently, hydrologic modeling of the main waterways for that area was performed as part of the planning for the Mariposa Lakes and Tidewater Crossing Developments. The studies attempt to characterize the approximate conveyance capacities, operations, and flood problems in that area and recommend improvements for their respective developments.

The Mariposa Lakes study presents a description of the previous studies, flow control measures, conveyance capacities, and operational methodologies of Farmington Dam and the flood control structures on Duck Creek and North Littlejohns Creek. The Tidewater Crossing study includes a description of South Littlejohns Creek, Lone Tree Creek, and French Camp Slough area.

Information on climate, geotechnical, or hydrologic information has been well documented in previous documents listed below and is therefore not re-visited here.

3.1 References

The following documents are referenced in this Plan and should be used during the planning and design of storm water infrastructure:

- Boyle Engineering, *Draft Hydrology Manual for San Joaquin County Department of Public Works*, September 1997

- City of Stockton *Standard Specifications,* adopted November 25, 2003

- City of Stockton Department of Municipal Utilities *Pump Station Design Guidelines*, revised August 27, 2001

- Domenichelli and Associates, *The Tidewater Crossing Draft Hydrology/Hydraulic Analysis and Pre-Design Report*, September 15, 2006.

- Ensign and Buckley Consulting Engineers, *North Little Johns Creek Drainage Study*

- Federal Emergency Management Agency, *Flood Insurance Study, San Joaquin County, California, Unincorporated Areas*, revised December 16, 2005
- Larry Walker Associates, City *of Stockton Storm Water Management Plan*, September 2003
- Larry Walker Associates, *City of Stockton Storm Water Quality Control Plan*, November 2003
- Pacific Advanced Civil Engineering, Inc., *Mariposa Lakes Development Off-Site Regional Hydrologic Investigation*, August 8, 2006.

4 Master Planning

This Plan is a framework document for developers and City Staff to define a process and criteria for future detailed sub-watershed storm drain planning in growth areas of the City's General Plan Boundary. Engineering of storm drainage systems in flat areas is highly sensitive to development land uses, street layouts, and grading plans. In addition, storm drainage systems tend to be de-centralized, draining to local channels or pump stations leading to channels. Past experience has shown that detailed Storm Drainage Master Plans are typically changed substantially once development-level planning and mapping occurs, so much of the technical effort involved in producing the Master Plan is wasted effort. However, receiving water systems have limits, and the City or its designee must control the fundamentals of storm drainage planning so that the incremental and cumulative impact of development is consistent with the design criteria for the San Joaquin Area Flood Control Agency (SJAFCA) and San Joaquin County Flood Control and Water Conservation District facilities.

Comparatively, master planned sewer systems are much less sensitive to final development mapping because they are not as sensitive to surface grading, and sewage production depends only on indoor uses, which is relatively predictable. Sewer systems also generally drain to a single point in a city, so it is both practical and necessary to master plan the backbone sewer piping systems to the outer limits of expected development, usually the General Plan Boundary. Additionally, water systems are fully interconnected pressurized systems which are relatively insensitive to grading, street layouts, and specific land uses, so prudent practice calls for establishing backbone piping and production systems in a Water System Master Plan.

Because storm drainage system planning is most efficiently planned in conjunction with planning of specific developments or groups of developments, the City's Storm Drainage Master Plan focuses on establishing a framework for subsequent planning by developers, and review by City staff. This Master Plan is structured to facilitate planning by presenting methodologies for use by community planners during the development phase. This document acts as the starting point for sub-watershed planning, presenting required information for planning and also directing the developer to other key documents that have been prepared for use in design.

4.1 Sub-watershed Delineation

The area within the General Plan Boundary was divided into drainage sub-watersheds as shown in Figure 4-1 This Plan focuses on undeveloped areas including the areas in the north, south and eastern portion of the City General Plan Boundary. Developed areas, predominantly in the center portion of the General Plan Boundary as shown in Figure 4-1, are not addressed by this Plan.

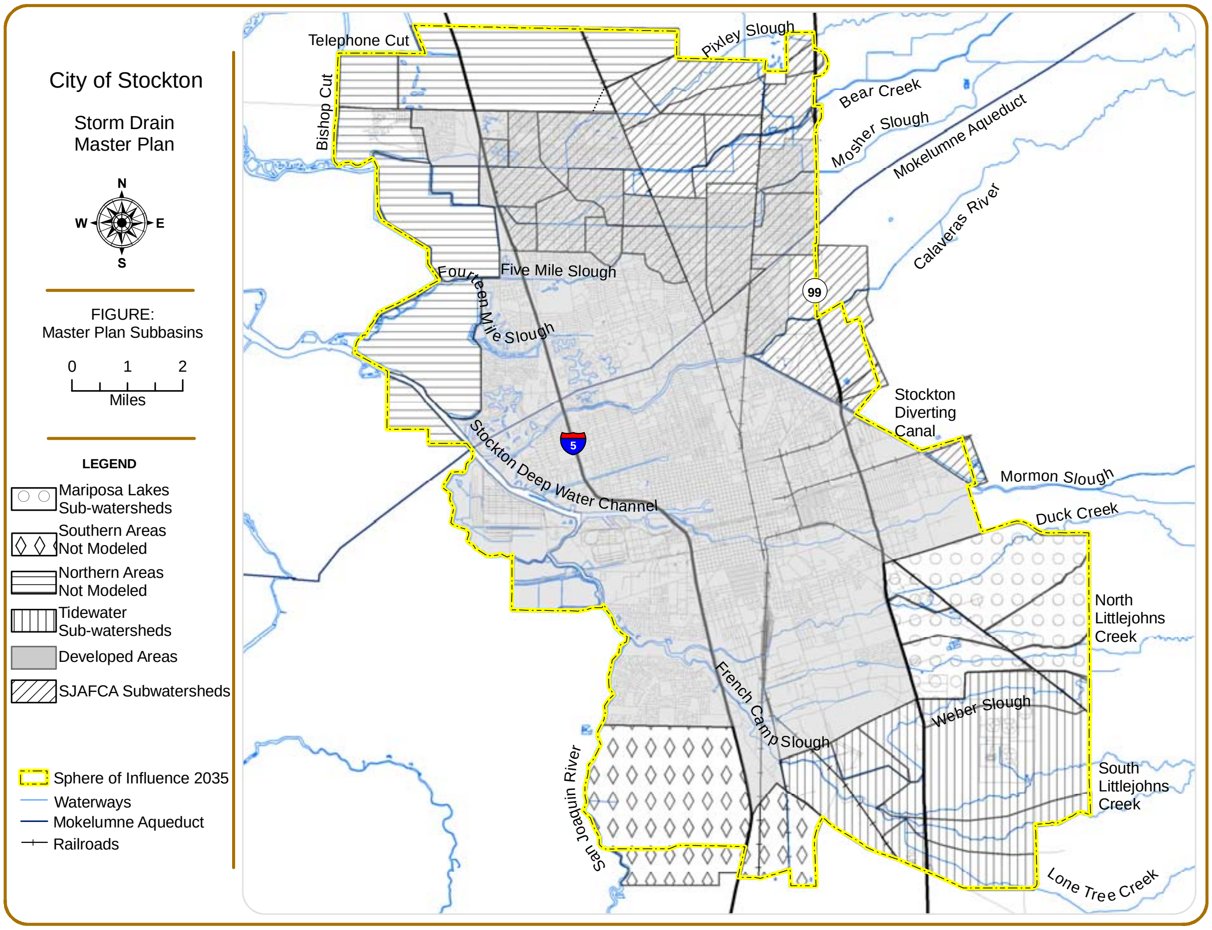

Figure 4-1 Sub-watersheds in the General Plan Boundary

Three hydrologic models were used to delineate sub-watershed boundaries including the Federal Emergency Management Agency (FEMA) approved San Joaquin Area Flood Control Agency (SJAFCA) models and two models developed separately for the Tidewater and Mariposa Lakes Developments in South Stockton. The SJAFCA models were approved by FEMA for use in the effective Flood Insurance Study, prepared in December, 2005 (revised). Neither the Tidewater or Mariposa Lakes models have been approved by the City, SJAFCA or FEMA at this time, but they are recognized as the best source of modeling information available. However, these models are subject to change pending final approval. No other hydrologic modeling was used in the development of this Plan.

As shown in Figure 4-1, the models represent sub-watersheds along the eastern portion of the General Plan Boundary. Areas in the northeastern portion of the General Plan Boundary were developed using the SJAFCA models. Waterways in the SJAFCA models include Pixley Slough, Bear Creek, Mosher Slough, Calaveras River, Diverting Canal and Mormon Slough. The Mariposa Lakes and Tidewater models represent the areas in the southeastern portion of the General Plan Boundary. Waterways in the Mariposa Lakes Model include Duck Creek, Branch Creek and North Littlejohns Creek. Waterways in the

Tidewater Model include Weber Slough, both North South Forks of South Littlejohns Creek, Duck Creek, North Littlejohns Creek, French Camp Slough and Lone Tree Creek.

As shown on Figure 4-2, the upstream watersheds for the Tidewater and Mariposa Lakes models overlap. This is due to a common upper watershed, with two diversion structures which alter the natural drainage patterns. The bifurcation points are both near Farmington Dam; one on Duck Creek and the other on Littlejohns Creek. At the most upstream diversion point, a diversion canal was constructed to divert water from Duck Creek to Littlejohns Creek. Downstream of that there is a bifurcation point on Littlejohns Creek where water can be diverted either to North Littlejohns Creek or South Littlejohns Creek.

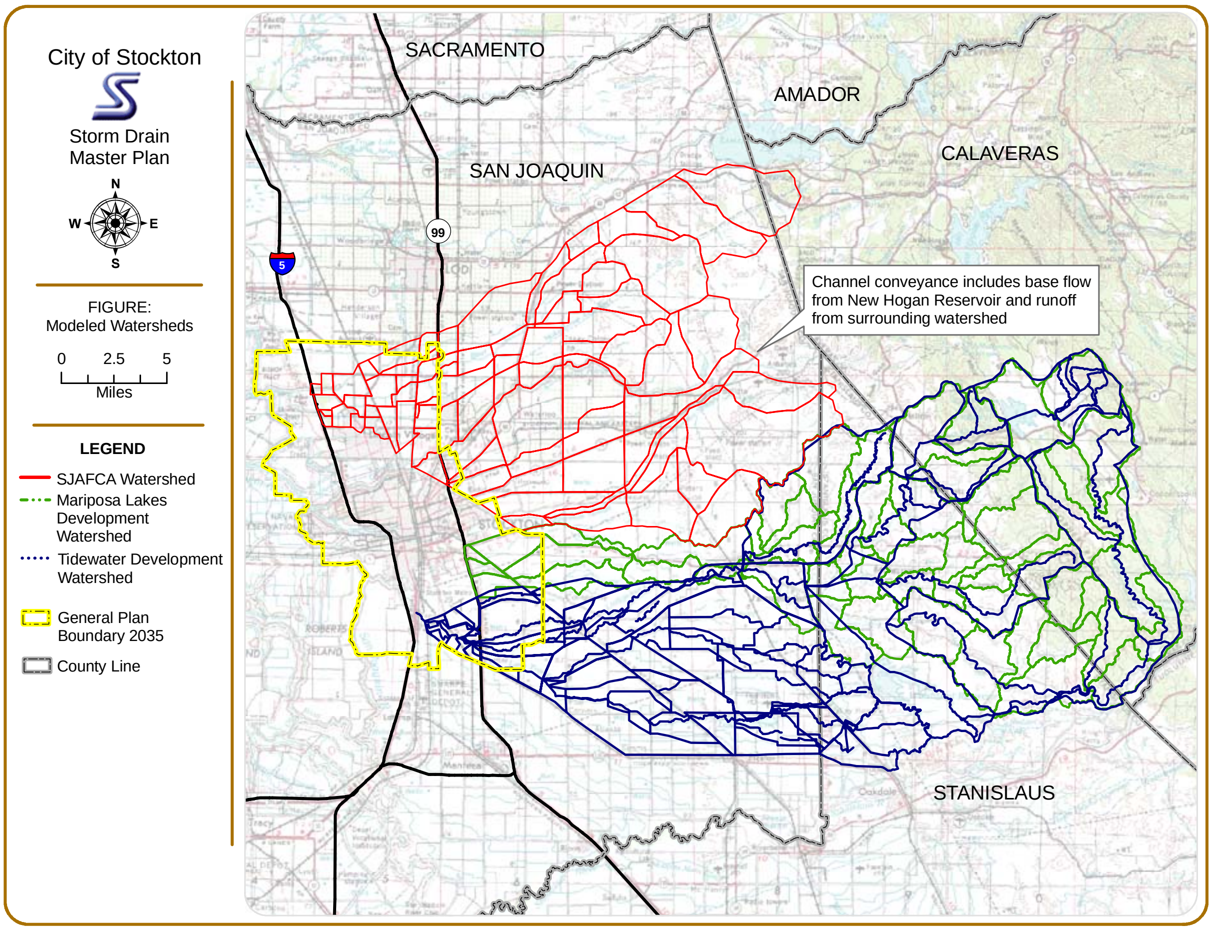

Figure 4-2 City of Stockton Watersheds incorporated into Hydrologic Models

The remaining subwatersheds were developed by the City with appropriate input from regional developers. The City considered a number of factors while developing the boundaries including the following considerations:

- Location and extent of currently planned developments

- Proximity to receiving waters
- Existing drainage patterns/boundaries
- Upstream runoff characteristics/limitations
- Current land use

4.2 Sub-watershed Planning

The situation arises too often in storm water planning that a conveyance system is built without fully considering the impact of upstream development, tributary areas and land use changes that result in modified runoff characteristics. This Plan attempts to avoid that pitfall by implementing strategic planning measures to create an appropriate storm water system for each sub-watershed.

The City of Stockton is located near the downstream end of a number of large watersheds as portrayed in Figure 4-2. Runoff from these watersheds is conveyed through the numerous waterways in the proposed General Plan Boundary. The high peak flows that runoff from these areas combined with the flat topography pose significant planning and design challenges. In addition, development changes drainage patterns and land use, which typically results in increased runoff, higher peak discharges and reduced time of concentration.

Large areas, such as the sub-watersheds presented in this Plan, are rarely developed all at once. Typically, the area will be built out in stages which can result in disjointed storm water systems if proper planning is not implemented. Therefore, it must be decided how to manage all the runoff from the sub-watershed, its upstream drainage, and downstream impacts before developing any portion of the area. The Stockton Municipal Code Section 16.355.210 sets the criteria for development within a drainage area. The following planning measure supports that code section.

> **Planning Measure One –** The entire area in each sub-watershed will be planned for storm water runoff collection, conveyance, detention and discharge prior to approval of any significant development within the sub-watershed.

Developers must be able to provide the proper facilities necessary to safely convey, store and discharge storm water. Measures will be taken to account for runoff upstream of the development and for downstream conveyance and storage. Detailed criteria for developing a sub-watershed master plan and criteria for design of infrastructure are presented in this plan.

It is crucial that Planning Measure One is implemented in the south eastern portion of the General Plan Boundary. The areas recently studied in the Mariposa Lakes and Tidewater Crossing studies have highlighted discrepancies between their findings and those presented in the FEMA FIS as well as other studies for that area. Both studies concluded that higher peak flows likely occur as opposed to those presented in the FIS and the other previously completed studies. The studies reiterate the need to implement improvements discussed in previous planning documents.

Developers shall work together as they develop the sub-watershed master plan as well as work closely with the City. Developments that overlap sub-watershed boundaries shall plan appropriately. Storm drain financing shall be done in accordance with the Stockton Municipal Code.

The second planning measure has been established to limit the amount of discharge from each sub-watershed so that the waterways in the City do not exceed channel conveyance capacities and that available capacity is fairly distributed among the sub-watersheds.

> **Planning Measure Two –** Storm water discharge from each sub-watershed shall be controlled to accommodate a sustainable conveyance capacity in each of the predominant waterways in the City.

Established discharge limitations for each sub-watershed are presented herein but are not established for sub-watersheds bordering the Delta waterways (i.e. San Joaquin River, Telephone Cut, Bishop Cut, Disappointment Slough, etc.), because incremental increases in Delta discharges due to the urbanization of these areas will not dramatically alter the water surface elevation due to the vast conveyance capacities and storage volume available in the Delta waterways.

Constraints are not established in this Plan, for the southern portion of the General Plan Boundary including Duck Creek, the Littlejohns Creeks, Weber Slough, Lone Tree Creek, and French Camp Slough. Although attempts have been made to identify the capacities of the waterways in the past, such as those in the Ensign and Buckley report, it is clear from the conclusions of the Mariposa Lakes and Tidewater Crossing studies that a comprehensive master plan for this area is needed to apportion flood flows between channels, and design functional and complete channels and protection systems.

4.3 Sub-watershed Discharge Limitations

The following section presents planning discussions, recommendations, and requirements for the areas identified in Figure 4-1. Section 5 Hydrology Methodology also contains more design requirements.

4.3.1 Northwestern Section

The sub-watershed division for the Northwestern Section of the General Plan Boundary is presented in Figure 4-3. All of areas BT4, Atlas, Shima and a portion of BT2 were undergoing planning as of the writing of this Plan. Planning has not begun for BT3 at this time.

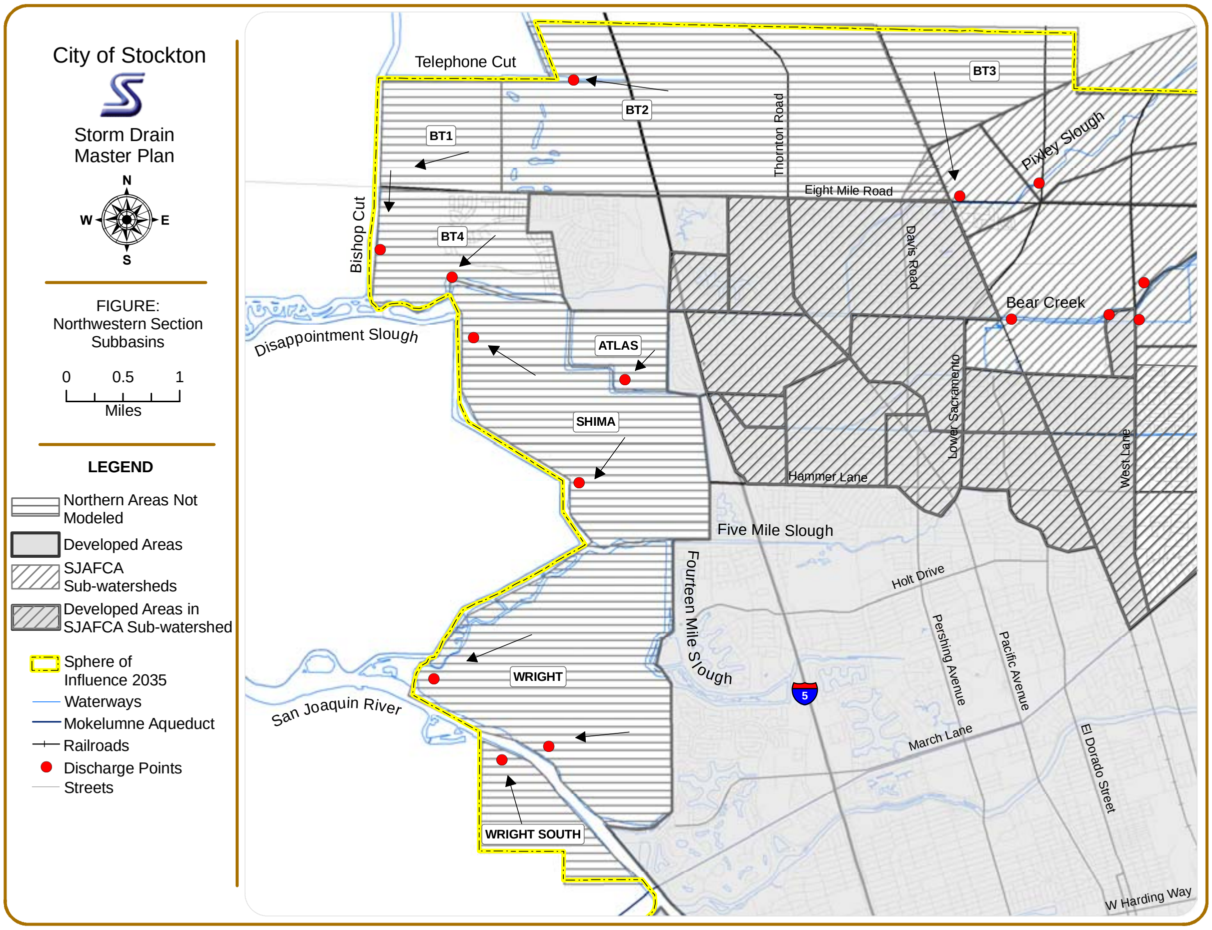

Figure 4-3 Northwestern and Western Drainage Area in the General Plan Boundary

Area BT1 – Planning is underway for this area. Receiving water quantity limitations are not stipulated for this area. Currently, water is pumped into Bishop Cut via a pump station at the southwest corner of the area. The pump station is approximately 2,800 feet south of Eight Mile Road and there is an existing drainage easement through BT4 for BT1 storm water. It is recommended that this pump station location continue to be utilized for the area post-development. However, should a pump station location north of Eight Mile Road become more favorable in the future, the station could be relocated. A condition assessment will be performed and any necessary improvements or additions will be implemented at the time of construction.

Area BT2 –Water naturally drains from east to west in this area (Figure 4-4). On the north side of the sub-watershed is the General Plan Boundary and to the south is existing development. Along the eastern portion of the sub-watershed, the Western Pacific Railroad acts as a natural barrier diverting runoff from area BT 3 to the north and south. Finally, on the west is area BT1.

Planning is well underway for the majority of this area. Planners have designed a series of detention basins and pipelines that ultimately discharge into Telephone Cut. The current plan does not cover the entire BT2 sub-watershed (Figure 4-4). It is recommended that the current planning efforts be adjusted to accommodate runoff from both isolated areas, with discharge to Telephone Cut.

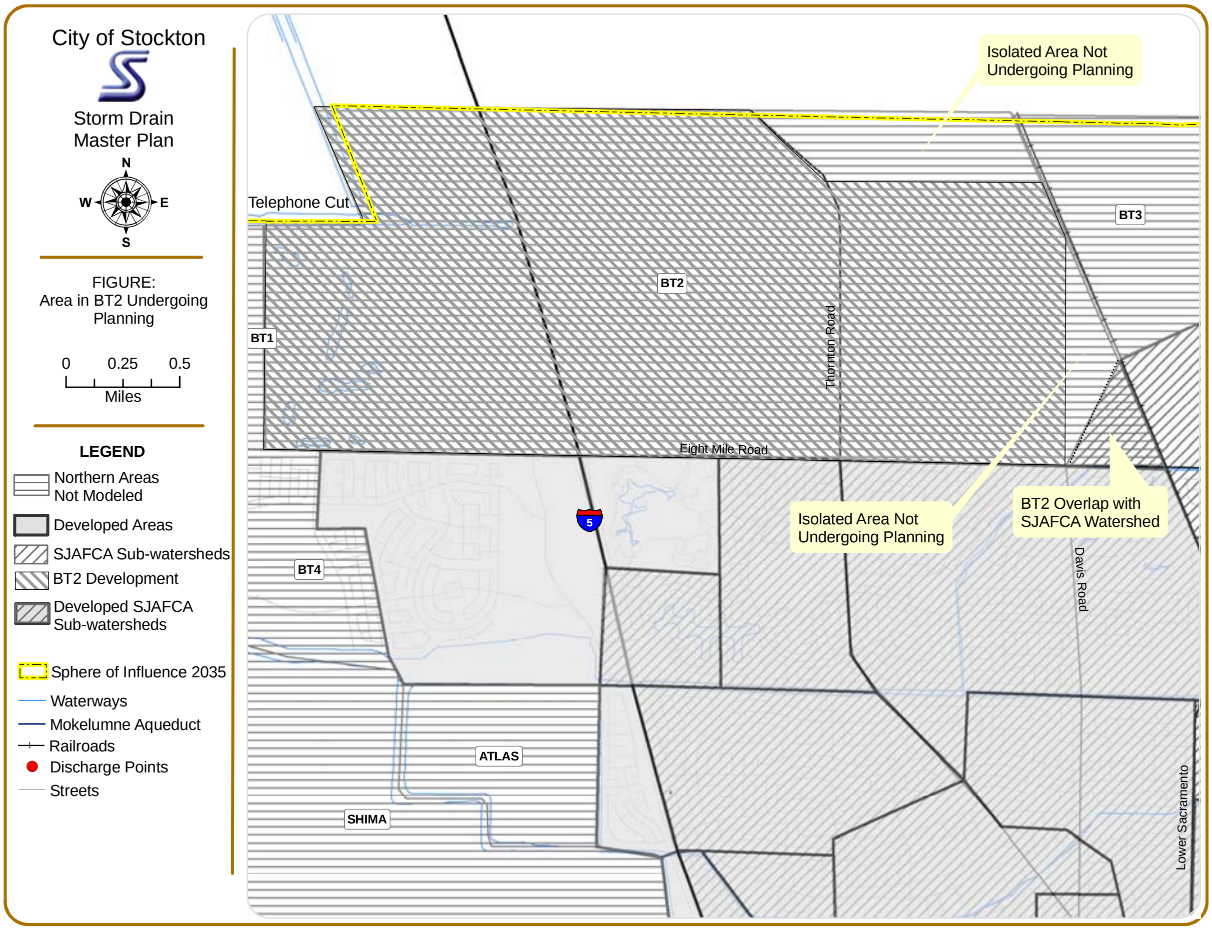

Figure 4-4 Current Area Undergoing Planning for Area BT2

Area BT3 – The area is bounded by the General Plan Boundary and the Western Pacific Railroad. Directly south lies undeveloped land that was included as part of the drainage area in the SJAFCA model. BT3 will discharge to Pixley Slough to the south and be included as part of the planning efforts for the areas directly to the south. Runoff in BT3 will have to be detained so that Pixley Slough will not be impacted.

Area BT4 – Planning for this entire area has begun. Storm water is intended to be discharged into Disappointment Slough. No planning modifications are required for this area.

4.3.2 Western Section

There are no receiving water constraints on the discharge flowrate for the areas in the Western Section of the City as shown in Figure 4-3. Planning is underway for the Atlas and Shima Tracts. Discharge for the Atlas Tract will go directly into Mosher Slough and the Shima Tract will discharge directly into 14-mile Slough. Discharge from the Wright-Elmwood Tract shall go directly into 14-mile Slough or the Stockton Deep Water Channel. Runoff from the Wright-Elmwood Tract South shall discharge directly to the Stockton Deep Water Channel.

4.3.3 Northeastern Section

The Northeastern Section is comprised of sub-watersheds that were developed as part of the SJAFCA study. The study was the basis for water body and levee improvements for Pixley Slough, Bear Creek, Mosher Slough, the Lower and Upper Calaveras River, the Stockton Diverting Canal and Mormon Slough. The improvements to these waterways were based on the conveyance capacities established in the SJAFCA model; therefore, it is appropriate to limit the discharges to those presented in the model. The planning and design criteria for these areas is presented in Appendix 3.

The majority of these areas within the General Plan Boundary have been developed. For areas within the General Plan Boundary that have not been developed, the sub-watersheds developed as part of the SJAFCA study will be used for future planning efforts as shown in Figure 4-5.

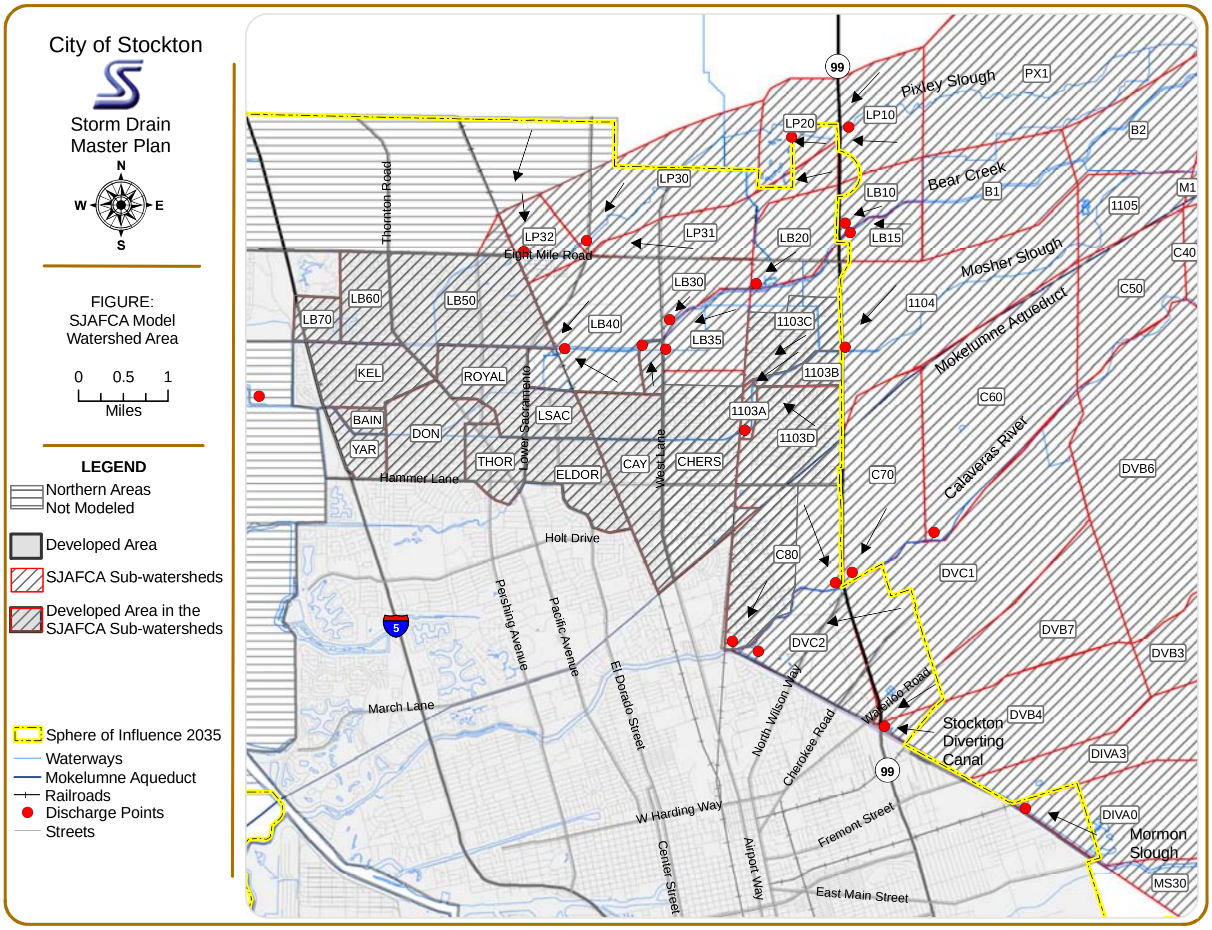

Figure 4-5 SJAFCA Model Sub-Watersheds in the General Plan Boundary

Area LP32 – Storm water is discharged into Pixley Slough. Discharge from the North (BT3) will be conveyed through this area.

Area LP30, LP20, LP10, LP31 – Storm water is discharged into Pixley Slough.

Area LB10, LB15, LB20, LB30, LB35, LB40 – Storm water is discharged to Bear Creek.

Area 1104, 1103C – Storm water is discharged into Mosher Slough.

Area C60, C70, C80, DVC1, DVC2 – Storm water shall be discharged into the Calaveras River.

Area DVB4, DVB7 – Storm water shall be discharged into the Stockton Diverting Canal.

4.3.4 Undeveloped Areas in the Southern Portion of the General Plan Boundary

The undeveloped areas in the southern portion of the General Plan Boundary include the sub-watersheds titled Southern Non-Modeled Areas, Mariposa Lakes Area, and the Tidewater Area as shown in Figure

4-6. These areas are not part of the SJAFCA modeling and do not have channel/levee improvements certified to FEMA specifications.

A comprehensive plan for flood management improvements in this region has not been completed, although recommendations have been made for isolated improvements. Discharge constraints cannot be developed without proper hydraulic modeling of the conveyance systems as previously discussed in this section. Comprehensive flood management planning is recommended for the entire French Camp Slough in order to properly size facilities, apportion discharge, prevent redirected impacts of development, and provide for operation and maintenance of facilities.

Prior to completion of the south area flood management plan, development in these areas must adhere to flood proofing standards, elevation, or new flood control measures on a case-by-case basis.

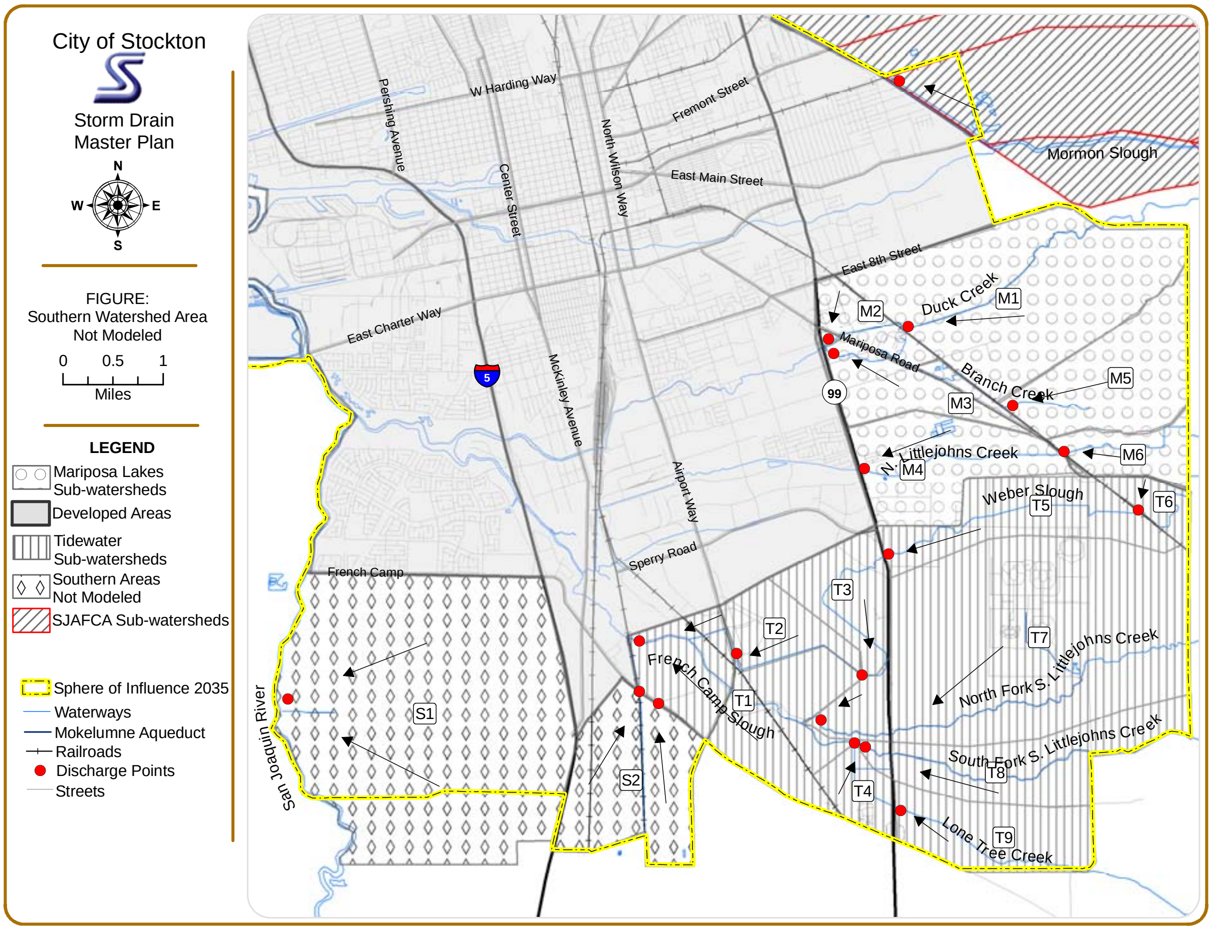

Figure 4-6 Southern General Plan Boundary Sub-watersheds

5 Hydrology Methodology

Storm water infrastructure improvements within the City of Stockton and local urbanized areas of San Joaquin County are primarily based on hydrologic/hydraulic methodologies presented in two documents: the City Standards and the Draft Hydrology Manual developed by San Joaquin County. The City Standards present design methods for improvements to pipelines, detention basins and appurtenant infrastructure whereas the Hydrology Manual presents hydrologic and hydraulic methodologies for design.

In addition to traditional methods used to design storm drainage systems, the design of these systems may also be based on detailed hydrologic and/or hydraulic modeling.

This Plan ties both those documents together and implements supplemental criteria. Planning and design requirements are presented in Appendix 3.

6 Discharge Water Quality Constraints

The City of Stockton rests at the confluence of two major Rivers, the San Joaquin and Calaveras Rivers, and on the boundary of the Sacramento-San Joaquin River Delta. Storm water discharges to these Rivers and other water bodies in the region not only impact the water quality of the receiving waters, but also the Sacramento-San Joaquin River Delta. Due to the size of the community, the City of Stockton is required to obtain a NPDES municipal storm water permit as discussed below.

The NPDES permit establishes waste discharge requirements and stipulates the City implement a Storm Water Management Program (SWMP). Additionally, on October 5, 2000, the State Board adopted Order WQ 2000-11 concerning the use of Standard Urban Storm Water Mitigation Plans that establish development standards for new developments and significant redevelopment by the private sector. In response to these requirements, the City developed a Storm Water Management Plan and Storm Water Quality Control Criteria Plan (SWQCCP) which must be incorporated into Storm Drain Master Planning. Both of these Plans are described below.

6.1 NPDES Permit

The City of Stockton and County of San Joaquin are joint permit holders of the NPDES Permit Number CAS083470. The permit was issued by the Central Valley Region, California Regional Water Quality Control Board in Order Number R5-2002-0181. Information on the NPDES program and important aspects of the City's permit are presented in Appendix 1. The full permit can be downloaded from the following websites:

Central Valley Regional Water Quality Control Board,
http://www.swrcb.ca.gov/rwqcb5/adopted_orders/index.html#joaquin

City of Stockton Municipal Utilities Department Document Room,
http://www.stocktongov.com/mud/General/reports_forms.cfm

6.2 Storm Water Management Plan

The NPDES permit requires permittees to develop and implement a SWMP designed to reduce the discharge of pollutants through their MS4s to the Maximum Extent Practicable (MEP). The City of Stockton in association with Larry Walker Associates completed a SWMP in September 2003. The SWMP is summarized in Appendix 1, but is not meant to replace it in any manner. The SWMP will be reviewed in its entirety in conjunction with sub-watershed master planning. This Plan can be found on the City of Stockton Document Room website listed above.

6.3 Storm Water Quality Control Criteria Plan

The SWQCCP was developed in response to the requirements of the NPDES permit. The SWQCCP will be reviewed in its entirety in conjunction with sub-watershed master planning. It is summarized in Appendix 1. This Plan can be found on the City of Stockton Document Room website listed above.

6.4 Guidance on Developer Responsibility

To comply with the standards established in the NPDES Permit, developers must review both the SWMP and SWQCCP. The Sub-Watershed Master Plan will include the following elements:

- Characterize expected pollutants, sources and measures to reduce and/or eliminate expected pollutants.

- Describe water quality control measures and BMPs included in the Sub-Watershed Master Plan. Describe how these measures will avoid, minimize, or mitigate the potential adverse impacts to storm water. For example, describe how pervious and impervious areas are connected and what actions were taken to minimize impervious areas. Describe how riparian corridors, wetlands and/or buffer zones were protected or enhanced. Additional ways to reduce adverse impacts are presented in Section 7 of the SWMP. Section 3 of the SWQCCP presents site design control measures that will be used to protect natural areas. Section 4 presents site-specific source control methods and Section 5 presents treatment control measures.

- Identify specific control requirements for the sub-watersheds. For example, if the receiving water is on the EPA 303d list, present what special efforts were taken to protect the water body.

Appendix 1 – NPDES Program, Permitting, and Compliance Measures

NPDES and the City of Stockton

Background

Storm water permitting dates back to 1972 when the federal Water Pollution Control Act (also known as the Clean Water Act [CWA]) was amended to provide that the discharge of pollutants to waters of the United States from any point source is unlawful unless the discharge is in compliance with a NPDES permit. The 1987 amendments to CWA added section 402(p), which established a framework for regulating storm water discharges under the NPDES Program. Subsequently, in 1990, the U.S. Environmental Protection Agency (U.S. EPA) promulgated regulations for permitting storm water discharges from industrial sites (including construction sites that disturb five acres or more) and from municipal separate storm sewer systems (MS4s) serving a population of 100,000 people or more. These regulations, known as the Phase I regulations, require operators of medium and large MS4s to obtain storm water permits. On December 8, 1999, U.S. EPA promulgated regulations, known as Phase II, requiring permits for storm water discharges from Small MS4s and from construction sites disturbing between one and five acres of land.

An "MS4" is a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) designed or used for collecting or conveying storm water; (ii) which is not a combined sewer; and (iii) which is not part of a Publicly Owned Treatment Works (POTW). [See Title 40, Code of Federal Regulations (40 CFR) §122.26(b)(8).]

A "Small MS4" is an MS4 that is not permitted under the municipal Phase I regulations, and which is "owned or operated by the United States, a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity…." (40 CFR §122.26(b)(16)).[1]

The CWA provides that MS4 permits must "require controls to reduce the discharge of pollutants to the maximum extent practicable (MEP), including management practices, control techniques and system, design and engineering methods, and such other provisions as the U.S. EPA Administrators or the State determines appropriate fro the control of such pollutants." The SWRCB has issued a memorandum interpreting the meaning of MEP to include technical feasibility, cost, and benefit derived with the burden being on the municipality to demonstrate compliance with MEP by showing that a BMP is not technically feasible in the locality or that BMPs costs would exceed any benefit to be derived. Numeric limits have not been established for any of the pollutants in storm water discharges.

[1] Fact Sheet for State Water Resources Control Board (SWRCB) Water Quality Order No. 2003-0005-DWQ (http://www.waterboards.ca.gov/stormwtr/phase_ii_municipal.html)

City of Stockton NPDES Permit

The City of Stockton qualifies as a medium municipality because the City's population is greater than 100,000 but less than 250,000 people. The County of San Joaquin contains urbanized areas and areas of potential growth surrounding the City and owns storm drains that are connected to the City's system. As a result, and due to other factors, the RWQCB designated the County as part of the medium MS4 system and designated both agencies as joint permittees. On October 18, 2002, the Regional Board adopted Waste Discharge Requirements and Monitoring and Reporting Program Order No. R5-2002-0181, NPDES No. CAS083470, prescribing waste discharges requirements for the City and portions of San Joaquin County. On September 5, 2003, the Regional Board adopted an Amendment of Waste Discharge Requirements Resolution No. R5-2003-0133 to the NPDES permit. Both of the documents can be viewed at the Central Valley RWQCB website[2].

The City and County have identified 114 and 48 outfalls, respectively, within their jurisdictions. Dating back to 1995, the City has sampled three storms per year at five locations representing Residential, Commercial, and Industrial storm water discharges. Their assessments and assessments by DeltaKeeper, and the Regional Board have identified impairment, or threatened impairment, of beneficial uses of water bodies in the Stockton Urbanized Area. The causes of impairment include oxygen demanding substances, certain heavy metals, pesticides, and pathogens.

Section 303(d) of the Clean Water Act requires the identification of waterbodies that do not meet, or are not expected to meet, water quality standards, or are considered impaired. The affected water body, and associated pollutant or stressor, is then prioritized in the 303(d) list. The Clean Water Act further requires the development of a Total Maximum Daily Load (TMDL) for each listing. The current list, approved by the EPA, is the 2002 303(d) list.[3]

Waterways in the Stockton Urbanized Area that are on the list are presented in Table A1-1.

The State Board has issued two statewide general NPDES permits for storm water discharges: one for storm water from industrial sites and the other for storm water from constructions sites. The Regional Board has issued a General Permit for dewatering and other low threat discharges, which authorizes such discharge to the MS4s owned and operated by Permittees. The NPDES permit requires the Permittees to conduct compliance inspections at industries and construction sites that discharge to their MS4s. The Permittees have adopted Ordinance Nos. 013-95 and 005-97, which allow the authority to protect and enhance the water quality of watercourses, water bodies, and wetlands in the Stockton Urbanized Area.

Storm water discharges from agricultural, rural or open space land use types are not subject to federal storm water regulations and are therefore exempt from the requirements of the NPDES permit unless they discharge directly to the Permittees' conveyance system.

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[2] From the State Water Resources Control Board website: http://www.swrcb.ca.gov/rwqcb5/adopted_orders/index.html#joaquin November 3, 2006

[3] From the Central Valley Regional Water Quality Control Board website: http://www.waterboards.ca.gov/centralvalley/programs/tmdl/index.htm#303d, October 31, 2006.

The NPDES permit is intended to develop, achieve, and implement a timely, comprehensive, cost-effective storm water pollution control program to reduce the discharge of pollutants in storm water to the MEP from the permitted areas in the Stockton Urbanized Area subject to the Permittees' jurisdiction. The Board requires that these requirements be addressed through the effective implementation of BMPs. A Storm Water Management Plan must be implemented during the entire duration of the permit and an annual report must be published that demonstrates compliance with the NPDES permit. The SWMP must act to reduce the discharge of pollutants in storm water to the MEP, and to effectively prohibit non-storm water discharges into municipal storm drain systems within the Permittees' jurisdiction during the five-year duration of the permit.

The NPDES permit orders the permittees to comply with a number of measures to comply with the CWC and CWA. A summary of these orders are presented below for reference:

- **Order A: Discharge Prohibitions – Storm Water Discharges**. This order prohibits discharges from MS4s in a manner causing, or threatening to cause, a condition of pollution, contamination, or nuisance as defined in the CWC; prohibits discharges which cause or contribute to exceedances of receiving water quality standards for surface and ground water; and prohibits discharges containing pollutants which have not been reduced to the MEP.

- **Order B: Discharge Prohibitions – Non-Storm Water Discharges.** This order prohibits non-strom water discharges into MS4s unless they are covered by a separate permit. Examples of such discharges include car washing runoff, irrigation water, diverted stream flows, etc. Emergency fire flows are allowed, but non-emergency fire flows must be mitigated using BMPs to the MEP.

- **Order C: Receiving Water Limitations.** This order sets receiving water limitations and requires that discharges from MS4s shall not cause certain conditions to exist. For example limitations are set on the amount of dissolved oxygen, oils, grease, waxes, chlorine, fungi, slime, turbidity, pH, sediment, radionuclides, toxic pollutants, and pathogens in the water. The discharge shall not violate the Basin Plan and the limitations set therein. The order requires the permittees to comply with the discharge constraints through timely implementation of control measures and other actions in accordance the SWMP and requirements of the order. The SWMP is meant to act as a living document that recognizes violations and acts to correct the occurrence. If a violation persists, the permittees must report the violation to the RWQCB via a report of water quality exceedance (RWQE). The RWQE shall identify current and proposed BMPs that will be used correct the violation. The RWQE shall be incorporated into the SWMP.

- **Order D: Provisions.** This order identifies the measures that the permittees are required to take to comply with the permit. The measures include such items as:

    - Establish conditions for approving new developments, adopt a Storm Water Quality Control Criteria Plan, adopt/update their standard specifications and plans to incorporate storm water quality provisions.

- Require coordinate among internal agencies/outside agencies
- Develop budget expenditure for storm water quality protection projects
- Develop a Storm Water Management Program
- Establish legal authority to implement the requirements of the permit
- Establish a program management program to ensure all aspects of the SWMP are implemented in accordance with the permit. The program should address the annual work plan, annual report, SWMP implementation, SWMP modification, departmental coordination, etc.
- Establish core programs to ensure compliance with the permit for the construction, industrial, commercial and municipal industries.
- Establish operations procedures and management for the various storm drain infrastructure components.
- Establish water quality based programs

The NPDES permit also establishes the Monitoring and Reporting Program (MRP). The MRP identifies what is required in the annual report. The annual report presents what efforts the permittees have made in protecting water quality, implementing BMPs, meeting the requirements of the MRP, etc.

Table A1-1 Waterways in the Stockton Urbanized Area on the EPA's 2002 303(d) list

Waterway	303(d) list pollutant	Potential Sources
Lower Calaveras River	Diazinon	Urban Runoff/Storm Sewers
	Organic Enrichment/Low Dissolved Oxygen	Urban Runoff/Storm Sewers
	Pathogens	Urban Runoff/Storm Sewers; Recreational and Tourism Activities (non-boating)
Delta Waterways (eastern portion)	Chlorpyrifos	Agriculture; Urban Runoff/Storm Sewers
	DDT	Agriculture
	Diazinon	Agriculture; Urban Runoff/Storm Sewers
	Group A Pesticides	Agriculture
	Mercury	Resource Extraction
	Unknown Toxicity	Source Unknown
Delta Waterway (Stockton Ship Channel)	Chlorpyrifos	Agriculture; Urban Runoff/Storm Sewers
	DDT	Agriculture
	Diazinon	Agriculture; Urban Runoff/Storm Sewers
	Group A Pesticides	Agriculture
	Mercury	Resource Extraction
	Organic Enrichment/Low Dissolved Oxygen	Municipal Point Sources; Urban Runoff/Storm Sewers
	Unknown Toxicity	Source Unknown
Five Mile Slough (Alexandria Place to 14-Mile Slough)	Chlorpyrifos	Urban Runoff/Storm Sewers
	Diazinon	Agriculture; Urban Runoff/Storm Sewers

Waterway	303(d) list pollutant	Potential Sources
	Organic Enrichment/Low Dissolved Oxygen	Urban Runoff/Storm Sewers
	Pathogens	Urban Runoff/Storm Sewers; Recreational and Tourism Activities (non-boating)
Mormon Slough (Commerce Street to Stockton Deep Water Channel)	Organic Enrichment/Low Dissolved Oxygen	Urban Runoff/Storm Sewers
	Pathogens	Urban Runoff/Storm Sewers; Recreational and Tourism Activities (non-boating)
Mormon Slough (Stockton Diverting Canal to Commerce Street)	Pathogens	Urban Runoff/Storm Sewers; Recreational and Tourism Activities (non-boating)
Mosher Slough (downstream of I-5)	Chlorpyrifos	Urban Runoff/Storm Sewers
	Diazinon	Agriculture; Urban Runoff/Storm Sewers
	Organic Enrichment/Low Dissolved Oxygen	Urban Runoff/Storm Sewers
	Pathogens	Urban Runoff/Storm Sewers
Mosher Slough (upstream of I-5)	Pathogens	Urban Runoff/Storm Sewers
San Joaquin River (Merced River to South Delta Boundary)	Boron	Agriculture
	Chlorpyrifos	Agriculture
	DDT	Agriculture
	Diazinon	Agriculture
	Electrical Conductivity	Agriculture
	Group A Pesticides	Agriculture
	Mercury	Resource Extraction
	Unknown Toxicity	Source Unknown
Stockton Deep Water Channel, Upper (Port Turning Basin)	Dioxin	Point Source
	Furan Compounds	Contaminated Sediments
	Pathogens	Urban Runoff/Storm Sewers; Recreational and Tourism Activities (non-boating)
	PCBs	Point Source

City of Stockton Storm Water Management Plan

The overall goals of the Plan, as stated in the SWMP, are to reduce the degradation, by urban runoff, of the beneficial uses of natural resources of the metropolitan area of Stockton. The objectives outlined in the SWMP include:

1. Identify and control those pollutants in urban runoff that pose significant threats to the natural resources and their beneficial uses;

2. Comply with the federal regulations to eliminate or control, to the maximum extent practicable, the discharge of pollutants from urban runoff associated with the metropolitan storm drainage system;
3. Develop a cost effective program which focuses on pollution prevention of urban storm water;
4. Seek cost effective alternative solutions where prevention is not a practical solution for a significant problem; and
5. Coordinate implementation of control measures with other agencies.

The SWMP is organized into ten sections as described below:

Section 1.0 Program Management - This section presents the overview and background of the SWMP. The section describes the methods for program coordination, fiscal analysis, and legal authority as required by the NPDES permit.

Section 2.0 Illicit Connections/Illegal Discharges - This section discusses the permit requirements for illicit discharges including control measures. The section describes in depth what are illicit discharges and how to handle illicit discharges when they occur.

Section 3.0 Public Education - This section describes the public education and outreach program that has been developed to enhance change in behavior and increase the knowledge of target communities to reduce pollutants to the storm drain systems.

Section 4.0 Municipal Operations - This section describes the program that has been developed to address municipal operations so that they are performed in a manner that is protective of water quality and minimizes the potential for pollutants to enter the storm drain system.

Section 5.0 Industrial and Commercial Businesses - This section describes the program that has been developed to inspect and outreach to industrial and commercial businesses.

Section 6.0 Construction - This section describes the program that has been developed to reduce pollutants from construction sites during all construction phases.

Section 7.0 Planning and Land Development - This section describes the program that has been developed to address the reduction of pollutants in new development through better site planning, design practices and post construction controls.

Section 8.0 Water Quality Based Programs - This section provides an overview of the various water quality based programs that are being developed and implemented such as the Pesticide Plan, Pathogens Plan, Dissolved Oxygen Plan and Smith Canal Study.

Section 9.0 Monitoring - This section describes the water quality monitoring program that was developed in order to assess the health of the local water bodies, evaluate selected treatment control Best Management Practices (e.g. detention ponds) and characterize storm water discharges.

Section 10.0 Program Implementation, Evaluation and Reporting - This section describes the implementation schedule and training program and identifies methods that will be used to evaluate the overall program and reporting requirements.

Storm Water Quality Control Criteria Plan

Generally, the SWQCCP presents Best Management Practices to optimize post-construction, on-site storm water pollution control. It identifies the process that each developer must undertake to get project approval. Primarily, developers must develop a Project Storm Water Quality Control Plan that demonstrates the development will comply with the requirements presented in the SWQCCP.

The SWQCCP is divided into five sections including:

- Section 1 – Background, Goals, and Subject Projects
- Section 2 – Overview and Use of Manual
- Section 3 – General Site Design Control Measures
- Section 4 – Site-specific Source Control Measures
- Section 5 – Treatment Control Measures

Section 1

As presented in Section 1, the SWQCCP was developed to accomplish the following goals:

- Assist new developments in reducing urban runoff pollution to the "maximum extent practicable";
- Ensure the implementation of measures in this Manual is consistent with NPDES permit and other State requirements;
- Provide development standards for developers, design engineers, agency engineers, and planners to use in the selection and implementation of appropriate storm water treatment and source control measures; and
- Provide maintenance procedures to ensure that the selected control measures will be maintained to provide effective, long-term pollution control.

Section 1 further defines the types of new development and significant redevelopment projects that are required to implement the controls identified in the SWQCCP include the following[4]:

1. **Significant Redevelopment –** Significant redevelopment is defined as the creation or addition of at least 5,000 square feet of impervious surfaces on an already developed site. Significant redevelopment includes, but is not limited to, expansion of a building footprint or addition or replacement of a structure; structural development including an increase in gross floor area and/or exterior construction or remodeling; replacement of impervious surface that is not part of a routine maintenance activity; and land disturbing activities related with structural or impervious surfaces. Where significant redevelopment results in an increase of less than fifty percent of the impervious surfaces of a previously existing development, and the existing development was not

[4] Information presented here is taken from the Storm Water Quality Control Criteria Plan

subject to development standards under this Plan, the numeric sizing criteria listed for items 2 through 8 below applies only to the addition, and not to the entire development.

2. **Home subdivisions of 10 housing units or more –** This category includes single-family homes, multi-family homes, condominiums, and apartments.
3. **Commercial developments greater than 100,000 square feet –** This category is defined as any development on private land that is not for heavy industrial or residential uses where the land area for development is greater than 100,000 square feet. The category includes, but is not limited to hospitals, laboratories and other medical facilities, educational institutions, recreational facilities, commercial nurseries, multi-apartment buildings, car wash facilities, mini-malls and other business complexes, shopping malls, hotels, office buildings, public warehouses, and other light industrial facilities.
4. **Automotive repair shops –** This category is defined as a facility that is categorized in any one of the following Standard Industrial Classification (SIC) codes: 5013, 5014, 5541, 7532-7534, or 7536-7539, where the total impervious area for development is greater than 5,000 square feet.
5. **Restaurants –** This category is defined as a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC code 5812), where the total impervious area for development is greater than 5,000 square feet.
6. **Parking lots 5,000 square feet or more or with 25 or more parking spaces and potentially exposed to urban runoff –** Parking lot is defined as a land area or facility for the temporary parking or storage of motor vehicles used personally, for business, or for commerce.
7. **Street and roads –** This category includes any paved surface in excess of one acre of impervious area used for the transportation of automobiles, trucks, motorcycles, and other vehicles.
8. **Retail Gasoline Outlets –** Retail Gasoline Outlet is defined as any facility engaged in selling gasoline with 5,000 square feet or more of impervious surface area.

Section 3

Section 3 presents General Site Design Control Measures that are designed to reduce storm water runoff peak flows and volumes. The intent of the control measures are to reduce downstream treatment controls and conveyance systems, reduced pollutant loading to treatment controls, and reduce hydraulic impact on receiving streams. The measures are required for all new categorical development and redevelopment projects. The control measures are organized as follows:

- **G-1: Conserve Natural Areas** – this measure requires structures be located on the least sensitive portion of the site and natural vegetated areas be conserved.
- **G-2: Protect Slopes and Channels –** this measure identifies appropriate slope protection measures to be utilized, such as rip rap.

- **G-3: Minimize Impervious Area** – this measure identifies ways to minimize impervious areas increase the amount of infiltration thereby reducing downstream pollute loading and a reduction in the runoff volume.

- **G-4: Minimize Effective Imperviousness –** this measure identifies ways to effectively use pervious areas by routing storm water runoff through the pervious area prior to entering the storm water conveyance system.

Section 4

This Section addresses site-specific, structural type source control measures consisting of specific design features or elements. Projects must use of appropriate control measures identified in the in this section. For example, a gas station will utilize different control measures than home subdivisions. Additionally, it is reiterated that nonstructural source control measures should be used in conjunction with the structural controls identified in this section. Eight examples of control measures are identified in this section including site signage, proper storage methods for trash and other outdoor objects, outdoor loading/unloading dock area design, outdoor repair/maintenance bay design, outside washing area design, fueling area design, and a maintenance plan.

Section 5

Section 5 identifies numerous BMPs that are to be used in varying degrees to accomplish the goals of the NPDES permit and this SWQCCP. Guidance is provided on what type of control measures are appropriate for the type of project. Methodology is presented to calculate to the storm water flow and volume produced during a storm event. This information is then used to size the BMPs.

Thirteen Treatment Control Measures are presented. Provided with each measure is a description, general application, advantages/disadvantages, performance, design criteria and procedures, design example, and maintenance requirements. The thirteen measures include vegetated buffer strips, vegetated swales, extended detention basin, wet pond, constructed wetland, detention basin/sand filter, porous pavement detention, porous landscape detention, infiltration basins, infiltration trenches, media filter, retention/irrigation, and alternative control measures and proprietary control measures.

Appendices

The Plan also presents eight appendices. The first appendix, Appendix A, presents a summary of the glossary of terms and list of acronyms. Appendix B presents the Standard Calculations for Diversion Structure Design. Storm water runoff in excess of the water quality flow or volume is to be diverted around or through the treatment control measure. This appendix provides equations and design criteria necessary to design diversion structures to divert runoff not captured by the control measure.

Appendix C is a sample Storm Water Treatment Device Access and Maintenance Agreement. Appendix D identifies the basic information and format for the Project Storm Water Quality Control Plan.

Appendix E discusses the properties of the Hydrologic Soil Groups in the region and discusses where to get soils information.

Appendix F discusses how to select appropriate plants suitable for vegetative control measures. Appendix G presents a number of design forms for use in designing the control measures and Appendix H lists the references used in the plan.

Appendix 2 – Sub-Watershed Master Plan Procedural Handout

City of Stockton Conceptual Storm Drain Master Plan
for the General Plan Boundary 2035
Handout on Preparation of a Storm Drain Master Plan

City of Stockton storm water sub-watersheds must be planned under an individual Sub-watershed Storm Drain Master Plan (SDMP). The SDMP should be submitted to the City at the same time as the environmental documentation. Submitters shall work with other land owners in the sub-watershed to develop a SDMP that works for the entire sub-watershed. If a proposed development is consistent with an existing SDMP on file with the City, a new one will not be required.

In addition to this Handout, the Stockton Municipal Code Chapter 16, Development Code Section 16-355.210 establishes standards for development of the SDMP.

The format and contents of the SDMP are further explained here. The SDMP must address:

- Proposed land use
- Pre- and post-project sub-watershed hydrology and hydraulics including upstream influences and receiving water constraints
- Planning methodology and assumptions
- Proposed storm drain infrastructure
- Water quality requirements
- Approximate staging and scheduling of improvements

The SDMPs must be clear, concise and generally contain the sections identified in this document. Where maps tell the story, it is not necessary to restate the information in text. The SDMP should be organized as follows:

Section 1 - Executive Summary

The executive summary shall present the key findings and recommendations of the SDMP in an easy to read concise layout. At a minimum the following items should be discussed:

- Provide a description of the watershed, developments, phasing, and expected timing of improvements
- Pre-project runoff characteristics and results.
- Post-project runoff characteristics and results, including interim phases plus buildout.
- Receiving water constraints and mitigation measures to control discharges.
- Water quality issues and best management practices that will be incorporated into the storm drain system.

Section 2 – Sub-Watershed Characteristics

This section shall include a description of the current and future land use, topography, and runoff characteristics. If intermediate phasing of development is contemplated, summarize conditions for each phase.

Provide a table and figure presenting both pre- and post-project land use. All pertinent information summarized in an exhibit will be provided on a 24” x 36” scale for City review.

Present the topography (1-foot contour intervals, unless better data exists) in the watershed, showing flow paths. In certain instances five foot contour intervals may be acceptable.

Present the soil information at the site including type and area. This information is readily available from the Natural Resources Conservation Service, NRCS, (formally known as the Soil Conservation Service) at their website http://soils.usda.gov/. Provide a tabular and graphical representation of the soil including infiltration and runoff characteristics.

Section 3 – Analysis Methodology

This section presents the tools and methods in which the designer used to develop the storm drain system. This section will be used by the City to verify the assumptions and methods used meet City criteria.

For both pre- and post-project scenarios, the designer shall reference drainage standards used in the analysis. If a hydrologic or hydraulic model was used, the designer shall identify which program and provide a description of the input and output parameters of that program.

All pertinent information summarized in an exhibit will be provided on a 24” x 36” scale for City review. This section should include figures that graphically present the following information:

1) Pre-project topography, drainage patterns, and major drainage facilities

2) Pre-project land use and runoff constraints (such as the CN and/or C values)

3) Post-project topography, drainage patterns, and major drainage facilities

4) Post Project land use

Section 4 – Sub-Watershed Analysis Results and Recommended Master Plan

This section should describe the results of the pre- and post-project analysis and describe the recommended plan. Results of the calculations and/or modeling for both scenarios shall be presented in a clear manner utilizing tables and figures. Compare and quantify the runoff differences between the pre- and post project scenarios. Discuss mitigation measures to reduce the peak discharge from the post project scenario to reduce it to the pre-project condition and/or adhere to receiving water limitations.

For the post-project scenario identify any changes that will be made. Changes include but are not limited to increased paved area, modified sub-watersheds, modification of drainage patterns, new infrastructure (including drainage inlets, piping, manholes outlets, storage basins), etc. If a model is being used, describe the input parameters and assumptions made.

Develop profiles that show the hydraulic grade lines for the design storm and 100-year storm. Discuss what happens and where the water goes when it exceeds the capacity of the storm drains.

Provide a discussion on the recommended project. Discuss the construction materials used for drainage inlets, piping, water quality features, pump stations, and storage basins. Discuss how the system operates. For storage basins, present the type, volume, location, etc. Pump stations should include wetwell volume, pump on/off setpoints, receiving water limitations, description of instrumentation and controls, pump curves and capacity.

All pertinent information summarized in an exhibit will be provided on a 24" x 36" scale for City review This section should include figures that graphically present the following information:

1) Recommended storm drain layout including drainage inlets, piping, hydraulic grade line and rim/invert elevations, detention basins, BMPs, etc (buildout and each phase).
2) Sections, elevations, plans and details sufficient to describe the SDMP features

Section 5 – Water Quality and Best Management Practices

This section should describe water quality constraints and proposed Best Management Practices (BMPs) that are to be incorporated into the project. Identify receiving water impairments and the methods used to eliminate the discharge of harmful pollutants to the receiving water. Best management practices shall be used during and after construction is completed and shall be consistent with the City's Storm Water Quality Control Criteria Plan (SWQCCP) and Storm Water Management Plan (SWMP). The following links provide additional valuable information on best management practices:

Literature on the Central Valley Regional Water Quality Control Board website located at http://www.waterboards.ca.gov/centralvalley/

The Construction Site Best Management Practices Manual by CalTrans, found at http://www.caltrans.ca.gov/manuals.htm.

The Storm Water Best Management Practice Handbooks by the California Storm Water Quality Association found at http://www.cabmphandbooks.com/

Section 6 – References

Develop and present a list of references used in the SDMP.

Appendix 3 – Storm Water Infrastructure Design Guidance Handout

City of Stockton Conceptual Storm Drain Master Plan

for the General Plan Boundary 2035

Handout on General Design Guidelines for Storm Water Infrastructure

Design standards for storm water infrastructure in the General Plan Area are presented in two documents – the City Standards and the San Joaquin County Draft Hydrology Manual. Additional standards are presented as part of this Plan. The following information summarizes the two documents and their applicable uses and provides guidance on the combined use of those documents.

City of Stockton Standards

The City Standards present design criteria for pipes, valves, trench sections, manholes, drop inlets, detention basins, curb and gutter sections, and related improvements. The standards will be used in conjunction with this Plan for:

- Calculating the 10-year rainfall event instantaneous peak flow rate using the rational method for design of appropriate infrastructure.
- Sizing detention basins (with and without discharge limitations), wet detention basins, and retention basins.
- Establishing hydraulic grade line restrictions (It is required that the hydraulic grade line is a minimum of one-foot below the top of curb at any point in the subdivision).
- Making recommendations for improvements to storm water infrastructure.

San Joaquin County Draft Hydrology Manual

The San Joaquin County Draft Hydrology Manual contains detailed hydrology and hydraulic criteria for use in calculating storm water runoff in the County. The methodologies presented in the Hydrology Manual are appropriate for use within the General Plan Boundary because the General Plan Boundary area and its large tributary area are located in the County. The Hydrology Manual provides an in-depth analysis of area precipitation, losses, hydrographs, flow through basin analysis, streamflow routing, and various modeling procedures that are needed to develop hydrographs for sub-watershed master planning. It provides computational techniques and criteria for estimating runoff, discharges, and volumes for use in hydrology submittals to the County.

The following information available in the Hydrology Manual will be used for storm water infrastructure design:

- Precipitation data shall be used. The Manual provides 2, 5, 10, 25, 50 and 100-year precipitation data for durations of 5, 10, 15, and 30 minutes and 1, 2, 3, 6, 12 and 24 hours. There are depth-duration-frequency and intensity-duration-frequency tables for these events, in addition to an isohyetal map of the County.

- The soils information shall be used. The County uses the SCS Curve Number Method to calculate runoff and the Manual provides the hydrologic soil groups, soil cover and hydrologic conditions necessary to calculate the runoff in the General Plan Boundary.
- The rational method will not be used. The City Standards provide a more detailed discussion of the rational method that is more appropriate for use in the City versus the County requirements.
- The Unit Hydrograph Method for Catchment Runoff Hydrographs and the Small Area Runoff Hydrograph Development shall be used to route storm water runoff (computer modeling) through the sub-watersheds when the area studied is too large or complex for use with the rational method.
- The Basin analysis shall be used conjunctively with the hydrograph routing methods for detention basin sizing. However, the detention basin criteria presented in the City Standards and the criteria presented in Table A3-1 takes precedence.
- The streamflow routing methods shall be used.
- The pipeflow routing method does not need to be used.
- The watershed modeling guidelines shall be used to support the other modeling efforts.

Use of this Plan, City Standards and the Hydrology Manual

As discussed, the City Standards and Draft Hydrology Manual will continue to both be used for developing Sub-Watershed Master Plans.

The City Standards shall be used for the design of specific infrastructure. For example, pipe materials, trenching, pump stations, construction methods, water quality control, etc. shall be governed by the standards.

The Hydrology Manual shall be used when developing the Sub-Watershed Master Plan. Generally, the methods presented in the Manual are for situations when the rational method alone will not suffice. This occurs when the area of interest is larger or more complex than what can be solved by simply using the rational method. The Manual presents routing methods that shall be used to route the runoff through the sub-watershed. The watershed characteristics, such as precipitation and losses shall be applied to the hydrograph routing methods for system planning. Table A3-1 presents guidelines for storm water infrastructure design using these documents.

Table A3-1 Guidance on Sizing Storm Water Infrastructure

Infrastructure	Design Standard
Inlets and Pipes[1]	• Convey the 10-year event for storm duration • Rational method (City Standards) or hydrologic and hydraulic models (Draft County Hydrology Manual) can be used
Pump Stations	• Maximum operating flow rate not to exceed values in Table A3-3 • Must have one redundant pump (does not contribute to the operating flow rate and is no smaller than largest pump at pump station) • Zero discharge from the sub-watershed once the water surface elevation in the receiving water reaches 0.5-feet below the FEMA 100-year water surface profile at the discharge point • Design governed by City of Stockton Department of Municipal Utilities Pump Station Guidelines

1) Design Standard consistent with the City of Stockton Standards and Specifications

Both the Hydrology Manual and the City Standards present methods for sizing detention basins. Additional criterion is presented in Table A3-2. The planner shall determine which detention basin sizing method is the most conservative by calculating the basin size using the criteria in the Standards, the Hydrology Manual and this Plan. The method that results in the largest detention basin shall govern.

Table A3-2 Guidance on Sizing Storm Water Detention Facilities

Infrastructure	Design Standard
Detention Basins[1]	Calculate the required detention using the following three methods. The calculation resulting in the most conservative detention volume shall be used (i.e. whichever detention volume is largest shall govern). • Volume is equal to 4 hours of maximum pumping rate (Volume already calculated and shown on Table A3-3), or • Volume is equal to 10-year 48-hour event (100 or 150 percent) with HGL at least 1-foot below top of curb at all points in system (Per City Standards), or • Volume is equal to Flow-through Basin Analysis as presented in the County Hydrology Manual.

Infrastructure	Design Standard
Sub-watershed Detention Storage and Grading Plan[2]	The detention volume calculated above must also contribute towards accomplishing the following requirements: • The overall storm water system (i.e. collection system, detention basins, street drainage swales, etc.) will convey the 100-year, 24-hour storm such that HGL is 1-foot below the finished floor elevation in all structures, without water draining to the adjacent basins • Street storage can be used in conjunction with detention basins for storms greater than the 10-year event • Starting water surface profile for the HGL for the 100-year 24-hour storm shall be the pump start elevation or the bottom of the lowest basin inlet pipe, whichever is lower (See the City Standards for the starting water surface elevation for the 10-year event) • Adjust basin size and/or grading to achieve desired result • 100-year storm will be evacuated from the system within 48 hours

1) The City of Stockton Standards and Specifications shall be used as the default standard when approved by the City authority.
2) Design Standards adopted as part of this Master Plan

Receiving Water Limitations

Improvements to City waterways in the north eastern area were based on the conveyance capacities established in the SJAFCA model; therefore, it is appropriate to limit the discharges to those presented in the model. Each sub-watershed is therefore allowed to discharge up to the values established in the SJAFCA model which are presented in Table A3-3. Beyond establishing discharge limits, it is also necessary to consider the timing of discharge to the receiving waters. The sub-watersheds in the General Plan Boundary are at the downstream end of large watershed areas. Peak discharges from the individual sub-watersheds generally occur before the upstream watershed peaks. Therefore, additional limitations have been developed for the operation of discharge facilities to accommodate the timing.

To effectively discharge storm water and take advantage of being located at the downstream end of the watershed, storm water runoff can be discharged as soon as it reaches the discharge point for each sub-watershed. However, caution must be taken as the upstream watershed peak runoff approaches. To accommodate for when the receiving water is at maximum capacity, the following measures shall be implemented:

- Zero discharge from the sub-watershed once the water surface elevation in the receiving water reaches 0.5-feet below the FEMA 100-year water surface profile at the discharge point.
- At a minimum, detention basins in the sub-watershed must be sized to store at least four (4) hours of the prescribed pumping rate to accommodate a discharge shutdown.

Table A3-3 Maximum Pumping Rate for the SJAFCA Sub-watersheds

Sub-watershed	Maximum Pumping Rate (cfs)	Area[4] (mi^2)	Volume (AF)
LP10	204	1.08	67
LP20	126	0.81	42
LP30	193	2.06	64
LP31	64	1.00	21
LP32	134	0.54	44
LB20	270	0.86	89
LB30	204	0.50	67
LB35	301	0.80	100
LB40	273	1.88	90
LB50	188	1.81	62
LB60	186	0.57	61
1103 A,B,C,D[1]	241	2.51	80
CHERS	673	1.85	222
C70	239	1.72	79
C80[5]	329	1.78	109
DVC1[2]	532	3.77	176
DVC2[2]	360	1.19	119
DVB4, DVB7[3]	100	2.46, 2.04	33
DIVA0[3]	16	5.00	5

1) Areas drain to SJAFCA Detention Basin 2. Peak pumping rate from Basin 2 to Mosher Slough shown.
2) Based on the modeling prepared by HDR in October, 2006 for the Conditional Letter of Map Revision (CLOMR) for the Oakmoore Gateway Specific Plan Area.
3) Discharge from these sub-watersheds cannot exceed the pumped discharge into the Diverting Canal as modeled in the SJAFCA HEC-1 model. DVB4 and DVB7 both drain to the same pump station in the SJAFCA model for which the maximum pumping rate for both subwatersheds combined is 100 cfs. Planners for this region must obtain the HEC-1 model from the City of Stockton for use in planning the drainage system.
4) All areas approximate.
5) The discharge for subwatershed C80 is shown as split; however, a water surface profile analysis is needed to verify the partial discharge at the reach does not violate the freeboard requirements in the Calaveras River. The SJAFCA project was constructed assuming all C80 pumping was discharged at the downstream end of the reach. Partial pumping capacity could be moved up stream, to the second discharge point indicated on Figure 4-5 if analysis by project proponent can verify that adequate freeboard would be maintained in the Calaveras River.

City of Stockton

Conceptual Storm Drain Master Plan

FIGURE 4-1:
Master Plan Subbasins

City of Stockton

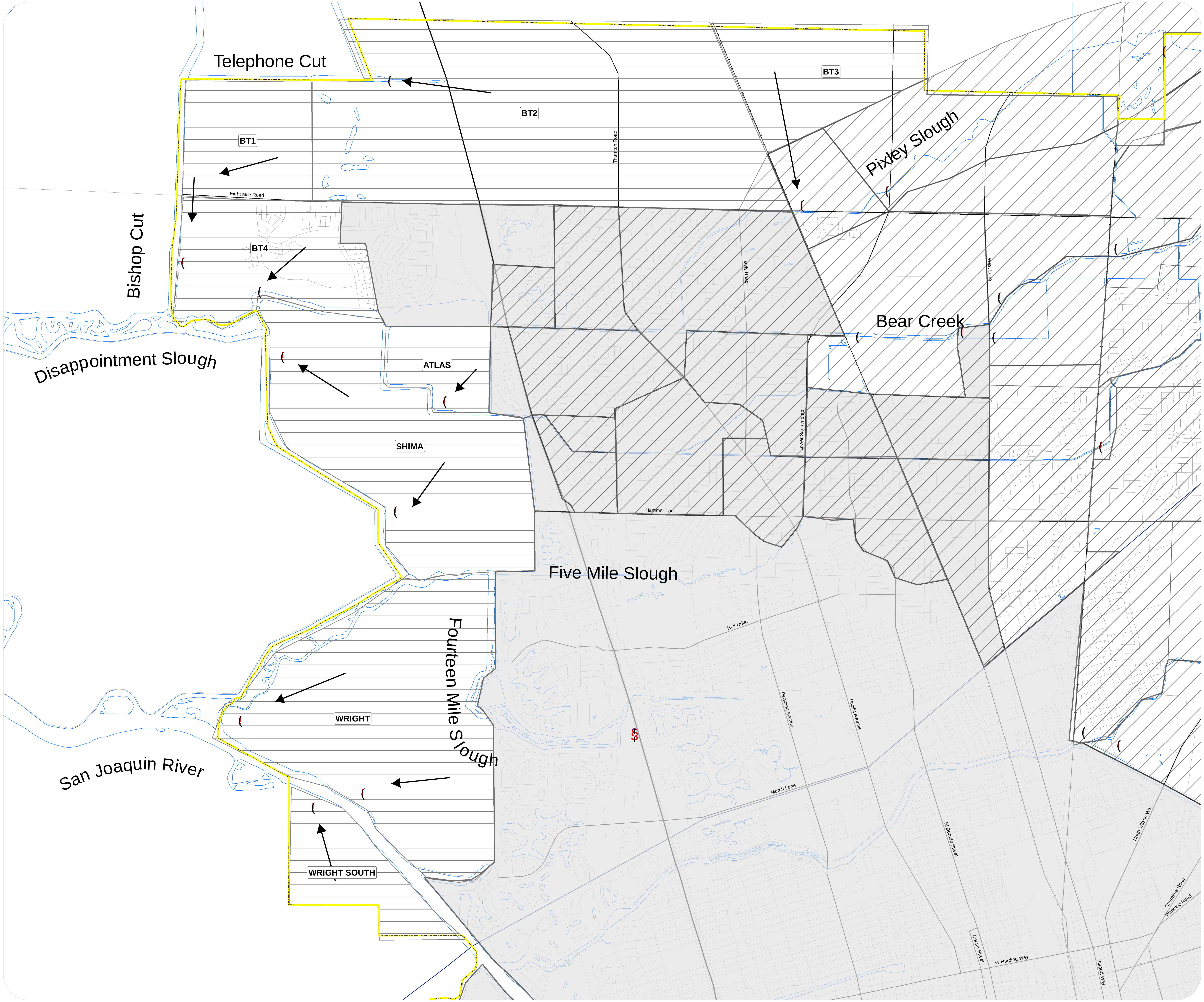
Conceptual Storm Drain Master Plan

FIGURE 4-3:
Northwestern Section Subbasins

0 0.5 1
Miles

LEGEND

Northern Areas Not Modeled
Developed Areas
SJAFCA Sub-watersheds
Developed Areas in SJAFCA Sub-watershed
General Plan Boundary 2035
Waterways
Mokelumne Aqueduct
Railroads
Discharge Points
Streets



City of Stockton

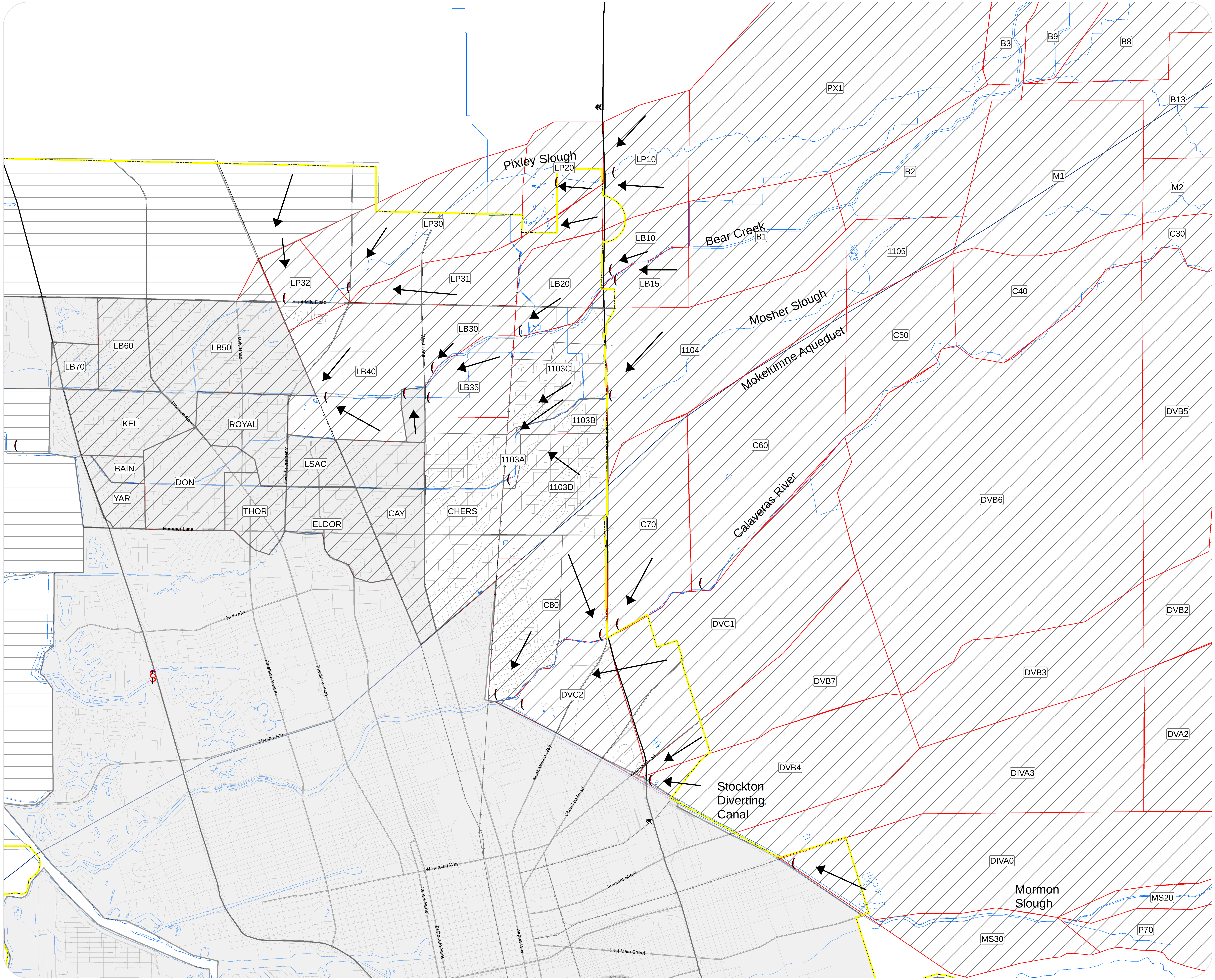
Conceptual Storm Drain Master Plan

FIGURE 4-5:
SJAFCA Model
Watershed Area

0 0.5 1
Miles

LEGEND

- Northern Areas Not Modeled
- Developed Area
- SJAFCA Sub-watersheds
- Developed Area in the SJAFCA Sub-watersheds
- General Plan Boundary 2035
- Waterways
- Mokelumne Aqueduct
- Railroads
- Discharge Points
- Streets



City of Stockton

Conceptual Storm
Drain Master Plan

FIGURE 4-6:
Southern Watershed Area
Not Modeled

0 0.5 1
Miles

LEGEND

- Mariposa Lakes Sub-watersheds
- Developed Areas
- Tidewater Sub-watersheds
- Southern Areas Not Modeled
- SJAFCA Sub-watersheds
- General Plan Boundary 2035
- Waterways
- Mokelumne Aqueduct
- Railroads
- Discharge Points
- Streets