CITY OF PATTERSON

# STORM DRAINAGE MASTER PLAN

FINAL VERSION
FEBRUARY 2018

Storm Water Consulting Inc.

Stantec

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# FINAL VERSION

Adopted by Patterson City Council
February 20, 2018

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Storm Water
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Stantec

2012-80

# Executive Summary

This report is a Storm Drainage Master Plan (SDMP) for the City of Patterson's General Plan Sphere of Influence, which is often referred to herein as the Study Area (see Figure 1-1). This SDMP includes hydrologic and hydraulic analyses; a conceptual plan for master plan level storm drainage infrastructure needed to serve new development and correct existing deficiencies; levels of services for storm drainage facilities; opinions of probable cost for new and upgraded storm drainage infrastructure; and documentation regarding existing conditions, facilities, studies, and regulations.

This SDMP is intended to be utilized as a guideline document for the identification of storm drainage facilities needed to serve future land development projects under the buildout condition for the City's Sphere of Influence and storm drainage facility upgrades needed to correct existing deficiencies, as well as serving as a reference document for existing storm drainage facilities and their functional characteristics.

The following information is provided and presented in this SDMP:

- A delineation of proposed drainage sub-basins within the Study Area.
- Hydrologic analyses for the 10-year and 100-year 24-hour storms using the HEC-HMS hydrologic computer model.
- Determination of average capacities for major existing storm drainage facilities.
- References to regulations that impact City storm drainage facility planning and management.
- Master plan level storm drainage infrastructure needed to serve new development and correct existing deficiencies.
- Typical cross-sections of selected proposed storm drainage infrastructure components.
- Guidelines for the planning and design of joint-use facilities.
- Opinions of probable cost for proposed storm drainage infrastructure to serve new development and the correct existing deficiencies.

The proposed storm drainage infrastructure plan recommended in this SDMP includes a combination of the following components (see Figures 4-1 and 4-2 in Section 4 along with a larger version of Figure 4-1 located in the pocket at the front of this SDMP):

- Detention basins
- Open channels
- Underground storm drains
- Pumping facilities (serving applicable detention basins)
- Percolation facilities, where feasible
- Temporary retention facilities

In general, new development projects will be required to provide site-specific or project-specific storm drainage solutions that are consistent with the overall infrastructure approach presented in this SDMP. The City may allow for a reasonable degree of flexibility to be incorporated into specific design approaches as a part of achieving effective solutions, including adjustments to alignments of linear storm drainage conveyance facilities and adjustments to configurations of detention facilities. Modifications and refinement to the storm drainage facilities master plan represented herein may be considered by the City during the development review process for new development.

*The City's Arambel Business Park and Villages of Patterson projects have their own Storm Drainage Master Plans for proposed onsite storm drainage infrastructure and this SDMP defers to the specific Storm Drainage Master Plans have been developed for them by others.*

In general, the storm drainage infrastructure plan presented in this SDMP consists of the following fundamental components:

- The majority of existing and new development areas within the overall Study Area are proposed to connect to existing Salado Creek storm drainage facilities, including the existing 96" CIPP outfall pipe that extends along the alignment of Olive Avenue to the San Joaquin River. For new development areas and several existing development areas, contributing flows will be or are already attenuated (metered) via detention basins prior to release to downstream facilities. Where feasible, new detention basins will be retrofitted to function as percolation basins and provide terminal discharge within the basin.

- Currently, the capacity of the 96" CIPP outfall is not being fully utilized due to capacity restrictions at and near the inlet of the pipe just east of State Highway 33. Capacity improvements are proposed in this area that will increase the discharge capacity at the inlet area for the 96" CIPP and fully utilize the available capacity of the pipe itself. Attenuated discharges from proposed detention basins serving new development are proposed to be accommodated by capacity improvements at this location.

- The northern portions of the Study Area are proposed to discharge to percolation basins, with Del Puerto Creek being available for low flow discharge if functional percolation issues or maintenance issues are encountered in the future. The applicable contributing areas that will discharge to percolation basins may never need to discharge to Del Puerto Creek.

- There are no new outfalls proposed to the San Joaquin River.

- Detention basins are proposed to be larger and lesser in number per unit contributing area than has been the practice in the City in the past. This will reduce operational requirements and costs, land acquisition costs, and maintenance costs and create greater opportunities for joint-use.

Opinions of probable cost for implementing storm drainage upgrades recommend in this SDMP are included in the following Tables in Section 5 of this SDMP:

- Composite of Facilities Needed to Serve New Development and to Correct Existing Deficiencies (Table 5-3)

- Facilities Needed to Serve New Development (Table 5-4)

- Facilities Needed to Correct Existing Deficiencies (Table 5-5)

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### APPENDICES

# 1.0 Introduction

This report is a Storm Drainage Master Plan (SDMP) for the City of Patterson's General Plan Sphere of Influence, which is often referred to herein as the Study Area (see Figure 1-1). This SDMP includes hydrologic and hydraulic analyses; a conceptual plan for master plan level storm drainage infrastructure needed to serve new development and correct existing deficiencies; levels of services for storm drainage facilities; opinions of probable cost for new and upgraded storm drainage infrastructure; and documentation regarding existing conditions, facilities, studies, and regulations.

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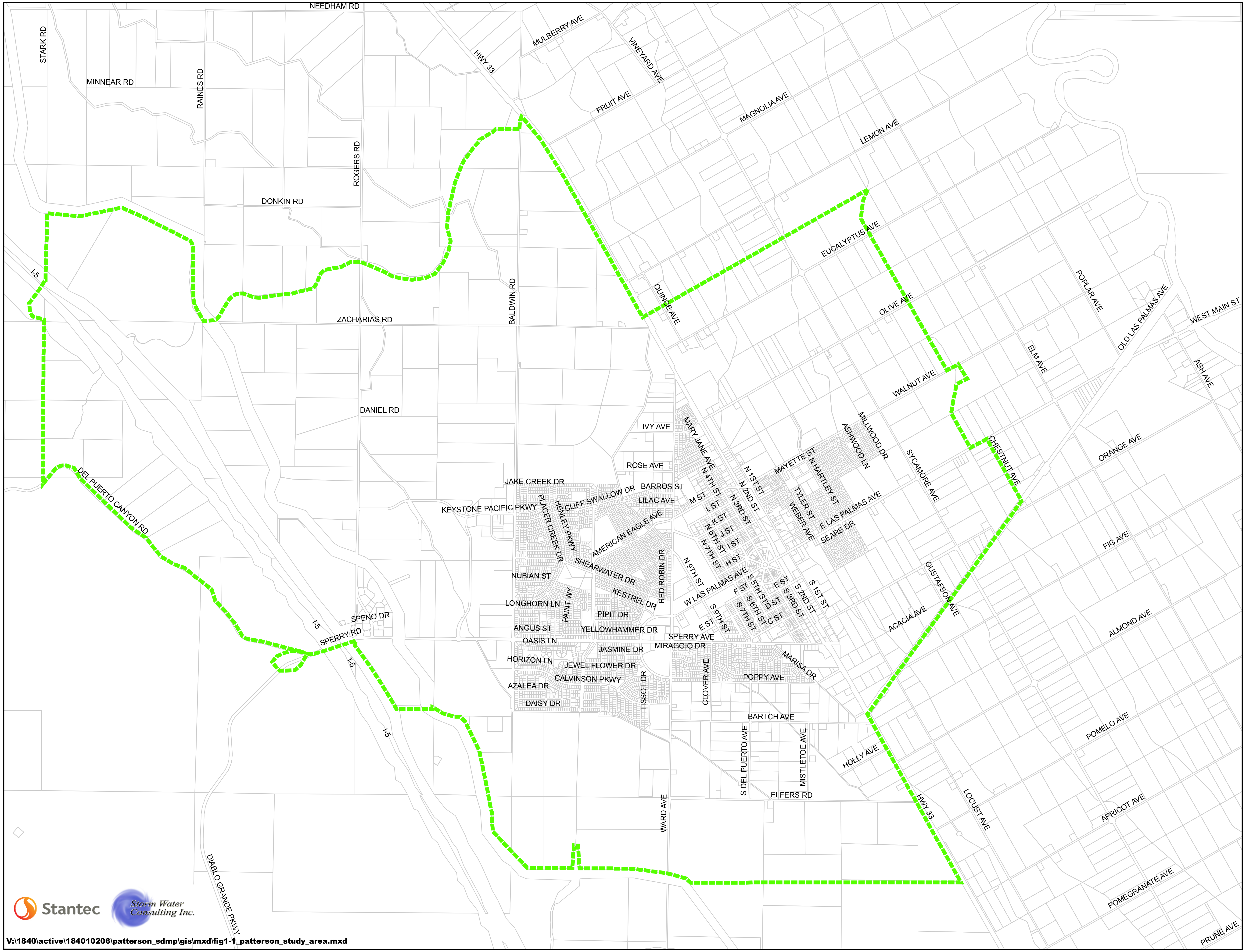

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**Legend**

🟩 Study Area Boundary

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Client/Project

CITY OF PATTERSON
STORM DRAINAGE MASTER PLAN

**FIGURE 1-1**

Title

# STUDY AREA MAP

FEBRUARY 2018
184010206
SCALE 1" = 3000'

- Opinions of probable cost for proposed storm drainage infrastructure to serve new development and to correct existing deficiencies.

Existing and proposed storm drainage infrastructure represented herein reflects the storm drainage facility needs to serve future buildout of the City's General Plan Sphere of Influence area.

## 1.1 PREVIOUS STUDIES

There are a number of previous studies that provide information that has been incorporated into the preparation of this SDMP. These studies are identified and a brief overview provided in the following subsections.

### 1.1.1 1992 Storm Drainage Master Plan

The 1992 Storm Drainage Master Plan was prepared for the City by Santina & Thompson, Inc. for a smaller area than the current General Plan Sphere of Influence area. It recommended a solution to address the flooding problems along Salado Creek and prepared a conceptual plan for the storm drainage systems needed to accommodate the needs of existing and proposed development as they existed and were projected at that time.

### 1.1.2 Northeast Area Storm Drainage Plan

This storm drainage plan was prepared by Stoddard & Associates in 1999 and analyzed storm drainage alternative solutions for existing development areas subject to flooding in the northeastern area of the City, including the Old Town area.

### 1.1.3 Master Storm Drainage Plan – Western Expansion Area

This master storm drainage plan was prepared by Stoddard & Associates in 2001 for the City's western expansion area consisting of properties on both sides of Sperry Avenue between Rogers Road and Ward Avenue. It provided recommendations for conceptual locations and sizes of storm drains and detention basins to serve new development in this area.

### 1.1.4 The Villages of Patterson – Storm Drainage Study and Master Plan

This study was prepared by GDR Engineering, Inc. in 2005 for a proposed large development project in the northeast quadrant of the City bounded by Eucalyptus Avenue on the north, 1st Street on the west, Walnut Avenue on the south and Sycamore Avenue on the east. The study included recommendations for proposed storm drainage infrastructure to serve new development of the area.

### 1.1.5 Storm Drain Study – General Plan

This study was prepared as a supporting Appendix (Appendix 5.13) to the City's current General Plan by AECOM in 2010. It includes an assessment of existing storm drainage conditions and provides alternatives and cost estimates for storm drainage facility solutions for three (3) different assumed land use plans.

### 1.1.6 Arambel Business Park/KDN Retail Center & Business Park Storm Drainage Master Plan

This storm drainage master plan was prepared by GDR Engineering, Inc. in early 2012 and provides conceptual storm drainage facility recommendations for the West Patterson Business Park Expansion area north of Sperry Avenue and west of Rogers Road. Recommendations include storm drain sizes and preliminary alignments and proposed detention basin (and/or percolation basin) locations and storage volumes.

## 1.2 STORM DRAINAGE REGULATIONS

### 1.2.1 Water Quality Orders (SWRCB)

The State Water Resources Control Board (SWRCB) has adopted several Water Quality Orders (General Permits) that have jurisdiction over storm drainage approaches utilized by local jurisdictions in the State of California, including the City of Patterson. These Water Quality Orders have emanated from the Federal Clean Water Act (CWA) and the California Porter-Cologne Water Quality Control Act.

#### 1.2.1.1 Storm Water Management Program

The Clean Water Act (CWA) was amended in 1972 to prohibit the discharge of pollutants to Waters of the United States from any point source unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. Section 402(p) was added to the CWA in 1987 to establish the framework for regulating municipal and industrial stormwater discharges under the NPDES program through a two-phase implementation plan. Phase I regulations were promulgated in 1990 and require large and medium size municipalities (population over 100,000) to comply with the NPDES municipal program. Phase II regulations were promulgated in 1999 and require small municipalities obtain coverage under the NPDES municipal program. The City of Patterson is considered a Phase II municipal program and has prepared a Storm Water Management Program (SWMP) to comply with the regulations (General Permit Number CAS000004, Water Quality Order No. 2013-0001-DWQ, effective July 1, 2013). The intent of the SWMP is to implement Best Management Practices to reduce the discharge of pollutants from the City to the Maximum Extent Practicable.

The Permit requires that the SWMP be developed to address the following program categories:

1. Program Management Element
2. Education and Outreach
3. Public Involvement and Participation
4. Illicit Discharge Detection and Elimination
5. Construction Site Storm Water Runoff Control
6. Pollution Prevention/Good Housekeeping
7. Post-Construction Storm Water Management Water Quality Monitoring
8. Program Effectiveness Assessment and Improvement
9. Total Maximum Daily Loads Compliance

In collaboration with the Cities of Lathrop, Lodi, Manteca, and Tracy and San Joaquin County, the City of Patterson adopted a *Multi-Agency Post-Construction Stormwater Standards Manual (June 2015)* to comply with the requirements of the Post-Construction Storm Water Management requirements. The Manual "provides guidance for planning, implementing, and maintaining effective control measures with the intention of improving water quality and mitigating potential water quality impacts, including hydromodification, from stormwater and non-stormwater discharges." The Manual includes examples of Best Management Practices to be implemented on new development and redevelopment projects, including site design measures, source control measures, low impact development (LID) treatment control measures, and post-construction peak runoff control measures. The Manual applies to the types of projects listed below:

- Small Projects that create and/or replace at least 2,500 sf, but less than 5,000 sf of impervious surface
- Regulated Projects that create and/or replace greater than or equal to 5,000 sf of impervious surface
- Hydromodification Management Projects (a subsection of Regulated Projects) that create and/or replace one acre or more of impervious surface

#### 1.2.1.2 Construction General Permit

The SWRCB has adopted a NPDES General Permit for construction activities, known as the Construction General Permit (CGP). On July 1, 2010, the current CGP (Order No. 2009-0009-DWQ) became effective, superseding a former CGP (Water Quality Order No. 99-08-DWQ). The CGP requires the development and implementation of a Storm Water Pollution Prevention Plan

(SWPPP) for construction activities. The SWPPP must contain a site map(s) which shows the construction site perimeter, existing and proposed buildings, lots, roadways, storm water collection and discharge points, general topography both before and after construction, and drainage patterns across the project. The SWPPP must list Best Management Practices (BMPs) that the discharger will use to protect storm water runoff and the placement of said BMPs. Additionally, the SWPPP must contain a Construction Site Monitoring Program (CSMP) to demonstrate that the site is in compliance with the CGP. Depending on the construction site risk level, the CSMP includes varying levels of visual monitoring and water quality sampling and analysis.

Some key elements of the CGP are listed below:

> *Rainfall Erosivity Waiver:* The CGP includes the option allowing a small construction site (>1 and <5 acres) to self-certify if the rainfall erosivity value (R value) for their site's given location and time frame compute to be less than or equal to 5.
>
> *Technology-Based Numeric Action Levels*: The CGP includes NALs [numeric action levels] for pH and turbidity.
>
> *Risk-Based Permitting Approach: T*he CGP establishes three levels of risk possible for a construction site. Risk is calculated in two parts: (1) Project Sediment Risk, and (2) Receiving Water Risk.
>
> *Minimum Requirements Specified:* The CGP imposes more minimum BMPs and requirements that were previously only required as elements of the SWPPP or were suggested by guidance.
>
> *Project Site Soil Characteristics Monitoring and Reporting:* The CGP provides the option for dischargers to monitor and report the soil characteristics at their project location. The primary purpose of this requirement is to provide better risk determination and eventually better program evaluation.
>
> *Construction Site Monitoring:* The CGP requires discharge monitoring and reporting for pH and turbidity in storm water discharges for Traditional Risk Level 2 and 3 projects. The purpose of this monitoring is to demonstrate that the site is in compliance with applicable NALs.
>
> *Receiving Water Monitoring and Reporting:* The CGP requires some Risk Level 3 dischargers to monitor receiving waters and conduct bio-assessments.
>
> *Rain Event Action Plan:* The CGP requires that certain sites develop and implement a Rain Event Action Plan (REAP) that must be designed to protect all exposed portions of the site within 48 hours prior to any likely precipitation event.

*Annual Reporting:* The CGP requires all projects that are enrolled for more than one continuous three-month period to submit information and annually certify that their site is in compliance with these requirements. The primary purpose of this requirement is to provide information needed for overall program evaluation and pubic information.

*Certification/Training Requirements for Key Project Personnel:* The CGP requires that key personnel (e.g., SWPPP preparers, inspectors, etc.) have specific training or certifications to ensure their level of knowledge and skills are adequate to support their ability to design and evaluate project specifications that will comply with General Permit requirements.

*Linear Underground/Overhead Projects:* The CGP includes requirements for all Linear Underground/Overhead Projects (LUPs).

#### 1.2.1.3 Industrial General Permit

The SWRCB has also issued a statewide General Permit (Water Quality Order No. 2014-0057-DWQ) for regulating storm water discharges associated with industrial activities, known as the Industrial General Permit (IGP). The IGP requires the implementation of management measures that will achieve the performance standard of best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT).

Examples of industrial facilities that are required to obtain coverage under the IGP include:

1. Manufacturing facilities
2. Landfills, land application sites, open dumps
3. Hazardous waste treatment, storage, or disposal facilities
4. Recycling facilities
5. Transportation facilities
6. Wastewater treatment plants (design flow of one MGD or more or required to have an approved pretreatment program)

In order to obtain coverage under the IGP, the facility owner must submit Permit Registration Documents (PRDs) online via the Storm Water Multi-Application Reporting and Tracking Systems. The PRDs include a Notice of Intent with basic facility and contact information, a site map, and a SWPPP. The SWPPP must include a list of industrial materials, description and assessment of potential pollution sources, minimum BMPs, advanced BMPs if necessary, a monitoring implementation plan, and an annual comprehensive facility compliance valuation process. Minimum BMPs include:

- Good Housekeeping
- Preventive Maintenance

- Spill and Leak Prevention and Response
- Material Handling and Waste Management
- Erosion and Sediment Controls
- Employee Training Program
- Quality Assurance and Record Keeping

The monitoring implementation plan must include monthly visual observations as well as storm event sampling and analysis for TSS, oil and grease, and pH at a minimum.

The IGP has three status levels – baseline, Level 1, and Level 2, each with additional reporting requirements. Facilities in Level 1 or Level 2 status must obtain the assistance of a Qualified Industrial Storm Water Practitioner (QISP).

#### 1.2.1.4 Trash Amendments

State Water Resources Control Board Resolution 2015-0019 adopted an Amendment to the Water Quality Control Plan for Ocean Waters of California to Control Trash and Part 1 Trash Provisions of the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Trash Amendments) on April 7, 2014. The Trash Amendments do the following: (1) establish a narrative water quality objective for trash, (2) establish corresponding applicability, (3) establish a prohibition on the discharge of trash, (4) provide implementation requirements for permitted storm water and other discharges, (5) set a time schedule for compliance, and (6) provide a framework for monitoring and reporting requirements.

The Trash Amendments are being implemented through MS4 Permits. There are two compliance methods for controlling trash in stormwater runoff:

- Track 1: Install, operate, and maintain full-capture systems for all storm drains that capture runoff from priority land use areas for municipal systems.
- Track 2: Install, operate, and maintain any combination of full capture systems, multi-benefit projects, other treatment controls and/or institutional controls (e.g., street sweeping, storm drain inlet identification, improving garbage containment and transport, and adopting ordinances that reduce the generation of litter-prone items such as plastic bags).

The City has chosen Track 1 as their compliance method. The next step is to prepare an Implementation Plan for achieving full trash capture. The Implementation Plan is due by December 1, 2018.

### 1.2.2 Urban Level of Flood Protection

The California Department of Water Resources (DWR) developed and published a document entitled *Urban Level of Flood Protection Criteria* in November 2013 that provides a systematic approach to assist cities and counties within the Sacramento-San Joaquin Valley in making "findings" related to the Urban Level of Flood Protection before approving certain land use decisions. This document may be downloaded from DWR's website at the following web address: http://www.water.ca.gov/floodsafe/urbancriteria/. DWR developed the *Urban Level of Flood Protection Criteria* document to fulfill the requirements outlined in the 2007 California Flood Legislation (that includes SB5) and associated amendments by subsequent legislation.

The definition of the Urban Level of Flood Protection as provided therein is as follows:

*Urban Level of Flood Protection means the level of protection that is necessary to withstand flooding that has a 1-in-200 chance of occurring in any given year using criteria consistent with, or developed by, the Department of Water Resources. Urban Level of Flood Protection shall not mean shallow flooding or flooding from local drainage that meets the criteria of the National FEMA Standard of Flood Protection.*

The *Urban Level of Flood Protection Criteria* document states that cities and counties shall make a "finding" related to an Urban Level of Flood Protection or the National FEMA Level of Flood Protection for any of the following pending land-use decisions when properties involved meet certain location criteria:

- Entering into a Development Agreement for all types of property development.
- Approving a discretionary permit or other discretionary entitlement for all development projects.
- Approving a ministerial permit for all projects that would result in the construction of a new residence.
- Approving a tentative map consistent with the Subdivision Map Act for all subdivisions.
- Approving a Parcel Map for which a tentative map is not required consistent with the Subdivision Map Act for all subdivisions.

The location criteria that requires that a "finding" be made for new development is met when all of the following conditions apply:

- It is located within an urban area that is a developed area, as defined by Code of Federal Regulations Title 44, Section 59.1, with 10,000 residents or more, or an urbanizing area that is a developed area or an area outside of a developed area that is planned or anticipated to have 10,000 residents or more within the next 10 years.
- It is located within a flood hazard zone that is mapped as either a Special Flood Hazard Area or an area of Moderate Flood Hazard on FEMA's effective FIRMs.
- It is located in the Sacramento-San Joaquin Valley.

If the location criteria are met per the above, but the new development would only experience shallow flooding or flooding from local drainage, a "finding" will still need to be made, but the standard that will apply is the National FEMA Standard of Flood Protection (100-year flood) and not the Urban Level of Flood protection (200-year flood). These types of flooding are defined below:

- *Shallow Flooding* – Flooding that is 3.0 feet or less in depth from sources of flooding other than local drainage.
- *Local Drainage* – Flooding caused by a contributing watershed area of less than 10 square miles, measured upstream from a given project.

The majority of areas within the City's Sphere of Influence that meet all of the location criteria only experience shallow flooding, and thus, will only need to meet the National FEMA Standard of Flood Protection (100-year flood). In 2015, the City adopted an *Urban Level of Flood Protection Summary Report*, prepared by Storm Water Consulting, Inc. and Stantec, and this report may be referenced for additional information on this topic.

### 1.2.3 City Municipal Code

The City's Municipal Code includes many provisions that relate to storm water, floodplain management and storm water quality regulations and requirements. Relevant provisions include the following:

*Chapter 13.32 (Urban Storm Water Quality Management and Discharge Control):* This chapter references and ties together many of the requirements established by the Federal Clean Water Act, Water Quality Orders and the California Porter-Cologne Water Quality Control Act that are regulated by the City.

*Title 17 (Flood Hazard Areas):* This title establishes floodplain management provisions and requirements associated with new development activities occurring within Special Flood Hazard Areas established by the Federal Emergency Management Agency that are administered by the City.

*Section 18.78.040 (Low Impact Development, LID):* This section is included in Chapter 18.78 (Landscaping) and references Low Impact Development strategies that should be considered and incorporated into new construction projects within the City.

# 2.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

## 2.1 CLIMATE

The Patterson area is typical to that of other Central Valley areas in Stanislaus County, with two distinct weather seasons; wet and cool winters along with dry and hot summers. Average high temperatures in the winter are in the 50s, and summer high temperatures average in the low to mid 90s.

## 2.2 PRECIPITATION

Precipitation records obtained from rain gage data monitored by the California Department of Water Resources in the City of Patterson area indicate that the amount of normal annual rainfall in the Patterson area averages slightly less than 11 inches per year. Approximately 95 percent of this rainfall typically occurs from early fall through mid-spring (generally October through May), although infrequent summer showers do occur. Storm events during the rainy season consist of either individual storms or clusters of storms. Storms of greater magnitude and duration generally occur during the rainy season; however, high intensity thunderstorms (though relatively infrequent) can occur in any season.

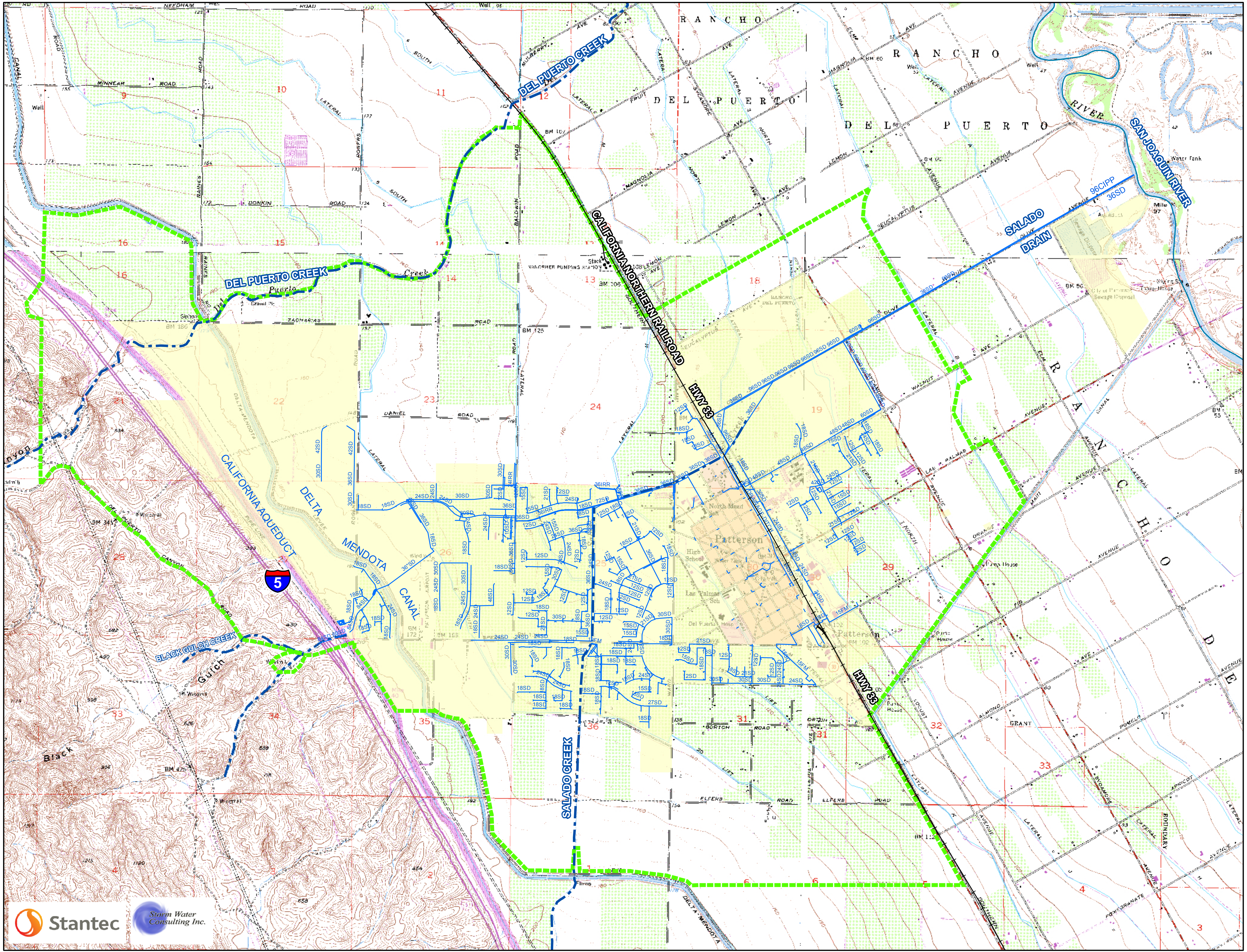
## 2.3 TOPOGRAPHY

The Study Area resides along the west side of the broad valley floor of the San Joaquin Valley, and generally slopes from southwest to northeast toward the San Joaquin River.  The eastern portions of the study area have flatter, gentler slopes ranging from about 0.3 to 0.5 percent. The western portions of the Study Area contain steeper transitional slopes between the hills to the west and the valley floor and have slopes ranging from 0.5 to 2 percent. The westernmost portions of the Study Area located west of the California Aqueduct and Interstate 5 are steep hillsides. East of the California Aqueduct, ground elevations in the Study Area range from about 60 feet to 220 feet.  West of the California Aqueduct, ground elevations in the Study Area range from about 220 feet to 530 feet.  Figure 2-1 depicts the Study Area superimposed over topographic mapping from the U.S. Geological Survey.

There are three (3) significant offsite watersheds (Del Puerto Creek, Salado Creek, and Black Gulch) that contribute storm runoff to the Study Area and extend further upstream into the hills to the west.  This highest point in these offsite watersheds is at Red Mountain, with an elevation of 3,675 feet.

## 2.4 MAJOR DRAINAGE FEATURES

There are a number of major drainage features within the Study Area or that have an impact on the Study Area. These major drainage features are also depicted on Figure 2-1 and are described below:



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## Legend

Rail Road

36"SD Existing Storm Drains

Study Area Boundary

City Limits

Creeks

Canals

Client/Project

CITY OF PATTERSON
STORM DRAINAGE MASTER PLAN

**FIGURE 2-1**

Title

# TOPOGRAPHIC AND MAJOR DRAINAGE FEATURES MAP

FEBRUARY 2018
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SCALE 1" = 3000'

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- *Salado Creek* – Salado Creek enters the Study Area via an overchute crossing of the Delta Mendota Canal at the south boundary of the Study Area, at roughly the extended alignment of American Eagle Avenue. Salado Creek has a contributing watershed area of 25.3 square miles measured at Interstate 5 and the rate of discharge is regulated by the existing overchute (12’ width x 7’ height). Salado Creek is an irregular channel of limited capacity within existing agricultural areas for roughly 1 mile north of the Delta Mendota Canal. It then transitions to an excavated open channel of much greater capacity as it extends north through residential development areas for roughly 1 ½ miles to Cliff Swallow Drive, then turns northeast via 2-72” SD conduits that discharge into an open channel that extends to State Highway 33. At State Highway 33, Salado Creek crosses underneath the highway and the California Northern Railroad (CNRR) via existing bridge/culverts and then enters a 96” SD that extends to the northeast along the alignment of Olive Avenue and discharges to the San Joaquin River east of the Study Area.

- *Del Puerto Creek* – Del Puerto Creek enters the Study Area within the north portions of the future Mixed Use hillside development area, crossing underneath Interstate 5 and the California Aqueduct via large culverts. At Interstate 5, Del Puerto Creek has a contributing watershed area of 72.6 square miles. The Delta Mendota Canal has a siphon crossing underneath Del Puerto Creek further downstream. From the Delta Mendota Canal downstream to State Highway 33, Del Puerto Creek is an open channel that forms the north boundary of the Study Area. Downstream of State Highway 33, Del Puerto Creek leaves the Study Area and continues to the northeast as an open channel and discharges to the San Joaquin River.

- *Black Gulch Creek* – Black Gulch Creek resides between Salado Creek and Del Puerto Creek and enters the existing Villa Del Lago development in the City via culvert crossings underneath Interstate 5 and the California Aqueduct. It extends through the Villa Del Lago development via an 84” SD and discharges to an existing detention basin within the development on the west (upstream) side of the Delta Mendota Canal. Discharge to the downstream side of the Delta Mendota Canal is regulated by a 30” SD outlet for the detention basin, and excess flow will spill into the canal via a large spillway. The 30” SD and spillway provide flood control for downstream areas of the City and are governed by a license agreement between the Bureau of Reclamation and Stanislaus County. This SDMP assumes that these provisions will remain in place or future alternative flood control measures will implemented that are beyond the scope of the SDMP. The downstream SD extends to the northeast through existing and proposed development areas, joins other storm drains and discharges to the Salado Creek system at Cliff Swallow Drive near American Eagle Drive.

- *Interstate 5* – Interstate 5 extends along the west edge of the Study Area along the base of proposed future Mixed Use hillside development areas and crosses Salado Creek, Black Gulch, and Del Puerto Creek. There are numerous cross-drainage culverts and bridges along Interstate 5 and these facilities accommodate storm runoff generated from the three major creeks and smaller local hillside watersheds and flows are discharged to the east side of the highway with little impact.

- *California Aqueduct* – The California Aqueduct traverses across the western portion of the study area just east of Interstate 5 and extends perpendicular to the direction of drainage flow dictated by topography. Storm runoff is collected on the upstream side of the aqueduct and is delivered to culverts that pass underneath the aqueduct. The California Aqueduct tends to consolidate runoff to fewer locations.

- *Delta Mendota Canal* – The Delta Mendota Canal runs generally parallel to and just downslope from the California Aqueduct. It further reduces the number of locations where storm runoff is concentrated. Storm runoff passes over or under the canal via overchutes, siphons, and culverts and further limits the rates discharged to lands below the canal at some of these crossings. The Delta Mendota Canal also contains a significant number of locations where local drainage flow that is collected on the upstream side of the canal simply enters the canal directly via drain inlets and is not released to downstream lands.

- *State Highway 33* – State Highway 33 extends along the east edge of the downtown area of the City. It is generally elevated above the existing grade of lands on the west (upstream) side of the highway and includes limited capacity drainage crossings and provisions for local runoff. The culvert/bridge crossing of Salado Creek is a higher capacity crossing that is commensurate with the average capacity of overall Salado Creek drainage facilities within the Study Area.

- *California Northern Railroad* – The California Northern Railroad (CNRR) track extends parallel to Highway 33, predominantly on the east (downstream) side of Highway 33 through the Study Area. Between Olive Avenue and Eucalyptus Avenue the CNRR crosses over Highway 33 and continues north along the west (upstream) side of the highway beyond the Study Area boundary. The CNRR bridge/culvert crossing of Salado Creek is a significant restriction in the capacity of the Salado Creek system and frequent flooding is experienced in areas upstream of the crossing. The CNRR crossing of Del Puerto Creek is also a restriction in capacity, but upstream flooding does not occur as frequently.

- *City Storm Drainage Facilities* – City storm drainage facilities include open channels, underground storm drains, cross-drainage structures, detention basins, and pump stations. The major components of the Salado Creek drainage facilities were constructed by the City in 1998. The majority of runoff generated within existing development areas in the City discharge ultimately to Salado Creek, and lesser amounts of runoff discharge to Black Gulch or Del Puerto Creek. Existing agricultural land uses discharge to tailwater ponds and ditches, the three (3) major creeks passing through the Study Area, and/or the San Joaquin River

- *San Joaquin River* – The San Joaquin River flows northwesterly and is aligned downstream to the east of the Study Area. The floodplain associated with the San Joaquin River does not encroach into the Study Area.

## 2.5 FLOODPLAIN AREAS

There are significant floodplain areas that have been mapped by FEMA that extend through the Study Area. These floodplain areas are associated with potential flooding originating from Salado Creek and Del Puerto Creek and are shown on Figure 2-2. The FEMA flood zones impacting the study area include Zone A, Zone AE, Zone AH, Zone AO, and shaded Zone X and are defined by FEMA as follows:

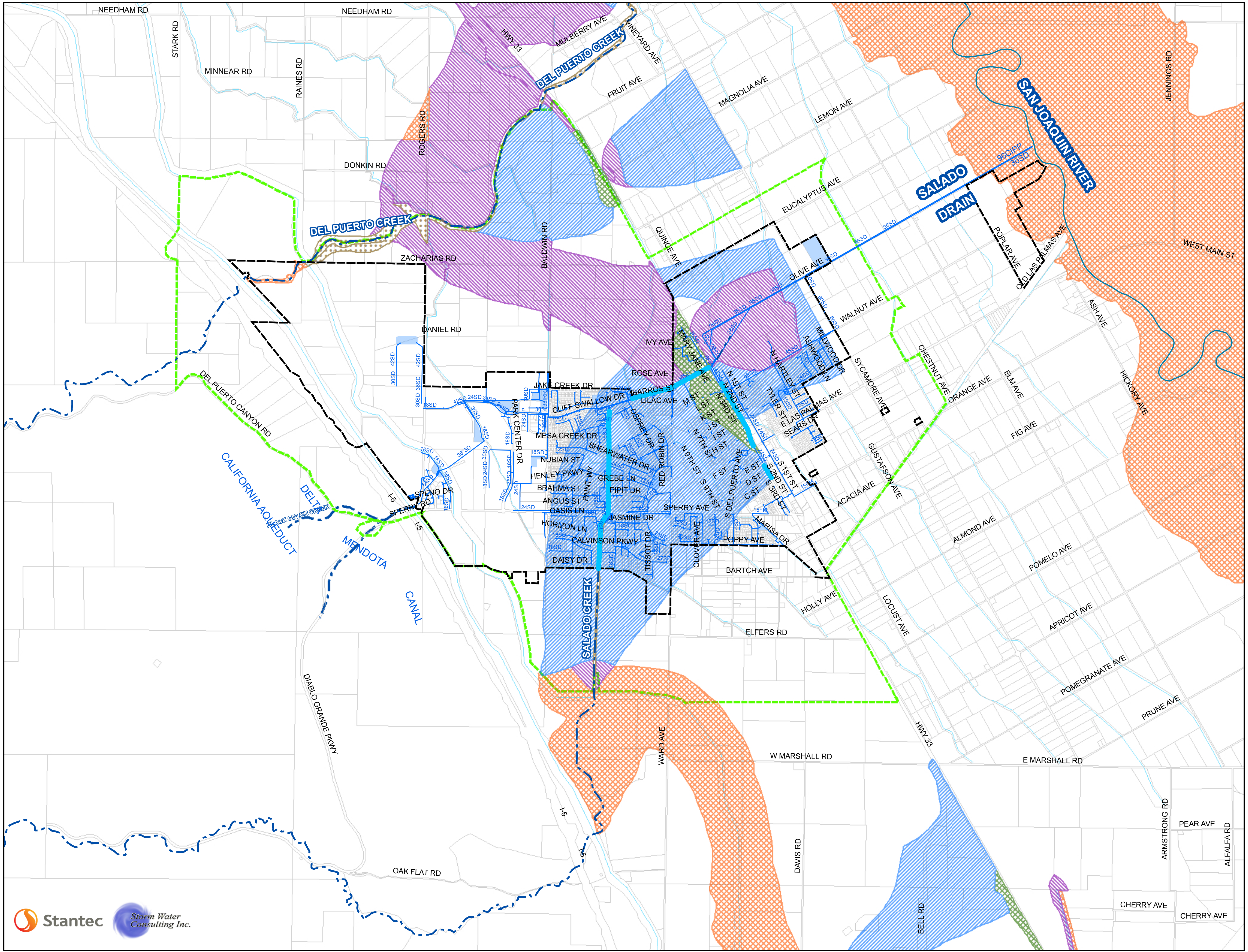
| | |
|---|---|
| *Zone A* | Flood Hazard Area subject to flooding by the 1% annual chance flood (100-year flood). No Base Flood Elevations determined. |
| *Zone AE* | Flood Hazard Area subject to flooding by the 1% annual chance flood (100-year flood). Base Flood Elevations Determined. |
| *Zone AH* | Flood Hazard Area subject to flooding by the 1% annual chance flood (100-year flood). Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined. |
| *Zone AO* | Flood Hazard Area subject to flooding by the 1% annual chance flood (100-year flood). Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. |
| *Shaded Zone X* | Areas of 0.2% annual chance flood (500-year flood); areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood. |

Much of the floodplain areas mapped by FEMA within the Study Area are in Shaded Zone X, but there are significant areas in the other flood zones as well.

The FEMA Flood Insurance Study (FIS) Report for Stanislaus County, California, and Incorporated Areas (Effective Date: September 26, 2008) lists the following watershed and discharge data for Del Puerto Creek and Salado Creek per Table 2-1 below:

**Table 2-1: Watershed and Discharge Information from FEMA FIS**

| Flooding Source and Location | Drainage Area | 100-Year Flood Discharge |
|---|---|---|
| DEL PUERTO CREEK | | |
| At Interstate 5 | 72.6 sq. mi. | 7,960 cfs |
| SALADO CREEK | | |
| At Interstate 5 | 25.3 sq. mi. | 2,820 cfs |
| Below DMC | 25.3 sq. mi. | 710 cfs |



# Legend

- ▬ Existing Open Channels and Ditches
- 36"SD Existing Storm Drains

## FEMA Flood Zone

- ▨ Shaded Zone X
- ▨ A
- ▨ AE
- ▨ AH
- ▨ AO
- ▭ Existing Detention or Percolation Basins
- ⬚ Study Area Boundary
- ⬚ City Limits
- ─·─ Creeks
- ─ Canals

N

Source: Panel Numbers 520, 540, 730, 731, 732, 733, 734, and 755 of FEMA Flood Insurance Rate Maps for Stanislaus County, California and Incorporated Areas dated September 26, 2008 and LOMR dated June 16, 2011

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## FIGURE 2-2

Title

# FEMA FLOODPLAIN MAPPING

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SCALE 1" = 4000'

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The reduction in the 100-year flood discharge for Salado Creek occurs downstream of the Delta Mendota Canal because the flow that is allowed to cross the canal is regulated by an existing 12’ x 7’ overchute at this location and excess runoff ponds on the upstream side of the canal or spills into the canal.

Per the City’s Municipal Code (Title 17, Flood Hazard Areas), all new construction and substantial construction pertaining to buildings shall have the lowest floor, including basement, elevated a minimum of one (1) foot above the base flood elevation (100-year flood elevation or depth) shown on FEMA FIRMs. Title 17 of the City’s Municipal Code contains many other provisions and requirements associated with development in a floodplain area mapped by FEMA.

## 2.6 SOILS AND PERMEABILITY

The Study Area contains many separate soil types according to the Soil Survey of Western Stanislaus County published by the Natural Resources Conservation Service in May 2009. The applicable soils are defined and classified as Hydrologic Soil Groups B, C, and D. Group B soils have moderate infiltration rates, Group C soils have low infiltration rates, and Group D soils have very low infiltration rates. Many areas within the Study Area contain Group B soils and these areas may be suitable for integrating percolation components into storm water detention basins. As part of the development process, site-specific subsurface soil investigations should always be completed to provide criteria and recommendations for grading, building foundations, percolation facilities and related design and construction items. The soil conditions as they relate to the hydrologic modeling completed for master planning purposes in this SDMP are discussed in greater detail in Sections 3.4 and 3.5 and are depicted on a Hydrologic Soils Map in these sections.

## 2.7 GROUNDWATER

In the upland (southern) portions of the Study Area along the canals and Interstate 5, groundwater is generally present below the ground surface at depths of 100 feet or more according to well data information available from DWR. As the topography falls to the lower lying, flatter topographic areas to the northeast within the Study Area, depths to groundwater become much shallower and are variable in the range of 10 to 30 feet below ground surface according to available data. In these lower lying areas, the depth to groundwater is potentially locally influenced by drains that support agricultural practices.

## 2.8 EXISTING DRAINAGE PROVISIONS

Existing drainage provisions within the City’s Sphere of Influence are variable, and are characteristically different between developed areas and undeveloped areas. The following general characterizations of existing drainage provisions may be made.

### 2.8.1 Developed Areas

Existing developed areas of the City generally drain from south to north and southwest to northeast toward the Salado Creek Outfall to the San Joaquin River. Drainage facilities serving existing developed areas of the City generally include the following components:

- Surface drainage via streets
- Underground storm drains
- Open channels (Salado Creek and ditches along State Highway 33)
- Cross-drainage culverts
- Detention basins, including joint-use park and recreation facilities
- Pumping facilities
- Temporary retention basins

Generally, storm drainage generated within the Study Area is accommodated well for the majority of the City's developed areas, particularly the newer development areas, with flooding being limited to a few local problem areas. However, storm runoff entering the Study Area from the offsite watersheds for Salado Creek and Del Puerto Creek are capable of causing significant flooding. The major flood control facility upgrades completed along Salado Creek as it extends through the City in 1998 have significantly reduced, but not eliminated, the flood hazards associated with the offsite watershed and local drainage contributing to Salado Creek within the Study Area.

### 2.8.2 Undeveloped Areas

Undeveloped areas within the City's Sphere of Influence predominantly consist of agricultural lands that drain from southwest to northeast to tailwater ponds and ditches that discharge to Del Puerto Creek, the San Joaquin River, or Salado Creek.

## 2.9 AVERAGE CAPACITIES OF SELECTED EXISTING DRAINAGE FACILITIES

The most significant storm drainage systems that serve urban runoff within the City of Patterson are the Salado Creek storm drainage conveyance system and the Walnut/Sycamore storm drain system. Sizes of key components of these drainage systems were obtained from available construction drawings and from field measurement. Average capacities of these components have been estimated based on normal depth calculations for open channel segments, normal depth calculations for full flow in storm drains, and inlet control nomographs for cross-drainage facilities. Additional capacity may be available in storm drains under pressure flow conditions. Table 2-2 that follows provides a listing of average capacities of key components of these drainage systems.

**Table 2-2: Average Capacities of Selected Drainage Facilities**

| Salado Creek Facilities – Upstream to Downstream | |
|---|---|
| **Facility Descriptions** | **Avg. Capacity** |
| Open Channel (South End of Residential Development to Sperry Avenue) | >500 cfs |
| 24’ x 4’ CBC Crossing @ Calvinson Pkwy. | 504 cfs |
| 16’ x 6.5’ CBC Crossing @ Sperry Avenue | 672 cfs |
| Open Channel (North of Sperry Avenue to Cliff Swallow Drive) | 1,220 cfs |
| 22’ x 4.5’ (at middle) x 2.5’ (at sides) CBC Crossing @ Shearwater Drive | 374 cfs |
| 2-72” SDs (Cliff Swallow Drive) | 542 cfs |
| Open Channel (WSWD Ditch to Ward Ave.) | 960 cfs |
| 2-9.5’ x 4.5’ CBC Crossing @ Ward Ave. + 2-30” HDPE Underdrains | 500 cfs |
| Open Channel (Ward Ave. to State Hwy. 33) | 866 cfs |
| 24’ x 5’ Bridge/Culvert Crossing @ State Hwy. 33 | 720 cfs |
| 28’ x 3’ Wooden Bridge Crossing @ California Northern Railroad (CNR) | Marginal |
| 96” Cast-In-Place Pipe (CIPP) to San Joaquin River | 538 cfs |
| 36” SD to San Joaquin River adjacent to 96” CIPP (storm water/ag tailwater) | 40 cfs |
| **Walnut/Sycamore SD System – Upstream to Downstream** | |
| 42” SD – CNR Crossing Near M Street | 35 cfs |
| 48” SD – Walnut Ave. (42” SD to Bennett Drive) | 120 cfs |
| 48” SD – Walnut Ave. (Bennett Drive to 60” SD) | 70 cfs |
| 60” SD – Walnut Ave. (48” SD to Sycamore Ave.) | 93 cfs |
| 60” SD – Sycamore Ave. | 93 cfs |
| 60” SD – Olive Ave. (Sycamore Ave. to Existing Detention Basin) | 63 cfs |

The Salado Creek "system" has a capacity that predominantly exceeds 500 cfs. However, there are some components that restrict the capacity below 500 cfs. These restrictions are identified in the following Section 2.10.

## 2.10 EXISTING DEFICIENCIES

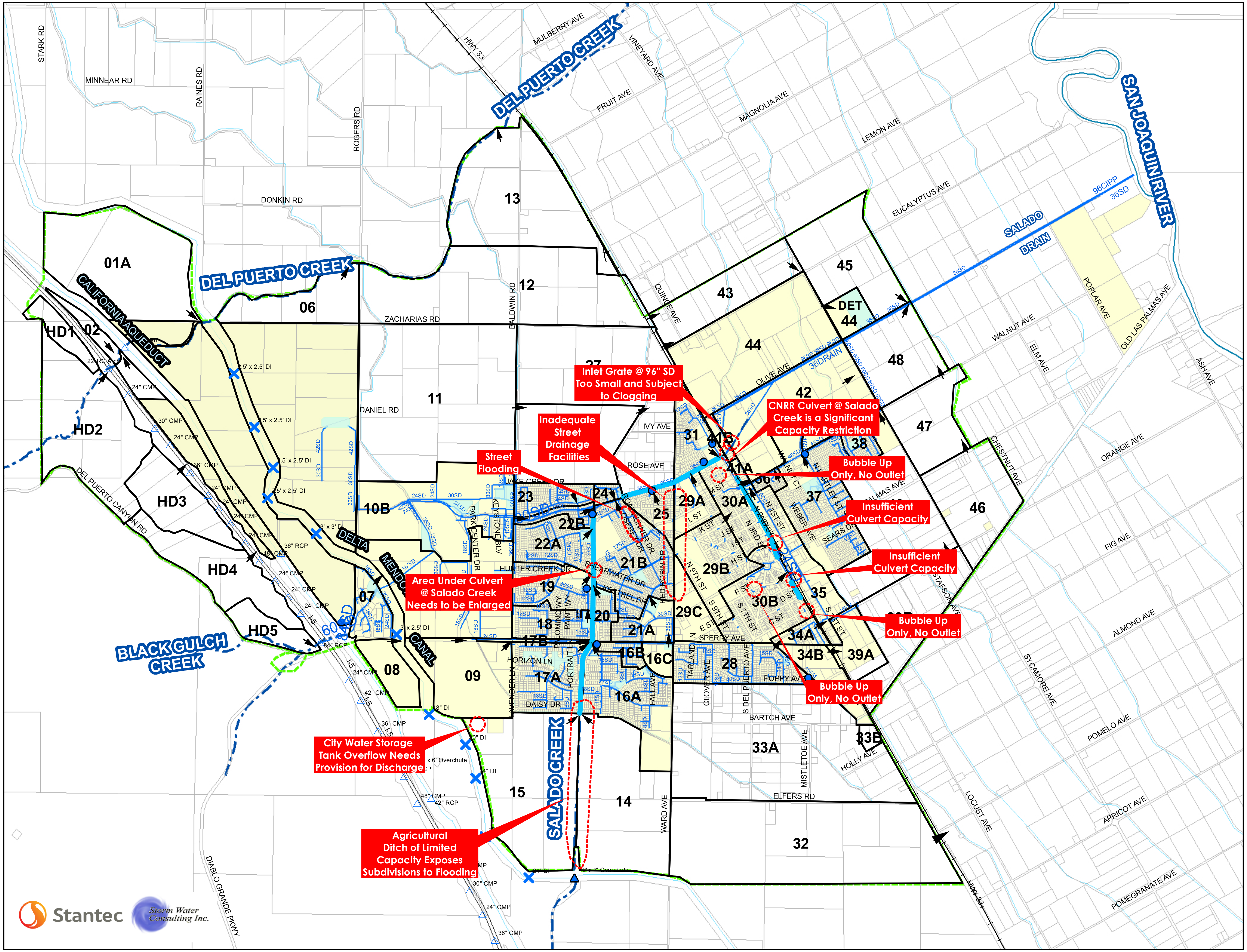
Existing deficiencies for storm drainage systems serving the City have been identified based on input from City Engineering and Operations & Maintenance Staff, the City Council, field reconnaissance, and hydraulic evaluations. The existing deficiencies that have been identified are shown on Figure 2-3. In Section 4.0 of this SDMP, recommendations for upgrades to facilities are provided that will address these existing deficiencies.

A high priority should be placed upon remedying the following existing deficiencies that significantly restrict the capacity of the Salado Creek conveyance facilities, and upgrades to these facilities will be needed in order to serve new development:

- The existing agricultural ditch that serves as the conveyance facility for Salado Creek downstream of the existing overchute at the Delta Mendota Canal to the south limit of existing residential development currently has very limited capacity and needs to be enlarged. During storm events that produce runoff rates from the offsite watershed for Salado Creek that exceed the capacity of the existing agricultural ditch, excess runoff spills onto adjacent agricultural lands and causes flooding of residential properties to the north. New development of the properties adjacent to this agricultural ditch will need to upgrade its size and conveyance capabilities in order for said development to be feasible.

- The existing 28' x 3' wooden bridge crossing of Salado Creek at the California Northern Railroad (CNRR) downstream of State Highway 33 has a very limited capacity and is subject to additional capacity reductions due to clogging during storm events. This condition contributes to frequent flooding within and upstream of this area. A new drainage crossing and channel improvements are needed at this location to reduce flooding and to provide discharge capacity for new development.

- The inlet structure for the 96" CIPP just downstream of the CNRR wooden bridge has a limited capacity and includes a debris collection grate at the pipe inlet that is too small. These conditions contribute to frequent flooding within and upstream of this area and prevent the available capacity in the 96" CIPP from being fully utilized. The inlet structure needs to be enlarged at this location to reduce flooding and to provide discharge capacity for new development.



Inlet Grate @ 96" SD Too Small and Subject to Clogging

Inadequate Street Drainage Facilities

Street Flooding

CNRR Culvert @ Salado Creek is a Significant Capacity Restriction

Bubble Up Only, No Outlet

Insufficient Culvert Capacity

Insufficient Culvert Capacity

Area Under Culvert @ Salado Creek Needs to be Enlarged

Bubble Up Only, No Outlet

Bubble Up Only, No Outlet

City Water Storage Tank Overflow Needs Provision for Discharge

Agricultural Ditch of Limited Capacity Exposes Subdivisions to Flooding

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## Legend

- 27 Drainage Sub-basins
- Existing Detention or Percolation Basins
- ● Existing Drainage Pump Stations
- ✕ Existing Drain Inlets to Delta Mendota
- ▲ Existing Overchutes
- △ Existing Culverts
- Rail Road
- Existing Open Channels and Ditches
- Existing Creeks
- Existing Canals
- 36"SD Existing Storm Drains
- Study Area Boundary
- City Limits
- → Proposed Direction of Flow
- Existing Deficiency

N

Note:
Upgrades to some of the existing deficiencies shown hereon are required to serve and facilitate new development.

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**FIGURE 2-3**

Title
# EXISTING DEFICIENCIES

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184010206
SCALE 1" = 3000'

# 3.0 Hydrologic Modeling

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## 3.1 MODELING APPROACH

The design of a citywide storm drainage system is based upon many factors, and the purpose of this Section is to define some of the more important elements so that a uniform set of criteria can be followed. Specifically, the City's proposed storm drainage system needs that are identified in this SDMP have been evaluated primarily using the levels of service described in Section 4. It is important to note that the criteria used at the master planning level (as in the development of this SDMP) are in some cases different than those used at a site design level (i.e., using City of Patterson Improvement Standards, hereinafter referred to as "City Standards"). For instance, the HEC-HMS computer program has been used in this SDMP for hydrologic modeling to simulate actual hydrologic conditions on a broad and cohesive Citywide scale, whereas the Rational Method is used to determine design flow rates for individual development projects per City Standards and only should be applied to smaller local watershed areas.

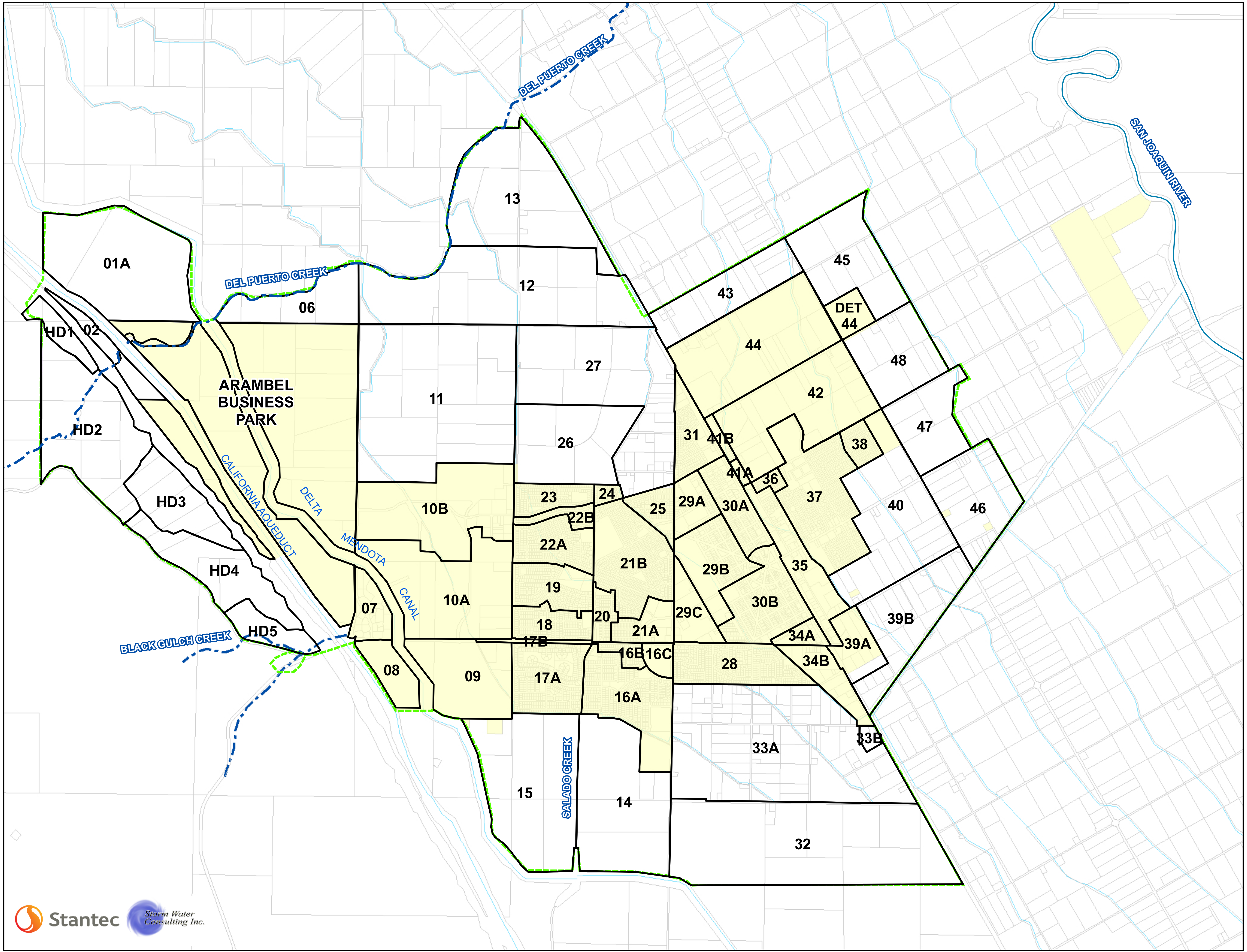
## 3.2 HEC-HMS MODEL

The U.S. Army Corps of Engineers' HEC-HMS computer program was used to develop a rainfall/runoff computer simulation for the watersheds and sub-basins in the Study Area in this SDMP. The Soil Conservation Service (SCS) dimensionless unit hydrograph method, frequently used in practice, was used for the analysis. The HEC-HMS computer model develops runoff hydrographs for individual sub-basins through the input of numerical representations of their physical and hydrological characteristics. The computed hydrographs are then routed and/or combined with hydrographs from other sub-basins to yield a dynamic numerical analysis of peak discharges (design flows) that may be expected to occur at key locations within the Study Area. The model was run for the 10-year 24-hour and 100-year 24-hour storm events. The resultant flows and routings were subsequently used for storm drainage facility sizing as described in Section 4.0.

The HEC-HMS model schematic is included in Appendix A and the input parameters utilized for sub-basins in the HEC-HMS analysis are presented in Appendix B. The input parameters are described in the following paragraphs.

## 3.3 SUB-BASIN DELINEATION

The boundaries for each sub-basin were determined based on field investigations, U.S. Geological Survey 7.5 minute quadrangle maps, prior studies and reports, aerial photographs, and other available maps and plans. The location of various physical features such as Salado Creek, Del Puerto Creek, roadways, irrigation canals, the Delta Mendota Canal, the California Aqueduct, storm drainage facilities, railroad tracks, and other physical features were also factors in establishing the sub-basins boundaries (see Figure 3-1).



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## Legend

- 27 Drainage Sub-basins
- 🟩 Study Area Boundary
- 🟨 City Limits
- Creeks
- Canals

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STORM DRAINAGE MASTER PLAN

**FIGURE 3-1**

Title

## SUB-BASIN MAP

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SCALE 1" = 3000'

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## 3.4 SOIL GROUP CLASSIFICATIONS

Watershed soil groups were determined using soil maps contained in a report entitled *Soil Survey of Western Stanislaus County, California* prepared by the Natural Resources Conservation Service (NRCS, formerly the US Department of Agriculture Soil Conservation Service) in May 2009. Hydrologic soil groups are classified as A, B, C, or D with Group A having the highest rate of infiltration (lowest runoff production) and Group D having the lowest rate of infiltration (highest runoff production). Hydrologic soil group classifications for the Study Area are shown on Figure 3-2.

## 3.5 RAINFALL LOSS AND SCS CURVE NUMBERS

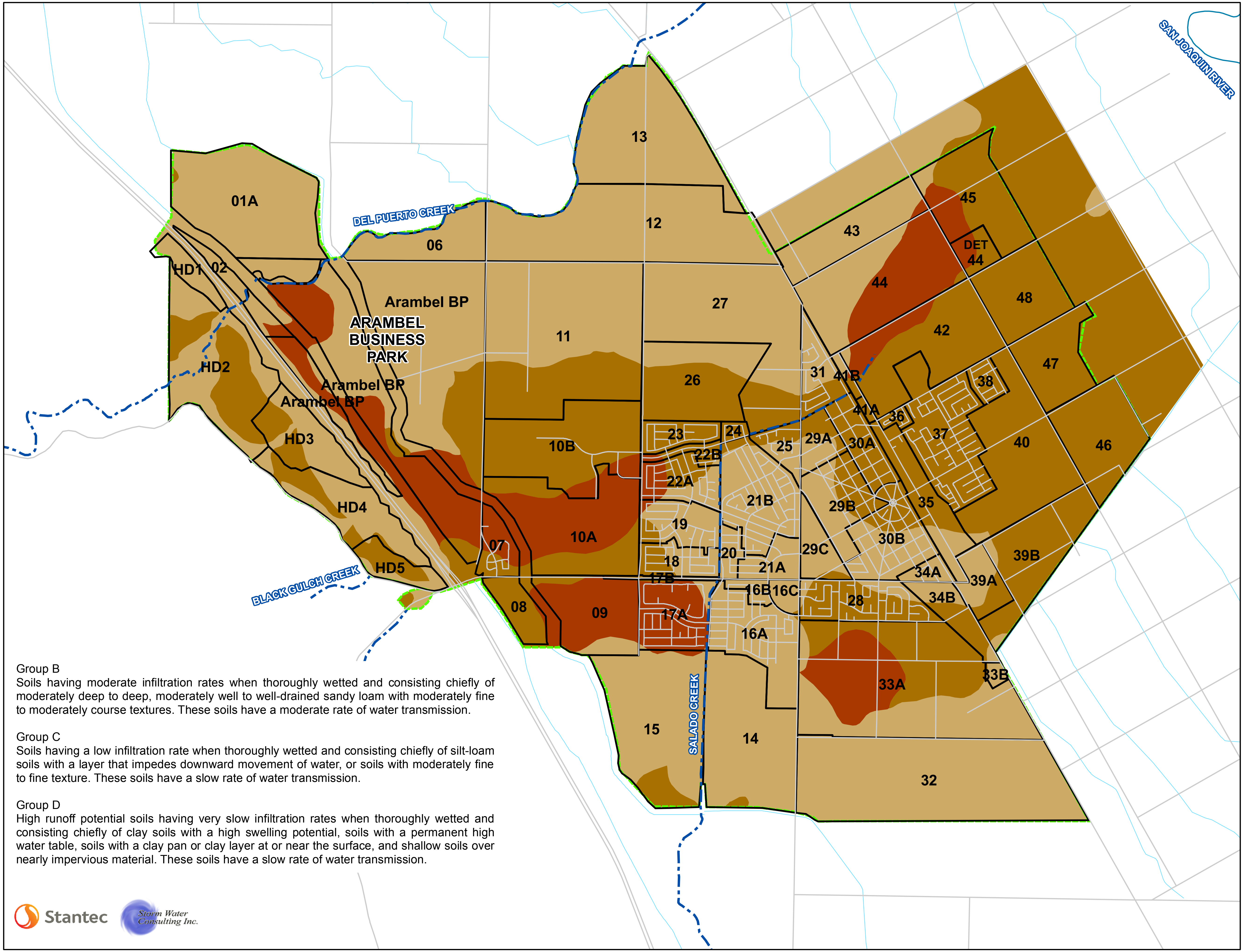
Rainfall loss is that portion of the precipitation depth that is lost due to evaporation, interception by vegetation, infiltration into soil, and surface depression storage. Rainfall excess is that portion of the precipitation depth that appears as surface or collected storm water runoff during and after a storm event. Rainfall losses consist of both initial and constant losses and were determined using the NRCS Curve Number (CN) Method that uses a soil cover complex for estimating watershed losses. The CN is related to the underlying hydrologic soil group (A, B, C, or D), land use, cover density, and soil moisture conditions. In addition to soil classification, the Curve Numbers are based on the vegetative cover. In this SDMP, a vegetative cover classified as “good” with grass cover on at least 75% of the area was assumed. The four hydrologic soil groups are described in greater detail as follows:

- *Group A:* Low runoff potential soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well-drained sands or gravels. These soils have a high rate of water transmission. No Group A soils are located within the Study Area.

- *Group B:* Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well-drained sandy-loam with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. *A CN of 61 was used for Group B in the SDMP.*

- *Group C:* Soils having a low infiltration rate when thoroughly wetted and consisting chiefly of silt-loam soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission. *A CN of 74 was used for Group C in the SDMP.*

- *Group D:* High runoff potential soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have slow rate of water transmission. *A CN of 80 was used for Group D in the SDMP.*



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

Group C
Soils having a low infiltration rate when thoroughly wetted and consisting chiefly of silt-loam soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

Group D
High runoff potential soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a slow rate of water transmission.

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## Legend

| | |
|---|---|
| 27 | Drainage Sub-basins |
| ▭ | Study Area Boundary |
| — | Roads |
| - · - | Creeks |
| — | Canals |

**Hydrologic Soil Group**

| | |
|---|---|
| ▨ | B |
| 🟥 | C |
| ▨ | D |

Source: Soil Survey of Western Stanislaus County prepared by the Natural Resources Conservation Service (NRCS), May 2009

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STORM DRAINAGE MASTER PLAN

**FIGURE 3-2**

Title

# HYDROLOGIC SOILS MAP

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SCALE 1" = 3000'

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## 3.6 LAND USE ASSUMPTIONS AND PERCENT IMPERVIOUS

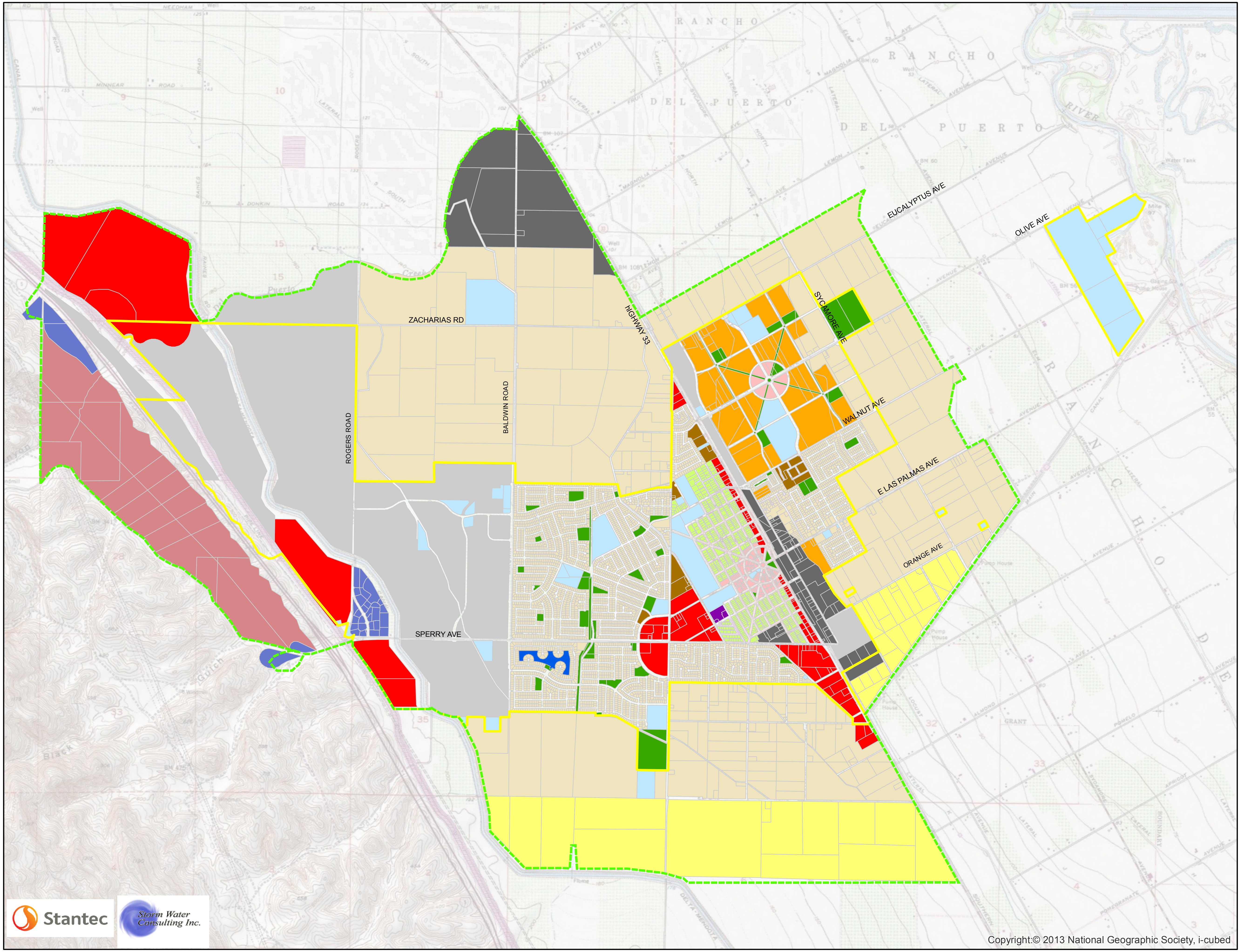
Land uses assumed in this SDMP were taken from the City's General Plan (see Figure 3-3).

The percent of impervious area for each sub-basin was based on a weighted average of the amount and type of the different land uses within the sub-basins, as estimated by direct measurements of the various land use areas shown in the General Plan. This is an important input parameter in the HEC-HMS program because the model relates the amount of impervious area to the total area of a given sub-basin to estimate the amount of runoff losses attributed to pervious areas. For the purposes of hydrologic modeling, design flow determination, and the planning of storm drainage facilities in this SDMP, future build-out of the City's Sphere of Influence (Study Area) was assumed.

Implementation of the site design and treatment measures mandated by the City's *Multi-Agency Post-Construction Stormwater Standards Manual* will have the effect of reducing and attenuating volumes and rates of runoff for new development areas governed by this manual when compared to existing development that has not been required to incorporate these measures. Using a calibration procedure, reductions in impervious cover percentages were estimated and incorporated into the HEC-HMS modeling input as a means of accounting for the effect of implementing site design and treatment measures for new development. Table 3-1 shows the impervious cover percentages of the different land uses that have been utilized in the HEC-HMS models developed for this SDMP.

**Table 3-1: Land Use Impervious Cover Values**

| General Plan Land Use Designation | % Impervious Cover Existing Development | % Impervious Cover New Development |
|---|---|---|
| Estate Residential | 10 | 6 |
| Low Density Residential | 30 | 19 |
| Medium Density Residential | 50 | 32 |
| High Density Residential | 60 | 38 |
| Downtown Residential | 40 | 25 |
| Highway Service Commercial | 80 | 50 |
| Downtown Core | 80 | 50 |
| General Commercial | 80 | 50 |
| Mixed Use (Hillside) | 20 | 13 |
| Medical Professional | 80 | 50 |
| Light Industrial | 70 | 44 |
| Heavy Industrial | 70 | 44 |
| Public/Quasi-Public | 60 | 38 |
| Parks/Open Space | 10 | 6 |
| Lake | 100 | 63 |



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## Legend

- ▭ Study Area Boundary
- ▭ City Limits

### Land Use Designations

- 🟨 Estate Residential
- ▨ Low Density Residential
- 🟧 Medium Density Residential
- 🟫 High Density Residential
- 🟩 Downtown Residential
- 🟦 Highway Service Commercial
- ▨ Downtown Core
- 🟥 General Commercial
- ▨ Mixed Use
- 🟪 Medical Professional
- ▨ Light Industrial
- ⬛ Heavy Industrial
- ▨ Public/Quasi-Public
- 🟩 Parks/Open Space
- 🟦 Lake

Source: City of Patterson
General Plan, Updated January 2014

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**FIGURE 3-3**

Title

## LAND USE MAP

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184010206
SCALE 1" = 3000'

*Though the Villages of Patterson will predominantly consist of "New Development", hydrologic modeling for Sub-basins 42 and 44 have assumed that required stormwater quality treatment measures will be provided within downstream DET 44 per City direction; and thus, reductions in land use impervious cover percentages have not been made for these sub-basins.*

*Please note that the hydrologic modeling procedures utilized in this SDMP are being applied to master plan level (major) storm drainage facilities, only, and are limited in application to the development of the storm drainage infrastructure master plan presented in this SDMP. The design of onsite storm drainage facilities shall continue to utilize the procedures set forth per City Standards.*

## 3.7 RAINFALL

The depths of precipitation shown on Table 3-2 that follows were incorporated into the HEC-HMS hydrologic model. The 100-year 24-hour depth of precipitation was obtained from DWR based on 81 years of precipitation record obtained from precipitation gage Station B00667905 in the City of Patterson. The 10-year 24-hour depth of precipitation was taken from City Standards. The SCS 24-hour Type I Rainfall Distribution was used for the Study Area.

**Table 3-2: Precipitation**

| Return Period Storm | Depth of Precipitation |
|---|---|
| 10-year 24-hour storm | 1.73 inches |
| 100-year 24-hour storm | 2.75 inches |

## 3.8 UNIT HYDROGRAPH

For runoff computations from each sub-basin, the NRCS Dimensionless Unit Hydrograph option was utilized in the HEC-HMS computer model.

## 3.9 LAG TIME

The temporal distribution of the unit hydrograph is a function of the basin lag time. The lag time is defined as a time required for 50 percent of the volume of runoff to reach the basin outlet and was estimated utilizing the NRCS method. The equation is as follows:

Lag = $(L)^{0.8} (S+1)^{0.7}/1900(Y)^{0.5}$

L = hydraulic length of watershed in feet

S = potential maximum surface retention = (1000/CN) -10

CN = hydrologic curve number

Y = average watershed land slope in percent

Parameters used for each sub-basin in lag time calculations and the resultant lag times are represented in the Appendix.

## 3.10 ROUTING

Routing of runoff between sub-basins was performed utilizing the Muskingum-Cunge method for open channel flow. The Modified Puls Reservoir Routing method was used to route flow through detention basins.

## 3.11 DETENTION BASINS

The proposed detention basins will store and attenuate storm water runoff, which will significantly reduce the peak flows that would have otherwise overburdened the available downstream outfall systems, and they will provide opportunities for water quality treatment prior to discharge. Due to the capacity limitations associated with the downstream outfall systems and storm water quality considerations, the detention basins proposed in this SDMP will have limited and regulated outflows as listed in Section 4.0. The detention basins were modeled by applying preliminary estimates of stage-storage and elevation-discharge data to their inflow hydrographs. Where feasible, detention basins will be retrofitted to function as percolation basins that provide terminal drainage within the basin under most conditions.

## 3.12 RESULTS

The HEC-HMS output files are included in Appendix C. The flows at particular concentration points and prorated flows within various sub-basins were used for infrastructure sizing as discussed in Section 4.0.

Selected 10-year return period and 100-year return period discharges are shown at key locations throughout the Study Area on Figures included in Section 4.0 of this SDMP.

## 3.13 OFFSITE WATERSHEDS (SALADO CREEK, DEL PUERTO CREEK AND BLACK GULCH CREEK)

The offsite watersheds for Salado Creek and Del Puerto Creek were not included in the HEC-HMS hydrologic modeling of the Study Area as they have been analyzed by FEMA. Their offsite watershed sizes are 25.3 square miles and 72.6 square miles, respectively, and a separate preliminary analysis of the Salado Creek watershed (the smaller of the two) revealed that implementing a flood control project to control inflow into the Study Area would be economically unfeasible and impractical based on the magnitude of flood control detention storage that would be required. Instead, potential flooding within the Study Area from either of these sources has been concluded to be a floodplain management issue that needs to be considered and managed with new development in consideration of the Title 17 of the City's

Municipal Code (Flood Hazard Areas) and the Urban Level of Flood Protection Criteria (see Section 1.2.2) . However, some of the capacity enhancements proposed in this SDMP for Salado Creek within the Study Area are being allocated towards reducing the severity of flooding within the City that will be incurred by an offsite flow event.

Flows generated by the offsite watershed for Black Gulch Creek are regulated by a detention basin, outlet structure (30” pipe), and a spillway on the west side of the Delta Mendota Canal. As stated in Section 2.4, this SDMP assumes that these provisions will remain in place or future alternative flood control measures will implemented that are beyond the scope of the SDMP. In consideration of these provisions, a fixed inflow rate of 50 cfs for Black Gulch Creek has been incorporated into the HEC-HMS model downstream of the Delta Mendota Canal.

# 4.0 Master Plan Storm Drainage Infrastructure

## 4.1 FACILITY COMPONENTS

The proposed storm drainage infrastructure plan recommended in this SDMP includes a combination of the following components (see Figures 4-1 and 4-2 herein and a larger version of Figure 4-1 located in the pocket at the front of the report):

- Detention basins
- Open channels
- Underground storm drains
- Pumping facilities (serving applicable detention basins)
- Percolation facilities, where feasible
- Temporary retention facilities

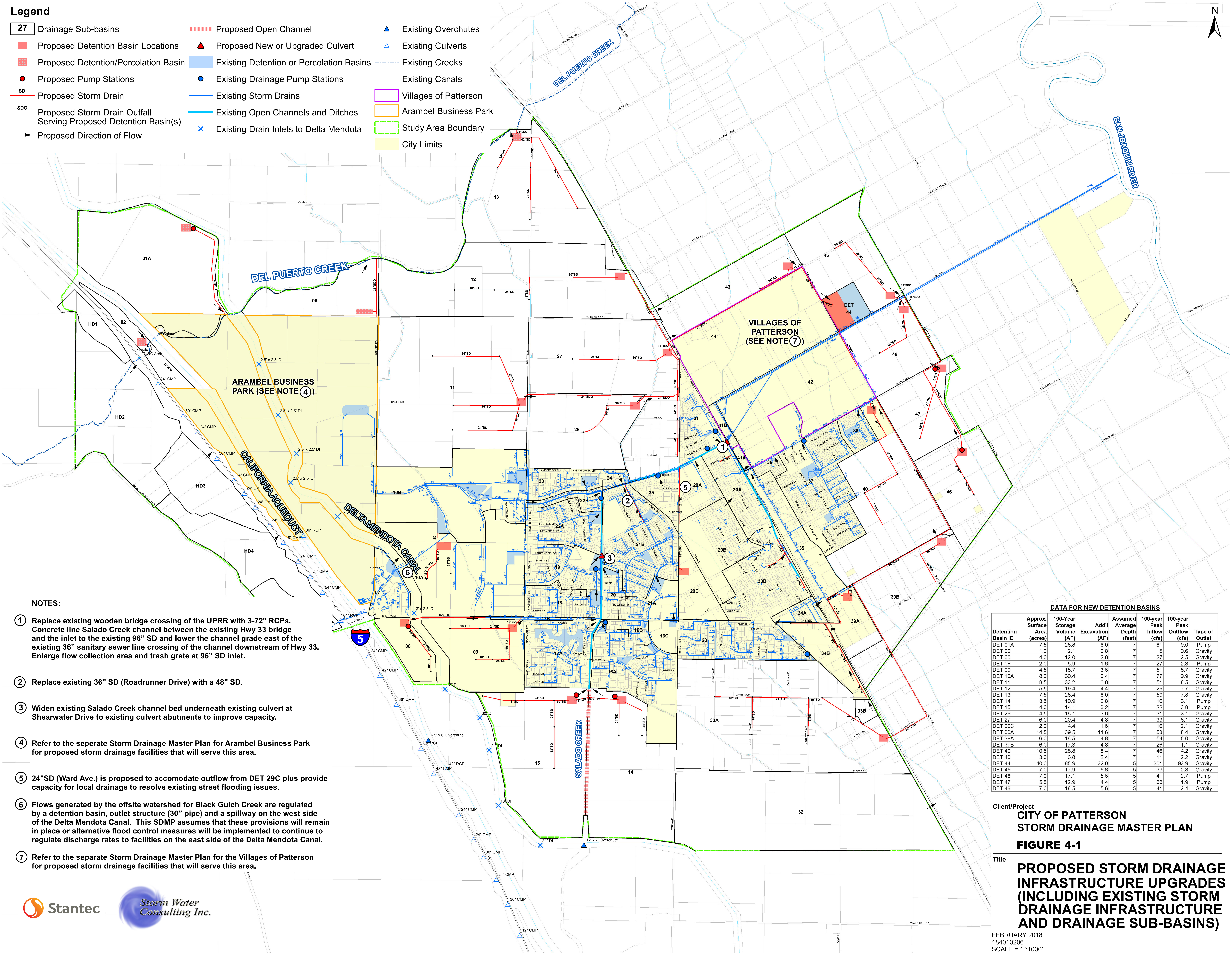
In general, new development projects will be required to provide site-specific or project-specific storm drainage solutions that are consistent with the overall infrastructure approach presented in this SDMP. The City may allow for a reasonable degree of flexibility to be incorporated into specific design approaches as a part of achieving effective solutions, including adjustments to alignments of linear storm drainage conveyance facilities and adjustments to configurations of detention facilities. Modifications and refinement to the storm drainage facilities master plan represented herein may be considered by the City during the development review process for new development.

New development projects will be required to construct elements of the master plan infrastructure that have alignments that pass through them or extend along their project boundaries. At the discretion of the City, the cost of construction of these master plan elements may be offset against other drainage funding requirements applicable to each project (such as drainage impact fees) or may be classified as eligible for future reimbursements within time frames to be determined by the City. In some instances, the City may require or may accept the construction of offsite facilities or interim versions of master planned facilities as appropriate.

*The City's Arambel Business Park and Villages of Patterson projects have their own Storm Drainage Master Plans for proposed onsite storm drainage infrastructure and this SDMP defers to the specific Storm Drainage Master Plans that have been developed for them by others.*

### 4.1.1 Overview of Framework for Master Plan Infrastructure

In general, the SDMP storm drainage infrastructure plan consists of the following fundamental components:



## Legend

- 27 Drainage Sub-basins
- 🟥 Proposed Detention Basin Locations
- ▨ Proposed Detention/Percolation Basin
- ● Proposed Pump Stations
- SD Proposed Storm Drain
- SDO Proposed Storm Drain Outfall Serving Proposed Detention Basin(s)
- → Proposed Direction of Flow
- Proposed Open Channel
- ▲ Proposed New or Upgraded Culvert
- Existing Detention or Percolation Basins
- ● Existing Drainage Pump Stations
- Existing Storm Drains
- Existing Open Channels and Ditches
- × Existing Drain Inlets to Delta Mendota
- ▲ Existing Overchutes
- △ Existing Culverts
- Existing Creeks
- Existing Canals
- Villages of Patterson
- Arambel Business Park
- Study Area Boundary
- City Limits

NOTES:

① Replace existing wooden bridge crossing of the UPRR with 3-72" RCPs. Concrete line Salado Creek channel between the existing Hwy 33 bridge and the inlet to the existing 96" SD and lower the channel grade east of the existing 36" sanitary sewer line crossing of the channel downstream of Hwy 33. Enlarge flow collection area and trash grate at 96" SD inlet.

② Replace existing 36" SD (Roadrunner Drive) with a 48" SD.

③ Widen existing Salado Creek channel bed underneath existing culvert at Shearwater Drive to existing culvert abutments to improve capacity.

④ Refer to the seperate Storm Drainage Master Plan for Arambel Business Park for proposed storm drainage facilities that will serve this area.

⑤ 24"SD (Ward Ave.) is proposed to accomodate outflow from DET 29C plus provide capacity for local drainage to resolve existing street flooding issues.

⑥ Flows generated by the offsite watershed for Black Gulch Creek are regulated by a detention basin, outlet structure (30" pipe) and a spillway on the west side of the Delta Mendota Canal. This SDMP assumes that these provisions will remain in place or alternative flood control measures will be implemented to continue to regulate discharge rates to facilities on the east side of the Delta Mendota Canal.

⑦ Refer to the separate Storm Drainage Master Plan for the Villages of Patterson for proposed storm drainage facilities that will serve this area.

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**DATA FOR NEW DETENTION BASINS**

| Detention Basin ID | Approx. Surface Area (acres) | 100-Year Storage Volume (AF) | Add'l Excavation (AF) | Assumed Average Depth (feet) | 100-year Peak Inflow (cfs) | 100-year Peak Outflow (cfs) | Type of Outlet |
|---|---|---|---|---|---|---|---|
| DET 01A | 7.5 | 28.8 | 6.0 | 7 | 81 | 9.0 | Pump |
| DET 02 | 1.0 | 2.1 | 0.8 | 7 | 5 | 0.6 | Gravity |
| DET 06 | 4.0 | 12.0 | 2.8 | 7 | 27 | 2.5 | Gravity |
| DET 08 | 2.0 | 5.9 | 1.6 | 7 | 27 | 2.3 | Pump |
| DET 09 | 4.5 | 15.7 | 3.6 | 7 | 51 | 5.7 | Gravity |
| DET 10A | 8.0 | 30.4 | 6.4 | 7 | 77 | 9.9 | Gravity |
| DET 11 | 8.5 | 33.2 | 6.8 | 7 | 51 | 8.5 | Gravity |
| DET 12 | 5.5 | 19.4 | 4.4 | 7 | 29 | 7.7 | Gravity |
| DET 13 | 7.5 | 28.4 | 6.0 | 7 | 59 | 7.8 | Gravity |
| DET 14 | 3.5 | 10.9 | 2.8 | 7 | 16 | 3.1 | Pump |
| DET 15 | 4.0 | 14.1 | 3.2 | 7 | 22 | 3.8 | Pump |
| DET 26 | 4.5 | 16.1 | 3.6 | 7 | 31 | 3.1 | Gravity |
| DET 27 | 6.0 | 20.4 | 4.8 | 7 | 33 | 6.1 | Gravity |
| DET 29C | 2.0 | 4.4 | 1.6 | 7 | 16 | 2.1 | Gravity |
| DET 33A | 14.5 | 39.5 | 11.6 | 7 | 53 | 8.4 | Gravity |
| DET 39A | 6.0 | 16.5 | 4.8 | 7 | 54 | 5.0 | Gravity |
| DET 39B | 6.0 | 17.3 | 4.8 | 7 | 26 | 1.1 | Gravity |
| DET 40 | 10.5 | 28.8 | 8.4 | 7 | 46 | 4.2 | Gravity |
| DET 43 | 3.0 | 6.8 | 2.4 | 7 | 11 | 2.2 | Gravity |
| DET 44 | 40.0 | 85.9 | 32.0 | 5 | 301 | 93.9 | Gravity |
| DET 45 | 7.0 | 17.9 | 5.6 | 5 | 33 | 2.8 | Gravity |
| DET 46 | 7.0 | 17.1 | 5.6 | 5 | 41 | 2.7 | Pump |
| DET 47 | 5.5 | 12.9 | 4.4 | 5 | 33 | 1.9 | Pump |
| DET 48 | 7.0 | 18.5 | 5.6 | 5 | 41 | 2.4 | Gravity |

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**CITY OF PATTERSON**
**STORM DRAINAGE MASTER PLAN**

**FIGURE 4-1**

Title

# PROPOSED STORM DRAINAGE INFRASTRUCTURE UPGRADES (INCLUDING EXISTING STORM DRAINAGE INFRASTRUCTURE AND DRAINAGE SUB-BASINS)

FEBRUARY 2018
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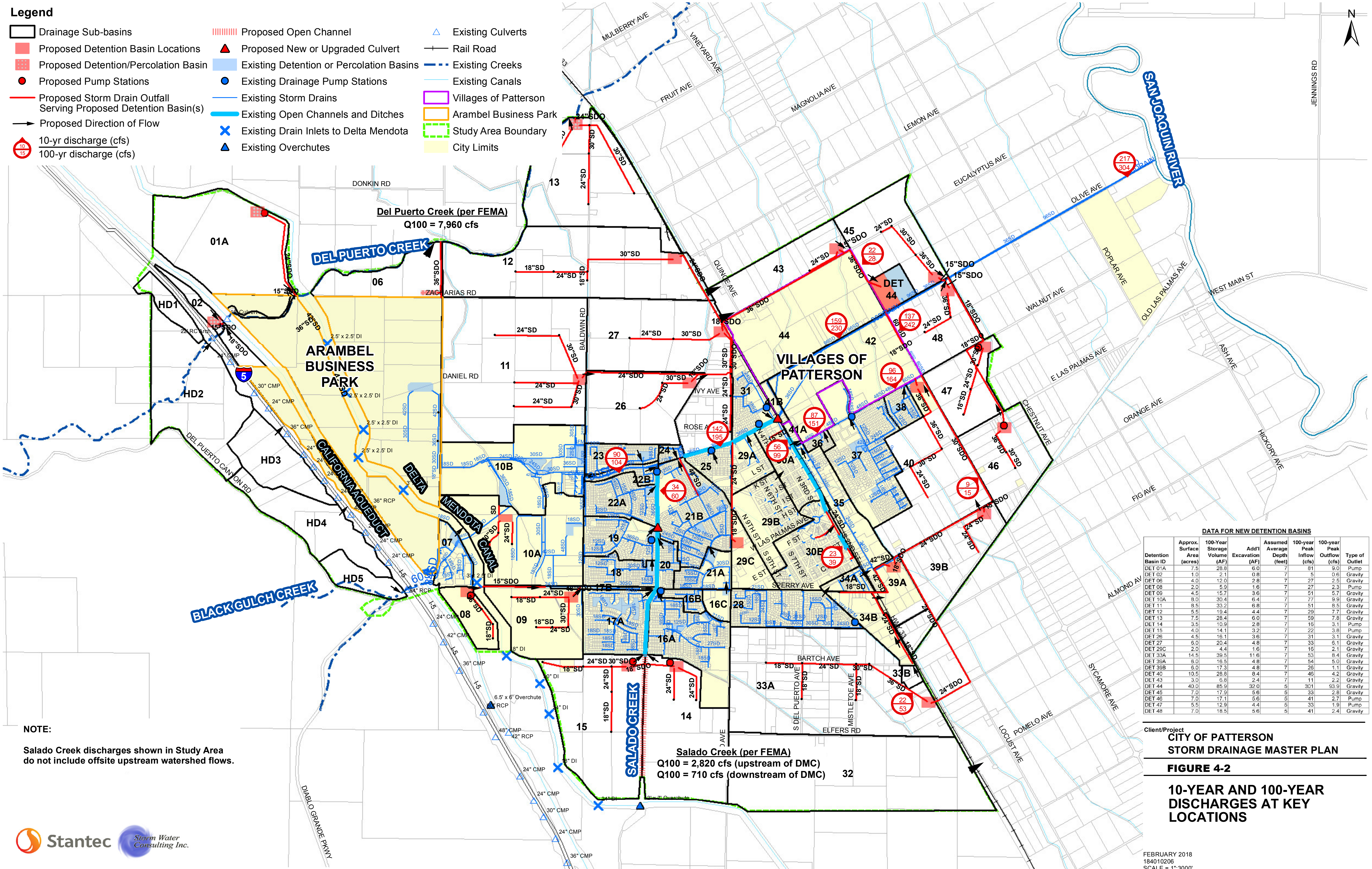

**NOTE:**

Salado Creek discharges shown in Study Area do not include offsite upstream watershed flows.

**DATA FOR NEW DETENTION BASINS**

| Detention Basin ID | Approx. Surface Area (acres) | 100-Year Storage Volume (AF) | Add'l Excavation (AF) | Assumed Average Depth (feet) | 100-year Peak Inflow (cfs) | 100-year Peak Outflow (cfs) | Type of Outlet |
|---|---|---|---|---|---|---|---|
| DET 01A | 7.5 | 28.8 | 6.0 | 7 | 81 | 9.0 | Pump |
| DET 02 | 1.0 | 2.1 | 0.8 | 7 | 5 | 0.6 | Gravity |
| DET 06 | 4.0 | 12.0 | 2.8 | 7 | 27 | 2.5 | Gravity |
| DET 08 | 2.0 | 5.9 | 1.6 | 7 | 27 | 2.3 | Pump |
| DET 09 | 4.5 | 15.7 | 3.6 | 7 | 51 | 5.7 | Gravity |
| DET 10A | 8.0 | 30.4 | 6.4 | 7 | 77 | 9.9 | Gravity |
| DET 11 | 8.5 | 33.2 | 6.8 | 7 | 51 | 8.5 | Gravity |
| DET 12 | 5.5 | 19.4 | 4.4 | 7 | 29 | 7.7 | Gravity |
| DET 13 | 7.5 | 28.4 | 6.0 | 7 | 59 | 7.8 | Gravity |
| DET 14 | 3.5 | 10.9 | 2.8 | 7 | 16 | 3.1 | Pump |
| DET 15 | 4.0 | 14.1 | 3.2 | 7 | 22 | 3.8 | Pump |
| DET 26 | 4.5 | 16.1 | 3.6 | 7 | 31 | 3.1 | Gravity |
| DET 27 | 6.0 | 20.4 | 4.8 | 7 | 33 | 6.1 | Gravity |
| DET 29C | 2.0 | 4.4 | 1.6 | 7 | 16 | 2.1 | Gravity |
| DET 33A | 14.5 | 39.5 | 11.6 | 7 | 53 | 8.4 | Gravity |
| DET 39A | 6.0 | 16.5 | 4.8 | 7 | 54 | 5.0 | Gravity |
| DET 39B | 6.0 | 17.3 | 4.8 | 7 | 26 | 1.1 | Gravity |
| DET 40 | 10.5 | 28.8 | 8.4 | 7 | 46 | 4.2 | Gravity |
| DET 43 | 3.0 | 6.8 | 2.4 | 7 | 11 | 2.2 | Gravity |
| DET 44 | 40.0 | 85.9 | 32.0 | 5 | 301 | 93.9 | Gravity |
| DET 45 | 7.0 | 17.9 | 5.6 | 5 | 33 | 2.8 | Gravity |
| DET 46 | 7.0 | 17.1 | 5.6 | 5 | 41 | 2.7 | Pump |
| DET 47 | 5.5 | 12.9 | 4.4 | 5 | 33 | 1.9 | Pump |
| DET 48 | 7.0 | 18.5 | 5.6 | 5 | 41 | 2.4 | Gravity |

Client/Project

**CITY OF PATTERSON**
**STORM DRAINAGE MASTER PLAN**

## FIGURE 4-2

## 10-YEAR AND 100-YEAR DISCHARGES AT KEY LOCATIONS

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Stantec

Storm Water Consulting Inc.

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- The majority of existing and new development areas within the overall Study Area are proposed to connect to existing Salado Creek storm drainage facilities, including the existing 96” CIPP outfall pipe that extends along the alignment of Olive Avenue to the San Joaquin River. For new and several existing development areas, contributing flows will be or are already attenuated (metered) via detention basins prior to release to downstream facilities. Where feasible, new detention basins will be retrofitted to function as percolation basins that provide terminal discharge within the basin.

- Currently, the capacity of the 96” CIPP outfall is not being fully utilized due to capacity restrictions at and near the inlet of the pipe just east of State Highway 33. Capacity improvements are proposed in this area in this SDMP that will increase the discharge capacity at the inlet area for the 96” CIPP and more fully utilize the available capacity of the pipe itself. Attenuated discharges from proposed detention basins serving new development are proposed to be accommodated by capacity improvements at this location.

- The northern portions of the Study Area are proposed to discharge to percolation basins, with Del Puerto Creek being available for low flow discharge if functional percolation issues or maintenance issues are encountered in the future. The low flow discharge provision will consist of storm drain pipes that are operated by a sluice gate that may be raised, if needed, for percolation basin drainage or maintenance. Installation of low flow discharge pipes may require environmental review and permitting depending upon the design specifics and degree of encroachment into the Del Puerto Creek area. Permitting may include Section 404 permitting (COE), Streambed Alteration Agreement (CA Fish and Wildlife), Section 401 Water Quality Certification (SWRCB), and possibly others. However, the applicable contributing areas that will discharge to percolation basins and may never need to discharge to Del Puerto Creek. .

- There are no new outfalls proposed to the San Joaquin River.

- Detention basins are proposed to be larger and lesser in number per unit contributing area than has been the practice in the City in the past. This will reduce operational requirements and costs, land acquisition costs, and maintenance costs and create greater opportunities for joint-use.

The composite of proposed components of the storm drainage infrastructure master plan are depicted and/or described on Figure 4-1.

### 4.1.2 Design Levels of Service

The design levels of service for master plan level storm drainage facilities that provide the “framework” for the City’s storm drainage infrastructure as presented in this SDMP differ from the design levels of service for “onsite” storm drainage facilities that are governed by City Standards. These design levels of service are discussed in greater detail in the following subsections.

### 4.1.2.1 Master Plan Facilities

The storm drainage infrastructure plan presented in this SDMP has been based on the following design levels of service:

> *Underground storm drains:* 1) 10-year 24-hour storm for storm drains (SDs) discharging to major storm drain trunk lines or detention basins, 2) 100-year 24-hour storm for storm drain outfalls (SDOs) carrying metered discharges from detention basins, and 3) lower design levels of service that are consistent with existing downstream system capacities in older development areas where existing deficiencies are proposed to be corrected.
>
> *Detention basins:* 100-year 24-hour storm, reduced to account for outflow rates, but no volume reduction for potential infiltration/percolation.
>
> *Detention basin pump stations (when needed):* Per City Standards, plus back up power systems.
>
> *Open Channels:* 100-year 24-hour storm.

These design levels are currently being applied to the planning and design of master plan storm drainage facilities in numerous other cities in Northern California and are considered appropriate from a flood nuisance and flood safety perspective.

### 4.1.2.2 “Onsite” Storm Drainage Facilities

Onsite storm drainage facilities are those facilities serving individual or small groups of development projects that will discharge to master plan storm drainage facilities presented in this SDMP. Onsite storm drainage facility design shall conform to City Standards which reference the following design levels of service:

> *Underground storm drains:* 5-year storm or greater.
>
> *Detention basins:* 1) Total runoff from a 10-year 24-hour storm if gravity discharge is used, and 2) total runoff from a 50-year 24-hour storm if a pump discharge is used. Volume requirement is not reduced to account for outflow rates.
>
> *Detention basin pump stations (when needed):* Pumping capacity that is required to drain 100% of the detention basin’s storage capacity within 48 hours.
>
> *Open Channels:* Not covered.

### 4.1.2.3 Master Plan Levels of Service vs. City Standards

The storm drainage infrastructure plan presented in this SDMP is an integrated “system” that will serve the buildout of the entire City Sphere of Influence. This “system” and its individual elements have been analyzed, sized, and connected utilizing the HEC-HMS hydrologic computer model. The design levels of service and approaches contained in the City Standards provide applicability to individual localized projects and are not integrated into the SDMP. In a sense, City Standards apply to pieces of a puzzle while the SDMP puts the puzzle together. A comparative discussion is provided below:

> *Underground Storm Drains:* City Standards use the Rational Formula for calculating flow capacity requirements for storm drain pipes. The Rational Formula is a simple method for estimating discharges for small local drainage sheds. There is quite a lot of varying literature regarding the maximum drainage sub-basin size for which the Rational Formula should be used, but a commonly applied size threshold is about 120 acres. Once the size threshold is exceeded, the Rational Formula overestimates flow rates as it does not adequately take flow attenuation into consideration (initial abstraction, surface storage, rainfall intensity reduction, hydrographs, and other peak flow reducing factors). Applying the 10-year 24-hour return period level of service to the SDMP facilities actually reduces the underground pipe size requirements for master plan storm drainage facilities when compared with City Standards as the integrated HEC-HMS model takes the components of flow attenuation into consideration.
>
> *Detention Basins:* Applying the 100-year 24-hour storm level of service for the sizing of master plan detention basins will not increase detention basin volumes when compared with sizing procedure contained in City Standards due to the attenuation components included in the hydrologic modeling process cited above and the volume reduction attributable to outflow rates.

### 4.1.3 Detention Basins

Detention basins are a significant and necessary component of the proposed master plan facilities that will serve new development in this SDMP. Though there are several important goals and benefits associated with the incorporation of detention basins as a storm drainage facility component, the primary driving factors that warrant detention basins are limitations in downstream outfalls and discharge capacities. New detention basins will provide a significant amount of storage capacity and will provide significant attenuation of peak flows to meter downstream releases of storm water to reduced rates that are considered to be reasonable, acceptable, and environmentally sound. All proposed detention basins have been sized to accommodate the 100-year 24-hour storm under build-out conditions, considering outflow discharge rates.

Table 4-1 that follows provides a listing of new detention basins proposed in this SDMP along with pertinent physical and hydraulic information. The general locations for proposed detention basins are shown on Figure 4-1. The detention basin IDs listed in Table 4-1 relate to the drainage sub-basin numbers in which each detention basin is located.

If for some reason onsite storm water quality treatment and other applicable measures are not incorporated into new development in conformance with the *Multi-Agency Post-Construction Stormwater Standards Manual,* applicable detention basin sizes and volumes will need to be augmented.

**Table 4-1: Data for New Detention Basins**

| Detention Basin ID | Approx. Surface Area (acres) | 100-Year Storage Volume (AF) | Add'l Excavation (AF) | Assumed Average Total Depth (feet) | 100-year Peak Inflow (cfs) | 100-year Peak Outflow (cfs) | Type of Outlet |
|---|---|---|---|---|---|---|---|
| DET 01A | 7.5 | 28.8 | 6.0 | 7 | 81 | 9.0 | Pump |
| DET 02 | 1.0 | 2.1 | 0.8 | 7 | 5 | 0.6 | Gravity |
| DET 06 | 4.0 | 12.0 | 2.8 | 7 | 27 | 2.5 | Gravity |
| DET 08 | 2.0 | 5.9 | 1.6 | 7 | 27 | 2.3 | Pump |
| DET 09 | 4.5 | 15.7 | 3.6 | 7 | 51 | 5.7 | Gravity |
| DET 10A | 8.0 | 30.4 | 6.4 | 7 | 77 | 9.9 | Gravity |
| DET 11 | 8.5 | 33.2 | 6.8 | 7 | 51 | 8.5 | Gravity |
| DET 12 | 5.5 | 19.4 | 4.4 | 7 | 29 | 7.7 | Gravity |
| DET 13 | 7.5 | 28.4 | 6.0 | 7 | 59 | 7.8 | Gravity |
| DET 14 | 3.5 | 10.9 | 2.8 | 7 | 16 | 3.1 | Pump |
| DET 15 | 4.0 | 14.1 | 3.2 | 7 | 22 | 3.8 | Pump |
| DET 26 | 4.5 | 16.1 | 3.6 | 7 | 31 | 3.1 | Gravity |
| DET 27 | 6.0 | 20.4 | 4.8 | 7 | 33 | 6.1 | Gravity |
| DET 29C | 2.0 | 4.4 | 1.6 | 7 | 16 | 2.1 | Gravity |
| DET 33A | 14.5 | 39.5 | 11.6 | 7 | 53 | 8.4 | Gravity |
| DET 39A | 6.0 | 16.5 | 4.8 | 7 | 54 | 5.0 | Gravity |
| DET 39B | 6.0 | 17.3 | 4.8 | 7 | 26 | 1.1 | Gravity |
| DET 40 | 10.5 | 28.8 | 8.4 | 7 | 46 | 4.2 | Gravity |
| DET 43 | 3.0 | 6.8 | 2.4 | 7 | 11 | 2.2 | Gravity |
| DET 44 | 40.0 | 85.9 | 32.0 | 5 | 301 | 93.9 | Gravity |
| DET 45 | 7.0 | 17.9 | 5.6 | 5 | 33 | 2.8 | Gravity |
| DET 46 | 7.0 | 17.1 | 5.6 | 5 | 41 | 2.7 | Pump |
| DET 47 | 5.5 | 12.9 | 4.4 | 5 | 33 | 1.9 | Pump |
| DET 48 | 7.0 | 18.5 | 5.6 | 5 | 41 | 2.4 | Gravity |

An additional benefit of detention basins is improved water quality. Detention basins provide attenuation storage and opportunities for pollutants to settle and be retained within the basin prior to the storm water being discharged to downstream conveyance elements, other detention basins, and/or receiving waters. Detention basins have been used as an acceptable BMP to help Cities achieve improvements in storm water quality. In general, a properly designed and maintained detention basin (that holds storm water for a prescribed period of time) will reduce the concentration of pollutant constituents discharged into receiving waters by providing for volatization, settlement, and subsequent absorption by vegetative matter and the soil. Suspended solids, heavy metals, hydrocarbons, sediments, and possibly some organic compounds are the most predominant constituents that would be expected to have reduced levels of concentrations after detention storage.

In some instances, the City may consider allowing certain future detention basins to remain privately owned and maintained as a component of an integrated system. When private ownership is proposed by a development entity, the City will consider the viability of the proposal during the development review process. If private ownership is deemed to be acceptable by the City, the City will establish appropriate governing requirements on a case-by-case basis.

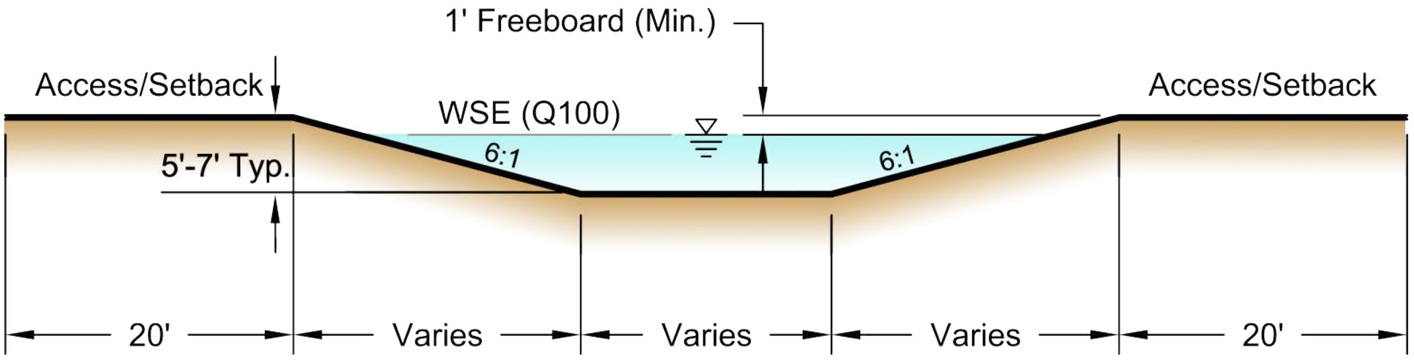
#### 4.1.3.1 Geometric Assumptions for Detention Basins

The surface areas of the proposed detention basins, including access roadways and appurtenant features, range from 1 acre to 40 acres. Detention basin depths have been typically assumed to be 7 feet but have been reduced to 5 feet in the far eastern portions of the Study Area where shallow groundwater may exist. These depths include one foot of freeboard above the 100-year water surface elevation. Side slopes for detention basins have been assumed to be 6:1 in conformance with City Standards. An additional 20% has been added to the surface area created by excavation for the detention basins to account for setbacks and provision for vehicular access to facilitate maintenance. Some detention basins have been sized based on a more specific evaluation of a given site. A detention basin typical cross-section is shown in Figure 4-3. The amount of storage required in applicable detention facilities as presented in this SDMP has not been reduced by a potential rate of percolation.

During the actual design of detention basins, depths, configurations, and surface areas will need to be adjusted to conform to local topography, groundwater depths, and other physical, functional and technical considerations. Design proposals to make geometric adjustments to detention basins will also be given reasonable consideration by the City as long as the functional storage volumes, outflow rates, and other hydraulic parameters presented in this SDMP are retained. If berms are integrated into the basin’s design, spillways shall be provided above the 100-year water surface elevation in order to control any overflow and provide for emergency releases should the design storm be exceeded.

Notes:

1. This is the typical cross-section assumed in the SDMP to estimate surface area of most detention basins. Actual geometry and dimensions will vary based on topography and site specific requirements.
2. Joint-use elements (active and passive recreation) are encouraged with all new detention basins and will require additional land area, grading, and contouring not shown in this cross-section or accounted for in the SDMP land acquisition requirements.
3. Components that promote percolation shall be incorporated into detention basins located in areas having permeable soils, when feasible.



# Detention Basin Typical Cross-Section

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STORM DRAINAGE MASTER PLAN

**FIGURE 4-3**

Title

**DETENTION BASIN**
**TYPICAL CROSS-SECTION**

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### 4.1.3.2 Joint-Use Detention Basins

As part of the future detailed design of the detention basins recommended in this SDMP, the City encourages the integration of aesthetic treatments, including active or passive joint-use recreational components. This SDMP does not specifically identify park-related joint-use components to be incorporated into any of the proposed detention basins, although it is a goal that joint-use elements be incorporated into detention basins wherever possible. By combining lands allocated to storm water detention with lands allocated to parks or open space, the functional, recreational, environmental and aesthetic value of these facilities will be dramatically improved. Detention basin land area requirements and cost estimates represented in this SDMP account for the acreage required to accommodate the storage volumes needed for storm drainage only, and additional land area will be required to incorporate provision for joint-use recreation facilities and differential grading, if such facilities are proposed.

An optimized joint-use detention basin will serve to:

- Maximize efficient use of land
- Satisfy attenuation needs for reducing peak flood flows
- Provide storm water quality treatment
- Expand community recreational opportunities, with minimal “down time” for recreation elements (and/or) provide habitat, recharge, and other environmental benefits
- Incur reasonable maintenance requirements and costs
- Serve as a functional open space amenity for the City

With regard to integrating recreation elements as a joint-use into storm water detention facilities, there are several fundamental guidelines that should be followed. They are:

- Low flow must be accommodated in a manner that confines the frequent inundations to areas that will create minimal nuisance or disruption of recreational uses and will characteristically require only limited maintenance.
- Contouring (differential grading) within detention facilities is recommended to create internal elevation variations (or tiers) that have differing frequencies and depths of inundation and differing flood risk.
- Internal drainage within detention facilities should provide for positive flow across elevated tiers and to the lowest lying areas of the facilities.

- Internal slopes should be flat enough to allow for mowing of turf areas and to allow other routine recreational-related maintenance activities to occur.

- Hydraulic design components should be included as needed (inflow structures, outflow structures, pump stations, sediment basins, spillways, surcharge structures, etc.).

- Other requirements as dictated by jurisdictional regulations and policies, local site conditions, or additional functional uses should be followed.

In general, passive recreational elements should be incorporated in portions of detention facilities having the greatest potential flood risk and frequency. Active recreation elements are more suitable in areas within detention facilities having lesser degrees of flood risk and frequency.

Additional information regarding joint-use facilities may be found in the City's Parks and Recreation Master Plan.

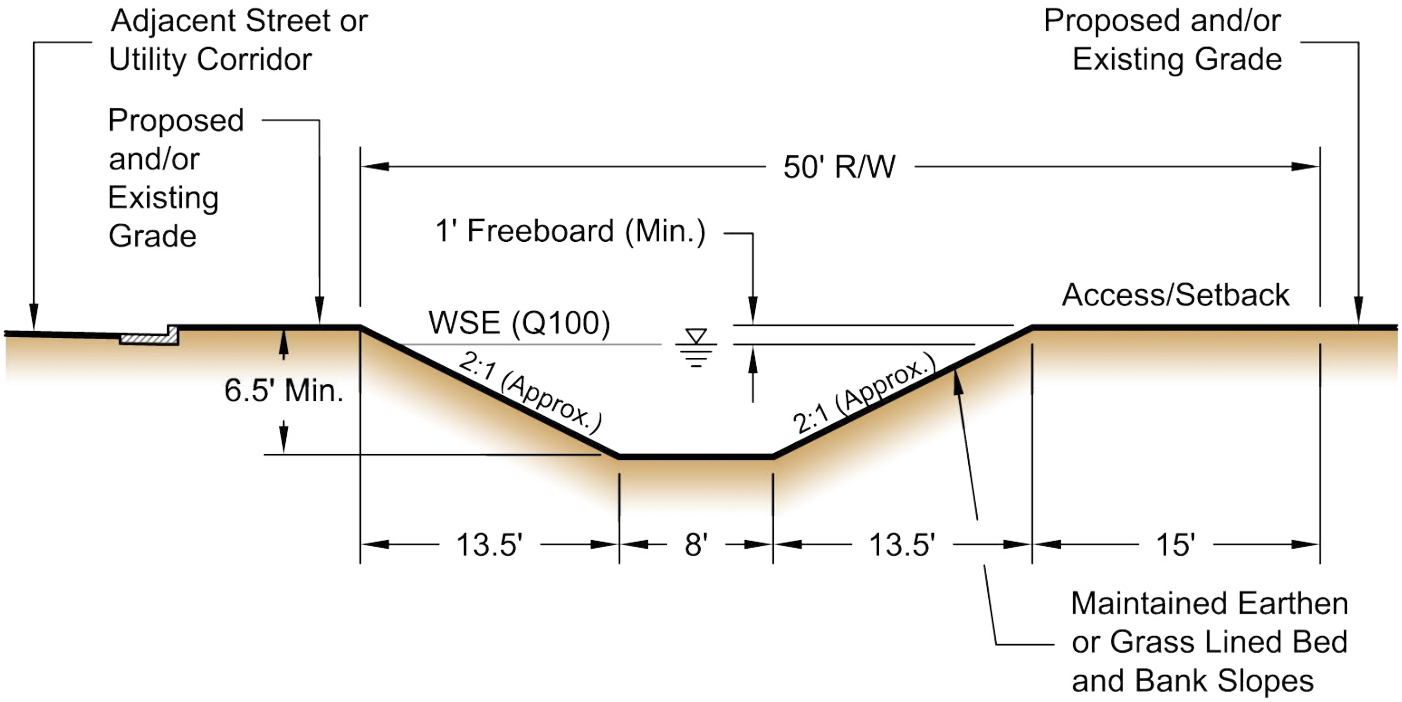
### 4.1.4 Open Channels

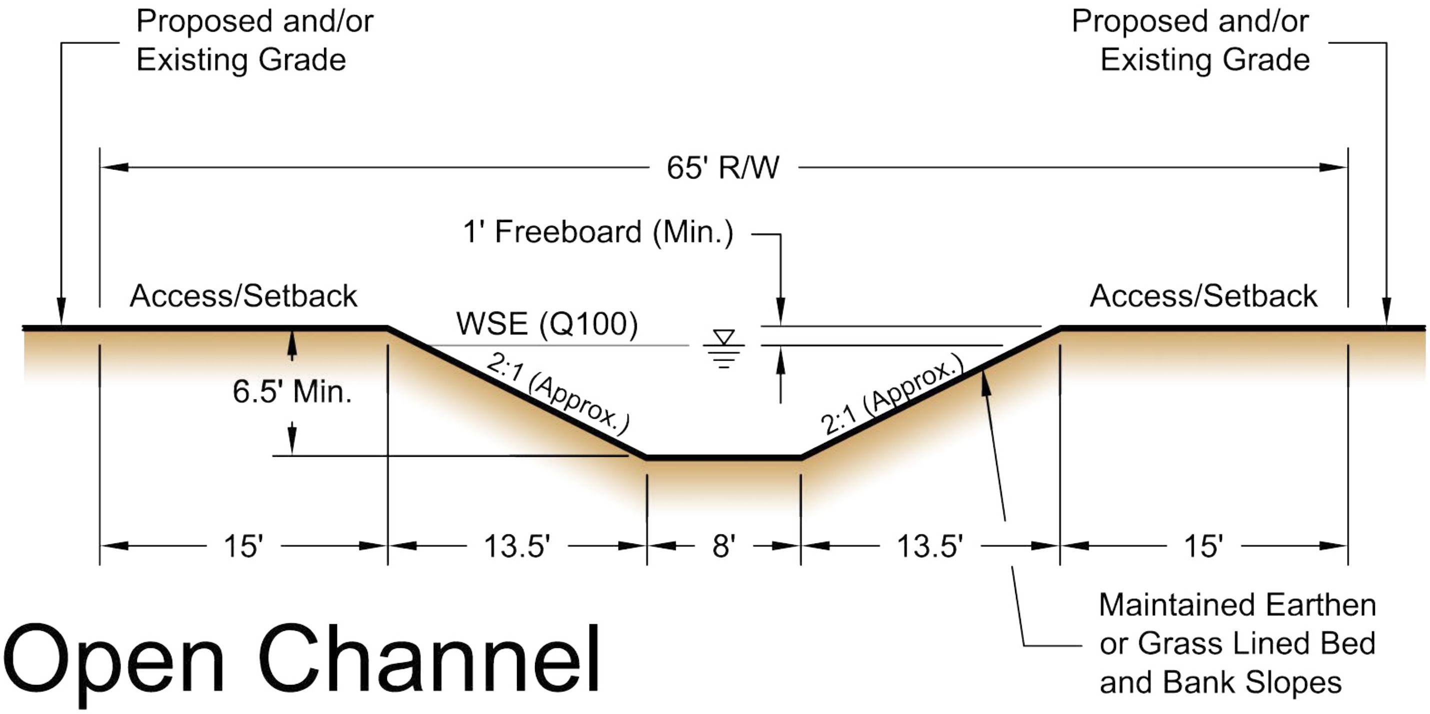
The storm drainage infrastructure plan presented in this SDMP includes several existing open channels and a proposed open channel for conveyance of storm runoff in certain areas. These facilities also assist in providing desired levels of flow attenuation and storm water quality treatment while also creating a community amenity. Typical cross sections of the proposed open channel are shown on Figure 4-4 and its location is shown on Figure 4-1.

### 4.1.5 Underground Storm Drains

Proposed underground storm drains have been incorporated into the master planned storm drainage facilities presented in this SDMP to serve as conveyance connections for new development to proposed detention basins, to serve as metered low-flow outfall facilities that drain proposed detention basins, and to reduce flooding in existing development areas. All underground storm drains have been assumed to be aligned within the public right-of-way for existing and future streets. Alignments shown in future development areas will need to be adjusted to conform to street alignments during the development design process. Proposed underground storm drains are shown on Figure 4-1.

Proposed storm drain sizes have applied prorated 10-year 24-hour storm discharges for sub-basins from the HEC-HMS model for individual segments to the full flow capacities for different pipe diameters depicted in Table 4-2.





# Open Channel Typical Cross-Sections

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CITY OF PATTERSON
STORM DRAINAGE MASTER PLAN

**FIGURE 4-4**

Title
**OPEN CHANNEL TYPICAL CROSS-SECTIONS**
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## Table 4-2: Full Flow Capacities for Storm Drain Pipes

| Pipe Diameter (in) | Pipe Slope (ft/ft) | Capacity (cfs) |
|---|---|---|
| 15 | 0.001 | 2.1 |
| | 0.002 | 3.1 |
| | 0.003 | 3.8 |
| 18 | 0.001 | 3.6 |
| | 0.002 | 5.0 |
| | 0.003 | 6.2 |
| | 0.006 | 8.0 |
| 24 | 0.001 | 8.0 |
| | 0.002 | 11.0 |
| | 0.003 | 14.0 |
| | 0.006 | 18.0 |
| 30 | 0.001 | 13.4 |
| | 0.002 | 18.7 |
| | 0.003 | 23.0 |
| | 0.006 | 34.0 |
| 36 | 0.001 | 21.5 |
| | 0.002 | 30.5 |
| | 0.003 | 37.5 |
| | 0.006 | 55.0 |
| 42 | 0.001 | 34 |
| | 0.002 | 49 |
| | 0.003 | 60 |
| | 0.006 | 83 |
| 48 | 0.001 | 49 |
| | 0.002 | 70 |
| | 0.003 | 85 |
| | 0.006 | 120 |
| 54 | 0.001 | 67 |
| | 0.002 | 95 |
| | 0.003 | 116 |
| | 0.006 | 163 |

The pipe slope selected to assess capacities for individual pipe segments was based on ground slopes and the pipe alignments.

### 4.1.6 Pumping Facilities

Some of the proposed detention basins are topographically situated in a manner that gravity outflows to downstream conveyance facilities are not possible. In these instances, pump stations are proposed to facilitate the draining of these applicable detention basins. The pump stations should be equipped with SCADA systems in conformance with City Standards and back-up power systems to assure function during a power outage.

### 4.1.7 Percolation Facilities

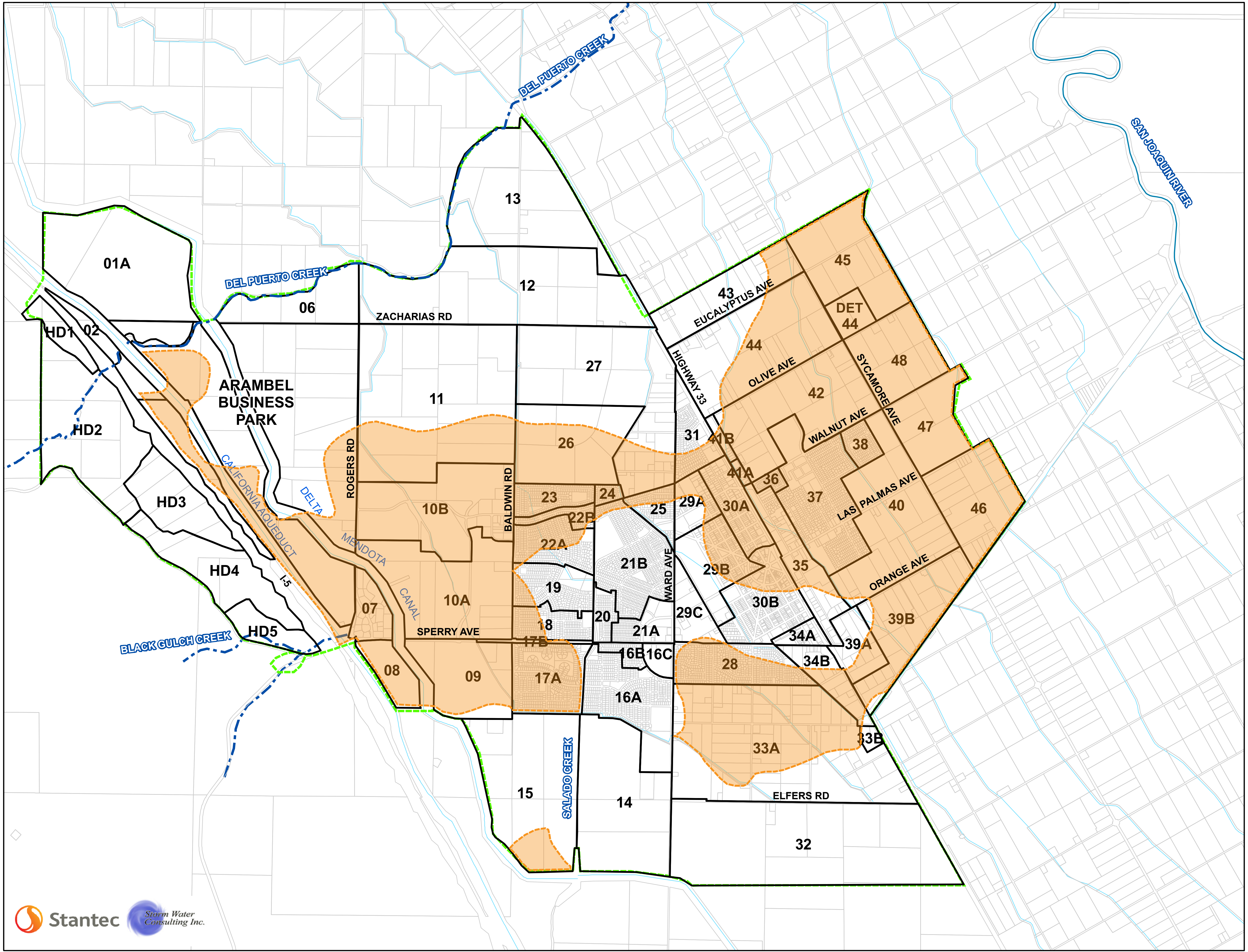
As discussed in Section 4.1.1, percolation basins are proposed to provide terminal drainage for sub-basins in the north portion of the Study Area that would otherwise drain to Del Puerto Creek. These percolation basins have been designated to serve Sub-basins 01A, 2, 06, and 13 as shown on Figure 4-1.

Detention basins proposed within Arambel Business Park and other locations that have subsurface soils that are found to be suitable for percolation are encouraged to incorporate low-lying components (such as gravel beds) that promote percolation as a primary or supplementary terminal drainage component to gravity or pumping facility outflows. Percolation basins should only be used when there is adequate separation between the basin bottom and the water table. The inclusion of percolation facilities is intended to aid in achieving sustainability by further reducing downstream impacts of land development on runoff production, improving storm water quality, and promoting recharge, where feasible. Figure 4-5 depicts areas within the Study Area that have greater and lesser potential to include percolation facilities, based on NRCS soils data and depth to groundwater estimates. The feasibility of incorporating percolation into detention basins will need to be verified by site-specific geotechnical studies.

Percolation basins shall be equipped with outlet facilities that may be used for discharge at the rates presented in this SDMP in the event of a failure or partial failure of the percolation function of the facility. The outlet facilities shall be controlled by a sluice gate that will only be utilized when drainage by percolation is insufficient but will remain shut when the percolation function is adequate. Discharge rates shown on Table 4-1 have been incorporated into the sizing of all detention basins, including those that will potentially function as percolation facilities. The volume of detention storage required for applicable detention basins as presented in this SDMP has not been reduced to account for any supplemental percolation capabilities and rates that exceed the discharge rates shown on Table 4-1.

### 4.1.8 Temporary Retention Facilities

When new development projects are not located near existing or proposed detention basins or conveyance facilities leading to detention basins, the City will consider allowing the use of temporary retention basins as an interim drainage solution, subject to appropriate engineering



## Legend

27 Drainage Sub-basins

🟩 Study Area Boundary

Creeks

Canals

Areas Having a **Higher** Potential to Include Percolation Facilities Within Detention Basins

🟧 Areas Having a **Lower** Potential to Include Percolation Facilities Within Detention Basins

N

## Notes:

1. Feasibility of detention basin locations depicted in this SDMP being suitable for percolation basins will need to be verified by site specific geotechnical studies.
2. All percolation basins shall be equipped with controllable outlets that may be used for discharge at the rates presented in this SDMP in the event of a failure or partial failure of the percolation function of the facility.

Client/Project

CITY OF PATTERSON
STORM DRAINAGE MASTER PLAN

**FIGURE 4-5**

Title

# PERCOLATION BASIN POTENTIAL WITHIN THE STUDY AREA

FEBRUARY 2018
184010206
SCALE 1" = 3000'

Stantec

Storm Water Consulting Inc.

V:\1840\active\184010206\patterson_sdmp\graphics\fig_4-5_patterson_perc_basin_zones.ai mlm 12-6-2017 substantiation regarding feasibility. When temporary retention basins are approved by the City, the project developer is required to maintain them until the storm drainage system for the development project is connected to the City’s permanent storm drainage system, the temporary storm drainage basin is filled and decommissioned, and the permanent system is accepted by the City. In the event that temporary retention basins are approved by the City for individual or groups of development projects, said approvals will only be provided with the understanding or anticipation that there is an approved permanent solution that will allow for the decommissioning of applicable temporary retention basins within a reasonable time frame. The City may require that the developer deposit enough funds in advance with the City to pay for the future decommissioning of a temporary storm retention basin.

# 5.0 Opinions of Probable Cost

## 5.1 GENERAL

This section presents opinions of probable cost and the methodology used to generate them for the proposed storm drainage infrastructure improvements. Separate storm drainage infrastructure cost estimates are provided for proposed storm drainage infrastructure elements recommended in this SDMP for the following:

- Composite of Facilities Needed to Serve New Development and to Correct Existing Deficiencies
- Facilities Needed to Serve New Development
- Facilities Needed to Correct Existing Deficiencies

## 5.2 COST ESTIMATION METHODOLOGY

### 5.2.1 Basis of Cost Estimating

The basis for the opinions of probable cost comes from a number of sources, including bid results from similar projects, previous studies, industry standardized cost data and direction received from City staff. They should be adjusted periodically for future construction time frames.

### 5.2.2 Cost Estimating Accuracy

The project costs were developed as a part of the preparation of the SDMP and are considered “order of magnitude” estimates that are relevant for initial budgeting and funding purposes. Final project costs will be dependent on a number of factors at the time of bidding, including actual scope of work, labor and material costs, number of competing projects, allotted construction schedule, and time of year, among other things. Order of magnitude estimates are appropriate for master planning level work, but it is important to note that they have been made without the benefit of detailed project specifications and design drawings.

### 5.2.3 Unit Cost Estimates

The unit costs for storm drainage infrastructure elements represent installation costs under what would be considered “typical” site conditions and project schedules.

It has been assumed that new underground storm drains will be constructed within the right-of-way (ROW) for public streets, and ROW acquisition costs for storm drains have not been included in the opinions of probable cost. However, proposed detention basins and open channels include ROW acquisition estimates and costs.

The City provided the following land acquisition unit cost to be utilized in the preparation of this SDMP:

- Drainage ROW Unit Cost = $125,000/acre

Table 5-1 lists unit costs that have been utilized in the cost estimates for storm drains of different diameters. It has been assumed that storm drains with diameters of 24” or larger will utilize cast-in-place construction methods, which is a cost saving construction approach that has previously been used for capital improvement projects by the City. However, reinforced pre-cast concrete pipe (RCP) has been assumed at crossings of existing facilities where bore & jack construction methods will be needed, regardless of the pipe diameter.

**Table 5-1: Unit Cost Data for Storm Drain Pipes**

| Pipe Diameter (inches) | Cost per Linear Foot ($/ft) |
|---|---|
| 15 | $75 |
| 18 | $100 |
| 24 | $110 |
| 30 | $150 |
| 36 | $180 |
| 42 | $210 |
| 48 | $240 |
| 60 | $300 |

### 5.2.4 Soft Cost Mark-Ups

Soft cost mark-ups incorporated into the preparation of the opinions of probable cost account for costs and functions that support the actual construction process and for contingencies. The actual costs for each item in the following three main categories of soft cost mark-ups will vary according to many individual project factors (i.e., complexity of the project, existing site conditions, etc.), but in general, they are supported historically as appropriate mark-up estimates for master planning purposes. The following soft cost mark-ups were provided by the City to utilize in the opinions of probable cost:

*Mobilization and Demobilization* – A soft cost mark-up of 3% has been applied to the Subtotal of Construction Items to yield the Construction Cost Subtotal.

*Contingencies* – A soft-cost mark-up of 30% has been applied to the Construction Cost Subtotal to yield the Construction Cost Total. This accounts for unknowns related to a given project at the master planning level; such as site conditions, unforeseen constraints, potential design alternatives, construction schedule uncertainties, environmental permitting requirements, and other unknowns.

*Engineering, Administration and Legal Costs* – An aggregate soft-cost mark-up of 27% has been applied to the Construction Cost Total to yield the Capital Improvement Cost Total. This aggregate amount includes 5% for Legal/Administration/Environment, 10% for Design, 8% for Construction Management and 4% for Engineering Services During Construction.

Table 5-2 shows an example of the mark-ups used in generating the cost estimates provided herein.

**Table 5-2: Opinion of Probable Cost Example**

| | |
|---|---|
| Subtotal of Construction Items | $100,000 |
| Mobilization and Demobilization (3%) | $ 3,000 |
| Construction Cost Subtotal | $103,000 |
| Contingencies (30%) | $ 30,900 |
| Construction Cost Total | $133,900 |
| Engineering, Administration & Legal Costs (27%) | $ 36,153 |
| Capital Improvement Cost Total | $170,053 |

Land acquisition costs have been added to the Capital Improvement Cost Total to yield a Capital Improvement Cost Total Including Land Acquisition without applying additional mark-ups.

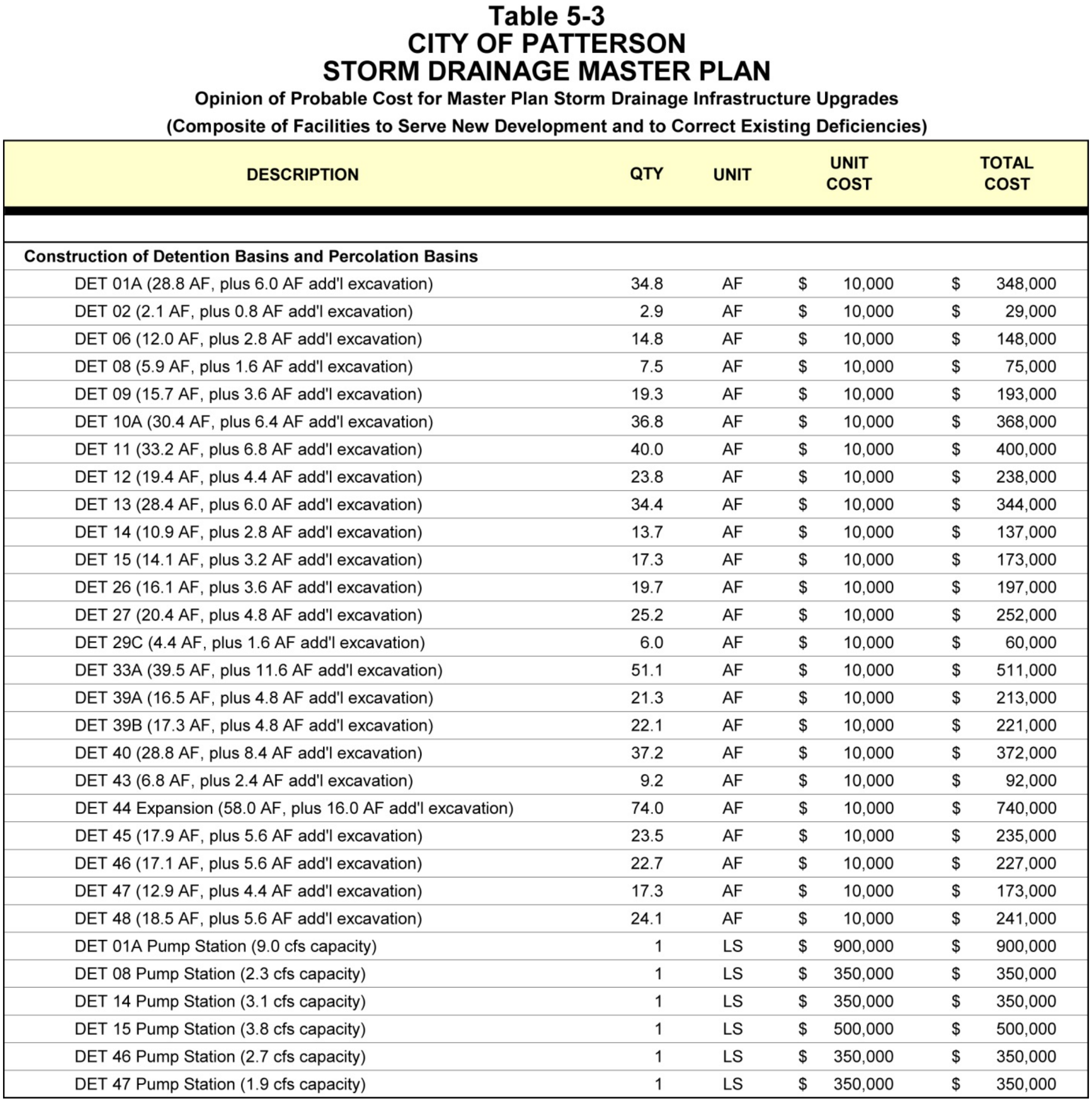
## 5.3 ESTIMATED INFRASTRUCTURE COSTS

The following tables provide opinions of probable cost for implementing storm drainage upgrades recommend in this SDMP:

- Composite of Facilities Needed to Serve New Development and to Correct Existing Deficiencies (Table 5-3)
- Facilities Needed to Serve New Development (Table 5-4)
- Facilities Needed to Correct Existing Deficiencies (Table 5-5)

Since it is likely that construction of the recommended facilities will be spread out over a number of years as development warrants and as funding becomes available, it is expected that the cost of implementing the recommendations will increase over the years. Therefore, it is important that the costs estimates be updated periodically to allow the funding mechanisms established to implement the various elements of this SDMP to be adjusted to account for the increased costs.

## Table 5-3: Composite of Facilities Needed to Serve New Development and to Correct Existing Deficiencies



# Table 5-3
# CITY OF PATTERSON
# STORM DRAINAGE MASTER PLAN

**Opinion of Probable Cost for Master Plan Storm Drainage Infrastructure Upgrades**

**(Composite of Facilities to Serve New Development and to Correct Existing Deficiencies)**

| DESCRIPTION | QTY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **Construction of Detention Basins and Percolation Basins** | | | | |
| DET 01A (28.8 AF, plus 6.0 AF add'l excavation) | 34.8 | AF | $ 10,000 | $ 348,000 |
| DET 02 (2.1 AF, plus 0.8 AF add'l excavation) | 2.9 | AF | $ 10,000 | $ 29,000 |
| DET 06 (12.0 AF, plus 2.8 AF add'l excavation) | 14.8 | AF | $ 10,000 | $ 148,000 |
| DET 08 (5.9 AF, plus 1.6 AF add'l excavation) | 7.5 | AF | $ 10,000 | $ 75,000 |
| DET 09 (15.7 AF, plus 3.6 AF add'l excavation) | 19.3 | AF | $ 10,000 | $ 193,000 |
| DET 10A (30.4 AF, plus 6.4 AF add'l excavation) | 36.8 | AF | $ 10,000 | $ 368,000 |
| DET 11 (33.2 AF, plus 6.8 AF add'l excavation) | 40.0 | AF | $ 10,000 | $ 400,000 |
| DET 12 (19.4 AF, plus 4.4 AF add'l excavation) | 23.8 | AF | $ 10,000 | $ 238,000 |
| DET 13 (28.4 AF, plus 6.0 AF add'l excavation) | 34.4 | AF | $ 10,000 | $ 344,000 |
| DET 14 (10.9 AF, plus 2.8 AF add'l excavation) | 13.7 | AF | $ 10,000 | $ 137,000 |
| DET 15 (14.1 AF, plus 3.2 AF add'l excavation) | 17.3 | AF | $ 10,000 | $ 173,000 |
| DET 26 (16.1 AF, plus 3.6 AF add'l excavation) | 19.7 | AF | $ 10,000 | $ 197,000 |
| DET 27 (20.4 AF, plus 4.8 AF add'l excavation) | 25.2 | AF | $ 10,000 | $ 252,000 |
| DET 29C (4.4 AF, plus 1.6 AF add'l excavation) | 6.0 | AF | $ 10,000 | $ 60,000 |
| DET 33A (39.5 AF, plus 11.6 AF add'l excavation) | 51.1 | AF | $ 10,000 | $ 511,000 |
| DET 39A (16.5 AF, plus 4.8 AF add'l excavation) | 21.3 | AF | $ 10,000 | $ 213,000 |
| DET 39B (17.3 AF, plus 4.8 AF add'l excavation) | 22.1 | AF | $ 10,000 | $ 221,000 |
| DET 40 (28.8 AF, plus 8.4 AF add'l excavation) | 37.2 | AF | $ 10,000 | $ 372,000 |
| DET 43 (6.8 AF, plus 2.4 AF add'l excavation) | 9.2 | AF | $ 10,000 | $ 92,000 |
| DET 44 Expansion (58.0 AF, plus 16.0 AF add'l excavation) | 74.0 | AF | $ 10,000 | $ 740,000 |
| DET 45 (17.9 AF, plus 5.6 AF add'l excavation) | 23.5 | AF | $ 10,000 | $ 235,000 |
| DET 46 (17.1 AF, plus 5.6 AF add'l excavation) | 22.7 | AF | $ 10,000 | $ 227,000 |
| DET 47 (12.9 AF, plus 4.4 AF add'l excavation) | 17.3 | AF | $ 10,000 | $ 173,000 |
| DET 48 (18.5 AF, plus 5.6 AF add'l excavation) | 24.1 | AF | $ 10,000 | $ 241,000 |
| DET 01A Pump Station (9.0 cfs capacity) | 1 | LS | $ 900,000 | $ 900,000 |
| DET 08 Pump Station (2.3 cfs capacity) | 1 | LS | $ 350,000 | $ 350,000 |
| DET 14 Pump Station (3.1 cfs capacity) | 1 | LS | $ 350,000 | $ 350,000 |
| DET 15 Pump Station (3.8 cfs capacity) | 1 | LS | $ 500,000 | $ 500,000 |
| DET 46 Pump Station (2.7 cfs capacity) | 1 | LS | $ 350,000 | $ 350,000 |
| DET 47 Pump Station (1.9 cfs capacity) | 1 | LS | $ 350,000 | $ 350,000 |

## Table 5-3
## CITY OF PATTERSON
## STORM DRAINAGE MASTER PLAN

**Opinion of Probable Cost for Master Plan Storm Drainage Infrastructure Upgrades**

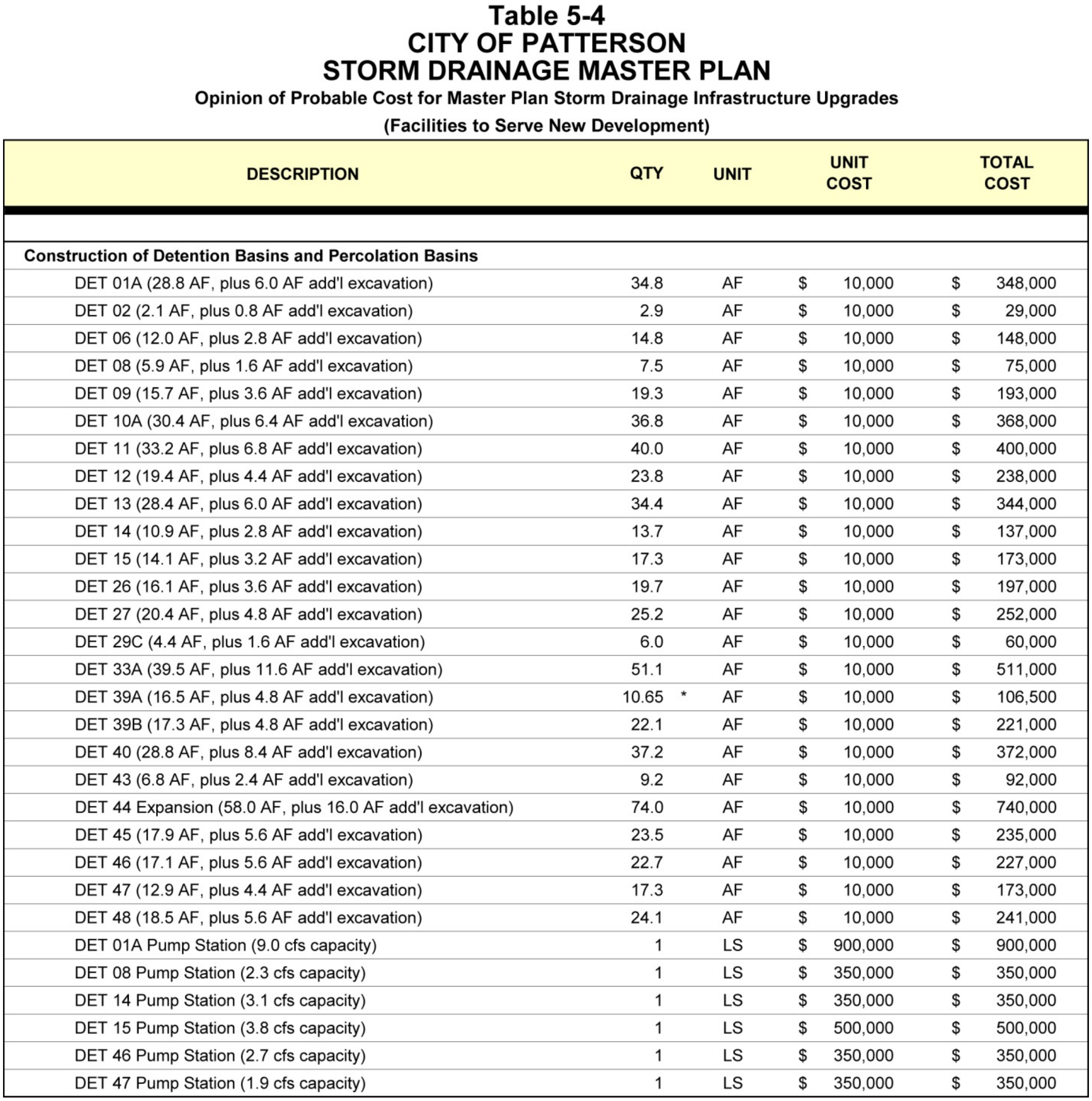
**(Composite of Facilities to Serve New Development and to Correct Existing Deficiencies)**

| DESCRIPTION | QTY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **Construction of Storm Drains (SDs) and Storm Drain Outfalls (SDOs)** | | | | |
| 15" SD (RCP) | 850 | LF | $ 75 | $ 63,750 |
| 18" SD (RCP) | 14,850 | LF | $ 100 | $ 1,485,000 |
| 24" SD (CIPCP) | 36,600 | LF | $ 110 | $ 4,026,000 |
| 30" SD (CIPCP) | 22,850 | LF | $ 150 | $ 3,427,500 |
| 36" SD (CIPCP) | 10,350 | LF | $ 180 | $ 1,863,000 |
| 42" SD (CIPCP) | 2,450 | LF | $ 210 | $ 514,500 |
| 42" SD (RCP, Bore & Jack) | 200 | LF | $ 800 | $ 160,000 |
| 48" SD (CIPCP) | 1,500 | LF | $ 240 | $ 360,000 |
| 60" SD (CIPCP) | 1,500 | LF | $ 300 | $ 450,000 |
| 15" SDO (RCP) | 4,850 | LF | $ 75 | $ 363,750 |
| 18" SDO (RCP) | 11,050 | LF | $ 100 | $ 1,105,000 |
| 24" SDO (CIPCP) | 23,200 | LF | $ 110 | $ 2,552,000 |
| 24" SDO (RCP, Bore & Jack) | 200 | LF | $ 650 | $ 130,000 |
| 30" SDO (CIPCP) | 7,350 | LF | $ 150 | $ 1,102,500 |
| 36" SDO (CIPCP) | 8,750 | LF | $ 180 | $ 1,575,000 |
| 36" SDO (RCP, Bore & Jack) | 200 | LF | $ 750 | $ 150,000 |
| 48" SDO (CIPCP) | 500 | LF | $ 240 | $ 120,000 |
| **Other Items** | | | | |
| Dewatering | 1 | LS | $ 4,000,000 | $ 4,000,000 |
| CNRR Crossing Agreements | 4 | EA | $ 5,000 | $ 20,000 |
| Delta Mendota Canal Crossing Agreements | 3 | EA | $ 5,000 | $ 15,000 |
| Future SDMP's/Updates | 1 | LS | $ 200,000 | $ 200,000 |
| 3-72" RCP Crossing of CNRR (Bore & Jack, Salado Creek) | 60 | LF | $ 1,200 | $ 72,000 |
| Concrete Lined Channel at CNRR (Salado Creek) | 90 | CY | $ 1,500 | $ 135,000 |
| Enlarge Collection Area & Trash Grate @ 96" SD Inlet (Salado Creek) | 1 | LS | $ 200,000 | $ 200,000 |
| Upgrade Capacity Shearwater Drive Culvert (Salado Creek) | 1 | LS | $ 10,000 | $ 10,000 |
| Open Channel (Salado Creek, DMC to Existing Open Channel) | 4,500 | LF | $ 100 | $ 450,000 |
| Bolt Down Manhole Covers for Existing 96" SD | 1 | LS | $ 25,000 | $ 25,000 |
| Miscellaneous Upgrades to Existing Pump Stations | 1 | LS | $ 1,000,000 | $ 1,000,000 |
| **Subtotal of Construction Items** | | | | **$ 34,362,000** |
| **Mobilization and Demobilization @ 3% of Subtotal of Construction Items** | | | | **$ 1,030,860** |
| **Construction Cost Subtotal** | | | | **$ 35,392,860** |
| **Contingencies @ 30% of Construction Cost Subtotal** | | | | **$ 10,617,858** |
| **Construction Cost Total** | | | | **$ 46,010,718** |
| **Engineering, Administration & Legal Costs @ 27% of Construction Cost Total** | | | | **$ 12,422,894** |
| **Capital Improvement Cost Total** | | | | **$ 58,433,612** |
| **Land Acquisition** | | | | |
| DET 01A | 7.5 | AC | $ 125,000 | $ 937,500 |
| DET 02 | 1.0 | AC | $ 125,000 | $ 125,000 |
| DET 06 | 4.0 | AC | $ 125,000 | $ 500,000 |

## Table 5-3
## CITY OF PATTERSON
## STORM DRAINAGE MASTER PLAN
### Opinion of Probable Cost for Master Plan Storm Drainage Infrastructure Upgrades
### (Composite of Facilities to Serve New Development and to Correct Existing Deficiencies)

| DESCRIPTION | QTY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| DET 08 | 2.0 | AC | $ 125,000 | $ 250,000 |
| DET 09 | 4.5 | AC | $ 125,000 | $ 562,500 |
| DET 10A | 8.0 | AC | $ 125,000 | $ 1,000,000 |
| DET 11 | 8.5 | AC | $ 125,000 | $ 1,062,500 |
| DET 12 | 5.5 | AC | $ 125,000 | $ 687,500 |
| DET 13 | 7.5 | AC | $ 125,000 | $ 937,500 |
| DET 14 | 3.5 | AC | $ 125,000 | $ 437,500 |
| DET 15 | 4.0 | AC | $ 125,000 | $ 500,000 |
| DET 26 | 4.5 | AC | $ 125,000 | $ 562,500 |
| DET 27 | 6.0 | AC | $ 125,000 | $ 750,000 |
| DET 29C | 2.0 | AC | $ 125,000 | $ 250,000 |
| DET 33A | 14.5 | AC | $ 125,000 | $ 1,812,500 |
| DET 39A | 6.0 | AC | $ 125,000 | $ 750,000 |
| DET 39B | 6.0 | AC | $ 125,000 | $ 750,000 |
| DET 40 | 10.5 | AC | $ 125,000 | $ 1,312,500 |
| DET 43 | 3.0 | AC | $ 125,000 | $ 375,000 |
| DET 44 Expansion | 20.0 | AC | $ 125,000 | $ 2,500,000 |
| DET 45 | 7.0 | AC | $ 125,000 | $ 875,000 |
| DET 46 | 7.0 | AC | $ 125,000 | $ 875,000 |
| DET 47 | 5.5 | AC | $ 125,000 | $ 687,500 |
| DET 48 | 7.0 | AC | $ 125,000 | $ 875,000 |
| Open Channel (Salado Creek, DMC to Existing Open Channel) | 6.7 | AC | $ 125,000 | $ 839,360 |
| **Subtotal of Land Acquisition** | | | | **$ 20,214,360** |
| **CAPITAL IMPROVEMENT COST TOTAL INCLUDING LAND ACQUISITION** | | | | **$ 78,647,971** |

## Table 5-4: Facilities Needed to Serve New Development



### Table 5-4
### CITY OF PATTERSON
### STORM DRAINAGE MASTER PLAN
**Opinion of Probable Cost for Master Plan Storm Drainage Infrastructure Upgrades**
**(Facilities to Serve New Development)**

| DESCRIPTION | QTY | | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|
| | | | | | |
| **Construction of Detention Basins and Percolation Basins** | | | | | |
| DET 01A (28.8 AF, plus 6.0 AF add'l excavation) | 34.8 | | AF | $ 10,000 | $ 348,000 |
| DET 02 (2.1 AF, plus 0.8 AF add'l excavation) | 2.9 | | AF | $ 10,000 | $ 29,000 |
| DET 06 (12.0 AF, plus 2.8 AF add'l excavation) | 14.8 | | AF | $ 10,000 | $ 148,000 |
| DET 08 (5.9 AF, plus 1.6 AF add'l excavation) | 7.5 | | AF | $ 10,000 | $ 75,000 |
| DET 09 (15.7 AF, plus 3.6 AF add'l excavation) | 19.3 | | AF | $ 10,000 | $ 193,000 |
| DET 10A (30.4 AF, plus 6.4 AF add'l excavation) | 36.8 | | AF | $ 10,000 | $ 368,000 |
| DET 11 (33.2 AF, plus 6.8 AF add'l excavation) | 40.0 | | AF | $ 10,000 | $ 400,000 |
| DET 12 (19.4 AF, plus 4.4 AF add'l excavation) | 23.8 | | AF | $ 10,000 | $ 238,000 |
| DET 13 (28.4 AF, plus 6.0 AF add'l excavation) | 34.4 | | AF | $ 10,000 | $ 344,000 |
| DET 14 (10.9 AF, plus 2.8 AF add'l excavation) | 13.7 | | AF | $ 10,000 | $ 137,000 |
| DET 15 (14.1 AF, plus 3.2 AF add'l excavation) | 17.3 | | AF | $ 10,000 | $ 173,000 |
| DET 26 (16.1 AF, plus 3.6 AF add'l excavation) | 19.7 | | AF | $ 10,000 | $ 197,000 |
| DET 27 (20.4 AF, plus 4.8 AF add'l excavation) | 25.2 | | AF | $ 10,000 | $ 252,000 |
| DET 29C (4.4 AF, plus 1.6 AF add'l excavation) | 6.0 | | AF | $ 10,000 | $ 60,000 |
| DET 33A (39.5 AF, plus 11.6 AF add'l excavation) | 51.1 | | AF | $ 10,000 | $ 511,000 |
| DET 39A (16.5 AF, plus 4.8 AF add'l excavation) | 10.65 | * | AF | $ 10,000 | $ 106,500 |
| DET 39B (17.3 AF, plus 4.8 AF add'l excavation) | 22.1 | | AF | $ 10,000 | $ 221,000 |
| DET 40 (28.8 AF, plus 8.4 AF add'l excavation) | 37.2 | | AF | $ 10,000 | $ 372,000 |
| DET 43 (6.8 AF, plus 2.4 AF add'l excavation) | 9.2 | | AF | $ 10,000 | $ 92,000 |
| DET 44 Expansion (58.0 AF, plus 16.0 AF add'l excavation) | 74.0 | | AF | $ 10,000 | $ 740,000 |
| DET 45 (17.9 AF, plus 5.6 AF add'l excavation) | 23.5 | | AF | $ 10,000 | $ 235,000 |
| DET 46 (17.1 AF, plus 5.6 AF add'l excavation) | 22.7 | | AF | $ 10,000 | $ 227,000 |
| DET 47 (12.9 AF, plus 4.4 AF add'l excavation) | 17.3 | | AF | $ 10,000 | $ 173,000 |
| DET 48 (18.5 AF, plus 5.6 AF add'l excavation) | 24.1 | | AF | $ 10,000 | $ 241,000 |
| DET 01A Pump Station (9.0 cfs capacity) | 1 | | LS | $ 900,000 | $ 900,000 |
| DET 08 Pump Station (2.3 cfs capacity) | 1 | | LS | $ 350,000 | $ 350,000 |
| DET 14 Pump Station (3.1 cfs capacity) | 1 | | LS | $ 350,000 | $ 350,000 |
| DET 15 Pump Station (3.8 cfs capacity) | 1 | | LS | $ 500,000 | $ 500,000 |
| DET 46 Pump Station (2.7 cfs capacity) | 1 | | LS | $ 350,000 | $ 350,000 |
| DET 47 Pump Station (1.9 cfs capacity) | 1 | | LS | $ 350,000 | $ 350,000 |

# Table 5-4
# CITY OF PATTERSON
# STORM DRAINAGE MASTER PLAN
## Opinion of Probable Cost for Master Plan Storm Drainage Infrastructure Upgrades
## (Facilities to Serve New Development)

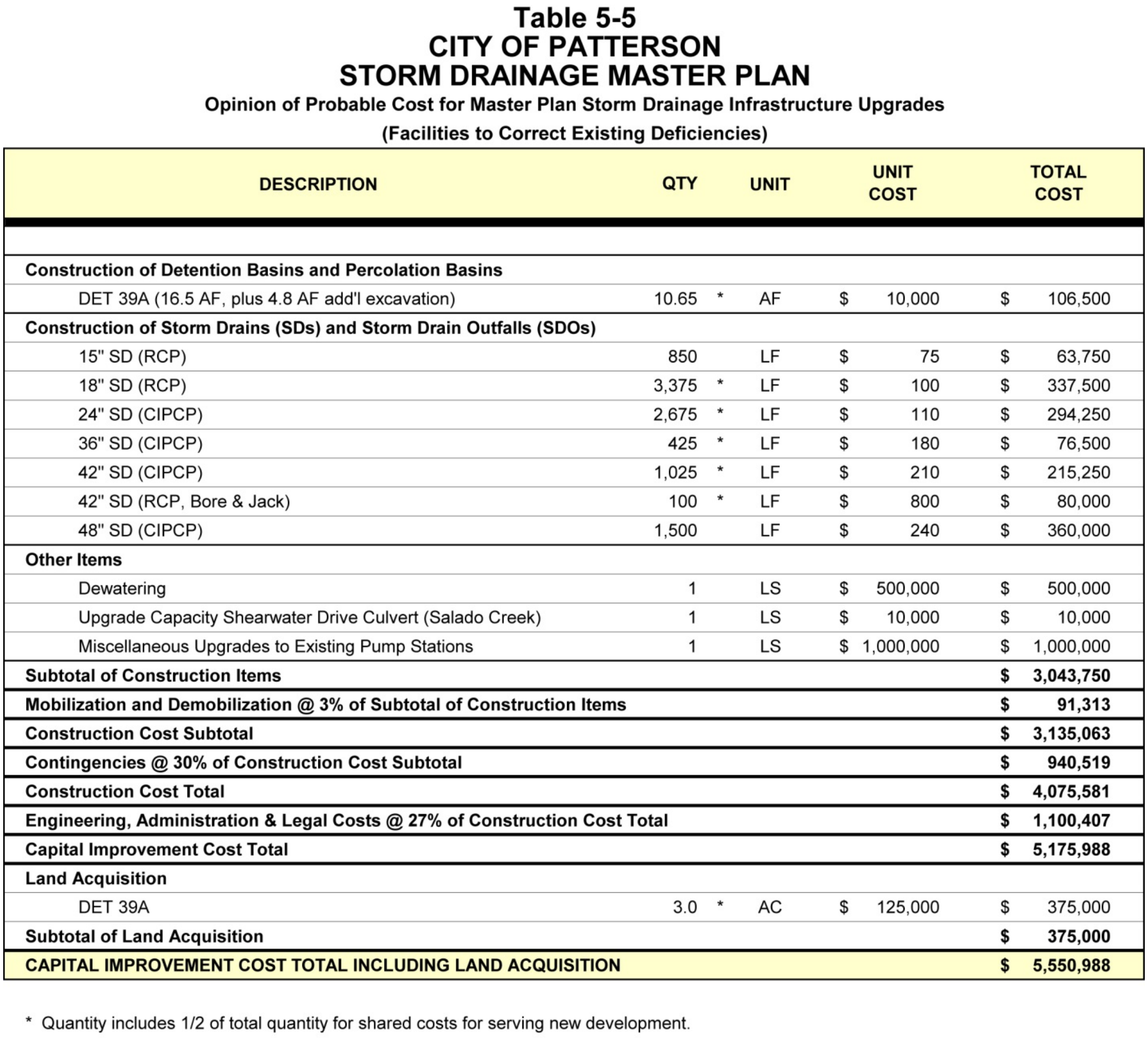
| DESCRIPTION | QTY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **Construction of Storm Drains (SDs) and Storm Drain Outfalls (SDOs)** | | | | |
| 18" SD (RCP) | 11,475 * | LF | $ 100 | $ 1,147,500 |
| 24" SD (CIPCP) | 33,925 * | LF | $ 110 | $ 3,731,750 |
| 30" SD (CIPCP) | 22,850 | LF | $ 150 | $ 3,427,500 |
| 36" SD (CIPCP) | 9,925 * | LF | $ 180 | $ 1,786,500 |
| 42" SD (CIPCP) | 1,425 * | LF | $ 210 | $ 299,250 |
| 42" SD (RCP, Bore & Jack) | 100 * | LF | $ 800 | $ 80,000 |
| 60" SD (CIPCP) | 1,500 | LF | $ 300 | $ 450,000 |
| 15" SDO (RCP) | 4,850 | LF | $ 75 | $ 363,750 |
| 18" SDO (RCP) | 11,050 | LF | $ 100 | $ 1,105,000 |
| 24" SDO (CIPCP) | 23,200 | LF | $ 110 | $ 2,552,000 |
| 24" SDO (RCP, Bore & Jack) | 200 | LF | $ 650 | $ 130,000 |
| 30" SDO (CIPCP) | 7,350 | LF | $ 150 | $ 1,102,500 |
| 36" SDO (CIPCP) | 8,750 | LF | $ 180 | $ 1,575,000 |
| 36" SDO (RCP, Bore & Jack) | 200 | LF | $ 750 | $ 150,000 |
| 48" SDO (CIPCP) | 500 | LF | $ 240 | $ 120,000 |
| **Other Items** | | | | |
| Dewatering | 1 | LS | $ 3,500,000 | $ 3,500,000 |
| CNRR Crossing Agreements | 4 | EA | $ 5,000 | $ 20,000 |
| Delta Mendota Canal Crossing Agreements | 3 | EA | $ 5,000 | $ 15,000 |
| Future SDMP's/Updates | 1 | LS | $ 200,000 | $ 200,000 |
| 3-72" RCP Crossing of CNRR (Bore & Jack, Salado Creek) | 60 | LF | $ 1,200 | $ 72,000 |
| Concrete Lined Channel at CNRR (Salado Creek) | 90 | CY | $ 1,500 | $ 135,000 |
| Enlarge Collection Area & Trash Grate @ 96" SD Inlet (Salado Creek) | 1 | LS | $ 200,000 | $ 200,000 |
| Open Channel (Salado Creek, DMC to Existing Open Channel) | 4,500 | LF | $ 100 | $ 450,000 |
| Bolt Down Manhole Covers for Existing 96" SD | 1 | LS | $ 25,000 | $ 25,000 |
| **Subtotal of Construction Items** | | | | **$ 31,318,250** |
| **Mobilization and Demobilization @ 3% of Subtotal of Construction Items** | | | | **$ 939,548** |
| **Construction Cost Subtotal** | | | | **$ 32,257,798** |
| **Contingencies @ 30% of Construction Cost Subtotal** | | | | **$ 9,677,339** |
| **Construction Cost Total** | | | | **$ 41,935,137** |
| **Engineering, Administration & Legal Costs @ 27% of Construction Cost Total** | | | | **$ 11,322,487** |
| **Capital Improvement Cost Total** | | | | **$ 53,257,624** |
| **Land Acquisition** | | | | |
| DET 01A | 7.5 | AC | $ 125,000 | $ 937,500 |
| DET 02 | 1.0 | AC | $ 125,000 | $ 125,000 |
| DET 06 | 4.0 | AC | $ 125,000 | $ 500,000 |
| DET 08 | 2.0 | AC | $ 125,000 | $ 250,000 |
| DET 09 | 4.5 | AC | $ 125,000 | $ 562,500 |
| DET 10A | 8.0 | AC | $ 125,000 | $ 1,000,000 |
| DET 11 | 8.5 | AC | $ 125,000 | $ 1,062,500 |

# Table 5-4
# CITY OF PATTERSON
# STORM DRAINAGE MASTER PLAN
## Opinion of Probable Cost for Master Plan Storm Drainage Infrastructure Upgrades
## (Facilities to Serve New Development)

| DESCRIPTION | QTY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| DET 12 | 5.5 | AC | $ 125,000 | $ 687,500 |
| DET 13 | 7.5 | AC | $ 125,000 | $ 937,500 |
| DET 14 | 3.5 | AC | $ 125,000 | $ 437,500 |
| DET 15 | 4.0 | AC | $ 125,000 | $ 500,000 |
| DET 26 | 4.5 | AC | $ 125,000 | $ 562,500 |
| DET 27 | 6.0 | AC | $ 125,000 | $ 750,000 |
| DET 29C | 2.0 | AC | $ 125,000 | $ 250,000 |
| DET 33A | 14.5 | AC | $ 125,000 | $ 1,812,500 |
| DET 39A | 3.0 * | AC | $ 125,000 | $ 375,000 |
| DET 39B | 6.0 | AC | $ 125,000 | $ 750,000 |
| DET 40 | 10.5 | AC | $ 125,000 | $ 1,312,500 |
| DET 43 | 3.0 | AC | $ 125,000 | $ 375,000 |
| DET 44 Expansion | 20.0 | AC | $ 125,000 | $ 2,500,000 |
| DET 45 | 7.0 | AC | $ 125,000 | $ 875,000 |
| DET 46 | 7.0 | AC | $ 125,000 | $ 875,000 |
| DET 47 | 5.5 | AC | $ 125,000 | $ 687,500 |
| DET 48 | 7.0 | AC | $ 125,000 | $ 875,000 |
| Open Channel (Salado Creek, DMC to Existing Open Channel) | 6.7 | AC | $ 125,000 | $ 839,360 |
| **Subtotal of Land Acquisition** | | | | **$ 19,839,360** |
| **CAPITAL IMPROVEMENT COST TOTAL INCLUDING LAND ACQUISITION** | | | | **$ 73,096,983** |

* Quantity includes 1/2 of total quantity for shared costs for correcting existing deficiencies.

## Table 5-5: Facilities Needed to Correct Existing Deficiencies



### Table 5-5
### CITY OF PATTERSON
### STORM DRAINAGE MASTER PLAN

**Opinion of Probable Cost for Master Plan Storm Drainage Infrastructure Upgrades**
**(Facilities to Correct Existing Deficiencies)**

| DESCRIPTION | QTY | | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|
| | | | | | |
| **Construction of Detention Basins and Percolation Basins** | | | | | |
| DET 39A (16.5 AF, plus 4.8 AF add'l excavation) | 10.65 | * | AF | $ 10,000 | $ 106,500 |
| **Construction of Storm Drains (SDs) and Storm Drain Outfalls (SDOs)** | | | | | |
| 15" SD (RCP) | 850 | | LF | $ 75 | $ 63,750 |
| 18" SD (RCP) | 3,375 | * | LF | $ 100 | $ 337,500 |
| 24" SD (CIPCP) | 2,675 | * | LF | $ 110 | $ 294,250 |
| 36" SD (CIPCP) | 425 | * | LF | $ 180 | $ 76,500 |
| 42" SD (CIPCP) | 1,025 | * | LF | $ 210 | $ 215,250 |
| 42" SD (RCP, Bore & Jack) | 100 | * | LF | $ 800 | $ 80,000 |
| 48" SD (CIPCP) | 1,500 | | LF | $ 240 | $ 360,000 |
| **Other Items** | | | | | |
| Dewatering | 1 | | LS | $ 500,000 | $ 500,000 |
| Upgrade Capacity Shearwater Drive Culvert (Salado Creek) | 1 | | LS | $ 10,000 | $ 10,000 |
| Miscellaneous Upgrades to Existing Pump Stations | 1 | | LS | $ 1,000,000 | $ 1,000,000 |
| **Subtotal of Construction Items** | | | | | **$ 3,043,750** |
| **Mobilization and Demobilization @ 3% of Subtotal of Construction Items** | | | | | **$ 91,313** |
| **Construction Cost Subtotal** | | | | | **$ 3,135,063** |
| **Contingencies @ 30% of Construction Cost Subtotal** | | | | | **$ 940,519** |
| **Construction Cost Total** | | | | | **$ 4,075,581** |
| **Engineering, Administration & Legal Costs @ 27% of Construction Cost Total** | | | | | **$ 1,100,407** |
| **Capital Improvement Cost Total** | | | | | **$ 5,175,988** |
| **Land Acquisition** | | | | | |
| DET 39A | 3.0 | * | AC | $ 125,000 | $ 375,000 |
| **Subtotal of Land Acquisition** | | | | | **$ 375,000** |
| **CAPITAL IMPROVEMENT COST TOTAL INCLUDING LAND ACQUISITION** | | | | | **$ 5,550,988** |

* Quantity includes 1/2 of total quantity for shared costs for serving new development.

# 6.0 Additional Funding Options and Opportunities

This SDMP identifies needs, priorities and costs for new and upgraded storm drainage facilities that are required to accommodate new development areas and to correct existing deficiencies. New and upgraded storm drainage facilities may consist of:

- Facilities that serve existing development and are needed to correct existing deficiencies.
- Facilities that are needed to serve new development.
- Facilities that serve a combination of existing development and new development, with varying percentages of costs being attributable to accommodating new development and correcting existing deficiencies.

Given the above general scenarios, several approaches are available to the City for consideration regarding funding the desired capital improvements. Funding approaches may potentially consist of one or a combination of the following elements:

- Development Impact Fees
- Assessment Districts (1913/15 Act)
- Special Tax Districts (Mello Roos Community Facilities District Act of 1982)
- Storm Drain Utility Fee (subject to Proposition 218)
- State and Federal Grants

## 6.1 DEVELOPMENT IMPACT FEES

To the extent that new development creates a need for new and upgraded storm drainage facilities to accommodate the resultant increase in storm runoff caused by said new development, development impact fees may be assessed against the new development that utilizes these facilities as a fair share contribution towards funding the required upgrades.

## 6.2 ASSESSMENT DISTRICTS (1913/15 ACT)

The potential exists for the establishment of one or more assessment districts to fund required storm drainage facilities and their maintenance where a common interest is shared by a large, but clearly defined group of constituents. Assessment district financing provides a vehicle to apportion the cost of improvements to those who will benefit by typically issuing bonds (although they can be established without bonding), which are then repaid with revenue generated by assessing those benefiting directly from the improvements. The establishment of an assessment district requires a finding of direct and special benefit to the parcels being assessed, which shall be set forth in an Engineer’s Report. Two public hearings and a mailed ballot are also required to establish an assessment district. If an assessment district is selected as a preferred financing mechanism, the SDMP may be utilized as a resource to assist in making the benefit findings required pursuant to Proposition 218 and preparing an Engineer's Report as part of formation of the district.

## 6.3 SPECIAL TAX DISTRICTS – MELLO ROOS COMMUNITY FACILITIES DISTRICT (ACT OF 1982)

If the City determines that more flexibility is needed in the allocation of costs and funding burdens, a Mello-Roos Community Facilities District (CFD) may be used instead of an assessment district. The Mello-Roos law does not require a finding of benefit for allocating costs among properties within the CFD, and the special tax can be spread in any "reasonable manner" according to the law. If a CFD is determined to be a more feasible funding tool, it will be necessary to prepare a Rate and Method of Apportionment of Special Tax for the CFD as a part of CFD formation and bond issuance. It does require a 2/3 approval of registered voters. However, if less than 12 registered voters reside in the area, which is often typical of undeveloped land, the special tax can be implemented with a property owner vote.

## 6.4 STORM DRAINAGE UTILITY FEE PROGRAM

The City may initiate the steps that are required to implement a City-wide "storm drainage utility fee" program for the purpose of funding street sweeping, leaf collection, system maintenance, storm drain repairs, vegetation removal, and capital improvements to improve existing storm drainage deficiencies. Many of these services are needed to meet the requirements of the Federal Clean Water Act. The proposed fees may include an operating component and a capital component. The process of establishing a storm drainage utility fee program will be subject to Proposition 218, which requires public hearings and a public election.

## 6.5 STATE AND FEDERAL GRANTS

The Federal government, through the Economic Development Administration, has in the past provided grants to assist communities with the funding of public works projects that contribute to the creation or retention of private sector jobs and to the alleviation of unemployment and underemployment. Depending on circumstances, the construction of drainage improvements identified in this SDMP may be eligible.

Funding for projects may also be available from various California Department of Water Resources (DWR) programs. Currently, the Storm Water Grant Program (SWGP) funded by Proposition 1 funds projects for planning and implementation of multi-benefit storm water projects. To be eligible for funds under the SWGP, a Storm Water Resources Plan (SWRP), or equivalent, must be developed. The intent of the SWRP is to evaluate and prioritize multiple projects within the watershed in an integrated metrics-based analysis for benefits such as water quality, storm water capture and use, water supply, flood control, and environmental and community benefits. The second round of Proposition 1 implementation projects is tentatively scheduled for 2018.

# 7.0 Glossary and List of Acronyms

| | |
|---|---|
| BMP | Best Management Practice as applied to any program, technology, or process used to improve or maintain downstream water quality under the NPDES program |
| CBC | Concrete Box Culvert |
| CIPP | Cast-in-place Concrete Pipe |
| COE | U.S. Army Corps of Engineers |
| CSD | Community Services District |
| CGP | Construction General Permit |
| CN | Curve Number |
| CVFPP | Central Valley Flood Protection Plan |
| CWA | Clean Water Act |
| Detention Basin (DET) | A depressed or bermed area that collects and stores surface runoff for regulated downstream release |
| Discharge | A rate of stormwater runoff experienced at a given location and at a given point in time during or after a storm event, usually expressed in cubic feet per second (cfs) |
| DWR | State of California Department of Water Resources |
| FEMA | Federal Emergency Management Agency |
| FIRM | Flood Insurance Rate Map |
| FIS | Flood Insurance Study |
| General Plan | City of Patterson General Plan |
| HEC-HMS | A hydrologic modeling computer program developed by the U.S. Army Corps of Engineers |
| IRWM Program | Integrated Regional Water Management Program |
| Joint-Use Facility | Storm drainage detention basin that includes active and/or passive recreation elements as a joint-use with flood storage |

| | |
|---|---|
| LID | Low impact development |
| MEP | Maximum Extent Practicable, a standard for water quality that applies to all MS4 operators regulated under the NPDES program. |
| NRCS | Natural Resources Conservation Service |
| NPDES | National Pollutant Discharge Elimination System, a program that regulates storm water quality from nonpoint sources |
| Offsite | Referring to watersheds that extend upstream, outside of the Study Area |
| Percolation | The subsurface gravity flow of runoff through the pore spaces in rock or soil |
| Return Period | The reciprocal of the percent probability of a flood event of a certain magnitude occurring in a given year, often expressed in terms of 10-year flood, 100-year flood, etc. |
| RCP | Reinforced Concrete Pipe |
| ROW | Right-of-Way |
| RWQCB | Regional Water Quality Control Board |
| SB 5 | Senate Bill 5 |
| SD | Storm Drain |
| SDMP | Storm Drainage Master Plan |
| SDO | Storm drain pipe serving as an outfall for a detention basin |
| SOI | Sphere of Influence per the City’s General Plan |
| Study Area | City’s General Plan Sphere of Influence |
| Surcharging | An overload of a storm drain system occurring when flow rates beyond the system’s capacity are introduced and the water level in a storm drain pipe rises above the crown of the pipe |
| SWMP | Storm Water Management Program, a plan developed to implement measures to improve stormwater quality in Phase II communities participating in the NPDES program |

| | |
|---|---|
| SWPPP | Storm Water Pollution Prevention Plan |
| SWRCB | State Water Resources Control Board |
| Temporary Retention | A depressed or bermed area that collects and stores surface runoff and that does not have an outlet other that infiltration or evaporation and is used as an interim storm drainage solution until a physical connection for a suitable downstream facility is available |

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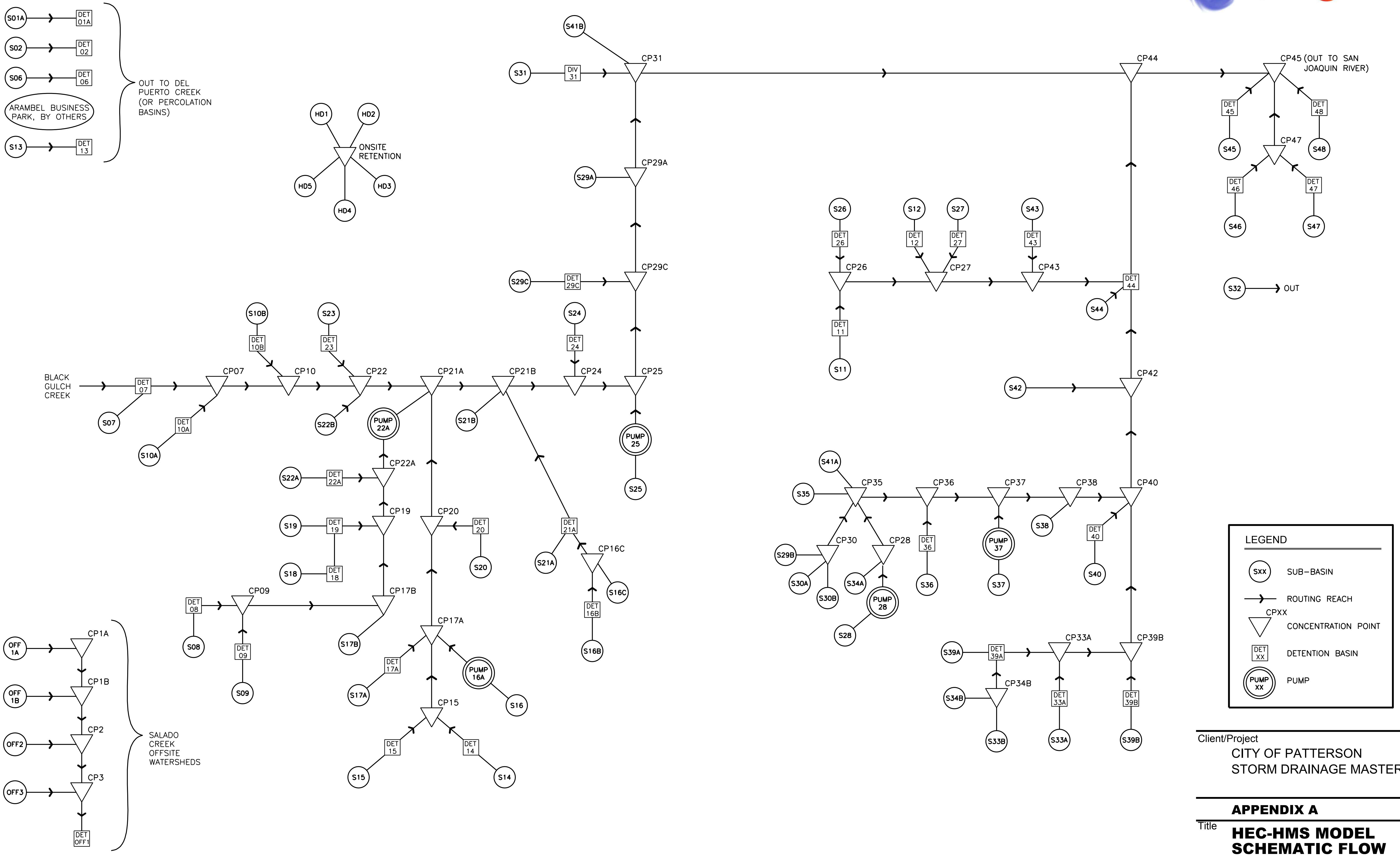
# Appendix A

# HEC-HMS Model Schematic Flow Diagram

Storm Water Consulting Inc.

Stantec



Client/Project

CITY OF PATTERSON
STORM DRAINAGE MASTER PLAN

## APPENDIX A

Title

# HEC-HMS MODEL SCHEMATIC FLOW DIAGRAM

FEBRUARY 2018
184010206
NOT TO SCALE

# Appendix B

# HEC-HMS Model Input Summaries

City of Patterson Storm Drainage Master Plan Percent Impervious Calculations

| Subbasin | Area (AC) | Development Condition | Land Use Area (ac) | | | | | | | | | | | | | | | Weighted % Impervious |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Downtown Core Ex 80% Fu 50% | Downtown Res Ex 40% Fu 25% | Estate Res Ex 10% Fu 6% | Gen Comm Ex 80% Fu 50% | Heavy Industrial Ex 70% Fu 44% | HDR Ex 60% Fu 38% | Highway SVC Comm Ex 80% Fu 50% | Lake Ex 100% Fu 100% | Light Industrial Ex 70% Fu 44% | LDR Ex 30% Fu 19% | Med Professional Ex 80% Fu 50% | MDR Ex 50% Fu 32% | Mixed Use (Hillside) Ex 20% Fu 13% | Parks/Open Space Ex 10% Fu 6% | Public/Quasi-Public Ex 60% Fu 38% | |
| 01A | 348.7 | Existing | | | | | | | | | | | | | | | | 50% |
| | | Future | | | | 348.7 | | | | | | | | | | | | |
| 2 | 26.2 | Existing | | | | | | | | | | | | | | | | 44% |
| | | Future | | | | | | | | | 26.2 | | | | | | | |
| 6 | 125.9 | Existing | | | | | | | | | | | | | | | | 44% |
| | | Future | | | | | | | | | 125.9 | | | | | | | |
| 7 | 55.8 | Existing | | | | | | | 54.7 | | | | | | | | 1.1 | 80% |
| | | Future | | | | | | | | | | | | | | | | |
| 8 | 60.6 | Existing | | | | | | | | | | | | | | | | 50% |
| | | Future | | | | 60.6 | | | | | | | | | | | | |
| 9 | 174.8 | Existing | | | | | | | | | | | | | | | 7.4 | 45% |
| | | Future | | | | | | | | | 167.3 | 0.1 | | | | | | |
| 10A | 300.0 | Existing | | | | | | | | | 43.7 | | | | | | | 48% |
| | | Future | | | | | | | | | 256.1 | | | | | | 0.2 | |
| 10B | 275.0 | Existing | | | | | | | | | 241.0 | | | | | | 11.7 | 67% |
| | | Future | | | | | | | | | 8.1 | | | | | | 14.2 | |
| 11 | 601.6 | Existing | | | | | | | | | 0.7 | | | | | | | 19% |
| | | Future | | | | | | | | | | 600.8 | | | | | 0.1 | |
| 12 | 475.7 | Existing | | | | | | | | | | | | | | | | 21% |
| | | Future | | | | | 0.3 | | | | 0.5 | 421.4 | | | | | 53.6 | |
| 13 | 349.9 | Existing | | | | | | | | | | | | | | | | 44% |
| | | Future | | | | | 349.4 | | | | | 0.5 | | | | | | |
| 14 | 323.1 | Existing | | | | | | | | | | | | | | | | 13% |
| | | Future | | | 174.2 | | | | | | | 135.9 | | | | | 13.0 | |
| 15 | 355.1 | Existing | | | | | | | | | | | | | | | 7.1 | 15% |
| | | Future | | | 138.8 | | | | | | | 209.2 | | | | | | |
| 16A | 173.1 | Existing | | | | | | | | | | 120.7 | | | | 35.2 | | 26% |
| | | Future | | | | | | | | | | 0.7 | | | | 4.1 | 12.4 | |
| 16B | 20.4 | Existing | | | | | | | | | | 19.2 | | | | 1.2 | | 29% |
| | | Future | | | | | | | | | | | | | | | | |
| 16C | 23.5 | Existing | | | | 23.5 | | | | | | | | | | | | 80% |
| | | Future | | | | | | | | | | | | | | | | |
| 17A | 130.4 | Existing | | | | | | | | 12.3 | | 111.2 | | | | 6.9 | | 36% |
| | | Future | | | | | | | | | | | | | | | | |
| 17B* | 10.2 | Existing | | | | | | | | | | | | | | | | 80% |
| | | Future | | | | | | | | | | | | | | | | |
| 18 | 64.6 | Existing | | | | | | | | | | 58.7 | | | | 6.0 | | 28% |
| | | Future | | | | | | | | | | | | | | | | |
| 19 | 88.8 | Existing | | | | | | | | | | 70.6 | | | | 6.7 | 11.4 | 32% |
| | | Future | | | | | | | | | | | | | | | | |
| 20 | 28.9 | Existing | | | | | | | | | | 23.8 | | | | 5.1 | | 26% |
| | | Future | | | | | | | | | | | | | | | | |
| 21A | 52.9 | Existing | | | | 28.6 | | 2.4 | | | | 12.4 | | | | 3.4 | 5.9 | 61% |
| | | Future | | | | 0.2 | | | | | | | | | | | | |
| 21B | 179.9 | Existing | | | | | | | | | | 152.0 | | | | 6.2 | 21.6 | 33% |
| | | Future | | | | | | | | | | | | | | | | |
| 22A | 88.4 | Existing | | | | | | | | | | 81.5 | | | | 6.4 | 0.5 | 29% |
| | | Future | | | | | | | | | | | | | | | | |
| 22B | 26.3 | Existing | | | | | | | | | | 25.4 | | | | 0.9 | | 29% |
| | | Future | | | | | | | | | | | | | | | | |
| 23 | 54.1 | Existing | | | | | | | | | | 48.9 | | | | 5.3 | | 28% |
| | | Future | | | | | | | | | | | | | | | | |
| 24 | 12.5 | Existing | | | | | | | | | | 11.9 | | | | 0.6 | | 29% |
| | | Future | | | | | | | | | | | | | | | | |
| 25 | 43.0 | Existing | | | | | | | | | | 40.9 | | | | 1.8 | 0.2 | 29% |
| | | Future | | | | | | | | | | | | | | | | |
| 26 | 221.3 | Existing | | | | | | | | | | 0.1 | | | | | | 19% |
| | | Future | | | | | | | | | | 221.2 | | | | | | |
| 27 | 423.1 | Existing | | | | | | | | | | 25.2 | | | | | 0.1 | 20% |
| | | Future | | | | | | | | | | 397.7 | | | | | | |
| 28 | 130.1 | Existing | | | | | | | | | | 91.0 | | | | 1.6 | 0.4 | 30% |
| | | Future | | | | 0.3 | | | | | | 36.9 | | | | | | |
| 29A | 51.8 | Existing | | 16.8 | | | | 2.9 | | | | | | | | | 32.1 | 53% |
| | | Future | | | | | | | | | | | | | | | | |

* Sub-basin 17B is an arterial street.

** Missing Acreage is an average value of landuse within sub-basin

*** Impervious values assume that storm water quality treatment for new development will be provided in DET 44 and not onsite

City of Patterson Storm Drainage Master Plan Percent Impervious Calculations

| Subbasin | Area (AC) | Development Condition | Land Use Area (ac) | | | | | | | | | | | | | | | Weighted % Impervious |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Downtown Core Ex 80% Fu 50% | Downtown Res Ex 40% Fu 25% | Estate Res Ex 10% Fu 6% | Gen Comm Ex 80% Fu 50% | Heavy Industrial Ex 70% Fu 44% | HDR Ex 60% Fu 38% | Highway SVC Comm Ex 80% Fu 50% | Lake Ex 100% Fu 100% | Light Industrial Ex 70% Fu 44% | LDR Ex 30% Fu 19% | Med Professional Ex 80% Fu 50% | MDR Ex 50% Fu 32% | Mixed Use (Hillside) Ex 20% Fu 13% | Parks/Open Space Ex 10% Fu 6% | Public/Quasi-Public Ex 60% Fu 38% | |
| 29B | 118.5 | Existing | 6.1 | 31.4 | | | | | | | | | 5.0 | | | | 75.2 | 56% |
| | | Future | | | | 0.4 | | 0.4 | | | | | | | | | | |
| 29C | 61.1 | Existing | | | | | | | | | | | | | | | | 47% |
| | | Future | | | | 47.4 | | 13.6 | | | | | | | | | | |
| 30A | 80.1 | Existing | 1.3 | 65.0 | | 13.5 | | 0.1 | | | 0.1 | 0.1 | | | | | | 47% |
| | | Future | | | | | | | | | | | | | | | | |
| 30B | 143.9 | Existing | 15.7 | 104.1 | | 5.3 | 10.0 | | | | | | | | | 2.3 | 6.4 | 48% |
| | | Future | | | | 0.1 | | | | | | | | | | | | |
| 31** | 73.8 | Existing | | | | 5.5 | | 11.3 | | | | 30.5 | | | | | 1.1 | 43% |
| | | Future | | | | | | | | | | | | | | | | |
| 32 | 571.1 | Existing | | | | | | | | | | | | | | | | 6% |
| | | Future | | | 571.1 | | | | | | | | | | | | | |
| 33A | 600.1 | Existing | | | | 0.1 | | | | | | | | | | | | 19% |
| | | Future | | | | | | | | | | 599.9 | | | | | | |
| 33B | 11.1 | Existing | | | | 10.8 | | | | | | | | | | | | 79% |
| | | Future | | | | | | | | | | 0.3 | | | | | | |
| 34A** | 24.7 | Existing | | 4.6 | | 5.8 | 7.0 | | | | | | | | | | | 65% |
| | | Future | | | | | | | | | | | | | | | | |
| 34B | 67.6 | Existing | | | | 64.9 | | | | | | 0.3 | | | | 0.1 | | 79% |
| | | Future | | | | 2.2 | | | | | | | | | | | | |
| 35 | 116.1 | Existing | | | | | 101.5 | | | 0.0 | 0.1 | 10.8 | | 3.6 | | | | 66% |
| | | Future | | | | | | | | | | | | | | | | |
| 36 | 12.8 | Existing | | | | | | | | | | 11.6 | | 0.2 | | 0.9 | | 29% |
| | | Future | | | | | | | | | | | | | | | | |
| 37 | 226.0 | Existing | | | | | | 15.0 | | | | 166.0 | | 13.0 | | 5.5 | 26.3 | 36% |
| | | Future | | | | | | | | | | | | 0.1 | | | | |
| 38 | 31.1 | Existing | | | | | | | | | | 28.7 | | | | 2.5 | | 28% |
| | | Future | | | | | | | | | | | | | | | | |
| 39A | 66.0 | Existing | | | | | 0.7 | | | | | | | | | | | 44% |
| | | Future | | | | | 25.2 | | | | 40.0 | 0.1 | | | | | | |
| 39B | 201.4 | Existing | | | | | | | | | | | | | | | | 6% |
| | | Future | | | 199.9 | | | | | | | 1.5 | | | | | | |
| 40 | 300.4 | Existing | | | | | | | | | | 0.5 | | 0.2 | | | | 19% |
| | | Future | | | | | | | | | | 299.7 | | | | | | |
| 41A | 6.3 | Existing | | | | | | | | | 6.2 | | | | | | | 69% |
| | | Future | | | | | | | | | | | | 0.1 | | | | |
| 41B | 11.9 | Existing | | | | | | | | | 11.5 | | | | | | | 68% |
| | | Future | | | | | | | | | | | | 0.1 | | 0.3 | | |
| 42*** | 275.4 | Existing | 9.6 | | | | | | | | | 45.6 | 194.2 | 194.2 | | 13.2 | 12.8 | 46% |
| | | Future | | | | | | | | | | | | | | | | |
| 43 | 155.5 | Existing | | | | | | | | | | | | | | | | 19% |
| | | Future | | | | | | | | | | 155.5 | | | | | | |
| 44*** | 322.0 | Existing | 7.3 | | | | 0.8 | | | | 24.5 | 47.6 | | 199.6 | | 19.8 | 22.5 | 46% |
| | | Future | | | | | | | | | | | | | | | | |
| 45 | 201.2 | Existing | | | | | | | | | | | | | | | | 19% |
| | | Future | | | | | | | | | | 201.2 | | | | 0.1 | | |
| 46 | 181.6 | Existing | | | | | | | | | | | | | | | | 19% |
| | | Future | | | | | | | | | | 178.8 | | | | | 2.7 | |
| 47 | 135.1 | Existing | | | | | | | | | | | | | | | | 19% |
| | | Future | | | | | | | | | | 135.1 | | | | | | |
| 48 | 196.2 | Existing | | | | | | | | | | | | | | | | 16% |
| | | Future | | | | | | | | | | 158.2 | | | | 38.1 | | |
| HD1 | 42.2 | Existing | | | | | | | | | | | | | | | | 50% |
| | | Future | | | | | | | 42.0 | | | | | | 0.2 | | | |
| HD2 | 306.2 | Existing | | | | | | | | | | | | | | | | 13% |
| | | Future | | | | | | | 0.1 | | | | | | 306.0 | | | |
| HD3 | 131.0 | Existing | | | | | | | | | | | | | | | | 13% |
| | | Future | | | | | | | | | | | | | 131.0 | | | |
| HD4 | 164.3 | Existing | | | | | | | | | | | | | | | | 13% |
| | | Future | | | | | | | | | | | | | 164.3 | | | |
| HD5 | 58.6 | Existing | | | | | | | | | | | | | | | | 13% |
| | | Future | | | | | | | 4.4 | | | | | | 54.2 | | | |

* Sub-basin 17B is an arterial street.

** Missing Acreage is an average value of landuse within sub-basin

*** Impervious values assume that storm water quality treatment for new development will be provided in DET 44 and not onsite

### CITY OF PATTERSON
### STORM DRAINAGE MASTER PLAN
### INPUT PARAMETERS

| Sub-basin | Length | Slope, ft/ft | Slope % | Weighted CN | % Imp | Adusted CN | S value | Lagtime (hrs) | Lagtime (mins) |
|---|---|---|---|---|---|---|---|---|---|
| OFF1a | 19678.00 | 0.065 | 6.50 | 76.4 | 3% | 77.1 | 3.0 | 1.48 | 88.51 |
| OFF1b | 71229.00 | 0.034 | 3.42 | 76.4 | 3% | 77.1 | 3.0 | 5.69 | 341.51 |
| OFF2 | 1442.00 | 0.017 | 1.73 | 63.5 | 3% | 64.5 | 5.5 | 0.50 | 29.91 |
| OFF3 | 6959.00 | 0.005 | 0.50 | 61.3 | 3% | 62.4 | 6.0 | 3.44 | 206.62 |
| HD1 | 3175.00 | 0.003 | 0.30 | 61.0 | 50% | 80.4 | 2.4 | 1.44 | 86.51 |
| HD2 | 6851.00 | 0.003 | 0.30 | 69.4 | 13% | 73.4 | 3.6 | 3.29 | 197.47 |
| HD3 | 2476.00 | 0.003 | 0.30 | 67.3 | 13% | 71.5 | 4.0 | 1.53 | 92.01 |
| HD4 | 5086.00 | 0.003 | 0.30 | 66.2 | 13% | 70.6 | 4.2 | 2.80 | 168.00 |
| HD5 | 3566.00 | 0.003 | 0.30 | 72.9 | 13% | 76.5 | 3.1 | 1.79 | 107.16 |
| 01A | 3756.00 | 0.003 | 0.30 | 61.1 | 50% | 80.5 | 2.4 | 1.64 | 98.64 |
| 2 | 3450.00 | 0.003 | 0.30 | 61.0 | 44% | 78.2 | 2.8 | 1.65 | 99.19 |
| 6 | 3777.00 | 0.003 | 0.30 | 67.2 | 44% | 81.6 | 2.2 | 1.59 | 95.64 |
| 7 | 1830.45 | 0.003 | 0.30 | 76.1 | 80% | 95.1 | 0.5 | 0.52 | 31.36 |
| 8 | 2596.00 | 0.003 | 0.30 | 79.8 | 50% | 89.9 | 1.1 | 0.88 | 52.68 |
| 9 | 3235.00 | 0.003 | 0.30 | 72.8 | 45% | 85.0 | 1.8 | 1.26 | 75.59 |
| 10A | 6014.00 | 0.003 | 0.30 | 76.2 | 48% | 87.6 | 1.4 | 1.88 | 113.00 |
| 10B | 6564.00 | 0.003 | 0.30 | 79.4 | 67% | 93.2 | 0.7 | 1.59 | 95.59 |
| 11 | 6484.00 | 0.003 | 0.30 | 67.4 | 19% | 73.6 | \ | 3.13 | 187.70 |
| 12 | 8994.00 | 0.003 | 0.30 | 61.0 | 21% | 69.3 | 4.4 | 4.58 | 274.68 |
| 13 | 5284.00 | 0.003 | 0.30 | 61.0 | 44% | 78.1 | 2.8 | 2.33 | 139.57 |
| 14 | 5371.00 | 0.003 | 0.30 | 61.3 | 13% | 66.2 | 5.1 | 3.29 | 197.22 |
| 15 | 5316.00 | 0.003 | 0.30 | 63.0 | 15% | 68.4 | 4.6 | 3.07 | 184.36 |
| 16A | 3322.02 | 0.003 | 0.30 | 61.1 | 26% | 71.2 | 4.0 | 1.96 | 117.51 |
| 16B | 1500.00 | 0.003 | 0.30 | 61.2 | 29% | 72.4 | 3.8 | 1.00 | 60.13 |
| 16C | 1140.00 | 0.003 | 0.30 | 61.2 | 80% | 92.2 | 0.8 | 0.41 | 24.66 |
| 17A | 2352.08 | 0.003 | 0.30 | 72.9 | 36% | 82.5 | 2.1 | 1.06 | 63.62 |
| 17B | 3822.95 | 0.003 | 0.30 | 73.0 | 80% | 94.6 | 0.6 | 0.97 | 58.06 |
| 18 | 2635.95 | 0.003 | 0.30 | 68.3 | 28% | 77.2 | 2.9 | 1.37 | 82.23 |
| 19 | 2964.24 | 0.003 | 0.30 | 63.8 | 32% | 75.4 | 3.3 | 1.59 | 95.30 |
| 20 | 2128.51 | 0.003 | 0.30 | 61.0 | 26% | 71.3 | 4.0 | 1.37 | 82.02 |
| 21A | 2127.92 | 0.003 | 0.30 | 61.0 | 61% | 84.6 | 1.8 | 0.91 | 54.74 |
| 21B | 4367.02 | 0.003 | 0.30 | 61.9 | 33% | 74.5 | 3.4 | 2.23 | 133.53 |
| 22A | 3265.87 | 0.003 | 0.30 | 71.0 | 29% | 79.4 | 2.6 | 1.53 | 91.53 |
| 22B | 2752.07 | 0.003 | 0.30 | 78.0 | 29% | 84.5 | 1.8 | 1.13 | 67.61 |
| 23 | 3263.95 | 0.003 | 0.30 | 80.0 | 28% | 85.6 | 1.7 | 1.24 | 74.44 |
| 24 | 820.85 | 0.003 | 0.30 | 80.0 | 29% | 85.8 | 1.7 | 0.41 | 24.48 |

**APPENDIX B**

**CITY OF PATTERSON**
**STORM DRAINAGE MASTER PLAN**
**INPUT PARAMETERS**

| Sub-basin | Length | Slope, ft/ft | Slope % | Weighted CN | % Imp | Adusted CN | S value | Lagtime (hrs) | Lagtime (mins) |
|---|---|---|---|---|---|---|---|---|---|
| 25 | 2118.40 | 0.003 | 0.30 | 69.5 | 29% | 78.5 | 2.7 | 1.11 | 66.53 |
| 26 | 4540.00 | 0.003 | 0.30 | 73.3 | 19% | 78.3 | 2.8 | 2.05 | 122.90 |
| 27 | 5752.00 | 0.003 | 0.30 | 63.7 | 20% | 70.8 | 4.1 | 3.07 | 184.09 |
| 28 | 6848.02 | 0.003 | 0.30 | 76.5 | 30% | 83.6 | 2.0 | 2.41 | 144.47 |
| 29A | 2520.91 | 0.003 | 0.30 | 69.6 | 53% | 85.9 | 1.6 | 1.00 | 59.95 |
| 29B | 4910.00 | 0.003 | 0.30 | 68.8 | 56% | 86.4 | 1.6 | 1.67 | 100.26 |
| 29C | 2524.00 | 0.003 | 0.30 | 62.7 | 47% | 80.3 | 2.4 | 1.20 | 72.21 |
| 30A | 3113.97 | 0.003 | 0.30 | 80.0 | 47% | 89.5 | 1.2 | 1.03 | 61.88 |
| 30B | 3122.33 | 0.003 | 0.30 | 67.0 | 48% | 82.9 | 2.1 | 1.32 | 78.95 |
| 31 | 3160.08 | 0.003 | 0.30 | 67.8 | 43% | 81.7 | 2.2 | 1.38 | 82.68 |
| 32 | 8745.00 | 0.003 | 0.30 | 61.0 | 6% | 63.3 | 5.8 | 5.23 | 313.66 |
| 33A | 9500.00 | 0.003 | 0.30 | 70.8 | 19% | 76.3 | 3.1 | 3.93 | 235.64 |
| 33B | 1193.00 | 0.003 | 0.30 | 62.2 | 79% | 91.9 | 0.9 | 0.43 | 25.94 |
| 34A | 2160.00 | 0.003 | 0.30 | 61.0 | 65% | 86.5 | 1.6 | 0.86 | 51.86 |
| 34B | 2822.00 | 0.003 | 0.30 | 71.8 | 79% | 94.0 | 0.6 | 0.78 | 46.96 |
| 35 | 5483.83 | 0.003 | 0.30 | 74.6 | 66% | 91.3 | 1.0 | 1.51 | 90.32 |
| 36 | 1016.51 | 0.003 | 0.30 | 80.0 | 29% | 85.8 | 1.7 | 0.48 | 29.09 |
| 37 | 1430.42 | 0.003 | 0.30 | 80.0 | 36% | 87.2 | 1.5 | 0.60 | 36.29 |
| 38 | 1504.33 | 0.003 | 0.30 | 80.0 | 28% | 85.6 | 1.7 | 0.67 | 40.06 |
| 39A | 3335.00 | 0.003 | 0.30 | 67.5 | 44% | 81.9 | 2.2 | 1.43 | 85.91 |
| 39B | 6967.00 | 0.003 | 0.30 | 79.1 | 6% | 80.4 | 2.4 | 2.71 | 162.62 |
| 40 | 8625.00 | 0.003 | 0.30 | 79.7 | 19% | 83.6 | 2.0 | 2.89 | 173.64 |
| 41a | 1181.00 | 0.003 | 0.30 | 80.0 | 69% | 93.8 | 0.7 | 0.39 | 23.57 |
| 41b | 1432.00 | 0.003 | 0.30 | 70.2 | 68% | 90.5 | 1.0 | 0.53 | 31.90 |
| 42 | 4755.00 | 0.003 | 0.30 | 78.6 | 46% | 85.0 | 1.8 | 1.71 | 102.57 |
| 43 | 5001.00 | 0.003 | 0.30 | 61.4 | 19% | 68.7 | 4.6 | 2.91 | 174.32 |
| 44 | 5313.00 | 0.003 | 0.30 | 68.5 | 46% | 78.0 | 2.8 | 2.35 | 140.97 |
| 45 | 5574.00 | 0.003 | 0.30 | 77.7 | 19% | 82.0 | 2.2 | 2.15 | 129.20 |
| 46 | 3915.00 | 0.003 | 0.30 | 80.0 | 19% | 83.9 | 1.9 | 1.52 | 91.50 |
| 47 | 3490.00 | 0.003 | 0.30 | 80.0 | 19% | 83.8 | 1.9 | 1.39 | 83.61 |
| 48 | 3956.00 | 0.003 | 0.30 | 79.5 | 16% | 82.9 | 2.1 | 1.59 | 95.27 |

# Appendix C

# HEC-HMS Model Output
# (10-year and 100-year)

Patterson 10-year Peak Flows

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|---|---|---|---|---|
| OFF1a | 5.662 | 134.9 | 22Mar2012, 00:00 | 101.6 |
| CP1 | 5.662 | 134.9 | 22Mar2012, 00:00 | 101.6 |
| Reach1 | 5.662 | 134.8 | 22Mar2012, 02:30 | 101.7 |
| OFF1b | 19.585 | 277.8 | 22Mar2012, 06:34 | 351.5 |
| CP1b | 25.247 | 364.7 | 22Mar2012, 05:46 | 453.1 |
| Reach-2 | 25.247 | 364.7 | 22Mar2012, 05:50 | 453.1 |
| OFF2 | 0.046 | 0.2 | 22Mar2012, 07:20 | 0.1 |
| CP2 | 25.293 | 364.8 | 22Mar2012, 05:50 | 453.2 |
| Reach-3 | 25.293 | 364.8 | 22Mar2012, 06:08 | 453.2 |
| OFF3 | 0.18 | 0.4 | 22Mar2012, 12:24 | 0.3 |
| CP3 | 25.473 | 364.9 | 22Mar2012, 06:10 | 453.5 |
| DET-OFF1 | 25.473 | 281.8 | 22Mar2012, 13:40 | 444 |
| S33A | 0.938 | 22.4 | 22Mar2012, 02:30 | 23 |
| Det33A | 0.938 | 4.8 | 22Mar2012, 16:10 | 11.5 |
| R33A | 0.938 | 4.8 | 22Mar2012, 16:18 | 11.5 |
| R33A' | 0.938 | 4.8 | 22Mar2012, 16:44 | 11.3 |
| S33B | 0.017 | 5.4 | 21Mar2012, 22:18 | 1.2 |
| R33B | 0.017 | 4.7 | 21Mar2012, 22:32 | 1.2 |
| S34B | 0.106 | 24 | 21Mar2012, 22:40 | 7.9 |
| CP34B | 0.123 | 28.5 | 21Mar2012, 22:38 | 9.2 |
| R34B | 0.123 | 25.8 | 21Mar2012, 22:48 | 9.1 |
| S39A | 0.103 | 9 | 21Mar2012, 23:20 | 4.5 |
| Det39A | 0.226 | 3.7 | 22Mar2012, 09:40 | 9.5 |
| CP33A | 1.164 | 8.2 | 22Mar2012, 13:58 | 20.8 |
| R39A | 1.164 | 8.2 | 22Mar2012, 14:14 | 20.7 |
| S39B | 0.315 | 8.9 | 22Mar2012, 01:38 | 7.7 |
| Det39B | 0.315 | 0.6 | 22Mar2012, 16:48 | 1.5 |
| CP39B | 1.479 | 8.8 | 22Mar2012, 14:26 | 22.2 |
| R39B | 1.479 | 8.8 | 22Mar2012, 14:52 | 21.9 |
| S30B | 0.225 | 22.6 | 21Mar2012, 23:14 | 10.6 |
| R30B | 0.225 | 22.6 | 21Mar2012, 23:18 | 10.6 |
| S29B | 0.185 | 18.9 | 21Mar2012, 23:36 | 10.1 |
| S30A | 0.125 | 16.7 | 21Mar2012, 22:58 | 6.9 |
| CP30 | 0.535 | 56.2 | 21Mar2012, 23:14 | 27.5 |
| R30A | 0.535 | 56.2 | 21Mar2012, 23:16 | 27.5 |
| S28 | 0.203 | 10.8 | 22Mar2012, 00:34 | 7.9 |
| PUMP28 | 0.203 | 1.3 | 22Mar2012, 02:04 | 4 |
| R28 | 0.203 | 1.3 | 22Mar2012, 04:28 | 3.9 |
| S34A | 0.039 | 6.8 | 21Mar2012, 22:44 | 2.4 |
| CP28 | 0.242 | 7.2 | 21Mar2012, 22:44 | 6.3 |
| R34A | 0.242 | 7.1 | 21Mar2012, 22:46 | 6.3 |
| R34A' | 0.242 | 7.1 | 21Mar2012, 23:04 | 6.2 |
| S35 | 0.181 | 23.7 | 21Mar2012, 23:26 | 11.8 |
| S41A | 0.01 | 3.1 | 21Mar2012, 22:16 | 0.7 |
| CP35 | 0.968 | 87.2 | 21Mar2012, 23:16 | 46.3 |

## Patterson 10-year Peak Flows

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|---|---|---|---|---|
| R35 | 0.968 | 87.2 | 21Mar2012, 23:16 | 46.3 |
| S36 | 0.02 | 3 | 21Mar2012, 22:24 | 0.8 |
| DET36 | 0.02 | 2.5 | 21Mar2012, 22:36 | 0.8 |
| CP36 | 0.988 | 88.7 | 21Mar2012, 23:16 | 47.2 |
| R36 | 0.988 | 88.6 | 21Mar2012, 23:18 | 47.1 |
| S37 | 0.353 | 53.5 | 21Mar2012, 22:30 | 16.6 |
| PUMP37 | 0.353 | 4 | 21Mar2012, 23:12 | 12.4 |
| CP37 | 1.341 | 92.6 | 21Mar2012, 23:18 | 59.5 |
| R37 | 1.341 | 92.3 | 21Mar2012, 23:24 | 59.5 |
| S38 | 0.049 | 6 | 21Mar2012, 22:36 | 2 |
| CP38 | 1.39 | 95.5 | 21Mar2012, 23:22 | 61.5 |
| R38A | 1.39 | 95.5 | 21Mar2012, 23:24 | 61.5 |
| S40 | 0.469 | 19.7 | 22Mar2012, 01:24 | 16.2 |
| Det40 | 0.469 | 2.6 | 22Mar2012, 15:28 | 6.3 |
| CP40 | 3.338 | 97.8 | 21Mar2012, 23:24 | 89.8 |
| R38B | 3.338 | 97.3 | 21Mar2012, 23:28 | 89.6 |
| S42 | 0.43 | 40.6 | 21Mar2012, 23:44 | 22.7 |
| CP42 | 3.768 | 137.2 | 21Mar2012, 23:32 | 112.3 |
| R42 | 3.768 | 136 | 21Mar2012, 23:38 | 112.2 |
| S11 | 0.94 | 23.1 | 22Mar2012, 01:20 | 20.7 |
| Det11 | 0.94 | 6.9 | 22Mar2012, 13:30 | 15.7 |
| R11 | 0.94 | 6.9 | 22Mar2012, 13:54 | 15.6 |
| S26 | 0.346 | 12.7 | 22Mar2012, 00:12 | 9.3 |
| Det26 | 0.346 | 2.7 | 22Mar2012, 13:20 | 6.3 |
| CP26 | 1.286 | 9.5 | 22Mar2012, 13:40 | 21.9 |
| R26A | 1.286 | 9.5 | 22Mar2012, 13:46 | 21.8 |
| R26B | 1.286 | 9.5 | 22Mar2012, 13:58 | 21.8 |
| S12 | 0.743 | 15.5 | 22Mar2012, 02:48 | 15.3 |
| Det12 | 0.743 | 6.3 | 22Mar2012, 11:10 | 13.4 |
| R12 | 0.743 | 6.3 | 22Mar2012, 11:26 | 13.4 |
| S27 | 0.661 | 16.7 | 22Mar2012, 01:08 | 13.8 |
| Det27 | 0.661 | 4.9 | 22Mar2012, 11:54 | 11.2 |
| CP27 | 2.69 | 20.7 | 22Mar2012, 12:56 | 46.3 |
| R27 | 2.69 | 20.7 | 22Mar2012, 13:20 | 46 |
| S43 | 0.243 | 6 | 22Mar2012, 00:56 | 4.6 |
| Det43 | 0.243 | 1.3 | 22Mar2012, 13:10 | 3.2 |
| CP43 | 2.933 | 22 | 22Mar2012, 13:20 | 49.2 |
| R43 | 2.933 | 22 | 22Mar2012, 13:26 | 49.1 |
| S44 | 0.503 | 34.6 | 22Mar2012, 00:22 | 23.1 |
| Det44 | 7.204 | 69.6 | 22Mar2012, 07:34 | 183.7 |
| S15 | 0.555 | 10.5 | 22Mar2012, 01:08 | 8.9 |
| Det15 | 0.555 | 3.8 | 22Mar2012, 01:12 | 8.7 |
| S14 | 0.505 | 7.9 | 22Mar2012, 01:22 | 6.8 |
| Det14 | 0.505 | 3.1 | 22Mar2012, 01:26 | 6.7 |

Patterson 10-year Peak Flows

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|---|---|---|---|---|
| CP15 | 1.06 | 6.9 | 22Mar2012, 01:26 | 15.4 |
| R15 | 1.06 | 6.9 | 22Mar2012, 01:34 | 15.4 |
| S16A | 0.27 | 11.6 | 21Mar2012, 23:54 | 6.8 |
| PUMP16A | 0.27 | 11.5 | 22Mar2012, 00:06 | 6.8 |
| S17A | 0.204 | 18.4 | 21Mar2012, 23:00 | 8.2 |
| DET17A | 0.204 | 2.5 | 22Mar2012, 10:38 | 6 |
| CP17A | 1.534 | 17.9 | 22Mar2012, 00:32 | 28.3 |
| R16 | 1.534 | 17.9 | 22Mar2012, 00:40 | 28.2 |
| S20 | 0.045 | 2.4 | 21Mar2012, 23:16 | 1.1 |
| DET20 | 0.045 | 1.3 | 22Mar2012, 00:38 | 1.1 |
| CP20 | 1.579 | 19.3 | 22Mar2012, 00:40 | 29.4 |
| R20 | 1.579 | 19.3 | 22Mar2012, 00:42 | 29.4 |
| S10A | 0.47 | 41.5 | 21Mar2012, 23:54 | 24.6 |
| Det10A | 0.47 | 9.5 | 22Mar2012, 07:46 | 21 |
| S07 | 0.087 | 25.4 | 21Mar2012, 22:24 | 6.7 |
| BlackGulch | 0.0001 | 50 | 21Mar2012, 12:00 | 198.3 |
| DET07 | 0.0871 | 66.5 | 21Mar2012, 22:48 | 202.1 |
| R07 | 0.0871 | 65.6 | 21Mar2012, 22:58 | 201.4 |
| CP07 | 0.5571 | 69 | 21Mar2012, 23:02 | 222.4 |
| R10A | 0.5571 | 68.3 | 21Mar2012, 23:16 | 221.5 |
| R10A' | 0.5571 | 67.5 | 21Mar2012, 23:36 | 220 |
| S10B | 0.455 | 60.9 | 21Mar2012, 23:32 | 31.2 |
| DET10B | 0.455 | 26 | 22Mar2012, 00:54 | 31.2 |
| CP10 | 1.0121 | 90.4 | 22Mar2012, 00:52 | 251.2 |
| R10 | 1.0121 | 90.4 | 22Mar2012, 00:54 | 250.7 |
| S23 | 0.085 | 7.2 | 21Mar2012, 23:14 | 3.5 |
| DET23 | 0.085 | 6.9 | 21Mar2012, 23:30 | 3.5 |
| R23 | 0.085 | 6.9 | 21Mar2012, 23:34 | 3.5 |
| S22B | 0.041 | 3.5 | 21Mar2012, 23:06 | 1.6 |
| CP22 | 1.1381 | 97.1 | 22Mar2012, 00:16 | 255.9 |
| R22 | 1.1381 | 97.1 | 22Mar2012, 00:16 | 255.8 |
| S09 | 0.273 | 27.4 | 21Mar2012, 23:12 | 13 |
| Det09 | 0.273 | 5.4 | 22Mar2012, 05:30 | 11.7 |
| S08 | 0.095 | 14.5 | 21Mar2012, 22:48 | 5.4 |
| Det08 | 0.095 | 2.3 | 21Mar2012, 22:22 | 5.4 |
| R08 | 0.095 | 2.3 | 22Mar2012, 00:30 | 5.4 |
| CP09 | 0.368 | 7.7 | 22Mar2012, 05:30 | 17 |
| R09 | 0.368 | 7.7 | 22Mar2012, 05:44 | 17 |
| S17B | 0.016 | 3.2 | 21Mar2012, 22:52 | 1.2 |
| CP17B | 0.384 | 8.2 | 22Mar2012, 04:24 | 18.2 |
| R17 | 0.384 | 8.2 | 22Mar2012, 04:28 | 18.2 |
| S18 | 0.101 | 5.8 | 21Mar2012, 23:18 | 3.1 |
| DET18 | 0.101 | 2.3 | 22Mar2012, 01:56 | 3.1 |
| R18 | 0.101 | 2.3 | 22Mar2012, 02:02 | 3.1 |

# Patterson 10-year Peak Flows

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|---|---|---|---|---|
| S19 | 0.139 | 8.3 | 21Mar2012, 23:30 | 4.4 |
| DET19 | 0.24 | 6.2 | 22Mar2012, 01:30 | 7.4 |
| CP19 | 0.624 | 14.3 | 22Mar2012, 01:48 | 25.6 |
| R19 | 0.624 | 14.3 | 22Mar2012, 01:54 | 25.6 |
| S22A | 0.138 | 8 | 21Mar2012, 23:30 | 4.6 |
| DET22A | 0.138 | 4.7 | 22Mar2012, 01:08 | 4.6 |
| R22A | 0.138 | 4.7 | 22Mar2012, 01:16 | 4.6 |
| CP22A | 0.762 | 19 | 22Mar2012, 01:36 | 30.2 |
| PUMP22A | 0.762 | 4 | 22Mar2012, 03:24 | 12.1 |
| CP21a | 3.4791 | 118.3 | 22Mar2012, 00:34 | 297.2 |
| R21b | 3.4791 | 118.3 | 22Mar2012, 00:36 | 297.1 |
| S16B | 0.032 | 2.3 | 21Mar2012, 22:54 | 0.9 |
| DET16B | 0.032 | 2.2 | 21Mar2012, 23:08 | 0.9 |
| R16b | 0.032 | 2.2 | 21Mar2012, 23:14 | 0.9 |
| S16C | 0.037 | 12.1 | 21Mar2012, 22:16 | 2.7 |
| CP16c | 0.069 | 13 | 21Mar2012, 22:16 | 3.6 |
| R16c | 0.069 | 12.7 | 21Mar2012, 22:26 | 3.6 |
| S21A | 0.083 | 13.2 | 21Mar2012, 22:48 | 4.7 |
| DET21A | 0.152 | 23.9 | 21Mar2012, 22:34 | 8.4 |
| R21A | 0.152 | 23.3 | 21Mar2012, 22:48 | 8.3 |
| S21B | 0.281 | 14.2 | 22Mar2012, 00:12 | 8.9 |
| CP21b | 3.9121 | 142.1 | 22Mar2012, 00:02 | 314.3 |
| R24 | 3.9121 | 142.1 | 22Mar2012, 00:02 | 314.3 |
| S24 | 0.02 | 3.3 | 21Mar2012, 22:18 | 0.8 |
| DET24 | 0.02 | 3.3 | 21Mar2012, 22:20 | 0.8 |
| CP24 | 3.9321 | 142.9 | 22Mar2012, 00:02 | 315.1 |
| R25A | 3.9321 | 142.9 | 22Mar2012, 00:02 | 315.1 |
| S25 | 0.067 | 4.6 | 21Mar2012, 23:02 | 2.1 |
| PUMP25 | 0.067 | 1 | 22Mar2012, 04:32 | 2 |
| CP25 | 3.9991 | 143.7 | 22Mar2012, 00:04 | 317.1 |
| R25B | 3.9991 | 143.7 | 22Mar2012, 00:04 | 317 |
| S29C | 0.095 | 9.9 | 21Mar2012, 23:06 | 4.2 |
| Det29C | 0.095 | 2.1 | 22Mar2012, 00:22 | 4.1 |
| R29C | 0.095 | 2.1 | 22Mar2012, 02:16 | 4.1 |
| CP29C | 4.0941 | 145.5 | 22Mar2012, 00:06 | 321.1 |
| R25C | 4.0941 | 145.5 | 22Mar2012, 00:06 | 321.1 |
| S29A | 0.081 | 10.6 | 21Mar2012, 22:54 | 4.2 |
| CP29A | 4.1751 | 151 | 21Mar2012, 23:54 | 325.3 |
| R29A | 4.1751 | 151 | 21Mar2012, 23:56 | 325.2 |
| S31 | 0.115 | 10.1 | 21Mar2012, 23:18 | 4.9 |
| Div31 | 0.115 | 7.6 | 21Mar2012, 23:18 | 1.4 |
| S41B | 0.019 | 4.6 | 21Mar2012, 22:24 | 1.2 |
| CP31 | 4.3091 | 158.6 | 21Mar2012, 23:42 | 327.9 |
| R96A | 4.3091 | 158.6 | 21Mar2012, 23:44 | 327.7 |

## Patterson 10-year Peak Flows

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|---|---|---|---|---|
| R96B | 4.3091 | 158.6 | 21Mar2012, 23:52 | 326.8 |
| CP44 | 11.5131 | 213.2 | 22Mar2012, 00:18 | 510.5 |
| R44 | 11.5131 | 213.2 | 22Mar2012, 00:22 | 510.1 |
| S46 | 0.284 | 17.4 | 21Mar2012, 23:38 | 10 |
| Det46 | 0.284 | 2.7 | 22Mar2012, 01:40 | 7.7 |
| R46 | 0.284 | 2.7 | 22Mar2012, 03:40 | 7.6 |
| S47 | 0.211 | 13.6 | 21Mar2012, 23:28 | 7.4 |
| Det47 | 0.211 | 1.9 | 22Mar2012, 01:26 | 5.5 |
| CP47 | 0.495 | 4.6 | 22Mar2012, 03:40 | 13.1 |
| R47 | 0.495 | 4.6 | 22Mar2012, 04:04 | 13.1 |
| S45 | 0.314 | 13.9 | 22Mar2012, 00:24 | 10 |
| Det45 | 0.314 | 1.8 | 22Mar2012, 14:22 | 4.3 |
| S48 | 0.307 | 16.4 | 21Mar2012, 23:44 | 9.9 |
| Det48 | 0.307 | 1.4 | 22Mar2012, 13:56 | 3.7 |
| CP45 | 12.6291 | 217.4 | 22Mar2012, 00:32 | 531.3 |
| S32 | 0.892 | 4.9 | 22Mar2012, 03:34 | 6.3 |
| S13 | 0.547 | 35.8 | 22Mar2012, 00:18 | 22.7 |
| Det13 | 0.547 | 7.8 | 22Mar2012, 08:28 | 18.1 |
| HD2 | 0.478 | 8.6 | 22Mar2012, 01:50 | 8.8 |
| S06 | 0.197 | 16.2 | 21Mar2012, 23:30 | 8.3 |
| Det06 | 0.197 | 1.4 | 22Mar2012, 13:14 | 3.8 |
| HD4 | 0.257 | 4.6 | 22Mar2012, 00:56 | 4.1 |
| HD3 | 0.205 | 5.2 | 21Mar2012, 23:30 | 3.4 |
| HD5 | 0.092 | 2.7 | 22Mar2012, 00:00 | 2 |
| HD1 | 0.066 | 6.5 | 21Mar2012, 23:20 | 3.1 |
| S01A | 0.545 | 49.9 | 21Mar2012, 23:34 | 25.6 |
| Det01A | 0.545 | 9 | 21Mar2012, 22:50 | 25 |
| S02 | 0.041 | 3.3 | 21Mar2012, 23:34 | 1.7 |
| Det02 | 0.041 | 0.6 | 22Mar2012, 01:02 | 1.5 |

Patterson 100-year Peak Flows

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|---|---|---|---|---|
| OFF1a | 5.662 | 508.7 | 21Mar2012, 23:40 | 279.5 |
| CP1 | 5.662 | 508.7 | 21Mar2012, 23:40 | 279.5 |
| Reach1 | 5.662 | 508.4 | 22Mar2012, 01:18 | 279.7 |
| OFF1b | 19.585 | 841.9 | 22Mar2012, 05:44 | 966.8 |
| CP1b | 25.247 | 1071.6 | 22Mar2012, 04:40 | 1246.5 |
| Reach-2 | 25.247 | 1071.6 | 22Mar2012, 04:42 | 1246.5 |
| OFF2 | 0.046 | 1.2 | 21Mar2012, 22:44 | 0.9 |
| CP2 | 25.293 | 1072.3 | 22Mar2012, 04:42 | 1247.4 |
| Reach-3 | 25.293 | 1072.3 | 22Mar2012, 04:56 | 1247.3 |
| OFF3 | 0.18 | 2.4 | 22Mar2012, 06:32 | 2.7 |
| CP3 | 25.473 | 1074.6 | 22Mar2012, 04:56 | 1250 |
| DET-OFF1 | 25.473 | 600 | 22Mar2012, 05:58 | 1219.8 |
| S33A | 0.938 | 52.5 | 22Mar2012, 02:44 | 51 |
| Det33A | 0.938 | 8.4 | 22Mar2012, 08:26 | 23 |
| R33A | 0.938 | 8.4 | 22Mar2012, 10:58 | 22.9 |
| R33A' | 0.938 | 8.4 | 22Mar2012, 12:20 | 22.6 |
| S33B | 0.017 | 8.6 | 21Mar2012, 22:18 | 2 |
| R33B | 0.017 | 7.1 | 21Mar2012, 22:32 | 2 |
| S34B | 0.106 | 39.5 | 21Mar2012, 22:40 | 13.1 |
| CP34B | 0.123 | 46.3 | 21Mar2012, 22:38 | 15.1 |
| R34B | 0.123 | 41.1 | 21Mar2012, 22:46 | 14.9 |
| S39A | 0.103 | 15.9 | 21Mar2012, 23:24 | 8.1 |
| Det39A | 0.226 | 5 | 22Mar2012, 00:56 | 15 |
| CP33A | 1.164 | 13.4 | 22Mar2012, 12:20 | 37.6 |
| R39A | 1.164 | 13.4 | 22Mar2012, 12:46 | 37.3 |
| S39B | 0.315 | 25.5 | 22Mar2012, 01:16 | 18.8 |
| Det39B | 0.315 | 1.1 | 22Mar2012, 08:04 | 3 |
| CP39B | 1.479 | 14.5 | 22Mar2012, 12:46 | 40.3 |
| R39B | 1.479 | 14.5 | 22Mar2012, 13:16 | 39.9 |
| S30B | 0.225 | 39 | 21Mar2012, 23:16 | 18.7 |
| R30B | 0.225 | 39 | 21Mar2012, 23:20 | 18.7 |
| S29B | 0.185 | 32.4 | 21Mar2012, 23:38 | 17.5 |
| S30A | 0.125 | 31.7 | 21Mar2012, 22:58 | 12.4 |
| CP30 | 0.535 | 98.8 | 21Mar2012, 23:16 | 48.6 |
| R30A | 0.535 | 98.8 | 21Mar2012, 23:16 | 48.6 |
| S28 | 0.203 | 22.8 | 22Mar2012, 00:36 | 15.6 |
| PUMP28 | 0.203 | 1.3 | 22Mar2012, 00:06 | 4.1 |
| R28 | 0.203 | 1.3 | 22Mar2012, 02:32 | 4.1 |
| S34A | 0.039 | 10.9 | 21Mar2012, 22:46 | 3.9 |
| CP28 | 0.242 | 11.5 | 21Mar2012, 22:46 | 8 |
| R34A | 0.242 | 11.4 | 21Mar2012, 22:48 | 8 |
| R34A' | 0.242 | 11.4 | 21Mar2012, 23:04 | 8 |
| S35 | 0.181 | 40.8 | 21Mar2012, 23:28 | 20.1 |
| S41A | 0.01 | 5.4 | 21Mar2012, 22:16 | 1.2 |
| CP35 | 0.968 | 151.1 | 21Mar2012, 23:16 | 77.9 |

Patterson 100-year Peak Flows

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|---|---|---|---|---|
| R35 | 0.968 | 151.1 | 21Mar2012, 23:18 | 77.9 |
| S36 | 0.02 | 6.5 | 21Mar2012, 22:22 | 1.7 |
| DET36 | 0.02 | 5.5 | 21Mar2012, 22:36 | 1.7 |
| CP36 | 0.988 | 154.3 | 21Mar2012, 23:16 | 79.5 |
| R36 | 0.988 | 154.1 | 21Mar2012, 23:18 | 79.5 |
| S37 | 0.353 | 109.7 | 21Mar2012, 22:30 | 31.5 |
| PUMP37 | 0.353 | 4 | 21Mar2012, 22:20 | 13.3 |
| CP37 | 1.341 | 158.1 | 21Mar2012, 23:18 | 92.8 |
| R37 | 1.341 | 157.2 | 21Mar2012, 23:24 | 92.7 |
| S38 | 0.049 | 13.1 | 21Mar2012, 22:34 | 4 |
| CP38 | 1.39 | 163.9 | 21Mar2012, 23:22 | 96.8 |
| R38A | 1.39 | 163.7 | 21Mar2012, 23:24 | 96.7 |
| S40 | 0.469 | 45.8 | 22Mar2012, 01:18 | 34.3 |
| Det40 | 0.469 | 4.2 | 22Mar2012, 07:04 | 11.9 |
| CP40 | 3.338 | 167.6 | 21Mar2012, 23:24 | 148.5 |
| R38B | 3.338 | 166.3 | 21Mar2012, 23:28 | 148.3 |
| S42 | 0.43 | 77 | 21Mar2012, 23:44 | 41.2 |
| CP42 | 3.768 | 242 | 21Mar2012, 23:32 | 189.6 |
| R42 | 3.768 | 238.6 | 21Mar2012, 23:38 | 189.1 |
| S11 | 0.94 | 51.4 | 22Mar2012, 01:40 | 45.7 |
| Det11 | 0.94 | 8.5 | 22Mar2012, 02:46 | 25.6 |
| R11 | 0.94 | 8.5 | 22Mar2012, 08:54 | 25.2 |
| S26 | 0.346 | 30.8 | 22Mar2012, 00:16 | 20.4 |
| Det26 | 0.346 | 3.1 | 22Mar2012, 01:28 | 9.5 |
| CP26 | 1.286 | 11.6 | 22Mar2012, 08:54 | 34.8 |
| R26A | 1.286 | 11.6 | 22Mar2012, 10:56 | 34.6 |
| R26B | 1.286 | 11.6 | 22Mar2012, 11:52 | 34.4 |
| S12 | 0.743 | 28.8 | 22Mar2012, 03:16 | 31.5 |
| Det12 | 0.743 | 7.7 | 22Mar2012, 03:50 | 22.8 |
| R12 | 0.743 | 7.7 | 22Mar2012, 10:52 | 22.6 |
| S27 | 0.661 | 32.9 | 22Mar2012, 01:30 | 29.4 |
| Det27 | 0.661 | 6.1 | 22Mar2012, 02:28 | 18.5 |
| CP27 | 2.69 | 25.4 | 22Mar2012, 11:52 | 75.6 |
| R27 | 2.69 | 25.4 | 22Mar2012, 13:28 | 74.6 |
| S43 | 0.243 | 11.1 | 22Mar2012, 01:14 | 9.8 |
| Det43 | 0.243 | 2.2 | 22Mar2012, 05:48 | 6.2 |
| CP43 | 2.933 | 27.6 | 22Mar2012, 13:28 | 80.8 |
| R43 | 2.933 | 27.6 | 22Mar2012, 16:42 | 80.5 |
| S44 | 0.503 | 61.5 | 22Mar2012, 00:26 | 41.5 |
| Det44 | 7.204 | 93.9 | 22Mar2012, 12:12 | 279.1 |
| S15 | 0.555 | 21.9 | 22Mar2012, 01:40 | 20.6 |
| Det15 | 0.555 | 3.8 | 21Mar2012, 23:48 | 12.3 |
| S14 | 0.505 | 16.2 | 22Mar2012, 02:00 | 16.3 |
| Det14 | 0.505 | 3.1 | 21Mar2012, 23:58 | 10 |

Patterson 100-year Peak Flows

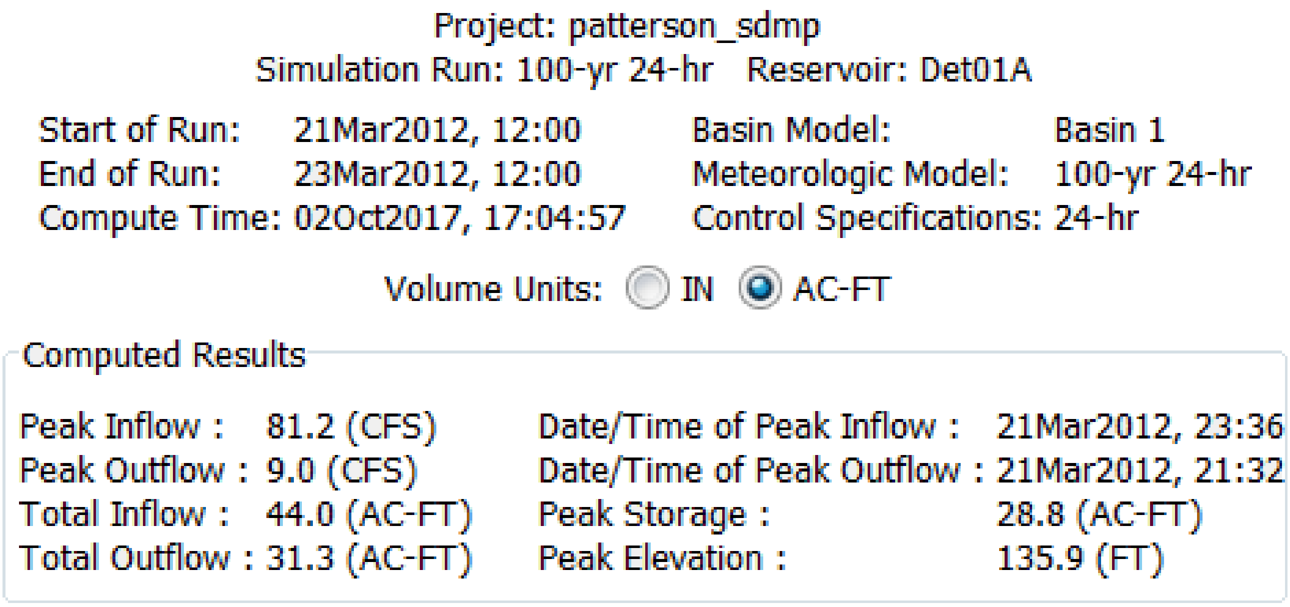
| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|---|---|---|---|---|
| CP15 | 1.06 | 6.9 | 21Mar2012, 23:58 | 22.4 |
| R15 | 1.06 | 6.9 | 22Mar2012, 00:06 | 22.3 |
| S16A | 0.27 | 19.8 | 22Mar2012, 00:00 | 13.3 |
| PUMP16A | 0.27 | 17 | 21Mar2012, 23:32 | 13.3 |
| S17A | 0.204 | 36.8 | 21Mar2012, 23:02 | 15.7 |
| DET17A | 0.204 | 4 | 22Mar2012, 02:40 | 11 |
| CP17A | 1.534 | 27.8 | 22Mar2012, 02:00 | 46.6 |
| R16 | 1.534 | 27.7 | 22Mar2012, 02:04 | 46.4 |
| S20 | 0.045 | 4 | 21Mar2012, 23:20 | 2.2 |
| DET20 | 0.045 | 2.3 | 22Mar2012, 00:58 | 2.2 |
| CP20 | 1.579 | 29.9 | 22Mar2012, 02:02 | 48.7 |
| R20 | 1.579 | 29.9 | 22Mar2012, 02:04 | 48.6 |
| S10A | 0.47 | 77.3 | 21Mar2012, 23:56 | 44.3 |
| Det10A | 0.47 | 9.9 | 22Mar2012, 00:18 | 31.4 |
| S07 | 0.087 | 42.3 | 21Mar2012, 22:24 | 11 |
| BlackGulch | 0.0001 | 50 | 21Mar2012, 12:00 | 198.3 |
| DET07 | 0.0871 | 70 | 21Mar2012, 22:24 | 206.4 |
| R07 | 0.0871 | 70 | 22Mar2012, 00:06 | 205.7 |
| CP07 | 0.5571 | 79.3 | 22Mar2012, 00:08 | 237.1 |
| R10A | 0.5571 | 78.7 | 22Mar2012, 00:10 | 236 |
| R10A' | 0.5571 | 77.9 | 22Mar2012, 00:20 | 234.5 |
| S10B | 0.455 | 105.4 | 21Mar2012, 23:34 | 53 |
| DET10B | 0.455 | 26 | 21Mar2012, 23:18 | 52.8 |
| CP10 | 1.0121 | 103.9 | 22Mar2012, 00:20 | 287.3 |
| R10 | 1.0121 | 103.9 | 22Mar2012, 00:26 | 286.7 |
| S23 | 0.085 | 15.7 | 21Mar2012, 23:14 | 7 |
| DET23 | 0.085 | 13 | 21Mar2012, 23:04 | 7 |
| R23 | 0.085 | 13 | 22Mar2012, 00:08 | 7 |
| S22B | 0.041 | 7.6 | 21Mar2012, 23:06 | 3.2 |
| CP22 | 1.1381 | 121.1 | 22Mar2012, 00:18 | 296.9 |
| R22 | 1.1381 | 121.1 | 22Mar2012, 00:20 | 296.8 |
| S09 | 0.273 | 51.1 | 21Mar2012, 23:14 | 23.6 |
| Det09 | 0.273 | 5.7 | 21Mar2012, 23:28 | 18.2 |
| S08 | 0.095 | 27.2 | 21Mar2012, 22:48 | 9.6 |
| Det08 | 0.095 | 2.3 | 21Mar2012, 21:24 | 8.1 |
| R08 | 0.095 | 2.3 | 21Mar2012, 23:30 | 8 |
| CP09 | 0.368 | 8 | 21Mar2012, 23:30 | 26.2 |
| R09 | 0.368 | 8 | 22Mar2012, 02:28 | 26.1 |
| S17B | 0.016 | 5.3 | 21Mar2012, 22:52 | 2 |
| CP17B | 0.384 | 11.5 | 21Mar2012, 23:10 | 28.1 |
| R17 | 0.384 | 11.5 | 21Mar2012, 23:14 | 28 |
| S18 | 0.101 | 11.6 | 21Mar2012, 23:24 | 6.1 |
| DET18 | 0.101 | 3.4 | 21Mar2012, 23:52 | 6.1 |
| R18 | 0.101 | 3.4 | 22Mar2012, 00:32 | 6.1 |

Patterson 100-year Peak Flows

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|---|---|---|---|---|
| S19 | 0.139 | 14.5 | 21Mar2012, 23:36 | 8.3 |
| DET19 | 0.24 | 11 | 22Mar2012, 01:44 | 14.4 |
| CP19 | 0.624 | 20.4 | 22Mar2012, 01:12 | 42.4 |
| R19 | 0.624 | 20.4 | 22Mar2012, 01:18 | 42.4 |
| S22A | 0.138 | 16.6 | 21Mar2012, 23:34 | 9.1 |
| DET22A | 0.138 | 9.6 | 22Mar2012, 01:22 | 9.1 |
| R22A | 0.138 | 9.6 | 22Mar2012, 01:28 | 9.1 |
| CP22A | 0.762 | 30 | 22Mar2012, 01:24 | 51.5 |
| PUMP22A | 0.762 | 4 | 22Mar2012, 01:02 | 12.6 |
| CP21a | 3.4791 | 153.7 | 22Mar2012, 00:28 | 358 |
| R21b | 3.4791 | 153.7 | 22Mar2012, 00:28 | 357.8 |
| S16B | 0.032 | 3.8 | 21Mar2012, 22:56 | 1.7 |
| DET16B | 0.032 | 3.6 | 21Mar2012, 23:10 | 1.7 |
| R16b | 0.032 | 3.6 | 21Mar2012, 23:16 | 1.7 |
| S16C | 0.037 | 19.3 | 21Mar2012, 22:16 | 4.5 |
| CP16c | 0.069 | 20.7 | 21Mar2012, 22:18 | 6.2 |
| R16c | 0.069 | 20.1 | 21Mar2012, 22:24 | 6.1 |
| S21A | 0.083 | 21.2 | 21Mar2012, 22:48 | 7.9 |
| DET21A | 0.152 | 37.9 | 21Mar2012, 22:34 | 14 |
| R21A | 0.152 | 36.7 | 21Mar2012, 22:48 | 14 |
| S21B | 0.281 | 24.1 | 22Mar2012, 00:18 | 16.6 |
| CP21b | 3.9121 | 195 | 21Mar2012, 23:42 | 388.5 |
| R24 | 3.9121 | 195 | 21Mar2012, 23:42 | 388.4 |
| S24 | 0.02 | 7.2 | 21Mar2012, 22:18 | 1.7 |
| DET24 | 0.02 | 7.2 | 21Mar2012, 22:20 | 1.7 |
| CP24 | 3.9321 | 196.7 | 21Mar2012, 23:40 | 390.1 |
| R25A | 3.9321 | 196.7 | 21Mar2012, 23:42 | 390 |
| S25 | 0.067 | 9.2 | 21Mar2012, 23:06 | 4.3 |
| PUMP25 | 0.067 | 1 | 21Mar2012, 23:06 | 3.3 |
| CP25 | 3.9991 | 197.7 | 21Mar2012, 23:42 | 393.3 |
| R25B | 3.9991 | 197.7 | 21Mar2012, 23:42 | 393.2 |
| S29C | 0.095 | 16.2 | 21Mar2012, 23:08 | 7.4 |
| Det29C | 0.095 | 2.1 | 21Mar2012, 23:00 | 6.6 |
| R29C | 0.095 | 2.1 | 22Mar2012, 00:56 | 6.6 |
| CP29C | 4.0941 | 199.8 | 21Mar2012, 23:42 | 399.8 |
| R25C | 4.0941 | 199.8 | 21Mar2012, 23:42 | 399.7 |
| S29A | 0.081 | 18.6 | 21Mar2012, 22:56 | 7.4 |
| CP29A | 4.1751 | 212.7 | 21Mar2012, 23:30 | 407.1 |
| R29A | 4.1751 | 212.7 | 21Mar2012, 23:30 | 407 |
| S31 | 0.115 | 18 | 21Mar2012, 23:20 | 9 |
| Div31 | 0.115 | 15.5 | 21Mar2012, 23:20 | 4.4 |
| S41B | 0.019 | 7.7 | 21Mar2012, 22:24 | 2.1 |
| CP31 | 4.3091 | 230.4 | 21Mar2012, 23:28 | 413.5 |
| R96A | 4.3091 | 230.3 | 21Mar2012, 23:30 | 413.2 |

Patterson 100-year Peak Flows

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (AC-FT) |
|---|---|---|---|---|
| R96B | 4.3091 | 230.2 | 21Mar2012, 23:38 | 412.1 |
| CP44 | 11.5131 | 297.2 | 21Mar2012, 23:58 | 691.3 |
| R44 | 11.5131 | 297.2 | 22Mar2012, 00:00 | 690.7 |
| S46 | 0.284 | 41.4 | 21Mar2012, 23:36 | 21 |
| Det46 | 0.284 | 2.7 | 21Mar2012, 23:26 | 8.6 |
| R46 | 0.284 | 2.7 | 22Mar2012, 01:30 | 8.5 |
| S47 | 0.211 | 32.5 | 21Mar2012, 23:26 | 15.6 |
| Det47 | 0.211 | 1.9 | 21Mar2012, 23:18 | 6.1 |
| CP47 | 0.495 | 4.6 | 22Mar2012, 01:30 | 14.6 |
| R47 | 0.495 | 4.6 | 22Mar2012, 01:54 | 14.5 |
| S45 | 0.314 | 33.4 | 22Mar2012, 00:22 | 21.5 |
| Det45 | 0.314 | 2.8 | 22Mar2012, 05:34 | 8.2 |
| S48 | 0.307 | 40.9 | 21Mar2012, 23:40 | 21.5 |
| Det48 | 0.307 | 2.4 | 22Mar2012, 05:32 | 7.1 |
| CP45 | 12.6291 | 303.6 | 22Mar2012, 00:00 | 720.4 |
| S32 | 0.892 | 15.2 | 22Mar2012, 05:46 | 20.2 |
| S13 | 0.547 | 59 | 22Mar2012, 00:22 | 39.8 |
| Det13 | 0.547 | 7.8 | 22Mar2012, 00:46 | 24.7 |
| HD2 | 0.478 | 23.2 | 22Mar2012, 02:10 | 21.4 |
| S06 | 0.197 | 27.2 | 21Mar2012, 23:34 | 14.8 |
| Det06 | 0.197 | 2.5 | 22Mar2012, 13:24 | 6.6 |
| HD4 | 0.257 | 11.4 | 22Mar2012, 01:28 | 10.1 |
| HD3 | 0.205 | 13 | 21Mar2012, 23:44 | 8.4 |
| HD5 | 0.092 | 7.5 | 22Mar2012, 00:02 | 4.8 |
| HD1 | 0.066 | 10.6 | 21Mar2012, 23:22 | 5.3 |
| S01A | 0.545 | 81.2 | 21Mar2012, 23:36 | 44 |
| Det01A | 0.545 | 9 | 21Mar2012, 21:32 | 31.3 |
| S02 | 0.041 | 5.4 | 21Mar2012, 23:36 | 3 |
| Det02 | 0.041 | 0.6 | 21Mar2012, 23:26 | 2 |



Project: patterson_sdmp

Simulation Run: 100-yr 24-hr   Reservoir: Det01A

Start of Run: 21Mar2012, 12:00   Basin Model: Basin 1

End of Run: 23Mar2012, 12:00   Meteorologic Model: 100-yr 24-hr

Compute Time: 02Oct2017, 17:04:57   Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

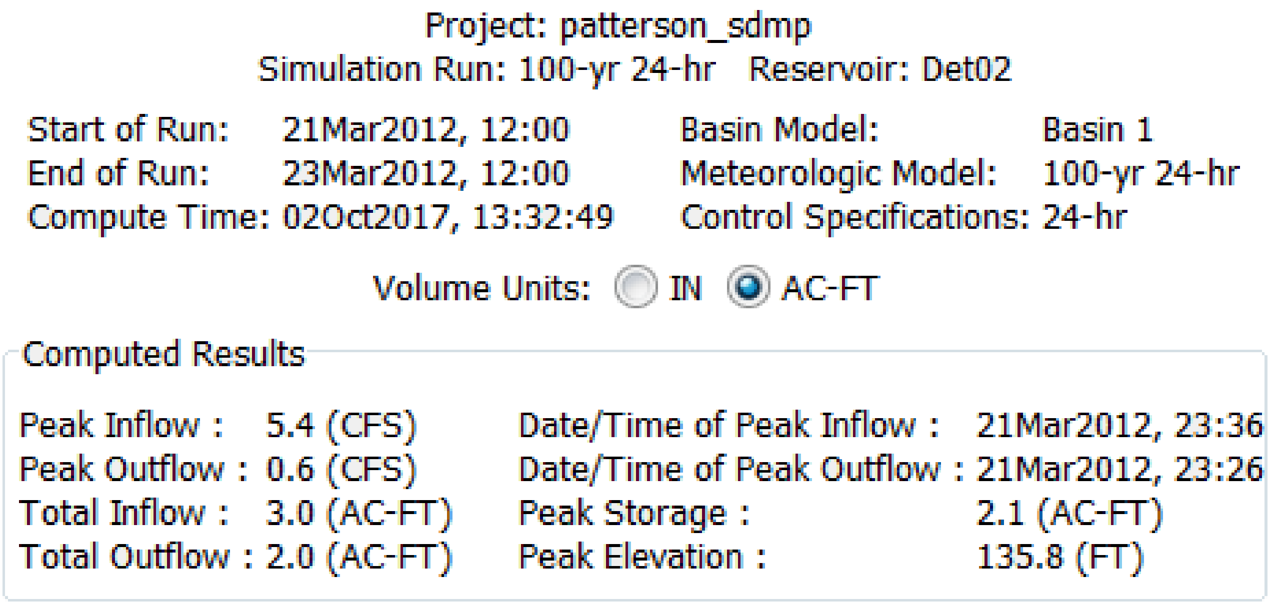
Computed Results

Peak Inflow : 81.2 (CFS)   Date/Time of Peak Inflow : 21Mar2012, 23:36

Peak Outflow : 9.0 (CFS)   Date/Time of Peak Outflow : 21Mar2012, 21:32

Total Inflow : 44.0 (AC-FT)   Peak Storage : 28.8 (AC-FT)

Total Outflow : 31.3 (AC-FT)   Peak Elevation : 135.9 (FT)



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det02

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 02Oct2017, 13:32:49

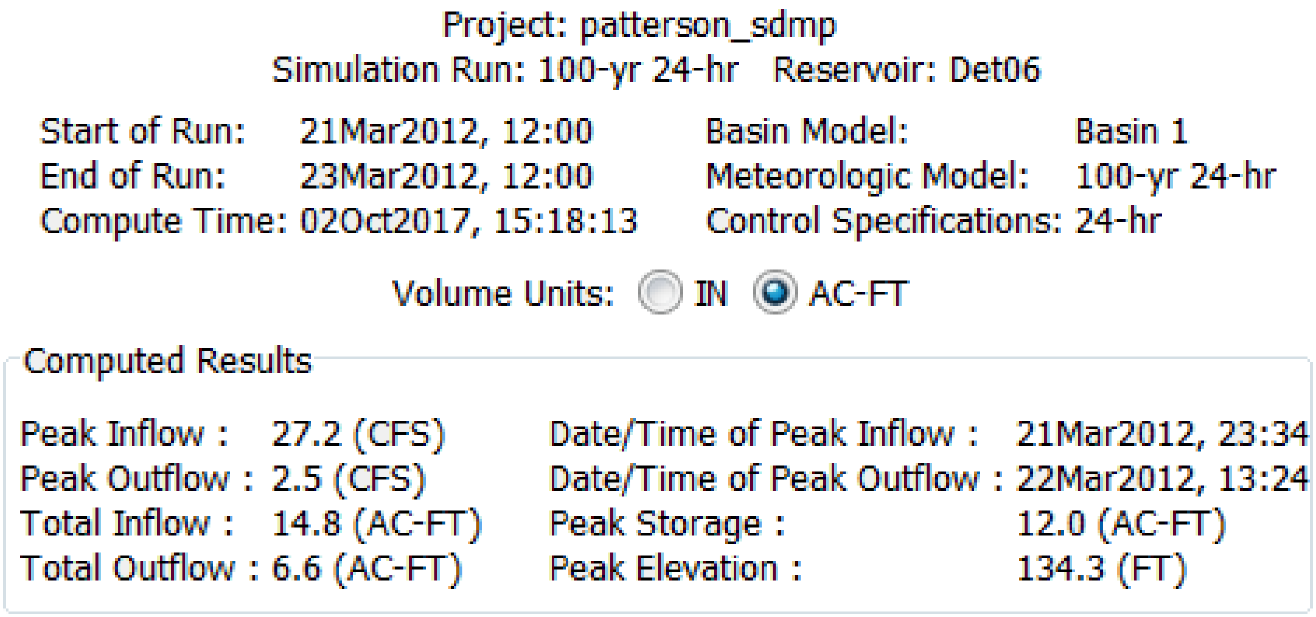
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 5.4 (CFS)
Peak Outflow : 0.6 (CFS)
Total Inflow : 3.0 (AC-FT)
Total Outflow : 2.0 (AC-FT)

Date/Time of Peak Inflow : 21Mar2012, 23:36
Date/Time of Peak Outflow : 21Mar2012, 23:26
Peak Storage : 2.1 (AC-FT)
Peak Elevation : 135.8 (FT)



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr   Reservoir: Det06

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 02Oct2017, 15:18:13

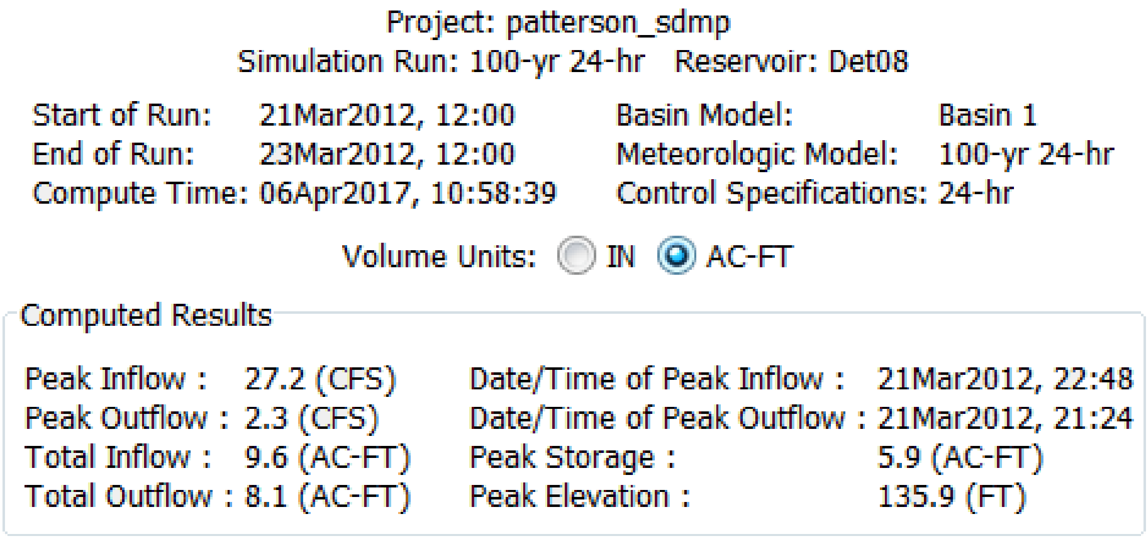
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 27.2 (CFS)
Peak Outflow : 2.5 (CFS)
Total Inflow : 14.8 (AC-FT)
Total Outflow : 6.6 (AC-FT)

Date/Time of Peak Inflow : 21Mar2012, 23:34
Date/Time of Peak Outflow : 22Mar2012, 13:24
Peak Storage : 12.0 (AC-FT)
Peak Elevation : 134.3 (FT)



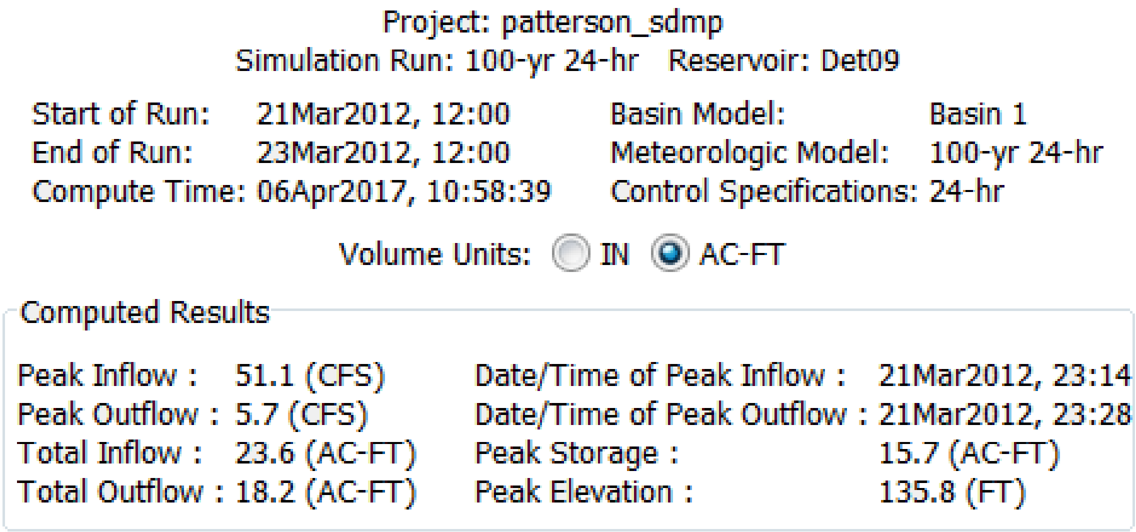
Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det08

| | | | |
|---|---|---|---|
| Start of Run: | 21Mar2012, 12:00 | Basin Model: | Basin 1 |
| End of Run: | 23Mar2012, 12:00 | Meteorologic Model: | 100-yr 24-hr |
| Compute Time: | 06Apr2017, 10:58:39 | Control Specifications: | 24-hr |

Volume Units: ○ IN ● AC-FT

Computed Results

| | | | |
|---|---|---|---|
| Peak Inflow : | 27.2 (CFS) | Date/Time of Peak Inflow : | 21Mar2012, 22:48 |
| Peak Outflow : | 2.3 (CFS) | Date/Time of Peak Outflow : | 21Mar2012, 21:24 |
| Total Inflow : | 9.6 (AC-FT) | Peak Storage : | 5.9 (AC-FT) |
| Total Outflow : | 8.1 (AC-FT) | Peak Elevation : | 135.9 (FT) |



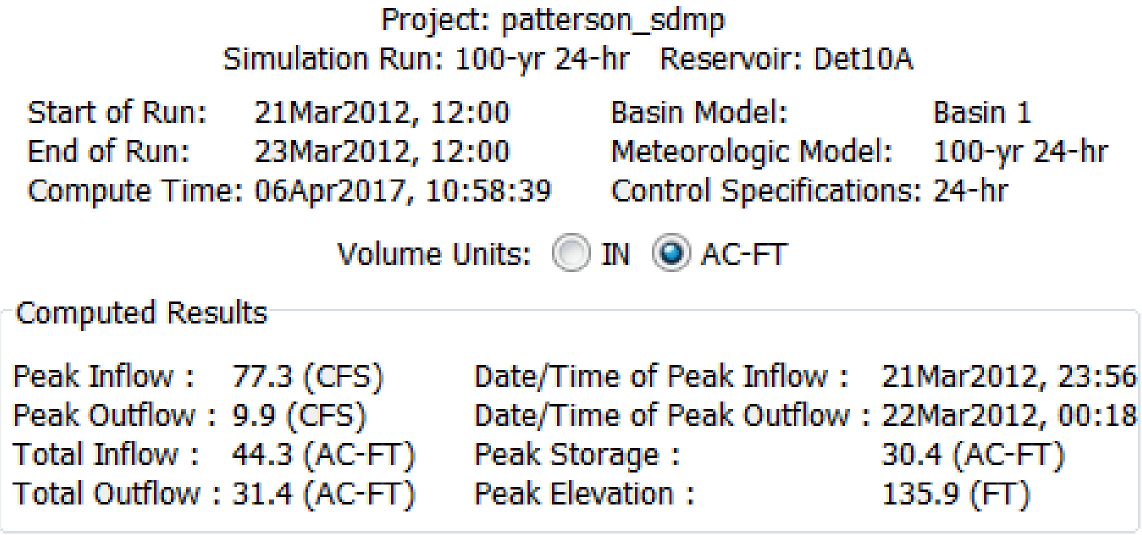
Project: patterson_sdmp
Simulation Run: 100-yr 24-hr   Reservoir: Det09

| | | | |
|---|---|---|---|
| Start of Run: | 21Mar2012, 12:00 | Basin Model: | Basin 1 |
| End of Run: | 23Mar2012, 12:00 | Meteorologic Model: | 100-yr 24-hr |
| Compute Time: | 06Apr2017, 10:58:39 | Control Specifications: | 24-hr |

Volume Units: ○ IN ● AC-FT

Computed Results

| | | | |
|---|---|---|---|
| Peak Inflow : | 51.1 (CFS) | Date/Time of Peak Inflow : | 21Mar2012, 23:14 |
| Peak Outflow : | 5.7 (CFS) | Date/Time of Peak Outflow : | 21Mar2012, 23:28 |
| Total Inflow : | 23.6 (AC-FT) | Peak Storage : | 15.7 (AC-FT) |
| Total Outflow : | 18.2 (AC-FT) | Peak Elevation : | 135.8 (FT) |



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det10A

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 06Apr2017, 10:58:39

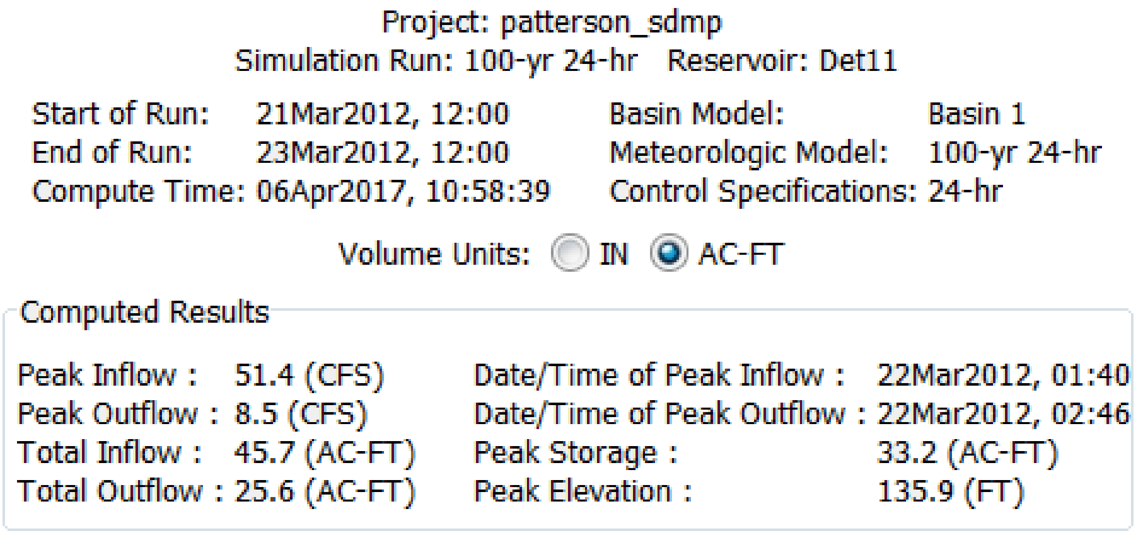
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 77.3 (CFS)
Peak Outflow : 9.9 (CFS)
Total Inflow : 44.3 (AC-FT)
Total Outflow : 31.4 (AC-FT)

Date/Time of Peak Inflow : 21Mar2012, 23:56
Date/Time of Peak Outflow : 22Mar2012, 00:18
Peak Storage : 30.4 (AC-FT)
Peak Elevation : 135.9 (FT)



Project: patterson_sdmp

Simulation Run: 100-yr 24-hr    Reservoir: Det11

Start of Run: 21Mar2012, 12:00    Basin Model: Basin 1

End of Run: 23Mar2012, 12:00    Meteorologic Model: 100-yr 24-hr

Compute Time: 06Apr2017, 10:58:39    Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

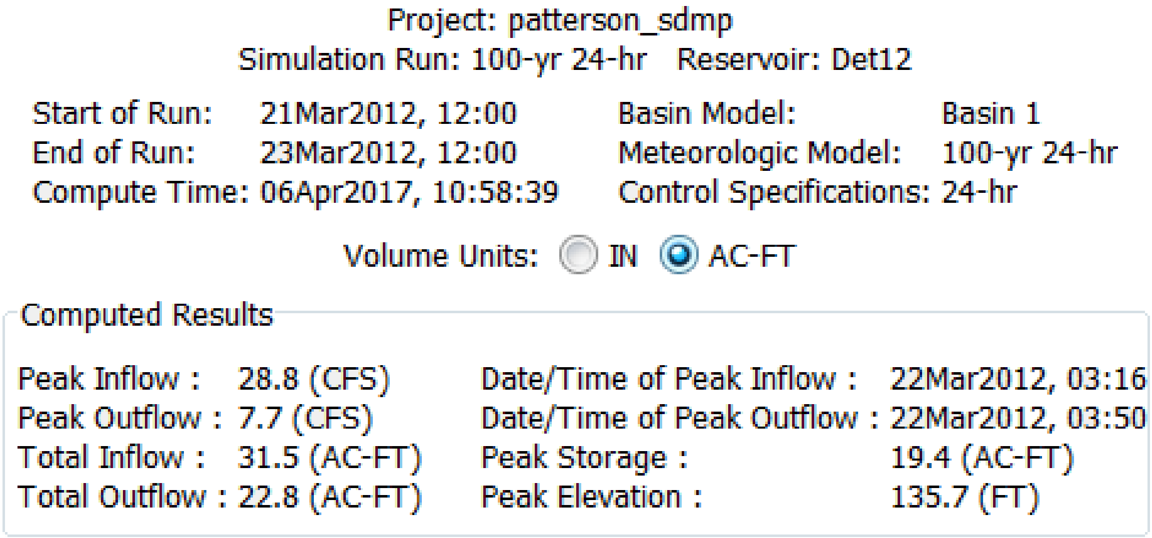
Computed Results

Peak Inflow : 51.4 (CFS)    Date/Time of Peak Inflow : 22Mar2012, 01:40

Peak Outflow : 8.5 (CFS)    Date/Time of Peak Outflow : 22Mar2012, 02:46

Total Inflow : 45.7 (AC-FT)    Peak Storage : 33.2 (AC-FT)

Total Outflow : 25.6 (AC-FT)    Peak Elevation : 135.9 (FT)



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det12

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 06Apr2017, 10:58:39

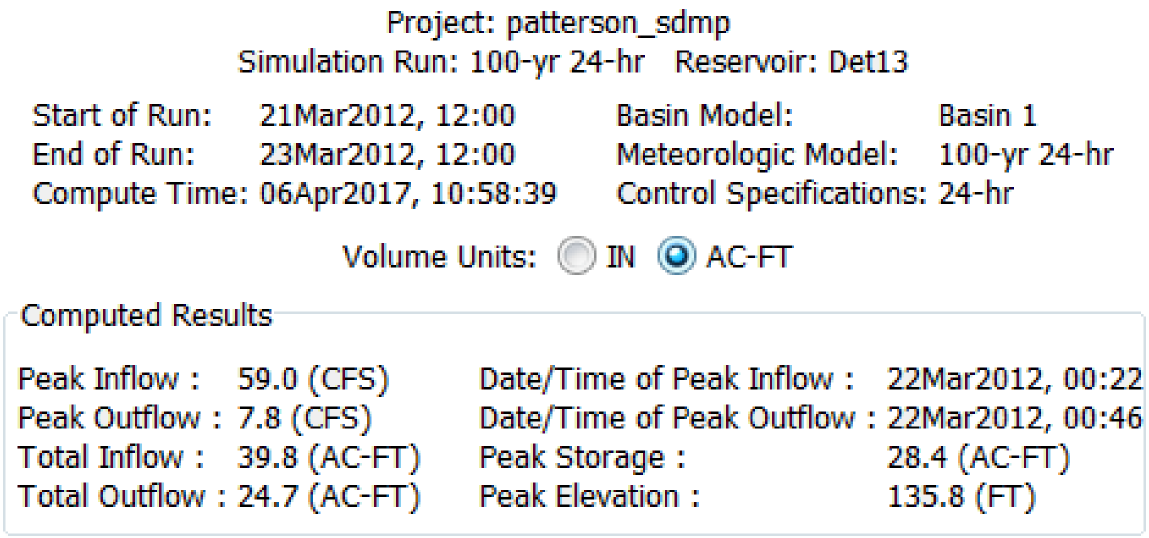
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 28.8 (CFS)
Peak Outflow : 7.7 (CFS)
Total Inflow : 31.5 (AC-FT)
Total Outflow : 22.8 (AC-FT)

Date/Time of Peak Inflow : 22Mar2012, 03:16
Date/Time of Peak Outflow : 22Mar2012, 03:50
Peak Storage : 19.4 (AC-FT)
Peak Elevation : 135.7 (FT)



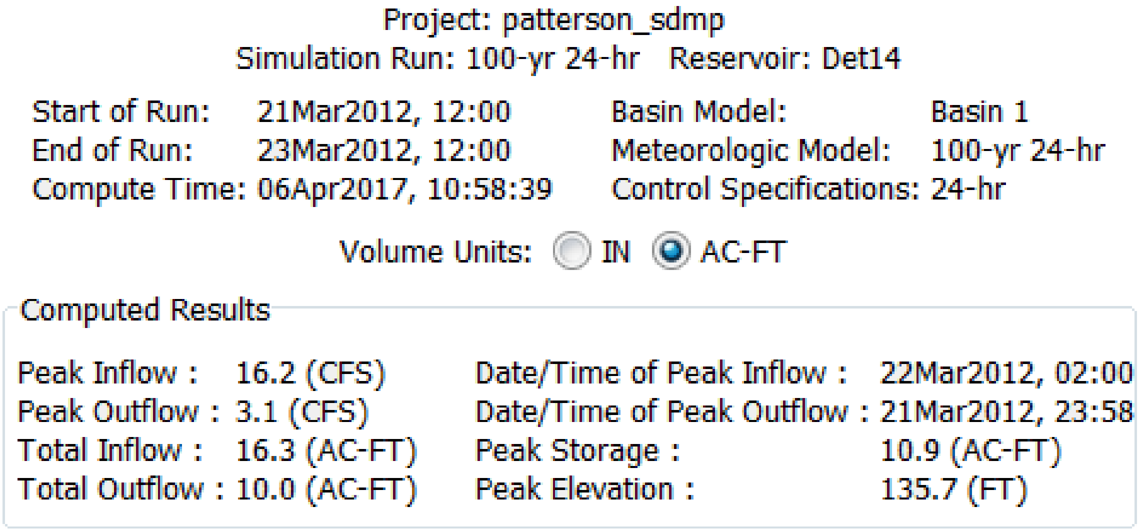
```
                    Project: patterson_sdmp
        Simulation Run: 100-yr 24-hr   Reservoir: Det13

 Start of Run:     21Mar2012, 12:00       Basin Model:             Basin 1
 End of Run:       23Mar2012, 12:00       Meteorologic Model:      100-yr 24-hr
 Compute Time: 06Apr2017, 10:58:39        Control Specifications: 24-hr

                 Volume Units:  ○ IN  ● AC-FT

Computed Results

Peak Inflow :    59.0 (CFS)       Date/Time of Peak Inflow :   22Mar2012, 00:22
Peak Outflow :   7.8 (CFS)        Date/Time of Peak Outflow :  22Mar2012, 00:46
Total Inflow :   39.8 (AC-FT)     Peak Storage :               28.4 (AC-FT)
Total Outflow :  24.7 (AC-FT)     Peak Elevation :             135.8 (FT)
```



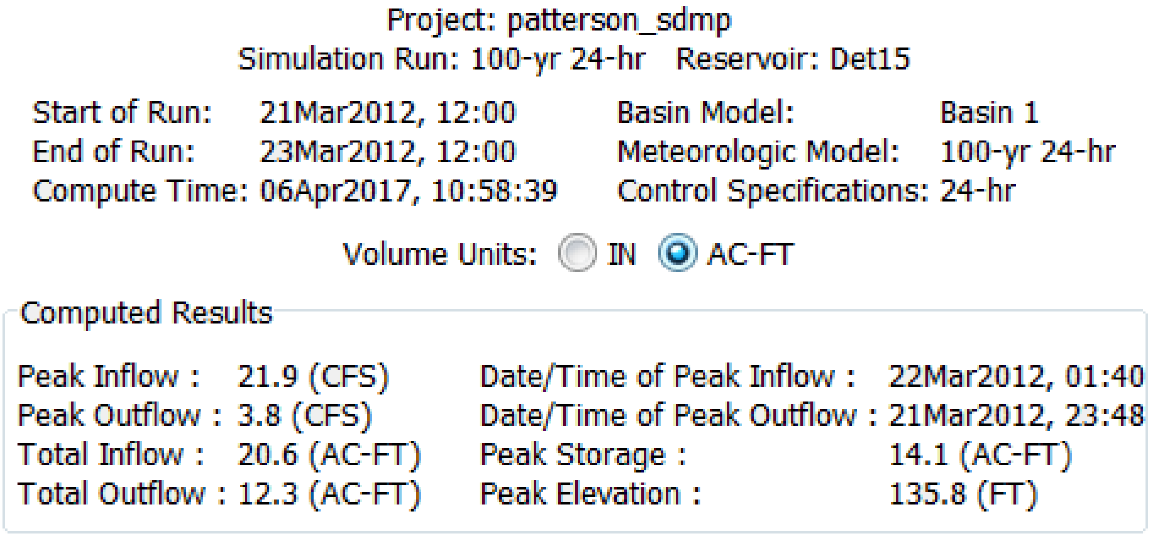
Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det14

| | | | |
|---|---|---|---|
| Start of Run: | 21Mar2012, 12:00 | Basin Model: | Basin 1 |
| End of Run: | 23Mar2012, 12:00 | Meteorologic Model: | 100-yr 24-hr |
| Compute Time: | 06Apr2017, 10:58:39 | Control Specifications: | 24-hr |

Volume Units: ○ IN ● AC-FT

Computed Results

| | | | |
|---|---|---|---|
| Peak Inflow : | 16.2 (CFS) | Date/Time of Peak Inflow : | 22Mar2012, 02:00 |
| Peak Outflow : | 3.1 (CFS) | Date/Time of Peak Outflow : | 21Mar2012, 23:58 |
| Total Inflow : | 16.3 (AC-FT) | Peak Storage : | 10.9 (AC-FT) |
| Total Outflow : | 10.0 (AC-FT) | Peak Elevation : | 135.7 (FT) |



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det15

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 06Apr2017, 10:58:39

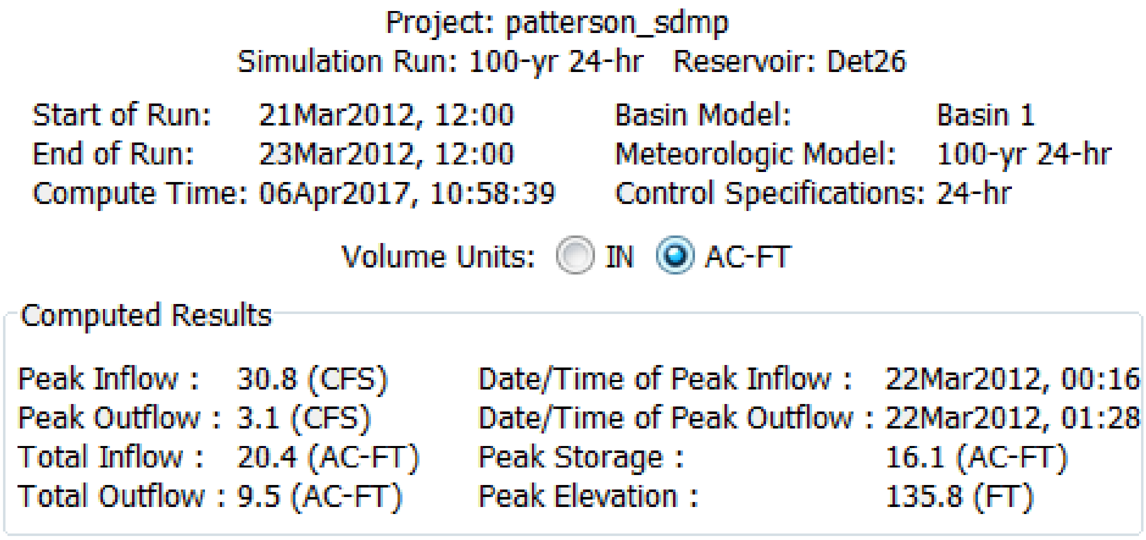
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 21.9 (CFS)
Peak Outflow : 3.8 (CFS)
Total Inflow : 20.6 (AC-FT)
Total Outflow : 12.3 (AC-FT)

Date/Time of Peak Inflow : 22Mar2012, 01:40
Date/Time of Peak Outflow : 21Mar2012, 23:48
Peak Storage : 14.1 (AC-FT)
Peak Elevation : 135.8 (FT)



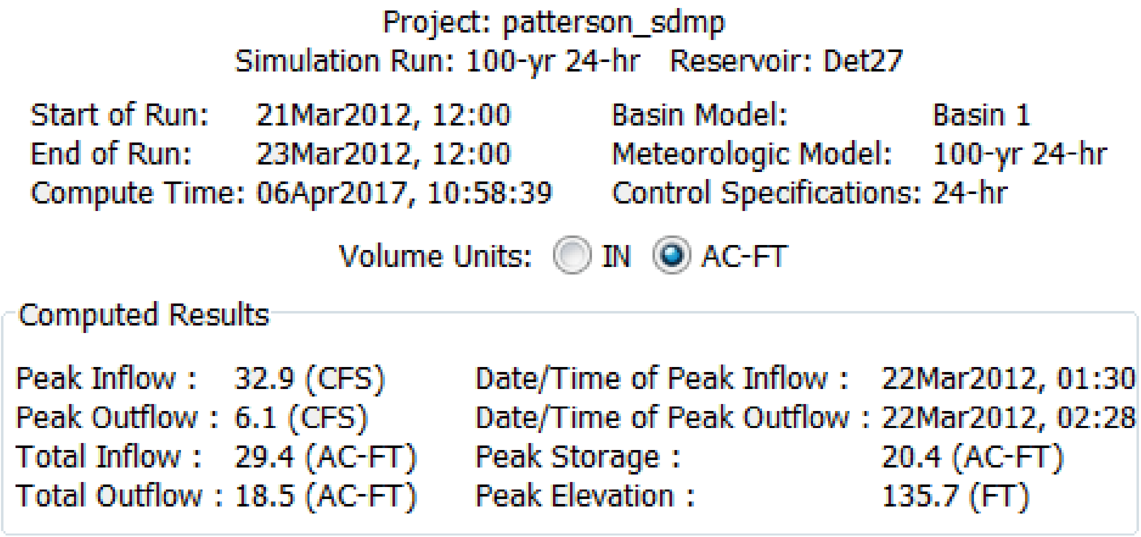
Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det26

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 06Apr2017, 10:58:39
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 30.8 (CFS)
Peak Outflow : 3.1 (CFS)
Total Inflow : 20.4 (AC-FT)
Total Outflow : 9.5 (AC-FT)
Date/Time of Peak Inflow : 22Mar2012, 00:16
Date/Time of Peak Outflow : 22Mar2012, 01:28
Peak Storage : 16.1 (AC-FT)
Peak Elevation : 135.8 (FT)



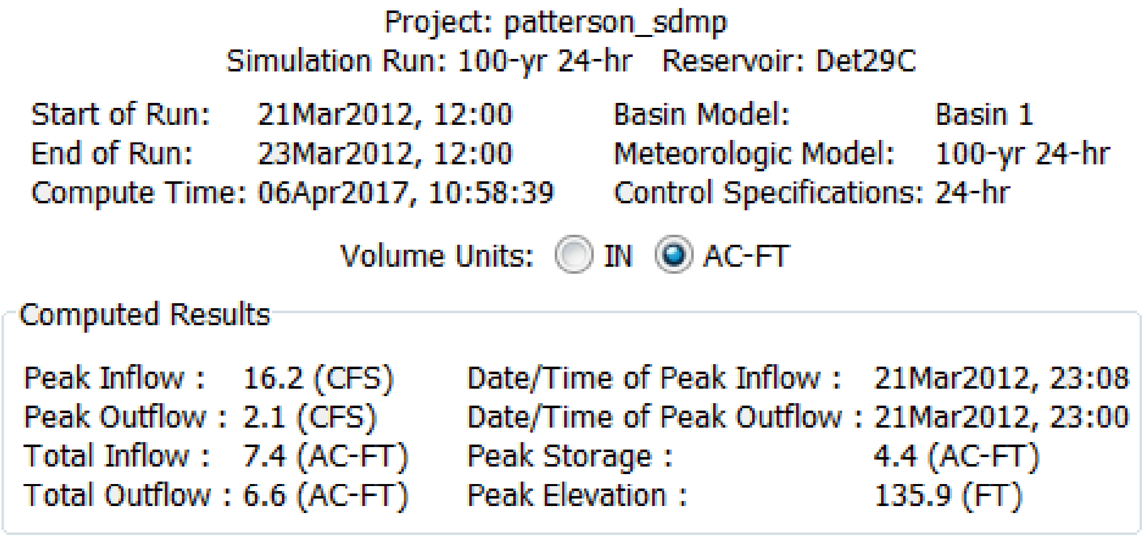
Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det27

Start of Run: 21Mar2012, 12:00 Basin Model: Basin 1
End of Run: 23Mar2012, 12:00 Meteorologic Model: 100-yr 24-hr
Compute Time: 06Apr2017, 10:58:39 Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 32.9 (CFS) Date/Time of Peak Inflow : 22Mar2012, 01:30
Peak Outflow : 6.1 (CFS) Date/Time of Peak Outflow : 22Mar2012, 02:28
Total Inflow : 29.4 (AC-FT) Peak Storage : 20.4 (AC-FT)
Total Outflow : 18.5 (AC-FT) Peak Elevation : 135.7 (FT)



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr   Reservoir: Det29C

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 06Apr2017, 10:58:39

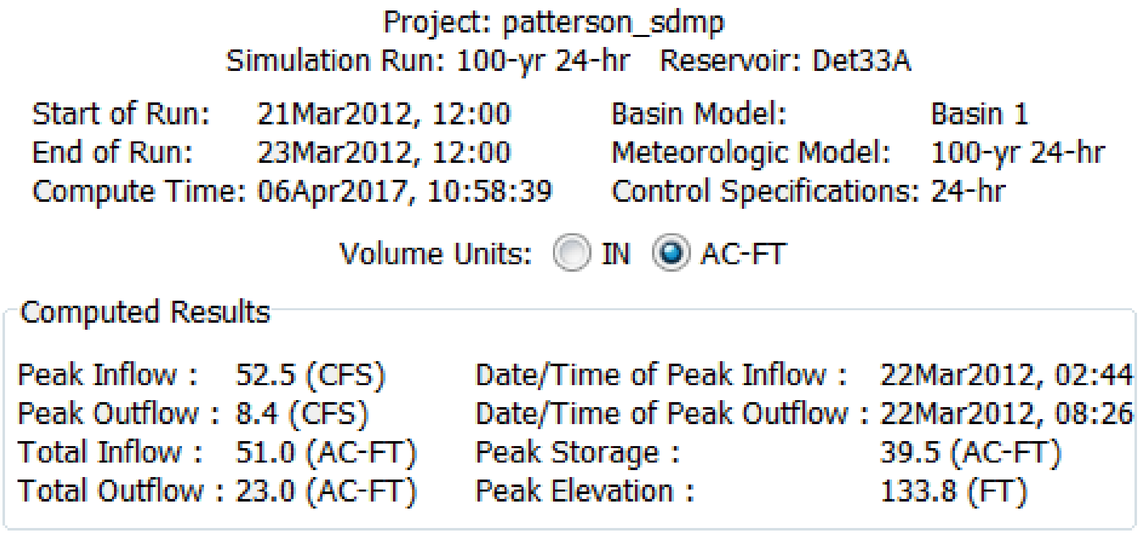
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 16.2 (CFS)
Peak Outflow : 2.1 (CFS)
Total Inflow : 7.4 (AC-FT)
Total Outflow : 6.6 (AC-FT)

Date/Time of Peak Inflow : 21Mar2012, 23:08
Date/Time of Peak Outflow : 21Mar2012, 23:00
Peak Storage : 4.4 (AC-FT)
Peak Elevation : 135.9 (FT)



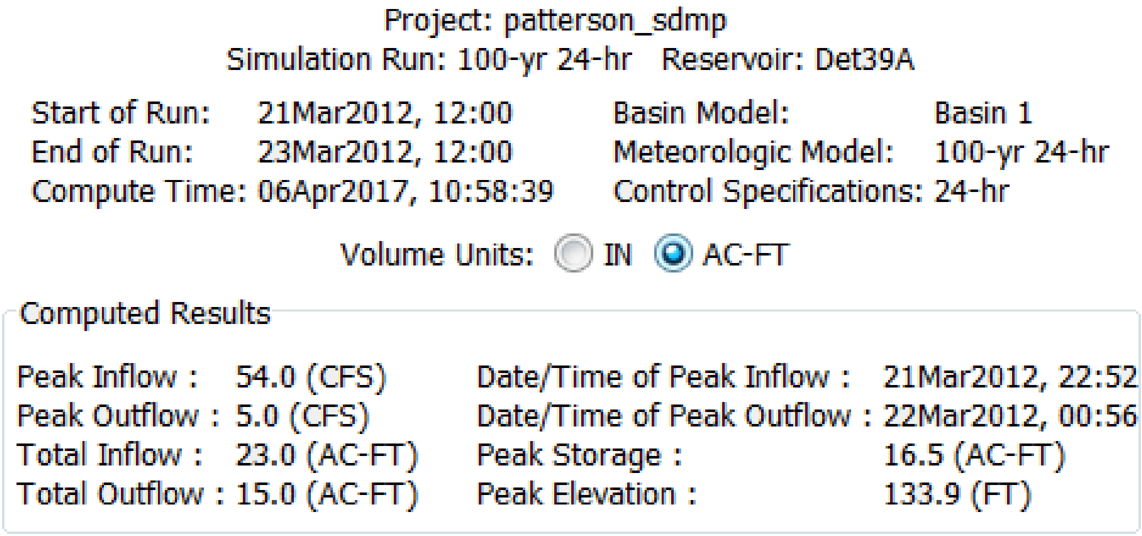
```
                    Project: patterson_sdmp
          Simulation Run: 100-yr 24-hr   Reservoir: Det33A

 Start of Run:     21Mar2012, 12:00      Basin Model:            Basin 1
 End of Run:       23Mar2012, 12:00      Meteorologic Model:     100-yr 24-hr
 Compute Time: 06Apr2017, 10:58:39       Control Specifications: 24-hr

                  Volume Units:  ○ IN  ● AC-FT

Computed Results

Peak Inflow :    52.5 (CFS)       Date/Time of Peak Inflow :  22Mar2012, 02:44
Peak Outflow :  8.4 (CFS)         Date/Time of Peak Outflow : 22Mar2012, 08:26
Total Inflow :   51.0 (AC-FT)     Peak Storage :              39.5 (AC-FT)
Total Outflow : 23.0 (AC-FT)      Peak Elevation :            133.8 (FT)
```



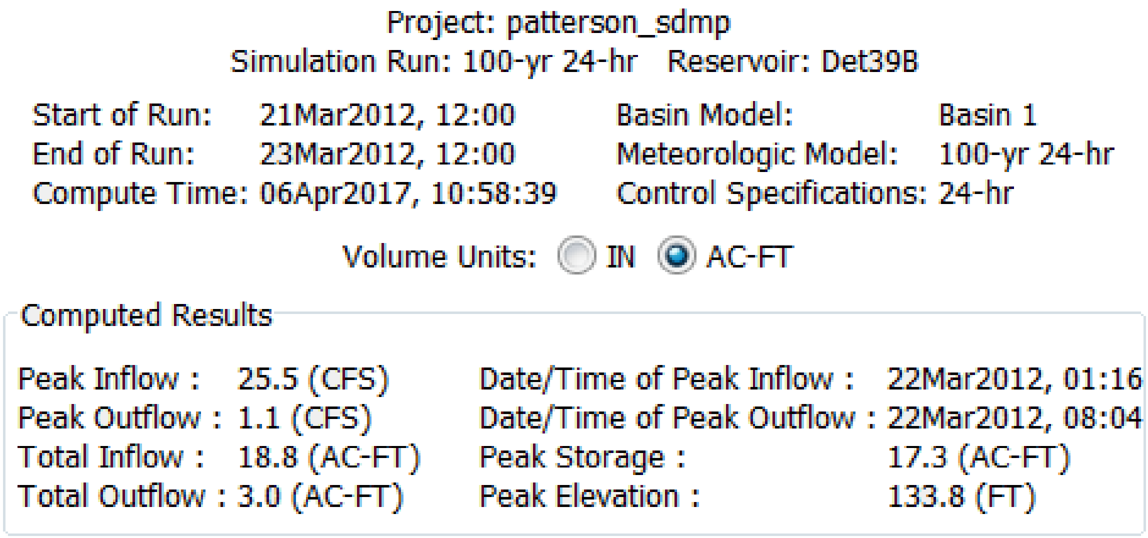
Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det39A

|  |  |  |  |
|---|---|---|---|
| Start of Run: | 21Mar2012, 12:00 | Basin Model: | Basin 1 |
| End of Run: | 23Mar2012, 12:00 | Meteorologic Model: | 100-yr 24-hr |
| Compute Time: | 06Apr2017, 10:58:39 | Control Specifications: | 24-hr |

Volume Units: ○ IN ● AC-FT

Computed Results

|  |  |  |  |
|---|---|---|---|
| Peak Inflow : | 54.0 (CFS) | Date/Time of Peak Inflow : | 21Mar2012, 22:52 |
| Peak Outflow : | 5.0 (CFS) | Date/Time of Peak Outflow : | 22Mar2012, 00:56 |
| Total Inflow : | 23.0 (AC-FT) | Peak Storage : | 16.5 (AC-FT) |
| Total Outflow : | 15.0 (AC-FT) | Peak Elevation : | 133.9 (FT) |



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det39B

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 06Apr2017, 10:58:39

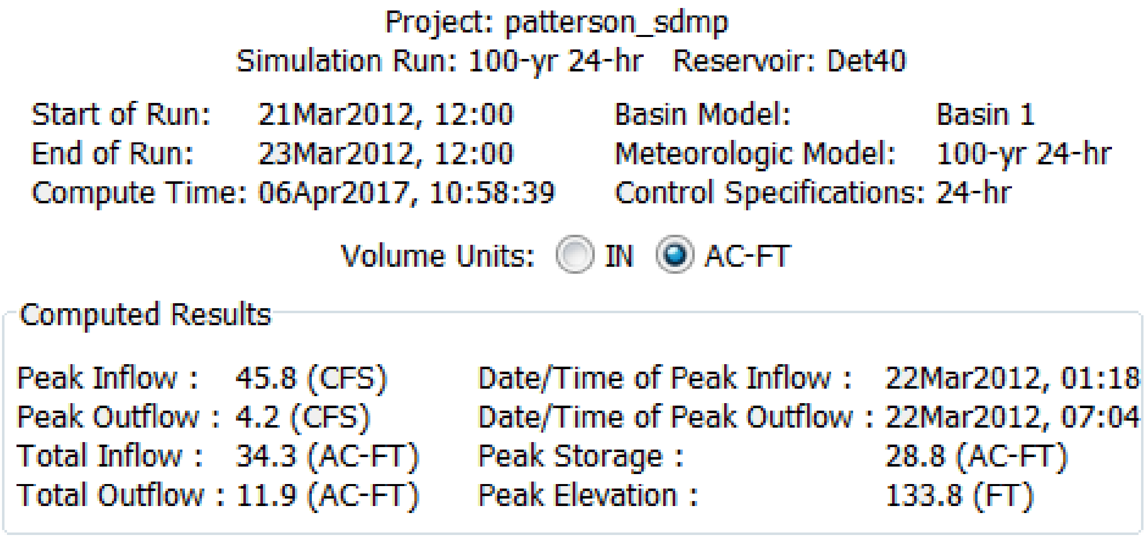
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 25.5 (CFS)
Peak Outflow : 1.1 (CFS)
Total Inflow : 18.8 (AC-FT)
Total Outflow : 3.0 (AC-FT)

Date/Time of Peak Inflow : 22Mar2012, 01:16
Date/Time of Peak Outflow : 22Mar2012, 08:04
Peak Storage : 17.3 (AC-FT)
Peak Elevation : 133.8 (FT)



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det40

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 06Apr2017, 10:58:39

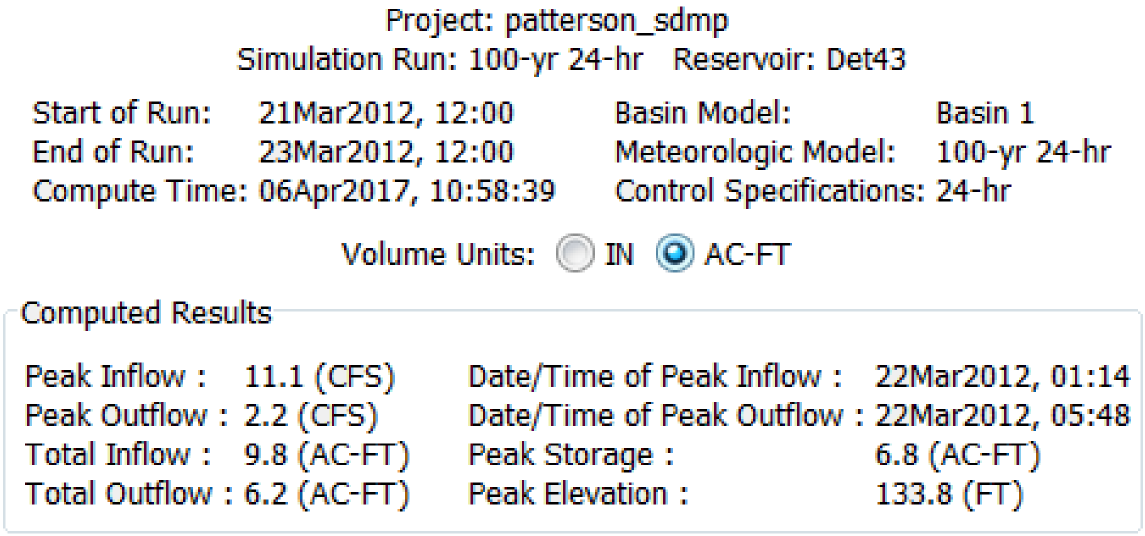
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 45.8 (CFS)
Peak Outflow : 4.2 (CFS)
Total Inflow : 34.3 (AC-FT)
Total Outflow : 11.9 (AC-FT)

Date/Time of Peak Inflow : 22Mar2012, 01:18
Date/Time of Peak Outflow : 22Mar2012, 07:04
Peak Storage : 28.8 (AC-FT)
Peak Elevation : 133.8 (FT)



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det43

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 06Apr2017, 10:58:39

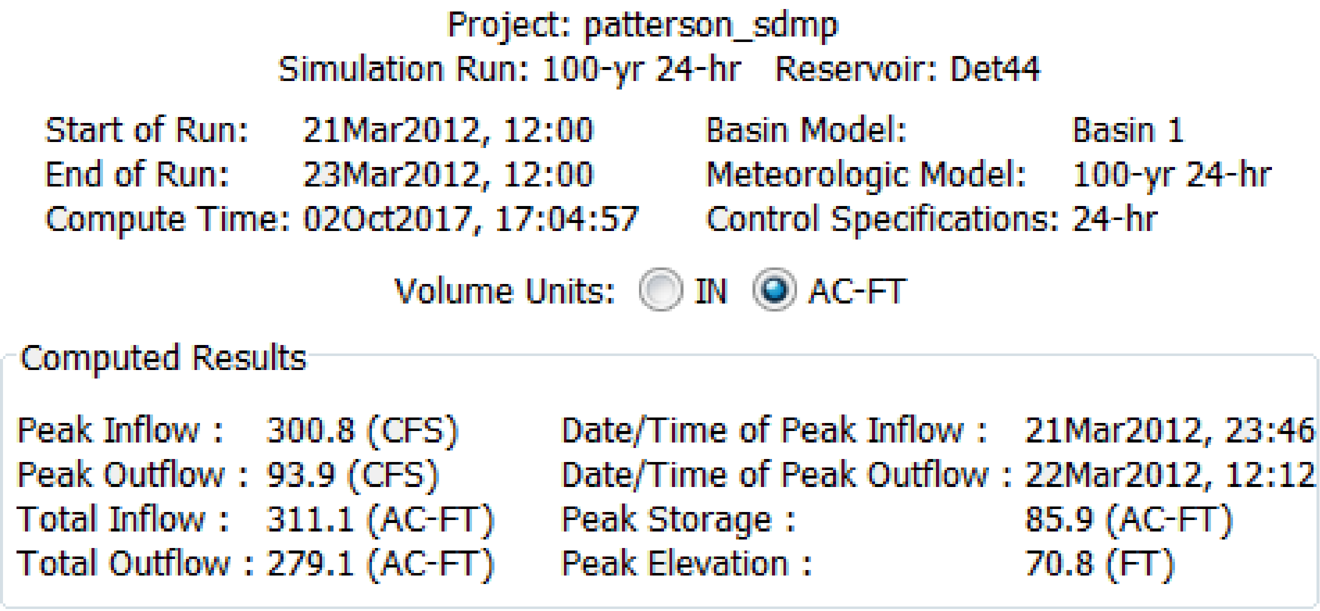
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 11.1 (CFS)
Peak Outflow : 2.2 (CFS)
Total Inflow : 9.8 (AC-FT)
Total Outflow : 6.2 (AC-FT)

Date/Time of Peak Inflow : 22Mar2012, 01:14
Date/Time of Peak Outflow : 22Mar2012, 05:48
Peak Storage : 6.8 (AC-FT)
Peak Elevation : 133.8 (FT)



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr   Reservoir: Det44

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 02Oct2017, 17:04:57

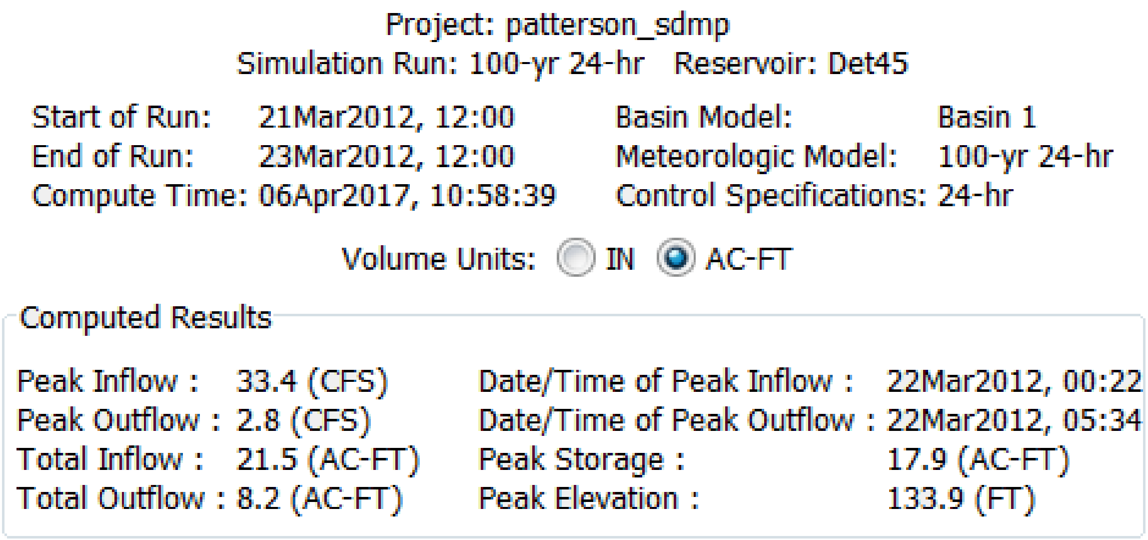
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 300.8 (CFS)
Peak Outflow : 93.9 (CFS)
Total Inflow : 311.1 (AC-FT)
Total Outflow : 279.1 (AC-FT)

Date/Time of Peak Inflow : 21Mar2012, 23:46
Date/Time of Peak Outflow : 22Mar2012, 12:12
Peak Storage : 85.9 (AC-FT)
Peak Elevation : 70.8 (FT)



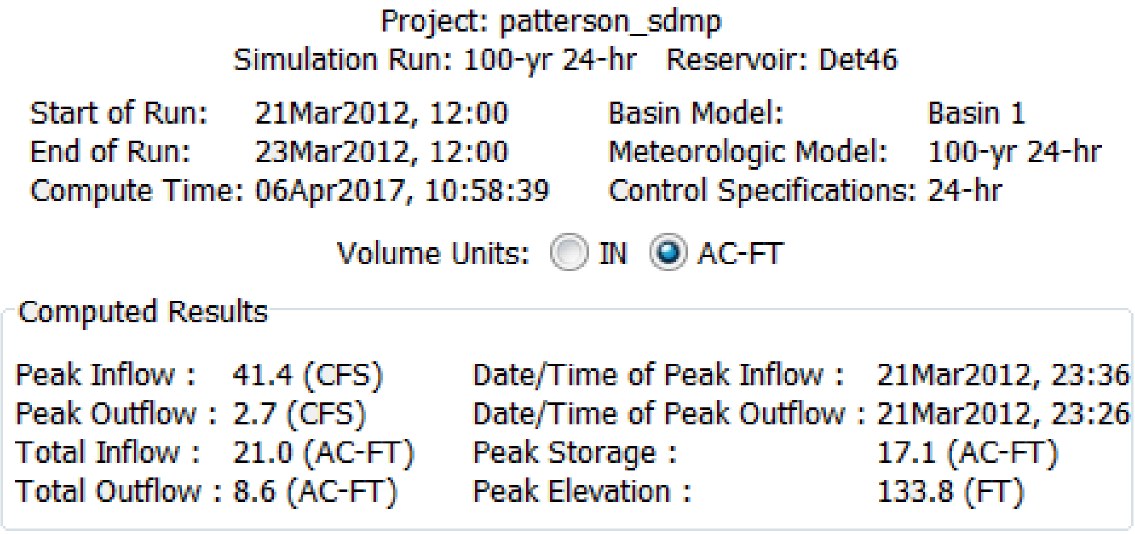
Project: patterson_sdmp
Simulation Run: 100-yr 24-hr   Reservoir: Det45

| | | | |
|---|---|---|---|
| Start of Run: | 21Mar2012, 12:00 | Basin Model: | Basin 1 |
| End of Run: | 23Mar2012, 12:00 | Meteorologic Model: | 100-yr 24-hr |
| Compute Time: | 06Apr2017, 10:58:39 | Control Specifications: | 24-hr |

Volume Units: ○ IN ● AC-FT

Computed Results

| | | | |
|---|---|---|---|
| Peak Inflow : | 33.4 (CFS) | Date/Time of Peak Inflow : | 22Mar2012, 00:22 |
| Peak Outflow : | 2.8 (CFS) | Date/Time of Peak Outflow : | 22Mar2012, 05:34 |
| Total Inflow : | 21.5 (AC-FT) | Peak Storage : | 17.9 (AC-FT) |
| Total Outflow : | 8.2 (AC-FT) | Peak Elevation : | 133.9 (FT) |



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr Reservoir: Det46

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 06Apr2017, 10:58:39

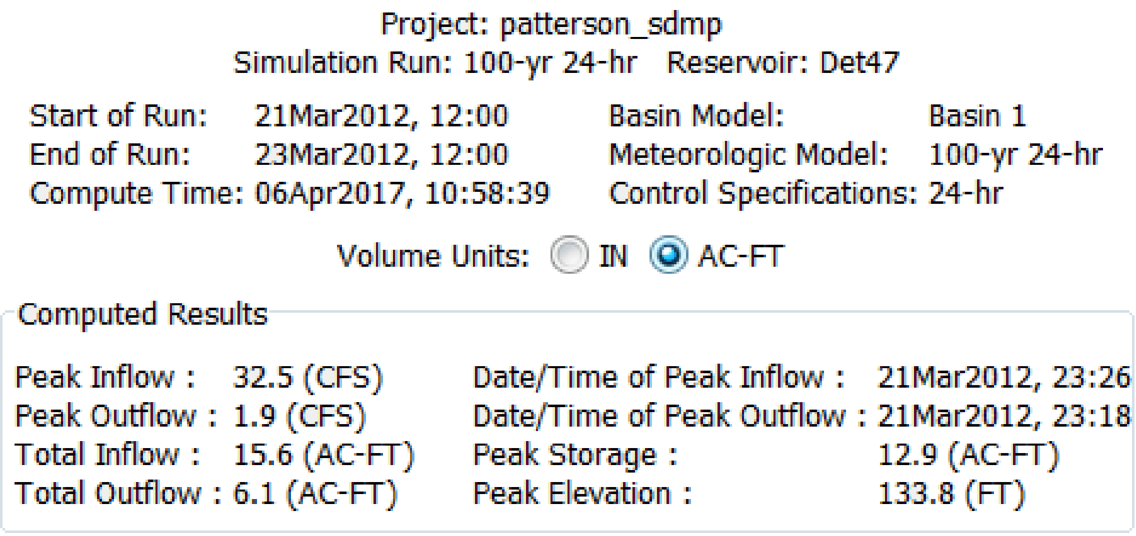
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 41.4 (CFS)
Peak Outflow : 2.7 (CFS)
Total Inflow : 21.0 (AC-FT)
Total Outflow : 8.6 (AC-FT)

Date/Time of Peak Inflow : 21Mar2012, 23:36
Date/Time of Peak Outflow : 21Mar2012, 23:26
Peak Storage : 17.1 (AC-FT)
Peak Elevation : 133.8 (FT)



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr    Reservoir: Det47

Start of Run: 21Mar2012, 12:00
End of Run: 23Mar2012, 12:00
Compute Time: 06Apr2017, 10:58:39

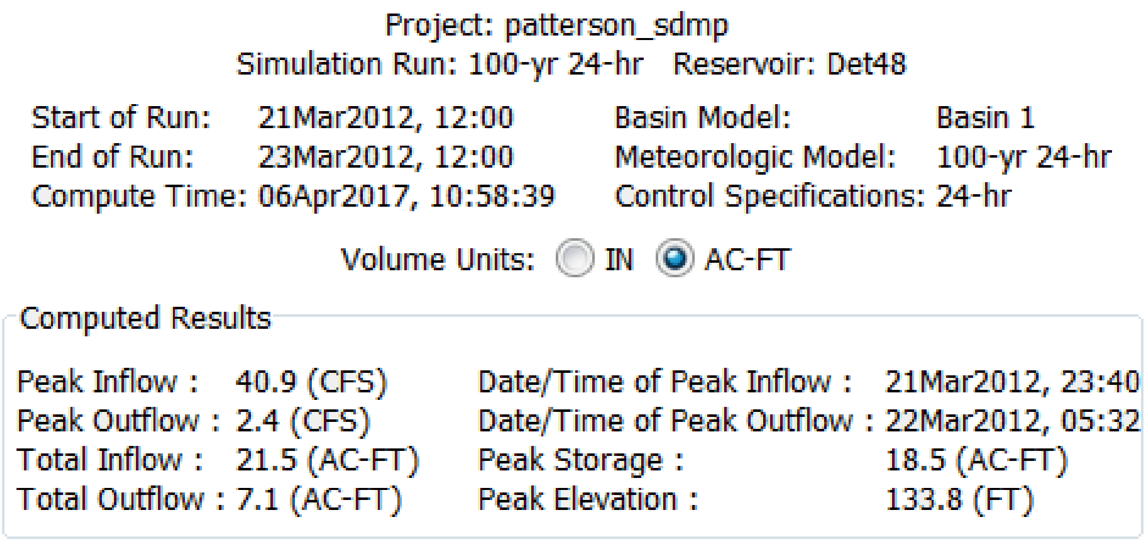
Basin Model: Basin 1
Meteorologic Model: 100-yr 24-hr
Control Specifications: 24-hr

Volume Units: ○ IN ● AC-FT

Computed Results

Peak Inflow : 32.5 (CFS)
Peak Outflow : 1.9 (CFS)
Total Inflow : 15.6 (AC-FT)
Total Outflow : 6.1 (AC-FT)

Date/Time of Peak Inflow : 21Mar2012, 23:26
Date/Time of Peak Outflow : 21Mar2012, 23:18
Peak Storage : 12.9 (AC-FT)
Peak Elevation : 133.8 (FT)



Project: patterson_sdmp
Simulation Run: 100-yr 24-hr  Reservoir: Det48

| | | | |
|---|---|---|---|
| Start of Run: | 21Mar2012, 12:00 | Basin Model: | Basin 1 |
| End of Run: | 23Mar2012, 12:00 | Meteorologic Model: | 100-yr 24-hr |
| Compute Time: | 06Apr2017, 10:58:39 | Control Specifications: | 24-hr |

Volume Units: ○ IN ● AC-FT

Computed Results

| | | | |
|---|---|---|---|
| Peak Inflow : | 40.9 (CFS) | Date/Time of Peak Inflow : | 21Mar2012, 23:40 |
| Peak Outflow : | 2.4 (CFS) | Date/Time of Peak Outflow : | 22Mar2012, 05:32 |
| Total Inflow : | 21.5 (AC-FT) | Peak Storage : | 18.5 (AC-FT) |
| Total Outflow : | 7.1 (AC-FT) | Peak Elevation : | 133.8 (FT) |



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