May 2004

City of Salinas

Storm Water Master Plan

CDM

Contents

Section 5 – Recommended Capital Improvement Program

Appendices

Tables

Page

Figures

Follows Page

Section 1
Introduction

1.1 Background

The City of Salinas owns and operates a municipal storm drainage system for the residents and businesses within its service area. The City periodically conducts studies to comprehensively plan for current and future storm drainage needs.

This Storm Drainage Master Plan updates the storm drainage information in the City's 1992 Sewage and Drainage Master Plan, which updated the 1972 Sewage and Drainage Survey. Since 1992, the City has experienced extensive development, particularly in the northern portion of its service area. In addition, the 1988 General Plan has been recently amended.

To address these changes and adequately plan for storm drainage facilities for existing and future users, the City requested that Camp Dresser & McKee Inc. (CDM) prepare an update to the 1992 Master Plan. This report presents the updated City of Salinas Storm Drainage Master Plan.

1.2 Scope of Services

To prepare the updated Storm Drainage Master Plan, the following tasks were completed:

Task 1 – Review Model

Task 2 – Establish Planning Criteria

Task 3 – Develop Updated Model

Task 4 – Inventory Existing Facilities

Task 5 – Conduct Storm Drainage System Analysis

Task 6 – Evaluate Alternatives for Improvements

Task 7 – Evaluate Storm Water Quality Features

Task 8 – Develop Capital Improvement Program

Task 9 – Prepare Report

Task 10 – Financing Options

1.3 Study Area

The City of Salinas, the county seat and largest city in Monterey County, is located in the northwest part of the Salinas Valley about 60 miles south of San Jose and 10 miles inland from Monterey Bay. The Figure 1-1 location map shows the City's general location.

Figure 1-1
Location Map

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Figure 1-2 shows the study area for this master plan. It includes the City's current incorporated area, and future areas identified in the 2002 General Plan that will ultimately be annexed and served by the City. The current incorporated area is about 18 square miles, and the existing incorporated area will be essentially builtout within the next few years.

Figure 1-2 also shows the major regional drainageways that convey runoff from the City to Monterey Bay. The topography within the study area is gently sloping, generally in a westerly to southwesterly direction. Most of the stormwater runoff from the City is conveyed westerly by the Reclamation Ditch system and Santa Rita Creek to Tembladero Slough and the Old Salinas River at Monterey Bay. Runoff from part of the southwestern portion of the City is pumped south to the Salinas River.

The climate of the Salinas Valley is typical of central coastal valleys in California, characterized by ocean-moderated temperatures that only occasionally exceed 85 degrees or drop below 35 degrees Fahrenheit. About 80 percent of the average annual rainfall occurs during the five-month period of November through March, and 55 percent typically falls during December through January.

1.4 Acronyms & Abbreviations

The following acronyms and abbreviations are used in this report:

AF	acre-feet
CDM	Camp Dresser & McKee Inc.
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CIP	Capital Improvement Program
CL	Carr Lake
ENR	Engineering News Record
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft	feet
GC	Gabilan Creek
GIS	geographic information system
in	inch
in/hr	inch per hour
LOMA	Letter of Map Amendments
LOMR	Letter of Map Revisions
MCWRA	Monterey County Water Resources Agency
MS	Markely Swamp
NC	Natividad Creek
NPDES	National Pollution Discharge Elimination System
RD	Reclamation Ditch

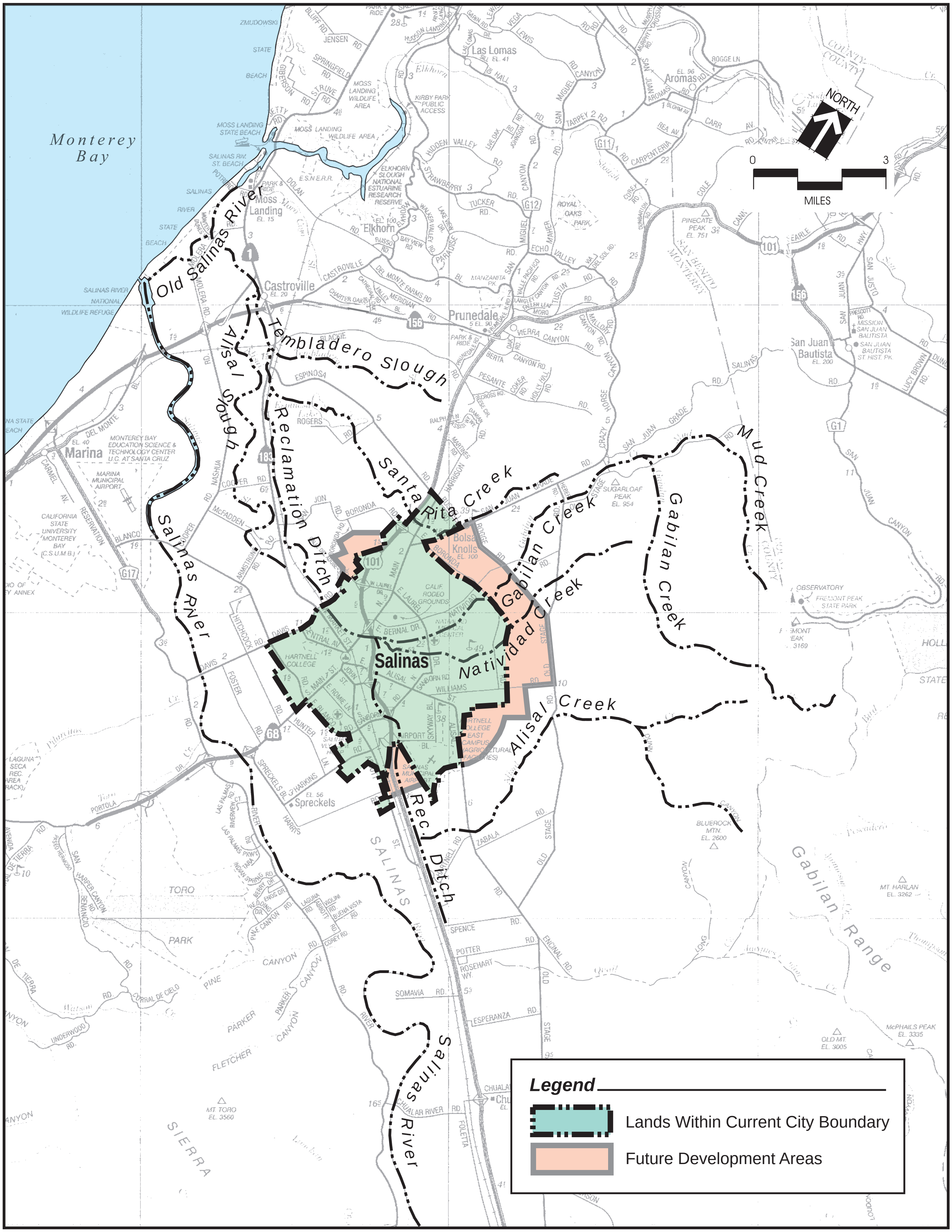

Figure 1-2
Study Area

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SCS	Soil Conservation Service
SR	Salinas River
SRC	Santa Rita Creek

1.5 Acknowledgements

This report would not have been possible without the valuable assistance of the City's staff, especially:

Mr. John White, formerly Deputy City Engineer

Mr. Arturo Adlawan, Senior Civil Engineer (City's Project Manager)

Mr. Leo Havener, formerly Water Resources Planner

Ms. Denise Estrada, Maintenance Services Director

Mr. Ron Cole, Wastewater Manager

Mr. Robert Halnais, Assistant Engineer

Section 2
Existing Storm Drainage System

2.1 Major Watersheds

The City's storm drainage system conveys runoff to the following major receiving waters: Reclamation Ditch, Carr Lake, Gabilan Creek, Natividad Creek, Santa Rita Creek, Markeley Swamp, and the Salinas River. Figure 2-1 shows the major receiving waters within the City and their tributary drainage areas.

The Reclamation Ditch is a major drainage channel that flows from east to west through the City. Most of the City drains to the Reclamation Ditch, which was constructed in 1917 following formation of Reclamation District No. 1665. Carr Lake is a dry lakebed on the Reclamation Ditch that now functions as detention storage for the ditch during winter rainy periods.

Natividad Creek and Gabilan Creek originate north of the City, then flow south through the City and drain to the Carr Lake area. At Carr Lake, both Gabilan and Natividad Creeks are tributary to the Reclamation Ditch. During major storms with high backwater in the Reclamation Ditch, these creeks overflow at their downstream end and inundate large areas of Carr Lake.

The total incorporated area that drains to the Reclamation Ditch system within the City is about 13 square miles, and comprises most of the northern and eastern parts of the City.

The Santa Rita Creek watershed is a small watershed of about 0.5 square mile in the northwestern part of the City. The Markely Swamp watershed is a small watershed of about 2 square miles on the west side of the City. Both these small watersheds drain out of the City to the west and south. Runoff from Santa Rita Creek and Markely Swam eventually reaches the Reclamation Ditch to the west of the City boundary.

The Salinas River watershed comprises about 2.5 square miles of the southwestern part of the City that drains to the southwest corner of the City. Runoff is then conveyed south to the Salinas River.

2.2 Existing City Facilities

The modeled storm drainage system consists of approximately 74 miles of the larger storm drains from 24- to 84-inches in diameter, as well as some 18-inch pipes. The City's system also contains many local storm drains that are 18-inches and smaller in diameter that were not modeled. Most of the existing pipes are reinforced concrete pipe or cast-in-place concrete.

Figure 2-1 provides an overview of the modeled storm drainage system. Detailed maps showing the modeled storm drainage system facilities and subareas are in the back pockets of this report.

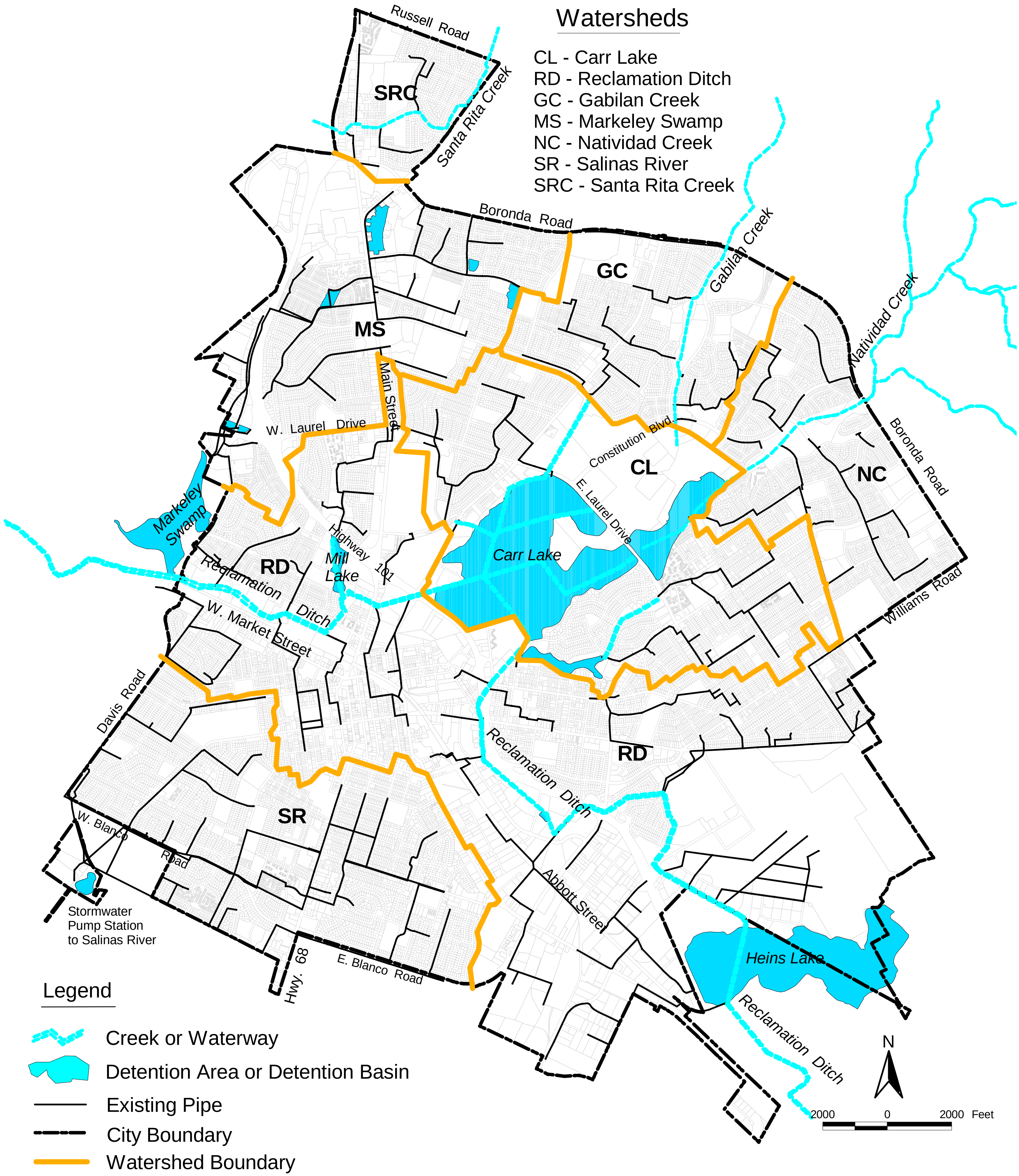

Figure 2-1
Major Watersheds

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The drainage system within each major watershed shown on Figure 2-1 consists of a series of branches of pipes that drain to the receiving water. About 360 drainage subareas within the watersheds were defined that drain to the modeled storm drain pipes. The drainage system flows by gravity to all receiving waters, except for the Salinas River outfall.

The Salinas River Storm Drainage Pump Station and Blanco Detention Basin are located at the site of the former wastewater treatment plant (TP 1 site) at the southwest City boundary. A 66-inch corrugated metal outfall conveys flows to the Salinas River. During low flow conditions, gravity discharge can occur. When the flow increases, it is pumped to the river. The pump station has two pumps with a peak capacity of 110 cubic feet per second (cfs). If inflow exceeds the pump station capacity, it is stored temporarily in the Blanco Detention Basin, which has a capacity of 36 acre-feet (AF) with freeboard, and up to 50 AF when the freeboard is used and the basin is completely full.

There are three small lift stations to drain localized low spots at major underpasses. Two lift stations are owned and operated by the City: one at the Alisal Street underpass, and one at Front and Market Streets. The third lift station on North Main north of Market Street is owned by Caltrans and operated by the City. These small lift stations were not modeled.

Modeled detention basins, in addition to the Blanco Detention Basin, include:

- **Harden Ranch** – detention storage at two parks - McKinnon Park and El Dorado Park
- **Harden Plaza** – parking lot detention at shopping plaza along North Main both north and south of Harden Ranch Parkway
- **Chavez Park** – detention storage at large park adjacent to Carr Lake area
- **Northgate Park** – detention storage at small park in residential community
- **Westridge Center (West Laurel Drive)** – two adjacent basins with permanent water level for water quality (flood storage above normal water level)

These detention basins store water temporarily during peak flows when the storm drain system capacity is exceeded. As the flows decrease and capacity becomes available in the system, the stored water is drained from storage. A detention basin can reduce the downstream pipe sizes by reducing the peak flows.

2.3 Existing Drainage Problems

City staff provided input on existing drainage problems within the City. In general, the existing drainage system functions well, unless there are blockages due to pipe or catch basin obstructions. There are some localized problem areas, typically on smaller storm drains, where additional inlets or larger laterals may be needed. There are some locations with inverted siphons that are often maintenance problems due to settlement of silt and debris in the siphon, and can cause localized ponding if not cleaned frequently.

Based on discussions with City staff, the major existing drainage problems occur at the boundary of the City where runoff from adjacent agricultural fields flows into the City. The two general locations affected by this problem are: the east side of the City near Williams Road, and the north side of the City along Boronda Road. At these locations, agricultural runoff can overtop the tailwater ditches and either enter the City's storm drain system at inlets at the boundary or flow in City streets to an inlet with capacity. The agricultural runoff has a very high sediment load and mud is deposited in the City storm drain system and City streets. In some cases, if flows from outside the City are very high, the agricultural runoff also affects private properties.

Section 3
Planning Criteria

This section presents the planning criteria used for the storm drain system analysis. The criteria include:

- Land uses
- Hydrologic criteria
- Hydraulic criteria
- Other criteria

The planning criteria discussed herein considered the City's 1985 storm drainage design standards, which were in effect during the master plan development. The standards were recently updated, and relevant updates have been incorporated into the master plan criteria. The criteria used for the 1992 Sewage and Drainage Master Plan were reviewed, and changes identified as appropriate for this update.

3.1 Land Uses

Figure 3-1 shows the land uses for this master plan study. These land uses consist of:

- Existing land uses as of April 2000 in developed areas within the current City boundary obtained from the City's Geographic Information System (GIS). Lands within the current City boundary are almost built-out. It is anticipated that build-out will occur by 2003-2004. Therefore, within the current boundary, the existing land uses as of April 2000 are fairly close to buildout conditions.

- Future land uses according to the 2002 General Plan for undeveloped areas within the current City boundary and for future development outside the current boundary. Future development will occur outside the current City boundary. It will be located primarily north of Boronda Road or east of Williams Road, as well as a small amount on the west side of the City.

3.2 Hydrologic Criteria

3.2.1 Method for Flow Generation

The 1992 Sewage and Drainage Master Plan used the Rational Method to generate flows. The City's 1985 storm drain design standards specified that the Rational Method be used to generate storm water flows for design of facilities. While the Rational Method is appropriate for smaller areas, such as a proposed development, there are other methods more suitable for determining storm flows on a citywide scale for this master plan update.

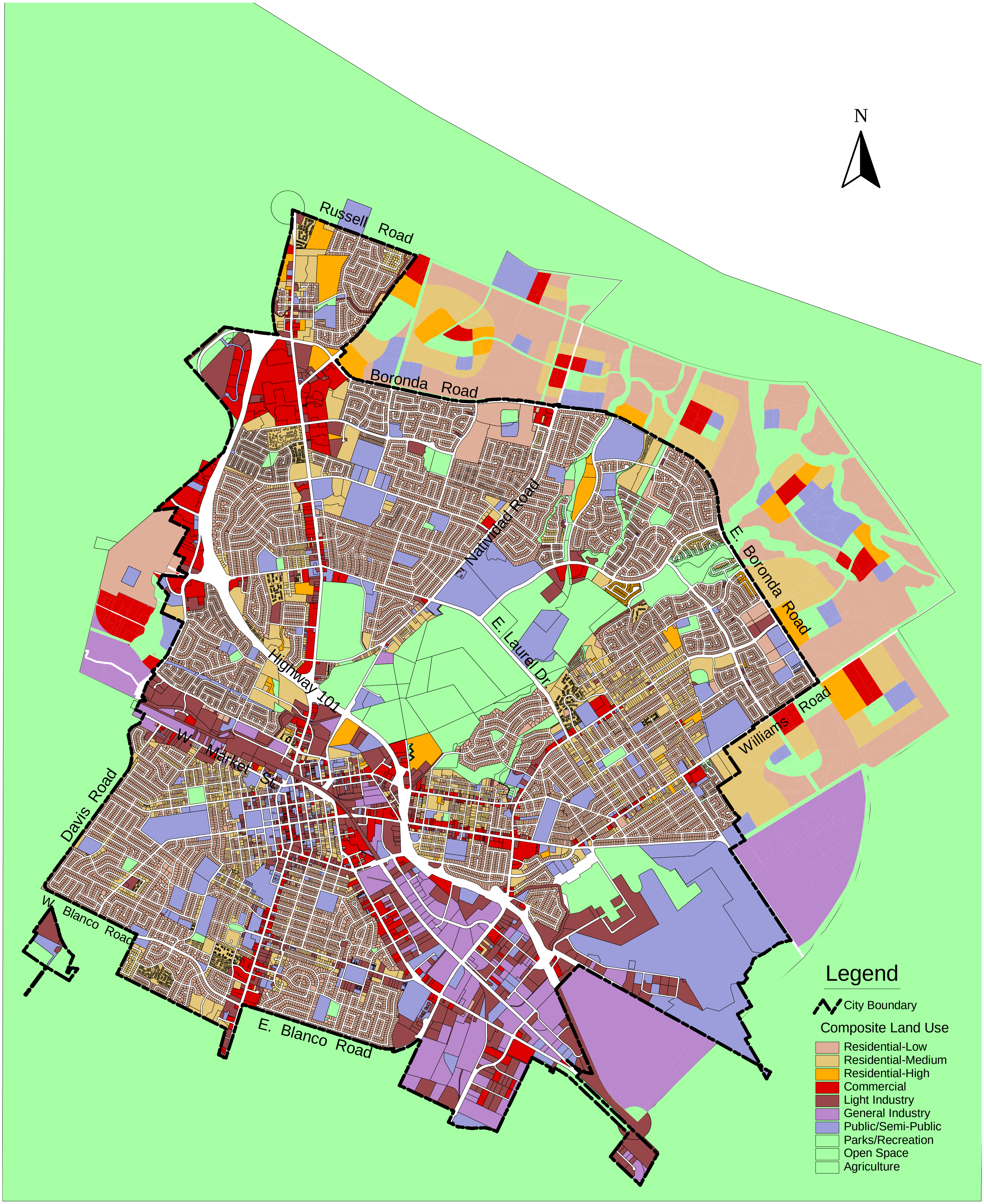

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Figure 3-1
Land Use for Master Plan

For this master plan, the HYDRA model was used to generate and route flows. There are three possible methods of generating storm flows in HYDRA: hydrologic true simulation, a modified Rational Method, and a modified SCS method. Of the three methods, hydrologic true simulation is the most appropriate for a citywide urbanized system, and has been used for this master plan.

The hydrologic true simulation method used for the master plan applies a design storm to the drainage area. The runoff hydrographs are based on the physical characteristics of each subarea, which are specified as input parameters in the model. This method allows more accurate simulation of the urban drainage area, and is similar in concept (although not the same in application) to the approach taken in other models, such as SWMM.

The other two methods are not appropriate for the City's master plan. The Rational Method should be limited to analysis of smaller areas. Since it provides only peak flow information, it cannot be used to analyze ponding or detention storage. The SCS Method was developed primarily for rural (undeveloped) drainage areas, and can be inaccurate for urban areas. HYDRA uses a modified version; the Santa Barbara SCS Method developed by the City of Santa Barbara to more accurately model urban areas. However, as noted in the HYDRA manual, the modified method is not considered as accurate as hydrologic true simulation.

3.2.2 Design Storm (level of protection)

The City's 1985 storm drain design standards specify that the following design storm be used for design of drainage facilities:

- 20-year storm in commercial and industrial areas, and for major trunks; and
- 5-year storm for residential and local facilities.

The City design standards also specify that the depth of water in streets is not to exceed curb heights for these return periods.

This master plan evaluated the 5-year and 20-year storms, as specified in the City's design standards, since the area within the current boundary is essentially built out.

- The 20-year storm criterion applies to drainage subareas that are primarily commercial and industrial, and the trunklines that convey runoff from those areas to the discharge outlet.
- The 5-year storm criterion applies to drainage subareas that are primarily residential and to local facilities, and the trunklines that convey water from those areas to the discharge outlet. Residential facilities draining to a 20-year trunkline serving commercial/industrial areas are sized for the 5-year storm. A trunkline serving only residential areas would be sized for the 5-year storm.

The 1992 Sewage and Drainage Master Plan evaluated the following storms: 25-year storm for basins that were mostly commercial or industrial land uses; and the 5-year storm for basins that were predominantly residential or public land uses. In the 1992 Plan, the 25-year storm was evaluated in response to Monterey County Water Resources Agency recommendations that the system be evaluated under the dual criteria of no ponding for the 10-year storm, and only street ponding for the 25-year storm. The 10-year rainfall amount is close to 20 percent higher than the 5-year rainfall, and the 25-year rainfall amount is about 5 percent higher than the 20-year rainfall.

The City has never required the 25-year storm for any storm drainage facilities design, and the 10-year storm is used only for sizing of detention basins. Extensive improvements to the existing system would be needed to provide a higher level of protection than that historically required by the City, and the existing drainage conditions do not appear to warrant a higher level of protection.

3.2.3 Design Storm Rainfall

The hydrologic true simulation method requires a rainfall pattern for the design storm. Rainfall information was developed from the following sources: City of Salinas intensity-duration-frequency curves from the 1985 Design Standards, which were used in the 1972 Sewerage and Drainage Master Plan; the County of Monterey Public Works Department Rainfall Intensity Chart (October 1977); and Department of Water Resources Bulletin 195 - Rainfall Analysis for Drainage Design (October 1976).

Table 3-1 shows the rainfall amounts for the 2-hour, 6-hour and 24-hour storm events. Storm drains are sized to convey the peak flows expected from the design storm, which typically occur during the shorter duration storms of 6 hours or less. A longer duration storm of 24 hours or more is typically used for sizing detention basins, since the key criterion is storage volume not peak flows.

Table 3-1
Rainfall Amounts for Various Storm Frequencies in Salinas Area

Frequency	*Duration (hours)*	*Rainfall Amount (inches)*
5-year	2	0.7
	6	1.2
	24	2.1
10-year	2	0.9
	6	1.4
	24	2.5
20-year	2	1.0
	6	1.6
	24	2.9
100-year	24	3.7

The storm duration for sizing the storm drains should be long enough so that the entire tributary watershed is contributing to major trunklines. For Salinas, a 6-hour storm is appropriate, since there are some long trunk lines and flow velocities are fairly low due to the flat slope. Table 3-2 shows the 5-year, 10-year, and 20-year rainfall pattern for the 6-hour design storm.

Total rainfall amounts for the design storm are consistent with the Monterey County information. Peak rainfall intensities during the storm are consistent with the Salinas curves.

Table 3-2
6-Hour Design Storm for Storm Drains

	5-Year Storm		***10-Year Storm***		***20-Year Storm***	
Time Interval (hours: minutes)	***Cumulative Rainfall Amount (inches)***	***Rainfall Intensity (in/hr)***	***Cumulative Rainfall Amount (inches)***	***Rainfall Intensity (in/hr)***	***Cumulative Rainfall Amount (inches)***	***Rainfall Intensity (in/hr)***
0:00-0:15	0.02	0.07	0.02	0.08	0.02	0.09
0:15-0:30	0.03	0.07	0.04	0.08	0.05	0.09
0:30-0:45	0.06	0.10	0.07	0.12	0.08	0.14
0:45-1:00	0.09	0.10	0.10	0.12	0.11	0.14
1:00-1:15	0.11	0.10	0.13	0.12	0.15	0.14
1:15-1:30	0.15	0.14	0.17	0.16	0.19	0.18
1:30-1:45	0.18	0.14	0.21	0.16	0.24	0.18
1:45-2:00	0.21	0.14	0.25	0.16	0.29	0.18
2:00-2:15	0.26	0.17	0.30	0.20	0.34	0.23
2:15-2:30	0.30	0.17	0.35	0.20	0.40	0.23
2:30-2:45	0.35	0.21	0.41	0.24	0.47	0.27
2:45-3:00	0.40	0.21	0.47	0.24	0.54	0.27
3:00-3:15	0.46	0.24	0.54	0.28	0.62	0.32
3:15-3:30	0.57	0.43	0.67	0.50	0.76	0.57
3:30-3:45	0.74	0.70	0.89	0.90	1.02	1.05
3:45-4:00	0.87	0.50	1.02	0.50	1.16	0.57
4:00-4:15	0.98	0.43	1.14	0.50	1.30	0.55
4:15-4:30	1.03	0.21	1.20	0.24	1.37	0.27
4:30-4:45	1.07	0.17	1.25	0.20	1.43	0.23
4:45-5:00	1.11	0.17	1.30	0.20	1.49	0.23
5:00-5:15	1.15	0.14	1.34	0.16	1.53	0.18
5:15-5:30	1.17	0.10	1.37	0.12	1.57	0.14
5:30-5:45	1.19	0.07	1.39	0.08	1.59	0.12
5:45-6:00	1.20	0.03	1.40	0.04	1.60	0.08

The Salinas peak intensities shown in Table 3-2 during the peak 15- to 30-minutes during the storm are somewhat lower than the values from the Monterey County chart. However, the Salinas maximum intensities over 60-minute (1-hour) duration are consistent with the Monterey County chart values. Below is a comparison of the peak intensities from the Salinas curves and the County chart for the 10-year storm:

Duration (minutes)	***Salinas Peak Intensity for 10-year storm (in/hr)***	***County Peak Intensity for 10-year storm (in/hr)***	***% Difference***
15	0.9	1.2	33%
30	0.7	0.8	14%
60 (1-hour)	0.6	0.6	0

The Salinas peak intensities are appropriate for the master plan analysis. If the actual peak 15- to 30-minute intensities are closer to the Monterey County values, there may be some temporary ponding during this peak period at inlets in smaller subareas with short times of concentration. However, such temporary ponding would not warrant the cost of improving existing pipes and inlets to convey the short duration peak flows without temporary ponding. Debris would still collect at the inlets, which would require regular maintenance, even if larger pipes were installed.

Table 3-3 shows the 24-hour design storm rainfall for sizing detention basin improvements. The 24-hour rainfall distribution is based on the SCS Type 1A precipitation curve, which is appropriate for areas similar to Salinas. According to the City standards, detention/retention basins are sized to accommodate the more stringent (higher) storage volume that would be needed under either of the following conditions: 1) to limit discharge to the 10-year pre-development rate, and store the difference between the 10-year pre-development and 100-year post-development runoff; or 2) to limit discharge to the available capacity of the downstream drainage facilities.

Table 3-3
24-Hour Design Storm for Detention Basins

	10-Year Storm		***100-Year Storm***	
Hour	***Cumulative Rainfall (in)***	***Rainfall Intensity (in/hr)***	***Cumulative Rainfall (in)***	***Rainfall Intensity (in/hr)***
0	0	0	0	0
1	0.08	0.08	0.11	0.11
2	0.15	0.08	0.22	0.11
3	0.23	0.08	0.33	0.11
4	0.30	0.08	0.44	0.11
5	0.38	0.08	0.56	0.11
6	0.50	0.13	0.74	0.19
7	0.65	0.15	0.96	0.22
8	1.00	0.35	1.48	0.52
9	1.28	0.28	1.89	0.41
10	1.43	0.15	2.11	0.22
11	1.55	0.13	2.29	0.19
12	1.68	0.13	2.48	0.19
13	1.75	0.08	2.59	0.11
14	1.83	0.08	2.70	0.11
15	1.90	0.08	2.81	0.11
16	1.98	0.08	2.92	0.11
17	2.05	0.08	3.03	0.11
18	2.13	0.08	3.15	0.11
19	2.20	0.08	3.26	0.11
20	2.28	0.08	3.37	0.11
21	2.35	0.08	3.48	0.11
22	2.40	0.05	3.55	0.07
23	2.45	0.05	3.63	0.07
24	2.5	0.05	3.70	0.07

3.2.4 Losses between Rainfall and Runoff

In the hydrologic true simulation method, several parameters are specified to model the losses between the rainfall and the runoff due to percolation into the soil, interception by vegetation, or depression storage in small surface puddles.

Soil infiltration rates are used to account for the losses due to percolation of rainfall into the soil. The infiltration rates are obtained from the permeability rates for the various soil types. The Soil Conservation Service (SCS) has mapped the major soil groups within the study area. Hydrologic group classifications have also been mapped by the SCS, which indicate the general potential of various soils to generate runoff from rainfall. The following definitions of hydrologic soils groups are used:

Group A: (Low runoff potential). Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravel.

Group B: Soils having moderate infiltration rates when thoroughly wetted, consisting chiefly of moderately deep to deep, moderately well to well drained soils, with moderately fine to moderately course textures.

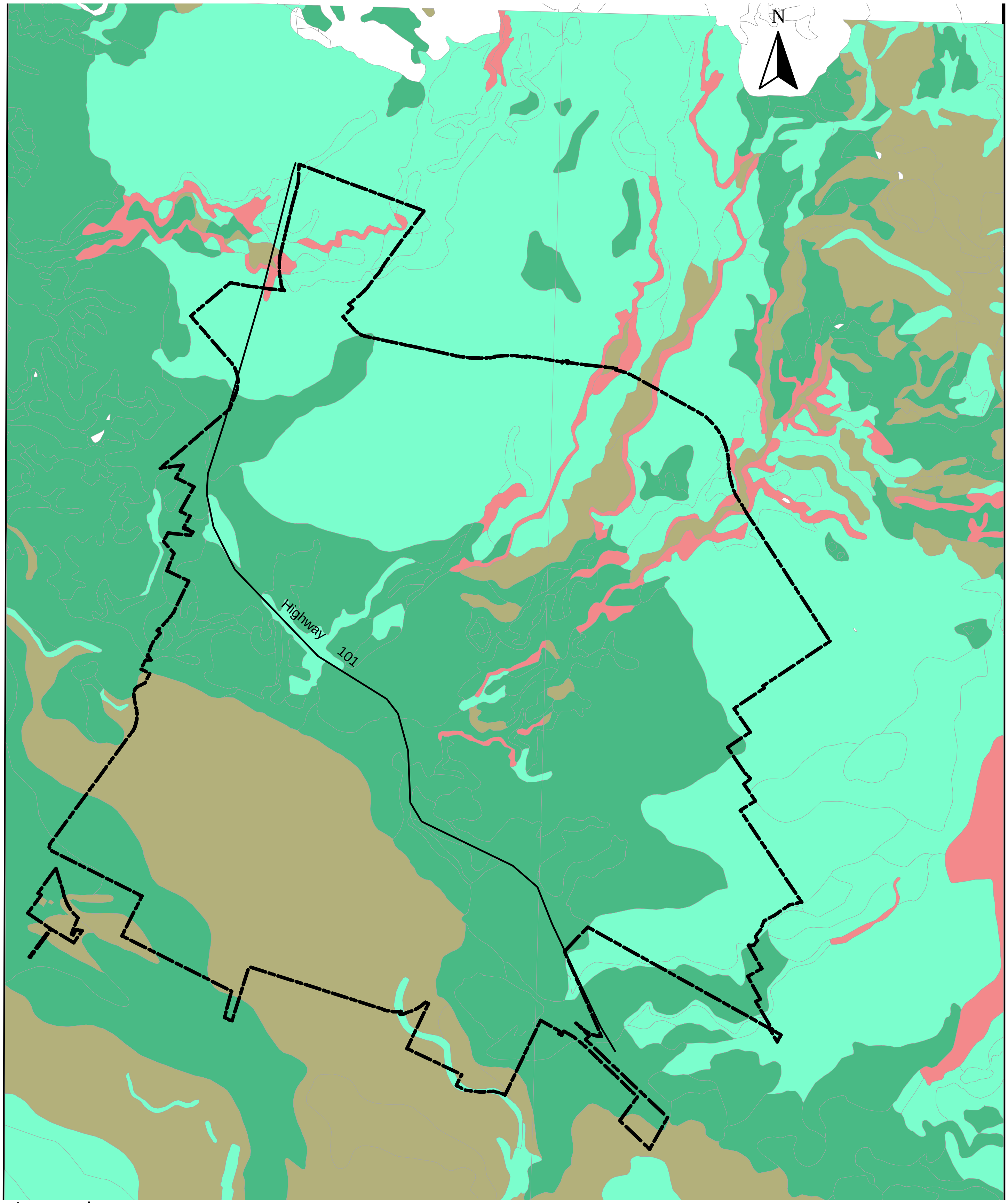
Group C: Soils having slow infiltration rates when thoroughly wetted, consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture.

Group D: (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted, consisting chiefly of clay soils with a high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material.

Figure 3-2 shows the hydrologic soil groups in Salinas and vicinity. Most soils in the City are in hydrologic soil Groups B, C and D. Along creeks, there are narrow areas of Group A soils that follow the drainages. The northern part of the City has primarily Group B soils. The central part, generally along both sides of Highway 101 and the Carr Lake area, has Group D soils. The southern part (approximately south of Market Street) to the current City boundary has Group C soils. South of the current City boundary, the soils are primarily Group D west of Highway 68 and primarily Group C east of Highway 68.

Table 3-4 shows the maximum and minimum infiltration rates of the soils within the study area. The infiltration rates are obtained from the permeability rates for the mapped hydrologic soil groups in the Soil Survey of Monterey County (SCS, April 1978). The maximum infiltration rate is when the soil is dry. The minimum infiltration rate is when the soil is fully saturated, and is the rate that soil will continue to absorb water no matter how long the storm lasts.

Generally, the falling off of the infiltration rate from the maximum to the minimum value during the storm is an exponential decay function. The rate of decrease of the infiltration rate depends on the initial soil moisture content at the start of the storm, with saturate soils having higher runoff. The rate can be set to decrease rapidly to simulate saturated soil conditions, which could occur with back-to-back storms. Based on out experience with similar studies, a typical decay rate of 0.00115 per second is used to estimate the time that it takes the infiltration capacity of the soil to



Legend

City Boundary

Hydrologic Soil Group

A - Low Runoff Potential

B

C

D - High Runoff Potential

CDM

Figure 3-2
Soil Types

go from its maximum to minimum rates. Generally, the minimum infiltration rate is reached within an hour after the start of the storm.

The percent impervious values for improved areas are discussed in Section 3.2.5.

Table 3-4
Infiltration Rates

Hydrologic Soil Group	Infiltration Rate Maximum (in/hr)	Infiltration Rate Minimum (in/hr)	Soil Associations Within Study Area
A	6.0	2.0	Sandy xerothents
B - High [1]	6.0	2.0	Arroyo Seco gravelly loams
B - Low	2.0	0.6	Chualar loams, Elder sandy loam
C	0.6	0.2	Rincon clay loams, Salinas loam, Salinas clay loam
D	0.2	0.06	Antioch very fine sandy loams, Clear Lake clays, Diablo clays, Placentia sandy loams [2]

(1) The Soil Survey classifies the Arroyo Seco gravelly loams as Group B. However, the infiltration rates given in the survey for these soils are those of Group A. For the model analysis, the higher infiltration rates will be used for these soils.

(2) Antioch very fine sandy loams and Placentia sandy loams are classified as Group D due to a hard pan layer located at a depth of approximately 13" and 21", respectively. The soil layer above the hard pan has a higher infiltration rate similar to Group B. However, under saturated conditions, the percolation rate would be that of Group D.

In addition to infiltration losses, depression storage losses are also estimated. Depression storage is a volume that must be filled prior to the occurrence of runoff on both pervious and impervious areas. It represents an initial loss caused by such phenomena as surface ponding, surface wetting, interception and evaporation.

The HYDRA model allows the fraction of the land segment covered by depression storage to be estimated, and the depth of the depression storage on this fraction to be specified. For this study, we will use an average depth over the entire subarea, based on experience from previous studies. Generally, the depression storage for impervious areas is negligible. The value for pervious areas ranges from approximately 0.1 to 0.2 inches on average over the entire subarea.

For this study, the following depression storage values will be used in the model as average values for the entire subarea, based on our experience from previous studies:

Pervious Areas	0.18 inches
Impervious Areas	0.06 inches

There are also losses from interception storage by vegetation and evaporation-transpiration. Such losses are minimal during rainy season conditions, and are typically not a significant factor in urban areas. For urban areas, the HYDRA model suggests assuming that only half the subarea is affected by interception storage, if no detailed data is available. The minimum value of 0.1 inches will be used for interception storage.

Because depression storage and interception storage are small, these parameters do not significantly affect peak runoff.

3.2.5 Percent Impervious

Table 3-5 use categories with similar percent impervious values that will be used for the master plan. It also shows the corresponding land use designations used by the City in their existing land use GIS and the General Plan, as they relate to the master plan land use designations.

Table 3-5
Percent Impervious Values by Land Use Category

Land Use Category			***Percent Impervious [1] [3]***	
For Master Plan	***In City's GIS for Existing Uses***	***General Plan Category***	***From 1985 Design Standards***	***Use for Master Plan***
Existing Residential				
Low Density	Single Family	Low Density	30 – 50	40
Medium Density	Multi-Family	Medium Density	50 – 60	55
High Density	Mobile Homes, Rooming & Boarding	High Density	60 – 80	70
Future Residential [3]				
Low Density	Single Family			
Less than 4 units/ac		Low Density	NA	50 - 70
4 – 8 units/ac		Low Density	NA	60 - 80
Medium Density	Multi-Family	Medium Density	NA	70 - 90
High Density	Mobile Homes, Rooming & Boarding	High Density	NA	70 - 90
Commercial	Retail Trade	Retail	90 – 100	90
Light Industry	Finance/Insurance/Real Estate, Services, Wholesale Trade, Transportation/Communication/Storage	Arterial Frontage, Office, Business Park, General Commercial/Light Industrial, Mixed Use	70 – 80	80
General Industry	Industrial	General Industrial	90 – 100	90
Public & Semi-Public	Public/Semi-Public [2]	Public/Semi-Public	40 – 60	50
Parks & Recreation	Parks [2]	Parks	10 – 20	10
Open Space, Vacant, Agriculture	Open Space, Vacant, Agriculture [2]	Open Space, Agriculture	10	10

(1) The percent impervious values are not runoff coefficients for the Rational Method. The City's design standards contain the runoff coefficients for the Rational Method. The Rational Method runoff coefficients incorporate several attributes that are modeled as separate parameters in the computer model, such as percent impervious, infiltration, and depression storage.

(2) In the City's GIS of existing land uses, parks and open space are included in the Public/Semi-Public category. For the master plan, these existing land use areas were identified separately so they could be assigned to the appropriate percent impervious category.

(3) Future residential development is anticipated to be higher density or have significantly higher impervious coverage than existing residential development. Therefore, the percent impervious or runoff coefficient values applicable to future residential development are higher than for existing development.

The model uses the percent of impervious area in a subarea as a key parameter in estimating the runoff amount. Impervious area is covered with buildings, paving or other hard surfaces that do not allow or significantly impede infiltration of storm water. The percent of impervious area is estimated for each subarea based on the land uses within that subarea.

The percent impervious factors are used to calculate a weighted percent impervious for each subarea, which is used in the computer model. The percent impervious values in Table 3-5 are consistent with the percent impervious values in the City's design standards. These values are also typical of similar communities, since the types of development generally are similar from one community to another.

Future residential development is anticipated to be higher density or have significantly higher impervious coverage than existing residential development. Therefore, higher percent impervious or runoff coefficient values are recommended for analysis and design of storm drain improvements for future residential areas. This trend is typically due to smaller lots with more building coverage for house and garage, as well as a greater amount of paving for driveways and patios.

3.3 Hydraulic Criteria

3.3.1 Pipe Hydraulic Capacity Criteria

The storm drainage system analysis identifies capacity deficiencies and calculates additional capacity needs based on a set of parameters related to hydraulics. These hydraulic parameters include Manning's "n", the trigger for capacity deficiencies, and percent full for sizing new pipes. The theoretical capacity of the pipe is calculated using Manning's equation.

A trigger for capacity deficiencies of 100 percent full is used to initially identify those pipes that have inadequate capacity. However, recommended improvements to existing pipes are prioritized based on a higher trigger that allows for acceptable surcharging in the storm drain system. For example, existing pipes that have surcharged flow under design storm conditions, but with a hydraulic gradeline below ground level, would be classified as low priority for improvement.

New pipes would be sized to flow at 100 percent full (without surcharge).

3.3.2 Friction Factors

Table 3-6 shows the Manning friction factors for pipe s to be used for this study, which are consistent with the City's design standards. The table also shows the factors that would be used for channels, if applicable. These values are typical of those used in other communities.

Table 3-6 Friction Factors for Pipes and Channels	
Type of Facility	**Friction Factor**
Reinforced Concrete Pipe	
Under 24" diameter	0.015
24" and larger diameter	0.013
Concrete-Lined Channels	
Smooth-trowled	0.015
Rough	0.017
Earth Channels	
Smooth Geometric	0.030
Irregular or Natural	0.050

3.3.3 Routing Method

The HYDRA model is used to route flows through the storm drain system and to generate hydrographs. HYDRA routes hydrographs through the system based on the travel time in the system, and the time of concentration of the subareas. When two hydrographs are added together, such as where two pipes meet, the hydrographs are attenuated based on the differences in routing time.

In addition, a recently available add-on module that links SWMM-EXTRAN to the HYDRA model was used for detailed hydraulic analysis of complex parts of the system, i.e., areas with many flow splits, looped pipes and surcharged locations. The SWMM-EXTRAN module provides dynamic routing, which more accurately simulates these conditions.

The backwater effects of ponding in Carr Lake and flows in the Reclamation Ditch and the major creeks are taken into account by specifying the beginning water surface elevations in those water bodies. HYDRA then computes the hydraulic gradeline in pipes discharging to these water bodies based on that water surface elevation.

3.3.4 Beginning Water Surface Elevations

The backwater effects of Carr Lake, the Reclamation Ditch and the major creeks were taken into account by specifying the beginning water surface elevations in those water bodies. The beginning water surface elevations were obtained from FEMA's Flood Insurance Study and the FEMA FIRM maps, which were prepared in 1981 (with some updates since then by Letter of Map Amendments and Letter of Map Revisions).

For the analysis, the design storm for the beginning water surface elevations was the same as the design storm used for sizing the pipe discharging into the waterway. For example, a pipe network serving a primarily residential area uses a 5-year water surface elevation, while a pipe network with a trunkline serving a commercial or industrial area uses a 20-year water surface elevation. The 5-year and 20-year water surface elevations are estimated based on plots of the 2-, 10- and 25-year elevations

Table 3-7 shows the beginning water surface elevations obtained from the FEMA study at some key locations. Beginning water surface elevations from FEMA were converted to the same datum as the pipe data: horizontal NAD 83, vertical NAVD 88.

Table 3-7
Beginning Water Surface Elevations from FEMA Study

Location	***From FEMA Study***			***Adjusted to Master Plan Datum*** [(1)]		
	10-Year	***50-Year***	***100-Year***	***10-Year***	***50-Year***	***100-Year***
Reclamation Ditch at Heinz Lake on east side of City	51.8	55.5	57.0	54.6	58.3	59.8
Carr Lake	40.5	42.7	43.9	43.3	45.5	46.7
Markeley Swamp on west side of City	35.5	37.5	38.0	38.2	40.2	40.7

(1) The elevations obtained from the FEMA information were converted to the master plan datum of horizontal NAD 83 and vertical NAVD 88.

Table 3-8 shows the beginning water surface elevations for the 5-year and 20-year design storms. These elevations were estimated from the adjusted FEMA elevations. The estimate was made based on the ratios of the respective rainfall amounts for the design storms, i.e., ratio of 5-year rainfall to 10-year rainfall, and ratio of 20-year rainfall to 10-year rainfall and to 25-year rainfall. This approximation was then checked for reasonableness based on an estimate of flow in a typical channel for the design storms.

Table 3-8
Beginning Water Surface Elevations for Master Plan Study [(1)]

Location	***5-Year Storm (feet)***	***20-Year Storm (feet)***
Reclamation Ditch at Heinz Lake on east side of City	53.4	56.2
Carr Lake	42.1	44.3
Markeley Swamp on west side of City	37.2	39.1

(1) These elevations are in the master plan datum of horizontal NAD 83 and vertical NAVD 88.

The *Zone 9 and Reclamation Ditch Drainage System Operations Study* prepared for the Monterey County Water Resources Agency by Schaaf & Wheeler (Draft, February 23, 1999) also provided information on backwater conditions. This study provides maximum water surface elevations in the Reclamation Ditch system of a 3-day duration storm for the 2-year, 10-year, 25-year, and 100-year storm frequencies under existing and future land use conditions. The maximum water surface occurs during the third day of the storm.

The Zone 9 study provides information on the water surface elevations with the existing Reclamation Ditch system, and also with implementation of recommended improvements to increase the capacity of the Reclamation Ditch system. The base case for the master plan analysis is the existing Reclamation Ditch system. A sensitivity analysis was done to determine the impact on reducing the amount of required improvements to the City's storm drain system, if the Reclamation Ditch improvements are implemented to reduce the water surface elevation.

Table 3-9 summarizes the maximum water surface elevations from the Zone 9 study at key locations in the Reclamation Ditch system under existing and future land use conditions with the existing facilities and after implementation of the recommended improvements.

As indicated in Table 3-9, the improvements to the Reclamation Ditch system would lower the maximum water surface elevations at Carr Lake by about 2 to 3 feet. The water surface elevations at Markeley Swamp would be lowered about 2 feet. The reduction would be less than 1 foot at Heins Lake.

Table 3-9
Maximum Water Surface Elevations
from Zone 9 and Reclamation Ditch Drainage System Operations Study
(elevation in feet)

Storm Event	Location in Reclamation Ditch System					
	Markley Swamp		Carr Lake		Heins Lake	
	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use
With existing Reclamation Ditch facilities						
2-year	32.1	33.3	37.4	38.1	47.2	48.1
10-year	34.4	35.9	40.9	41.4	51.2	51.8
25-year	36.0	37.0	42.9	43.6	54.0	54.5
100-year	37.0	37.3	45.6	45.9	56.8	56.8
After implementation of recommended improvements to Reclamation Ditch						
2-year	NA	31.6	NA	35.9	NA	47.6
10-year	NA	33.4	NA	38.9	NA	51.2
25-year	NA	34.3	NA	40.8	NA	53.5
100-year	NA	35.6	NA	43.2	NA	56.3

Note: Only future land uses analyzed with the improved Reclamation Ditch system.

3.3.5 Allowable Slopes and Velocities

The City's design standards specify that pipe slopes must be sufficient to provide a velocity of not less than 2.0 nor more than 8.0 feet per second, when flowing full.

These criteria will be used in sizing new pipes. Existing pipes that can convey the design flow will be not identified as recommended improvements solely on the basis of not meeting these criteria.

3.3.6 Minimum Pipe Sizes

According to the City's standards, the minimum allowable diameter for storm drains is 15 inches, and 12 inches for catch basin laterals.

3.4 Storm Water Detention

The City requires that new development and redevelopment provide storm water detention or retention to mitigate increases in storm water discharges between pre-development and post-development conditions.

Drainage system design must also be in accordance with Monterey County Water Resources Agency detention criteria for new development discharging to Carr Lake or its tributaries, and to the Reclamation Ditch system. County criteria for storm water detention is to limit discharge to the 10-year pre-development rate, and store the difference between 10-year pre-development and 100-year post-development runoff.

Detention/retention basins must be sized to accommodate the highest storage volume that would be needed under either of the following conditions:

1) To limit discharge to the 10-year pre-development rate, and store the difference between the 10-year pre-development and 100-year post-development runoff; or
2) To limit discharge to the available capacity of the downstream drainage facilities.

The required storage volume is determined using a 24-hour duration design storm. The discharge rate from the basin can not exceed the available capacity of the City's downstream drainage facilities.

Regional detention basin locations, as identified in Section 5, are required when development occurs in new areas. All new development must either construct detention storage as part of the planned development or participate in implementation of the regional basins.

A detention basin has a small outlet, and flow returns to the downstream drainage system at a low rate. A retention basin has no outlet, and water leaves only by evaporation or percolation into the ground. The City prefers that detention basins be used rather than retention basins due to the proximity of major drainage channels, and the relatively low soil permeability (slow percolation characteristics) in much of the City.

Each basin must have an uncontrolled spillway to keep storm water from overtopping the banks. A surface route for overflows downstream from the basin is required, so that downstream properties and facilities will not be damaged. Outlets release incoming flows to downstream facilities at retarded rates, but not greater than the capacity of the downstream facilities.

Basin design must incorporate features that provide storm water quality benefits, while still meeting flood control needs. Basin design must include appropriate landscaping, and recreational features that can be used during the dry season.

The Stormwater Management Practice Handbook for New Development and Redevelopment (California Stormwater Quality Association, 2003 or most current version) is the basis for design of the storm water quality features. All new basins must include a de-silting chamber or sediment forebay. Basins must provide adequate detention time for runoff from the small storm events that have the greatest impact on water quality, as specified in the Handbook.

Detention basins must drain within a maximum of 48 to 72 hours to prevent mosquito/vector control problems, unless a longer draining time is required due to downstream capacity constraints.

3.5 Stormwater Quality

Storm drainage system design must be in compliance with the storm water quality requirements of the City's NPDES Municipal Storm Water Permit and Storm Water Management and Discharge Control Ordinance. Storm water quality best management practices (quality control measures) must be incorporated as part of all new and redevelopment projects.

The City's Design Standards (current version) contains the City's requirements for stormwater quality controls. The City uses the California Stormwater Quality Association's Stormwater Management Practice Handbook for New Development and Redevelopment (2003 or current version) as the basis for selection and design of best management practices (BMPs) for storm water quality.

Source control BMPs and treatment control BMPs, as described in the Stormwater Management Practice Handbook, must be incorporated into the design as needed to control sources of potential pollutants. A combination of measures may be needed depending on the type and size of the project and the potential for storm water quality impacts.

3.6 Floodway and Floodplain Requirements

A Flood Insurance Study and Flood Insurance Rate Map (FIRM) was prepared for the City by the Federal Emergency Management Agency (FEMA). In addition, there have been a number of Letter of Map Amendments (LOMA) and Letter of Map Revisions (LOMR) over time that revised the original FIRM maps. Regulations for new construction, subdivisions, utilities, and the regulatory floodway as stipulated in the study, map, and floodplain ordinance are applicable to storm drainage improvements within the floodplain/floodway.

3.7 Other Federal and State Requirements

There are also Federal and State requirements related to storm water quality and other environmental concerns.

Federal

- Wetlands Protection - Clean Water Act Section 404 Permit program for projects constructed within wetlands, administered by the Corps of Engineers.

- National Marine Fisheries Services 4D listing of steelhead in the Salinas River as a threatened species. Steelhead fish require specific flow conditions to migrate to spawning and rearing habitat in certain tributaries. The major migration periods are from December 1 through April 15 for adults migrating upstream to spawn; and from January 15 to May 31 for adults returning downstream to the ocean. Minimum flows must be maintained in the river during these periods to allow for fish migration, and the river mouth must be open to the ocean.

- National Pollution Discharge Elimination System (Clean Water Act, NPDES program for construction, industrial, and municipal permits). The City is already complying with these requirements through its NPDES Storm Water Program.

State

- Protect and continue the fish and game resources in lakes and streams (Fish & Game Code Sections 1600 through 1603)

- Water Quality Control Plan, Central Coast Basin (Regional Water Quality Control Board). These requirements with respect to storm drainage are addressed through the City's NPDES Storm Water Permit.

Section 4
Storm Drainage System Analysis

4.1 Storm Water Model

The HYDRA model was used to generate and route flows for the drainage system analysis. A GIS (Arc View) database stores the information needed for the model. Prior to selecting the HYDRA model, an evaluation was done of available hydraulic models and their applicability for the master plan study. Appendix A contains a technical memorandum describing this evaluation.

Maps showing the modeled storm drainage system and subareas are included in back pockets of this report. The modeled storm drain system includes all pipes 24-inches and larger in diameter, as well as some 18-inch pipes to appropriately model the system at a master planning level. The model also includes the City-owned detention basins, and the Salinas River Pump Station and Blanco Detention Basin. Information on the detention basins and pump station obtained from improvement plans and City staff is summarized in the Section 2 description of existing facilities.

The hydrologic true simulation method for generating flows (runoff hydrographs) in the HYDRA model was selected as the most appropriate for a citywide urban system. The hydrologic true simulation method applies a design storm to the drainage area and simulates the runoff from drainage subareas in order to generate hydrographs.

HYDRA routes the hydrographs through the system based on the travel time in the system, and the time of concentration of the subareas. When two hydrographs are added together, such as where two pipes meet, the hydrographs are attenuated based on the differences in routing time.

In addition, a recently available add-on module that links SWMM-EXTRAN to the HYDRA model was used for detailed hydraulic analysis of complex parts of the system, i.e., areas with many flow splits, looped pipes and surcharge locations. The SWMM-EXTRAN module provides dynamic routing, which more accurately simulates these conditions.

The backwater effects of Carr Lake, the Reclamation Ditch and the major creeks are taken into account by specifying the beginning water surface elevations in those water bodies. The model then computes the hydraulic gradeline in pipes discharging to these water bodies based on that water surface elevation. The beginning water surface elevations were obtained from FEMA studies.

Information on the modeled pipes was obtained from the City's storm drain maps, supplemented by review of improvement plans for newer areas. The modeled pipes were digitized to provide spatial information (geographic coordinates for mapping purposes) and flow direction (upstream to downstream). The model input parameters for pipes include diameter, slope, and roughness coefficient.

The pipe slopes were determined from first surveying invert and rim elevations at key manholes. This survey information was used, in conjunction with ground elevations and topography, to interpolate the invert and rim elevations at other manholes. The datum for the field survey and all invert and rim elevations are: horizontal NAD 83, and vertical NAVD 88. The beginning water surface elevations at discharge outlets (from FEMA studies) were adjusted to the same datum as used for the master plan survey.

Subareas were identified within each watershed draining to concentration points along the modeled storm drain system. These subareas are hydraulically isolated drainage areas that define the peak flows at a single point on the modeled storm drain system. The subareas were identified through review of the storm drain system maps, street maps, aerial photos, and topographic mapping. A map in the back pocket of this report shows the modeled subareas.

The runoff hydrographs are based on the physical characteristics of each subarea, which are specified as input parameters in the model. These parameters include subarea size, overland flow length/width, percent of impervious area based on composite land uses, soil infiltration rates, and depression storage and surface roughness.

The numbering system for the pipe and subarea identification numbers is Watershed Designation followed by Branch Number followed by Pipe Number (XX-XXXX-XXX). The watershed designations are: Reclamation Ditch (RD), Carr Lake (CL), Natividad Creek (NC), Gabilan Creek (GC), Salinas River (SR), Markely Swamp (MS), and Santa Rita Creek (SRC).

Each branch was identified first by the watershed designation, and then numbered to show its location within the watershed. The branches were generally numbered from south to north and west to east, i.e., the lowest numbers were in the southwest part of the watershed. Within each branch, the last three digits of the identification number show the pipe's location in the branch, with the discharge outlet of each branch numbered 000, and then the numbers increase in the upstream direction.

Initial model runs were done to check the reasonableness of the model results and the hydraulic gradeline profiles. After the checking was completed, the model was used for the storm drainage system analysis.

4.2 Analysis Methodology

This master plan evaluated the 5-year and 20-year design storms, as discussed in Section 3:

- The 5-year storm criteria applied to subareas that are primarily residential and to local facilities, and the trunklines that convey water from those areas to the discharge outlet. The 5-year storm applied to most of the city.

- The 20-year storm criteria applied to subareas that are primarily commercial and industrial and the trunklines that convey runoff from those areas to the discharge outlet. The 20-year storm applied to the commercial-industrial area that is generally along Highway 101 and the other major arterials.

Figure 4-1 shows the general areas within the current city boundary where the drainage facilities were analyzed for the 5-year or 20-year design storm.

The hydraulic model was used to conduct simulations of the existing storm drainage system for these design storms. The model results were analyzed to identify capacity deficiencies. The following steps were used to review and prioritize capacity deficiencies:

1) The initial screening for capacity deficiencies identified all pipes that are flowing more than 100 percent full.

2) These pipes flowing more than 100 percent full are then analyzed in more detail by reviewing the hydraulic profile to determine if the surcharge (hydraulic gradeline) would remain below the ground.

3) Those locations where surcharge would remain below ground are screened out as not requiring improvement. Such surcharging is acceptable for a storm drain system.

4) For those locations where surcharge would pond above ground, an evaluation is done of the volume of anticipated ponding to see if it would be negligible (nuisance) or significant.

5) For those locations with nuisance overflows, no improvements are recommended. Nuisance overflow is considered to be less than 0.5 AF over a 30-minute period. Such overflow may occur at catch basin inlets until capacity becomes available. This nuisance overflow would not damage property or significantly affect the public.

6) For those locations with significant overflows, the need for improvements is evaluated. Significant overflow is considered to be 0.5 AF or greater for more than 30 minutes.

For locations where significant overflows do occur, the following alternative improvements would be considered in determining the most effective solution:

- Providing detention storage locations for those locations where it would not be advisable to allow overflows to continue or if the overflow volume is too great, in order to eliminate or reduce pipe improvements. This alternative is only an option if there is available land for detention storage at a suitable location.

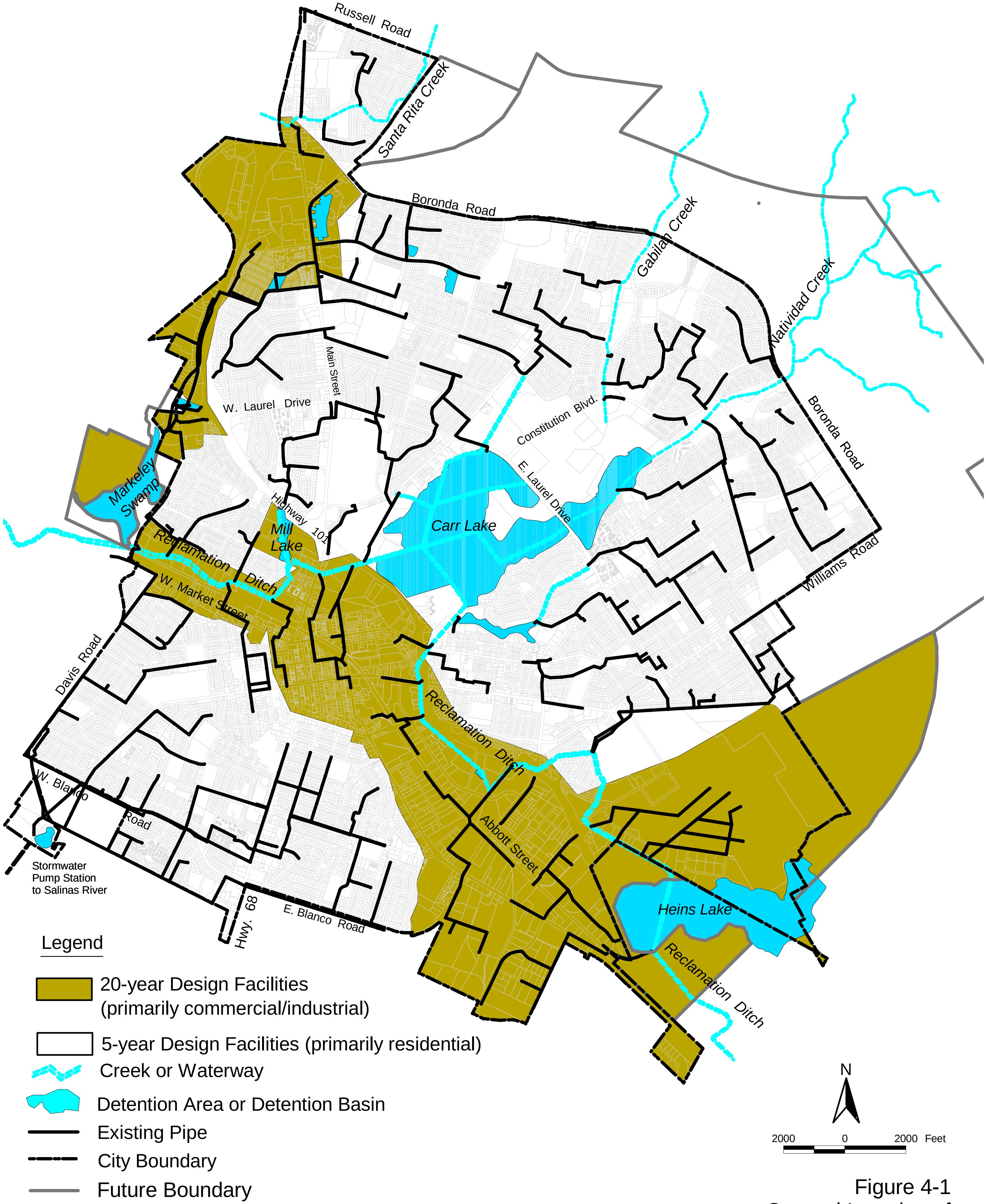


Figure 4-1
General Location of
Design Storm Areas

CDM

- Diversions or bypasses, where flows from a deficient pipe or branch are conveyed to another pipe or branch with available capacity, in order to eliminate or reduce deficiencies. Because of the layout of the city's system with many small branches and discharge locations, this option has limited applicability.

- Relief or replacement pipes to provide additional capacity and eliminate overflows. Relief pipes would be used if the existing pipes were in good structural condition. Replacement pipes would be used if the existing pipes were in poor structural condition. Where pipe improvements are recommended, the new pipes would be sized to flow at 100 percent full.

- Reducing the beginning water surface elevations at the discharge outlets in order to lower the hydraulic gradeline and reduce or eliminate overflows. This option can only be implemented on a regional basis, since the Monterey County Water Resources Agency controls the receiving waters (Reclamation Ditch, Carr Lake, and creeks).

- Increasing pumping capacity at the Salinas River Pump Station, if needed, or providing pumped discharge from pipe branches severely impacted by high backwater in the Reclamation Ditch or other waterways. This alternative would have limited application. The capital cost and ongoing maintenance cost and effort would be much higher than for gravity discharge.

4.3 Analysis Findings

The hydraulic analysis identified that the city's system typically operates in a surcharged condition. However, there were few locations where significant overflows occurred within the city's system, and no locations that were identified as high priority for improvement. For those locations where minor ponding for short durations would occur, no improvements are recommended.

The major existing drainage problems occur at the boundary of the city where runoff from adjacent agricultural fields overtops tailwater ditches and flows into the city. The agricultural runoff has a very high sediment load and leaves mud in the city system and city streets. If flows from outside the city are very high, the agricultural runoff also affects private properties. The Williams Road area has encountered the most severe impacts with agricultural runoff affecting streets and private properties. Detention of agricultural runoff upstream of the City's system will be needed to address these problems.

City staff also indicated that the existing drainage system operates well except the agricultural runoff impacts and some localized problem areas where there are inadequate inlets or laterals. These types of localized problems are beyond the scope of the hydraulic analysis, and have been identified based on past maintenance history. The City provided information on these localized improvements, which include such items as installing larger inlets, upgrading laterals, and replacing cross gutters. These localized improvements are included in the Section 5 recommended improvements based on the information provided by the City.

The hydraulic analysis indicated some overflows at a few locations upstream of pipes with inadequate hydraulic capacity. Although the hydraulic model shows the overflow occurring at one location, it would actually be distributed over a larger area that is tributary to the pipe. The hydraulic model includes only the larger pipes and does not account for overflows being dispersed upstream at smaller laterals and inlets. Because of the flat topography, the ponding would be occur over a larger tributary area, so the ponding depth is typically shallow and does not cause large impacts at a single location.

The overflow locations are discussed below. To eliminate the overflows at these locations would require relief or replacement of about 9,000 LF of existing pipe.

- At three locations in the Salinas River watershed area (5-year design storm), the overflow amounts ranged from 0.6 to 1.2 acre-feet for the 5-year storm. The subareas tributary to these overflow locations ranged from 70 to 85 acres. These locations are included as low priority improvements in the Section 5 Capital Improvement Program and shown on Figure 5-1B.

- At one location in the Reclamation Ditch watershed, the overflow amount was 2.4 acre-feet for the 5-year storm. Assuming the total overflow amount is evenly distributed over the tributary subarea, the depth of ponding would be about ½ inch. This location is included as low priority improvements in the Section 5 Capital Improvement Program and shown on Figure 5-1B.

There were several locations in the industrial area draining to the Reclamation Ditch, where overflows occurred for the 20-year storm. However, these overflows were not due to inadequate pipe capacity, but rather to high backwater in the Reclamation Ditch. The pipes at these locations are adequately sized for the design storm flows, but cannot convey the water due to the high backwater conditions. This has not been a major impact, since many are food processing related industries in this industrial area that conduct their winter operations at other locations, e.g., southern California and Arizona, or have reduced winter operations. The impacted locations are shown on Figure 5-1B in Section 5.

The analysis of the storm drain in Tampico Avenue assumed that the two upstream parallel 24-inch pipes between Rainier Drive and Elwood Street were connected to both downstream pipes. One downstream pipe discharges directly to Carr Lake, and the other conveys flows farther south to the Reclamation Ditch. With the connection to both downstream pipes to maximize their use, there were no overflows at this location. The City's old storm drain maps had indicated that there was no connection at this location; however, information on historic drainage problems indicates this is not the case since no problems have been reported. The map of the modeled system in the back pocket shows this storm drain branch and connection.

4.4 Storm Water Quality Features

The city's storm drain system uses storm water detention for flood control. The detention basins also provide storm water quality benefits. Sediment and other pollutants tend to settle out in the detention basins rather than being discharged into the downstream system. The longer the detention time, the greater the storm water quality benefits.

The city's existing detention basins are currently designed for larger storms for flood control purposes, such as the 10-year storm to meet Monterey County Water Resources Agency detention requirements for drainage to Carr Lake and the Reclamation Ditch system. To enhance their water quality benefits, it would be beneficial to detain or retain runoff from smaller storms. Statewide studies have found that the maximum water quality benefits occur from detaining the runoff from the 2-year storm or less.

The location of the existing detention basins is shown on the map of the modeled storm drainage system in the back pocket of this report. Many of the basins are located in parks. Detention storage at Harden Plaza is provided in the parking lot. Potential stormwater quality enhancements for these basins are discussed below.

Two linked basins at the Westridge Shopping Center were designed for water quality enhancement, and operate to hold low flows and allow drainage to Markely Swamp when water levels rise to a certain level. These Westridge basins already incorporate stormwater quality best management practices. The Blanco Detention Basin holds runoff until it is pumped to the Salinas River. The sump/wet well at the basin and pump station already provide debris and silt control, and should be regularly cleaned and maintained to ensure adequate capacity for settled material and removal of material prior to pumping.

For basins in parks, the city should consider modifying the basin outlets to have a stepped detention or retention discharge. Low flows, 2-year flow or less, would be retained in the basin and infiltrated if soil conditions are suitable, or detained for at least 24-hours prior to discharge, while higher flows would cause the outlet to operate as intended for flood control purposes, i.e., higher flows would bypass the low flow retention/detention control and discharge to the outlet as designed for flood control purposes.

Detention basin discharge outlets should also be outfitted with debris and sediment traps to prevent these pollutants from entering the downstream storm drain system. Regular maintenance is required at the outlets to ensure that high storm flows do not wash accumulated sediment and debris into the downstream system.

The parking lot detention at Harden Plaza would be much more difficult to retrofit. It is likely that an underground sand filter system would be needed. This would be very costly and may not be technically feasible due to space and grade limitations. Since this runoff eventually discharges into Markely Swamp, the storm water quality benefits from detention would be more easily realized at that location, which acts as a wetlands treatment BMP.

In addition to the detention basins located in upstream portion of the storm drain system, much of the city's storm drain system conveys flows to detention areas that are dry lakebeds associated with the Reclamation Ditch system, such as Heins Lake, Carr Lake, and Markeley Swamp. These natural detention areas also provide storm water quality benefits. Due to the impacted nature of the existing Reclamation Ditch system, which is at or over capacity, the Monterey County Water Resources Agency requires storm water detention to limit flows entering these facilities. Therefore, new development will also be required to provide storm water detention to limit flows to impacted areas.

The city is currently participating in a joint study with the Monterey County Water Resources Agency regarding improvements to the Reclamation Ditch system, and enhanced use of Carr Lake. The city is considering a multi-use facility at Carr Lake that would continue its detention storage function, and also provide open space, recreation and habitat benefits. The Carr Lake area is a critical detention area for proper functioning of the Reclamation Ditch system, which is the key drainage way for most of the city. The detention function should be considered as the highest priority relative to other intended uses. Landscaping and open space uses at Carr Lake could enhance the pollutant removal efficiencies of the detention storage.

The design of new detention basins and related stormwater quality best management practices should meet the criteria discussed in Sections 3.5 and 3.6. The City's Design Standards reference the Stormwater Management Practice Handbook for New Development and Redevelopment (California Stormwater Quality Association, 2003 or most current version) as the basis for design of storm water quality features.

Section 5
Recommended Capital Improvement Program

5.1 Storm Drainage System Recommendations

Based on the storm drainage system analysis, Figures 5-1A and 5-1B and Table 5-1 show the recommended Capital Improvement Program (CIP). The projects are categorized into the following priorities:

- **Priority 1** - The first priority projects are to mitigate the existing drainage problems due to agricultural runoff in the Williams Road area.

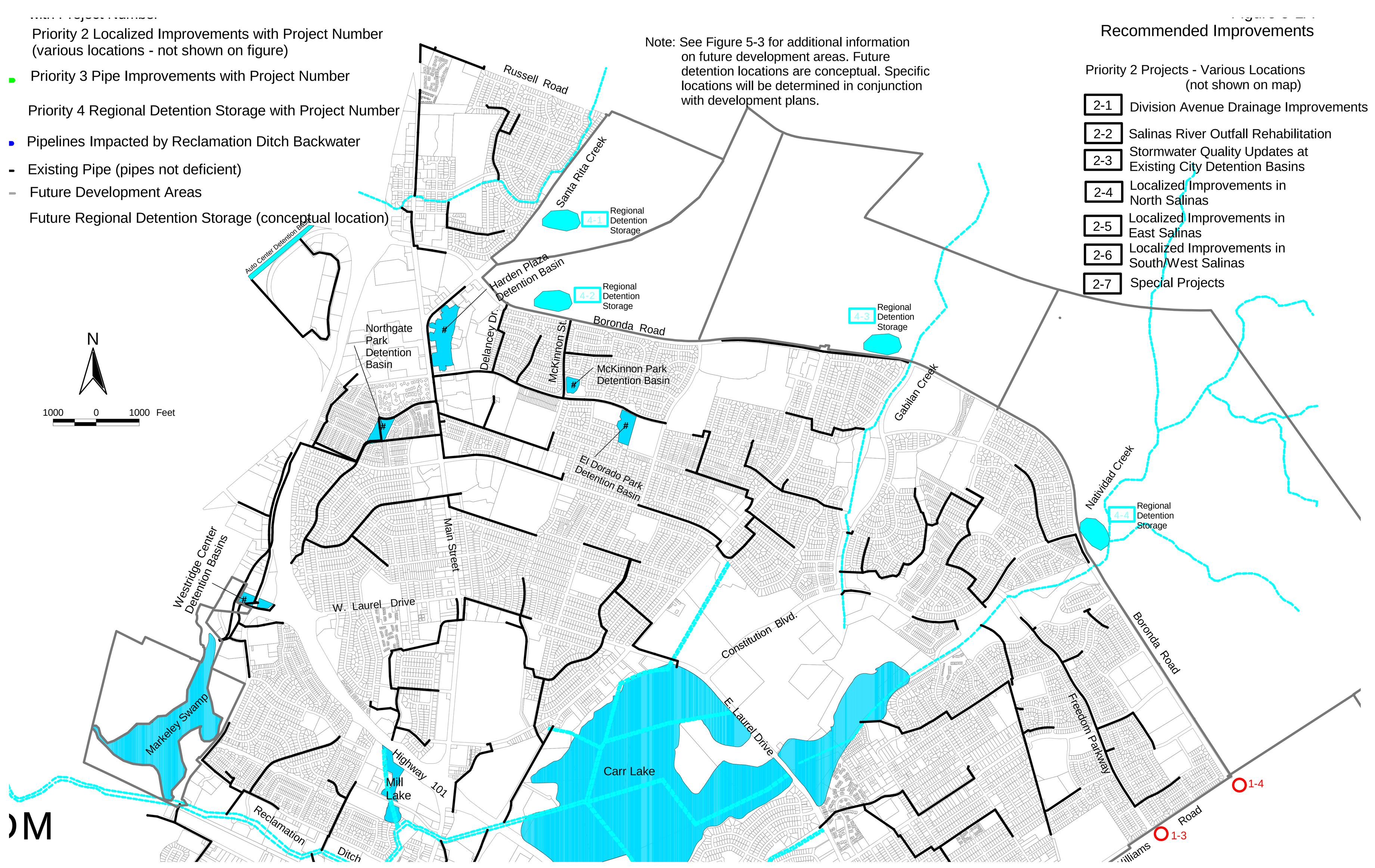
- **Priority 2** - The second priority projects are to construct drainage improvements in the vicinity of Division Avenue, rehabilitate the Salinas River storm drain outfall, retrofit existing City detention basins with stormwater quality features, and correct localized problems identified by City staff based on historic maintenance data and complaint records. Depending on specific conditions and ongoing refinement of priorities by City staff, some of these Priority 2 improvements may be implemented before Priority 1 projects.

- **Priority 3** – These are low priority projects for the existing system that are potential improvements to the existing system requiring field verification. The Priority 3 improvements are locations where the hydraulic model has indicated that significant overflows may occur upstream of existing pipes with inadequate hydraulic capacity. However, City maintenance staff have not historically experienced flooding problems at these locations.

- **Priority 4** – New development areas will require detention storage. These regional detention projects to serve new areas would be undertaken as needed for new development.

The order of projects within each priority category does not indicate their relative order of importance within each priority category. City staff will prioritize individual projects for ongoing implementation as part of development of the 5-year Capital Improvement Programs. The specific priority for implementation of individual projects will depend on the City's needs.

Other recommendations are also provided regarding future improvements to the Reclamation Ditch system and their impact on the Salinas storm drainage system. Such improvements are a regional project that would be undertaken by the Monterey Water Resources Agency.


Recommended Improvements
Priority 2 Localized Improvements with Project Number
(various locations - not shown on figure)
Priority 3 Pipe Improvements with Project Number
Priority 4 Regional Detention Storage with Project Number
Pipelines Impacted by Reclamation Ditch Backwater
Existing Pipe (pipes not deficient)
Future Development Areas
Future Regional Detention Storage (conceptual location)
Note: See Figure 5-3 for additional information on future development areas. Future detention locations are conceptual. Specific locations will be determined in conjunction with development plans.
Priority 2 Projects - Various Locations
(not shown on map)
2-1 Division Avenue Drainage Improvements
2-2 Salinas River Outfall Rehabilitation
2-3 Stormwater Quality Updates at Existing City Detention Basins
2-4 Localized Improvements in North Salinas
2-5 Localized Improvements in East Salinas
2-6 Localized Improvements in South/West Salinas
2-7 Special Projects
N
1000 0 1000 Feet
Russell Road
Santa Rita Creek
Regional Detention Storage
Harden Ranch Detention Basin
Boronda Road
Northgate Park Detention Basin
McKinnon Park Detention Basin
El Dorado Park Detention Basin
Gabilan Creek
Natividad Creek
Main Street
W. Laurel Drive
Westside Center Detention Basins
Markley Swamp
Constitution Blvd.
E. Laurel Drive
Freedom Parkway
Boronda Road
Carr Lake
Highway 101
Mill Lake
Reclamation Ditch
Williams Road
1-3
1-4

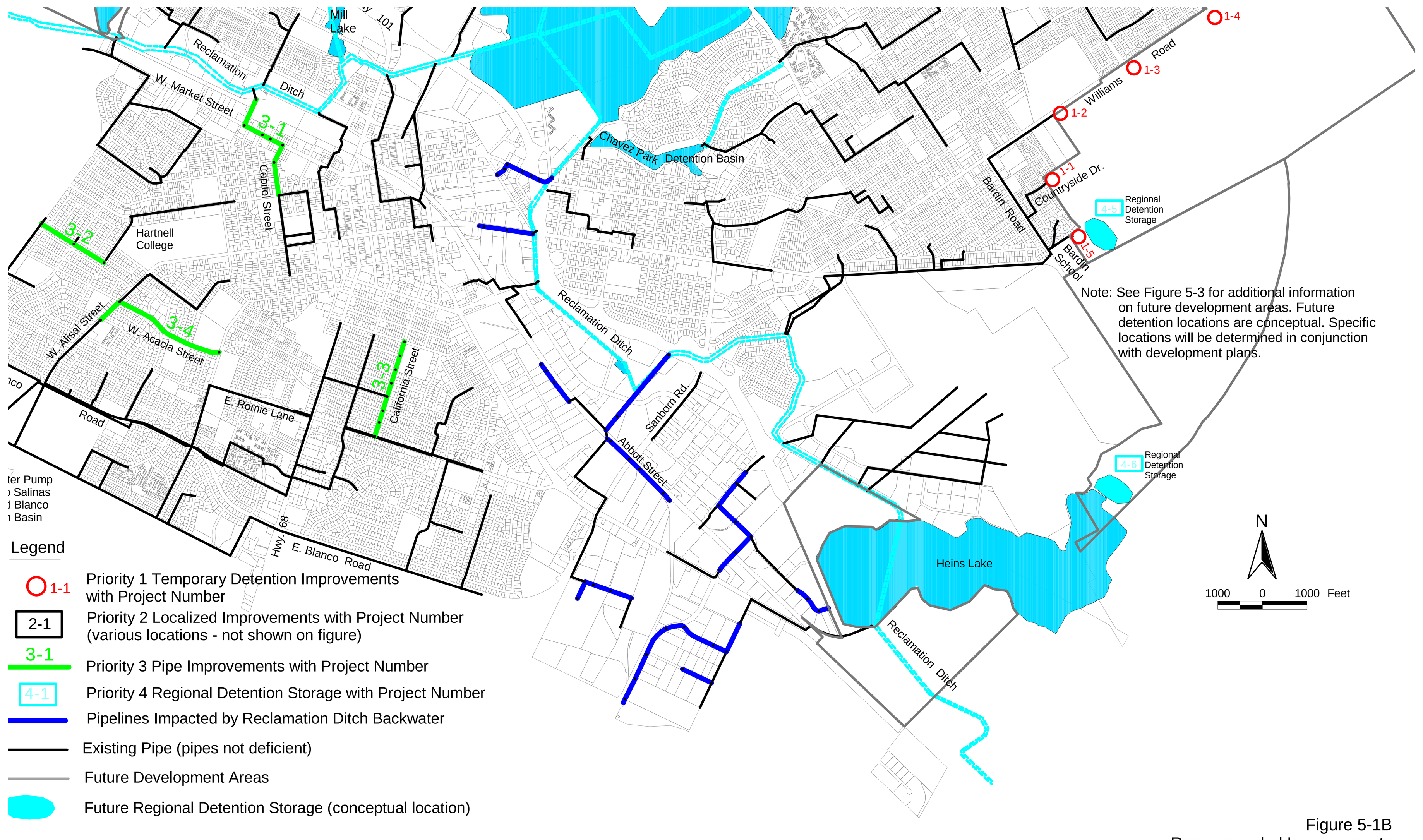


Figure 5-1B
Recommended Improvements

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Table 5-1
Recommended Storm Drainage System Improvements

Project	Description	Estimated Capital Cost ($ million)	Location
Priority 1 Improvements – Temporary Detention for Agricultural Runoff in Williams Road Area These projects are high priority for implementation, and should be undertaken when feasible and funds are available. The locations of the Priority 1 projects are shown on Figure 5-1.			
1-1	Temporary detention basin (3 AF net storage capacity) and related berms and structures, capital cost includes 0.5-acre land acquisition.	$0.20	East side of Williams Road at terminus of Countryside Drive
1-2	Temporary detention basin (3 AF net storage capacity) and related berms and structures, capital cost includes 0.5-acre land acquisition.	$0.20	East side of Williams Road near Del Monte Avenue
1-3	Temporary detention basin (3 AF net storage capacity) and related berms and structures, capital cost includes 0.5-acre land acquisition.	$0.20	East side of Williams Road upstream of farm culvert at Freedom Parkway
1-4	Temporary detention basin (3 AF net storage capacity) and related berms and structures, capital cost includes 0.5-acre land acquisition.	$0.20	East side of Williams Road just north of Boronda Road
1-5	Temporary detention basin (3 AF net storage capacity) and related berms and structures, capital cost includes 0.5-acre land acquisition.	$0.20	At inlet to existing storm drain behind Bardin School (near Argentine Drive)
Total for Priority 1 Projects		***$1.00***	
Priority 2 Improvements - Projects to Correct Localized Problems These projects are the second highest priority for implementation, and should be constructed as needed and as funds are available. The specific locations of the Priority 2 projects are not shown on Figure 5-1, due to the large number of locations. The City will determine the priority for implementation of specific improvements and implementation would occur over time as funding becomes available. Depending on specific conditions and priorities to be determined by City staff, some of these improvements may be implemented before Priority 1 projects.			
Project	***Description***	***Estimated Capital Cost ($ million)***	***Location***
2-1	Division Avenue Drainage Improvements: Improvements to drainage ditch and/or pipe improvements to convey runoff to wetlands area at Chavez Park.	$0.80	Vicinity of Division Avenue (near Market and Short Streets).
2-2	Salinas River Discharge Outfall Rehabilitation/Relining: Field assessment would be conducted first to confirm that rehabilitation was warranted. 66-inch pipe, 7500 LF, unit capital cost of $530 per LF for relining ($8 per in-dia-ft). Total capital cost includes all markups for implementation and contingencies, including cost of field assessment.	$4.00	Between Salinas Stormwater Pump Station and Salinas River.
2-3	Stormwater quality upgrades at City detention basins (, e.g., siltation and debris basins/traps, stepped outlets for low flows, sand filter and/or oil/grease traps for parking lot detention. Specific improvements for each basin would be evaluated and determined during predesign studies. The City will determine the priority for specific improvements and implementation would occur over time as funding becomes available.	$2.00	At City detention basins.
2-4	Localized storm drainage improvements in North Salinas area: Replace siphons at three locations (E. Laurel Drive & Huntington Street, E. Laurel Drive & Claremont Street, E. Laurel Drive & Parkside Street). Upgrade lateral from inlet to storm drain at Aragon Circle & Barcelona Circle. Install larger inlets at various locations (E. Laurel Drive & Tyler Street, E. Laurel Drive & Polk Street, E. Laurel Drive and Monroe Street, E. Laurel Drive & Adams Street, E. Laurel Drive & Noice-Southside, Reata & Linwood, Sequoia & Linwood, Elwood & Linwood, Maryal & Reata, Elwood & Loma, 325 Elwood, north and south sides of Chaparral at Noice Ditch, northside of E. Curtis at Noice Ditch, Crescent & Adams, North Main and Russell - Southside).	$0.48	Various locations in North Salinas as noted in Description column.
2-5	Localized storm drainage improvements in East Salinas area: Replace siphon at Sharon & Beverly. Replace 400 LF CMP main at end of Merced. Install larger inlet at Mortensen Street. Check lateral to main for slow drainage and determine if pipe upgrades needed at East & Sanborn.	$0.16	Various locations in East Salinas as noted in Description column.
2-6	Localized storm drainage improvements in South/West Salinas area: Replace siphon at Cherry & Peach. Install larger inlets at various locations (Nacional & Santa Rosa, Nacional & San Clemente, Lang & West, Maple & California, Maple & Front, West & Park, College & Amherst, W. Alisal & Church, Capital & Clay, Clay & Lincoln). Replace cross gutters at several locations (Soledad & E. San Luis, California & E. San Luis, Cayuga & Gabilan). Reconstruct gutter and metal plate across sidewalk at end of Calle Cebu and Sun. Check lateral to main for slow drainage and determine if pipe upgrades needed at various locations (Pajaro & E. Alisal, Rianda, Geil & Capital, Geil and West, Pajaro & Maple, Lincoln & Howard, Lang & Iverson, Iverson & Geil, Capital & Clay, Clay & Lincoln).	$0.41	Various locations in South/West Salinas as noted in Description column.
2-7	Special storm drainage projects to be investigated further and needed improvements determined: Install two access ramps at Santa Rita Ditch for maintenance access to improved concrete channel. Repair concrete around outfall at Rico and Rossi, and possibly two more outfalls along Natividad Creek near Las Casitas that may be undermined from storm damage. Determine adequacy of storm drainage facilities at several locations where street drainage may impact private properties (766 Elton Place, 1741 Elton Place, end of Elm, end of Holly, Monterey and E. Market southside)	$0.55	Various locations throughout the City as noted in Description column.
Total for Priority 2 Projects		***$8.40***	

Table 5-1
Recommended Storm Drainage System Improvements

Priority 3 Improvements – Capacity Deficiencies Identified by Hydraulic Modeling

These pipe improvement projects are low priority for implementation, and should only be undertaken if field verification determines the improvements are needed to correct flooding problems. The recommended improvements are sized to convey the design flow at 100% full without surcharging. It is anticipated that pipe improvements would be parallel pipes, unless the existing pipe is in poor condition and would warrant replacement or the replacement size is only one standard pipe diameter larger than the parallel size.

Project	*Upstream Pipe*	*Downstream Pipe*	*Length (ft)*	*Average Slope (ft/ft)*	*Design Flow (cfs)*	*Existing Diameter (in)*	*New Diameter (in)*		*Estimated Capital Cost ($ million)*		*Location*
							Parallel	*Replace*	*Parallel*	*Replace*	
3-1	RD-1200-028	RD-1200-002	3,010	0.0025	60	30	33	42	$0.99	$1.26	New St to Reclamation Ditch, West Market Street between New St and Capitol St, Capitol St between West Market St and Central Ave
3-2	SR-3030-008	SR-3030-004	1,650	0.0025	40	24	27	36	$0.45	$0.59	Easement located between Fairfax Dr and Lemos Dr that extends from Davis Road to Hartnell St extension
3-3	SR-1019-028	SR-1019-016	1,280	0.003	20	18	24	27	$0.31	$0.35	California St between Maple St and E. Romie Lane
3-4	SR-1011-080		2,550	0.003	20	24	18	30	$0.46	$0.77	West Acacia St between West Alisal St and Iverson St
		SR-1011-027	590	0.0001	50	33	30	42	$0.18	$0.25	West Alisal St between Carmelita Dr and West Acacia St
	Subtotal for Project 3-4		3,140						$0.64	$1.02	
Total for Priority 3 Projects			***9,080***						***$2.39***	***$3.22***	

Priority 4 Improvements – Regional Detention Storage for Future Development Areas

These projects would be undertaken as needed for new development areas. Conceptual locations for the regional detention storage is shown on Figure 5-1; specific locations would be determined by the City as part of the development planning process.

Project	*Description*	*Estimated Capital Cost ($ million)*	*Location*
4-1	Santa Rita Creek - Regional Detention Storage (40 AF net storage capacity)	$0.80	As determined for new development
4-2	Markeley Swamp - Regional Detention Storage upstream of McKinnon Street and/or Delancey Street storm drains (40 AF net storage capacity)	$0.80	As determined for new development
4-3	Gabilan Creek - Regional Detention Storage (75 AF net storage capacity)	$1.50	As determined for new development
4-4	Natividad Creek - Regional Detention Storage (175 AF net storage capacity)	$3.50	As determined for new development
4-5	Reclamation Ditch (Williams Road) - Regional Detention Storage (80 AF net storage capacity)	$1.60	As determined for new development
4-6	Heinz Lake - Regional Detention Storage (90 AF net storage capacity)	$1.80	As determined for new development
Total for Priority 4 Projects		***$10.00***	
GRAND TOTAL FOR ALL RECOMMENDED IMPROVEMENTS (assumes all Priority 3 projects are replacement pipes)		***$22.62***	

Notes regarding the Table 5-1 priorities and cost estimates:

The order of projects within each priority category does not indicate their relative order of importance within the priority category. City staff will prioritize individual projects for ongoing implementation as part of development of the 5-year CIP's. The specific priority for implementation of individual projects will depend on the City's needs as determined over time.

The Table 5-1 cost estimates for the recommended improvements are planning-level capital costs (Twenty Cities ENR 7000, April 2004). The capital costs include construction costs plus 50 percent for engineering, environmental, legal, administration, and contingencies.

Priority 1 temporary detention basin costs are estimated using a unit capital cost of $70,000 per acre-foot of net storage capacity, including sediment/debris traps, ancillary berms and structures, security fencing and land acquisition.

Priority 2 localized improvement costs are estimated based on average estimated unit capital costs of $70,000 per replacement siphon, $150 per LF of replacement lateral, $15,000 per replacement inlet, and $8 per inch-diameter-foot for rehabilitation/lining of the discharge outfall. The unit capital costs are for retrofitting the existing locations with the new improvements and include demolition/removal costs, and restoring the sites after construction.

Priority 3 pipe costs for new storm drains are estimated using a unit capital cost of $10 per inch-diameter-foot. Pipe costs for rehabilitation/relining of existing storm drains are estimated using a unit capital cost of $8 per inch-diameter-foot. The unit pipe cost is based on Class III reinforced concrete pipe, and includes pavement removal and replacement, traffic control, correction of utility interferences, manholes and catch basins.

Priority 4 regional detention storage costs are estimated using a unit capital cost of $20,000 per acre-foot of net storage capacity for new basins, including stormwater quality features. It is assumed that the sites would be dedicated to the City by developers so no land costs are included.

The Table 5-1 CIP costs are for specific projects. The costs do not include an annual amount to be budgeted for miscellaneous improvements to address unforeseen conditions. City staff will include an annual amount for miscellaneous drainage improvements in the 5-year CIP budgets.

The cost estimates for the recommended improvements in Table 5-1 are planning-level capital costs (Twenty Cities ENR 7000, April 2004). The capital costs include construction costs plus 50 percent for engineering, environmental, legal, administration, and contingencies. The footnotes to Table 5-1 provide the unit cost assumptions for the cost estimates.

The Table 5-1 CIP costs are for specific projects. The costs do not include an annual amount to be budgeted for miscellaneous improvements to address unforeseen conditions. City staff will include a separate line item for an annual amount for miscellaneous drainage improvements as part of the 5-year CIP budgets.

Appendix B contains a technical memorandum discussing potential funding sources for the City's stormwater system.

5.1.1 Priority 1 Improvements in Williams Road Area

The major existing drainage problems occur at the boundary of the City where runoff from adjacent agricultural fields overtops tailwater ditches and flows into the City. The agricultural runoff has a very high sediment load and mud is deposited in the City system and City streets. If flows from outside the City are very high, the agricultural runoff also affects private properties.

The Williams Road area has encountered the most severe impacts with agricultural runoff affecting streets and private properties. Runoff drains south/southwesterly toward the City from about 550 acres of agricultural area east of Williams Road. As shown on Figure 5-2, the agricultural drainage area affecting the City extends from approximately midway between Boronda and Old Stage Roads south to the City boundary. The approximate area is based on limited field visits and topography from USGS quad maps. The area is privately owned and not accessible to the public. Natural drainage patterns have been altered for agricultural operations.

During storms, runoff from the agricultural area has caused major problems within the City in the residential area near Freedom Parkway and Williams Road, and in the residential area near Del Monte Avenue and Countryside Drive off Williams Road. To mitigate the impacts to the City, detention storage would be used to control agricultural runoff prior to it entering the City's storm drain system. The stored runoff would then be allowed to enter the City's storm drain system at specific inlet locations, when capacity is available in the system. The detention storage would be a temporary measure until future development occurs and the permanent infrastructure is constructed.

It is anticipated that the temporary detention basins would be located along the east side of Williams Road, which will require agreements with the private property owners. It is recommended that several smaller detention basins be constructed at key locations rather than one larger basin. A single larger basin would require extensive ditch and culvert improvements and berms to convey flow without overtopping.

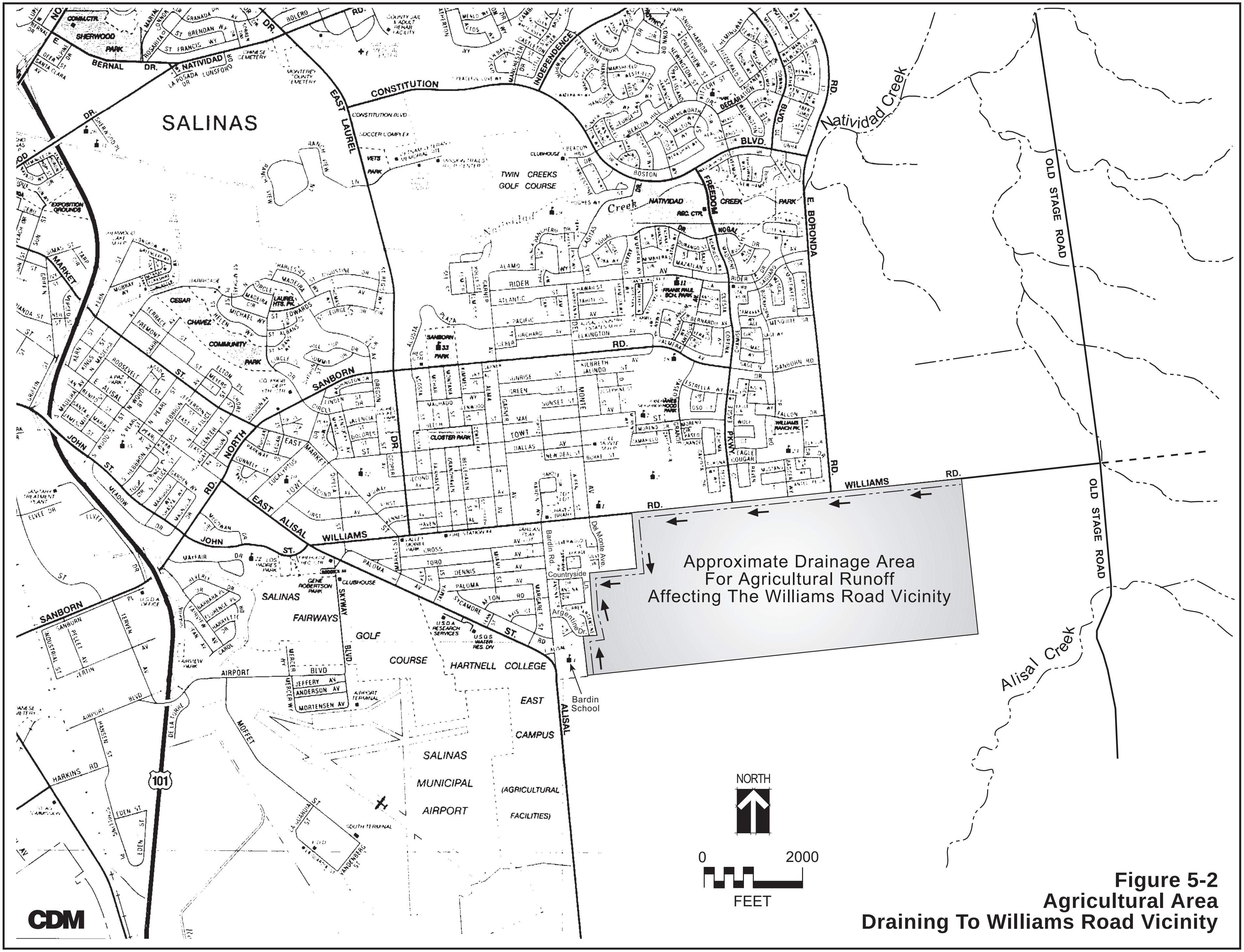


Figure 5-2
Agricultural Area
Draining To Williams Road Vicinity

The key locations for detention storage of runoff from the agricultural area, as shown on Figure 5-1B, are described below:

- North side of Boronda Road to help control runoff from upstream of the City that flows southerly in the agricultural tailwater ditch.
- Northeast side of Freedom Parkway (north side of undersized culvert on agricultural road on east side of Williams Road). Currently water will overtop the undersized culvert and flow across Williams Road to the residential area in the vicinity of Freedom Parkway.
- Upstream of the existing inlet to the City's storm drain system at Del Monte Avenue. Currently water will overtop the inlet and flow into the residential area near Bardin Road.
- Upstream of the existing inlet to the City's storm drain system at Countryside Drive. Currently water will overtop the inlet and flow into the residential area near Bardin Road.
- Upstream of the existing inlet to the City's storm drain system near Bardin School. This location will be more difficult to access, since it is not located adjacent to an existing City street. Access would be from farm roads adjacent to the fields.

Assuming a runoff coefficient of 0.2 for cultivated flat fields, the total detention storage volume to contain the runoff from the entire agricultural area would be: 11 acre-feet for the 5-year storm runoff, 13 acre-feet for the 10-year runoff, or 15 acre-feet for the 20-year runoff.

These storage volumes would be sufficient to contain the anticipated total runoff volume for the storm event to allow a factor of safety in case of inlet restrictions. It is assumed that 3 acre-feet of net storage capacity would be provided at each of the five locations, for a total net storage volume of 15 acre-feet.

At the downstream locations (Del Monte Avenue, Countryside Drive, Bardin School), the basins would drain into existing inlets to the City storm drain system. At the upstream locations (Freedom Parkway and Boronda Road), the basins would drain back into the tailwater ditch and be conveyed south to existing inlets. At the upstream locations, it may also be necessary to have a pipe connection to the nearest City storm drain in order to completely drain the basin, if the bottom is below the ditch invert.

At the inlets to the City's system, the improvements should include berming or concrete walls to contain flow in the detention basins. The detention basins should also include silt and debris traps at the inlets. The basin floor would be dropped below the inlet for sediment storage. It is recommended that the capacities of the inlets to the City's system not be enlarged, in order to avoid potential future claims that such changes may have caused future flooding, if flooding were to occur during major storms. Security fencing should be provided around the detention area and inlet for safety of children and others.

Assuming a 6-foot average depth, each basin would require about a 0.5-acre storage area plus some buffer area for berms and access. The total area for all 5 basins would be about 3 acres.

The City would be responsible for maintenance of the detention basins and related berms. A regular maintenance program would be needed to clean out the basins after major storms, due to the large amount of sediment from the agricultural fields. The City should also check that the tailwater ditches conveying water to the basins are kept operational by the landowners. The City may need to initiate appropriate enforcement action through the City and/or County to ensure that the private facilities are kept operational.

The agricultural area to east of Williams Road is part of the future development area in the new General Plan. When it is developed, this problem will be eliminated by improvements for the new development. Until that occurs, the recommended temporary improvements will reduce, although not eliminate, these impacts. These improvements would be considered temporary and could be moved or eliminated as warranted when development occurs, based on the needs of the proposed development.

During larger storms with higher flows that exceed the capacity of the temporary basins, it may still be possible for runoff from agricultural field to overtop the basins and enter the City. Implementation of these improvements should include investigating and providing a route for overflows during major storm events (greater than the design storm) that would be the least damaging for the community and private properties.

5.1.2 Priority 2 Improvements to Correct Localized Problems

The Priority 2 projects consist of several types of projects to correct special or localized problems. These projects are identified in Table 5-1, although the specific locations of these improvements are not shown on Figure 5-1 due to the large number of locations.

A Priority 2 project is included for drainage improvements in the vicinity of Division Avenue near Market and Short Streets. This project consists of drainage ditch (or pipe) improvements to convey runoff to a wetlands area at Chavez Park.

A Priority 2 project is included for rehabilitation of the Salinas River Storm Drainage Outfall that conveys water from the Salinas Storm Drainage Pump Station to the river. The last assessment of the 66-inch Salinas River outfall was done almost 25 years ago. A re-assessment should be done to determine its current condition to confirm the need for and timing for rehabilitating (lining) the pipe. Based on the available information from the previous assessment, it is likely that the rehabilitation project will be needed.

A Priority 2 project is included to retrofit existing City detention basins with stormwater quality features as discussed in Section 4.4. These features could include the following as appropriate for the particular basin: modifying the basin outlets to have a stepped detention or retention discharge; providing debris and sediment traps to prevent pollutants from entering the downstream storm drain system; or providing sand filters or oil & grease traps for parking lot detention basins. The specific improvements that would be the most appropriate at each location must be evaluated during predesign.

City staff provided information about drainage upgrades to correct localized problems at various locations throughout the City. These Priority 2 improvements consist primarily of replacing siphons, installing larger inlets, installing larger laterals between inlets and storm drains, and replacing cross gutters. Some special projects were also identified to investigate some areas with localized problems in order to determine appropriate actions. The Priority 2 projects will be implemented over time based on severity of the problem and availability of funding.

Caltrans is responsible for upgrading storm drains within State highways. There are some needed projects to resolve localized problems that will be implemented by Caltrans, and are not in the City's CIP. These Caltrans projects would include:

- Upgrading all non-standard size drains on South Main Street (State Route 68 A) between Blanco Road and John Street;
- Upgrading all non-standard size drains on John Street (State Route 68 B) between South Main Street and Abbott Street, including the siphons at Monterey and John Streets and any tree root damaged curb/gutters that do not allow proper drainage; and
- Upgrading all non-standard size drain on West Market Street (State Route 183) between Davis Road and North Main Street.

5.1.3 Priority 3 Improvements

The Priority 3 projects consist of low priority projects for improvements to the existing system that should only be implemented based on field verification. The sizing for the Priority 3 projects is based on providing full pipe flow with no surcharge.

At some locations, the hydraulic model predicts significant overflows; however, there is little historic indication of problems. These improvements should be undertaken only if City staff determines that overflows are actually causing damage or public nuisance. As discussed in Section 4, the overflows may actually be distributed over a large tributary area at a shallow depth that is a minor nuisance only.

The City does not have a planned replacement program for storm drains based only on age of the facility. Storm drains are replaced only if needed to correct capacity (flooding) problems, or for breaks or poor condition due to age or other causes.

5.1.4 Priority 4 Improvements

The Priority 4 improvements consist of regional detention basin storage to serve new development areas. Figure 5-1 shows conceptual locations and storage volumes for new regional detention storage basins. The specific locations and sizes for new detention storage will be determined by the City, in conjunction with the development planning process.

The requirements for new development areas are discussed in detail later in this section, as part of Section 5.2 Expansion to Future Areas.

5.1.5 Other Recommendations

The majority of the City drains to the Reclamation Ditch system. Only the southwest portion of the City drains directly to the Salinas River. The Reclamation Ditch system consists of the ditch and a series of dry lakebeds that provide essential detention storage along the ditch. The Reclamation Ditch system is very complex and a series of small events may fill detention storage if draining does not happen quickly enough.

As discussed in Section 4, there are some industrial areas draining to the Reclamation Ditch where the hydraulic model predicts overflows for the 20-year design storm. At these locations, there is adequate pipe capacity to convey the design flows. The overflows are due to high backwater conditions in the Reclamation Ditch. If Reclamation Ditch water surface elevations were lower by 3 to 5 feet, then no overflows would occur.

The backwater conditions affecting the industrial area have not been a major impact, since many are food processing related industries that conduct their winter operations at other locations, e.g., southern California and Arizona, or have reduced winter operations. However, it may become more of an issue in the future if more industries locate in the area and continue operations through the winter season.

The City should continue to coordinate with the Monterey County Water Resources Agency (MCWRA) regarding potential improvements to the Reclamation Ditch system that would lower the water surface elevations along the entire Reclamation Ditch system and in Carr Lake. These improvements are a major regional project that would benefit all users of the Reclamation Ditch system. However, due to the high cost of the required improvements, there is no anticipated timeframe for implementation. Therefore, the City's master plan recommendations are based on the existing Reclamation Ditch system capacity.

The MCWRA has investigated the required improvements in the "Zone 9 and Reclamation Ditch Drainage System Operations Study" (Draft Report, February 1999).

The recommended improvements in MCWRA's *Zone 9 Reclamation Ditch Drainage System Operations Study* (Draft Report, February 1999) would lower the water surface elevations by 2 to 3 feet along the Reclamation Ditch system from Carr Lake to Markeley Swamp. There have been ongoing discussion and some studies related to the Carr Lake configuration since that time.

Improvements to provide additional system capacity and reduce water surface elevations are required from the downstream discharge outlet (tide gates at Potrero Road on the Old Salinas River) to the upstream detention areas at Smith Lake and Heins Lake that are upstream of the City. The Zone 9 study indicates that most improvements must be implemented starting from downstream to upstream, in order to avoid worsening downstream flooding if upstream improvements are made.

The Zone 9 study also investigated whether a diversion from the Reclamation Ditch system to the Salinas River at Smith Lake upstream of the City would be effective in reducing water surface elevations within the City. The analysis determined that pumping would be required, and there would be a negligible reduction in the water surface elevation of Carr Lake. The study found the most cost effective solution to be the proposed regional improvement project.

5.2 Expansion to Future Areas

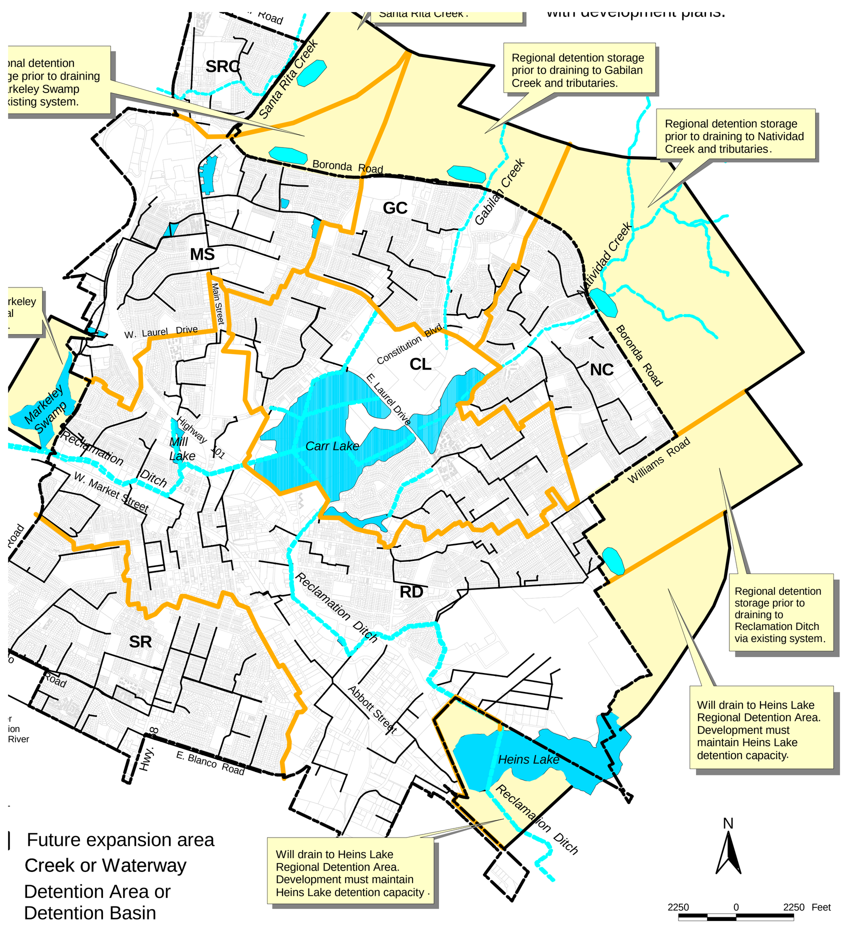
5.2.1 Overview

The area within the current City boundary is essentially built out. Future development will occur primarily north of Boronda Road and east of Williams Road. Some industrial development is also planned for areas west and east of the City. Figure 5-3 shows the future expansion areas, and indicates the major receiving water for each area.

The City's existing storm drain system is already operating at its maximum capacity. The Reclamation Ditch system, which is the ultimate receiving water for the majority of the City, does not have capacity to handle additional runoff. Therefore, future development must participate in the regional detention basins to store the difference between the 10-year pre-development and 100-year post-development runoff prior to discharge to the creeks or to the City's existing storm drain system.

Figure 5-3 shows conceptual locations for new regional detention storage basins. Table 5-1 indicates the approximate required storage volume for each future development area. The specific locations for new detention storage will be determined in conjunction with the development planning process. Depending on the proposed configuration for new development and the size of the drainage area, the regional detention storage may be at one or more locations within each future expansion area.

All new development must either construct detention storage as part of the planned development or participate in implementation of the regional basins. The planning criteria applicable to the new regional detention basins are discussed in detail in



Future expansion area
Creek or Waterway
Detention Area or Detention Basin
Existing Pipe
City Boundary
Watershed Boundary
Future Regional DetentionStorage (conceptual location)

Note: Detention storage will be required for new development to limit flows to the available capacity of existing City system and avoid impacting the Reclamation Ditch System and Carr Lake.

Figure 5-3
Future Expansion Areas

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Section 3.4 Stormwater Detention. Basin design must incorporate features that provide storm water quality benefits, while still meeting flood control needs. Basin design must include appropriate landscaping, and recreational features that can be used during the dry season.

Storm drains to serve new development will be constructed as part of the development. As development occurs in the future areas, developers will be required to provide the proposed storm drain layout for their areas to the City for review and approval. The requirements for storm drain system sizes and design will be as specified in the City's Design Standards. Developers will be required to size the storm drains serving their development for ultimate buildout of the tributary drainage area including any off-site drainage that would be conveyed by the facilities. The storm drain systems would outlet to detention storage, and the detention areas would outlet to either the creeks or the City's existing storm drain system, as appropriate for the particular location, at a discharge rate that would not exceed the capacity of the downstream system.

No new development is planned for the Salinas River drainage area. This is the only area that does not ultimately drain to the Reclamation Ditch system. The stormwater pump station and detention basin are adequately sized for the current drainage area, but have no excess capacity to add additional areas to this system.

Each future development area shown on Figure 5-3 is discussed in detail below.

5.2.2 North of Boronda Road

The area north of Boronda Road is within the Santa Rita Creek, Markeley Swamp, Gabilan Creek and Natividad Creek drainages. Detention storage will be required for new development in this area.

Most of the westernmost portion of the north area is within the Santa Rita Creek drainage. There are no existing storm drains draining to Santa Rita Creek that are of adequate size to convey additional runoff from new development. In addition, some reaches of Santa Rita Creek through the City are already at capacity during major storm events, particularly the reach through Santa Rita Park that is adjacent to an existing elementary school. Detention storage will be required for the new development area prior to discharge to Santa Rita Creek.

Some of the western portion of the north area drains to Markeley Swamp. Some existing City storm drains extend to Boronda Road and currently convey off-site agricultural runoff that overtops the tailwater ditches north of Boronda Road. These storm drains are part of the Markeley Swamp drainage system. These storm drains include:

- 36-inch pipe in Delancey Street
- 60-inch pipe in McKinnon Street

Both of these pipes are upstream of several existing detention basins. Stormwater detention will be required for new development north of Boronda Road to avoid impacting the existing basins and overloading the downstream storm trunkline to Markeley Swamp that conveys runoff from a large commercial area. The detention storage for the new area would drain into the existing pipes in McKinnon and/or Delancey Streets at a low rate.

An existing 24-inch pipe in San Juan Road between Main Street and Boronda Road has no available capacity for additional runoff from north of Boronda Road.

The middle portion of the area north of Boronda Road is within the Gabilan Creek drainage. Detention storage will be required for this area prior to discharge into Gabilan Creek or its tributaries to avoid adversely impacting Carr Lake and the Reclamation Ditch. Depending on the location of future detention basins, the detention storage areas could be drained to an existing 42- and 48-inch pipe in Boronda Road between El Dorado Drive and Gabilan Creek that currently conveys agricultural runoff from north of Boronda Road to Gabilan Creek. The full pipe capacity of this line is 50 cfs for 42-inch segment to 120 cfs for 48-inch segment.

The eastern portion of the area north of Boronda Road and west of Williams Road drains to Natividad Creek. There are no existing City storm drain facilities with capacity to serve this area. Detention storage will be required for this area prior to discharge into Natividad Creek or its tributaries to avoid adversely impacting Carr Lake and the Reclamation Ditch.

5.2.3 East of Williams Road

East of Williams Road and north of approximately Bardin Road, future residential development is planned. This area currently drains to the Reclamation Ditch. Detention storage will be required for this area to avoid adversely impacting the Reclamation Ditch.

The following existing storm drains would serve this future area:

- 30-inch pipe in Williams Road (available capacity of 10 cfs for 5-year storm)
- 42-inch pipe in Countryside Drive (available capacity of 50 cfs for 5-year storm)
- 36-inch pipe adjacent to Bardin School (available capacity of 20 cfs for 5-year storm)

These storm drains convey flows to a 66- to 72-inch pipe in East Alisal Street that drains to the Reclamation Ditch.

Another option, depending on the future development plans, would be to convey runoff from this area to the southeast and provide the detention storage in the Heins Lake area. The Heins Lake detention area is discussed below for Southeast Salinas.

Adequate detention storage volume must be maintained for new development that currently drains to Heins Lake.

5.2.4 Southeast Salinas

Two future general industrial areas are planned for southeast Salinas: south of the airport, and east of the Hartnell College East Campus adjacent to the airport.

The area south of the airport is within the Heins Lake drainage. Heins Lake is a dry lakebed that provides detention storage for the Reclamation Ditch system upstream of the current City boundary. The Heins Lake area is subject to overflows and flooding from the Reclamation Ditch during 10-year and greater storms. Future development in this area must be planned to allow continued detention storage, while protecting new development. The Heins Lake detention storage is an integral part of the Reclamation Ditch system and cannot be eliminated without requiring much more extensive downstream improvements than envisioned in MCWRA's Zone 9 Study.

The second area east of the Hartnell College East Campus adjacent to the Salinas Airport also drains to Heins Lake under existing conditions. Future storm drains will be required to convey runoff southwest to the Heins Lake detention area. Although this area is close to an existing storm drain in East Alisal Street, it should not drain to the existing line. The existing storm drains would serve the residential area east of Williams Road, which would be designed for the 5-year storm flows. The industrial area would be designed for the 20-year storm flows.

5.2.5 West Salinas

A small amount of future industrial development is anticipated on the west side of the City. This unincorporated area, known as the Boronda Redevelopment Area, currently has some industrial development. Most of the Boronda Redevelopment Area drains south to Markely Swamp. A portion drains west across Boronda Road to Boronda Lake.

The Monterey County Public Works Department has a storm drain master plan for part of this area. Drainage facilities for this area should be provided separate from the City's existing storm drain system. According to the County's Master Plan, on-site detention storage in this area would not be required, since it would not improve, and may worsen, backwater conditions in Markley Swamp and Boronda Lake.

5.3 Project Implementation

Implementation activities for CIP projects should include:

- Incorporate CIP recommendations into the City's 20-year CIP.
- Evaluate availability of City staff to design and inspect projects or to manage the work of outside consultants.

- Develop a plan for environmental review of projects.
- Conduct preliminary and final design of projects.
- Coordinate the CIP projects with other construction projects such as water, sewer, gas, electric, telephone, or street paving projects that may share common alignments.

Other improvements to the system will be undertaken that are not part of the City's CIP. The CIP does not include new facilities to serve areas that are currently undeveloped. These facilities would be constructed as part of new development. Further actions regarding these non-CIP improvements may include:

- Provide guidance to new development on requirements for system improvements.
- Evaluate availability of City staff to review and approve development improvement plans.

Other general recommendations applicable to both CIP and non-CIP projects include:

- Continue coordination with MCWRA regarding capacity improvements for the Reclamation Ditch system.
- Incorporate new data as it becomes available to refine/update the master plan recommendations.
- Update the Master Plan every 5 to 10 years to reflect changed conditions.
- Coordinate Master Plan updates with NPDES Stormwater Permit renewals and review of drainage fees.

Appendix A
Technical Memorandum on Task 1 Model Review

Technical Memorandum
Salinas Storm Water Master Plan
Task 1 – Model Review

Introduction

The last citywide drainage system model was developed in 1990-91 for the Sewage and Drainage Master Plan (Final Report, January 1992). Significant growth has occurred since that time, especially in the north part of the City. Therefore, the model is substantially out-of-date. In addition, the invert elevations for the 1992 model were not based on comprehensive field survey information and the accuracy of the data is uncertain. A new model will be created for this master plan based on current information on the storm drain system and field survey data of manhole elevations.

This technical memorandum evaluates several hydraulic models with respect to their appropriateness for use in this master plan and subsequently by the City. Factors considered in the evaluation include: appropriateness for modeling urban storm water systems, ease of use, compatibility with the City's GIS and other software, graphics capability, costs to purchase/update to new versions, and model support and documentation.

The following topics are addressed in this technical memorandum:

- Hydraulic Models Evaluated
- Discussion of Hydraulic Models
- Evaluation Findings and Recommendations

Hydraulic Models Evaluated

The following models are evaluated in detail because they are appropriate for analysis of urban storm drain pipe systems:

- Hydra 6.0 (Pizer Inc.)
- Stormwater Management Model – SWMM (U.S. EPA)
- MIKE-SWMM (DHI/CDM customized package of SWMM with user interface)
- MOUSE (Danish Hydraulic Institute - DHI)

The following models are discussed briefly as to why they are not appropriate for the master plan analysis:

- HEC-1 (U.S. Army Corps of Engineers)
- TR20/TR55 (U.S. Soil Conservation Service, now Natural Resource Conservation Service)

Discussion of Hydraulic Models

The following sections provide an overview of these models.

HYDRA 6.0

HYDRA 6.0 consists of several modules for the hydrologic and hydraulic analysis of sewer systems. It is a proprietary package developed and distributed by Pizer, Inc. The modules include a graphical interface to prepare data for analysis and view analysis results, a hydraulic analysis engine to perform the hydrologic and hydraulic computations, and a GIS tool to facilitate graphical data transfer between AutoCAD and HYDRA. HYDRA 6.0 incorporates all the features of the previous HYDRA engine and Hydrographics package. Pizer is currently working on Version 7.0, which will more fully integrate the hydrologic, hydraulic, and GIS modules, but it is not yet available.

HYDRA has internal flow generation routines for simulation of storm water runoff. Also, flows may be input from an external flow generation package. HYDRA provides a choice of three methods of generating flows: (1) a modified rational method; (2) Santa Barbara SCS method; and (3) hydrologic true simulation. The rational method is typically used for relatively small drainage areas. The SCS method was originally developed for large rural basins and has been modified for urban drainage areas. The hydrologic true simulation method is similar to the SWMM runoff generation (described in next section) and would simulate runoff based on drainage area characteristics for a specified design storm rainfall.

HYDRA performs a simple technique of routing hydrographs through a system and computes a hydraulic grade line for the peak flow condition encountered. This model is not dynamic, in that the equations of continuity and momentum are not solved and hydraulic grade lines are computed statically (at one point in time). HYDRA has features to perform backwater calculations and generate hydraulic gradeline profiles. Detention basins are modeled using a user-specified volume-discharge curve.

Since HYDRA is not a dynamic model, it must be carefully used when there are extensive overflows or surcharging in the system. Special techniques must be used to route flows downstream under such conditions. The results must be carefully reviewed and adjusted if needed in an iterative process, in order to ensure that the overflow/surcharge conditions are accurately represented.

EPA Stormwater Management Model (EPA-SWMM)

EPA-SWMM consists of a series of models that simulate the hydrology and hydraulics of storm water, wastewater, or combined sewer systems. Since the original release of the EPA SWMM model in the early 1970's, EPA has continuously maintained and funded periodic updates and improvements to the model. The model simulates both hydrographs and water surface profiles at intermediate points throughout both closed conduit and open channel networks.

The SWMM-RUNOFF module was the first watershed model to be designed exclusively for urban storm water studies. SWMM-RUNOF simulates the runoff hydrograph from a storm event by applying a rainfall pattern to the watershed area and routing the flows through the modeled system. SWMM-RUNOFF first develops an overland flow hydrograph for each subarea based on the subarea physical characteristics. Each subarea is connected to a pipe or channel segment for routing the flows through the pipe and channel system using the kinematic wave method. The model also identifies surcharge/overflow locations, and calculates the surcharge/overflow volumes and durations. SWMM-RUNOFF results can be saved for input to the Extended Transport (EXTRAN) module of SWMM to perform hydraulic routing.

SWMM-EXTRAN, the hydraulic module of EPA-SWMM, computes a time series of flows and hydraulic grade lines throughout the system using an explicit numerical solution of the St. Venant shallow-water wave equations. The model uses the data from the RUNOFF module to specify system pipeline, junction and flow information for the system to be modeled. The model generates an alpha-numeric output file consisting of hydraulic grade lines at modeled junctions and flows in modeled pipes for specified time increments through the simulation period. SWMM-EXTRAN handles surcharge flow in storm sewers (i.e., full pipes) and backwater effects in open channels. It can be used to simulate the downstream interactions and impacts of outflows from detention ponds, stream crossings (e.g., culverts), and channel improvements.

The source code for EPA-SWMM is in the public domain and can be customized for a given application, although this is rarely required. A benefit of public domain code is that the routines used for hydraulic computations have been carefully scrutinized by a wide range of users and have been tested and verified on thousands of different systems. A SWMM users group meets annually in the U.S., and a network of national and international SWMM users communicate through the Internet and a regular newsletter publication.

EPA-SWMM Version 4.0 and higher has a free format data input file that can be set up using any word processing software. A DOS-based graphical post-processor, Model Turbo View EXTRAN (MTVE), is available for a charge from 10 Brooks Software to view animated EXTRAN results. MTVE has multiple output data display features that allow model results (i.e., flows, hydraulic grade lines, overflow locations) to be displayed in profile or plan view. MTVE also has thematic mapping capabilities to color-code system maps based on modeled parameters such as depth to surcharging and percent of pipe capacity used.

A drawback of the publicly available SWMM RUNOFF and EXTRAN modules is that they are not integrated as part of a user interface package. The modules are easily linked to GIS and other applications using standard GIS formats (such as .shp files in ARC-Info) for data development and graphical display of results, and ASCI files for data manipulation and reporting. However, for staff without extensive modeling experience, an integrated menu-driven package may be easier to handle. There is a customized package called MIKE-SWMM, discussed next, which combines the EPA-SWMM modules with a user-friendly interface.

MIKE-SWMM

MIKE-SWMM is an integrated package that combines the public domain EPA-SWMM RUNOFF and EXTRAN modules with a Windows-based user interface. MIKE-SWMM was developed jointly by Camp Dresser & McKee Inc. (CDM) and the Danish Hydraulics Institute (DHI).

MIKE-SWMM includes a pre-processor for developing input data sets for the RUNOFF and EXTRAN modules. The current versions of RUNOFF and EXTRAN are included as part of the MIKE-SWMM package. MIKE-SWMM also includes a user-friendly results viewer (post-processor) called MIKE-VIEW to graphically present model results, such as hydraulic gradeline profiles and surcharge/overflow locations, and to generate reports.

As explained for EPA-SWMM, EPA keeps the RUNOFF and EXTRAN modules up-to-date, and updated versions are available free of charge. MIKE-SWMM is kept up-to-date by DHI to ensure that it is always compatible with the latest version of EPA-SWMM.

MOUSE

MOUSE is the hydrologic/hydraulic analysis portion of a suite of water-related models from the Danish Hydraulic Institute (DHI). DHI is a privatized provider of water resources software and consulting services throughout the world.

MOUSE computes a time series of flows and hydraulic grade lines throughout the system using an implicit numerical solution of the St. Venant shallow-water wave equations. The model uses a link-node representation for pipes and junctions and requires setting up an input data set to specify system pipeline, junction, and flow information for the system to be modeled. The model generates an alpha-numeric output file consisting of hydraulic grade lines at modeled junctions and flows in modeled pipes for specified time increments through the simulation period.

Similar to the other dynamic models, the MOUSE package has internal flow generation routes that allow simulation of storm water flows. Also, flows may be input from an external flow generation package.

MOUSE-GIS provides an interface with the MOUSE model through ArcView. This interface provides network building and model interpretation tools in a GIS environment.

HEC-1

The HEC-1 model (Flood Hydrograph Package) developed by the Army Corps of Engineers, is particularly applicable to less developed drainage basins. HEC-1 tends to be more useful in applications involving large subbasins in less developed areas.

HEC-1 is primarily a hydrologic model to generate storm water flows. The HEC-1 model analyzes small portions (subbasins) of the drainage basin. It models the physical characteristics of each subbasin, such as slope, roughness, and infiltration, and generates runoff hydrographs at desired locations for a given rainfall pattern.

HEC-1 cannot simulate flow through storm sewers and backwater and surcharge effects. HEC-1 is often run in series with the steady-state HEC-2 model for backwater analyses and the development of water surface profiles.

Therefore, HEC-1 is not considered an appropriate model for analyzing the City's storm drainage system.

TR-20/TR-55

The TR-20 model (SCS, 1982) was originally developed by the Soil Conservation Service (now the Natural Resource Conservation Service) for evaluation of flood protection measures in small agricultural watersheds. It relies upon "SCS Curve Number" hydrology which was originally derived for non-urban land uses only (SCS, 1969).

With the release of SCS Technical Report No. 55, known as TR-55, SCS curve number hydrology was routinely applied to urban watersheds, even though the original hydrologic methods were not intended for urban storm water studies (SCS, 1975). The popularity of this "urban" hydrologic method stems from the fact that it is a simple step-by-step procedure that does not require extensive engineering judgment or a detailed understanding of basic hydrologic/hydraulic principles.

However, the hydraulics computations in TR-20 are restricted to open channels and reservoirs, meaning that it cannot directly simulate storm sewer systems. In addition, some studies have suggested that the SCS curve number hydrology, which was developed for rural areas, may not be as accurate as some other methods for urban storm water systems.

Therefore, TR-20/TR-55 is not considered an appropriate method for the master plan analysis of the citywide urban storm drain system.

Evaluation Findings and Recommendations

Table 1 summarizes the key features of the four models that would be appropriate for analysis of an urban drainage system.

Based on our evaluation, we recommend that the City continue using the HYDRA model. The City already has the HYDRA software, and City staff is already familiar with it. HYDRA has a menu-driven format and built-in GIS and graphics tools, which are helpful to users who do not have extensive modeling experience. By staying with HYDRA, the City would continue using the same software as in the past for both its storm and sanitary sewer systems. The disadvantage of HYDRA is that it is not a dynamic model, and requires special techniques to route flows in overflow/surcharge conditions. However, we think the model can be used to appropriately model the Salinas storm water system, and do not feel that this limitation is sufficient to require changing to another model. If HYDRA is utilized, we will conduct checks of the reasonableness of the model results as part of the master plan analysis.

While EPA-SWMM, as a dynamic model, would provide more accurate routing than HYDRA under some conditions, it is not as user-friendly as HYDRA without purchase of the MIKE-SWMM pre- and post-processors. MIKE-SWMM would provide a windows-based package that includes the EPA-SWMM RUNOFF and EXTRAN modules. However, even with MIKE-SWMM, it would not be easier to use than HYDRA for those without extensive modeling experience. In addition, if the City were to convert to SWMM for the storm water system, the sanitary sewer model should also be converted at the time of the next comprehensive update of the Sanitary Sewer Master Plan, so that the City would continue using the same model for both systems.

MOUSE is very expensive relative to HYDRA, SWMM, or MIKE-SWMM. MIKE-SWMM is comparable to MOUSE and much less expensive. Therefore, there do not appear to be any advantages to the City of utilizing MOUSE.

Table 1
Summary of Hydraulic Models

Characteristic	***Model Name***			
	Hydra 6.0	***EPA-SWMM***	***MIKE-SWMM***	***MOUSE***
Background/Development	Developed by Pizer about 1980.	Developed by EPA in 1973, and continuously updated since then.	Uses EPA-SWMM in package with Windows-based menu-driven pre- and post-processors developed by DHI/ CDM.	Developed by Danish Hydraulics Institute (DHI).
Distributor	Pizer, Inc.	EPA via the Internet Site http://www.ccee.orst.edu/SWMM	DHI through CDM.	DHI.
Applications	Applications throughout U.S. for sanitary sewer and storm drain (more for sanitary than storm)	Appropriate for storm water and sanitary sewer system analysis. Thousands of applications throughout U.S.	Same as for EPA-SWMM.	Primarily applied in Europe. A few U.S. applications.
Solution Technique	Hydrologic flow routing technique. Steady-state hydraulic grade line solution.	Explicit solution of the St. Venant shallow water wave equations in EXTRAN module. Fully dynamic flows and hydraulic grade line solutions	Same as for EPA-SWMM.	Implicit solution of the St. Venant shallow water wave equations. Fully dynamic flows and hydraulic grade line solutions.
Flow Generation	Internal flow generator available for modified rational method, SCS method, and hydrologic true simulation. Also accepts input from external packages.	SWMM RUNOFF has hydrologic continuous simulation, unit hydrograph and other surface runoff generation routines that may be linked to EXTRAN.	Same as for EPA-SWMM.	Internal flow generator available. Also accepts input from external packages.
Ability to Handle Surcharge/Overflows	Requires special techniques since it is a static model.	Good – built-in features since it is a dynamic model.	Same as for EPA-SWMM.	Similar to SWMM.
Ability to Model Detention Basins	Yes	Yes	Same as for EPA-SWMM	Same as for SWMM.
Graphical, GIS Capabilities	Windows-based pre- and post-processors come with package. GISMaster Module links Hydra with AutoCAD to display results. Links to other GIS packages available.	Windows-based pre-processor available from EPA to create and edit data input files. DOS-based graphical post-processor available (MTVE) from 10Brooks Software.	Windows-based menu-driven pre-processor and post-processors for easy creation of data input files, data editing, graphical display of model results, and generating reports.	Includes MOUSE-GIS, a Windows-based pre- and post-processor that will run from within ArcView.
Model Cost	Price varies by model size. Price is $5,500 for 1,500 pipes and $8,500 for 3,000 pipes.	None for SWMM. MTVE costs $1,000.	$2,250 for unlimited pipes (available through CDM at this discounted price, which is 50% of regular price).	Price for the model and ArcInfo link is $12,500 for up to 2,000 pipes, and $14,000 for unlimited pipes.
Source Code Availability	Proprietary code not available to user.	Yes, non-proprietary code is available to user.	EPA-SWMM modules non-proprietary code available. Pre- and post-processor code not available.	Proprietary code not available to user.
Vendor Support	Limited initial free telephone support. Annual support available for a fee.	Support through EPA and users groups.	Support through EPA and users groups for hydrologic and hydraulic modules. Support through DHI for entire package – one year free, then $450 annual fee	One year of free support; annual support fee at 10 percent of software cost.
Model Documentation	Hardcopy and on-line manuals. Hypertext links to help.	Hardcopy and on-line manual.	Hardcopy and on-line manual.	Hardcopy and on-line manuals. Hypertext links to help.
Training Options	No regular training courses. Customized training available.	Training courses offered annually to bi-annually.	EPA sponsored courses on RUNOFF and EXTRAN. Customized training available from DHI /CDM.	No regular training courses. Customized training available.

Appendix B
Technical Memorandum on
Task 10 Alternative Funding Sources

Salinas Stormwater Master Plan
Final Task 10 Technical Memorandum
Alternative Funding Sources

Background on Current Funding Sources

The City of Salinas has worked to provide funding mechanisms for stormwater system improvements, operation, maintenance, and compliance with regulatory requirements such as NPDES stormwater quality requirements.

The City collects development fees for all construction requiring a building permit. A storm drain fee is collected to provide new drainage facilities to handle additional runoff generated by new development. The current development fees are: $4,355 per acre for commercial/industrial development, $3,474 per acre for schools, and $343 per bedroom for residential units. In addition, the City requires that new development construct the storm drain improvements that are required to serve their development, including required off-site improvements.

Due to the severe funding constraints placed on the General Fund, the City Council implemented a storm sewer fee in July 1999. The City developed the fee based on the percent of impervious area and its relative contribution to stormwater runoff to the City's stormwater system. The fee was applied to all parcels within the City and collected on the property tax bill.

In August 2002, legal challenges resulted in invalidation of the fee. After the fee was implemented, the Howard Jarvis Taxpayers Association challenged it as not meeting the requirements of Proposition 218. The Monterey County Superior Court found in favor of the City and upheld the fee. The Howard Jarvis Taxpayers Association then appealed the decision to the State Appeals Court.

In early June 2002, the State Appeals Court reversed the Monterey County Superior Court decision and found that the fee did not meet the requirements of Proposition 218. The City then petitioned the State Supreme Court to review the Appeal Court decision. On August 28, 2002, the State Supreme Court denied the City's request to review the case. Due to the State Supreme Court decision, the storm sewer fee was invalidated and could no longer be collected as of the date of the decision.

The City has been forced to find other sources to replace revenues formerly provided by the storm sewer fee. Since late 2002, gas tax revenues have been used for NPDES storm water program activities. Gas tax revenues are being used until a viable permanent funding source can be identified. In the meantime, the City is deferring street improvements that would otherwise have been funded from the gas tax.

The decision by the State Supreme Court blocked the imposition of a stormwater fee on owners of improved or undeveloped graded properties by considering it a "property related" fee subject to Proposition 218 balloting. Existing law, established by Proposition 218 in 1996, requires local voter approval of certain property-related fees. The imposition or increase of a property related fee or charge must be approved by a majority vote of the property owners subject to the fee or charge or, at the option of the agency imposing the fee or charge, by a 2/3 vote of the electorate residing in the area affected by the fee or charge. Proposition 218 exempts certain types of fees, such as those for water, sewer, and refuse, from the voter approval requirements of Proposition 218.

Assembly Constitutional Amendment 10 (ACA 10), a proposed amendment to the State Constitution, would add exemptions for fees for stormwater and urban runoff management to the sewer, water, and refuse fee exemptions already included in Proposition 218. The proposed amendment would make the classification of storm water and urban runoff management fees or charges consistent with the Proposition 218 (1996) classification of similar fees or charges related to sewer, water, and refuse collection services. If passed by the legislature, this Amendment would be placed before the voters for approval in the March 2004 statewide primary election ballot.

The current inconsistency creates an unnecessary and presumably unintended barrier to local governments' ability to raise funds to reduce pollutants in storm water. ACA 10 would address this barrier by correcting a technical inconsistency in the law while maintaining the spirit of the limited exemptions allowed under Proposition 218. ACA 10 would make it easier for cities to fund and comply with new and increasingly stringent federal Clean Water Act National Pollutant Discharge Elimination System (NPDES) Stormwater Permit requirements adopted by the California Regional Water Quality Control Boards for pollution prevention programs for stormwater and urban runoff.

As it now stands pending approval of Assembly Constitutional Amendment 10 (ACA 10) and/or any future successful appeal or review by the State Supreme Court, potential approaches for implementing a storm sewer fee may include:

1. Pursuing a stormwater fee drafted to be legally clear that the fee imposed is on the stormwater runoff contributor as opposed to those who own improved property, i.e., that it is <u>not</u> a "property-related" fee. The City's approach already ties the amount of the fee to the amount of impervious area, which is a direct indicator of that it is tied to the stormwater runoff contribution. This linkage should be made clear in the legal language. It may also be helpful with this approach for the City to identify an alternate billing mechanism that does not rely on collecting the fee through property tax bills in order to be clear that it is a fee for services provided, not a property-related fee.

2. Treating the stormwater fee as a property owner "assessment" and complying with Proposition 218's requirements for voter approval.

3. Using a combination of other funding methods that are discussed in this memo.

Alternative Funding Mechanisms

The remainder of this memo contains a brief description of alternative funding mechanisms for the stormwater system. Table 1 summarizes the major funding mechanisms and indicates their relative availability (likelihood of implementation).

Table 1
Summary of Alternative Funding Mechanisms for Stormwater Management Activities

Funding Option	*Availability*	*Applicability*			
		Program Administration, Engineering, Construction Inspection	*Operations and Maintenance*	*Water Quality Monitoring*	*Capital Improvements*
Development Contributions					
Subdivision Requirements	Current				✓
Development Fees	Current				✓
General Fund	Limited	✓	✓	✓	✓
General Obligation and Revenue Bonds	Possible	✓			✓
Special Districts					
Local Assessment Districts	Possible		✓		✓
Mello-Roos Community Facilities District	Unlikely				
Surcharges on Flood Control Assessments of Special Districts	Unlikely				
Stormwater Utility (Stormwater User Fee)	Potential	✓	✓	✓	✓
Federal/State/County Grants and Loans					
Federal	Unlikely				
State/County	Potential	✓		✓	✓
Supplemental Revenue Sources					
Local Taxes	Unlikely				
Fees/Licenses/Permits	Current	✓			
Penalties and Fines	Current	✓			

Development Contributions

Stormwater improvements for new development can be financed through development contributions. Two methods for development contributions are discussed below: subdivision requirements and development fees. The City of Salinas currently uses both methods.

Subdivision Requirements

As a condition for development approval, many municipalities require the developer to construct stormwater management facilities to serve the development and dedicate them to the City upon completion. In addition, developers can be required to donate drainage easements or other land use rights to the City for stormwater management purposes. The City then assumes responsibility for the facilities' operation and maintenance.

The advantage of this funding option is that the facilities are built concurrently with development and serve development's needs at the developer's capital expense. However, this approach does not provide for funds to continue operation and maintenance of the constructed facilities.

Development Fees

When an area is being developed for residential, commercial, or industrial purposes, a fee can be levied against the developer to offset the capital costs of infrastructure improvements. These charges are designed to provide a mechanism by which owners of properties which will be developed in the future share in the cost of constructing infrastructure improvements which will eventually benefit them.

General Fund

Each year, certain monies from the City's General Fund may be allocated for the stormwater system based on public hearings before the City Council. A specific allocation of funds for stormwater management is negotiated during the annual budget process. However, this funding source is very limited.

The General Fund is made up of many revenue sources and can be considered as a "bank" into which revenues are placed, and from which many municipal services are funded. However, it is a limited source of revenue and the competing demands for funding usually place stormwater improvements below more immediate priorities, such as public safety and health.

General Obligation and Revenue Bonds

General obligation and revenue bonds are normally used by municipalities to pay for large capital improvements projects. Bonds allow large-scale projects to be initiated when the facilities are needed rather than waiting until the funds are accumulated. In some cases, it may be possible to structure bond issues as Certificates of Participation (COP's) in order to eliminate the need for Proposition 218 voter approval.

General obligation bonds rely on their security through the taxing powers of the issuing agency. Unlimited and limited general obligation bonds are backed by the full faith and credit of the City and are paid for through property tax levies. Unlimited general obligation bonding typically requires voter approval. Limited general obligation bonding can typically be undertaken by Council action alone.

Revenue bonds require both the demonstration of adequate revenues and the pledge to create and maintain a reserve fund. It is typically necessary to establish a fiscal track record to secure cost-effective revenue bond rates. Revenue bonds are typically backed by the revenues of a utility fund. Revenue bond funding may be established without voter approval.

General obligation bonds are a less costly form of debt than revenue bonds (excluding costs related to securing voter approval via a bond election), and are administratively easier to manage. Conversely, revenue bonds offer ease of administration, but are the most costly form of debt financing due to issuance costs and coverage requirements. Both general obligation and revenue bond financing are geared toward supporting specific capital improvements, and have been successfully employed by other jurisdictions for stormwater facilities construction.

Special Districts

Three funding mechanisms associated with special districts are discussed below: local assessment districts; Mello-Roos community facilities districts; and surcharges on flood control assessments of water districts.

Local Assessment Districts

Assessment district financing provides a vehicle to apportion the cost of improvements to those who will benefit by issuing bonds which are then repaid with revenue generated by assessing direct beneficiaries of the improvements. Assessment districts can be a good method of funding public works improvements in a favorable bond market due to the limited taxing ability of public agencies. Assessment districts can also be established to fund ongoing maintenance costs, as well as for construction of improvements.

Assessment districts may include new developments and existing developments. The property owners in a new development generally pay 100 percent of the costs to finance infrastructure improvements. However, in some cases, the cost of improvements constructed in existing developed areas may be shared with the City. Property owners within the boundaries of the proposed district must agree to the establishment of the improvement district.

Projects funded through the district must have an identifiable benefit to the properties included in the assessment area, and charges for each parcel must be consistent with the relative benefit to each property. However, it may be difficult to quantify the benefit to individual properties for stormwater improvement districts. In sewer improvement districts, the benefit is normally determined through frontage along the improvement. The situation in drainage differs in that upstream or hillside properties that are major runoff contributors may not be specific recipients of project benefits, and therefore not required to participate in the district.

Mello-Roos Community Facilities District

The Mello-Roos Community Facilities District Act allows cities to form a separate district to finance certain public facilities on a pay-as-you-go basis, certain public facilities through the sale of bonds, certain public services on a pay-as-you-go basis, or any combination of these methods. The sponsoring public entity is authorized to collect a special tax within the district.

A community facilities district may provide for the planning, design, purchase, construction expansion or rehabilitation of any real or other tangible property with an estimated useful life of at least five years. The district may include areas that are not contiguous, and the facilities need not be physically located within the district.

A Mello-Roos community facilities district may provide flood and storm protection services including the operation and maintenance of storm drainage systems. However, it may provide only services in addition to those provided before the district was created and may not supplant those services already available within the district.

Surcharges on Flood Control Assessments of Special Districts

California law permits the establishment of districts for special needs/services. This type of district typically is created for flood control and other special usages, like irrigation, sanitary sewers, and potable water systems. In California, there is a Flood Control and Water Conservation District associated with most of the counties, which is the Monterey County Water Resources Agency. The funding or revenue base of these districts is generally either the property tax based on assessed value or an assessment per parcel based on the benefit received. Revenues generated within a district can be used only within that district.

Stormwater Utility (Stormwater User Fee)

A stormwater utility (stormwater user fee) involves funding local stormwater management programs through a monthly or quarterly fee assessed to all property owners. A correlation exists between the stormwater runoff potential of a parcel and the cost of the stormwater management services provided to that parcel. Therefore, the user fee is based upon each parcel's contribution of stormwater flow to the local facilities. The user fee covers local costs for operation and maintenance, basin planning, facility construction, and program administration, similar to user fees for other public utilities.

The stormwater user fee is typically based on the square footage of impervious ground cover (e.g., rooftops, driveways, parking lots), since imperviousness is a common indicator of stormwater flow and can be quantified. The average impervious area per dwelling unit (in square foot) for residential land use categories is typically designated as the "base unit" for the utility fee structure. This base unit is called an Equivalent Residential Unit (ERU). The base unit represents the stormwater discharge potential of the average residential dwelling and its associated lot. It can be based upon all residential development (including multifamily), which is referred to as average residential unit basis, or on single-family residential development only, which is referred to as single-family residential unit basis.

The stormwater utility typically charges a "flat fee" to each residential dwelling and charges a non-residential parcel based upon the ratio of the parcel's impervious area to that of the base unit. For example, if a commercial parcel has four times as much impervious area as the base unit, the commercial site would be billed four times the monthly flat fee for residential dwellings.

A stormwater utility is a more equitable funding mechanism than reliance on general fund revenue or special districts, since charges assessed to each parcel of land are based upon usage of the drainage system rather than property value. Because commercial and industrial properties generally generate much more runoff and stormwater pollution per square foot than single-family residential properties, commercial and industrial sites are charged a proportionately greater fee by the stormwater utility.

Federal/State/County Grants and Loans

State Propositions

Several propositions have been approved for bond issues at the State level to fund various types of infrastructure. Each proposition has its own application and approval requirements and criteria. The funds are administered by various agencies. There is significant competition, and active lobbying is generally required to successfully obtain funds.

Proposition 13

Proposition 13, the Safe Drinking Water Bond Act was approved in March 2000 and provides $1.9 billion for safe drinking water, flood protection and water quality programs focused on addressing California's water problems. Any currently uncommitted Proposition 13 funding will be determined by Legislative appropriation and competitive grants awards from the SWRCB, DWR, and other state agencies.

Proposition 40

Proposition 40, approved in March 2002, provides $2.6 billion bond for water, habitat, air and park-related projects. Proposition 40 provides every city and county with funds on a per capita basis to make parks safer with the goals of promoting tourism to the state, providing safe playgrounds for kids, preserving coastal lands and improving air quality. Many potential applicants for Proposition 40 monies are actively pursuing legislative-lobbying efforts to secure allocations of this funding. Competitive and programmatic grant programs have already begun.

Proposition 50

Proposition 50, known as the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002, passed in the November 2002 elections. Proposition 50 provides for a $3.4 billion state General Obligation bond measure. Proceeds from the sales of the bonds will fund a variety of water projects.

Allocation of Proposition 50 monies has not been determined yet. Active lobbying for allocation of legislatively-appropriated and directed funding has already started. It is very likely that there will be interaction between Proposition 40 and Proposition 50 for both legislatively-direct appropriations and availability of state agency-administered competitive grant funding.

State/County Cost Sharing

At the state level, drainage and flood control funding mechanisms administered by the State of California through the Department of Water Resources are well defined; but availability of funds is uncertain due to state budget and appropriation decisions.

The County Transportation Authority is typically responsible for distributing funds from the California Department of Transportation related to design and construction of State roads.

State Revolving Fund

The Federal Water Pollution Control Act, as amended in 1987, provided for establishment of a State Revolving Fund (SRF) loan program, which is administered by the State Water Resources Control Board (State Board). SRF loans are intended to assist municipalities in funding the following types of water pollution control project: implementation of nonpoints source (NPS) pollution control projects or programs; development and implementation of estuary conservation and management programs; and construction of wastewater treatment facilities.

Examples of eligible non-point source projects for SRF loans include construction of demonstration projects, retention/detention basins, wet ponds, infiltration strips, grassy swales or any other structures intended to remove pollutants. Non-point source programs include training, public education, technology transfer, ordinance development, development of pollutant source reduction management practices or any activity associated with non-point source pollution control.

The interest rate on an SRF loan is 50 percent of the interest rate on the most recently sold general obligation bond. The maximum amortization period is 20 years. Loans may cover up to 100 percent of the cost of planning, design, and construction of non-point source pollution control structures and 100 percent of non-point source pollution control programs. The borrower must begin making annual repayments of principal and interest one year after completion of the project or implementation of the program.

Federal Urban Creek Restoration Program

Chapter 2, Title 23, of Subchapter 2.4 of the California Code of Regulations provides for a grant program under the Urban Creek Restoration and Flood Control Act of 1985. This Urban Creek Restoration Program is intended to protect, restore, and enhance urban creek channels by combining effective, low cost flood control with preservation and enhancement of the natural environment. Its purpose is to reduce flooding and erosion in ways which restore the ecological viability of creek environments located in predominantly urban areas, thereby enhancing aesthetic, recreational, and fish and wildlife values.

Some grant funding in limited amounts is available for eligible project costs associated with the projects approved under this program. The grant application cycle is conducted on an annual basis. Applications are submitted to the California Department of Water Resources, who is responsible for administrating the program and establishing an annual priority list for receiving available funds.

U.S. EPA State/Tribal Wetlands Grant Program

The U.S. Environmental Protection Agency (EPA) has expanded its State/Tribal Wetlands Grant Program to include local grant recipients, including city, county, and regional government agencies, regional planning boards, and local conservation districts who support efforts to protect wetland resources. This grant program will support projects in two broad categories, including wetlands/watershed protection projects and river corridor/wetlands restoration.

EPA will give priority to local government projects that involve cooperative restoration, incentive programs, voluntary efforts, joint public/private partnerships, and consensus-based watershed planning. Priority also will be given to projects that develop partnerships among federal, state, and local governments involved with wetlands protection and restoration.

Applications are submitted to the U.S. EPA. A 25 percent match in funding is required for local projects.

Nonpoint-Source Implementation Grants

This funding option is based on federal grants provided to the states to implement nonpoint-source mitigation projects and programs in accordance with Section 319 of the Clean Water Act. Examples of projects that 319(h) grants cover are implementation of best management practices (BMPs) in agricultural settings; implementation of BMP systems for lake, estuary, or stream watersheds; and basin wide education programs. These grants are funded federally for 60 percent of the cost of the project, with a local match of 40 percent.

Stream Restoration Mitigation Bank

This funding mechanism is relatively new, and the bank can be either a public or public/private relationship tool. To qualify, communities must assess their streams for restoration, preservation, and enhancement, and then submit a plan to the United States Army Corps of Engineers for approval and the establishment of the bank. If local governments develop the bank on their own, they can sell the credits for the restoration of the stream segments. If a partnership is established, a bank is created and credits sold for development of the streambank program.

Federal Metropolitan Transit Authority's TEA-21

The Transportation Equity Act for the 21st Century (TEA-21) signed June 9, 1998, reauthorized, modified and extended ISTEA which continued the improved relationship between transportation and the environment. ISTEA made wetlands mitigation efforts eligible under both the National Highway System and Surface Transportation Program. Eligible activities included mitigation banking, wetland preservation and restoration efforts, and State and regional wetland planning. TEA-21 retains wetland mitigation project eligibility and has added natural habitat. It allows up to 20 percent of reconstruction, resurfacing, rehabilitation or restoration project costs for environmental restoration and pollution abatement, including retrofit or construction of stormwater treatment systems to address environmental problems caused or contributed to by transportation facilities. Other eligible activities, including purchase of scenic easements, scenic beautification and landscaping, preservation of abandoned railway corridors, and mitigation to address water pollution due to highway runoff, are reauthorized with 40 percent more money. Contingent upon regulations implementing changes made by the reauthorization, state transportation agencies will be able to undertake a variety of measures to combat air pollution, restore and preserve wetlands, and otherwise mitigate environmental impacts.

Other Supplemental Sources

Other supplemental revenue sources are discussed below. None of these are sufficient as a major funding method. However, all are compatible as a supplemental source with any of the major methods previously discussed.

Local Taxes

A public agency can apply a general tax against property for a demonstrated revenue need. Taxation would be an appropriate financing device where the public need is apparent to the electorate. Special taxes may be levied per house, per lot, per lot size, or on any other appropriate basis.

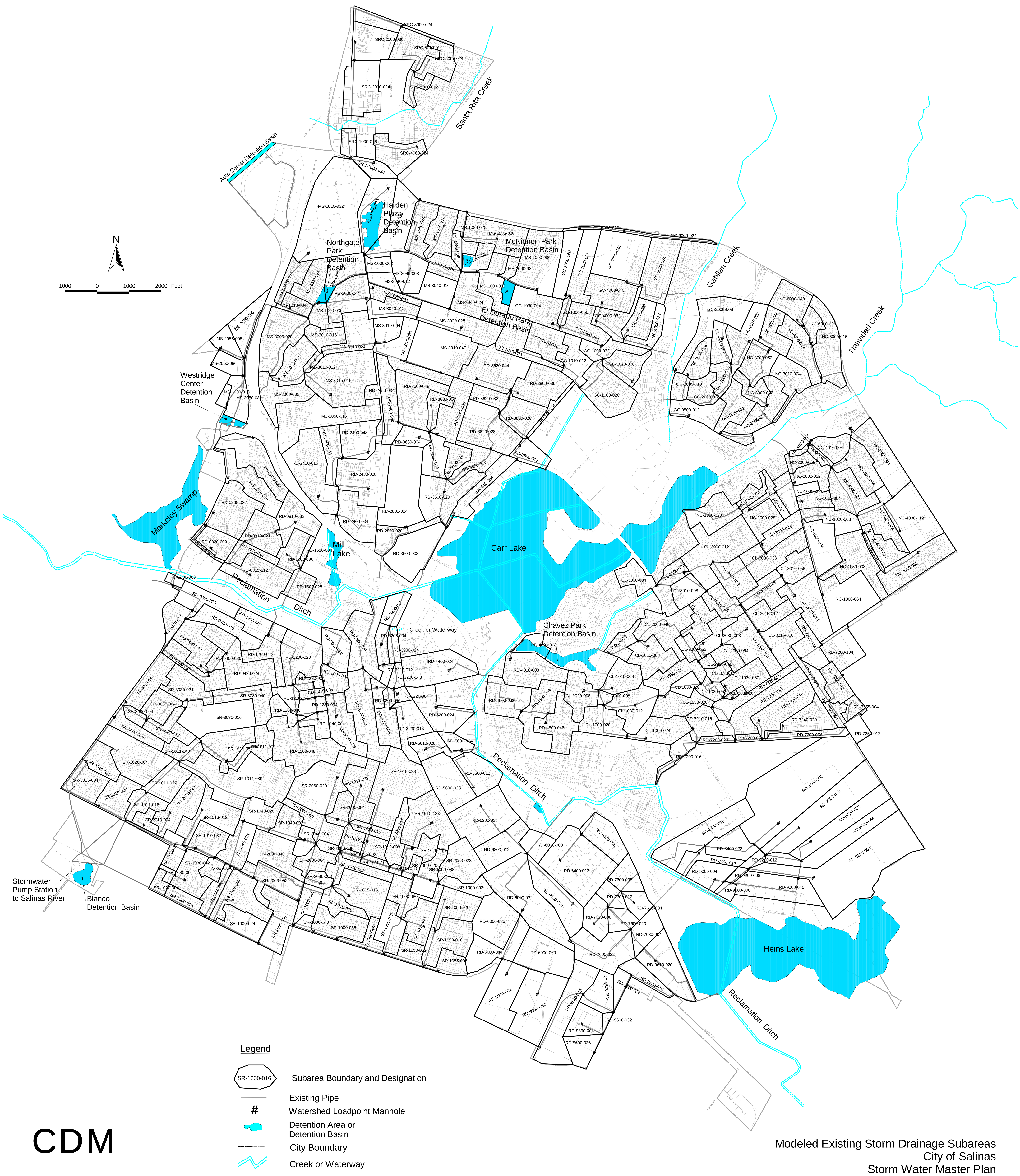
California municipalities have enabling legislation that would allow the funding of stormwater management construction projects with a local option sales tax if approved by voters. The revenue from this tax has very specific limitations. The focus of these limitations is aimed at funding general purpose construction projects. Funds from this source cannot be used for administration or the operation and maintenance of local governmental facilities.

Fees/Licenses/Permits

Charges can be imposed for plan review, issuance of applicable licenses and permits, and construction inspection of new stormwater facilities. Revenue from this source is limited to the recovery of the associated costs and can only be viewed as a supplemental revenue source.

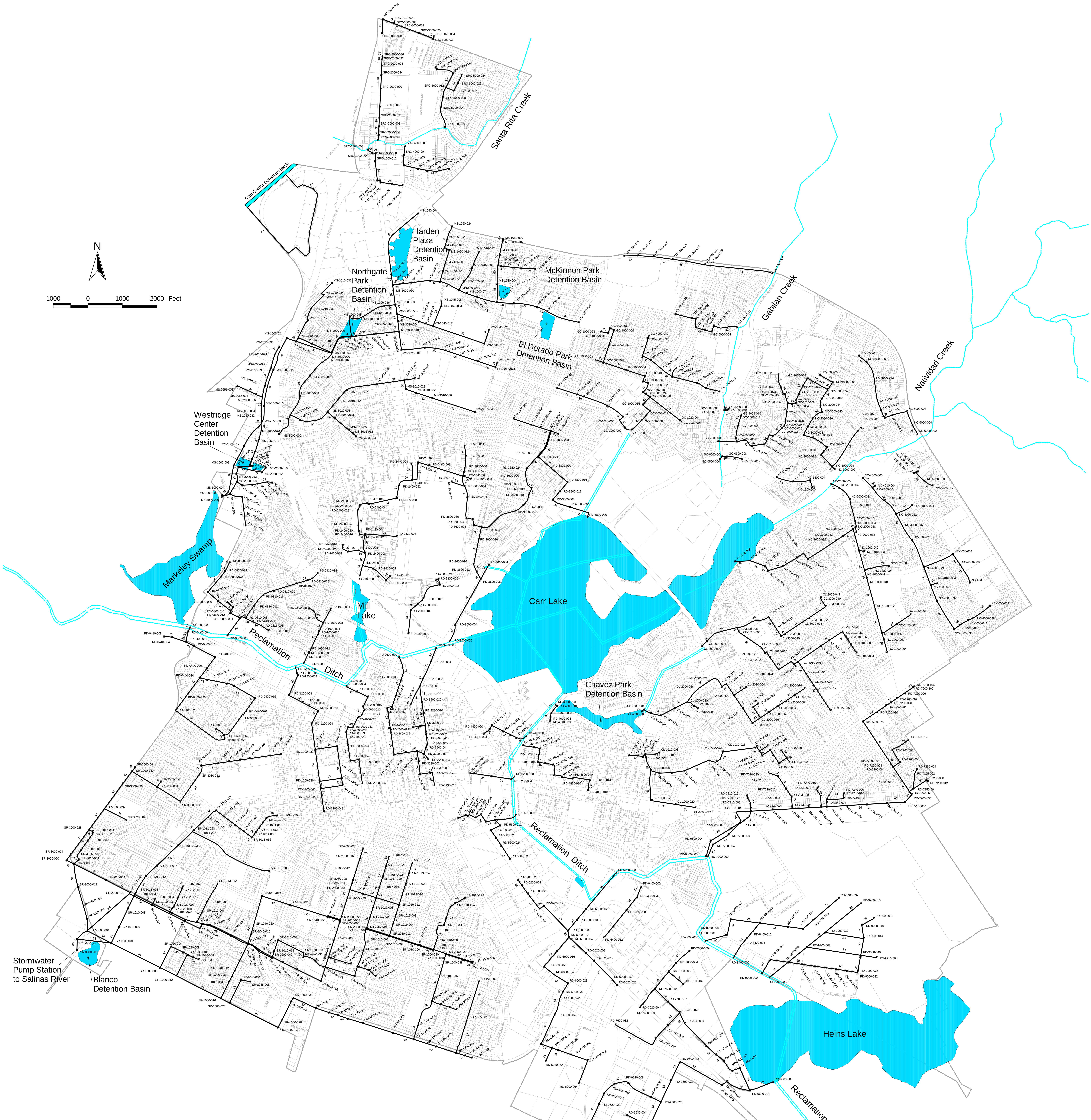
Penalties and Fines

Revenues from penalties and fines are limited, but could be considered a supplemental revenue source. Although such income can be placed in the General Fund, it could be used to correct the specific violations and improve enforcement.



CDM

Modeled Existing Storm Drainage Subareas
City of Salinas
Storm Water Master Plan
April 2004



Legend

24 Existing Pipe and Diameter (inches)

SR-1000-016 Manhole and Designation

Detention Area or Detention Basin

City Boundary

Creek or Waterway

CDM

Modeled Existing Storm Drainage System
City of Salinas
Storm Water Master Plan
April 2004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