Section 4
Storm Drainage Systems Analysis

4.1 Storm Water Models

RMA developed three storm water models for hydrology and hydraulic analysis.

- NRCS TR-55 model was developed for hydrology analysis of watersheds that are north and northwestern of current city limits of Soledad. These areas range in elevation of 190+/- feet to 2000 +/- feet and are mostly covered by natural vegetation of native grasses, scrub brush and oak trees in the drainage courses.

- Gabilan Drive and San Vicente Road Hydra Model for comparison analysis to the 2000 storm drain impact fee study for verification of proposed large storm drainage trunk and outfall lines (48 inch dia to 96 inch dia)

- Miravale III Hydra Model

The HYDRA model was used to generate and route flows for the drainage system analysis. The database was developed from both AutoCAD (release 2007), drawing files (DWG and DXF) and GIS (ARC View). The HYDRA model store information required in GIS format conversion programs and are required to convert the DWG files (AutoCAD) and shape files (ARC View).

Prior to selecting the HYDRA model, an evaluation was done of available hydraulic models and their applicability for the master plan study. Appendix "D" contains a technical memorandum describing this evaluation.

Figures are provided in the report and large maps showing the modeled storm drainage system and sub-basins are included in rear pockets in this report. The modeled storm system includes all main collector pipes for the proposed Miravale III subdivision and only trunk lines and outfall lines with existing city drainage basins and sub-basins.

The HYDRA models were developed for both proposed drainage systems with detention basins and existing drainage system with city-owned detention basin and temporary retention basin, also models were developed for existing drainage system north of Gabilan Drive with the elimination of temporary Toledo Park basin, Santana Park Bain, then with the elimination of the temporary Toledo Park Basin, Santana Park Bain and Veteran's Park Basin (refer to Appendix "C" for details results and drainage calculations).

The result from HYDRA model with the elimination of Veteran’s Park Basin indicates that the existing 54-inch and 84-inch San Vicente storm drain pipe would be severally impacted (both pipes in surcharge and stormwater from 54-inch pipe would overflow into San Vicente Road). The removal of Veteran’s Park basin would require the installation of a parallel storm drain pipe within San Vicente Road from Gabilan Drive to Market Street. The proposed 96-inch storm drain pipeline from San Vicente Road and Market Street to the City’s regional drainage basin would have insufficient capacity and require the size be increased to at least a 108-inche pipeline. Further analysis would be required to confirm the final pipe sizes. The drainage basin information for existing storm drainage system was obtained from City GIS database and the proposed drainage system from tentative maps, GIS and AUTOCAD databases.

The Santa Barbara Urban Hydrograph 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 sub areas 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 sub areas. When two hydrographs are added together, such as where two pipes meet, the hydrographs are attenuated based on the differences in routing time.

The backwater of Salinas River and drainage basin (retention and detention) 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 elevation was 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 the 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 for proposed development were determined from invert and rim elevation from tentative subdivision maps with proposed improvements and the preliminary design information. For existing drainage systems, manhole inlet rim and invert elevations were not available. In lieu of “as-built” elevation data, RMA referred to Soledad G.I.S. contour maps and assigned this elevation as manhole rim elevations. Due to a lack of manhole invert elevations, an assumption had to be made, namely that the top of all pipes are six feet below the existing ground elevations. Therefore the manhole invert elevations are assumed to be six feet, plus the diameter of the pipe, down from the rim elevation.

It appears the existing and proposed grades for Miravale III are based on the National Geodetic Vertical Datum (NGVD) of 1929 which is the same datum as USGS Topographical Maps. The Soldedad G.I.S. contours are based on the North American Vertical Datum (NAVD) of 1988. (There is approximately 2.1 feet difference between the 1929 NGVD and the 1988 NAVD.)

Sub-areas were identified within each watershed draining to concentration points along the modeled storm drain system. These sub-areas are hydraulically isolated drainage areas that define the peak flows at a single point on the modeled storm drain system. The sub-areas 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 sub-areas.

The runoff hydrographs are based on the physical characteristics of each sub-area, which are specified as input parameters in the model. These parameters include sub-area 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 sub-area identification include numbered Watershed Designation followed by Branch Number followed by Pipe Number (XX-XXXX-XXX).

The Watershed designations are: Miravale III (MV III), Upper San Vicente (USV), Central Basin (CB), Bryant Canyon (BC), Lower San Vicente (LSV), Caltrans Basin (CTB), Los Coches Basin (LCB), Mirassou Basin (MB) and Moranda Basin (MRB).

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 grade line profiles. After the checking was completed, the model was used for the storm drainage system analysis.

In addition (if the city so chooses in the future) a recently available add-on module that links the SWMM-EXTRAN to the HDRA model can be used for detailed hydraulic analysis of complex part 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.

4.2 Analysis Methodology

This master plan evaluated the 10 year, 25 year and 100 year design storms as discussed in Section 3.

- The 10 year storm criteria applied to sub-areas that are primarily residential and public facilities (schools, parks, golf courses), and those trunk lines that only convey from those areas to the discharge outlet.

- The 25 year storm criteria applied to sub-areas that are primarily commercial, industrial or mixed use of commercial and multifamily residential and those trunk lines that only convey from those areas to the discharge outlet, and also those trunk lines that convey combined sub-areas from both residential and commercial from those to the discharge outlet.

- The 100 year storm criteria applied to offsite watersheds and onsite open spaces that are part of an original watershed and those trunk lines that convey runoff from those areas to the discharge outlet. The design capacity of trunk lines that share flows from both residential and offsite drainage are designed to conveyed the stormwater from a 10 year storm for residential and the 100 year storm from offsite watersheds and onsite open spaces.

Figures 4-1, 4-2 and 4-3 show the general areas within the study area where proposed existing and future drainage facilities were analyzed for the 10 year, 25 year and 100 year design storms per city standards.

The hydraulic models were used to conduct simulations of the proposed, existing and future drainage systems for these design storms. The individual model results were to identify capacity deficiencies for both proposed and existing drainage systems and design both detention basin or basins, trunk and outfall lines for the future drainage system. The following steps were used to review and prioritize capacity deficiencies.

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

- 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 grade line) would remain below the ground.

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

- 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.

- For those locations with nuisance overflows, no improvements are recommended. Nuisance overflow is considered to be less that 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.

- 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:

- Enlarge proposed detention basin and pipelines (Miravale III)

- For existing drainage, install parallel pipelines to increase capacity and enlarge existing detention or retention basins; increase proposed trunk and outfall pipelines above those indicated in the current Master Plan

- Diversion 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.

- Lowering the beginning water surface elevations at the discharge outlets in order to lower the hydraulic grade line and reduce or eliminate overflows.

- Install storm drain pumping stations at drainage basins and interconnect the downstream gravity drainage system to certain drainage basins with force mains. A feasibility analysis would be required to determine if a pump station would increase the discharge volume of existing storm drain pipes, increase volume of existing or proposed basin by lowering the bottom of basin below the discharge elevation of the basin outfall pipeline, against installation cost, power cost, maintenance cost and replacement cost. It also would be required that the storm drain pump station be included in a future maintenance assessment district.

Insert Figure 4-1

NRCS TR-55 Major Watershed Storm Water Model Map

Insert Figure 4-2

Miravale III HYDRA Storm Water Watershed Model Map

Insert Figure 4-3

Miravale III HYDRA Storm Water Piping Model Map

4.3 Analysis Findings

The newly adopted September 2005 City of Soledad General Plan greatly increases the required planning area for future growth and development. The natural and man made jurisdictional boundaries being the Salinas River and prime agricultural land on both the southerly and westerly sides of current city limits. Soledad State Prison is located approximately two miles westerly of San Vicente Road which at the time is the westerly limit of residential and commercial development. There is also a substantial amount of prime agricultural land between San Vicente Road and Soledad State Prison.

LAFCO has directed that no growth shall occur between the Salinas River and State Highway 101 and the southern side and no growth shall occur on the eastern side of the Bryant Canyon Flood Control Channel.

With the above limits of growth set by LAFCO, the immediate expansion of city limits had to be in a northerly direction towards the surrounding foothills.

This proposed development towards the surrounding foothills has greatly increased the required study area for the Storm Drain Master Plan and required a substantially different storm water model than what was created for the 2000 storm water impact fee study. Another requirement was the creation of multiple storm water models for each watershed.

Section 2.1 provides a detailed description of the major watersheds, drainage basins and sub-basins. Storm water models were created to best simulate individual watersheds, basins and sub-basins.

The NRCS TR-55 storm water model was created by Soil Conservation to determine the storm water runoff from large watersheds with large rolling terrain of hills, valleys, drainage channels and covered with mostly natural grasses, scrub brush and trees.

For the NRCS TR-55 storm water model to calculate the runoff from each watershed, the following items must first be determined and entered into the model.

- Boundary of each watershed
- Delineation of drainage basins of each watershed
- Type of vegetation that covers each drainage basin
- Delineation of drainage channels, of drainage basins
- Calculate the average slope of each drainage channel
- Calculate the average ground slope of each individual sub-basin that contributes runoff into the drainage channel
- Select a type of rainfall storm for the Salinas Valley, California
- Select the design storms for the model (2-year, 10-year, and 100-year)
- Create connectivity of drainage basin in each watershed

The NRS-TR55 storm water model was created for both Moranda Basin (northwest expansion area) and Mirrasou Basin (Miravale III). Refer to figure 4-1 for delineation of individual sub-basin (TR-55 designated as watersheds) within both the Mirrasou and Moranda Basins.

- Mirrasou Basin (Miravale) – TR55, Watersheds I,II,III,IV and XVI
- Moranda Basin (Northwest expansion) –TR55, Watersheds V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV and XV

The upstream watersheds of Miravale III are designated Watershed I, III and IV and consist of a total of 2,225 acres. Of the 2,225 acres of watersheds that impact the proposed subdivision, 325 acres are considered onsite and 1,900 acres are offsite.

Tabular results of the TR55 storm water results for Mirassou Basin – Watershed I through Watershed IV and Watershed XVI are provided in table 4-1 and tabular results for Moranda Basin – Watersheds V through Watershed XV are provided in Table 4-2.

Table 4-1

Watershed Number	Area (Acres)	Peak Flows (cfs) and Peak Time (hr)		
		2 year	**10 year**	**100 year**
I	1319	18.33	58.52	236.61

III	560	7.88	25.18	113.38
IV	346	7.15	36.96	111.81
II	335	5.05	21.25	75.51
XVI	762	25.83	80.19	190.21
Total	3,322	N/A	N/A	N/A
I and II	1,654	24.12	75.42	297.84
III,IV and XVI	1,668	35.37	128.72	398.73

Table 4-2				
Watershed Number	**Area (Acres)**	**Peak Flow (cfs) and Peak Time (hr)**		
		2 year	**10 year**	**100 year**
V	412	6.9	28.8	108.4
VI	229	3.3	12.5	57.2
VII	152	2.2	8.5	38.8
VIII	321	31.6	82.2	174.2
IX	202	4.6	26.9	76.0
X	262	12.7	44.2	106.7
XI	322	21.6	59.8	131.0
XII	435	7.8	30.7	105.9
XIII	624	36.7	100.1	218.9
XIV	727	28.4	83.7	192.6
XV	499	17.9	57.1	136.4

Total	4,185	N/A	N/A	N/A

Refer to appendix "C" for TR55 storm water model drainage calculation for each individual watershed, which provide the necessary hydrology information; drainage area; runoff coefficient number; time of concentration; rainfall depth and rainfall return period; rainfall distribution type. Hydrology results that are provided are peak flows and peak times for each rainfall return (design storm) and most important that it generates an output hydrograph for each design storm (2 year, 10 year, and 100 year).

Then TR-55 routes the individual watershed hydrograph from upper watershed through a lower watershed. Each hydrograph will have its own routing time based on the time of concentration at the discharge point of each watershed and the travel time through the watershed. At the discharge point of lower watersheds where flows from the higher watershed will be combined with the lower watershed or the discharge point is common to two or more watersheds, the flows will be combined at the point two or more hydrographs are added together, such as where two drainage courses meet. The hydrographs are attenuated based on the difference in routing time.

Tabular results from routing the output hydrograph through watersheds are provided in Table 4-3. (Refer to Appendix "C2" for the TR55 hydrology calculation of the routing of output hydrographs through the watersheds).

Table 4-3				
Moranda Basin – Westerly Half (Flows along Camphoria-Gloria Road)				
Junction Number	**Area (Acres)**	**Design Storm**		
		2-year	**10-year**	**100-year**
1	381	5.42	20.95	95.93
2	523	35.68	108.88	249.49
3	1,963	76.47	256.70	650.97
4	2,690	100.90	328.35	825.04
Moranda Basin – Easterly Half (Flows towards Camphoria – Gloria Road)				
Junction Number	**Area (Acres)**	**Design Storm**		
		2-year	**10-year**	**100-year**

1	996	33.79	128.92	338.33
2	1,495	56.60	194.85	487.32
Mirassou Basin – Miravale III (Flows towards State HWY 101)				
Junction Number	**Area (Acres)**	**Design Storm**		
		2-year	**10-year**	**100-year**
1	1,654	24.12	75.12	297.84
2	906	14.86	58.19	219.90
3	1,668	35.37	128.72	398.73

Once the initial verification of results from NRCS TR-55 storm water models were completed and initial storm water flows had been summarized to differentiate the pre-development runoff for the offsite watershed (drainage area that lays between the study area boundary and the 50-year sphere of influence boundary) and onsite watershed (drainage area bounded by both the 20-year and 50-year SOI), RMA proceeded with development of storm water HYDRA models.

Two separate storm water models were developed at the same time that could be joined together at any time or separated as hydrology and hydrolysis analysis. A model was first developed for the proposed 920 acre Miravale III for the land use tributary drainage areas storm drainage piping and disposal system and the proposed grading. This storm water model also had to include storm water flows from over 1,900 acres of offsite watershed that were modeled with NRCS-TR55.

A second HYDRA storm water model was developed for those areas encompassed by the current city limits. Section 2.3 “Existing Storm Drainage Basin and Storm Drainage System” contains is updated naming and delineation of the current drainage basins and sub-basins. That is somewhat different than the 2000 Storm Water Impact Fee Study prepared by Hanna & Brunett. For example, the San Vicente Basin has been divided and redesignated into the upper San Vicente Basin (north of Gabilan Drive) and lower San Vicente Basin. Metz Road sub-basin, Green Leaf Estates sub-basin, Munras Johnson sub-basin have also been combined with Western Hambey sub-basin and eastern Hambey sub-basin to create an updated Bryant Canyon Basin. The UPRR Right of Way – St.

Elena Mobile Home Park sub-basin, easterly S.R 101 Right of Way sub-basin were combined with Braga sub-basin and Western Front Street Sub-basin to become part of the updated Lower San Vicente Basin.

In this drainage analysis, the Western Hambey sub-basin and the Northern portion of Eastern Hambey sub-basin will be considered as combined into a diversion sub-basin into the Upper San Vicente Basin. Also the northern portion of the original Central Basin (north of Gabilan Avenue except for portions as Lu Cuesta Views – tract 1166 and La Cuesta Views unit No. 3 – tract 1196) will be considered as a diversion sub-basin into the upper San Vicente Basin.

This HYDRA storm water analysis will be developed to address the following tasks;

- Verification of the intended capacity of proposed pipelines in San Vicente Road for offsite drainage (RMA watershed I – 1319 acres) "10 year frequency for the ground piping, and the 100 year return frequency for overland flow."

- The verification of the actual capacity of the 48-inch pipeline installed in San Vicente Road from Gabilan Drive to south boundary of Miravale III was also included.

- Verification of the proposed capacity of the 96-inch storm drain outfall line; existing capacity of the 84-inch pipeline in San Vicente Road between Market Street and Gabilan Drive; capacity of the proposed 60-inch to 48-inch pipeline in Gabilan Drive with the elimination of three existing detention basins for the 10 year storm. Backwater, ponding and flooding for 100 year storm and flooding for 100 year storm. Reduction of flooding with the three existing basins for 100 year storm.

- Verification that the existing 48-inch pipeline installed in Gabilan Drive between San Vicente Road and West Street is of sufficient size to accept the storm water flows from the proposed extension of 42-inch to 30-inch pipelines in Gabilan drive between West Street and Toledo Street with the existing Santana Park Detention Basin and Toledo Park Retention Basin. Also, if full capacity of existing basins is required for 10 year and 100 year design storms.

- Determining the required design capacity for existing retention basins (percolation of storm water is the only discharge currently provided for the basin, except backwater overflow into Front Street and surface discharge towards Moranda Road) to accept storm water from lower San Vicente Basin for a 10 year and 100 year design storm; spillover discharge into Front Street and if capacity exists for the proposed 96-inch diameter to accept all or a portion of discharge from the retention basin, feasibility to enlarge the proposed outfall pipeline, enlarge the retention basin; install a pump station to facilitate discharge from the basin, a gravity or force main diversion to the Central Basin 60-inch outfall line; or if existing spillover from retention basin during flooding is to continue into the future that either the North Entry Commercial or the northwest expansion area shall incorporate this storm water in the design of their storm drainage collection and disposal system.

- Determination of the storm water discharge for the central basin existing 60 inch outfall with the diversion of that portion of central basin north of Gabilan Drive (Santana Park Retention Pond Discharge) into the upper San Vicente Basin and feasibility to divert additional storm water from the upper central basin (Soledad High School) that currently discharges to the existing 24 to 36-inch piping system in Gabilan Drive and West Street to the Upper San Vicente Basin.

- Determination of storm water discharge (point load) from the Caltrans basins and verification of capacity of the 42-inch storm drain and Caltrans culverts for 10 year storm and the potential for ponding of storm water in existing streets. Overflows/flooding into adjacent drainage basin for a 100 year design storm.

- Determination of storm water discharge into the Salinas River from the Los Coches Basin.

A storm water analysis of the Moranda Basin encompasses an area from two watersheds of approximately 4,185 acres. Of these two watersheds, 1,500 acres was designated in the 2005 General Plan as the northwest expansion area to provide for the future growth of Soledad from the year 2025 to the year 2055 also known as the 50 year SOI planning area.

The storm water analysis for the pre-development flows was completed with the NRCS-TR55 storm water model. A new TR55 was developed for the two watersheds with 2,685 acres offsite watershed with pre-development flows and 1500 acres at post-development for land use designation per current general plan.

From the NRCS-TR55 storm water model the following scenarios were analyzed and feasibility determination made for post-development watersheds.

- Location and design capacity of retention basins for the offsite watershed (2,685 acres) to retain the difference between the pre-development flows for the 10 year 24 hour storm and 100 year 24 hour storm.

- Location and design capacity of retention basins for the northwest expansion are (1,500) acres) to retain the difference between the post-development flows for the 100 year 24 hour storm and the pre-development flows.

- Trapazoidal outfall ditch cross section and capacity to convey the 10 year pre-development storm water flows from both watersheds (4,185) acres) from state Highway 101 to the Salinas River.

- Pipeline sizes and capacity to convey the 10 year post-development flow from the upper retention basin to the lower retention basin and from the lower retention basin to the outfall ditch on the westerly side of S.R. 101

4.4 Storm Water Quality Features

The City's storm drain system uses storm water detention and retention basins for flood control. The 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 and retention 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 basin systems. 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 locations of the existing detention basins are 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. Potential storm water quality enhancements for these basins are discussed below.

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

Figure 4-4
Soledad Existing Storm Drainage System Map

Figure 4-5
Upper and Lower San Vicente HYDRA Storm Water Watershed Model Map

Figure 4-6
Upper and Lower San Vicente
HYDRA Piping Model Map

Figure 4-7
Moranda Basin TR-20/TR-55
Post Development Storm Water Model Map