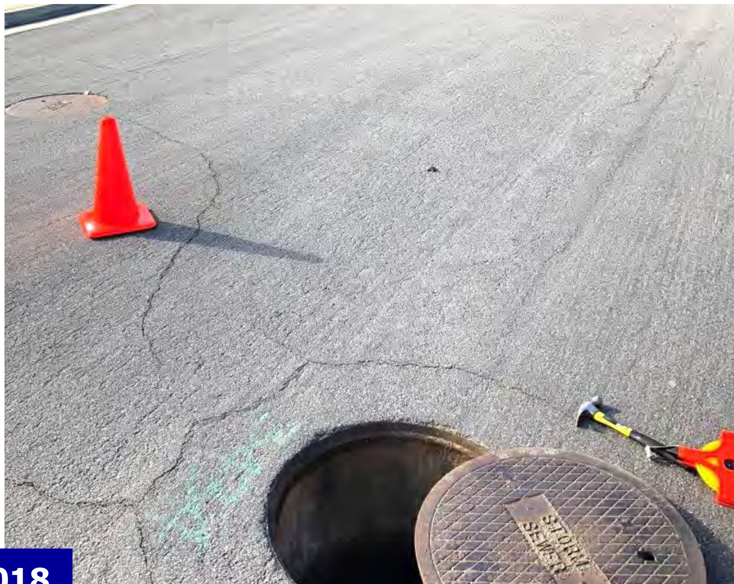
CUPERTINO

City of Cupertino
Storm Drain Master Plan



September 2018

Final Report by

Schaaf & Wheeler

CONSULTING CIVIL ENGINEERS

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List of Abbreviations

BCDC	Bay Area Conservation and Development Commission
CAD	Computer-aided Design
CEQA	California Environmental Quality Act
CFS	cubic feet per second
CGP	Construction General Permit
CIP	capital improvement program
CMP	corrugated metal pipe
DHI	Danish Hydraulic Institute
FT	feet
GIS	geographic information system
HGL	hydraulic grade line
LID	low impact development
LiDAR	Light Detection and Ranging
MAP	mean annual precipitation
MRP	Municipal Regional Permit
MU	MIKE URBAN
NAVD	North American Veridical Datum of 1988
NLCD	National Land Cover Dataset
RCP	reinforced concrete pipe
ROW	Right of Way
RWCQB	Regional Water Quality Control Board
S&W	Schaaf & Wheeler
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SCVWD	Santa Clara Valley Water District
SDMP	storm drain master plan
SQ.MI	square mile

Executive Summary

This storm drain master plan (SDMP) establishes a prioritized capital improvement program to reduce the risk of flooding within the City of Cupertino (City). The identified storm drain system improvement projects are intended to provide 10-year (10% annual exceedance) storm conveyance throughout the City.

Study Objectives

The basic objective of this master plan document is to provide an examination of the flood risks within the City limits and recommend actions necessary to accomplish appropriate levels of service for storm drain systems owned by the City so as to appropriately manage flood risks. Several tasks have been undertaken and completed as part of this study:

- Conversion of CAD-based storm drain maps to geographic information systems (GIS) data
- Collection of field data to build an existing conditions model of the storm drainage network
- Use of Santa Clara Valley Water District hydraulic models to develop coincident boundary conditions for the major drainage ways into which storm drains outfall
- Assessment of the performance of existing storm drainage systems
- Identification of capital improvements to reduce flood risk
- Prioritization of capital improvements for risk reduction and cost benefit
- Establishment of a prioritized Capital Improvement Program (CIP) for storm drainage
- Estimation of project costs for the prioritized CIP based on current ENR indices

In accordance with California Environmental Quality Act (CEQA) Guidelines, Section 15262 (Statutory Exemptions), this SDMP is considered a planning study and therefor adoption of this document is exempt from the requirements to prepare Environmental Impact Reports (EIR) or Negative Declarations (ND). However, CEQA must be satisfied for any major capital improvement project described in this report that may be implemented by the City in the future through the preparation of an appropriate EIR or ND.

Background

The City's storm drainage system consists of storm drain pipes with outfalls to creeks. In some instances, for example along Regnart Creek, the creeks are routed through underground culverts. The majority of the City's system has capacity for smaller storms; however, portions of the system lack the capacity necessary to meet the 10-year design standard. Some known, recurring problem areas have been identified by City staff. The majority of the system performs well in a 10-year storm with most flooding confined to the streets.

Cupertino generally drains in a southwest to northeast direction from the Santa Cruz Mountains toward San Francisco Bay. The natural channels to which storm drain systems discharge are generally deeply incised.

Work Products

This master plan is intended to function as a multipurpose storm drain system resource guide for the City's staff and residents. City engineers responsible for the storm drain capital improvements should find sufficient background information and data in this document to serve as the basis for storm drainage Capital

Improvement Program (CIP) implementation and/or modification. Improvement descriptions, maps, project costs, and other modeling data have been included in the appendices of this report.

System Evaluation

A MIKE URBAN rainfall-runoff model has been developed for the City which contains the portions of the overall storm drainage pipe and channel system that provide essential conveyance capacity for storm runoff. Detailed review, field investigations, analysis, and modeling of the area's storm drainage system lead to several conclusions. These conclusions have been utilized to recommend improvements to the system intended to reduce flood risk within the City. The recommended improvements are preliminary in nature and are based on currently available information. Detailed project designs will ultimately require more data, including utility locations, which remain to be obtained.

The drainage system surcharges in areas where the pipes do not provide the necessary capacity to convey runoff. This in itself is not a problem, but some degree of flooding may occur where surcharge exceeds the ground surface. Generally, streets provide some capacity for conveying flow, and it is not uncommon to observe gutter flows up to the top of adjacent curbs during high intensity rainfall events. Flooding greater than a foot in depth, however, is regarded as problematic regardless of whether such flooding results in significant property damage.

Capital Improvement Program

A Capital Improvement Program has been developed based on model results and suggested improvements. The $79 million in improvements recommended by this master plan are based on the capacity of the existing system and the need to correct identified deficiencies. Improvements are broken down into three priority levels as shown in Table ES-1. Recommended improvements are intended for public rights-of-way and other City-owned property, not private facilities or private property.

Table ES-1: Storm Facility CIP Summary

Priority	CIP Cost[1]	Length (feet)	Pipes
High	$12,520,000	20,600	105
Moderate	$25,880,000	56,700	240
Low	$40,880,000	86,700	413
Total	$79,280,000	164,000	758

1. *CIP Costs rounded to the nearest ten thousand*

Future Development

The CIP does not include the cost of new facilities related solely to new development (e.g., pipeline extensions to serve areas that are currently undeveloped). These new facilities would be constructed as part of the new developments and are not included in the CIP. The CIP discussed within this report does not account for future land use changes as it is anticipated that the majority of currently proposed land use changes may result in a decrease in runoff. Much of the future development within the City is anticipated to be in the form of infill projects- where impervious surfaces may actually decrease. While this type of development may in fact reduce stormwater flows to the system, a detailed study should be conducted at the expense of the developer to more accurately analyze any impacts. In addition, some developments may occur in areas where the existing or possibly improved downstream systems are currently undersized. The City may request assistance from developers to improve the system and in turn be reimbursed for improvements made to the existing system.

Conclusion

This Master Plan provides a tool for citizens and officials of the City to use in their efforts to reduce both nuisance flooding and the likelihood of more serious storm water related hazards to private and/or public property. This study and proposed CIP is merely the conceptual starting point. It is anticipated that City staff and/or their consultants will perform more detailed studies and alternatives analyses to identify the most affordable and effective improvement projects with information gathered as part of the design process, including detailed topography, utility conflicts, available easements and rights-of-way, construction impacts, and long-term operation and maintenance.

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Chapter 1. Master Plan Area Characteristics

1.1. Overview

This Storm Drain Master Plan provides a capacity analysis of existing storm drain collection systems, a discussion of drainage design standards, and recommended improvement projects to reduce the risk of flooding within the City with estimated costs. Its primary focus is on City-owned drainage facilities (although certain facilities owned by others are discussed and analyzed if those facilities affect property within the City) and should be used to guide the City in planning, financing, engineering, and maintaining its own infrastructure. Each chapter of this report is intended to help the City identify problems, manage resources, and provide cost-effective and comprehensive solutions.

This chapter provides a general discussion of drainage and flood management systems and issues currently affecting the City, historic flooding, and a summary timeline of regulatory floodplain mapping efforts within the City. It also describes the Master Plan objectives, explains the criteria used to evaluate storm drain system performance, and presents a summary of data acquired as part of the storm drain master planning process. Existing hydrologic and environmental settings of the City are described along with flood protection and storm drain facilities.

1.2. Setting

The City of Cupertino lies on the western edge of the Santa Clara Valley, stretching into the foothills of the Santa Cruz Mountains 40 miles south of San Francisco. Soil deposits on the valley floor are characteristic of alluvial fan development. Calabazas Creek, Regnart Creek, Stevens Creek and their tributaries deposited fans of coarser sands and gravel at their banks during flood events, with finer materials spreading out through the flatter areas between creeks. Generally, because the City lies partially in the foothills above the valley floor, the existing natural channels are relatively incised, in contrast to the "perched" channels formed by these deposits downstream. As such, there are generally no levees present along these channels through Cupertino.

The study area is defined by the City limits, which covers an area of approximately 11 square miles. The study area is bound by the Cities of Sunnyvale and Los Altos to the North, unincorporated Santa Clara County to the West, the Cities of Saratoga and San Jose to the South, and the Cities of Santa Clara and San Jose to the East. The area is predominantly urban and ranges in elevation between 150 feet and 800 feet on the 1988 North American Vertical Datum (NAVD88). Figure 1-1 shows the vicinity of the City Limits and study area.

1.3. Climate

Cupertino has a subtropical Mediterranean climate consisting of warm, sunny summers and relatively light rainfall during winters. The average annual high temperature is 69.8°F, and the average annual low temperature is 47.6°F. Summertime averages range from 53°F to 82°F, while wintertime averages range from 38°F to 64°F. Mean annual precipitation varies throughout the City, from about 16 inches at low elevations closer to San Francisco Bay to 24 inches at higher elevations. The City-wide average is 18 inches per year, the vast majority of which occurs during winter months. Precipitation within the City occurs entirely as rainfall; snowmelt is not a process that significantly affects runoff in the City or receiving water bodies.

1.4. Flood Protection Facilities

Runoff generated by precipitation within the City and surrounding area is conveyed through various flood protection systems. The majority of runoff captured by the storm drain networks is discharged through gravity outfalls into four ephemeral creeks (Stevens Creek, Regnart Creek, Calabazas Creek, and Junipero Serra Channel) and their tributaries as shown in Figure 1-1.

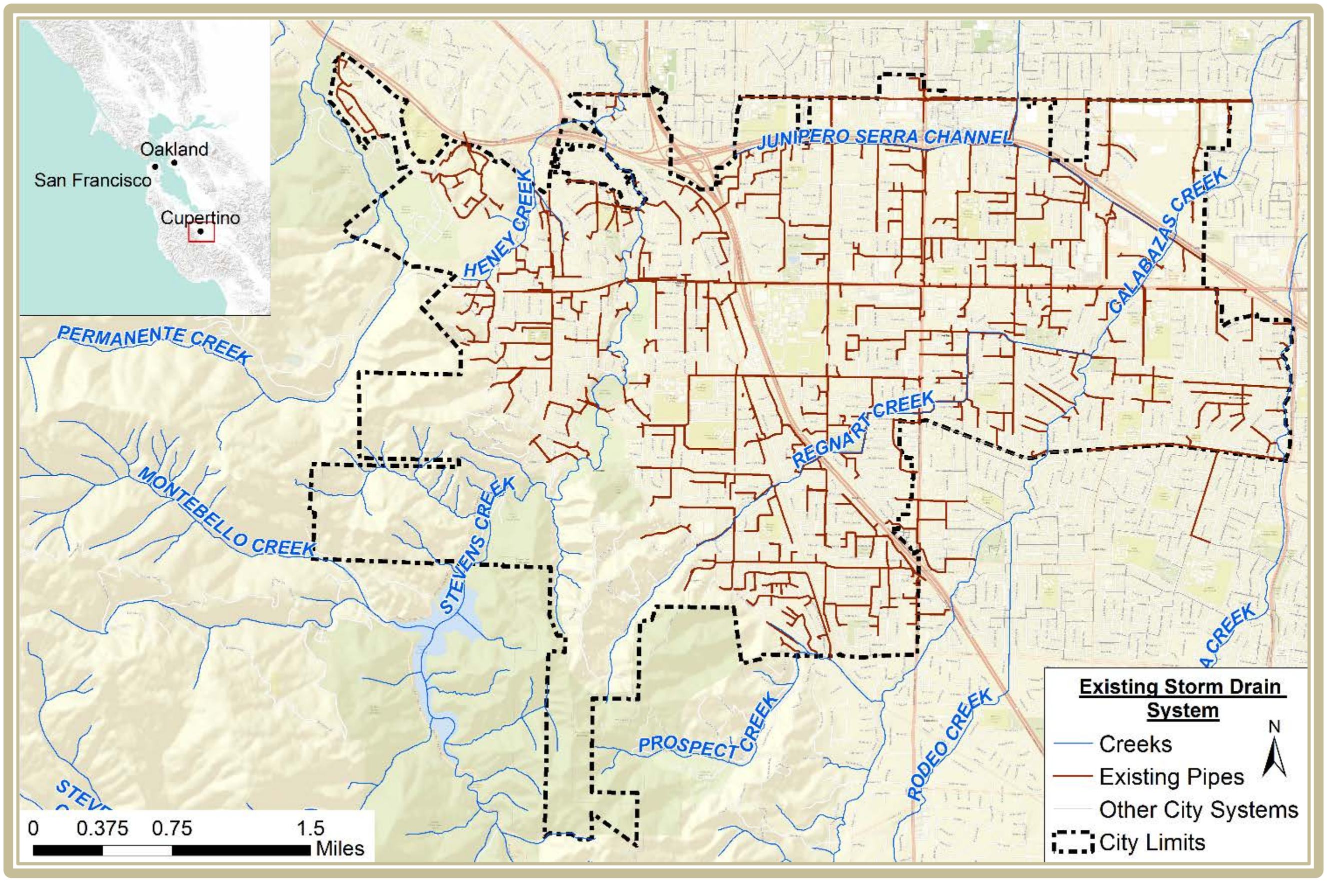

Figure 1-1: Existing Cupertino Drainage System

1.5. History of Flooding within Cupertino

Historical flooding information can be valuable in highlighting areas of recurring problems and prioritizing future improvements. Areas with known flooding problems have been identified by Schaaf & Wheeler and City employees and are discussed in detail in Chapter 2. Figure 1-2 shows historical flooding at Elm Court and various existing storm drain structures.

Figure 1-2: Elm Court Flooding and Storm Drain Structures in Cupertino

1.6. Regional Storm Water Coordination

A variety of agencies and municipalities maintain storm drainage systems within the study area. The most significant of these is the Santa Clara Valley Water District (SCVWD), which maintains jurisdiction over most of the four major creeks in the City. The City of Cupertino has jurisdiction over a portion of Stevens Creek. Improvement projects involving outfalls will require coordination with SCVWD to comply with regulations and permitting requirements. Cupertino's drainage network also interties with the cities of Sunnyvale, San Jose and Los Altos.

1.7. Recent Flood Protection Measures

The City of Cupertino has been working to alleviate inadequacies in the existing storm drain system by making system improvements. Some recent activity has focused on adding pipes along McClellan Road and Foothill Boulevard to alleviate flooding, and along Homestead Road in anticipation of land development.

1.8. Master Plan Process

Cupertino's storm drain system performance has been analyzed using the level of service criteria established herein to identify deficiencies and recommend capital improvements. Several tasks have been completed to reach this goal:

1. Develop a storm drain geographical information system (GIS) built using City CAD block maps. The GIS data is used to create the hydraulic model. Network features include: manhole invert and rim elevations, pipe length and diameter, and watershed runoff characteristics.
2. Review existing data and field verify where necessary to complete representative models of the system.
3. Establish storm drainage analysis methodologies and performance criteria with City staff.
4. Establish channel boundary conditions for storm drain system models.
5. Perform hydrologic and hydraulic analyses of the existing storm drain facilities throughout Cupertino for the 10-year event based on methodology established in the Santa Clara County Drainage Manual. System deficiencies on City-owned facilities are categorized in terms of the risk to public safety, property, and infrastructure.
6. Identify projects that will improve storm drain system performance.
7. Outline a prioritized Capital Improvement Program (CIP) for storm drainage infrastructure.
8. Project and summarize capital improvement costs for the CIP.

1.9. References

- City of Cupertino Standard Details. City of Cupertino Public Works Department. Web. Accessed June 2018. <http://www.cupertino.org/our-city/departments/public-works/permitting-development-services/engineering-standards-policies-procedures>.
- General Construction Permit. State Water Resources Control Board: Division of Water Quality. (Order 2009-0009-DWQ as amended by 2010-0014-DWQ). (2010).
- Municipal Regional Stormwater NPDES Permit No. CAS612008. California Regional Water Quality Control Board: San Francisco Bay Region. (Order R2-2015-0049). (2015).
- Santa Clara County Drainage Manual. (2007).

Chapter 2. Data

2.1. Data Sources

Schaaf & Wheeler reviewed and utilized readily available land use, topographic, geological, geographical, and storm drain system data within the Cupertino Storm Drain Master Plan Area (study area). Available data, while mostly complete and accurate, had some missing or incorrect information. Efforts have been made to improve and add to the collective data. Where necessary, assumptions and engineering judgment are used to complete remaining data gaps. This chapter summarizes the findings and data acquired as part of the Cupertino Storm Drain Master Plan (CSDMP). Data limitations, assumptions, and impacts are also summarized herein.

2.1.1. Topography and Aerial Imagery

All project data and results are in vertical datum NAVD88 (feet) and the State Plane (California Zone III) coordinate system. The City of Cupertino provided elevation data from LiDAR point data measured on the NAVD88 datum. This high resolution aerial data provides topographic information with an accuracy of half of a foot (plus or minus 0.5 foot) for ground returns where no water ponding occurs. To perform hydrologic and hydraulic analyses, a terrain model of the City and surrounding area has been built from these LiDAR-based datasets. In addition, 2016 high-resolution aerial imagery from the City of Cupertino has been used.

2.1.2. GIS Data

The most current City system data was provided to Schaaf & Wheeler in GIS shapefile (.shp) format. The storm system elements have been imported into GIS and reduced to main-line pipes 12-inches and larger. Initial data included diameters for approximately 91% (3,905) of the 4,303 pipes included in the GIS for the modeling area, and depths for approximately 68% (1,392) of the 4,310 nodes (manholes, catch basins, and outfalls).

Land use, hydrologic soil group, curve number, and percent impervious data were all provided by the City of Cupertino. The National Land Cover Database (NLCD) impervious dataset has been downloaded to estimate the typical imperviousness of each land use type in the City, a process described in detail in Section 2.2: Land Use Data and Runoff Characteristics. Other GIS data used for this master plan include city limits, existing catchment delineations, parcels, land use zoning, and streets.

Schaaf & Wheeler identified missing data in the documents provided by the City, as well as items in need of verification. Information needed to create an accurate model of the system included:

- Missing pipe diameters
- Missing node depths
- Verification of some pipe diameters and node depths
- Some outfall elevations

Measures were taken to collect or approximate data necessary to compile a master plan level analysis. These steps include measurements described in Section 2.1.4 and estimation techniques described in Section 2.5 of this chapter. No surveying was completed under this study.

2.1.3. System Ownership

City-provided CAD files include ownership data. While most of the storm drainage systems within the study area are City-owned, some components are owned by others including the Santa Clara Valley Water District, the City of San Jose, and the City of Sunnyvale. Other parts of the system are privately owned. The provided ownership data is assumed to be current and accurate in the development of capital improvements.

2.1.4. Pump Stations

Pump stations are often an important element of Master Plan models where they play a large part in managing stormwater runoff. While some minor pump station facilities are located within City limits, none are owned or operated by the City. Because none of these facilities are expected to have a major effect on overall system performance, none are included in the City's master plan storm drain models.

2.1.5. Field Measurements and Record Drawings

Schaaf & Wheeler examined system profiles and identified irregularities in the modeled system data (e.g. potentially incorrect pipe diameters and invert elevations). These irregularities were compared with profile plots from the City's storm drain GIS. If City GIS data confirmed an irregularity, City, County, or Caltrans record drawings were reviewed to verify City-provided data or fill data gaps. Record drawings are assumed to be accurate and up-to-date.

In cases where record drawings are not sufficient to complete system verification, selective field measurements of pipe sizes, layout, and invert depth have been taken. Field information was collected by Schaaf & Wheeler staff. Corrections are entered into the storm drain network GIS files with data sources noted. Because storm drain systems are designed for pressure flow and surcharge, the system's hydraulic grade lines (HGLs) are not governed by open channel flow dynamics. For this reason, correct pipe diameters are a more critical component of the model than the accuracy of invert elevations.

2.1.6. Catchments

Catchments have been delineated using GIS with the City's watershed shapefile used as a baseline. Larger drainage areas to physically unconnected systems have been defined by the City and refined by Schaaf & Wheeler based on elevation data, consisting of 2016 LiDAR topography within the City. This provides a rough estimate of drainage area to each individual pipe system in the City's GIS (each draining eventually to a Santa Clara Valley Water District channel or culvert).

To build a detailed and accurate model, catchments have been further divided into "sub-catchment" areas. While sub-catchments create a better picture of system performance, they generally do not represent the drainage area to a single catch basin. The City's model includes pipes 12-inches and larger that are primarily responsible for conveyance of stormwater runoff to creeks.

2.2. Land Use Data and Runoff Characteristics

National Resource Conservation Service (NRCS) Curve Numbers (CN) were assigned to each catchment in accordance with the 2007 Santa Clara County Drainage Manual methodology. Curve Numbers are empirical parameters used to predict runoff or infiltration from runoff excess. These rainfall runoff characteristics are estimated based on land use, soil classification, and percent impervious surface.

2.2.1. Land Use

Models have been built to represent current land use conditions. Starting with the City's Zoning Designations, land use types were consolidated in GIS from approximately 22 categories (or variations thereof) to 12 that resemble land use types presented in the County Drainage Manual. The City's Zoning Designations, used as a starting point, are shown in Figure 2-1. Consolidation of zoning types to modeled land use types is summarized in Figure 2-1. Land use in Cupertino is predominantly Residential (39.1% by area including all densities), followed by Open Space (including Undeveloped area and Parks, 28.3%), Street/Transportation Right of Way (14.6%), and Commercial/Industrial (9.5%). Approximately 85% of residential area is Very Low or Low Density, single family housing.

Streets, which are not part of the GIS parcel polygons, were added to the land use shapefile. Some parcels within the City may be undeveloped. For these areas, current zoning is used to represent a built-out condition if necessary. In locations where redevelopment has occurred or zoning designations are not representative of current conditions, designations were altered to reflect existing land cover. An example of such a parcel is "Apple Campus 2", which may be considered a Commercial parcel, but deviates significantly from typical Commercial parcel properties.

Model drainage areas extend into Unincorporated Santa Clara County and San Jose. In these areas, it was necessary to extend land use polygons based on publicly available zoning shapefiles and aerial imagery. The existing land use conditions and categories for curve number calculation are shown in Figure 2-2.

Table 2-1: Zoning Designation and Consolidated Land Use Categories

Zoning Designation	Consolidated Land Use Type	% of Total Area
Commercial	Commercial/Industrial	9.5%
Commercial/Office/Residential		
Commercial/Industrial/Residential		
Industrial/Commercial		
Neighborhood Commercial		
Very Low Density Residential (Various)	Very Low Density Residential	9.2%
Low Density (1-5 DU/Ac, 1-6 DU/Ac, etc)	Low Density Residential	23.5%
Other Res. (0-4.4 DU/Ac, 1-5 DU/Ac, etc)		
Low/Medium Density Res. (5-10 DU/Ac)	Low-Medium Density Residential	2.6%
Other Res. (4.4-12 DU/Ac)		
Medium Density Res. (10-20 DU/Ac)	Medium Density Residential	3.0%
Other Res. (10-20 DU/Ac, 10-15 DU/Ac)		
Medium/High Density Res. (10-20 Du/Ac)	Medium-High Density Residential	0.3%
High Density Res. (>35 DU/Ac)	High Density Residential	0.4%
Public Facilities	Public	4.5%
Quasi-Public/Institutional	Quasi-Public/Institutional	3.0%
Transportation	Transportation/Right of Way	14.6%
Streets (No Parcel Polygons)**		
Water	Open Water	1.0%
County	Undeveloped	23.9%
Riparian Corridor		
From Other County/City Shapefiles	Varies*	N/A (Included Above)

**A desktop survey of current aerial and street level imagery was performed to determine land use type*

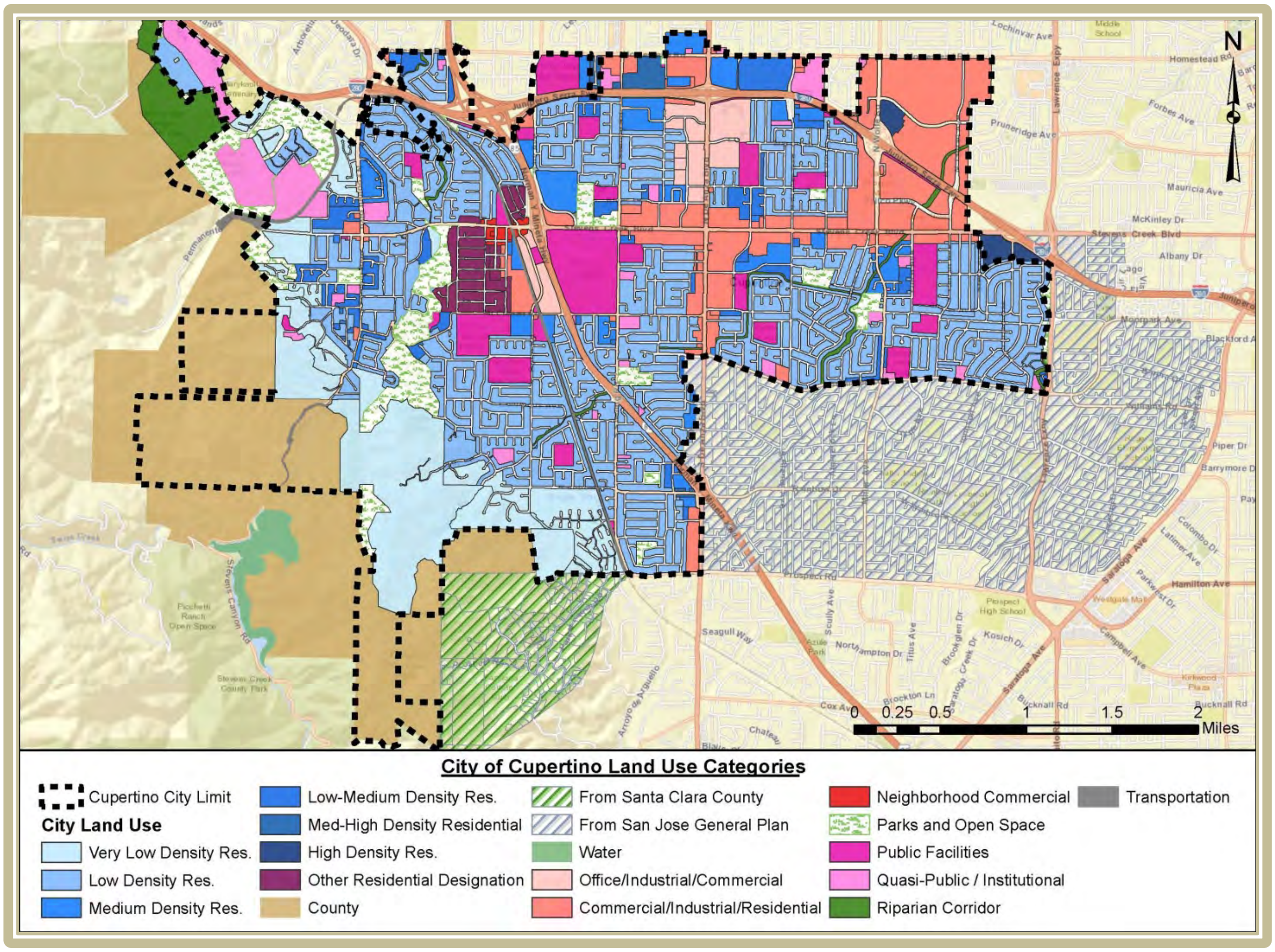

Figure 2-1: Cupertino Zoning Map

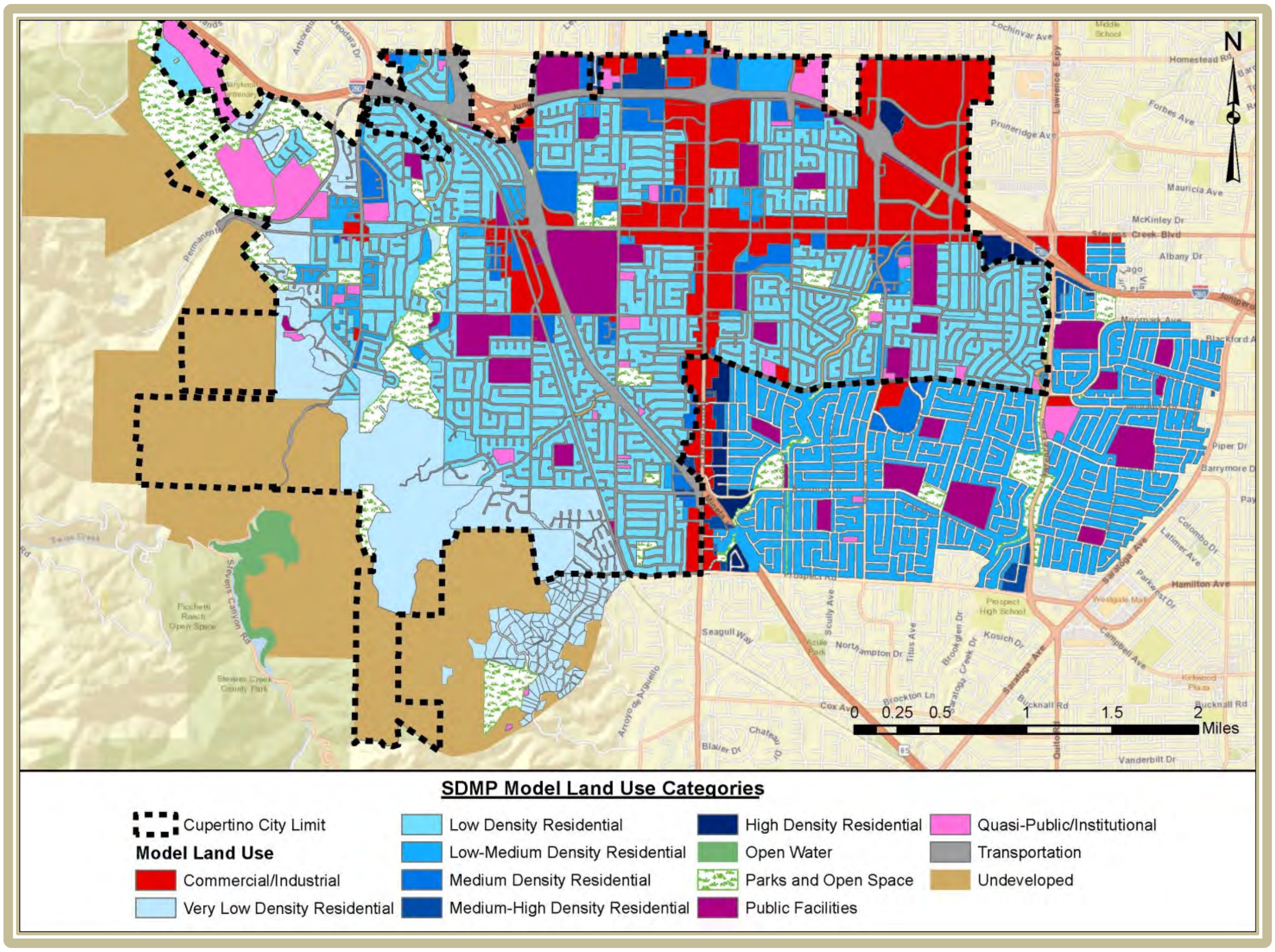

Figure 2-2: Existing Land Use Map

2.2.2. Future Land Use

The City is currently close to build-out with very few empty lots. The majority of future development will involve the redevelopment of sites, such as infill projects. Future development will need to comply with C.3 requirements of the Municipal Regional Permit (MRP) for the Bay Area. These requirements to treat storm water runoff may result in a reduction of impervious surface. In addition, the majority of the City requires hydromodification management plans (HMP) for developments over one acre in size. C.3 measures are typically only designed to target 2-year storm runoff, and are not anticipated to significantly reduce 10-year peak discharge; however, redevelopment in Cupertino will generally not increase the 10-year flow. It is not anticipated that future development will impact the City's storm drainage system; in fact, it is possible that future development will reduce the overall flows in the City's system. The current land use condition is considered the 'worst case' condition and CIPs developed under the existing condition should meet or exceed future conditions. Impacts of planned development can be analyzed in detail by the storm drain model created for the Storm Drain Master Plan; however, these detailed studies are not part of this contract.

2.2.3. Percent Impervious Surface

Percent impervious surface is estimated for each of the 13 land use types from three sources: 2011 National Land Cover Dataset (NLCD) impervious surface data, County Drainage Manual assumptions, and aerial imagery. From the NLCD Landsat-based dataset, GIS is used to calculate an average percent impervious surface for each land use designation.

Values from the NLCD analysis are compared to County Drainage Manual assumptions and checked against aerial imagery of the City to estimate final percent impervious values used for modeling. Percent impervious values for each land use type are summarized in Table 2-2.

Table 2-2: Percent Impervious Surface Comparison and Assumed Model Values

	Percent Impervious Surface		
Land Use	**Drainage Manual**	**NLCD 2011**	**Adjusted Based on Aerial**
Commercial/Industrial	80	70	85
Very Low Density Res.	N/A	15	35
Low Density Res.	25	47	55
Low-Medium Density Res.	N/A	47	70
Medium Density Res.	37.5	56	80
Medium-High Density Res.	N/A	63	75
High Density Res.	50	64	70
Open Water	100	N/A	100
Parks/Open Space	10	12	15
Public (Schools, Gov't, etc)	80	50	45
Quasi-Public/Institutional	N/A	43	65
Transportation/Right of Way	90	60	90
Undeveloped	0	3	0

The Drainage Manual and NLCD estimates of percent impervious are below those estimated from 2016 City aerial imagery. NLCD provides a low-resolution (30-meter grid) estimate of impervious percentage, intended to support broader, regional studies which don't require precise percent impervious values. It is useful here only to illustrate that the Drainage Manual estimates may be, in general, either too high or too low for use in this study. Ultimately, adjusted percent impervious values shown in the table above are assumed to be most representative of each land use category for Cupertino, as they have been formulated from imagery within the City on a relatively fine resolution.

It's notable that percent impervious values for residential land covers estimated from aerial imagery peak for Medium Density residential developments, then decrease with increasing density. This is because "density" in this context refers to a number of dwelling units per area. There are very few High Density Residential parcels within Cupertino. For the few that exist, density is concentrated in multi-floor buildings on large parcels, with extensive pervious areas between structures and concrete and asphalt cover. In comparison, Medium Density Residential predominantly consists of condominium buildings on smaller lot footprints (i.e. more impervious square footage per inhabitant), and can include streets within the communities. While dwelling unit density is lower, impervious area is more prominent in Medium Density Residential land use.

2.2.4. Soil Classification

The NRCS has classified soils into four hydrologic soil groups (A, B, C, and D) according to their infiltration rates. Group A soils have low runoff potential when thoroughly wet and typically consist of sand or gravel type soils. Group B soils are moderately well draining when thoroughly wet and consist of loamy sand or sandy loam textures. Group C soils have moderately high runoff potential when thoroughly wet and consist of loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Group D soils have high runoff potential when thoroughly wet and consist of clayey textures. All soils with a water table within 24-inches of the surface are in Group D. The City of Cupertino study area consists of 4% Group A soils, 23% Group C soils, and 73% Group D soils, as shown in Figure 2-3.

Hydrologic Soil Group (HSG) classifications are included in the shapefiles downloaded from SSURGO. Where HSG classifications are missing, other data included in the shapefiles (e.g. infiltration rate, soil classification, etc) may be used to estimate the degree of runoff from pervious surfaces and assign a HSG.

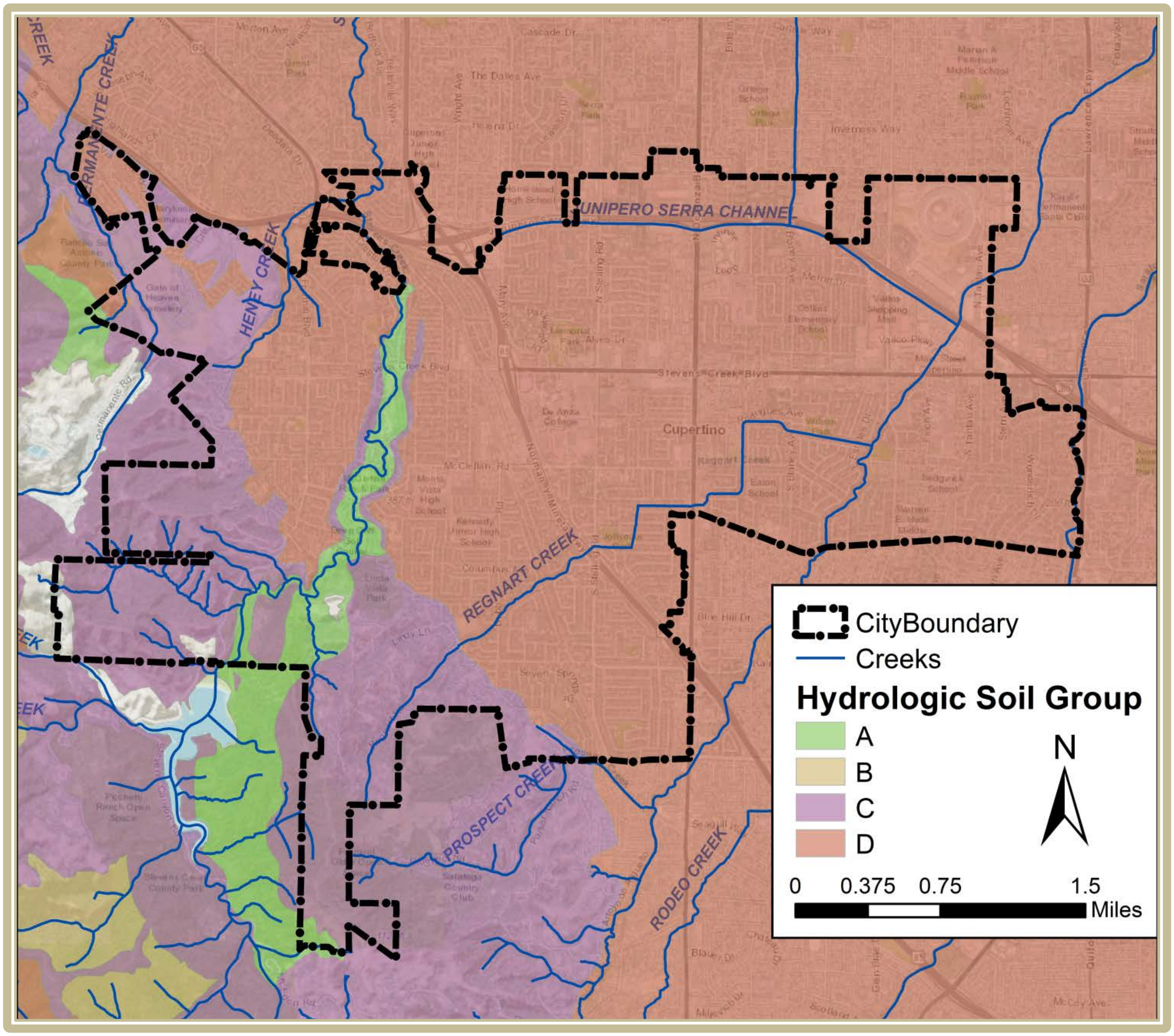

Figure 2-3: NRCS Soil Classification in Study Area and Immediate Vicinity

2.2.5. Runoff Curve Numbers

Runoff Curve Numbers (CNs) are assigned to each catchment in the model based on land use and soil classifications as shown in Table 2-3.

Table 2-3: NRCS Curve Numbers by Land Use Soil Group

Land Use Type	% Impervious	Curve Number (AMC II) by Soil Group			
		A	B	C	D
Commercial/Industrial	85	44	58	71	74
High Density Residential	70	44	58	71	74
Low Density Residential	55	44	58	71	74
Low-Medium Density Residential	70	44	58	71	74
Medium Density Residential	80	44	58	71	74
Medium-High Density Residential	75	44	58	71	74
Parks and Open Space	15	44	58	71	74
Public	45	44	58	71	74
Public Facilities	45	44	58	71	74
Quasi-Public/Institutional	65	44	58	71	74
Transportation	90	64	68	78	79
Undeveloped	0	35	51	65	72
Very Low Density Residential	35	35	51	65	72

2.3. Data Quality

There is some variation and inconsistency in the quality and accuracy of available data. While a small amount of information was present in City GIS files at the start of the study, the invert of many nodes (manholes, inlets, and outfalls) was not included. Record drawings have been provided by the City and were used to fill in these data gaps where available. Limited field investigations have been performed as necessary to complete the data set.

The City has an estimated 100 linear miles of pipe (4,303 links) and 4,310 nodes (including manholes, catch basins, detention basins, and outfalls) in the study area. The hydraulic model contains all known pipes 12-inches in diameter or larger, primarily belonging to Cupertino, with some pipe belonging Sunnyvale, San Jose, Santa Clara Valley Water District, and Santa Clara County. After an initial model was built and missing data was estimated or interpolated, results revealed some locations where further verification was necessary. The methods described in Section 2.4 have been used to assign missing data.

2.3.1. Modeled Data Assumptions

To create a uniform ground surface for hydraulic modeling, rim elevations at all system nodes have been extracted to the system node shapefile from the LiDAR terrain model. Invert elevations are assigned to each node based on depths from City provided data and field measurements.

Where node depths are unknown, record drawings have been reviewed wherever possible; otherwise, invert elevations are assumed or interpolated for modeling purposes. Unknown catch basin inverts are assigned assuming a minimum pipe cover of three feet where the catch basin is positioned at the end of a line (i.e. where there is no pipe upstream of the catch basin). For other unknown inverts, elevations are interpolated between upstream and downstream nodes with assigned inverts using the interpolation tool in the MIKE URBAN

(MU) model, providing a sufficient estimate of missing data for a master plan level analysis given that most storm drain pipes are surcharged under design storm events of interest. Once surcharged, storm drain pipe slope (and therefore inverts) do not affect hydraulic analyses.

Inverts and ground elevations in the model have been checked manually for irregularity (e.g. ground elevations below the top of pipes, negative pipe slopes, and incorrect pipe diameters) and corrected as necessary. Small spatial inaccuracies in the GIS have been corrected as necessary using aerial imagery, the record drawings and field measurement. Pipe diameters missing from City GIS have been assumed based on the connecting pipes or the pipe location (e.g. laterals with unknown diameter are assumed to be 12-inches). At critical hydraulic locations, missing pipe diameters have been verified using field measurement.

2.4. Future Use of Models

The models developed for this SDMP are developed to Santa Clara County Drainage Manual standards and can be used to analyze future development impacts to the existing system or alternative improvements that are not part of this SDMP. It is recommended that the models are continually updated when new information is received or when improvement projects are completed. The models should serve as a tool that the City can use to further analyze the storm drain system.

Chapter 3. Master Planning Methodology

3.1. Overview

The criteria used to evaluate storm drain system performance must be technically sound yet simple to understand and apply. Ideally, the same methodology used to analyze system performance for this report will also continue to be used for future infrastructure design. Schaaf & Wheeler applied NRCS hydrology methods to estimate storm runoff from current land uses for the Cupertino Storm Drain Master Plan. This method is being used along with MIKE URBAN by DHI storm drain modeling software to evaluate system performance, identify deficiencies and recommend necessary improvements. Physical parameters used in the model are based on the City's GIS data and other information detailed in Chapter 2 - Data. Storm drain evaluation criteria described in the following section have been discussed with and agreed upon by the City.

3.2. Evaluation Criteria

The NRCS Unit Hydrograph Method is used to estimate storm water runoff in Cupertino in accordance with the 2007 Santa Clara County Drainage Manual. The County Drainage Manual was developed to provide consistent design and evaluation criteria for storm drainage throughout Santa Clara County. The Unit Hydrograph method allows for the development of a flood hydrograph using a design storm, an appropriate infiltration technique, varying antecedent moisture condition, storage within the watershed, and a synthetic unit hydrograph.

The storm duration used for rainfall simulation is 24-hours, the standard Santa Clara County Drainage Manual storm duration. The storm pattern used in the models is based upon the three-day December 1955 rainfall event, still considered to be the storm of record for Northern California. The pattern intensity values have been adjusted to preserve local rainfall statistics within Santa Clara County, can be found in Appendix D of the County Drainage Manual, and are reproduced here as Figure 3-1.

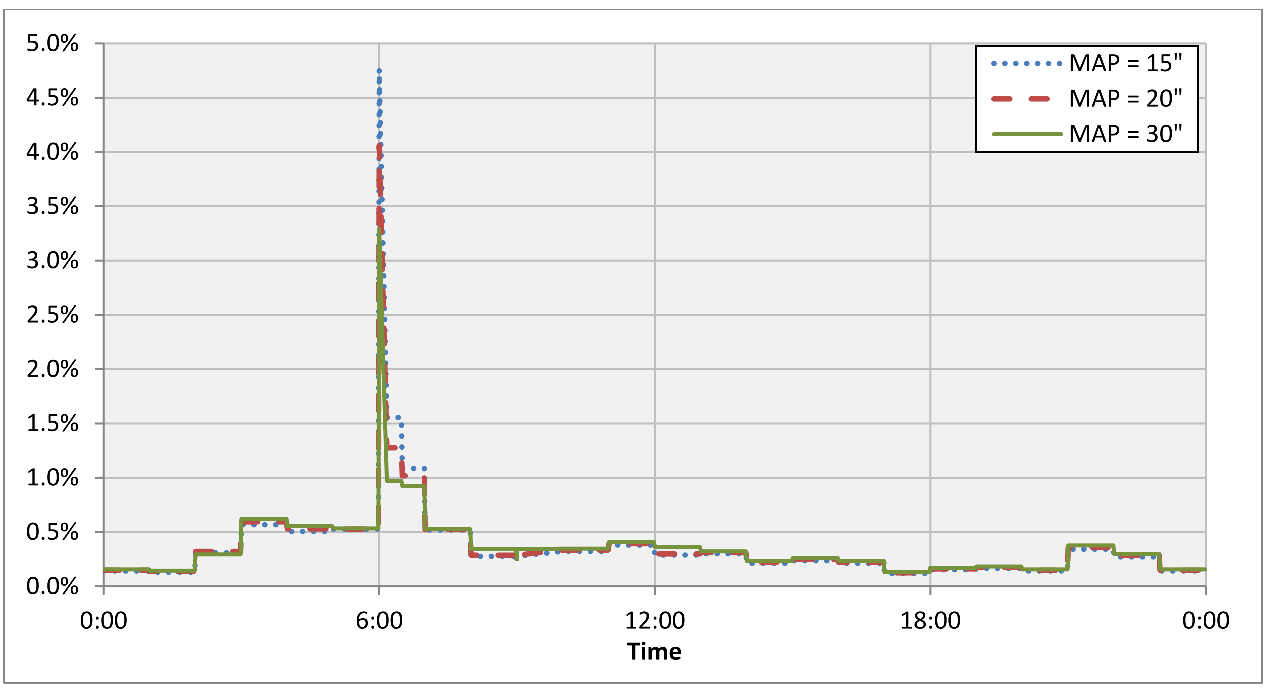

Figure 3-1: 24-hour Design Storm from County Drainage Manual

Using these design storms, hydrologic and one dimensional (1-D) hydraulic models have been created for the 10-year event. The 10-year storm event is used as the design event for the storm drain system evaluation since the 10-year level-of-service standard is consistent with the City's design standard for general storm drain system conveyance.

Improvements are recommended to reduce the 10-year hydraulic grade to no higher than 0.5 foot above the rim elevation at any location. These criteria minimize the risk to private property and public safety and are common standards used throughout the Bay Area by other jurisdictions.

3.3. Modeling Software

The Danish Hydraulic Institute (DHI) MIKE-URBAN (MU) software with MOUSE solver is selected to model the City of Cupertino storm drain system because it is tested and reliable software with a GIS interface. MU is a package of software programs designed by DHI for the analysis, design and management of urban drainage systems, including storm water sewers and sanitary sewers. The MU model works within the ArcMap GIS interface and can simulate runoff, open channel flow, pipe flow, water quality, sediment transport, and two dimensional surface flow. The City's modeling package consists of two interrelated products:

1. MOUSE is a group of hydrologic, hydraulic, water quality and sediment transport modeling modules which can be used together or used independently. The modules used in the Cupertino storm drain model include the Surface Runoff Module, which computes surface runoff using one of five computational methods; and the Hydrodynamic Pipe Flow Module, which calculates an implicit finite-difference numerical solution of the St. Venant flow equations for the modeled pipe network.
2. MIKE-URBAN (MU) is an ArcMap based program which includes tools specifically designed to develop urban drainage models. MU provides a graphical user interface for data input and editing and serves as a bridge between ArcMap GIS and the MOUSE modeling program. Capabilities of MU include import and export of model data, network editing and gap-filling, catchment delineation, and network simplification. MU can also be used to present results including plan, longitudinal, and cross-section views; animation of results; presentation of flooding including water depth and pressure; and overlay of results on background graphics such as maps or aerial photos

The entire City's "main" conveyance pipes are included in a single model. Small lateral pipes are not included.

3.3.1. Operation

Two separate calculations are performed by MU for the City models. First a runoff calculation estimates the amount of water entering the storm drain system during a design rainfall event. Second a network flow calculation replicates how the storm drain system will convey flows to outlet locations. Flows resulting from the runoff calculation are used as inflows for the subsequent network flow calculation.

The MU runoff model offers a choice of infiltration methods. The City storm drain models use the NRCS dimensionless unit hydrograph method (UHM) to calculate surface runoff. A simulation can be started at any point during the chosen design storm to assess surface runoff for any period of the design storm, with computations made based on a user-specified time step. The runoff time steps are chosen to be at 1-minute intervals.

The MU network flow model also offers a choice of three flow description approximations distinguished by the set of forces each takes into account: Diffusive Wave, Dynamic Wave, and Kinematic Wave. The Cupertino storm drain models use the most comprehensive flow description, Dynamic Wave, which incorporates the effects of gravitational, friction, pressure gradient and inertial forces. Because it accounts for all major forces affecting flow conditions, this equation allows the model to accurately simulate fast transients and backwater profiles. For a one-dimensional pipe flow simulation, flooding at a node is accommodated by the insertion of an artificial “basin” above the node which will store water when the water level rises above the ground level. The surface area of the “basin” gradually increases (up to a maximum of 1000 times the node surface area) with rising water levels at the node, replicating the effects of flooding.

Water stored in the “basin” begins to reenter the system when the outflow from the node becomes greater than the inflow. The pipe flow simulation can be executed using either a constant or variable time step, and can be run for any portion of the time interval specified by the input rainfall time series and corresponding calculated runoff hydrograph.

3.3.2. Input and Output

MU surface runoff calculations require two types of input data: boundary data and urban catchment data. Boundary data for the run-off computation consists of an input rainfall time series representing the design storm event for the model. Urban catchment data includes the pipe network and boundaries of each drainage catchment, along with relevant physical and hydrologic parameters including surface area and parameters used to calculate basin lag time. Drainage catchments for the study area are shown in Figure 3-2. While the majority of the City drains directly into the pipe system, a few drainage areas consist of open space or parks that drain directly into the adjacent stream.

MU network flow calculations require two types of inputs: network element data (links and nodes) and boundary data (rainfall and creek/river water surface elevations). Network elements consist of nodes (which can include manholes, catch basins, retention/detention basins, and outfalls) and links (which can include pipes, culverts, and open channel cross sections). Parameters required to describe links include the name of upstream and downstream nodes (“to node” and “from node”), shape (circular, egg shaped, defined cross section, etc) and dimensions, material or roughness, and upstream and downstream node invert elevation. Geometry and data corresponding to network elements are imported from GIS shapefiles. Connections to urban catchments are defined within the MU interface as node elements where catchment runoff enters the network. Boundary data can include direct results of runoff calculations based on rainfall input, external loadings, inflow discharges, or external water levels at interaction points with receiving waters (outfalls).

Output from the pipe flow computation includes the calculated water level at each node, discharges, water level in network branches, discharge in network branches, velocity in network branches, water volume in the system, and time step data. Output is viewed using GIS, MU, or the MIKE-VIEW program. Results may be displayed in plan-view or as a profile for a selected network section, and may be viewed as a temporal animation or at maximum or minimum values. Additional outputs which can be derived from MU pipe flow results using GIS and include: water depth, flooding level, pressure in closed conduits, percentage pipe filling, and the flow calculated for each link.

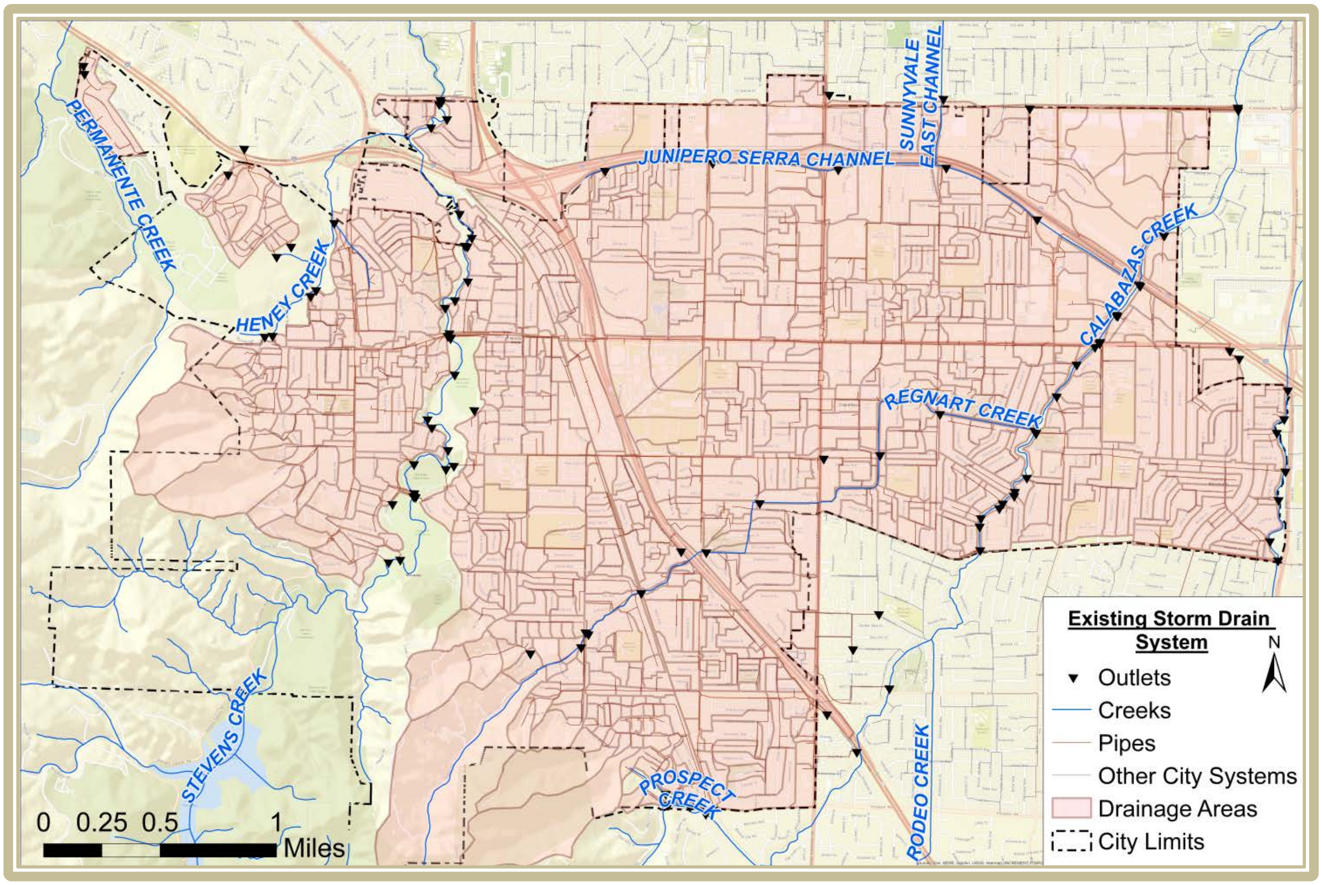

Figure 3-2: Cupertino Storm Drain System Catchments

A summary of inputs and outputs is listed in Table 3-1.

Table 3-1: Summary of Inputs and Outputs for Each Model Element

Model	Inputs	Outputs
Runoff	Boundary Data • Rainfall time series Urban Catchment Data • Drainage catchments • Lag time	Runoff hydrographs for each individual catchment
Pipe Flow	Storm Drain Network • Nodes (catch basins, manholes, outfalls, etc) • Links (pipes, culverts, open channels) Operational Data • Catchment connections • Pump curves • Junction Losses Boundary Data • Catchment runoff hydrographs • Water surface elevation time series	Water level at each node Water level in network links Velocity in network links Water volume in the system Discharges

3.4. Hydrologic Calculations

Methods used in this master plan to estimate peak storm water flow rates and volumes require the input of precipitation data. Since it is impossible to anticipate the impact of every conceivable storm, precipitation frequency analyses are often used to design facilities that control storm runoff. A common practice is to construct a design storm, which is a rainfall pattern used in hydrologic models to estimate surface runoff. A design storm is used in lieu of a single historic storm event to ensure that local rainfall statistics (i.e. depth, duration and frequency) are preserved. When combined with regional specific data for land use and loss rates, the model should produce runoff estimates that are consistent with frequency analyses of gauged stream-flow in the Santa Clara County area. In other words, the 10-year design storm pattern used for MU modeling create results consistent with 10-year storm runoff events.

Precipitation frequency analyses are based on concepts of probability and statistics. Engineers generally assume that frequency (probability) of a rainfall event is coincident with frequency of direct storm water runoff, although runoff is determined by a number of factors (particularly land use conditions in the basin) in addition to the precipitation event. Because the County's 24-hour pattern has been adjusted to preserve local statistics, there is increased confidence in the runoff predictions created by the City models.

3.4.1. Mean Annual Precipitation

Mean Annual Precipitation (MAP) information is taken from the Santa Clara Valley Water District Isohyet map, which has been digitized into GIS. The SCVWD isohyet map indicates a MAP varying between 16 and 24 inches per year within the study area (Figure 3-3).

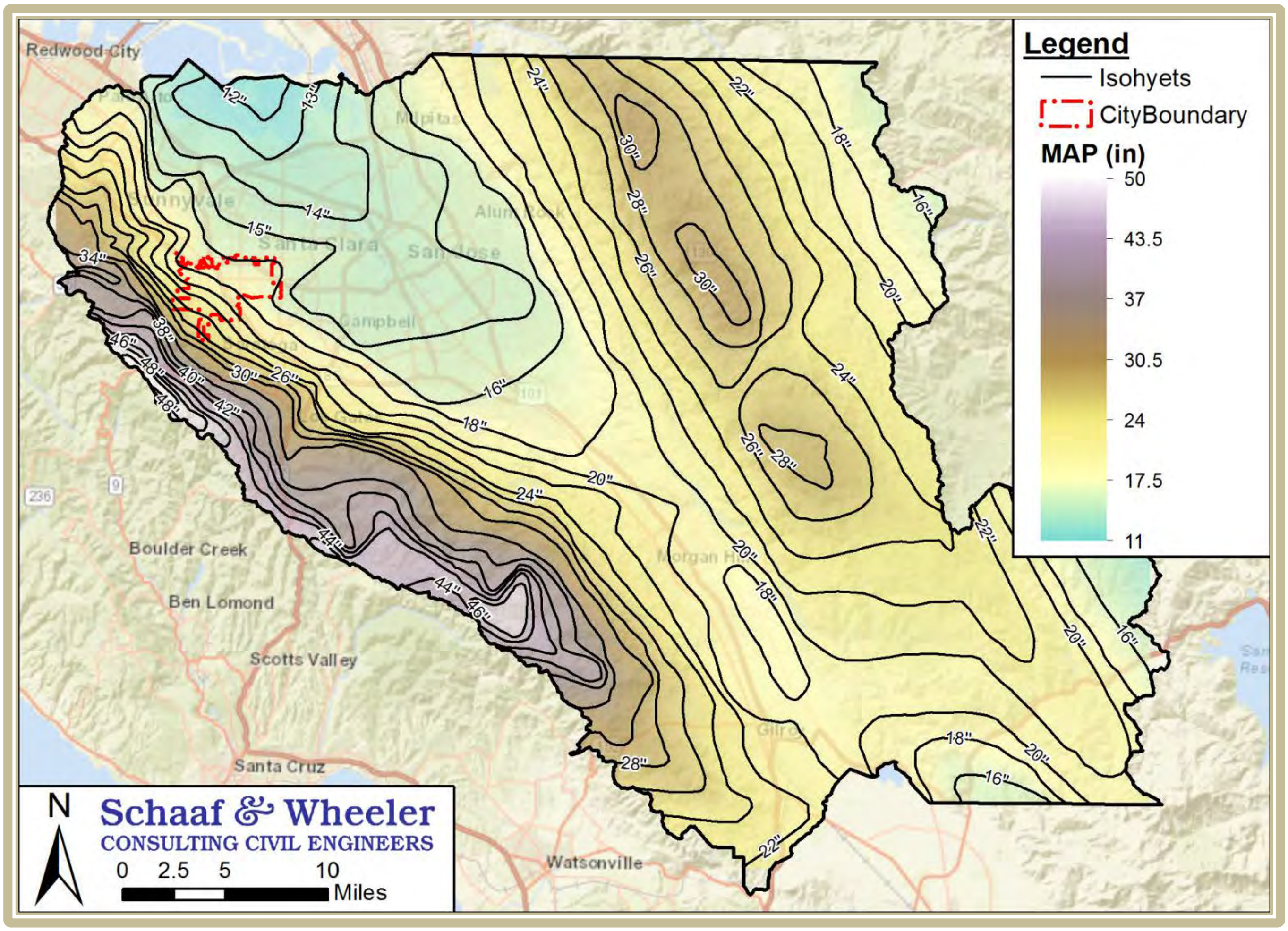

Figure 3-3: SCVWD Mean Annual Precipitation Map

From the isohyet contours, a continuous, county-wide raster is created. GIS zonal statistics tools are used to find the spatially averaged MAP within each catchment. Varying rainfall depths are applied to each catchment in the models based on average catchment MAP as described in Section 3.4.2.

3.4.2. Rainfall Depth and Pattern

The rainfall distribution pattern for the Cupertino Storm Drain Master Plan is obtained from the County Drainage Manual. The County's rainfall pattern is distributed in 5-minute time increments with a fraction of the total rainfall apportioned to each 5-minute increment. The total depth of each pattern is based on the mean annual precipitation taken from the Isohyet GIS layer.

The Santa Clara County Drainage Manual provides the following equation to calculate the total rainfall depth for each MAP and storm frequency:

$$X_{T,D} = A_{T,D} + \left(B_{T,D} * MAP\right)$$

Where: $X_{T,D}$ = precipitation depth for a specific return period and storm duration (inches),

T = return period (years),

D = storm duration (hours),

$A_{T,D}$ & $B_{T,D}$ = dimensionless coefficients from County Drainage Manual Tables B-1 and B-2

MAP = Mean Annual Precipitation (inches)

The precipitation intensity, $i_{T,D}$ is given by:

$$i_{T,D} = \frac{x_{T,D}}{D}$$

Because the MAP over the City of Cupertino varies by approximately seven inches, nine different MAP rainfall patterns are applied to catchments in the models to represent that variation. The seven patterns are applied based on ranges of spatially averaged catchment MAP, as shown in Table 3-2. Fractions of rainfall for the 10-yr event are shown in

Table 3-3. These fractions are then multiplied by the depths listed in Table 3-2 to get a rainfall pattern in inches. The rainfall pattern in inches per 5-min interval for MAP 16 and MAP 24 is show in Figure 3-3.

Table 3-2: MAP Patterns Applied to Model Catchments

Pattern MAP	Catchment MAP	10-yr Depth (in)
16"	15.5" - 16.5"	3.17
17"	16.5" - 17.5"	3.33
18"	17.5" - 18.5"	3.49
19"	18.5" - 19.5"	3.66
20"	19.5" - 20.5"	3.82
21"	20.5" - 21.5"	3.98
22"	21.5" - 22.5"	4.14
23"	22.5" - 23.5"	4.31
24"	23.5" - 24.5"	4.47

Table 3-3: MAP 15 24-Hour Rainfall Pattern (From Drainage Manual)

Time (Starting)	10-yr	Time (Starting)	10-yr	Time (Starting)	10-yr
0:00	0.01694	**7:00**	0.06212	**16:00**	0.02542
1:00	0.01553	**8:00**	0.03316	**17:00**	0.01412
2:00	0.03696	**9:00**	0.02762	**18:00**	0.01836
3:00	0.06800	**10:00**	0.03868	**19:00**	0.01976
4:00	0.06061	**11:00**	0.04559	**20:00**	0.01694
5:00	0.06326	**12:00**	0.03454	**21:00**	0.04094
6:00	0.0952	**13:00**	0.03592	**22:00**	0.03247
6:10	0.0622	**14:00**	0.02542	**23:00**	0.01694
6:30	0.0651	**15:00**	0.02824		

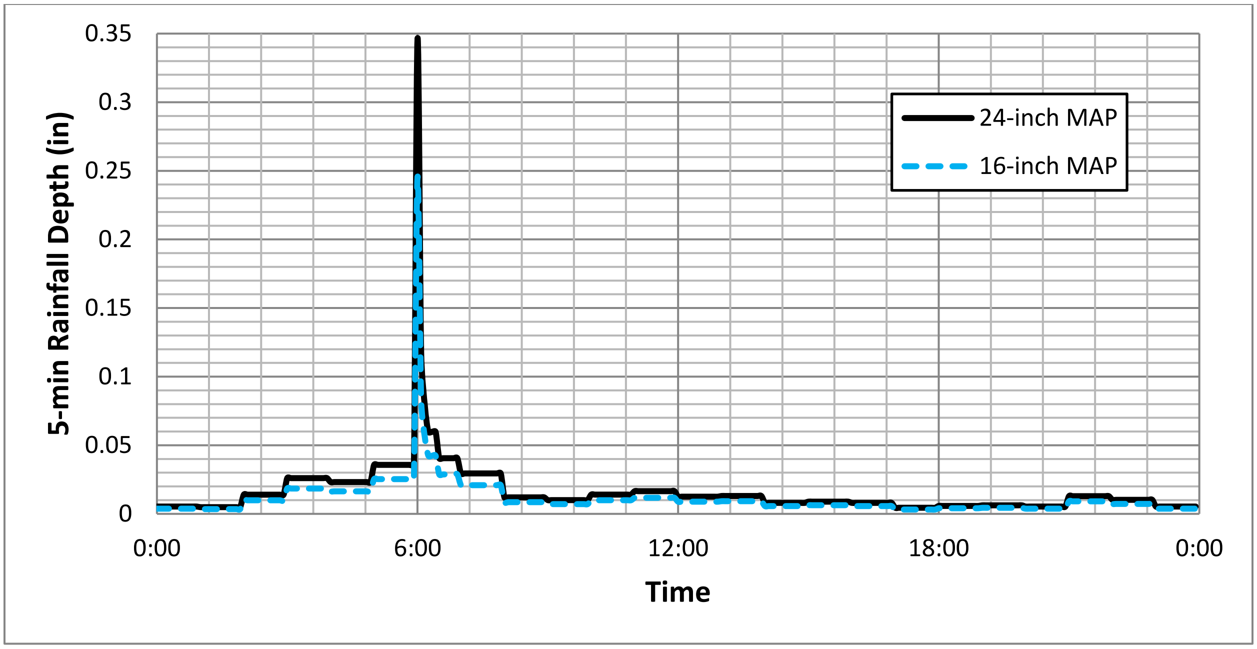

Figure 3-4: 10-year MAP 16 and MAP 24 Rainfall Patterns (inches)

3.5. Catchment Data

Cupertino is divided into drainage areas, called catchments, as described in Section Catchments2.1.6. The catchment delineations completed by Schaaf & Wheeler rely on engineering judgment and experience using contours, lot lines, storm drainage system, and aerial imagery. Urban catchment data includes the boundaries of each drainage catchment, along with relevant physical and hydrologic parameters including surface area, land use characteristics, and parameters used to calculate basin lag times.

3.5.1. Unit Hydrograph

A unit hydrograph is a numerical representation of the time response of catchment runoff caused by one inch of excess rainfall applied uniformly over a unit of time. Many different techniques are available to estimate unit hydrographs. The NRCS-dimensionless unit hydrograph is used in the Cupertino storm drain models as it matches the County's specified unit hydrograph methodology. Direct runoff is estimated by subtracting soil infiltration and other losses from the rate of rainfall. Uniform loss, which accounts for constant infiltration of rainfall into the soil, is a function of both soil type and ground cover (i.e. vegetation type or land use).

3.5.2. NRCS Curve Number

The NRCS Curve Number (CN) methodology is used to determine storm water runoff from each catchment with design precipitation. Curve numbers are used to characterize basin infiltration and runoff potential based on a combination of land use and soil characteristics discussed in Chapter 2 and a parameter known as antecedent moisture condition, or AMC. AMC is defined as the moisture content of a soil prior to any precipitation event. AMC is characterized by the NRCS as:

AMC I	Soils are dry
AMC II	Average conditions
AMC III	Heavy rainfall, saturated soil

The County Drainage Manual specifies a calibrated AMC value to properly convert the rainfall event's frequency of occurrence into the equivalent frequency of runoff event. The standard AMC assumption for a 10-year model is II-1/2, lying between heavily saturated and average conditions.

Curve numbers vary from 0 to 100, with a CN of 0 representing no runoff from a basin and a CN of 100 meaning that all precipitation will run off. As shown in Table 2-3, County Drainage Manual pervious surface curve numbers are applied to the Cupertino model based on land use and soil type. Land use and soil type polygons have been intersected with Cupertino's catchments, and the appropriate CN applied to each resulting intersected polygon. Each catchment is then assigned a pervious, area-weighted mean CN. The pervious CN for each catchment is adjusted to AMC II 1/2 for use in the 10-year analysis. Impervious areas are assigned a CN of 100 and overall weighted curve numbers are calculated for each catchment polygon.

3.5.3. Basin Lag

For urban storm drain systems, basin lag generally consists of three components: roof or overland flow, gutter flow, and pipe flow. Because the MU pipe flow model accounts for lag time through pipe systems, roof and gutter flow are properties that are calculated as inputs for catchments.

Due to the relatively small size and mild slope of the delineated catchments, an alternative lag equation has been chosen. A modified SCS lag equation expresses basin lag time as:

$$t_{lag} = \left(0.862 \times 24 \times N \left(\frac{L \times L_c}{\sqrt{S}}\right)^{0.38}\right) - \frac{D}{2}$$

t_{lag} = lag (minutes)

N = watershed roughness value (dimensionless)

L = longest flow path from catchment divide to outlet (miles)

L_c = length along flow path from a point perpendicular with the basin centroid to its outlet (miles)

S = average slope (feet/mile)

D = duration of unit hydrograph (hours)

This equation uses basin length, slope, and curve number (which is a function of land use and soil type) to estimate basin lag. A minimum lag of 5 minutes in the street is set based on engineering judgment. The overall minimum basin lag time is 10 minutes to account for roof top drainage through individual properties to the street. (This minimum lag is consistent with the County Drainage Manual.) Schaaf & Wheeler used the City's LiDAR topography data and GIS tools to estimate basin flow paths and slopes. Weighted Curve Number calculation is discussed in detail in Section 3.5.2.

3.6. Model Calculations

MU pipe flow calculations require network data, operational data, and boundary data as input. Network data consists of the pipe network elements including nodes (manholes, outlets, and storage nodes) and links (pipes, culverts, and open channels).

Detailed analyses of peak storm water discharge are performed by the MU program, which also determines the flow condition in each drainage system element. The MU technical manuals may be referenced for a more detailed description.

3.6.1. Links

Parameters required to describe model links include the name of upstream and downstream nodes, pipe shape and dimensions, material or roughness, and upstream and downstream inverts. Structural system elements including weirs are all modeled as functional relationships connecting two nodes in the system, or associated with one node in the case of free flow out of the system. Operational data consists of parameters which describe how these elements function in the network. Boundary data for the pipe flow computation can include any external loading, inflow discharges, water levels at interaction points with receiving waters, as well as the results of a run-off calculation.

Pipes are modeled as one-dimensional closed conduit links which connect two nodes in the models. The conduit link is described by a constant cross-section along its length, constant bottom slope, and straight alignment. Unsteady flow in closed conduits is calculated using conservation of continuity and momentum equations, distinguishing between pipes flowing partially full (free surface flow), and those flowing full (pressurized flow). Most pipes within the Cupertino model are modeled as reinforced concrete pipe (RCP) with a Manning's '*n'* of 0.013 or corrugated metal pipe (CMP) with an 'n' of 0.025.

3.6.2. Junction Losses

Parameters required to describe nodes include *x* and *y* coordinates of the node, a unique name, node type (junction, outlet, or basin), depth and invert levels, and water levels at outlets. Hydraulic losses at junctions (manholes, inlets, or intersections) can be significant in pressurized drainage systems. Losses can vary due to construction methods, condition, and shape. Schaaf & Wheeler performed a sensitivity analysis of the loss coefficients used in MU to determine the most realistic model parameters. The MU Weighted Inlet Energy Method is used for this study.

3.6.3. Outlet Boundary Conditions

Pipe network outlets can be modeled with either a free outfall or a water surface elevation (fixed or variable with time) which captures backwater effects due to receiving water levels. The modeled system contains 119 nodes modeled as outfalls. 10-year fixed stage boundaries are used at each outlet to Stevens and Calabazas Creeks. These are extracted from FEMA profiles. Because both Creeks are deeply incised, the fixed water surface generally does not impact the function of the pipe systems draining to them.

Regnart Creek and Junipero Serra are both an integral part of the City's drainage system. While Regnart is technically a creek and collects hillside drainage from its upstream reach, much of it consists of an approximately seven foot diameter culvert. This means that it behaves as part of the City's storm drain system, and the timing of peak flows through the Creek can potentially have a significant impact on the functionality of connected pipe systems. Therefore, the portion of Regnart Creek that flows through the City is included in the storm drain model, with the upper hillside reach represented as a catchment area.

While Junipero Serra Channel is mostly an open, concrete-lined channel, it is relatively shallow and does not have a large upstream drainage area outside of the area draining to the City's pipe system. Because the channel is relatively shallow, peak timing and water surface elevation is far more likely to have an impact on connected pipe systems. For this reason, portions of the open channel that flow through the City are included in the storm drain model.

3.6.4. Limits of SCVWD Jurisdiction

The Santa Clara Valley Water District (SCVWD) manages potable water, groundwater, flood protection, and stream stewardship on behalf of Santa Clara County. The City lies within two of the five major watersheds (Lower Peninsula and West Valley Watersheds) managed by Santa Clara Valley Water District (Figure 3-5).

Coordination with SCVWD will be required for the construction of any master plan improvements located on stream banks. This includes the alternation of existing outfalls, or the construction of new outfalls. The City should also coordinate with SCVWD during the design of improvements that alter the floodplain.

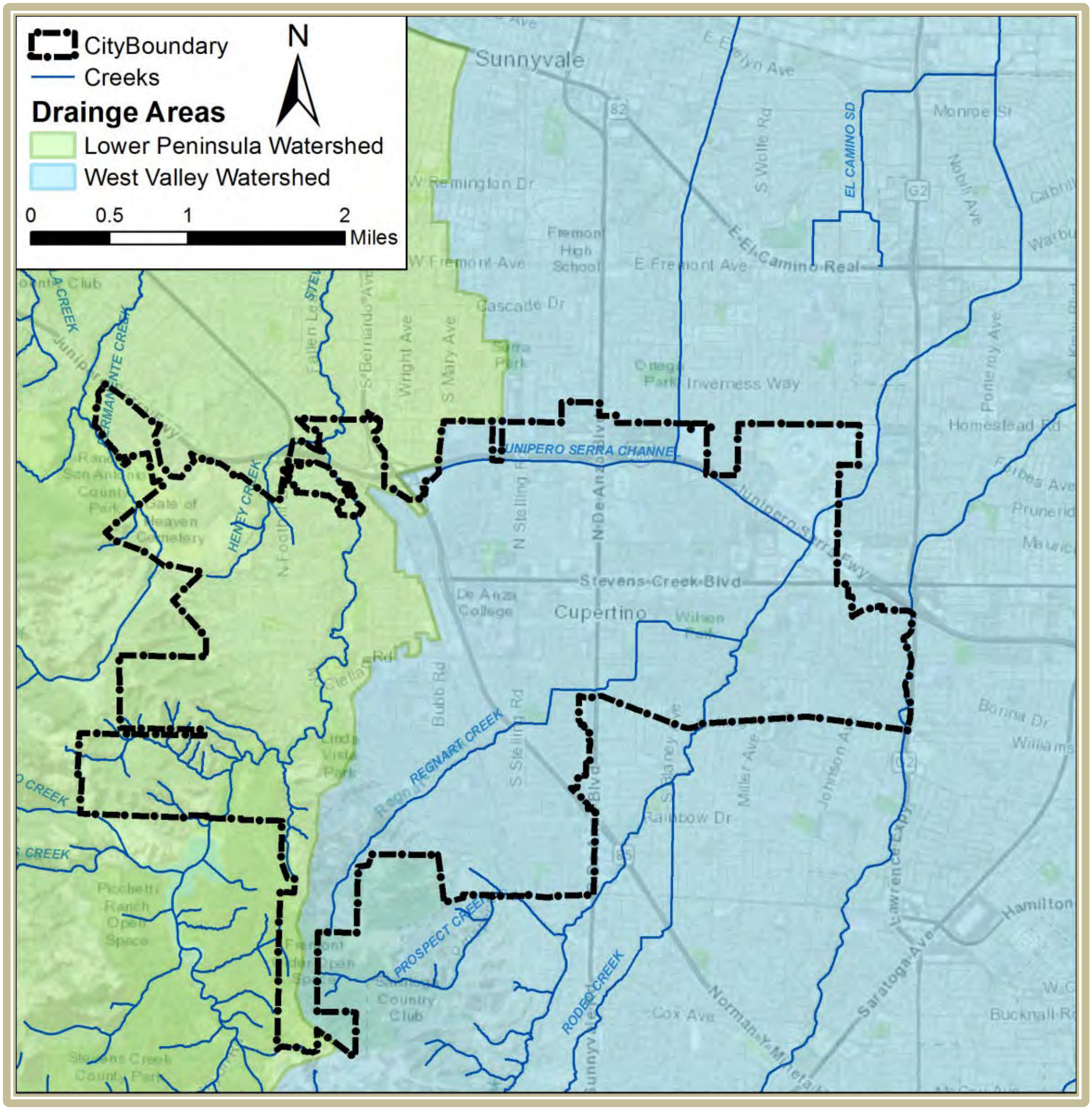

Figure 3-5: Santa Clara Valley Water District Watersheds and Creeks

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Chapter 4. Evaluation of Storm Drain Systems

4.1. Overview

A performance analysis of Cupertino's storm drain system is the primary focus of the storm drain master plan. This chapter describes Cupertino's storm drainage facilities and known drainage system issues within Cupertino in detail. Flooding depths predicted by the one-dimensional model are presented for the 10-year event assuming the existing land use condition. Improvement projects that are required to alleviate or minimize flooding based on the 10-year performance standard are identified and prioritized herein.

4.2. Evaluation of Storm Drain Capacity

Cupertino's storm drain system has been analyzed with current land use conditions during the design 10-year storm. Areas of significant flooding based on past occurrences and results of the MIKE URBAN (MU) models are discussed herein, and improvement projects are recommended based on required additional flow capacity. Projects have been developed by upsizing existing pipes in the MU model until flooding is contained within the street right of way (i.e., top of curb) for the 10-year event.

Areas of significant potential flooding are recognized herein. Improvements are recommended to improve system performance for the 10-year storm. It is impossible to entirely remove flooding throughout the project area, either due to local topography (for example, at minor 'bathtub' areas that can occur in parking lots where private systems are not modeled), but the majority of model-predicted flooding due to storm drain pipe system surcharge can be mitigated with the capital improvements proposed herein.

Figure 4-1 below shows the existing conditions for Cupertino storm drain pipes for the 10-year storm event as modeled in MU. This figure is also included in Appendix A.

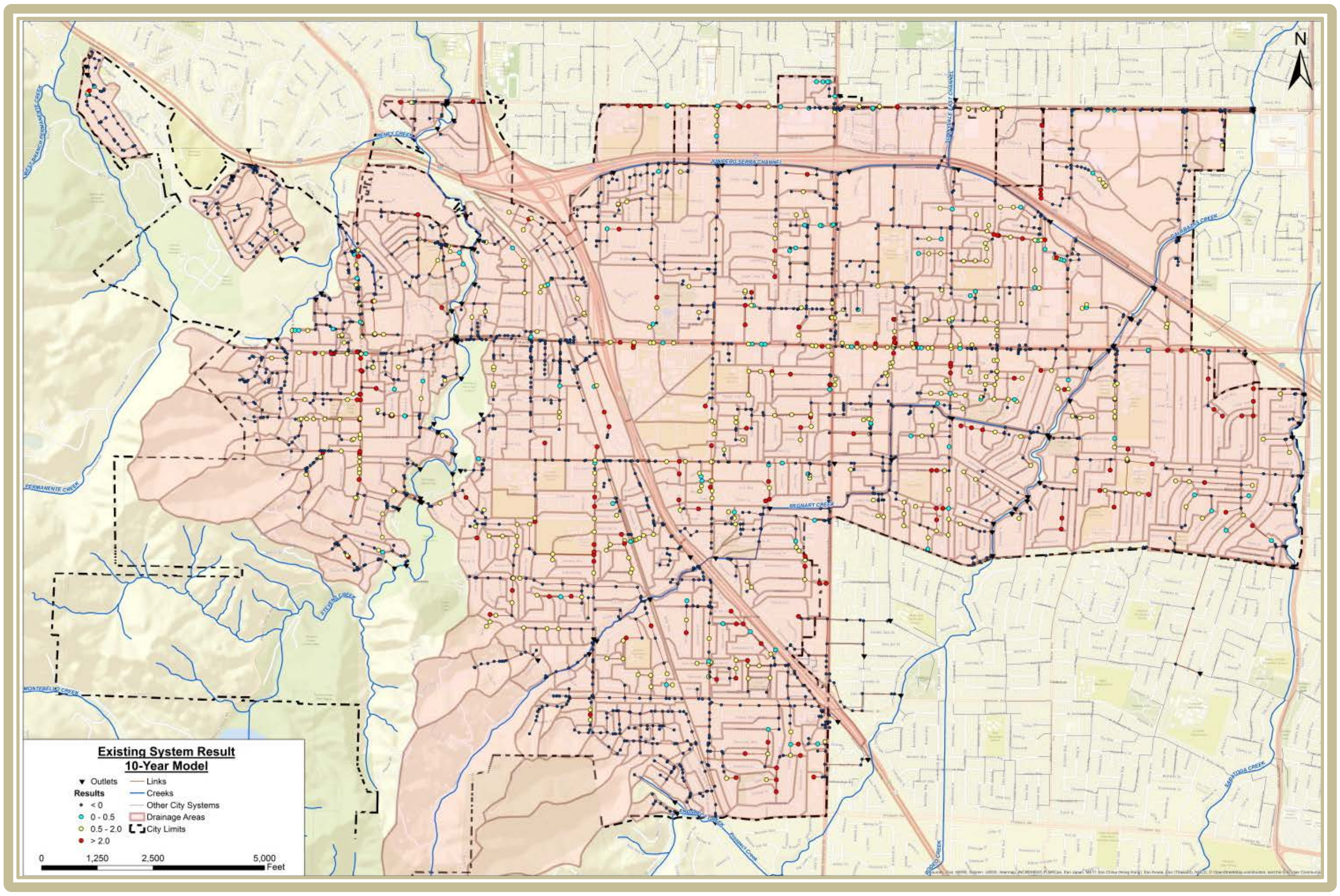

Figure 4-1: Drainage Areas and Existing Storm Drain Pipe System

4.2.1. Design Criteria

The City of Cupertino currently requires that storm drain pipe systems be designed such that 10-year storm runoff is no higher than 0.5 foot above the rim elevation at any location. Similar standards are common practice to prevent flooding during more frequent storm events and utilize street conveyance capacity and storage in large, less frequent events. This standard will form the basis of the storm drain master plan effort and development of a capital improvement plan.

While specifying a design standard such as conveyance of 10-year runoff is the most important element in governing the sizing of a system, a minimum pipe diameter and slope may also be established to reduce maintenance requirements through the life of the system. Minimum pipe size specified by the City is 15-inches, with slopes dictated by a minimum required flow velocity. Setting such requirements helps to ensure that pipes remain clean and clear of blockage to the greatest extent possible.

A city-wide model was developed to analyze the 10-year event for existing land use conditions and recorded soil conditions. The model revealed that a portion of the City's storm drain system does not meet the published criteria. While containing the 10-year below the street surface forms the foundation of this analysis in general, at certain project locations this standard is not necessarily economically feasible to achieve. This doesn't necessarily mean that a standard should not be enforced on future construction; however, a CIP may deviate from the standard for a number of reasons (for example, utility conflicts that make meeting a standard prohibitively expensive).

4.3. Prioritizing Deficiencies and Needed Capital Improvements

Storm drain systems in Cupertino (both City-owned systems and those owned by others) convey the majority of storm water runoff toward the major creeks through storm drain systems consisting of gutters, catch basins, pipes and some small pump stations (primarily those owned by Caltrans).

Recommended improvements have been prioritized based on the results of the above process, combined with consideration of the anticipated severity of flooding at each location and the benefit/cost relationship of proposed improvements. The following color code is used to highlight project prioritization:

Priority	Description
High Priority	Projects under this category eliminate areas of 10-year flooding with significant depths, or address areas where City staff has indicated frequent and/or significant historical flooding issues. These projects improve conditions at locations with the deepest and longest-duration flooding situations.
Moderate Priority	These improvements are intended to contain most of the 10-year flooding within the street right-of-way. The duration and depth of flooding corrected by a moderate priority improvement is less than that of a high priority improvement.
Low Priority	Low priority improvements are aimed at containing the remaining 10-year flooding in the street right-of-way. The areas of flooding addressed by low priority projects are much smaller than those of moderate and high priority projects.

This section summarizes improvements to City-owned systems needed to achieve a level of service characterized by flooding no greater than street level for a 10-year event. Improvements have been grouped together to reflect projects that could feasibly be undertaken simultaneously. Project naming conventions use major street names where possible. Project names and unique numerical IDs assigned to each project identify improvements in maps and tables included in this SDMP. A map of the proposed CIPs is included in Appendix B. Some areas within City Limits drain directly to adjacent streams rather than into the storm drain system and are therefore not included in the models.

Moderate and Low priority projects are not discussed in project-specific detail, as there are a large number of these projects and they will likely not be constructed in the foreseeable future, certainly not before the storm drain master plan is updated. A complete set of CIP tables including existing pipe size, recommended pipe size, and improvement cost breakdowns for all priorities are provided as Appendix C.

4.4. Cupertino System Evaluation

The modeled drainage area is approximately 11 square miles. The modeled collection system within Cupertino City limits consists of 2,596 pipe segments, 2655 nodes, and 119 outlets. The project area has a total of 474,000 linear feet (89.8 miles) of modeled storm drain pipe equal to or greater than 12-inches in diameter.

4.4.1. Identified Deficiencies

Deficiencies identified by Schaaf & Wheeler include segments of Bubb Road, South Foothill Boulevard, McClellan Road, South Blaney Avenue, and certain areas in Cupertino neighborhoods.

4.4.2. Known Problem Areas

Known problem areas identified by City staff include Bubb Road, South Foothill Boulevard, and Pumpkin Drive at Cranberry Drive. These areas are included in the high priority projects.

4.4.3. Prioritized Improvements

Thirteen high priority projects (Appendix D) are aimed at reducing significant 10-year flooding throughout the City.

Twenty-seven moderate priority projects will reduce most flooding at the 10-year level of service. The City may need to progressively re-prioritize moderate priority projects based on funding, other utility improvements, land use changes, and condition assessments.

Eighty-one low priority projects are recommended to alleviate minor 10-year flooding. These projects are not likely to be constructed before the next storm drain master plan update.

Chapter 5. Capital Improvement Plan

5.1. Overview

Chapter 4 discusses Cupertino's storm drain collection system and recommends prioritized capital improvements to address known and modeled deficiencies. This chapter provides a Capital Improvement Program (CIP) that recognizes these priorities. The CIP provides an overall guideline for the City to use as a tool in preparing annual budgets. Exigent circumstances and future in-field experiences may necessitate deviations from the Storm Drain CIP. A master plan is intended to be a tool for planning. Capital improvement priorities are not intended to be hard and fast.

The CIP does not include the cost of new facilities related to new development (e.g., pipeline extensions to serve areas that are currently undeveloped). These new facilities may be constructed as part of the new developments, and are not included in the CIP.

5.2. Capital Improvements Priorities

The proposed CIP for storm drainage in Cupertino is broken into three priority levels for the purpose of funding and implementation. The total cost summary for CIP projects is shown for each priority level in Table 5-1. Summary of CIP Costs Based on Priority Level (total project cost)

Table 5-1: Summary of CIP Costs Based on Priority Level (total project cost)

Priority Level	Cost[1]
High Priority Capital Improvements	$12,520,000
Moderate Priority Capital Improvements	$25,880,000
Low Priority Capital Improvements	$40,880,000
Total Capital Improvement Program	**$79,280,000**

1. Cost rounded to the nearest ten thousand

The above costs do not include design, administration, or construction contingencies. Project subtotals (cost of pipe demolition and replacement), construction totals (including traffic control, mobilization, demobilization, and contingency), and CIP totals (including design and engineering costs) are detailed in Appendix C.

5.3. Open Trench Improvements

Two essential types of projects are traditionally utilized to increase storm drain system capacity:

- Install a new relief storm drain parallel to the system lacking capacity, or
- Replace the overloaded pipe with larger diameter pipe in the same alignment.

The two alternatives can be made equivalent to one another using the following formula, assuming that pipe material and length are equal:

$$D_R = (D_e^{2.63} + D_p^{2.63})^{0.38}$$

Where D_R = diameter of replacement pipe;

D_e = diameter of overloaded pipe; and

D_p = diameter of parallel relief drain.

Assuming the existing pipe is adequate in terms of condition, the installation of a new parallel pipe is typically more cost effective than pipe replacement because the required pipe size is smaller and the existing pipe does not need to be removed. This does not take into account the long term maintenance associated with a parallel system. The selection of a capacity improvement strategy will vary from project to project, and be governed by field constraints such as conflicting utilities, rights-of-way, environmental concerns, permit requirements and traffic control.

5.4. Trenchless Improvements

Traditional cut and cover methods of construction will likely be employed for a large portion of the storm drain improvements. However, the utilization of trenchless methods such as bore and jack, directional drilling, cured-in-place pipe (CIPP), slip-lining, pipe bursting, and others, may increasingly find application in special circumstances where existing development encroaches upon the pipe alignment, or disruption of other services and land uses is too costly. These trenchless methods also have their own constraints and should be chosen based on pipe material, access, and other site specific circumstances.

5.5. Cost Basis for Improvements

Costs have been estimated using information from other projects, other master plans, and engineering judgment. All estimates are based on the ENR May 2018 index. The cost per linear foot of improvement used for the pipe cost estimates are given in Table 5-2, and most projects assume replacement pipe is installed using the open trench method *(note that these costs do not include the cost of design, administration, and contingency).* Projects that cross a railroad are assumed to be jack and bore, not open trench. Costs are likely to vary greatly depending on site specific circumstances and the economic climate at the time of bidding; in some cases it may be more practical to use trenchless methods or a parallel pipe for construction. These cost estimates are also based on larger scaled projects and thus, the replacement of shorter lengths of pipe as individual projects may incur significantly higher costs due to the nature of construction work.

As per our estimates, connection (manhole or catch basin) replacement cost estimates depend on connecting pipe diameters and ranged from $12,740 (15-inch pipe) to $17,440 (72-inch pipe). New outfall costs are estimated to be $40,000 per new outfall. It should be noted that wide variations in actual outfall costs are expected due to location of outfall, whether energy dissipation is required, environmental concerns, etc. Since most of these improvement projects are expected to qualify for negative declarations from permitting agencies, these costs do not include permitting or any environmental documentation. Unit costs assuming three feet of pipe cover are shown in Table 5-2.

Table 5-2: Storm Drain Replacement Unit Costs

Diameter (inches)	2018 Dollar per Linear foot of Pipe[1]	2018 Dollar Per Connection[1]
15	$ 270	$ 12,740
18	$ 290	$ 12,830
21	$ 310	$ 12,920
24	$ 350	$ 12,990
27	$ 370	$ 13,070
30	$ 400	$ 13,150
33	$ 430	$ 13,510
36	$ 460	$ 13,650
42	$ 510	$ 14,000
48	$ 550	$ 14,800
54	$ 630	$ 15,600
60	$ 680	$ 16,000
66	$ 720	$ 17,080
72	$ 780	$ 17,440
Note: These costs do not include increases for design, administration, and for contingency included in all other tables. Unit costs are based on an average 3 feet of ground cover over the pipe. Greater cover will raise estimated costs.		

1. Dollar amounts rounded to the nearest ten

5.6. Capital Improvement Program

5.6.1. Storm Drain Improvement CIP

The CIP costs and pipe lengths based on priority level are summarized in Table 5-1 and Figure 5-1. Detailed project sheets with required replacement pipe for high priority CIPs are included in Appendix D.

Figure 5-1: Storm Drain CIP Summary Chart

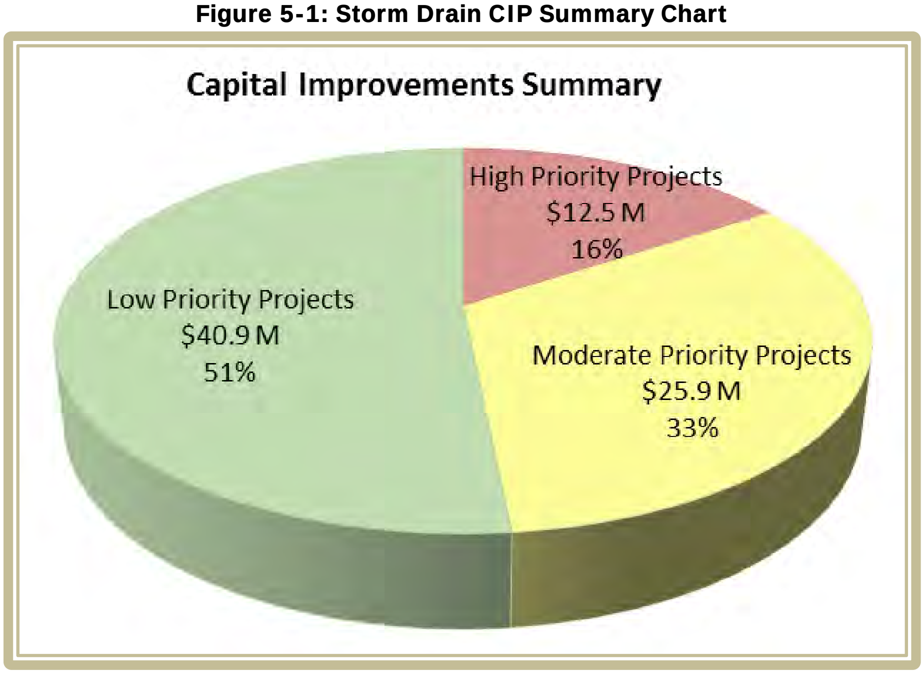

Table 5-3: CIP Projects for the City of Cupertino

Project	Priority	Project Length	Total MH #	Total Project Cost[1]
Pumpkin Fiesta Phase 1	High	587	4	$ 476,000
Pumpkin Fiesta Phase 2	High	1698	9	$ 1,402,000
Bubb Phase 1	High	302	2	$ 182,000
Bubb Phase 2	High	823	10	$ 583,000
Bubb Phase 3	High	3048	17	$ 1,651,000
Foothill South Phase 1	High	1643	11	$ 1,295,000
Foothill South Phase 2	High	2186	9	$ 1,219,000
McClellan Phase 1	High	4270	20	$ 2,558,000
McClellan Phase 2	High	2020	10	$ 1,136,000
Stevens East	High	1428	6	$ 816,000
Foothill North Phase 1	High	1164	9	$ 567,000
Foothill North Phase 2	High	1192	7	$ 515,000
Cali	High	235	4	$ 115,000
Beardon	Moderate	2211	11	$ 1,060,000
Blaney North	Moderate	3034	12	$ 1,503,000
Blaney South	Moderate	2633	12	$ 1,221,000
Bollinger	Moderate	2987	16	$ 1,612,000
Calle de Barcelona	Moderate	4144	15	$ 2,019,000
Calvert	Moderate	1465	6	$ 690,000
Columbus	Moderate	4547	19	$ 2,072,000
Finch	Moderate	1000	6	$ 428,000
Fort Baker	Moderate	3280	14	$ 1,432,000
John	Moderate	982	6	$ 379,000
Kingsbury	Moderate	1689	9	$ 676,000
Majestic Oak	Moderate	513	4	$ 200,000
Peach Blossom	Moderate	3694	13	$ 1,539,000
Poppy	Moderate	1331	7	$ 623,000
Rainbow	Moderate	1119	4	$ 568,000
Rodrigues	Moderate	4811	20	$ 2,259,000
Royal Oak	Moderate	746	6	$ 304,000
Scenic	Moderate	682	6	$ 308,000
Scotland	Moderate	1349	8	$ 550,000
Stafford	Moderate	1217	6	$ 496,000
Stelling North	Moderate	2689	13	$ 1,541,000
Stelling South	Moderate	3232	14	$ 1,374,000
Stern	Moderate	1390	6	$ 533,000
Stevens West	Moderate	1578	8	$ 621,000
Stokes	Moderate	2283	13	$ 1,048,000
Vista	Moderate	1571	10	$ 633,000
Weymoth	Moderate	518	3	$ 189,000
Adriana	Low	140	2	$ 66,000
Ainsworth	Low	637	4	$ 348,000

Project	Priority	Project Length	Total MH #	Total Project Cost[1]
Alcalde	Low	847	6	$ 418,000
Alhambra	Low	924	6	$ 366,000
Alves	Low	2926	19	$ 1,326,000
Bandly	Low	219	2	$ 89,000
Baywood	Low	828	5	$ 307,000
Bubb North	Low	1617	5	$ 697,000
Bubb South	Low	1219	7	$ 584,000
Byrne	Low	678	6	$ 304,000
Candlewood	Low	1348	7	$ 562,000
Castine Phase 1	Low	1587	9	$ 920,000
Castine Phase 2	Low	1069	4	$ 429,000
Clarkston	Low	991	6	$ 370,000
Clifford	Low	944	4	$ 344,000
Colony Hills	Low	605	3	$ 214,000
De Anza Circle	Low	298	3	$ 125,000
De Anza North Phase 1	Low	1660	7	$ 859,000
De Anza North Phase 2	Low	1776	15	$ 936,000
De Anza South	Low	1014	5	$ 569,000
De Foe	Low	466	5	$ 230,000
DeAnza	Low	203	2	$ 97,000
Deep Cliffe	Low	482	3	$ 172,000
Derbyshire	Low	1101	5	$ 389,000
Drake	Low	985	5	$ 341,000
Elmsford	Low	1182	4	$ 394,000
Estates	Low	727	4	$ 292,000
Fairwoods	Low	627	4	$ 271,000
Farallone	Low	330	3	$ 134,000
Felton	Low	330	4	$ 206,000
Gardena	Low	166	2	$ 70,000
Gardenside	Low	933	5	$ 335,000
Greenwood	Low	712	3	$ 245,000
Homestead	Low	2873	10	$ 1,325,000
Homestead West Phase 1	Low	7946	38	$ 4,339,000
Homestead West Phase 2	Low	1260	5	$ 430,000
Imperial	Low	493	4	$ 237,000
Kim	Low	916	6	$ 399,000
La Mar	Low	1603	10	$ 638,000
Lazaneo	Low	351	3	$ 163,000
Lilac	Low	950	5	$ 342,000
Linda Vista	Low	363	3	$ 144,000
Longdown	Low	332	3	$ 143,000
Mariani	Low	555	4	$ 339,000
Martinwood	Low	548	4	$ 210,000

Project	Priority	Project Length	Total MH #	Total Project Cost[1]
Mary	Low	432	4	$ 276,000
Merritt	Low	934	6	$ 511,000
Meteor	Low	542	4	$ 197,000
Miramonte	Low	686	7	$ 319,000
Norwich	Low	2909	10	$ 1,311,000
Palo Vista	Low	649	6	$ 339,000
Par Three	Low	201	2	$ 80,000
Parlett	Low	514	2	$ 175,000
Pendergast	Low	824	2	$ 356,000
Phar Lap 1	Low	1397	9	$ 607,000
Phar Lap 2	Low	1229	5	$ 480,000
Plum Tree	Low	762	4	$ 272,000
Portal	Low	1847	10	$ 778,000
Richwood	Low	1180	6	$ 419,000
Rivercrest	Low	208	2	$ 205,000
Scofield	Low	1903	7	$ 787,000
Somerset	Low	617	3	$ 217,000
St Joseph	Low	258	3	$ 118,000
Stevens Canyon	Low	281	4	$ 148,000
Stevens Creek	Low	11439	66	$ 7,312,000
Suisun	Low	391	4	$ 189,000
Swallow	Low	192	2	$ 93,000
Terrace	Low	1034	5	$ 396,000
Torre	Low	1028	6	$ 445,000
United Place	Low	203	3	$ 98,000
Vallco Parkway 1	Low	441	3	$ 216,000
Vallco Parkway 2	Low	384	5	$ 199,000
Vallco Parkway 3	Low	838	5	$ 429,000
Valley Green 1	Low	502	3	$ 198,000
Valley Green 2	Low	349	3	$ 161,000
Voss	Low	809	4	$ 302,000
Wheaton	Low	572	3	$ 204,000
White Fir	Low	116	2	$ 57,000
Wildflower	Low	162	2	$ 73,000
Wolfe	Low	1315	7	$ 543,000
Wunderlich	Low	1778	6	$ 657,000

1. *Total Project Cost rounded to the nearest thousand*

5.7. Green Infrastructure

The 2015 MRP section C.3.j includes development of a Green Infrastructure Program Plan to include LID (Low Impact Development) design on public and private lands, including streets, roads, storm drains and other storm drain infrastructure elements. The Plan is intended to act as a roadmap to turn the City's 'gray' infrastructure into 'green'. Additionally, the intent of the Plan is to provide reasonable assurance that the TMDL wasteload allocations for mercury and PCBs in San Francisco Bay will be met. The Plan will identify opportunities and prioritize particular areas for LID implementation throughout the City. The Plan will also allow for tracking and reporting of green infrastructure project design and construction.

A portion of the GI Plan requirements includes reviewing other City planning documents for incorporation of LID elements. The City should look for and evaluate opportunities to incorporate green infrastructure and LID facilities into the design of capital projects recommended in the master plan.

Because of the emphasis that the MRP puts towards using LID, there are numerous regional groups tracking the most up to date technologies on LID and the corresponding NPDES regulations. The following sites contain useful information for municipal staff, developers, general public, and elected officials to keep abreast with trends and policies in the often changing arena.

California Stormwater Quality Association

https://www.casqa.org/resources/california-lid-portal

California State Water Resources Control Board

http://www.waterboards.ca.gov/water_issues/programs/low_impact_development/index.shtml

SCVURPPP

http://www.scvurppp-w2k.com/

5.8. Summary of Findings

Several conclusions have been reached regarding Cupertino's storm drainage systems. From these conclusions, improvements are recommended for the system's performance so as to reduce the risk of flooding. While there are many areas within the City of Cupertino that provide adequate stormwater conveyance for a 10-year event, there are also areas that would benefit from improvements to enhance Stormwater conveyance capacity. There are also regions of the City that lack a formal drainage system and require improvements. Complying with the Municipal Regional Permit (MRP) will require additional O&M and Engineering staff services. The improvements recommended in this Master Plan should be considered a comprehensive Capital Improvement Program within the study area.

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Chapter 6. Financial Analysis and Funding Strategies

This chapter presents the funding strategies and their implications that are available to the City to fund capital projects for the Stormwater system. The findings presented in this chapter represent a high-level overview of the financial condition of the City's Stormwater Program and potential impacts to the General Fund and/or property owners. Financial plans and levy/fee options should not be implemented without the specific analysis and justification required by statutory obligations for the revenue mechanism the City selects.

6.1. Summary of Findings

This chapter finds:

- The City of Cupertino, like many California cities, faces increasing expenditures to fulfill mandated obligations and community expectations associated with its Stormwater Program.
- The Stormwater Program has historically been supported by the General Fund; however, the projected cost of these expenditures in a time of increasing demands on the City's General Fund warrants the consideration of a dedicated revenue stream.
- Over the next 10-years, the Stormwater program could invest approximately $14 million to improve or construct capital infrastructure. These investments, while ordered in a prioritized manner, could occur in an uneven pattern from year to year.
- Over this 10-year period, the Stormwater Program is also projected to spend approximately $10,000 annually (in 2018 values) on maintenance in problem spots in the system.
- The City's system operation and maintenance and permit compliance costs are expected to be approximately $1,000,000 on an annual basis (in 2018 values).
- An annual revenue stream will be needed to ensure capital improvement projects, as well as ongoing maintenance and permit compliance costs, are fully funded.
- This annual revenue stream can be generated through an annual levy on properties ranging from an estimated $50 to $150 per equivalent dwelling unit[1] per year. Further studies are recommended to refine these numbers and to establish Land Use based fees.
- While multiple levy/fee mechanisms are available to create a dedicated revenue stream from properties in the City, some form of direct property owner or voter approval of the fee will be required. The City will need to determine the political feasibility of this new funding source, in addition to preparing the formal justification and documentation of the selected levy/fee mechanism.
- Other minor revenue streams may also be developed which would reduce the annual levy on property owners. These might include fees for specific operational or regulatory tasks and/or mitigation fees from new development or redevelopment that impact the Stormwater infrastructure.

[1] *An equivalent dwelling unit is equal to a typical single family residential parcel.*

6.2. Introduction

This chapter has been prepared following a “revenue requirements” analytical methodology common to financial analyses underlying most utility rates and charges imposed by traditional utilities, similar to the sanitary sewer systems. While California law does not enable municipalities to impose “utility rates” for stormwater management services, the Stormwater Program shares similarities to traditional utilities and will likely require a primary, dedicated revenue source akin to rates.

The Stormwater Program includes long-term capital financing requirements to fund equipment, infrastructure, and problem-spot maintenance projects and will eventually have ongoing operations, maintenance, administration, and regulatory obligations to fund. Properly managing the Program may also require establishing reserves and using debt financing. Therefore, the following analyses have been prepared:

- Evaluation of financing strategies for the capital improvement program.
- Projected debt proceeds and debt service payments.
- Analysis of cash and reserve requirements.
- Determination of net annual revenue requirements for the program.

6.3. Potential Revenue Sources

In establishing a dedicated revenue stream for the Stormwater Program, the City will likely want to pursue a property-related fee or a special tax. The political feasibility of these mechanisms will likely be critical factors in determining which one the City implements.

6.3.1. Property-Related Fee

A property-related fee is a fee for service attributable to the parcel being charged. A fee for stormwater services is levied upon the County tax roll and is imposed as an incident of property ownership. As such, it would be subject to the substantive and procedural requirements of California Constitution Article XIII D (known commonly by its enacting ballot measure: Proposition 218). The fee must be submitted and approved by a majority vote of the property owners or by a two-thirds vote of the electorate. The amount charged to each parcel must be proportional to the cost of service attributable to that parcel. Due to this proportionality requirement, the costs attributable to public parcels should be paid by City revenues (e.g., General Fund appropriation) or by individual City departments.

For a property owner election, each parcel generally receives one ballot, and each ballot has one vote regardless of the potential levy amount, although the City may also have the power to provide for weighted voting. In one-parcel-per-vote elections, a large commercial parcel with a calculated levy that is an order of magnitude greater than that of a smaller parcel would have the same, single vote as the smaller parcel.

The revenue stream from a property-related fee may be used for capital, annual operating and maintenance costs. This revenue stream could also be pledged as credit support for a revenue bond issued to fund major capital improvements.

6.3.2. Special Tax

A Community Facilities District (CFD) can be formed pursuant to the Mello-Roos Community Facilities Act of 1982. A CFD can fund capital projects as well as ongoing maintenance. Bonds would be issued to pay for capital costs secured by a special tax levy. The same CFD can also fund ongoing maintenance costs through a special tax levy.

There is great flexibility in both the geographic area to be levied and the formula by which to levy when using a CFD. A CFD may include non-contiguous geographic areas. There is no requirement that the special tax be apportioned on the basis of benefit to any property. Property owned by a public entity is generally exempt from the CFD special tax, ensuring no lingering obligation of other City revenues.

Successful creation of a CFD requires approval of two-thirds of the registered voters voting in an election (or approval of the landowners if less than 12 persons are registered to vote within the CFD boundary). With a voter election, each voter has one vote, regardless of their weighted share of the proposed special tax levy. In a landowner election, the vote is one vote per acre or portion thereof.

6.4. Other Sources of Revenue

Although the revenue strategy introduced in this chapter has estimated the full cost to property owners of funding the entire Stormwater Program, there are at least two other additional revenue sources that, if justifiable and collectible on a substantive scale, would reduce that final levy amount needed from the community, or in other words, the total revenue requirement. The chief benefit of examining the viability of these revenue sources is that both may be approved by consensus of the City Council alone after proper public noticing and public hearing processes.

6.4.1. Development Impact Fees

A development impact fee is a one-time fee imposed as a condition of approval on new development, infill, or redevelopment that creates new, unmitigated impermeable surface area. Development impact fees are authorized by Government Code 66000 et seq., created by the Mitigation Fee Act and commonly referred to as "AB 1600" fees.

A development impact fee may be justifiable for the Stormwater Program under one of two conditions:

- The City has previously invested in Stormwater infrastructure which has remaining value and is available and/or sized to meet impacts caused by future development/redevelopment.
- The capital projects documented in this Stormwater Master Plan are sized to meet stormwater related impacts caused by future development/redevelopment and not just the demands of existing development.

An impact fee may be based on (1) a "buy-in" to existing infrastructure, or (2) the "incremental" costs of new facilities necessary to serve new development that will create additional impermeable surface areas. A combination of these two impact fees may also be used to repay existing customers for historical capital investments. However, they cannot be used to fund operating or maintenance costs, which must be met through the Stormwater Program's annual fees.

6.4.2. Regulatory Fees

Regulatory fees are imposed to recover costs associated with the City's constitutional and statutory power to govern activities, such as development and construction. For example, within the Stormwater program, the City provides services/activities which may be eligible for recovery in a regulatory fee. These services/activities may include:

- Plan review and site inspection of development/construction that must meet Stormwater program regulations. (A common area for stormwater program activity is grading and drainage permitting/oversight.)

- Review of maintenance plans for, and periodic site inspection of onsite stormwater management/mitigation facilities.
- Inspection of properties documented under the municipal permit as high-pollution risk operations requiring onsite management and/or facilities to mitigate risk to the environment and public rights-of-way.

The statutory limit in imposing these fees is that they may not exceed the estimated reasonable cost of service. Most regulatory fees like these have historically been implemented by consensus of the City Council alone.[2] Data used to justify fee amounts must be prepared and made available to the public in advance of the public hearing.

6.4.3. Benefit-Assessment District

A benefit-assessment district assigns project costs in direct proportion to the benefits received. Benefit assessment districts are often formed for specific projects within a specific watershed. The only properties assessed are those that directly benefit from the projects and in direct proportion to that benefit.

[2] The November 2010 passage of Proposition 26 calling for voter approval of "regulatory fees" has raised some questions about the City Council's authority to set some fees. While prevailing industry consensus is that the fee examples listed here are exempt from the requirements of Proposition 26 due to the direct link between individual action and resulting regulation, the City should be aware of, and seek legal counsel regarding the ongoing debate in this area before proceeding. In establishing any regulatory fee for the Stormwater Program, the City should ensure that the broader costs of the Program – those with broader community benefits – are explicitly excluded from the cost of service calculation. Those costs must be borne by the Program's primary revenue source.