Appendix F: Preliminary Hydrology Report

SAN RAMON CITY CENTER

Preliminary Hydrology Report

Prepared for

Sunset Development Company

Prepared by

RBF CONSULTING
500 Ygnacio Valley Road, Ste 270
Walnut Creek, CA 94596-3847

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1 INTRODUCTION

This report presents the preliminary hydrologic analysis for the stormwater management infrastructure proposed for the San Ramon City Center Project (Project) located in Contra Costa Country at the Bishop Ranch business park in San Ramon, California. The purpose of this report is to present an initial analysis of the Project's affects on the local and regional drainage basin. This report is meant to serve as a background for subsequent reports that are required during the development process such as a Stormwater Control Plan and a Stormwater Pollution Prevention Plan. These and other subsequent documents will detail the design recommendations for the control of stormwater for the Project site and be used to meet local and regional regulatory requirements.

The Project site is an approximately 44-acre mixed use civic, commercial, residential, and retail development located at the intersection of Bollinger Canyon Road and Camino Ramon, 0.5 miles east of Highway 680. A Vicinity and Proposed Site Map of the Project are presented as Exhibits 1 and 2. The nomenclature used in this report to reference the area within the Project and its surrounding areas may differ from the nomenclature used in other Project related reports. The correlation between the nomenclature used in this report and other Project reports is presented in Table 1.

Table 1: Reference Nomenclature in Report

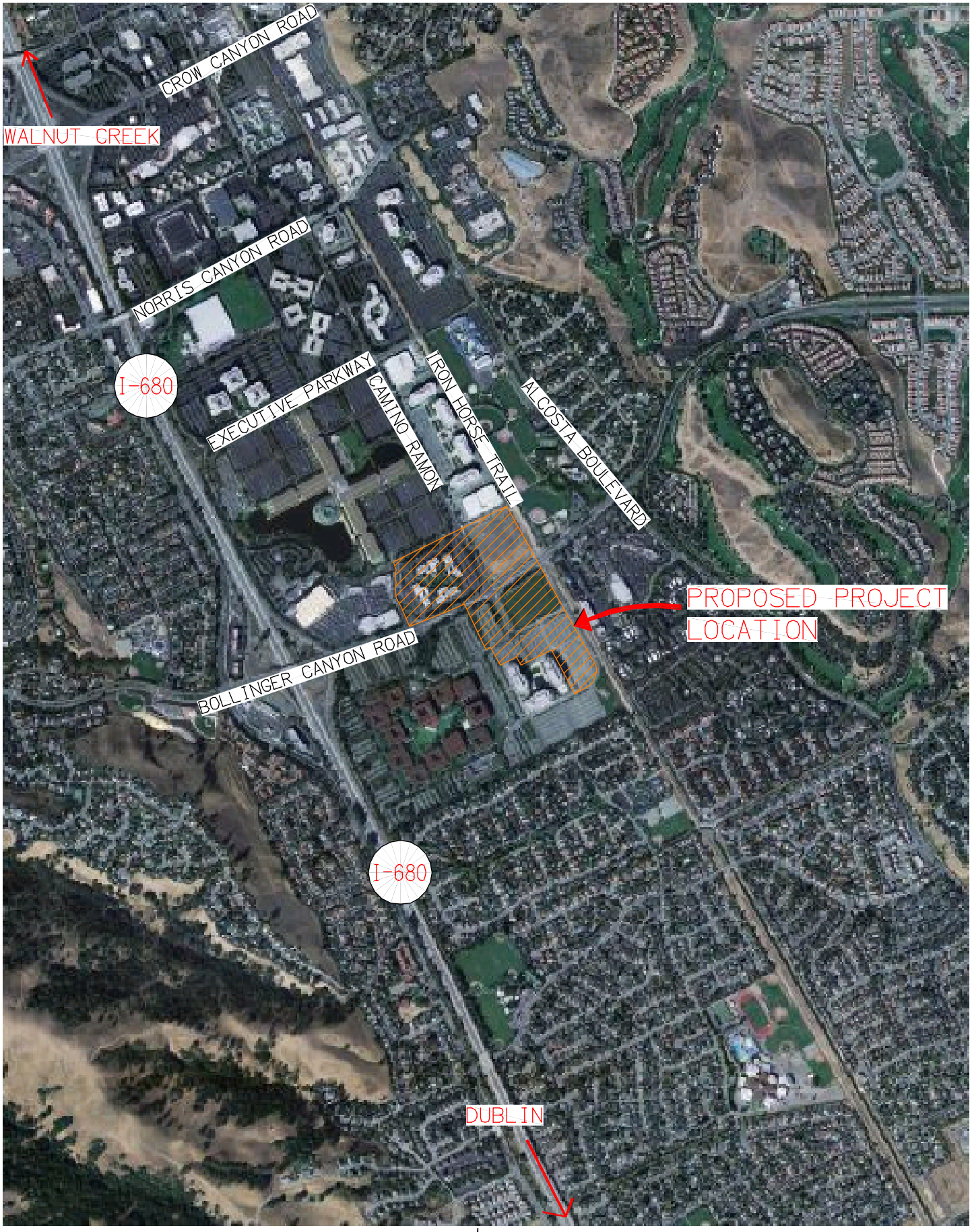
Report Nomenclature	Other Possible Designations
Bishop Ranch 1 (BR1)	BR 1, Existing BR1
Bishop Ranch 1A (BR1A)	BR 1A, Proposed Commercial Offices
Bishop Ranch 1B (BR1B)	BR 1B, Proposed Civil Center
Bishop Ranch 2 (BR2)	BR 2, Existing BR 2, Proposed Blocks A, B, C, D,
	Proposed Retail/ Residential
Bishop Ranch 3A (BR3A)	BR 3A, Proposed Blocks E, F, G, H
	Proposed Retail/ Residential
Bishop Ranch 3 (BR3)	BR 3, Existing BR3

The San Ramon City Center site is planned to incorporate four adjacent parcels of land that form the intersection of Bollinger Canyon Road and Camino Ramon. Parcels BR3A & BR1A of land to the immediate northeast and southeast of the intersection are currently undeveloped.

Parcels BR2, BR1B, and the south of BR1 are developed as commercial buildings and parking lots. There are several existing stormwater conveyance facilities on the site and throughout the surrounding area. This Project setting presents a number of considerations that will be addressed in the planning and design of the infrastructure to handle stormwater runoff. The planning process is fundamental to developing a stormwater management strategy that meets the broadest range of needs, both locally and regionally.

This report is intended to accomplish the following objectives:

- Identify key opportunities and constraints that will impact the stormwater management strategy to the site, including facilities for peak flow management and water quality management.
- Preliminarily evaluate on-site and off-site hydrologic conditions.
- Present the basis for, and preliminary calculations of, the initial sizing of stormwater basins to mitigate potential increases in peak flows.
- Identify opportunities for incorporating water-quality Best Management Practices (BMPs) for treatment of the runoff from the site.
- Set forth a preliminary drainage plan that is self-maintaining to the greatest extent practical and consistent with appropriate design guidelines of Contra Costa County and the City of San Ramon.



SAN RAMON CITY CENTER

PRELIMINARY HYDROLOGY REPORT

EXHIBIT 1: VICINITY MAP

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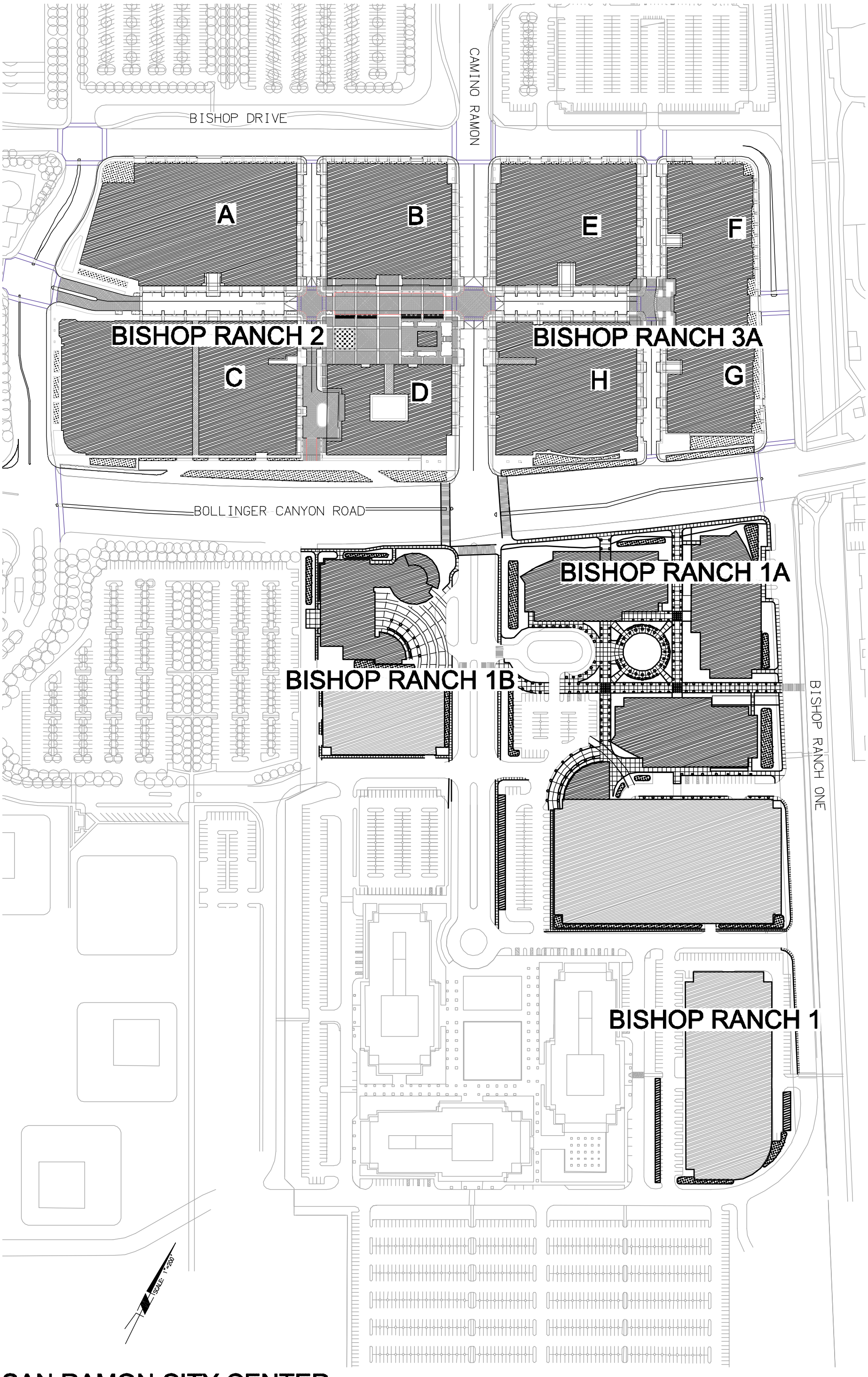

SAN RAMON CITY CENTER

PRELIMINARY HYDROLOGY REPORT

EXHIBIT 2: PROPOSED SITE MAP

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1.1 Site Description

This section presents a description of the Project location and surrounding areas. It also presents the existing and proposed land uses of the Project site.

1.1.1 Project Location and Description

The approximately 44-acre San Ramon City Center Project site is located in the Bishop Ranch business park in San Ramon, California, approximately at the intersection of Bollinger Canyon Road and Camino Ramon, 0.5 miles east of Highway 680. The San Ramon City Center site is planned to incorporate four adjacent parcels of land that form the intersection of Bollinger Canyon Road and Camino Ramon. Parcels BR3A & BR1A of land to the immediate northeast and southeast of the intersection are currently undeveloped. Parcels BR2, BR1B, and the south of BR1 are developed as commercial buildings and parking lots. BR3 houses AT&T's Western Regional Headquarters building and parking lots bounds the site to the north. The site is bounded to the west by The Shoppes at Bishop Ranch, to the south by Chevron corporate headquarters, and to the east by the Iron Horse Trail.

There are no dominating topographic characteristics of the site. The land is generally flat. The developed areas are graded to drain to local catch basins. The undeveloped parcels are roughly graded to drain off the parcel to a storm drain inlet. The high point of the Project site is approximately at elevation 450 feet at the northwest area of the site and the low point is approximately at elevation 427 feet at the southeast area of the site. The terrain naturally slopes at approximately 1% to the southeast. The site is located in a valley with hills approximately 1.5 miles to the east and west of the site. The hills rise to elevations of approximately 1,000 feet.

1.1.2 Existing Land Use

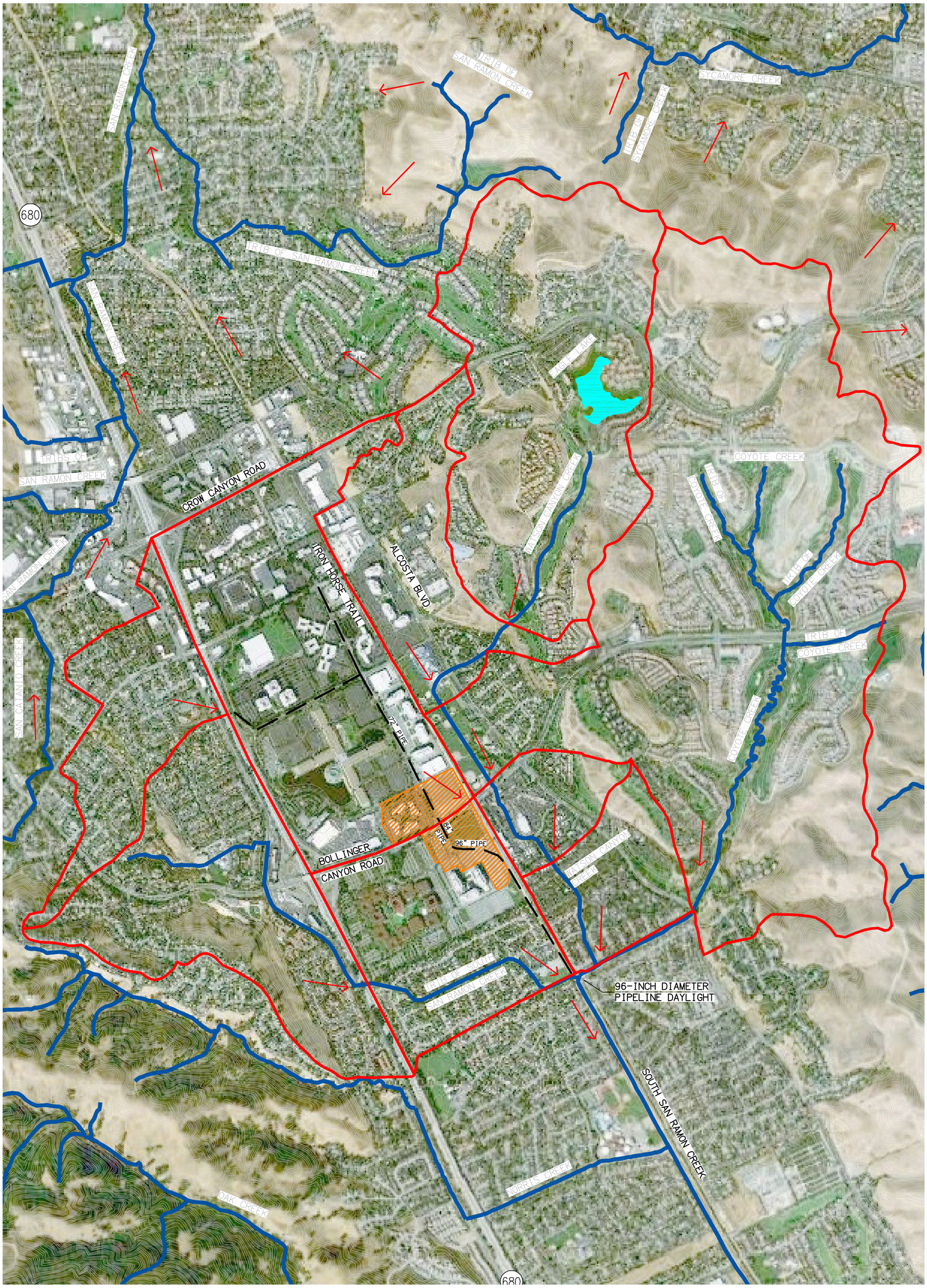
The Bishop Ranch business park is almost fully developed. The parcels BR3A and BR1A are the only two parcels on the Project site that have not been developed. They consist of almost completely pervious areas, and are mostly grass-covered lots. Most of the developed area

consists of impervious surfaces developed to accommodate office buildings, parking lots, and roadways. The impervious area currently covers approximately 41% of the entire Project site.

The Project lies within the upper portion of South San Ramon Creek sub-watershed. South San Ramon Creek sub-watershed is the uppermost in its hydrologic unit and consists of an area of approximately 13.1 square miles. A large diameter cast-in-place concrete pipeline is located through the Project site in Camino Ramon. The pipeline ranges from 72-inches to 96-inches in diameter in the site. Most of the runoff in the Project area drains into this large diameter pipeline through a network of smaller storm drains. The large diameter pipeline continues off the Project site and discharges downstream to South San Ramon Creek. Areas to the east and west of the Project site drain to locations downstream of the Project site, and beyond the outlet of the existing large diameter pipeline. The regional hydrologic conditions are further discussed in Section 2.1 and presented in Exhibit 3.

1.1.3 Proposed Land Use

The San Ramon City Center Project is proposed to include a mixed-use redevelopment consisting of commercial, parking, residential, and retail. The Project development plan envisions a fairly high-density development, with several structures being multi-level. In fact, the Project plan reflects a density of development that is becoming increasingly common throughout California and high-density development is one of the key factors in the formulation of the stormwater management strategy for the site. Most of the development plan consists of impervious surface cover used as commercial, residential, and retail space. The impervious area is proposed to cover approximately 79% of the entire Project site.


680
TRIB OF SAN RAMON CREEK
SAN RAMON CREEK
SYCAMORE CREEK
TRIB OF SYCAMORE CREEK
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TRIBS OF SAN RAMON CREEK
SAN RAMON CREEK
SAN CATARINO CREEK
CROW CANYON ROAD
IRON HORSE TRAIL
ALCOSTA BLVD
ALCOSTA BLVD
ALCOSTA BLVD

2 HYDROLOGIC SETTING

This section presents the existing hydrologic conditions of the Project site and the immediate surrounding area. It describes aspects of the site pertinent to stormwater management including climate, soil, groundwater conditions, drainage patterns, and flooding potential.

2.1 Existing Regional Hydrologic Setting

The Project site is in the Upper South San Ramon Creek Watershed, which is part of the Upper Alameda Creek Watershed, which is in turn part of the South County Watershed. The Upper South San Ramon Creek Watershed has a drainage area of 13.1 square miles. The valley floor area of San Ramon, the western-most area of the watershed, is highly urbanized and continues the recent trend of urbanization of the Interstate 680 corridor from the Town of Danville to the north, to the City of Dublin to the south. Surface water of the South San Ramon Creek is channelized and often times runs underground to accommodate residential and commercial development areas.

An existing 72 to 96-inch diameter pipeline is located in the Project site, traveling from the north to southeast. This pipeline conveys stormwater from north of the Project site to a discharge point at South San Ramon Creek. The regional hydrology of the site is presented in Exhibit 3.

The following are general characteristics of the Upper South San Ramon Creek Sub-Watershed:

- Sub-Watershed Size - 8,357 acres
- Elevation of Headwaters - 1739 feet
- Total Length of Channels - 26.2 miles
- Longest Channel Reach - 4.7 miles
- Major Water Bodies: Watson Canyon Creek, Big Canyon Creek, Coyote Creek, Oak Creek, and Norris Creek.

2.2 Climate

The climate characteristics of the site reflect the general Mediterranean climate of eastern Bay Area region of California. This climate regime is characterized by cool, wet winters and hot, dry summers. The rainy season generally occurs from the beginning of October through the end of April. Rainfall ranges from approximately 18 to 21.25 inches per year. According the Contra Costa County hydrologic design standards, the average annual rainfall for the site is 21.0 inches per year. Actual rainfall totals vary strongly as a result of regional and global weather patterns such as periods of drought and the El Niño Southern Oscillation.

The Project site is located far enough inland to substantially reduce or eliminate the cooling effect and summer fog formation characteristic of the coastal margin to the west, resulting in a period from April to October when average evapotranspiration exceeds precipitation. According to the California Irrigation Management Information System (CIMIS), the total annual evapotranspiration for the site is approximately 46 inches, more than double the annual average precipitation. Table 2 presents a summary of monthly averages for temperature, precipitation, and evapotranspiration. These averages are combined from 20 years of data from a nearby CIMIS station number 65 located in Walnut Creek, CA.

Table 2: Climate Data for San Ramon

Monthly Average	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°F)	47	51	54	58	63	68	72	72	70	64	53	47
Precipitation (in)	4.4	4.2	3.3	1.8	0.6	0.1	0	0	0.2	1	2.3	3.1
Evapotranspiration (in)	0.82	1.47	2.92	4.4	5.57	6.66	7.4	6.35	4.73	3.34	1.54	1.01

2.3 Soils

Harding Lawson Associates (HLA) conducted several geotechnical investigations throughout the Bishop Ranch business park, including the proposed Project site. The results of these geotechnical investigations were presented in several reports in 1986. These reports investigate, among other things, the soil conditions of the site.

The results of these investigations indicate that the soils have low hydraulic conductivity and that the surface permeability is very low. Therefore, using the soils as a means to percolate stormwater would likely be ineffective since clayey and silty soils tend to have very low

permeability rates. While the geotechnical engineer did not perform a percolation test for the site, percolation rates for clayey and silty soils are typically in the range of 0.001 to 0.01 cm per second.

HLA's geotechnical investigations indicated that the soils in the upper 3 to 5 feet consist of hard, desiccated clays with a high expansion potential. This expansion potential means that the clays tend to swell with increased moisture content. Beneath this expansive clay are alluvial deposits to a depth of 73 feet, consisting of inter-bedded clays, silts, and sands with occasional gravelly layers. The clays and silts are generally very stiff to hard in the upper 6 to 9 feet, medium-stiff to stiff between 9 and 30 feet, and then very stiff to hard below 30 feet. Sands are generally medium dense in the upper 20 to 30 feet and become dense to very dense near the maximum depths explored. These sands occur generally in relatively thin (less than 3 feet thick) lenses, which appear to be discontinuous across the site.

2.4 Groundwater

Groundwater for the site is located in the San Ramon Valley Groundwater Basin as described by the San Francisco Regional Water Quality Control Board (RWQCB) Basin Plan Report. The Basin has limited existing municipal, domestic, and agricultural water supply use according to the RWQCB's Basin Plan Report. Similar to the Basin Plan Report, the Department of Water Resources published Bulletin 118 in 2003. Bulletin 118 details the groundwater basins throughout California. According to Bulletin 118, there are no historical records of groundwater elevations in the San Ramon Valley Groundwater Basin.

Results from HLA’s geotechnical investigations indicate that groundwater across the site is approximately 11 feet below the surface. The extent of the existing and planned impervious surfaces, the limited planned percolation facilities, and the low hydraulic conductivity of the exiting soils would act as a barrier between the Project and the existing groundwater. Therefore post-development runoff conditions would not affect the local groundwater basin.

2.5 Existing Drainage Patterns

The Project site consists of both developed and undeveloped areas. The developed areas of the Project site use a stormwater collection system. This collection system consists of catch

basins that collect stormwater from local areas. The stormwater is then conveyed through a series of pipes south and off of the Project site. The most prevalent of these pipelines is a large diameter pipeline that ranges in size from 72 to 96-inches in diameter. The pipeline enters the site from the north along Camino Ramon. The pipeline continues southeast in Camino Ramon, then east toward Bishop Ranch One East (road), then southeast in Bishop Ranch One East, and continues south off of the Project site adjacent to Iron Horse Trail. This large diameter pipeline eventually daylights to a large concrete lined channel (South San Ramon Creek) located approximately at Montevideo Drive and the Iron Horse Trail. All of the stormwater that flows from the Project site enters this stormwater pipeline and eventually to the South San Ramon Creek.

The undeveloped areas of the Project site do not have stormwater collection facilities. These areas consist of parcel BR3A and the northern part of parcel BR1A. Stormwater at these parcels travels overland and into storm drain inlets located at a corner of each property. From these inlets, the stormwater is conveyed to the large 72 to 96-inch diameter pipeline, and finally offsite.

The Project site has no significant existing infrastructure for stormwater detention. There is also limited infrastructure for the enhancement of stormwater quality. Parcel 2 has storm drain inlets surrounded by grassy areas, however much of the stormwater enters the collection system immediately after flowing over paved or other impermeable areas. There is no infrastructure for water infiltration.

2.6 Flooding

According to the most recent Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) for the Project site, the site is in a Zone X designation, meaning it is outside of the 100-year and 500-year floodplains. Any location has the potential to flood; however, the chance of occurrence within the Zone X designation is 0.2% each year as determined by FEMA. Appendix A contains a copy of the latest FEMA mapping taken from the currently effective FIRM panels 060710 0001A and 060710 0002B both dated revised on May 03, 1990. On these FIRM panels there have been additional areas removed from the floodplain by Letters of Map Revisions (LOMRs). These LOMRs have not affected the Project site. While the Project site may be outside of the floodplain, it should be noted that the maps do not

necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas.

3 STORMWATER MANAGEMENT SYSTEM

This section describes the requirements for managing stormwater on a flow basis and a water quality basis. It also describes some of the negative impacts that result from a lack of stormwater management. Included in this section is a description of the proposed stormwater management system.

3.1 Control of Peak Flows

Increases in peak stormwater flows are often a concern related to development. These concerns are often warranted if the development alters site hydrology to such an extent that peak flow rates are increased significantly and if the receiving waters are susceptible to impacts related to the increased flow. Increased impervious areas related to development often alter an area's natural hydrologic conditions.

Maintaining peak stormwater flows is the major criteria for the design of stormwater detention facilities. The Contra Costa Clean Water Program (CCCWP) requires that post-development peak flows not exceed pre-development peak flows. Specifically, provision C.3.f in the stormwater National Pollutant Discharge Elimination System (NPDES) permit requires Contra Costa municipalities to "manage increases in peak runoff flow and increased volume, where such increased flow or volume is likely to cause increased erosion of creek beds and banks, silt pollutant generation, or other waterbody impacts to beneficial uses due to increased erosive forces." Additionally, stormwater detention must not be allowed to idle for an extended period of time. Mosquito breeding habitat, algae growth, and other adverse conditions arise with stagnant water.

Controlling increases in peak flows and durations requires the implementation of hydrograph modification management to the maximum extent practicable. This requires advanced hydrologic analysis. The two applications that could be used with the Project are the implementation of Integrated Management Plan (IMP) or the use of a continuous hydrologic model.

The implementation of IMPs, such as planters, swales, and bioretention areas use the CCCWP low impact development site design procedures and sizing tools. This method is based more on a water quality standard approach. However, it can also be used to size facilities required for the control of peak flows.

A second application that could be used to control peak flows is the use of a continuous-simulation hydrologic computer model to simulate pre-development and post-development runoff. This could include the effect of proposed IMPs, detention basins, or other stormwater management facilities. Hourly rainfall data from 30 years of storm records must be simulated and the results used to compile flow statistics and produce a summary result of peak flow and flow duration information.

3.2 Stormwater Quality Management

There has recently been a growing awareness of the role played by urban stormwater runoff in the quality of receiving waters throughout the U.S. and California. This is reflected in the increasing attention being placed on the inclusion of stormwater quality Best Management Practices (BMPs) in all types and sizes of Projects throughout the state. Specifically, the state's Regional Water Quality Control Boards (RWQCBs) have progressively adopted more stringent guidelines on the application of BMPs with the overall goal of controlling the amount of non-point source pollutants that are discharged to the waters of the State.

The Project site would be required to incorporate a number of water quality control measures to control the amount of non-point source pollutants that would be discharged into receiving waters. Water quality control measures, such as bio-swales, green roofs, and permeable pavement would be incorporated into the Project design. Bio-swales would be used around the parking lots, where substantial automotive pollution is collected by the paving and then flushed by rain. The bio-swale wraps around the parking lot and treats the runoff before releasing it into the storm drain. Green roofs decrease the total amount of runoff and slow down the rate of runoff flowing off the roof. They also remove many pollutants before entering a stormdrain system. Permeable pavements would be used in areas with curbs and gutters. These would allow stormwater to enter an engineered layer of soil and filter fabric to remove sediments before entering a colletion pipeline that would convey it to the stormdrain system.

The South San Ramon Creek is tributary to Arroyo de la Laguna, which the State has identified as a Clean Water Act Section 303d Water Quality Limited Segment for diazinon from urban runoff. This strictly requires that the Project site not discharge stormwater containing diazinon. Diazinon is a pesticide that has been found to be harmful to humans. However, the United States outlawed the sale of diazinon on December 31, 2004. Since purchase of this substance is illegal, the Project would not use it and thus would not further contribute diazinon to Arroyo de la Laguna or any other water body.

As required by the Clean Water Ac, the RWQCB requires that the Project shall use controls that reduce the discharge of pollutants to the "maximum extent practicable." The term "maximum extend practicable" is not defined in Federal law or regulation. The CCCWP updates performance standards that establish, for various elements of the stormwater pollution prevention program, the level of effort that currently corresponds to the "maximum extent practicable." CCCWP's C.3 amendments have established numeric standards for sizing stormwater treatment and flow control facilities (BMPs). These treatment-sizing standards will be used during the final Stormwater Control Plan to ensure that the proposed BMPs are adequately sized to meet the "maximum extent practicable." Additionally, Appendices B to D contain data sheets on the proposed BMPs and list pollutant removal efficiencies based on previous installations of the BMPs.

3.2.1 Federal Water Quality Standards and Objectives

In 1972, the Federal Water Pollution Control Act [later referred to as the Clean Water Act (CWA)] was amended to require NPDES permits for the discharge of pollutants to waters of the United States from any point source. In 1987, the CWA was amended to require that the United States Environmental Protection Agency (EPA) establish regulations for permitting of municipal and industrial stormwater discharges under the NPDES permit program. The EPA published final regulations regarding stormwater discharges on November 16, 1990. The regulations require that municipal separate storm sewer system (MS4) discharges to surface waters be regulated by a NPDES permit. The NPDES stormwater program is described below.

3.2.2 State Water Quality Standards and Objectives

The Project would be required to comply with the statewide NPDES General Construction Activities Stormwater Permit. In California, the NPDES Stormwater Program is administered by the RWQCB. Pursuant to the Phase I NPDES Stormwater Program Phase II Final Rule, dated December 8, 1999, discharges of stormwater associated with construction activities that result in the disturbance of equal to or greater than one-half acre of land must apply for coverage under the statewide General Construction Activities Stormwater Permit (General Permit). Construction activities include, but are not limited to clearing, grading, demolition, excavation, construction of new structures, and reconstruction of existing facilities involving removal and replacement that results in soil disturbance. Landowners can obtain coverage under the General Permit by filing a Notice of Intent (NOI) with the State Water Resources Control Board's Division of Water Quality Stormwater Permit Unit. Generally, a site is considered to be covered by the General Permit upon filing the NOI and submitting the appropriate annual fee. The NOI must be submitted, and the permit obtained, before construction starts.

In addition to submitting the NOI, the discharger must develop and implement a Stormwater Pollution Prevention Plan (SWPPP) and develop and implement a monitoring and reporting plan. The SWPPP should be developed to meet the following objectives:

- Identify pollutant sources that may affect the quality of discharges of stormwater associated with construction activity from the construction site;
- Identify, construct, implement and maintain best management practices (BMPs) to reduce or eliminate pollutants in stormwater discharges from the construction site during construction; and
- Develop a maintenance schedule for BMPs installed during construction designed to reduce or eliminate pollutants after construction is completed (post-construction BMPs).

In February 2003, the California RWQCBs for the San Francisco Bay Region and the Central Valley Region revised Provision "C.3" in the NPDES general permit governing discharges from the municipal storm drain systems of Contra Costa County and cities and towns within the County.

The new "C.3" requirements are separate from, and in addition to, requirements for erosion and sediment control for pollution prevention measures during construction. Project site designs must minimize the area of new roofs and paving. As of August 15, 2006, all new development and significant redevelopment that create or replace 10,000 square feet or more of impervious surface must treat stormwater runoff on-site. Where feasible, pervious surfaces should be used

instead of paving so that runoff can percolate to the underlying soil. A Hydrograph Modification Plan is required under these provisions.

3.2.3 Local Water Quality Standards and Objectives

The local water quality standards and objectives are the most stringent requirements for this Project. They require that measures be taken to control stormwater to the maximum extent practicable. Under these requirements, both volume based and flow based treatment criteria aim to ensure treatment of approximately 80% of the average annual runoff. A large portion of annual runoff is produced by small storms that occur many times a year. To achieve treatment of 80% of average annual runoff, treatment facilities can be sized to treat smaller, more frequent storms and therefore can be considerably smaller than flood control facilities. To meet this requirement, treatment facilities should be designed to accommodate runoff from the specified storm intensity of 0.2 inches per hour.

To comply with the CWA, RWQCB required Contra Costa County, 19 of its incorporated cities (including the City of San Ramon), and the Contra Costa County Flood Control and Water Conservation District to submit a joint application for a stormwater permit. As part of the joint permit application, the jurisdictions formed the Contra Costa Clean Water Program (CCCWP). The CCCWP initially obtained a Joint Municipal NPDES Permit from the San Francisco Bay and Central Valley RWQCB's in September 1993 and January 1994, respectively. These permits, valid only for a five-year period, were reissued in 1999 (San Francisco Bay RWQCB Permit) and 2000 (Central Valley RWQCB Permit), and have been extended through 2010. The permit includes a comprehensive plan to reduce the discharge of pollutants to the “maximum extent practicable.”

The CCCWP provides guidance and training on the following:

- Adopting legal ordinances;
- Conducting public education programs such as installing informational signs like “No Dumping Drains to Bay” on storm drain covers;
- Instituting or enhancing programs such as street sweeping, storm drain maintenance, pesticide management, and trash management;
- Performing erosion control practices; and

- Identifying illicit pollutant discharges to the storm drain system, and requiring new development and industrial discharge controls. Typical stormwater protection measures are described below:

Best Management Practices. Contributors to non-point source pollution must establish BMPs to minimize the potential for pollution. A BMP program document may be prepared. Typical elements of such a program may include:

- Operational BMPs: Practices and procedures used to modify everyday behaviors that contribute to stormwater pollution.
- Permanent BMPs: Structural devices intended to last the life of the project. Structural devices include bio-swales, green roofs, permeable pavement, and trash control devices.
- Source Control BMPs: Measures used to stop pollutants from entering the stormwater system including street sweeping and litter removal/cleanup.

Source Control. Industrial and commercial entities may be required to demonstrate that the hazardous materials used on their sites cannot be easily mobilized and carried off by stormwater runoff. This involves confining some operations to roofed/covered areas and preventing on-site runoff from flowing through these areas. Hazardous material storage in uncovered areas requires the capability for full containment of the material during periods of rain. Uncovered parking areas are required to conduct street sweeping periodically to remove pollutants, oils, and greases before they are mobilized.

3.2.4 Stormwater Pollutants

According to the San Francisco Bay RWQCB Basin Plan Report, the overall goals of water quality regulation are to protect and maintain thriving aquatic ecosystems and the resources those systems provide to society. California's regulatory framework uses water quality objectives both to define appropriate levels of environmental quality and to control activities that can adversely affect aquatic systems.

There are two types of objectives: narrative and numerical. Narrative objectives present general descriptions of water quality that must be attained through pollutant control measures and watershed management. They also serve as the basis for the development of detailed numerical objectives. Numerical objectives typically describe pollutant concentrations, physical/chemical conditions of the water itself, and the toxicity of the water to aquatic organisms. Objectives include, but are not limited to, regulations for, bacteria bioaccumulation,

biostimulatory substances, dissolved oxygen, floating materials, oil and grease. These objectives are designed to represent the maximum amount of pollutants that can remain in the water column without causing any adverse effect on organisms using the aquatic system as habitat, on people consuming those organisms or water, and on other current or potential beneficial uses. Together, the narrative and numerical objectives define the level of water quality that shall be maintained within the region. These objectives are considered necessary to protect the high quality waters of the state and will be achieved primarily through establishing and enforcing waste discharge requirements and by implementing the San Francisco Bay RWQCB water quality control plan. Some of the anticipated and potential pollutants of concern generated from this Project include:

- Pathogens
- Heavy Metals
- Nutrients
- Pesticides
- Organic Compounds
- Sediments
- Trash and Debris
- Oxygen Demanding Substances
- Oil and Grease

The Basin Plan Report categorizes several beneficial uses for the watershed. The following beneficial uses apply to the South San Ramon Creek sub-watershed:

- Agricultural Supply
- Groundwater Recharge
- Cold Freshwater Habitat
- Fish Migration
- Fish Spawning
- Warm Freshwater Habitat
- Wildlife Habitat
- Water Contact Recreation
- Noncontact Water Recreation

3.2.5 Hydromodification

Hydromodification is the alteration of streams and river channels, installation of dams and water impoundments, and streambank and shoreline erosion. The RWQCB, California Coastal Commission and other State agencies have identified seven management measures to address

non-point sources of pollution through hydromodification. The three hydromodification management measures applicable to this Project are:

- Channelization and Channel Modification - Physical and Chemical Characterizations of Surface Waters;
- Channelization and Channel Modification - Instream and Riparian Habitat Restoration;
- Streambank and Shoreline Erosion - Eroding Streambanks and Shorelines.

Limited hydromodification would occur on the Project site since there is an existing extensive stormwater collection system. The outlet of the 96-inch diameter pipeline is to the South San Ramon Creek. The creek at this location is a lined trapezoidal channel, incapable of channelization or streambank erosion. Furthermore, since flow management practices would require post-development peak flows to not be more than the pre-development flows, hydromodification would not occur as a result of the Project.

3.3 Proposed Stormwater Management System

The proposed stormwater management system consists of an Integrated Management Practice (IMP) with several flow and water quality control devices. These devices include green roofs, bio-swales, permeable pavement, stormwater detention, and trash collection. While the final design of these facilities has not been determined as part of this report, preliminary locations for these facilities has been recommended. Once advanced hydrologic modeling has been performed, exact sizing and facility requirements will be selected.

Several types of detention were considered for controlling peak stormwater runoff. These included use of the stormwater treatment facilities, underground detention, and pumping the stormwater to nearby fields for detention. However, results from the Preliminary Onsite Hydrologic Analysis (Section 4.2) indicate that sufficient detention was available in the stormwater treatment facilities. Thus, these facilities will serve as both the peak flow control and water quality treatment facilities for stormwater runoff.

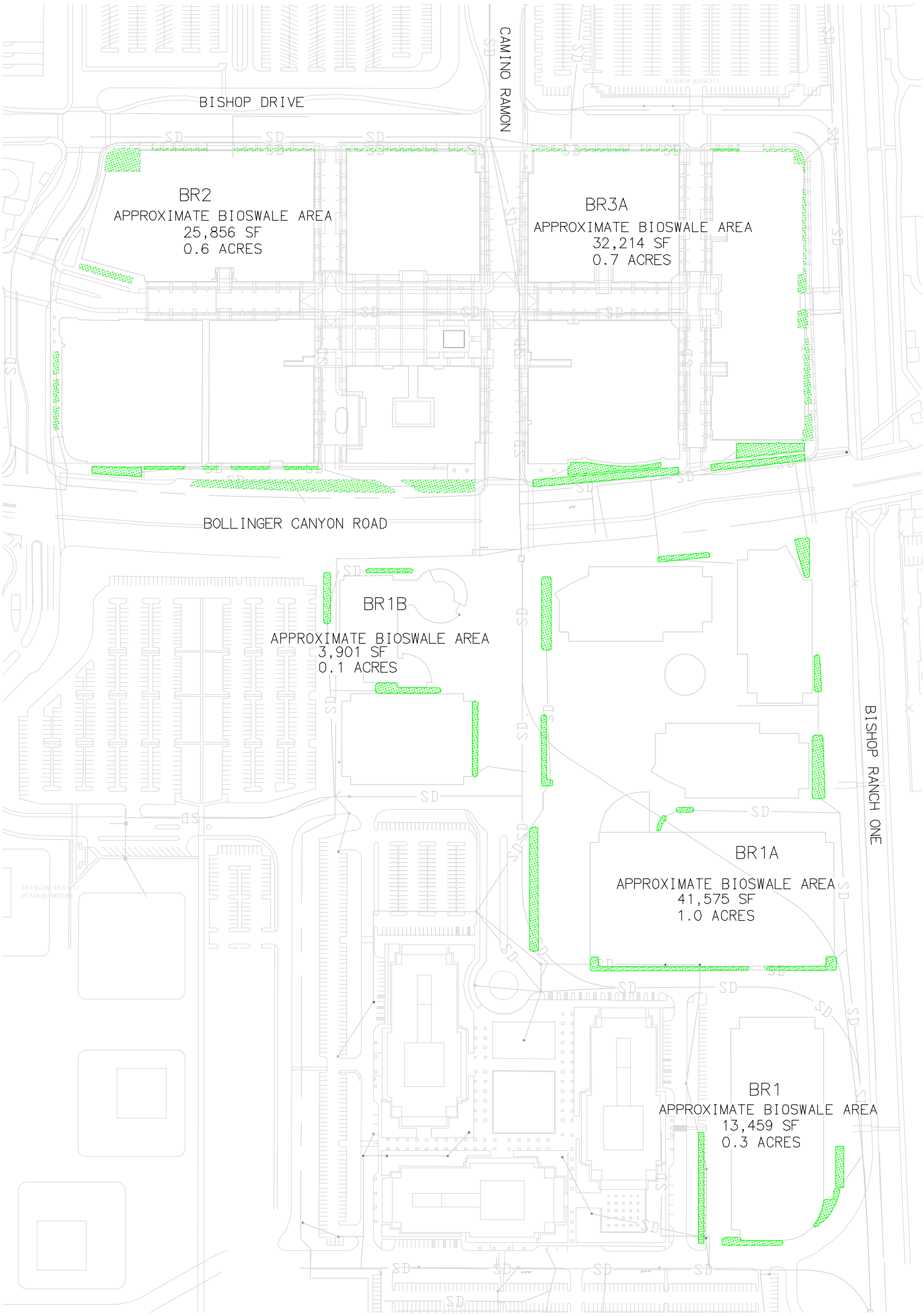
The stormwater treatment facilities considered for this Project are bio-swales, green roofs, permeable pavement, and trash interception devices. The bio-swales and green roofs will be used as both stormwater treatment facilities and peak flow control facilities. Information from

the California Stormwater BMP handbook and the CCCWP Stormwater C.3 Guidebook about these three stormwater treatment facilities is presented in Appendices B through D.

Bio-swales, or vegetated swales, are open, shallow channels with vegetation covers the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into underlying soils. They trap particulate pollutants, promote infiltration, and reduce the flow velocity of stormwater runoff. Bio-swales would be used as water quality treatment devices and are planned in locations throughout the site. They will serve as the primary method for water quality treatment. The bio-swales will also be used as stormwater detention facilities. The swales will be approximately 3 to 4 feet deep, allowing for detention during 100-year rainfall events. The locations of the bio-swales are presented in Exhibit 4.

Green roofs consist of a series of layers that create an environment suitable for plant growth without damaging the underlying roof system. Two types of green roofs are typically created: extensive or intensive. Extensive roofs are typically 4 inches or less of growing medium, using drought tolerant vegetation. Intensive systems are heavier, have a greater soil depth, can support a wider range of plants, and can support increased pedestrian traffic. Intensive green roofs would be used with this Project. The green roofs would also be used to detain a portion of the stormwater. The locations for the green roofs are presented in Exhibit 5.

A combination or porous and permeable pavement would be used as an alternative to standard asphalt or concrete pavement. The final locations of porous and permeable pavement have not been determined. Porous pavement is a porous asphalt or concrete material that can infiltrate water across the entire surface. Porous pavement is suitable for installation in areas of high vehicular or pedestrian traffic. It is much like standard paving except it has a high percentage of void space. Water is allowed to pass through the void spaces very easily. Permeable pavement is a combination of impermeable modular blocks or grids separated by spaces or joints that water drains through. Permeable pavement is suitable for installation in locations with light vehicle loading or in parking areas. It is anticipated that porous and permeable pavements would primarily be installed along Bishop Ranch 2, between buildings B and D. The anticipated porous and permeable pavement areas are presented in Exhibit 6.



SCALE: 1"=200'

LEGEND:

PROPOSED BIO-SWALE

STORMDRAIN — SD —

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PRELIMINARY HYDROLOGY REPORT

EXHIBIT 4:
PROPOSED BMP
BIO-SWALE AREAS

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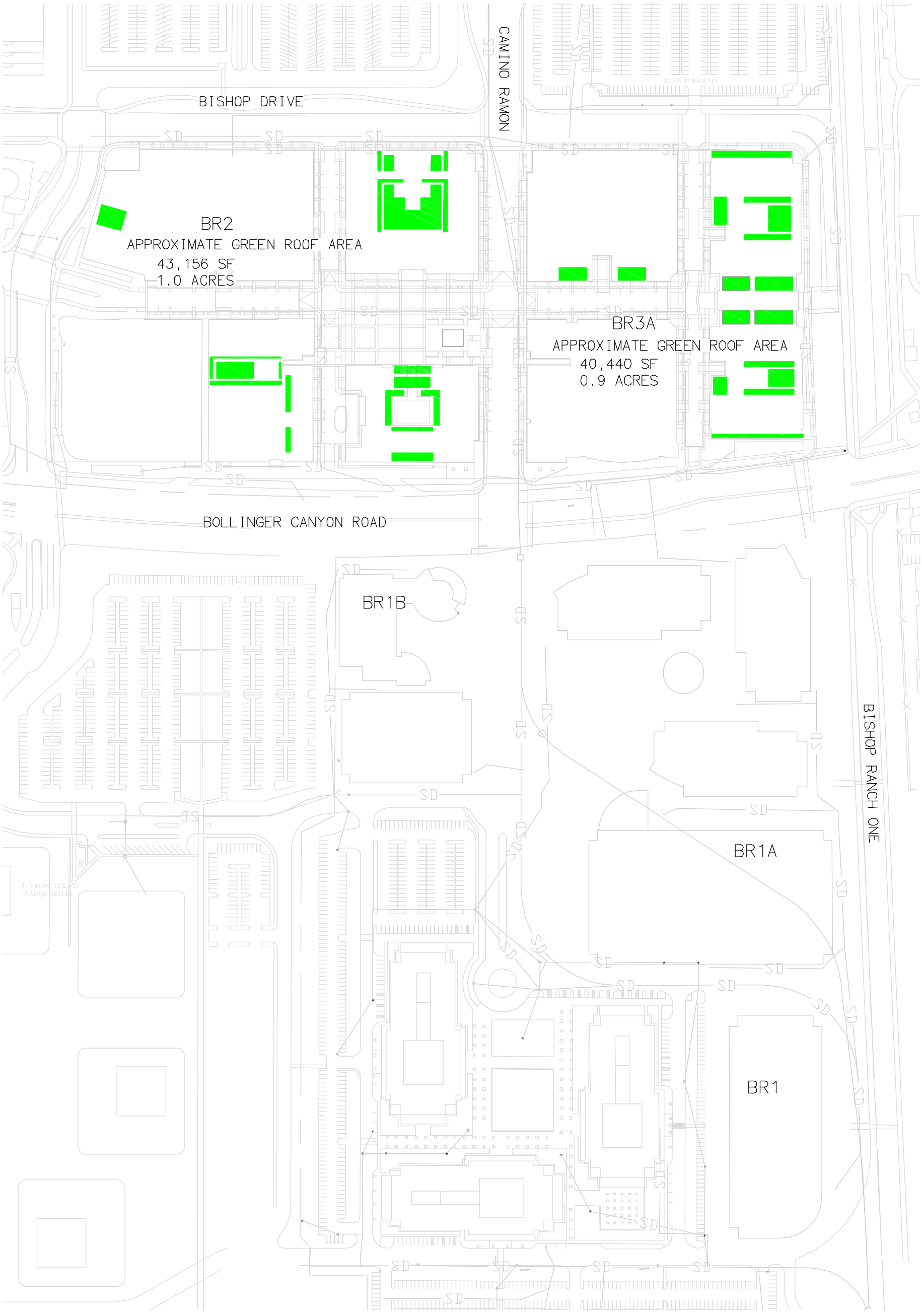

SCALE: 1"=200'

LEGEND:

PROPOSED GREEN ROOF

STORMDRAIN — SD —

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PRELIMINARY HYDROLOGY REPORT

EXHIBIT 5:
PROPOSED BMP
GREEN ROOF AREAS

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BISHOP DRIVE

CAMINO RAMON

BR2
APPROXIMATE PERMEABLE PAVING AREA
44,130 SF
1.0 ACRES

BR3A
APPROXIMATE PERMEABLE PAVING AREA
3,154 SF
0.1 ACRES

BOLLINGER CANYON ROAD

BR1B

BR1A

BISHOP RANCH ONE

BR1

SCALE: 1"=200'

LEGEND:

ANTICIPATED POROUS PAVING

ANTICIPATED PERMEABLE PAVING

STORMDRAIN — SD —

SAN RAMON CITY CENTER

PRELIMINARY HYDROLOGY REPORT

EXHIBIT 6:
ANTICIPATED BMP POROUS
& PERMEABLE PAVING AREAS

RBF CONSULTING

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4 PRELIMINARY HYDROLOGIC ANALYSIS

This section presents the preliminary hydrologic analysis for the San Ramon City Center. This analysis is not intended to be a final design recommendation. Rather, it is meant to serve as a guide in the planning process for development and a reference for the Stormwater Control Plan. Included in this section are the assumptions of the hydrologic analysis, the onsite hydrologic analysis, and the watershed hydrologic analysis.

4.1 Equations, Methodology, and Assumptions

The peak flows for pre-development and post development were calculated using the Rational Method. This equation was first employed in Ireland by Mulvaney in 1849 and was introduced into the U.S. by Kuichling in 1889. In basic concept, the Rational Method ensures that the peak rate of runoff from a small watershed occurs when the entire watershed is contributing, and that this rate of runoff equals a percentage C of the average rainfall rate *i*.

The Contra Costa County Flood Control District (District) defines the Rational Method formula as:

$$Q = C \cdot C_f \cdot i \cdot A$$

where Q = Peak flow rate in cubic feet per second (cfs)
C = Runoff Coefficient
C_f = Adjusting factor for 10, 25, 50, and 100-year storms
i = Rainfall intensity in inches per hour
A = Watershed area in acres

The Rational Method formula employs the following assumptions:

a) The rainfall intensity, *i*, is uniformly distributed over the entire watershed
b) The runoff rate, *Q*, resulting from any rainfall intensity, *i*, is a maximum when this rainfall intensity lasts as long or longer than the time of concentration, t_c.
c) The maximum runoff resulting from a rainfall intensity is a simple fraction of such rainfall intensity.
d) The frequency of peak runoff is the same as that of the rainfall intensity for a given time of concentration, t_c.
e) The runoff coefficient is the uniform within the watershed for various storm frequencies and durations.

The runoff coefficients, *C*, for this equation were chosen from a recommended range provided by District Standards. For example, the runoff coefficient for an open, undeveloped (grassy)

area is estimated between 0.20 and 0.40 in the District's standards. In this analysis, the value to 0.40 was chosen for all undeveloped and existing pervious areas. The runoff coefficients anticipated for proposed green roofs and permeable pavements are considerably less than 0.40. However, to obtain a conservative estimate of post-development hydrologic conditions, the largest runoff coefficient of the range of values was used. This methodology of selecting runoff coefficients was employed with all runoff coefficients.

The rainfall intensity is related to its storm frequency and the time of concentration of the watershed. The time of concentration, t_c, is the time required for runoff to travel from the most remote point of a watershed to its outlet. Since the path from the most remote point of the watershed to the outlet is often across various surfaces, different methods were required to determine the incremental time of concentration. Based on District standards, the time of concentration from a rooftop to the gutter in a business land use ranges from 3 to 8 minutes. To be conservative in this preliminary analysis, the values attributed to the roof runoff times are estimated closer toward 3 minutes.

The time of concentration across a land surface often occurs as a sheet flow. To most accurately measure this time of concentration, the overland flow time was estimated using the Kerby Equation:

$$t_c^{2.14} = \frac{2 \cdot L \cdot n}{3 \cdot S^{1/2}}$$

where: t_c = Time of concentration in minutes
L = Length of flow in feet
n = Surface Retardance factor
S = Slope of flow path in ft/ft

Several assumptions were used in determining the factors of the Kerby Equation. The length of flow in feet was assumed to be linear feet. The flow was assumed to either travel across a smooth impervious surface such as a paved lot or an average grassy surface such as a lawn area. The surface retardance factors were then chosen based on one of these two surfaces. While the values for these surfaces might not exactly match actual conditions, they are close approximations and provide conservative estimates. Finally the slope of the flow path was assumed to be constant across the entire flow length.

The time of concentration required for water to travel in a street gutter was also conservatively assumed. District Standards provide a range of gutter flow velocities from 2.0 to 4.0 feet per second. For the analysis, all gutter flow velocities were assumed to be 2.0 feet per second.

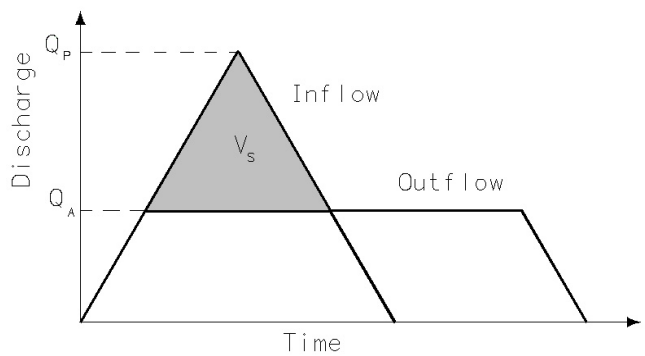
The rainfall intensities were determined from Contra Costa County standard mapping. The depths of rainfall for 10-year, 25-year, and 100-year storm events are determined using the time of concentration. Contra Costa County Flood Control and Water Conservation District has developed standardized rainfall figures. Figure B-166 depicts the mean seasonal isohyets from which the average precipitation of an area can be determined. The precipitation of the 10-year, 25-year, and 100-year storms are presented in the Precipitation Duration-Frequency-Depth Curves of figures B-159, B-160, and B-162 respectively. These figures are attached as Appendix E.

Stormwater detention requirements were also assumed using a simplified method developed by Abt and Grigg in 1978. Abt and Grigg considered a triangular inflow hydrograph and a trapezoidal outflow hydrograph to develop the following relationship to estimate the required storage volume, Vs, for detention using consistent units:

$$\frac{V_s}{V_r} = \left(1 - \frac{Q_A}{Q_P}\right)^2$$

where V_r = Runoff Volume
Q_A = Allowable peak outflow rate
Q_P = Peak inflow rate

This procedure assumes that the rising limbs of the inflow and outflow hydrograph coincide up to the allowable peak outflow rate, Q_P. This method is for approximating the volume of storage required for a system and can be applied to the storage necessary in post-development conditions to meet the pre-development outflow. Because many factors come into play in stormwater detention sizing that are not known until a detailed hydrologic study is performed, this methodology provides a sufficient estimation of the required stormwater detention to meet the C.3 requirements set for by the CCCWP. The methodology of this simplified detention approach can be seen in the following diagram.



In order to determine the retention volume, V_r, a triangular shaped inflow and outflow hydrograph is used to determine preliminary estimates. The retention volume is simply calculated using the following equation:

$$V_r = 0.5 \cdot t_b \left(Q_P - Q_A \right)$$

where t_b = Time base of the inflow hydrograph in hours
Q_P = Peak flow post-development
Q_A = Peak flow pre-development

It is assumed that since the inflow and outflow are triangular shaped, the time base of the inflow hydrograph, t_b, is equal to twice the time of concentration, t_c. This is a simplified assumption that provides a reasonable estimation of the results for this preliminary analysis.

Conservative assumptions were used in the preliminary hydrologic analysis that result in a high estimate of runoff. These assumptions were used for both pre-development and post-development runoff estimates. These assumptions provide good preliminary estimates for treatment and storage volumes of runoff, but may result in low estimates of increases if runoff. The final Stormwater Control Plan will include a more detailed analysis of both pre-development and post-development runoff and the required treatment and storage facilities.

4.2 Preliminary Onsite Hydrologic Analysis

An analysis was preformed to understand the onsite hydrologic characteristics as they relate the pre-development conditions to the post-development conditions. This analysis is not intended to be a final design based recommendation. Rather, it is meant to serve as a guide in the planning process and aid as a reference in the development of the Stormwater Control Plan. The final Stormwater Control Plan will include a more detailed hydrologic and hydraulic analysis.

The peak flow rates of both pre-development and post development conditions are crucial in determining the required storage and water quality treatment required for the Project. The

Rational Method was used to determine the peak flow rates of the pre-development conditions and the post development conditions. Pervious and impervious areas were sized with runoff coefficients to determine the increase in runoff as a result of development. The site consists of 5 sub-watershed areas. The delineation of these sub-watersheds and the existing pervious areas are presented as Exhibit 7. The locations of the proposed pervious areas of the post-development conditions are presented as Exhibit 8. Both Exhibit 7 and 8 shade the pervious areas for visual display and show the calculated quantities.

To determine the rainfall intensity, the time of concentration is required. The time of concentration was calculated based on the combination of incremental flow times. These times include the flow from the roof to the gutter, flow in the gutter, and overland flow. The time of concentration was calculated for both pre-development conditions and post-development conditions. The times of concentration are presented in Table 3.

Table 3: Estimated Time of Concentration

Site Name	**Roof to Gutter t_c (min)**	**Overland Flow - Kerby Equation**				**Gutter Flow t_c**		**Total t_c (min)**
		L (ft)	*n*	*S*	t_c (min)	L (ft)	t_c (min)	
PRE-DEVELOPMENT								
BR3A	0	760	0.40	0.012	33.9	0	0	33.9
BR2	3	295	0.40	0.020	19.1	0	0	22.1
BR1B	0	35	0.40	0.140	4.5	0	0	8.3
		175	0.02	0.018	3.8			
BR1A	0	665	0.40	0.017	29.1	0	0	29.1
BR1	0	10	0.40	0.130	2.5	0	0	8.1
		345	0.02	0.014	5.6			
POST-DEVELOPMENT (slopes estimated)								
BR3A	5	0	0	0	0	160	0.7	5.7
BR2	5	0	0	0	0	110	0.5	5.5
BR1B	0	158	0.02	0.02	3.5	125	0.5	4.1
BR1A	4	182	0.40	0.02	15.3	0	0	19.3
BR1	0	133	0.02	0.02	3.3	0	0	20.2
		226	0.40	0.02	16.9			

The runoff for the site was calculated using the Rational Method. Each sub-watershed in the site was evaluated for the 10-year, 25-year, and 100-year rainfall event for both pre-development and post-development conditions. The results of this analysis show that there is an increase in the post-development peak runoff in each of the sub-watersheds except sub-watershed BR1. This is because there is proposed to be more pervious area in this sub-

watershed after development. The largest increase in post-development peak runoff flow is experienced in sub-watershed BR3A. The remaining sub-watersheds show a moderate increase in post-development peak runoff. These runoff calculations are presented as Table 4.

Table 4: Pre-Development and Post-Development Runoff Flows

PRE-DEVELOPMENT RUNOFF

Storm Recurrence Interval	Site Name	Approximate Area (acre)			Runoff Coefficient, C		ΣCA (acre)	Storm Adjustment Factor, Cf	Time of Concentration t_c (min)	Depth of Rainfall (in)	Rainfall Intensity *i* (in/hr)	Flow Rate Q (cfs)
		Total	Pervious	Impervious	Pervious	Impervious						
10-Year Storm	BR3A	11.2	10.7	0.5	0.40	0.95	4.73	1.00	33.9	0.66	1.17	5.52
	BR2	15.1	5.9	9.2	0.40	0.95	11.10	1.00	22.1	0.53	1.44	15.97
	BR1B	3.9	2.1	1.9	0.40	0.95	2.59	1.00	8.3	0.32	2.32	6.00
	BR1A	13.5	8.9	4.6	0.40	0.95	7.97	1.00	29.1	0.62	1.28	10.20
	BR1	4.1	0.6	3.5	0.40	0.95	3.55	1.00	8.1	0.31	2.29	8.14
25-Year Storm	BR3A	11.2	10.7	0.5	0.40	0.95	4.73	1.10	33.9	0.76	1.34	7.00
	BR2	15.1	5.9	9.2	0.40	0.95	11.10	1.10	22.1	0.63	1.71	20.89
	BR1B	3.9	2.1	1.9	0.40	0.95	2.59	1.10	8.3	0.37	2.68	7.64
	BR1A	13.5	8.9	4.6	0.40	0.95	7.97	1.10	29.1	0.70	1.44	12.67
	BR1	4.1	0.6	3.5	0.40	0.95	3.55	1.10	8.1	0.36	2.66	10.40
100-Year Storm	BR3A	11.2	10.7	0.5	0.40	0.95	4.73	1.25	33.9	0.95	1.68	9.94
	BR2	15.1	5.9	9.2	0.40	0.95	11.10	1.25	22.1	0.76	2.06	28.63
	BR1B	3.9	2.1	1.9	0.40	0.95	2.59	1.25	8.3	0.45	3.26	10.55
	BR1A	13.5	8.9	4.6	0.40	0.95	7.97	1.25	29.1	0.87	1.80	17.89
	BR1	4.1	0.6	3.5	0.40	0.95	3.55	1.25	8.1	0.44	3.25	14.45

POST-DEVELOPMENT RUNOFF

Storm Recurrence Interval	Site Name	Approximate Areas (acre)			Runoff Coefficient, C		ΣCA (acre)	Storm Adjustment Factor, Cf	Time of Concentration t_c (min)	Depth of Rainfall (in)	Rainfall Intensity *i* (in/hr)	Flow Rate Q (cfs)
		Total	Pervious	Impervious	Pervious	Impervious						
10-Year Storm	BR3A	11.2	1.8	9.4	0.40	0.95	9.67	1.00	5.7	0.26	2.75	26.61
	BR2	15.1	2.6	12.5	0.40	0.95	12.91	1.00	5.5	0.26	2.86	36.90
	BR1B	3.9	0.7	3.2	0.40	0.95	3.31	1.00	4.1	0.23	3.40	11.26
	BR1A	13.5	3.5	10.1	0.40	0.95	10.96	1.00	19.3	0.50	1.55	17.03
	BR1	4.1	0.9	3.2	0.40	0.95	3.40	1.00	20.2	0.51	1.52	5.15
25-Year Storm	BR3A	11.2	1.8	9.4	0.40	0.95	9.67	1.10	5.7	0.30	3.18	33.78
	BR2	15.1	2.6	12.5	0.40	0.95	12.91	1.10	5.5	0.30	3.30	46.84
	BR1B	3.9	0.7	3.2	0.40	0.95	3.31	1.10	4.1	0.25	3.63	13.19
	BR1A	13.5	3.5	10.1	0.40	0.95	10.96	1.10	19.3	0.57	1.77	21.36
	BR1	4.1	0.9	3.2	0.40	0.95	3.40	1.10	20.2	0.58	1.72	6.44
100-Year Storm	BR3A	11.2	1.8	9.4	0.40	0.95	9.67	1.25	5.7	0.36	3.81	46.06
	BR2	15.1	2.6	12.5	0.40	0.95	12.91	1.25	5.5	0.36	3.96	63.87
	BR1B	3.9	0.7	3.2	0.40	0.95	3.31	1.25	4.1	0.31	4.59	18.97
	BR1A	13.5	3.5	10.1	0.40	0.95	10.96	1.25	19.3	0.71	2.21	30.23
	BR1	4.1	0.9	3.2	0.40	0.95	3.40	1.25	20.2	0.72	2.14	9.09

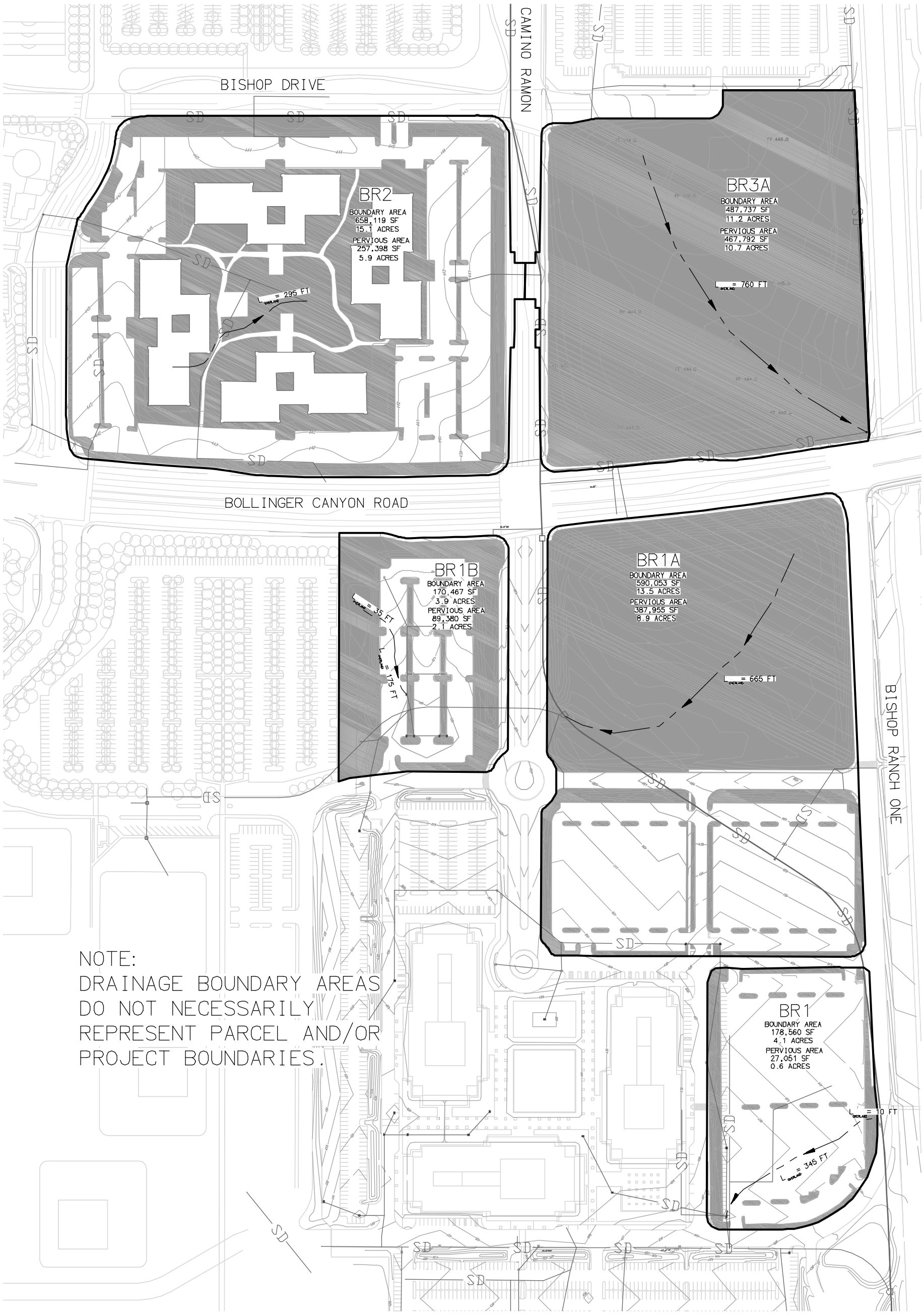
A certain volume of water must be detained by the Project to maintain the post-development peak flows at a level equal to or lesser than the pre-development peak flows. The Abt and Grigg equation was used for this computation. This calculation estimates the storage that is required by the Project, based on pre-development flows. The results show that only sub-watershed BR1 will not require some amount of detention time. This is because the Project proposes to increase the pervious area of the sub-watershed. The results show that sub-watershed BR3A would require the most detention at approximately 1.56 acre-ft of water during the 100-year event. The remaining sub-watersheds require less than 1/2 an acre of detention. The estimated storage volume required by development is presented as Table 5.

Table 5: Estimated Storage Volume for Peak Flow Control Required by Project Development

Site Name	Storm Recurrence	Pre-Development Peak Runoff (cfs)	Post-Development Peak Runoff (cfs)	Pre-Development Time of Concentration (min)	Time Base (min)	Retention Volume (acre-ft)	Storage Volume (acre-ft)	Storage + 50% Contingency (acre-ft)
BR3A	10-Year	5.52	26.61	33.9	67.8	0.99	0.62	0.93
	25-Year	7.00	33.78	33.9	67.8	1.25	0.79	1.18
	100-year	9.94	46.06	33.9	67.8	1.69	1.04	1.56
BR2	10-Year	15.97	36.90	22.1	44.2	0.64	0.20	0.31
	25-Year	20.89	46.84	22.1	44.2	0.79	0.24	0.36
	100-year	28.63	63.87	22.1	44.2	1.07	0.33	0.49
BR1B	10-Year	6.00	11.26	8.3	16.6	0.06	0.01	0.02
	25-Year	7.64	13.19	8.3	16.6	0.06	0.01	0.02
	100-year	10.55	18.97	8.3	16.6	0.10	0.02	0.03
BR1A	10-Year	10.20	17.03	29.1	58.1	0.27	0.04	0.07
	25-Year	12.67	21.36	29.1	58.1	0.35	0.06	0.09
	100-year	17.89	30.23	29.1	58.1	0.49	0.08	0.12
BR1	10-Year	8.14	5.15	8.1	16.2	-0.03	not required	not required
	25-Year	10.40	6.44	8.1	16.2	-0.04	not required	not required
	100-year	14.45	9.09	8.1	16.2	-0.06	not required	not required

It should be noted that these storage requirements are for flow control only. According to the CCCWP, flow based treatment aims to ensure approximately 80% of the average annual runoff is treated before entering the stormwater collection system. A large portion of annual runoff is produced by small storms that occur many times a year. To meet this requirement, treatment facilities should be designed to accommodate runoff from the specified storm intensity of 0.2 inches per hour. Treatment is planned to occur through three primary treatment BMPs: bio-swales, green roofs, and pervious pavements. As the Project develops from the planning stages and a more rigorous hydrologic analysis is performed final designs of the stormwater detention and treatment facilities will be recommended.

Based on the calculated detention area required, it appears that there is sufficient area in each sub-watershed for detention facilities. The use of the proposed bio-swale, green roof, and permeable pavement stormwater treatment techniques can also be used to detain stormwater for the period required to curb peak flows. For example, the bio-swales would be constructed at a depth of approximately 3 to 4 feet below the surrounding area to act as a temporary storage facility during design rainfall events. Green roofs are typically constructed at shallow depths such as 4 inches. These could be enlarged to depths of approximately 2 feet to act as a temporary water storage facility. Ultimately, based on the results of the preliminary storage requirements, it is anticipated that the site would be able to detain water in its water quality facilities.



NOTE:
DRAINAGE BOUNDARY AREAS DO NOT NECESSARILY REPRESENT PARCEL AND/OR PROJECT BOUNDARIES.

SCALE: 1"=200'

LEGEND:

- APPROXIMATE DRAINAGE BOUNDARIES
- BUILDING OUTLINE
- EXISTNIG STORMDRAIN — SD —
- 72 TO 96-INCH STORMDRAIN — SD —
- PERVIOUS AREA OUTLINE
- LONGEST FLOW PATH
- CALCULATED AREAS: 658,119 SF / 15.1 ACRES (EXAMPLE)

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PRELIMINARY HYDROLOGY REPORT

EXHIBIT 7: PRE-DEVELOPMENT PERVIOUS AND IMPERVIOUS AREAS

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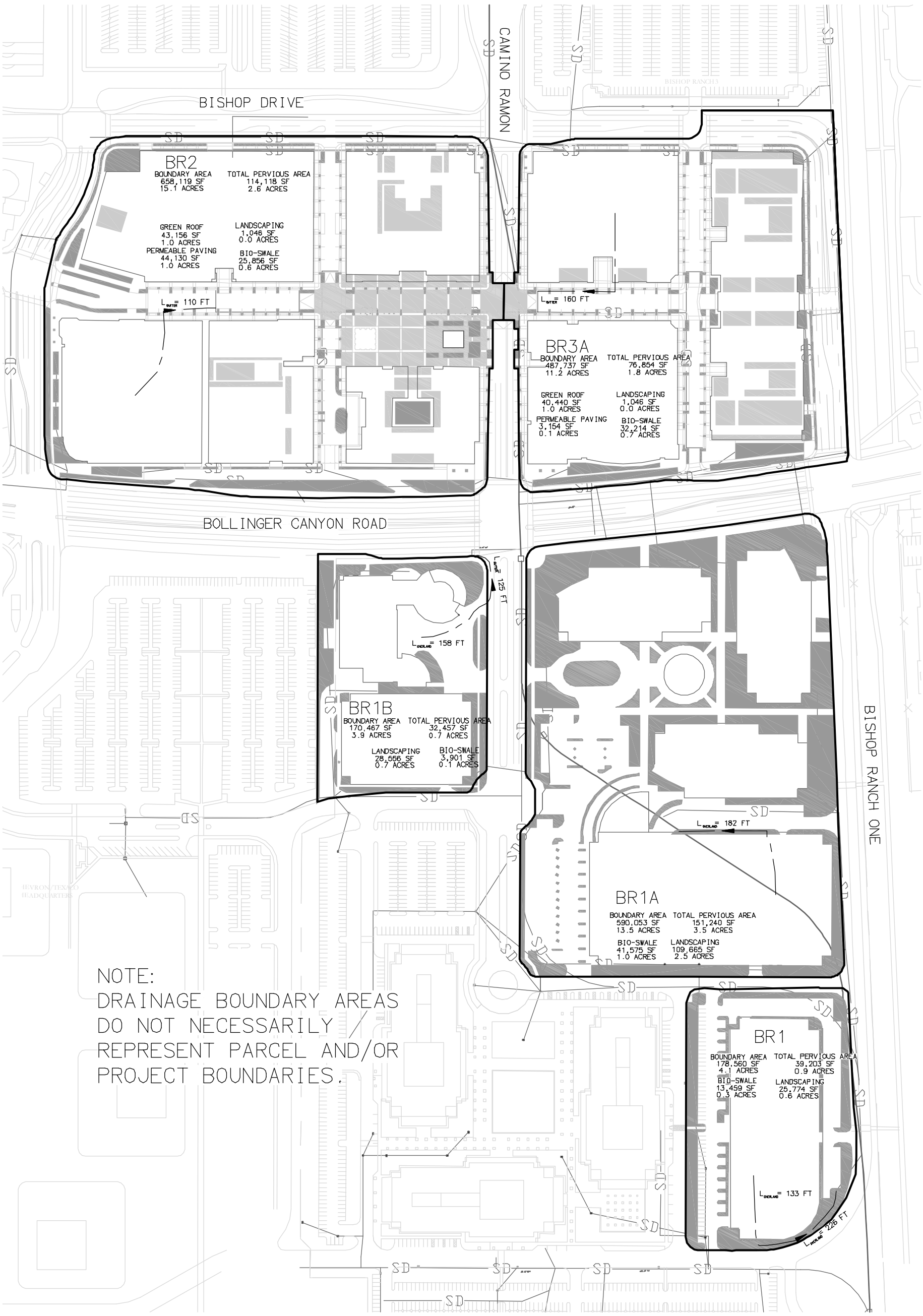

NOTE:
DRAINAGE BOUNDARY AREAS DO NOT NECESSARILY REPRESENT PARCEL AND/OR PROJECT BOUNDARIES.

SCALE: 1"=200'

LEGEND:

- APPROXIMATE DRAINAGE BOUNDARIES
- BUILDING OUTLINE
- LONGEST FLOW PATH
- PERVIOUS AREA OUTLINE
- GREEN ROOF OUTLINE
- PERMEABLE PAVEMENT
- 72 TO 96-INCH STORMDRAIN —SD—
- CALCULATED AREAS 658,119 SF 15.1 ACRES (EXAMPLE)

SAN RAMON CITY CENTER

PRELIMINARY HYDROLOGY REPORT

EXHIBIT 8:
PROPOSED POST-DEVELOPMENT PERVIOUS AND IMPERVIOUS AREAS

RBF CONSULTING
PLANNING • DESIGN • CONSTRUCTION
[illegible] PLEASANT VALLEY ROAD, SUITE 270
WALNUT CREEK, CALIFORNIA [illegible]
[illegible] · FAX [illegible] · [illegible]

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4.3 Preliminary Watershed Hydrologic Analysis

The Project site would not cause any changes to the regional hydrologic conditions. The site would maintain peak flow requirement and water quality requirements set forth in the CCCWP. The peak flow from the Project site after the development would not exceed the peak flow of the Project site before the development. The stormwater would meet water quality requirements before entering the storm drain collection system. Flows would be routed through passive stormwater treatment facilities, such as bio-swales.

An extensive regional stormwater collection and conveyance system has been developed. This collection and conveyance system routes stormwater flows through a network of pipelines and channels to South San Ramon Creek. The areas above the Project site would not significantly influence the drainage patterns onsite.

The major drainage conveyance facility for the Project site is an existing 72 to 96-inch diameter storm drain. The approximate location of the storm drain pipeline is presented in Exhibit 3. This pipeline eventually discharges beyond the Project site to the South San Ramon Creek, which is a concrete lined trapezoidal channel. The storm drain pipelines were sized to convey stormwater flows from the drainage areas to the north of the project site and to the far northwest as depicted in Exhibit 3. Some stormwater is also conveyed from the drainage area in the vicinity around the southern portion of the Project site. The entire storm drain pipeline is a cast in place concrete and appears to be in adequate condition to effectively convey stormwater flows. Limited existing design information is available about this pipeline. Based on available information, the following is estimated for each pipeline within the Project site:

72-inch Diameter Pipeline

- Pipeline Slope = 0.0535
- Flow Capacity (90% full) = 905 cfs
- Buildout Flow = 450 cfs

84-inch Diameter Pipeline

- Pipeline Slope = 0.0090
- Flow Capacity (90% full) = 560 cfs
- Buildout Flow = 525 cfs

96-inch Diameter Pipeline

- Pipeline Slope = 0.0062
- Flow Capacity (90% full) = 663 cfs
- Buildout Flow = 620 cfs

The proposed building layout is in the same location as the existing pipeline alignment. Thus, several alternatives for rerouting the pipeline were considered. Modifying the pipeline alignment in the areas to the immediate north and south of the Project site would not be feasible. These areas are substantially developed and have many constraints such as existing utilities, traffic impacts, and building setbacks. Thus, three alternatives for pipeline locations within the Project site were considered: Alignment A, B, and C. These alignments are primarily located in streets or parking areas. They are also setback from the surrounding buildings so as not in interfere with the building foundations. The proposed alignments would all be 96-inches in diameter. They would all deviate from the existing pipeline alignment along Camino Ramon, approximately 250 feet south of Bollinger Canyon Road. Each proposed alignment returns to the existing pipeline alignment further downstream, along Bishop Ranch One (road). The proposed alignments are presented in Exhibit 9. The approximate lengths of the pipelines are presented in Table 6.

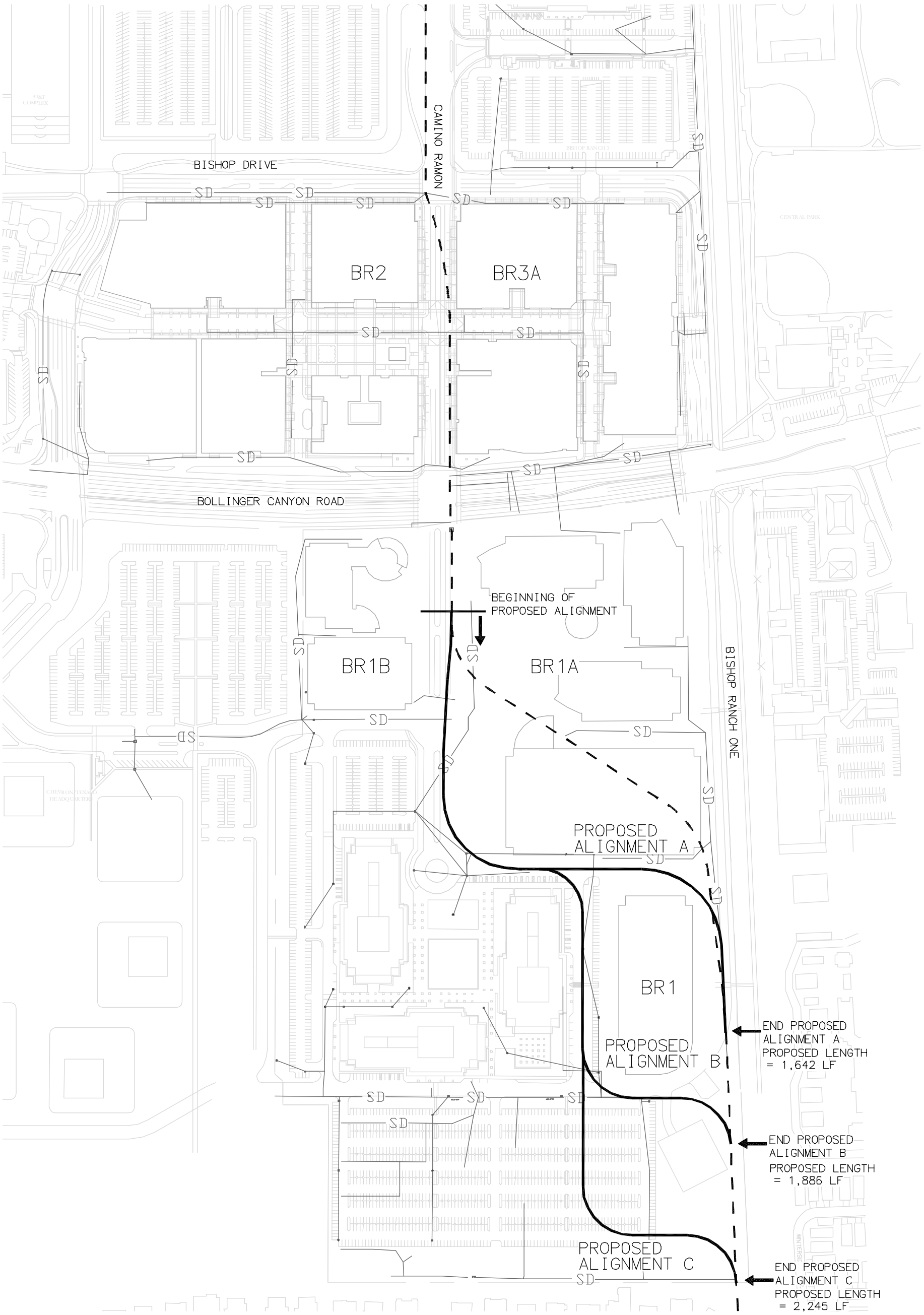
Table 6: Conceptual 96-Inch Pipeline Alignment Alternatives

Alternative	New Pipe Length (LF)	Abandoned Pipe Length (LF)
A	1,642	1,426
B	1,886	1,703
C	2,245	2,062

These alternatives should be evaluated by more than just their proposed size. The potential conflicts with existing utilities, setback requirements from all existing and proposed structures, the feasibility with the surrounding stormwater collection system, and the compatibility with the existing 96-inch diameter storm drain should be considered. For example, a proposed recycled water pump station owned by the Dublin San Ramon Services District / East Bay Municipal Utilities District Recycled Water Authority (DERWA) is planned to be located in near the south end of Alternative B. Any modifications to the existing pipeline alignment would need to ensure the hydraulic characteristics of the pipeline allow for the conveyance of stormwater during ultimate flow conditions.

Special attention will likely be required during the final design of the pipe curvature since the proposed pipeline alignments include curvatures of approximately 90 degrees to avoid proposed buildings. The angle of the pipeline's curves would need to be designed in coordination with the pipeline manufacturer. It is likely that precast concrete would be the applicable material for this pipeline since the existing pipe is cast in place concrete. The pipe in the curved alignment may require the use of radius pipe. Radius pipe, also referred to as beveled or mitered pipe, incorporates the deflection angle in the pipe joint. Radius pipe is manufactured by shortening one side of the pipe. This technique allows for sharper curves to be handled. Other options for tightening pipe curvature radii include using shortened pipe lengths or specially constructed pipes.

The final Stormwater Control Plan should address these alternatives and further investigate the benefits of each.



SAN RAMON CITY CENTER

PRELIMINARY HYDROLOGY REPORT

EXHIBIT 9:
96-INCH STORMDRAIN PIPELINE
CONCEPTUAL ALIGNMENT ALTERNTATIVES

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H:\PDATA\35100678\CADD\STRMWATER\EXHIBITS\009 – PRELIMINARY HYDROLOGY STORM DRAIN ALTERNATIVES.DWG JMARSHALL 5/31/07 3:44 pm

5 LIMITATIONS

This analysis is not intended to provide final design based recommendations or to serve as the final Stormwater Control Plan. Rather, it is intended to serve as a guide in the planning process in the development of the San Ramon City Center Project. Further, it is anticipated that the recommendations of this report will require coordination, review, and approval with representatives of the City and County prior to initiation of final design.

This report was prepared in general accordance with the accepted standards of practice in surface-water hydrology existing in Northern California for Projects of similar scale at the time the investigations were performed. No other warranties, expressed or implied, are made.

Concepts, findings, and interpretations contained in this report are intended for the exclusive use of Sunset Development Company, under the conditions presently prevailing except where noted otherwise. Their use beyond the boundaries of the site could lead to environmental or structural damage, and/or to noncompliance with policies, regulations, or permits. The assumptions and findings in this report were developed solely for initial recommendations for the planning of storm drainage infrastructure at the site as an aid to more detailed civil engineering work. They should not be used for other purposes without great care, updating, review of analytical methods used, and consultation with RBF staff familiar with the site.

6 REFERENCES

American Concrete Pipe Association, Concrete Pipe Design Manual, 2000.

California Department of Water Resources, California's Groundwater: Bulletin 118, 2003.

California Stormwater Quality Association, California Stormwater BMP Handbook: New Development and Redevelopment, January 2000.

Contra Costa Clean Water Program, Stormwater Quality Requirements for Development Applications: Stormwater C.3 Guidebook, October 2006.

Mays, Larry W., Water Resources Engineering, 2005.

San Francisco Regional Water Quality Control Board, Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin, December 22, 2006.

8 APPENDICES

Appendix A: FEMA FIRM Maps

Appendix B: BMP Bio-Swale Fact Sheets

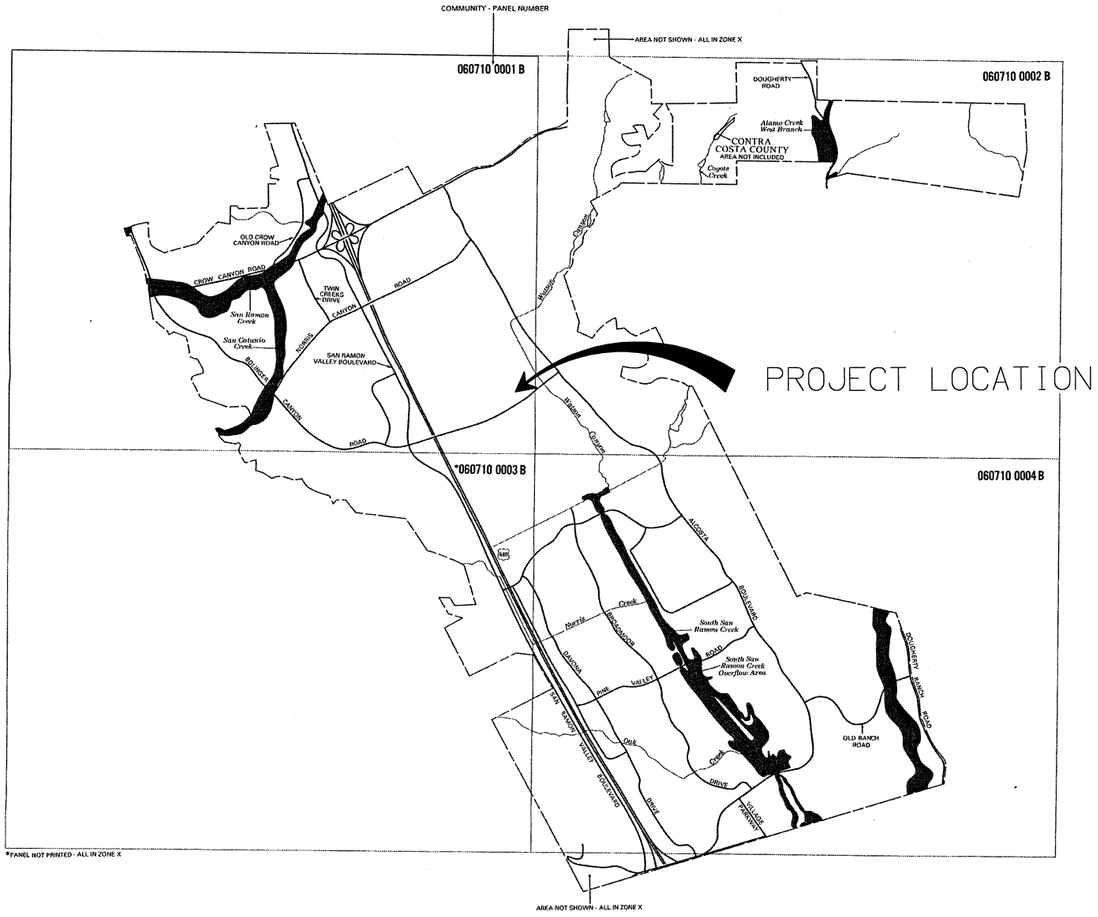
Appendix C: BMP Green Roof Fact Sheets

Appendix D: BMP Permeable Pavement Fact Sheets

Appendix E: Contra Costa County Rainfall Figures

APPENDIX A

FEMA FIRM Maps



LEGEND

FLOOD - PRONE AREAS: FOR ORIENTATION PURPOSES ONLY

FLOOD - PRONE STREET INDEX

NOTE TO USER

This index provides a list of all streets shown on the Flood Insurance Rate Map (FIRM) that are partially or totally within Special Flood Hazard Areas (SFHAs). This index should not be used as an authoritative source for determining whether specific streets, properties, or buildings are within an SFHA. The appropriate FIRM panel must be consulted for these purposes. This index is intended to be used only as a guide for determining which FIRM panel displays the street in question and the relative location of the street on the FIRM panel.

KEY

Riverview Drive 0015 (B6)

street name — panel number — grid location

NAMED STREETS

Alcosta Boulevard	0004 (F5)
Bollinger Canyon Road	0001 (C3, C4, E6)
Bronco Court	0001 (E6)
Canyon Creek Road	0001 (E4)
Corral Circle	0001 (E6)
Craydon Circle	0004 (E6)
Crow Canyon Road	0001 (C4, E4)
Del Mar Drive	0004 (C3)
Degle Court	0001 (E6)
Dogwood Court	0004 (E6)
Dogwood Place	0004 (E6)
Dougherty Road	0002 (F2)
Fircrest Court	0004 (E5)
Fircrest Lane	0004 (E5)
Marsh Court	0001 (E5)
Marsh Drive	0001 (E5)
Marsh Place	0001 (E5)
Neptune Place	0004 (E6)
Norris Canyon Road	0001 (E5)
Norris Court	0001 (E5)
Old Crow Canyon Road	0001 (E4)
Old Ranch Road	0004 (G4)
Pebble Place	0004 (D4)
PG & E Road	0004 (C3)
Pinehurst Place	0004 (C4)
Pine Valley Road	0004 (C4)
Pony Court	0001 (E6)
San Ramon Valley Boulevard	0001 (F3)
Thunderbird Place	0004 (D4)
Winged Foot Court	0004 (E5)
Winged Foot Place	0004 (E5)
Winter Haven Court	0004 (E6)
Wisteria Street	0004 (E6)

MAP REPOSITORY

Public Works Department
2226 Camino Ramon
San Ramon, California 94583
(Maps available for reference only, not for distribution)

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

CITY OF
SAN RAMON,
CALIFORNIA
CONTRA COSTA COUNTY

MAP INDEX
and
STREET INDEX
PANELS PRINTED: 1, 2, 4

COMMUNITY-PANEL NUMBERS
060710 0001 - 0004

MAP REVISED:
MAY 3, 1990

Federal Emergency Management Agency

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION
500 YGNACIO VALLEY ROAD, SUITE 270
WALNUT CREEK, CALIFORNIA 94596-3842
925/930.6460 • FAX 925/930.6465 • www.rbf.com

FEMA
FLOOD INSURANCE RATE MAP
MAP INDEX AND STREET INTDEX

SAN RAMON CITY CENTER
PRELIMINARY HYDROLOGY REPORT

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

- ZONE A — No flood elevations determined.
- ZONE AE — Base flood elevations determined.
- ZONE AH — Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
- ZONE AO — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE A99 — To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.
- ZONE V — Coastal flood with velocity hazard (wave action); no base flood elevations determined.
- ZONE VE — Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

- ZONE X — Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

- ZONE X — Areas determined to be outside 500-year flood plain.
- ZONE D — Areas in which flood hazards are undetermined.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 — Base Flood Elevation Line; Elevation in Feet*

(D)——(D) — Cross Section Line

(BL 987) — Base Flood Elevation in Feet Where Uniform Within Zone*

RM7 X — Elevation Reference Mark

*Referenced to the National Geodetic Vertical Datum of 1929

NOTES

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size or all planimetric features outside Special Flood Hazard Areas.

Areas of special flood hazard (100-year flood) include Zones A, A1-30, AE, AH, AO, A99, V, V1-30 AND VE.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

Coastal base flood elevations apply only landward of the shoreline.

Elevations reference marks are described in the Flood Insurance Study Report.

For adjoining map panels see separately printed Map Index.

MAP REPOSITORY

Public Works Department
2228 Camino Ramon
San Ramon, California 94583
(Maps available for reference only, not for distribution)

INITIAL IDENTIFICATION:
SEPTEMBER 27, 1985

FLOOD HAZARD BOUNDARY MAP REVISIONS:

FLOOD INSURANCE RATE MAP EFFECTIVE:
SEPTEMBER 27, 1985

FLOOD INSURANCE RATE MAP REVISIONS:

Map revised May 3, 1990 to update corporate limits, to add base flood elevations, to add special flood hazard areas, to update map format, to add roads and road names and to reflect updated topographic information.

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

APPROXIMATE SCALE IN FEET
500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

CITY OF
SAN RAMON,
CALIFORNIA
CONTRA COSTA COUNTY

PANEL 1 OF 4
(SEE MAP INDEX FOR PANELS NOT PRINTED)

PANEL LOCATION

COMMUNITY-PANEL NUMBER
060710 0001 B

MAP REVISED:
MAY 3, 1990

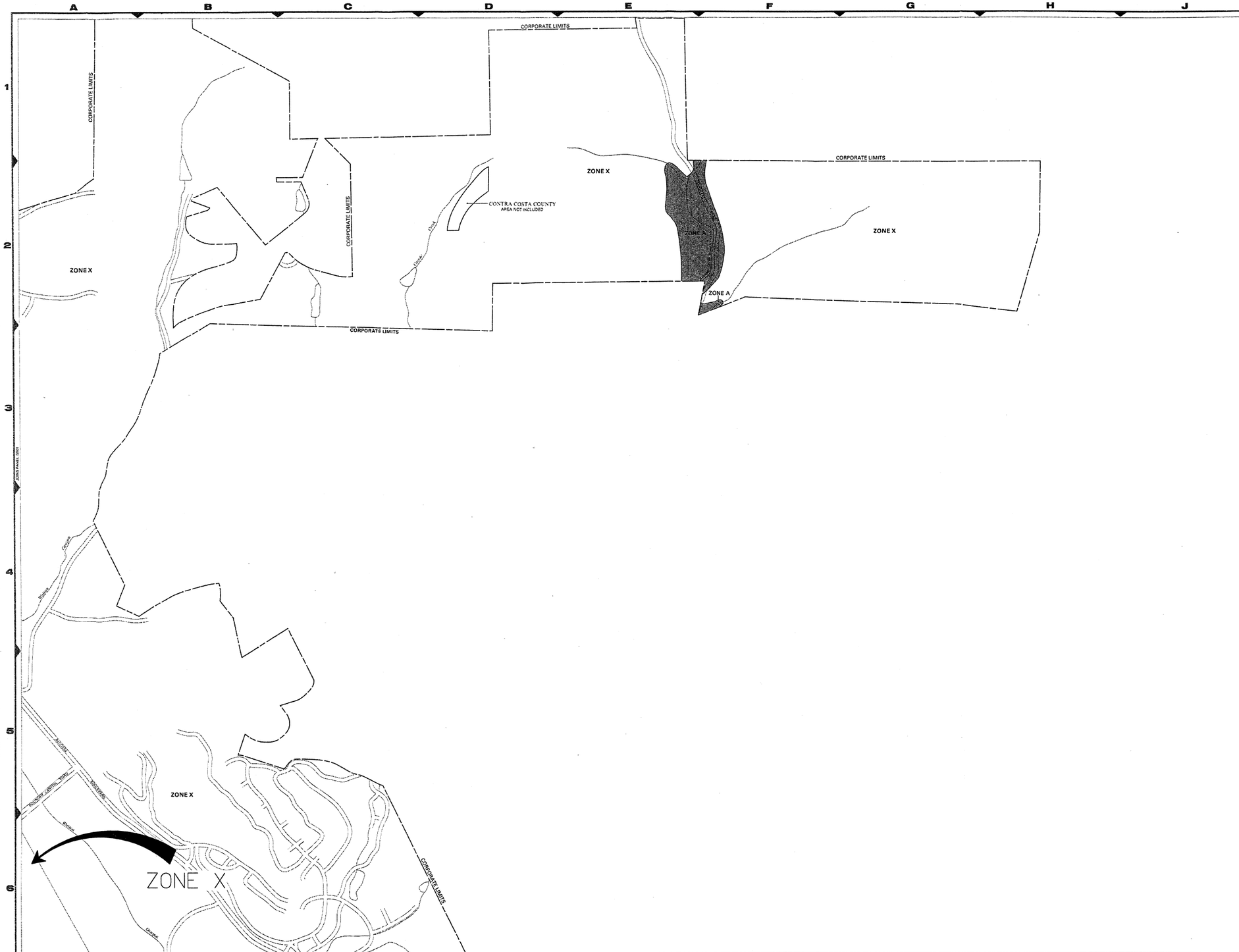
Federal Emergency Management Agency

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION
500 YGNACIO VALLEY ROAD, SUITE 270
WALNUT CREEK, CALIFORNIA 94596-3847
925.905.1460 • FAX 925.905.1465 • www.rbf.com

FEMA
FLOOD INSURANCE RATE MAP
COMMUNITY-PANEL NUMBER 0001 B

SAN RAMON CITY CENTER
PRELIMINARY HYDROLOGY REPORT

H:\PDATA\35100678\CADD\STRMWATER\EXHIBITS\FEMA FIRM MAP 2.DWG JMARSHALL 3/30/07 3:24 pm



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MAP REPOSITORY
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3338 Camino Ramon
San Ramon, California 94583
(Maps available for reference only -not for distribution)

INITIAL IDENTIFICATION:
SEPTEMBER 27, 1985

FLOOD HAZARD BOUNDARY MAP REVISIONS:

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N

APPROXIMATE SCALE IN FEET
500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

CITY OF
SAN RAMON,
CALIFORNIA
CONTRA COSTA COUNTY

PANEL 2 OF 4
(SEE MAP INDEX FOR PANELS NOT PRINTED)

PANEL LOCATION

COMMUNITY-PANEL NUMBER
060710 0002 B

MAP REVISED:
MAY 3, 1990

Federal Emergency Management Agency

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FEMA FLOOD INSURANCE RATE MAP COMMUNITY-PANEL NUMBER 0002 B

SAN RAMON CITY CENTER
PRELIMINARY HYDROLOGY REPORT

LEGEND

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San Ramon, California 94583
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N

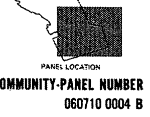
APPROXIMATE SCALE IN FEET
500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

CITY OF
SAN RAMON,
CALIFORNIA
CONTRA COSTA COUNTY

PANEL 4 OF 4
(SEE MAP INDEX FOR PANELS NOT PRINTED)



PANEL LOCATION

COMMUNITY-PANEL NUMBER
060710 0004 B

MAP REVISED:
MAY 3, 1990

Federal Emergency Management Agency

SAN RAMON CITY CENTER
PRELIMINARY HYDROLOGY REPORT

FEMA
FLOOD INSURANCE RATE MAP
COMMUNITY-PANEL NUMBER 0004 B

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APPENDIX B

BMP Bio-Swale Fact Sheets

FORTHCOMING

APPENDIX C

BMP Green Roof Fact Sheets

Green Roofs

Gap Headquarters, San Bruno (*William McDonough & Partners)*

Green roofs can be either *extensive*, with a 3"-7" lightweight substrate and a few types of low-profile, low-maintenance plants, or *intensive* with a thicker (8" to 48") substrate, more varied plantings, and a more garden-like appearance.

The extensive installation pictured above, at Gap Headquarters in San Bruno, has experienced relatively few problems after nearly a decade in use.

Design and Construction. Extensive green roof systems contain several layers of protective materials to convey water away from the roof deck. Starting from the bottom up, a waterproof membrane is installed, followed by a root barrier, a layer of insulation (optional), a drainage layer, a filter fabric for fine soils, the engineered growing medium or soil substrate, and the plant material.

Design and installation is typically by an established vendor.

Maintenance. Installations require inspection at least semiannually and may or may not require irrigation in the Bay Area semi-arid climate.

Agilent Headquarters, Santa Clara *(Agilent)*

See www.greenroofs.com for information about and more examples of green roofs.

Best Uses

- New buildings with innovative architecture
- Urban centers

Advantages

- Minimize roof runoff
- Reduce "heat island" effect
- Absorb sound
- Provide bird habitat
- Structural requirements similar to other roofing options (for extensive green roofs).
- Maintenance costs similar to other roofing options

Limitations

- Sloped roofs require steps or cross-battens
- Non-traditional design

Integrated Management Practices Fact Sheets

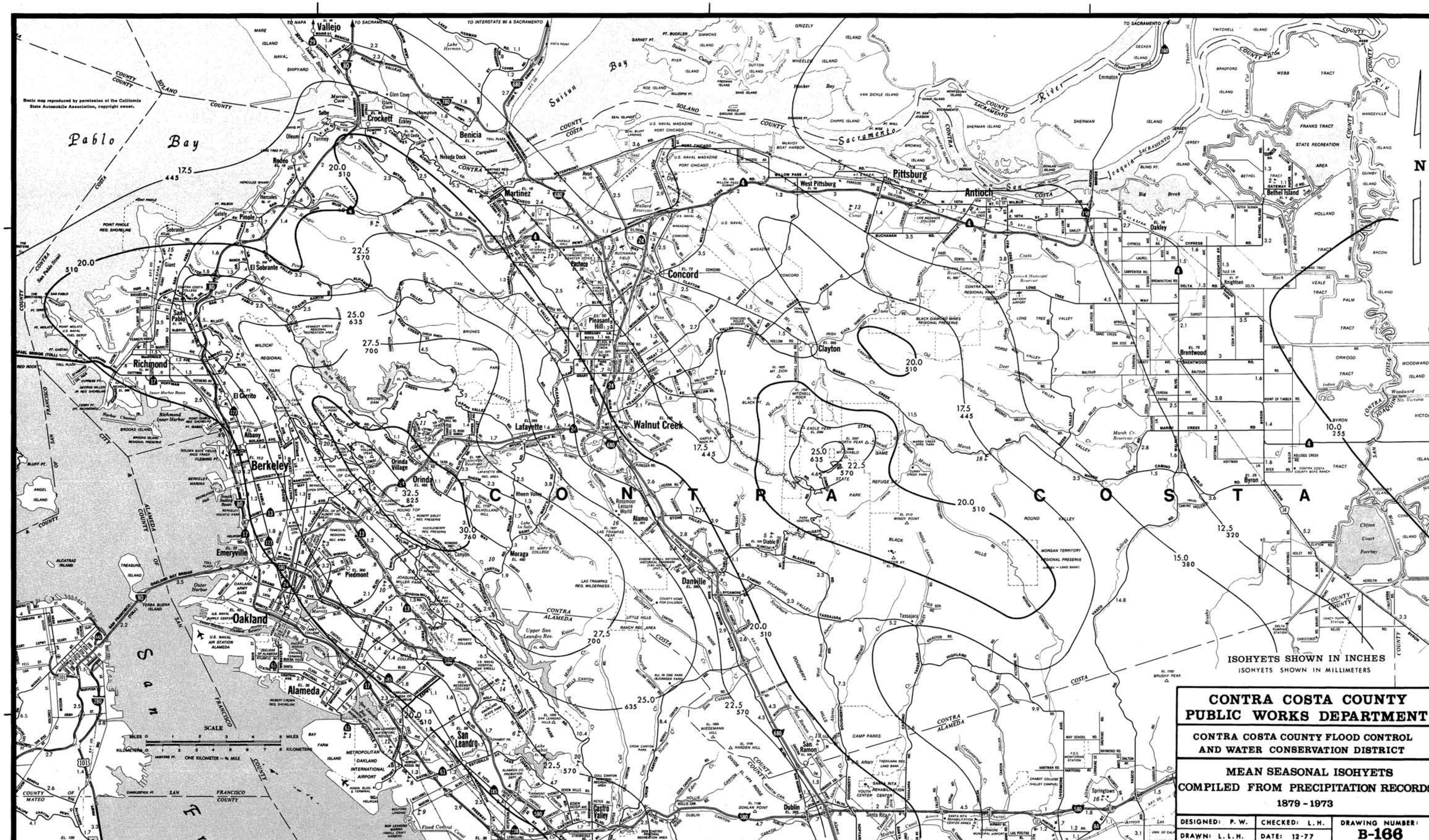
APPENDIX D

BMP Permeable Pavement Fact Sheets

FORTHCOMING

APPENDIX E

Contra Costa County Rainfall Figures

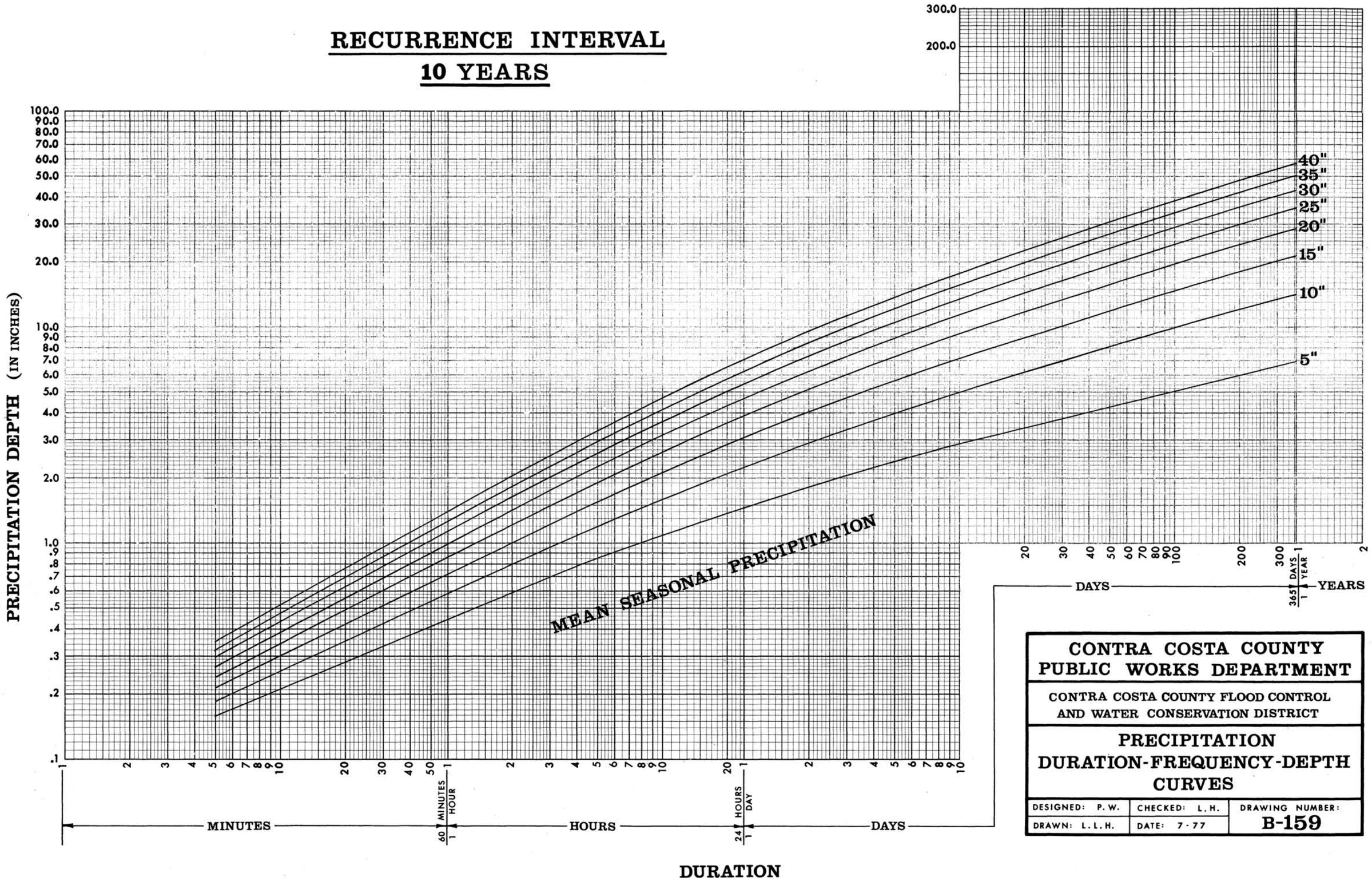


CONTRA COSTA COUNTY
PUBLIC WORKS DEPARTMENT

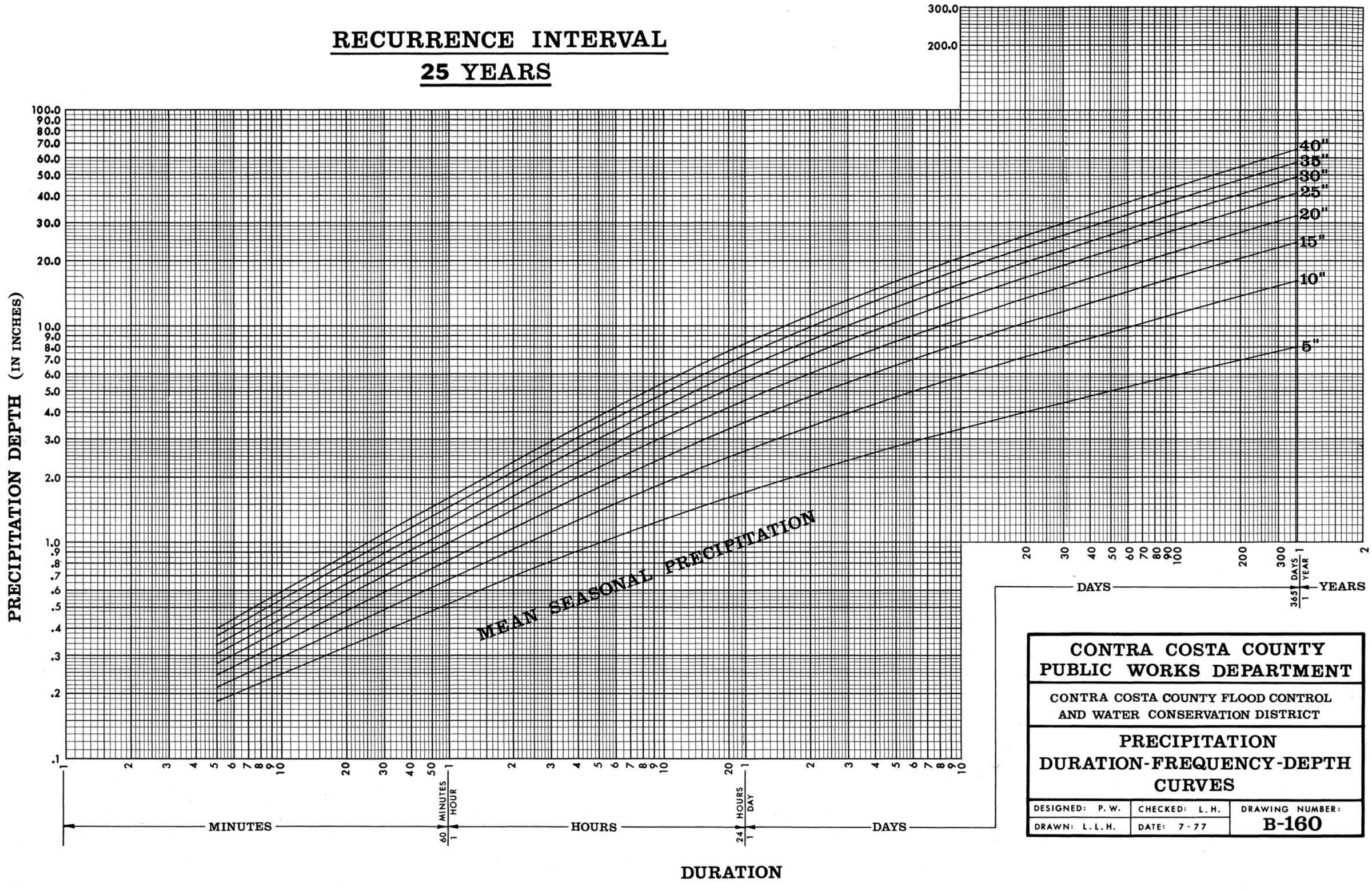
CONTRA COSTA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

MEAN SEASONAL ISOHYETS
COMPILED FROM PRECIPITATION RECORDS
1879 - 1973

DESIGNED: P. W.	CHECKED: L. H.	DRAWING NUMBER:
DRAWN: L. L. H.	DATE: 12-77	B-166



CONTRA COSTA COUNTY PUBLIC WORKS DEPARTMENT		
CONTRA COSTA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT		
PRECIPITATION DURATION-FREQUENCY-DEPTH CURVES		
DESIGNED: P. W.	CHECKED: L. H.	DRAWING NUMBER:
DRAWN: L. L. H.	DATE: 7-77	B-159


RECURRENCE INTERVAL
25 YEARS
PRECIPITATION DEPTH (IN INCHES)
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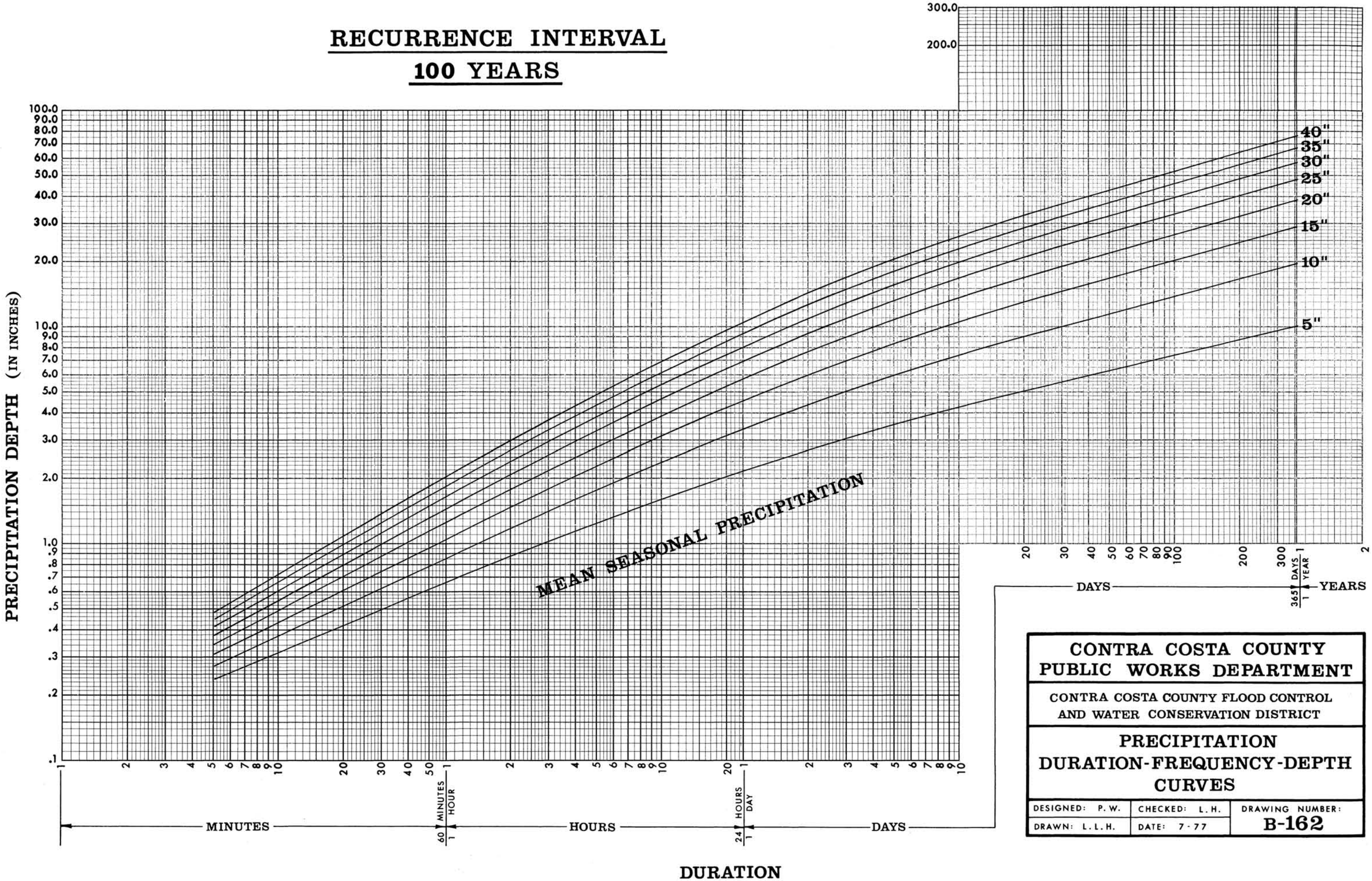
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
300.0
200.0
40"
35"
30"
25"
20"
15"
10"
5"
MEAN SEASONAL PRECIPITATION
MINUTES
60 MINUTES 1 HOUR
HOURS
24 HOURS 1 DAY
DAYS
365 DAYS 1 YEAR
YEARS
DURATION
CONTRA COSTA COUNTY
PUBLIC WORKS DEPARTMENT
CONTRA COSTA COUNTY FLOOD CONTROL
AND WATER CONSERVATION DISTRICT
PRECIPITATION
DURATION-FREQUENCY-DEPTH
CURVES
DESIGNED: P. W.
CHECKED: L. H.
DRAWING NUMBER:
DRAWN: L.L.H.
DATE: 7-77
B-160



CONTRA COSTA COUNTY PUBLIC WORKS DEPARTMENT		
CONTRA COSTA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT		
PRECIPITATION DURATION-FREQUENCY-DEPTH CURVES		
DESIGNED: P. W.	CHECKED: L. H.	DRAWING NUMBER: B-162
DRAWN: L. L. H.	DATE: 7-77	