MARIN COUNTYWIDE PLAN

Flooding
Technical Background Report

Alex Hinds, Community Development Agency Director
Brian Crawford, Deputy Director of Planning
Michele Rodriguez, Principal Planner, AICP
Fred Vogler, GIS Manager
Dan Dawson, Senior Planner, AICP
Kristin Drumm, Planner
Barbara Collins, Affordable Housing Strategist
Larisa Roznowski, Assistant Planner
Sharon Silver, Clerical Support

Special Consultants:

Clearwater Hydrology
2974 Adeline St.
Berkeley, CA 94703

Nichols • Berman
110 East D Street, Suite E
Benicia, CA 94510

Updated November 2005

This page intentionally left blank.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF EXHIBITS

This page intentionally left blank.

I. FLOODING

A. PURPOSE AND BACKGROUND

This Flooding Background report updates the previous Environmental Hazards Element Technical Report #1 – Flood Hazards in Marin which was prepared in 1991. That report described the existing hydrologic environment, the flooding regime and historical floods, applicable County regulations, the basis of the National Floodplain Insurance Program, the composition and responsibilities of the Marin County Flood Control and Water Conservation District (MCFCWCD), and the delineation and status of flood protection in the County Flood Control Zones, as well as an assessment of the County's performance via a vis the policies adopted in the 1994 *Marin Countywide Plan*. The dual focus of the current report comprises an assessment of the modifications to the flooding environment described in the 1991 assessment and an evaluation of the efficacy of current of County flood protection policies.

B. REGULATORY FRAMEWORK

Federal and local regulations have been promulgated to reduce both the exposure of the developed areas of the County to damaging flooding and the funds required to rebuild communities following such major floods. Until the early to mid-1980s, the flood control and reduction strategies that were typically applied in Marin and other Bay Area counties often had detrimental impacts on aquatic, riparian and wetland habitats. Federal and state agencies including the U.S Environmental Protection Agency (USEPA) and its sister agency, the California Environmental Protection Agency (CalEPA) and the state's regional water quality control boards were created, in part, to develop and enforce environmental regulations that would protect the integrity of streams, wetlands and sensitive habitats. Even the Corps of Engineers, which was the principal advocate of dam building, river regulation and large scale flood control works, added the Regulatory Branch to its organization in order to regulate the discharge of fill into streams and wetlands. In addition, growth in the understanding of the linkage between hydraulic and fluvial geomorphological processes caused a re-evaluation of some of the commonly applied flood control techniques, such as use of concrete channel lining, channel straightening and the elimination of functional floodplain areas. The current and evolving regulatory environment affecting flood control activities reflects this understanding of the stream channel and its contributing watershed as an integrated physical (fluvial) and biological entity.

1. National Flood Insurance Program and Related County Code Provisions

The National Flood Insurance Act of 1968 and the Flood Disaster Prevention Act of 1973 established the National Flood Insurance Program (NFIP) which is administered by the Federal Emergency Management Agency (FEMA). The NFIP provides insurance coverage to property owners within flood hazard areas that are delineated on published Flood Insurance Rate Maps (FIRMs) for both the 100-year and 500-year flood events. In order to quality for the program, candidate municipalities and unincorporated county areas must adopt local floodplain development policies and enforce flood control measures for new construction and redevelopment projects within their jurisdictions. FEMA prepares Flood Insurance Studies and associated FIRM maps to assist communities in local land use planning and flood control decision-making.

The County of Marin entered into the NFIP in 1982, the date the original FIRM maps were published for the incorporated area. Portions of the FIRM map coverage for Eastern Marin were updated in 1997. Exhibit 1 delineates the 100-year and 500-year flood hazard zones throughout the Countywide Plan area.

Relevant sections of the Marin County Code that address flooding issues and related development standards include:

- Title 11: Harbors and Waterways – regulates both the construction and repair of dams not regulated by the State and the diversion or obstruction of watercourses. Of particular interest regarding flooding are Sections 11.08.010 Interfering with water flow; and 11.08.050-060 Permit required for construction/Application-Fees. Section 11.08-010 prohibits the discharge of fill, debris, waste, bank stabilization materials into creeks if the discharge obstructs or impedes flow in the channel. However, it also exempts channel or bank modifications that improve or realign the channel, as long as natural flows are not diverted, obstructed or prevented. Sections 11.08.050-060 require that any property owner contemplating instream improvements such as channel realignment and bank protection measures secure a creek permit from the County Department of Public Works prior to construction.

  Chapters 11.24, 11.28 and 11.32 refer to design standards for harbors, marinas and related structures such as piers, gangways and floats.

- Title 22: Development Code – encompasses both Zoning and Subdivision Ordinances. Chapter 22.14 Special Purpose and Combining Districts contains Section 22.14.070 Primary Floodway District (F-1) and Section 22.14.080 Secondary Floodway (F-2) District – which establish Primary and Secondary Floodway Districts and regulates floodway encroachment. It also establishes requirements for site preparation, design and use of projects to satisfy the goals and objectives of the Countywide Plan, both within the City-Centered Corridor and the Coastal Recreational Corridor, which is subject to the permitting authority of the California Coastal Commission. The F1/F2 zoning designation should not be confused with other regulations and restrictions. They are not redundant they deal with different aspects of flooding.

  The defined floodway pertains to that portion of the channel/floodplain cross-section that is required to pass the base (i.e. design) 100-year flood. The F-1 District prohibits the construction of buildings or other structures in the floodway that would either increase flood water surface elevations or otherwise impede floodwaters. It does allow any property in the floodway zone to install a single floating boat dock.

  The F-2 District applies to the floodway fringe, as defined by the Federal Emergency Management Agency (FEMA). It encompasses the portion of the natural floodplain between the outer edge of the F-1 floodway zone and the limits of inundation during the design 100-year flood. This zone is subject to some inundation during the design flood, but flow depths and velocities are typically low. Encroachment by development is allowed therein only through an agreement with the MCFCWCD and is limited to a specified area. The remainder of the area must be available for storage of ponded waters during severe flood events. Provisions of the required agreement with MCFCWCD include ponding availability, dedication of F-1 (Primary Floodway) areas to the County or other maintaining public agency, drainage improvements to accommodate floodwater

ponding, and a performance bond, among others. The current section language allows for a release from the agreement if ultimate (i.e. 100-year) flood control improvements are implemented from the subject property to the mouth of the stream.

Sections 22.10.040 and 22.16.030 identify design requirements for projects zoned as Residential, Multiple Planned District (RMP), including those applied to site preparation, grading, roadway design, erosion control measures and site drainage. While the sub-section on Drainage discusses design measures to reduce the risk of erosion to adjacent properties, it does not mention the conversion of natural channels to storm drain systems.

Section 22.14.060, Bayfront Conservation (-BFC) Combining District, identifies the boundaries of environmentally sensitive areas along the shoreline of San Francisco Bay and restricts development therein. The BFC enhances the County's policy of encouraging regulatory flood control by discouraging development in sensitive baylands.

Article V, Coastal Zones was approved by the Marin County Board of Supervisors on June 24, 2003, however, this recent County Code update has not yet been approved by the California Coastal Commission (CCC). Pending approval by the CCC, land located within the coastal zone will continue to be regulated by relevant provisions of Title 22 of the Marin County Code that were in effect prior to the current Code. The Coastal Development Code describes development requirements, standards and conditions for developments in the Coastal Recreational Corridor. Many of these projects are subject to conditions of the Local Coastal Program (LCP) and must secure coastal development permits from thick. In nearly every case, the standards described in this section are much stricter than those governing development elsewhere in the County, i.e. outside the Coastal Recreation Corridor. Water supply, septic system design, sediment and erosion control, and stream and wetland resource protection are discussed in detail in this section. Two specific provisions relate to flooding for developments within or adjacent to blue line streams as identified on USGS 7.5-minute quadrangle sheets: 1) post-project peak flow rates shall not exceed those of the pre-project condition, and 2) development setbacks from stream channels shall be 100 feet from the nearest top of bank, or 50 feet beyond the edge of established riparian vegetation, whichever is greater.

Chapter 22.52, Tidelands Permits, pertains to land and water areas with elevations below the mean high tide (MHT). Construction, dumping, filling, excavating dredging and the placement of piers or other structures is prohibited in the defined tidelands. Applications for the installation of structures may be conditionally approved as long as they meet certain conditions, including not causing an increase in the likelihood of flooding on adjoining lands.

- Title 23 Natural Resources: Chapter 23.09 Floodplain Management – establishes the Special Flood Hazard Areas (SFHAs) as defined by FEMA for the base 100-year flood event as the standard definition of the channel floodplain covered by the section. It also establishes permit requirements for proposed floodplain construction projects, prohibits floodway encroachments and sets standards for construction, utilities and subdivisions. Special provisions for coastal high hazard areas are defined in Section 23.09.039.

  Sections 23.18.093 Best Management Practices for New Developments and Redevelopments and 23.18.094 Watercourse Protection – grant the Director of Public Works the authority to establish

temporary and/or permanent controls on the volume and rate of stormwater runoff from new developments and redevelopments; establishes creek maintenance responsibilities and guidelines for creekside property owners; controls unpermitted discharges, channel excavation and fill; and regulates unpermitted construction, modification or removal of existing structures within a watercourse.

- Title 24 Development Standards, Chapter 24.04 Improvements, VI. Drainage Facilities, VII. Subsidence, and VIII. Grading – set standards for the design and construction of channels, catch basins and conduits, and drainage setbacks; cites minimum elevations for garage floors and finished floors of structures for flood protection; and regulates the conduct of grading with no distinction between instream and off-stream environs.

  The Title 24 Development Standards specify minimum elevations for new construction, including roadways, garages and finished floors, allowing for ultimate ground settlement – normally interpreted over a 50 – to 100-year period. In areas immediately adjacent to tidal influence, minimum elevations for garages and finished floors of structures cited in the statute are +8.0 feet NGVD and +9.0 feet NGVD, after settlement respectively. These elevations reflect relatively recent increases due to consideration of the projected rise in sea level. Where stormwater inflows, wind and wave runup or other factors contribute to the flood risk, the minimum garage and finished floor elevations are increased accordingly by applying the appropriate hydraulic analyses. Similar standards apply to redevelopment and residential remodeling that exceeds 50 percent of the value of the structure. (Clearwater Hydrology conversation with John Wooley, MCFCWCD, ibid)

C. MAPPING SUMMARY

Exhibit 1 delineates the 100-year and 500-year flood hazard zones mapped by the Federal Emergency Management Agency and its contractors. These flood boundaries are determined through application of standard methodologies for the analysis of watershed peak flow rates, tidal magnitudes and frequencies, and flood water surface profiles. Dam inundation areas for major reservoirs in the County are also shown on the exhibit. These inundation areas represent the path and extent of floodwaters that would progress downstream in the unlikely event of a dam failure. Dam failures could occur in response to a catastrophic rainfall and flooding event or as the result of a severe seismic event. Finally, Exhibit 1 delineates the County Flood Control Zones and shows the locations of County-operated and maintained pump stations for floodwater evacuation.

D. SETTING

1. Historical Flooding

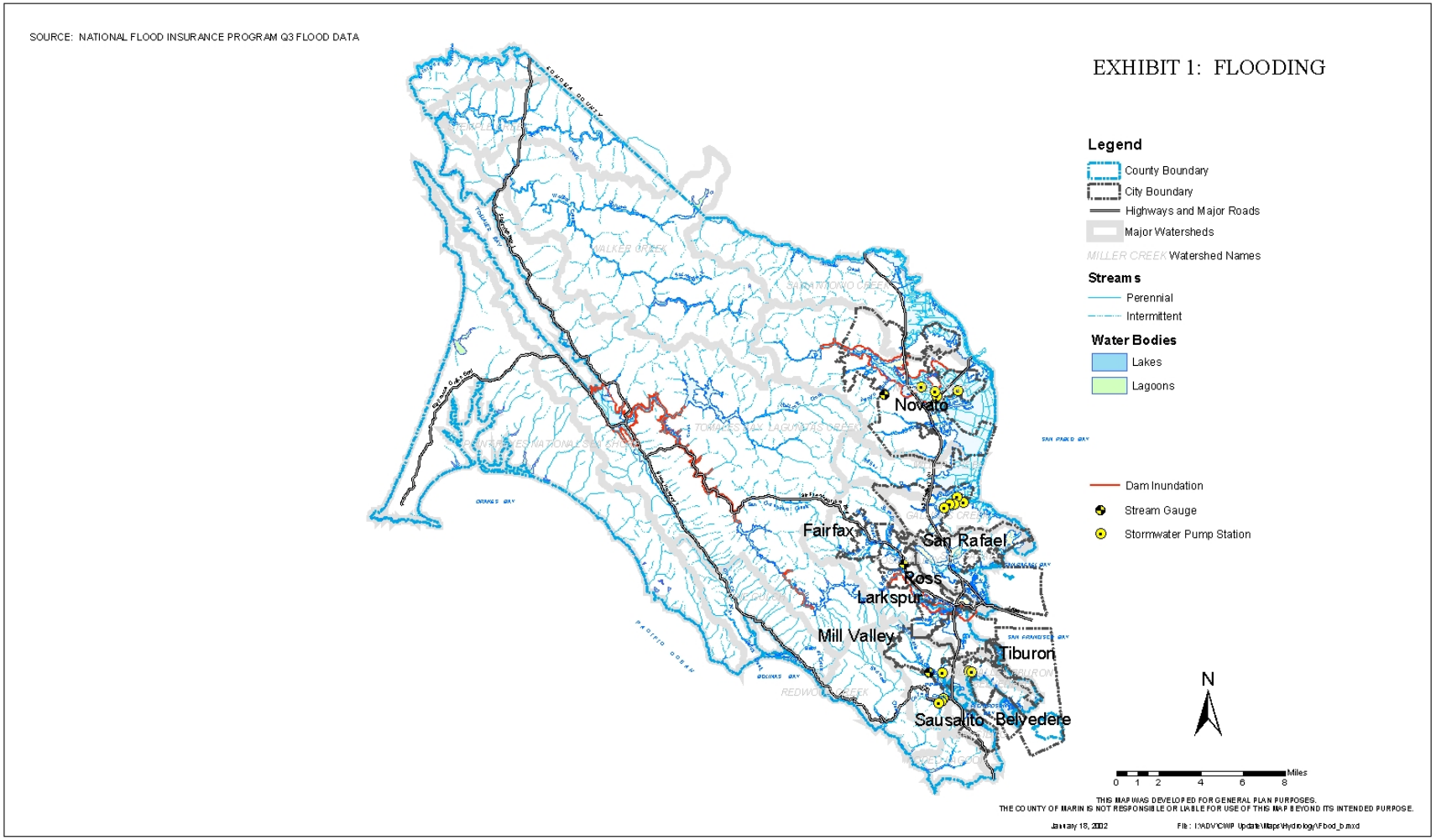
Damage-inducing flooding has occurred infrequently in the Countywide Plan area, primarily in the lower lying alluvial valleys and Bay plains of the City-Centered Corridor. From 1950 to 1970, major floods occurred in 1952, 1955, 1958, 1967 and 1970. Over the past 30 years, significant flooding has occurred in portions of Corte Madera, Larkspur, Greenbrae, Ross, San Anselmo, San Rafael and Novato in January 1982, January and December 1983, February 1986, January 1997 and February

1998. The 1982-'83, '86 and 1997-'98 periods were influenced to some degree by the El Nino climatic phenomenon. El Ninos involve a warming of offshore areas of the Pacific Ocean and an alteration in the normal weather patterns affecting Northern California. Typically, the associated weather is much wetter and storms more intense than during non-El Nino periods. High than normal tides are also associated with El Ninos due, in part, to the expansion of warmer ocean waters.

Two forms of flooding occur in the Countywide Plan area: 1) tidal flooding and 2) watershed flooding. Coincident tidal and watershed flooding can also occur. Tidal flooding develops when high tides exceed either the top of bank elevation of tidal sloughs and channels, or the crest of bay levees. Watershed flooding occurs in response to severe runoff-inducing rainfall over the tributary watershed of one of the region's stream channels. Major watershed floods are typically generated by rainstorms of 3-4 days duration that include nested periods of high intensity rainfall. Such rainstorms occur primarily during the wet winter season which normally extends from November through March. When watershed flooding occurs in conjunction with high bay tides, the extent and/or depth of overbank flooding or levee overtopping can increase due to an upward adjustment in the flood water surface profile.

This page intentionally left blank.

SOURCE: NATIONAL FLOOD INSURANCE PROGRAM Q3 FLOOD DATA



This page intentionally left blank.

The filling of former baylands initially allowed for their development, as the higher land elevations protected the areas from tidal flooding. However, subsequent subsidence of the landward fills eventually reduced the level of flood protection. Levees were then constructed to segregate the subsided lands from tidal flooding. In addition, watershed runoff had to be evacuated from these low-lying areas using pump stations, maintained inlet channels and pipe networks.

Watershed flooding is commonly associated with the development of formerly active floodplains and an increase in the peak rates of watershed runoff. Peak flows increase due to increases in impervious surface coverage and the construction of storm drain systems, which reduce the time of concentration for runoff. When peak flow rates increase substantially and the altered flow regime is not accommodated using channel modifications, stormwater detention or diversion, and/or stream conservation zones, episodic flooding can ensue.

Since 1980, damaging watershed and/or tidal flooding has occurred at several locations within the Countywide Plan area. In the storm of January 2-5, 1982, watershed flooding on Corte Madera Creek produced floodplain inundation depths of 1-3 feet through the Towns of San Anselmo, Ross, Kentfield, and Greenbrae. The same storm produced damaging flooding in portions of the City of Novato along Novato Creek, Warner Creek and Arroyo Avichi. The community of Santa Venitia, which functions as an independent watershed due to its leveed segregation from Las Gallinas Creek, experienced flooding as watershed runoff and entrained hillslope debris obstructed inlet channels and pump station inlets. Nuisance flooding also occurred in San Rafael on the southern tributaries to San Rafael Creek, in the Bret Harte/Picnic Valley and Irwin Street neighborhoods, and on the eastern tributary (aka Sisters Creek) to Black Canyon Creek in the vicinity of Dominican College. Along the Pacific Ocean recreational corridor, the 1982 storm generated numerous catastrophic landslides and related flooding, as land debris obstructed or completely filled drainageways. In general, the watershed flooding in this portion of the Countywide Plan area produced minimal damage because of its low population density.

The Valentine's Day storm of February 1986 caused overbank flooding along the Corps of Engineers flood control channel on Corte Madera Creek, although the depths of floodplain inundation (1-2 feet) were less than those experienced during the January 1982 flood. Damaging flooding was avoided in the Town of Novato due to the 1985 expansion of reservoir capacity at Stafford Lake, which stores and regulates outflows from the upper Novato Creek Watershed.

Extreme high tides with recurrence intervals exceeding 100-years occurred in January and December 1983. Levee overtopping and the resulting tidal flooding was documented in the communities of Santa Venitia and Corte Madera (Lucky Drive), and historically susceptible low-lying areas of eastern San Rafael. Tidally induced flooding occurred again in the Lucky Drive area of Corte Madera in 1997 and 1998. Both Tamalpais Valley (Coyote Creek) and Santa Venetia survived the January 1997 and February 1998 El Nino floods and high tides, without serious flood damage. However, this was due to a lack of coincidence between watershed flood peaks and high Bay tides, rather than substantial improvements in flood control facilities. (Clearwater Hydrology conversation with John Wooley, P.E., MCFCWCD, Land Development Division, Sept. 2001)

2. Dam Inundation Flooding

Significant, even catastrophic flooding can occur in valley areas downstream of major dams in the event of a complete or partial dam failure. Such events are extremely rare due to the stringent design and

permitting requirements for dam construction and operation. However, in the active tectonic environment of the San Francisco Bay Area, the risk of a dam failure during a major earthquake remains a possibility. Dam failures can occur in response to full or partial structural collapse of the dam face (concrete arch dam) or embankment (earthfill dam) during a major earthquake. The dam could also partially rupture during an earthquake and fail completely sometime later due to leakage/seepage through the damaged embankment or dam face. In addition, a seiche (i.e. a long period, oscillating wave) generated over the reservoir surface in response to severe ground motion and stored water displacement could also cause overtopping of the dam. Overtopping by a seiche wave could trigger a structural failure of the dam.

Water supply dams are an integral part of the water resources environment in the Countywide Plan area. The Marin Municipal Water District (MMWD) and the North Marin Municipal Water District operate and maintain eight major dams for municipal water supplies within their jurisdictions. MMWD dams include Alpine Dam, Bon Tempe Dam, Lagunitas Dam, Phoenix Dam, Peters Dam (Kent Lake), Nicasio Dam, and Soulajule Dam. NMWD maintains and operates one dam at Stafford Lake on Novato Creek for its smaller service area. Storage characteristics for these dams were listed in the 1991 Environmental Hazards Element Technical Report #1 Flood Hazards in Marin County (Marin Co. Community Services Agency 1991).

An additional dam and reservoir, which will be owned and operated by Lucasfilm Ltd., is currently under construction at Big Rock Ranch. This dam and reservoir will serve a local water supply function for the film production facilities at Big Rock Ranch. Its storage capacity is estimated at roughly 120 acre-feet. While it is much smaller than any of the other water supply reservoirs operated by MMWD and NMWD, it still falls under the jurisdiction and control of the State Division of Dam Safety (DDS). All reservoirs with storage capacity exceeding 50 acre-feet or with dam heights over 25 feet are permitted and inspected by the DDS. Numerous small dams and stock ponds occur throughout the Inland Rural and Coastal Recreation Corridor lands in the Countywide Plan area and fall outside of the state's jurisdiction. These smaller impoundments are under the permitting authority of the County Department of Public Works in accordance with Marin County Code Title 11.04, Dam Construction and Repair.

Inundation mapping is conducted for most significant dam/reservoir complexes where downstream valleys are inhabited and the risk of loss of life and extensive property damage is significant. In the early-mid 1970s, MMWD and NMWD conducted hydraulic modeling of the downstream flood waves and associated inundation areas that would occur in response to dam failures at their water supply damsites in the Inland Rural and Coastal Recreation Corridor areas of Marin County. Of the eight dams under their jurisdictions, only the Soulajule Dam was excluded from the inundation mapping. Inundation maps for the modeled dams/reservoirs are on-file with the Community Development Agency (CDA) and were also included in the 1991 Environmental Hazards Element Technical Report on Floods. To date, the inundation mapping for Soulajule Dam remains undone. Since a failure of Soulajule Dam would inundate largely rural land and a Pacific Bell receiving site, and would endanger few populated areas (Technical Report: Floods 1991), it is unlikely that expensive hydraulic modeling and inundation mapping will be conducted under the current zoning. A preliminary hydraulic modeling of dam failure and downstream inundation was conducted for the new earthfill dam at Big Rock Ranch (Vandivere 1995). However, a more refined modeling using numerical methods would be required to verify and/or adjust the results of the preliminary analysis, prior to the publication of an

inundation map for planning purposes. Also, areas subject to inundation from failures at the many smaller dams and stock ponds under County jurisdiction have not been mapped (Technical Report: Floods ibid).

3. Sea Level Rise

The Bay Conservation and Development Commission's study of sea level rise and its impacts on San Francisco Bay (BCDC 1988) cited evidence that global sea level rise during the preceding century was about 0.0039 feet/year. According to BCDC staff, the 1988 study remains the local benchmark study for assessing the impacts of sea level rise in the Bay Area (Clearwater Hydrology conversation with Bob Batha, staff scientist, BCDC). Along the City-Centered Corridor, the nearest tide gaging stations studied were at Point Orient and Sausalito on San Pablo and San Francisco Bays. The local relative sea level change (i.e. the apparent rate minus the rate of local land uplift or subsidence) for these stations ranged from 0.0059 feet/year (Point Orient) to 0.0002 feet/year (Sausalito). The only Pacific coastline station that was included in the study was the Presidio gaging station (Golden Gate) which is the tidal reference station for San Francisco Bay. Since there was no vertical land motion indicated during releveling surveys of that benchmark tidal datum, the Presidio station was assumed to equal the global rate of sea level rise (0.0039 feet/year).

Further analysis of sea level rise during a more recent 19-year tidal epoch extending from 1964 to 1982, indicated that global sea level rise had quickened to roughly 0.0072 feet/year. Based on this more recent rate of rise, mean sea level at the Point Orient gaging station was estimated to increase from a present (1986) elevation of +0.40 feet to +0.86 feet NGVD in 2036. Similarly, mean sea level at the Sausalito gaging station was estimated to rise from +0.30 feet to +0.48 feet NGVD in 2036. For the Presidio gage, mean sea level was predicted to increase from +0.29 feet to +0.65 feet NGVD in 2036.

Given the unknowns at work in the generation of sea level rise, BCDC and its consultants (BCDC ibid.) propose a range of 0.005 to 0.05 feet per year for general planning purposes. Moreover, similar extrapolations applied to the computation of the highest estimated tide (HET) produced a predicted HET for the Year 2036 for the Point Orient, Sausalito and Presidio gaging stations of 6.9 feet, 6.3 feet and 6.4 feet NGVD, respectively. These HET elevations represent an increase of 0.2 to 0.5 feet over the station estimates cited by the Corps of Engineers (1984).

These predicted increases in both global sea level rise and San Francisco and San Pablo Bay tide elevations will increase the risk of flooding in the low-lying communities of Tamalpais Valley (Coyote Creek) and Santa Venetia during infrequent, extreme tides and/or high tides with coincident, severe watershed flooding. The risk of coastal flooding in Bolinas, Stinson Beach and other coastal communities due to extreme tides, storm swells and storm-generated runup could also increase due to the gradual increase in sea level. The extent of overtopping of seawalls, roadways and other coastal erosion works, as well as undermining of jetties and breakwater barriers could be exacerbated by sea level rise.

A re-mapping FEMA-designated flood hazard boundaries based on the projected 0.2-0.5 feet of sea level rise through the year 2036 (50 years from the date of the 1986 BCDC report) was considered for inclusion in this Environmental Hazards Element Technical Report update.

However, two problems became immediately apparent due to the minor elevation differential involved:

- The effect of a rise in the Corps' Highest Estimated Tide (HET), which is roughly equivalent to the 100-year high tide, on flood elevations along the Bay and Pacific Ocean shoreline is non-linear. In other words, a 0.5-feet rise in the HET may not translate to a 0.5-feet increase in the existing 100-year base flood elevation as mapped by FEMA. This is due to the fact that significant changes in flooding are likely to occur when low-lying, subsided levee sections are overtopped by the higher tides. Similarly, where streams are not segregated from their floodplains, small changes in elevation can intersect significant topographic features (e.g. slope break on a bank or flood terrace). In each case, the hydraulic behavior of floodflows or tidal flows can change. Thus, this phenomenon is site specific and cannot be evaluated based on the macro-scale assessment of sea level rise on the HET level at any position along the shorelines.

  Most communities within the active County Flood Zone network have raised, or are in the process of raising, levee elevations in response to the prudent changes in the Title 24 Development Standards and the general guidance given by the County DPW and other public works departments in the incorporated areas. Title 24 establishes the minimum elevations after subsidence for garages, finished floors and other structures adjacent to areas of tidal influence.

- *The topographic mapping for Marin County is not refined enough to support the mapping of a 0.2–0.5 feet change in flood elevations.* Thus, even if the impact on flood elevations were linear relative to the increase in the HET elevation, it wouldn't be possible to discriminate between the current and 2036 flood boundaries at this differential.

For these reasons, the mapping of 2036 flood boundaries dictated by the increased sea level was deemed infeasible at this level of investigation. An extensive program of flood modeling based on an updated survey of watershed channel conditions and levee elevations through the Countywide Plan area would be required to quantify the effects of sea level rise on the flood hazard. If more severe global warming and its potentially attendant impacts (e.g. melting of polar ice caps) were forecasted with a high likelihood of occurrence, the extent of sea level rise would increase on the order of feet rather than tenths of a foot. Under these conditions, such a high-profile re-assessment of flooding would be prudent.

4. FEMA Flood Mapping for the Countywide Plan Area

Exhibit 1 is a composite FIRM map for the Countywide Plan area which incorporates revisions through 1997. The base 100-year flood elevation in low-lying unincorporated areas in and adjacent to Santa Venetia was uniformly mapped at +6.0 ft NGVD, based on the demonstrated flooding that occurred in January 1982. Other flood zones were mapped using standard engineering methods involving hydrologic assessments of peak flow rates, flood water surface profile modeling and flood routing techniques. The Santa Venetia subdivision lies immediately adjacent to a leveed reach of lower Gallinas Creek, which is subject to both infrequent tidal flooding (due to levee overtopping by extreme tides) and watershed flooding (due to severe watershed runoff and debris inflows).

Portions of the FIRM map coverage for Western Marin were updated in 1986 and for Eastern Marin were updated in 1997. The most significant changes in the 1997 mapping were identified on the

revised FIRM maps for the Marin County Unincorporated Areas – Southern Part. The San Rafael Community Development Department (CDD) and the City's engineering consultant submitted a Letter of Map Revision (LOMR) application to FEMA for the lower reaches of Miller Creek, based on a revised flood analysis that was conducted in 1993. (Ensign and Buckley, Letter Report submitted to City of San Rafael, 1993) The flood analysis was initiated on the strength of new information on channel conditions (e.g. modifications) and more detailed topographic data. The resulting changes to the delineated flood hazard zone in this area were incorporated into the 1997-revised FIRM mapping.

Specific property owners can also petition FEMA for changes to flood hazard designations via the LOMR process. Information on this process is available from the County Department of Public Works or FEMA.

5. The Marin County Flood Control and Water Conservation District

The Marin County Flood Control and Water Conservation District (MCFCWCD) was established in 1953 by the State Legislature through the Marin County Flood Control and Water Conservation District Act (Chapter 68 of the Appendix of the California Water Code). Boundaries of the District coincide with county boundaries, with the exception that the Town of Corte Madera is not part of the District. The Marin County Board of Supervisors sits as the Board of Supervisors of the Flood Control District, and the District is operated in coordination with the County Department of Public Works. The District administers flood control projects and oversees revenue collection in each of the eight active Flood Control Zones in Marin. Flood Control District staff work for the County of Marin, but charge their time to the appropriate Flood Zones.

Marin County Flood Control Zones are located principally in populated area, although one of the Zones (Inverness Ridge – Zone 10) encompasses the largely rural area of Inverness. Each Zone has an Advisory Board which recommends flood control projects and funding to the Board of Supervisors. Flood Control Zones raise money through property taxes and assessment overrides. The Zones fund their own flood control projects, and contribute funds to the central administration of the Flood Control District. The Zones vary considerably in size, financial resources, and hazard severity. Funds raised within a Flood Control Zone can only be spent within that Zone. The Flood Control District has problems addressing all County flood control needs under a system characterized by revenue surpluses in some Zones, inadequate financing of flood control projects in others, and very little money for areas outside the system of Flood Control Zones altogether. The eight Flood Control Zones in the County are delineated in Exhibit 1.

The County has administered a number of flood protection measures in County Flood Control Zones. County Code Section 23.09 requires that projects include the purchase of land to re-establish the floodplain, flood proofing of property by raising flood prone buildings and making them watertight, construction of berms and retaining walls, and floodplain zoning. Other flood control activities undertaken in flood zones include the construction of physical facilities such as engineered stream channels, pump stations, levees and bank stabilization works.

The eight flood control zones in Marin are:

Flood Control Zone 1 (Novato) – This Zone encompasses the entire watershed tributary to Novato Creek, which includes all of the City of Novato plus a substantial amount of unincorporated area

around Novato. In November of 1984, the voters of this Zone approved a four-year, $9 million project to reduce flooding from Novato Creek and its tributaries. The Zone also periodically dredges watercourses and began an annual debris removal program in 1983 with the Marin Conservation Corps.

Flood Control Zone 3 (Richardson Bay) – Flood Control Zone 3 includes the area tributary to the upper end of Richardson Bay, all of Mill Valley, plus unincorporated areas such as Marin City, Tamalpais Valley, Homestead Valley, the Alto-Sutton Manor area, and portions of the Strawberry Peninsula. The Zone has built pump stations at Cardinal Road, Marin Avenue, Shoreline Highway at Coyote Creek and one station on Ryan Creek. The Zone has also adopted a plan for constructing major flood control works over several years.

Flood Control Zone 4 (Bel Air) – This small Zone is located off Tiburon Boulevard, recently annexed to the Town of Tiburon. The Zone maintains two ~~a~~ major storm water pump station, cleans existing drainage ditches, and plans to replace culverts under Highway 131 in conjunction with Caltrans, and construct an additional storm water pump station.

Flood Control Zone 5 (Stinson Beach) – Flood Zone 5 includes the entire area tributary to Eskoot Creek which runs through Stinson Beach. The Zone has a very limited budget and present policy includes maintenance operations only. Periodic inspection of the creek and required enforcement of County code provisions regarding debris and/or illegal structures occurs under the jurisdiction of the Flood Control District.

Flood Control Zone 6 (Rafael Meadows) – This Zone, located across the Highway 101 from the Marin County Civic Center, lies within the City of San Rafael. While the City of San Rafael performs all maintenance within the Zone, residents and the City keep the Zone active as a potential source of revenue for future projects.

Flood Control Zone 7 (Santa Venetia) – Flood Zone 7, located east of the Marin County Civic Center, faces a number of ongoing problems related to its location in a floodplain and atop bay mud which is slowly subsiding. The area was particularly hard hit during the winters of 1982 and 1983, affected both by stormwater runoff and extreme high tides. The Zone began reinforcing the existing levee system after the 1982-83 floods with a loan from Flood Control Zone 4. The Zone built a bypass system to take runoff from the adjacent southern hillslopes and convey it around local drainage systems into Las Gallinas Creek, and a series of stormwater pump stations to lift stormwater out of the area during prolonged, intense rainstorms. The Flood Control District presently maintains internal drainage systems, perimeter levees and five stormwater pump stations.

Flood Control Zone 9 (Ross Valley) – This Zone encompasses all of the Ross Valley with the exception of San Anselmo and Fairfax and is currently acting under court order to complete the Corte Madera Creek project. The project, though 70 percent completed, has been stalled for a number of years due to public opposition, litigation and funding shortfalls. An update of the Corte Madera Creek project discussion is presented in the following section.

Flood Control Zone 10 (Inverness Ridge – This Zone formed after the disastrous January 2-5, 1982 rainstorm. The Zone collects taxes and cleans and restores local creek channels. During the late 1980s, it received Coastal Conservancy grant funding for creek maintenance in Haggarty Gulch and

Fish Hatchery Creek. (Environmental Hazards Element Technical Report #1 Flood Hazards in Marin County 1991)

6. Current Status of County Flood Control Programs

a. Las Gallinas Creek Watershed – Santa Venetia

The community of Santa Venetia was constructed in the 1950s and occupies a north-facing hillslope and the former southern floodplain of Las Gallinas Creek, near its confluence with San Pablo Bay. Subsequent subsidence of the underlying Bay mud increased the local flood hazard, so a levee system was constructed to minimize the risk of tidal flooding from lower Las Gallinas Creek. The levee construction essentially segregated the floodplain from the Creek, such that the current community and its adjoining hillslopes comprise an independent watershed. Pump stations were also installed to evacuate local stormwater runoff. An extension to the perimeter levee, consisting of a double-bulkhead timber wall, was constructed in 1983. The low-lying areas of the subdivision remain prone to backwater flooding during periods of extreme high tides (such as January and December 1983), or coincident high tides and high magnitude floodflows on Las Gallinas Creek.

The perimeter levee that protects Santa Venetia from tidal flooding is the most critical element in the flood control plan. Up until recently, the rate of levee subsidence was causing concern among MCFCWCD staff. Another extension or reconstruction of the existing levee was viewed as a high priority for Zone 7. However, in the last few years, the documented rate of levee subsidence has decreased to an extent that staff feels there is more time to implement the reconstruction. MCFCWCD staff have recently made inquiries with the Corps of Engineers about instituting a new federally funded flood control project at Santa Venetia. (Clearwater Hydrology conversation with John Wooley, Land Development Engineer, MCFCWCD, Dec. 2001)

The MCFCD Zone 7 currently operates and maintains five stormwater pumping stations within the affected areas. Bypass pipes convey runoff from the adjoining southern hillslopes directly to outlets in Las Gallinas Creek. This reduces the volume of stormwater that must be evacuated by the pump stations, which are subject to occasional obstruction by debris and mechanical or electrical failures. In addition, the Zone installed two of three segments of an intertie pipeline connecting four of the five pump stations. The intertie allows surcharged stormwater accumulating at one or more station inlets to be redirected to other unobstructed or higher capacity stations. The referenced 1998 engineering studies determined that one installed segment of the intertie requires reconstruction, while the second installed segment is functioning satisfactorily. Utility line conflicts and the resulting field adjustments made to the grade of the Pump Station No. 1 to 5 intertie segment reduced its effectiveness. The absence of the third segment, in association with the severely inadequate capacity of Pump Station No. 1, further reduces the overall capacity of the dewatering system. At present, the pump station network and its partially completed intertie pipeline are sufficient to evacuate the incoming stormwater runoff generated by the design 10-year rainstorm, assuming no levee overtopping by tide waters.

Engineering recommendations for upgrading the capacity of the Santa Venetia stormwater evacuation system were cited in the Nute Engineering report (Ibid). Those which are still planned for implementation by MCFCWCD Zone No. 7 include:

- Rebuild Pump Station No. 2 with enough capacity to discharge the 100-year watershed inflow of roughly 50 cfs; incorporate backup generation and outlet piping as required.

- Construct a new pump station at the end of Estancia Way; this pump station will divert stormwater that currently enters the drainage ditch leading to Pump Station No. 5, which has an insufficient gradient to effectively convey incoming stormwater runoff, directly to Las Gallinas Creek.

In conjunction with the recommendations cited above, the Zone conducted a recent assessment of the pumping facilities at each of the five stations. Three of the five pump stations were determined to be in good condition and all five are equipped with back-up electrical generators. Easements adjacent to Pump Station No. 1 were purchased and the pump was rebuilt with a minimum total pumping capacity of 65 cfs, along with an upgraded 42-inch outlet pipe to Las Gallinas Creek. The rebuilding of Pump Station No. 1 eliminated any need for an intertie to Pump Station No. 5. As indicated above, Station No. 2 require some level of renovation and upgrading to achieve more reliable service and the target 100-year level of flood protection.(Clearwater Hydrology conversation with Tracy Clay, MCFCWCD, September 2005)

b. Coyote Creek Watershed – Tamalpais Valley

The community of Tamalpais Valley is bisected by Coyote Creek, a northeast trending tributary of Richardson Bay. The Coyote Creek Watershed encompasses highland areas within the Golden Gate National Recreation Area (GGNRA), as well as the low-lying and hillside subdivisions adjoining its lower reach. The US Army Corps of Engineers (COE) constructed a federal flood control project on Coyote Creek in the early 1960s. The lower tidally-influenced reach of the creek consists of an earthen, roughly trapezoidal channel section. Upstream of this reach, a rectangular concrete channel was constructed. It extends from roughly 500 feet upstream of Flamingo Road to just above Maple Street. Both the lower earthen reach and the concrete reach, totaling a distance of approximately 1.25 miles, are periodically dredged to maintain flood conveyance. Over the lifetime of the project, the dredging frequency has averaged once every 6-10 years. The MCFCWCD oversees the maintenance dredging which is contracted to private dredging firms. The COE conducts annual inspections of the project and makes recommendation to the County regarding maintenance needs.

Earthen levees were also constructed along the lower reach of the Corps project. Thus, at high bay tides, local stormwater runoff must be evacuated via pumping. The MCFCWCD operates and maintains three pump stations in the low-lying residential areas adjacent to the levees. The pumping stations are in good condition and the levee has been maintained at the original design elevation. All but one of the flood control improvements cited in the *Master Drainage Plan for the Tamalpais Valley Watershed* (Murray-McCormick Environmental Group 1973) have been implemented. These facilities afford flood protection ranging from the 25-50 year recurrence interval for Coyote Creek (depending on the extent of accumulated channel sedimentation), 25-year recurrence intervals for Crest Marin and Tennessee Creeks, and 50-year recurrence interval for the stormwater pumping stations. Higher levels of protection (e.g. 100-year) were not adopted by the Master Plan due to economic and engineering considerations. The close proximity of the levees to residential backyards and structures has restricted the County's options for any extension of the levee which could potentially increase protection levels (Clearwater Hydrology conversation with John Wooley, MCFCWCD, op cit).

c. Corte Madera Creek Flood Control Project

The Corte Madera Creek Flood Control Project (CMCFCP) is similar in form to the project on Coyote Creek. It consists of a earthen tidal reach which is maintained for navigation, a middle concrete channel reach and stilling basin (upstream end), and an unmodified upper reach, which extends upstream from the historic bridge crossing in the Town of Ross. As in other Corps flood control projects undertaken in the 1950s-70s, the rectangular concrete channel was designed to convey the 100-year flood without overtopping. However, failure to account for the increased hydraulic roughness that results from the transport of large quantities of sediment and debris in major flooding events caused a reduction in the actual flood conveyance in the modified channel reach. This became evident after the January 3-5, 1982 flood that overtopped the channel and caused major flood damage in the adjoining communities of Ross, Kentfield and Greenbrae. (San Anselmo, which lies further upstream of the concrete channel reach, was also subject to damaging flooding during the January 1982 event.) Subsequent hydraulic analysis of the flood utilizing tufts of vegetation that were deposited in fencing along the concrete reach confirmed the more viscous hydraulic behavior of the floodflows (Vandivere & Williams, 1982). The results of the investigation also indicated the need for more frequent dredging of the concrete channel, its stilling basin and the downstream outlet channel. Since January 1982, the MCFCWCD has dredged the concrete reach, stilling basin and outlet channel area twice: later in 1982 and again in 1996. Upon completion of the Corps project, the MCFCWCD intends to conduct maintenance dredging of the channel and stilling basin on a roughly 3-5-year cycle.

Until the early 1990s, public opposition to traditional flood control engineering rebutted any attempts to extend the original form of the Corps project upstream. However, in 2000 a community consensus for an extension of the project was finally reached. The consensus project is referred to in federal parlance as the Locally Preferred Project (LPP). The current elements of the LPP include raising of sections of the sidewalls of the existing concrete channel by 1.0 to 3.0 feet, deepening and stabilization of the upper earthen channel reach, and construction of a new state-of-the-art fish ladder. While the overall design concept has been approved, deliberations between the Corps and participating stakeholders continue over final design details. Flood bypass systems, an instream sediment trap under the Lagunitas Road Bridge, and various fish ladder designs are among the design details being discussed. The Town of Ross currently dredges this part of Corte Madera Creek, so its designation as a sediment trap would only be a formal recognition of this use.

Following its adoption, the LPP proceeded to the design and environmental review stage, which to date has not been completed. Once the project is constructed, the flood protection level should rise to that of roughly the 30-40 year recurrence interval event. This is equivalent to the hydraulic capacity of the Lagunitas Road Bridge undercrossing after the proposed channel deepening, which is estimated at 5,400 cfs. Additional flood carrying capacity could be achieved if the bridge were replaced. However, it was recently declared a State historic structure, so this existing channel constriction will likely keep the effective reach capacity at the 5,400 cfs level. (Clearwater Hydrology conversation with John Wooley, MCFCWCD, ibid)

d. Lucky Drive Neighborhoods – Town of Corte Madera

Lucky Drive encompasses portions of two neighborhoods and extends from a point roughly 1,500 feet west of Highway 101 to the east side of the highway. To the west of Highway 101, Lucky Drive serves a small commercial area. To the east of the highway, it transitions to the frontage road, known as Old

Redwood Highway. In this area east of Highway 101, a long-established trailer park occupies a low-lying area immediately south of the Greenbrae Board Walk and the Corte Madera Creek tidal channel. In January and December 1983, the local Creek levees were overtopped and these areas and a short section of Highway 101 at Lucky Drive were inundated by tide waters. The local community called for a flood control project, including heightened levees and pump stations. A benefit tax assessment was levied on all properties in the floodprone areas and environmental documents were prepared. However, citizens opposed to the project sued to block the project. While the stormwater pumping stations were eventually installed, none of the proposed levee improvements were implemented.

The El Nino flooding of 1997-'98 again resulted in inundation of the Lucky Drive neighborhoods and Highway 101. This spurred new interest in the flood control project and it was resurrected. A new EIR/EIS was prepared based on a revised set of levee requirements, including maximum heights of 6 to 8 feet adjacent to the east-side trailer park. These levee heights were requested by the trailer park residents in order to remove them from the FEMA-designated flood hazard zone. Removal from the flood hazard zone would have eliminated the federal requirement for flood insurance. However, other residents west of the freeway balked at the aesthetics of the lengthy and non-uniform levee configuration. At present, the project has again been shelved.

e. Novato Creek Flood Control Project

The Novato Creek Flood Control Project (NCFCP) currently consists of four phases (Phases 1-4) which were constructed successively during the period 1987-1991. The NCFCP was funded by a local bond measure and thus, is not a federal flood control project. Channel modifications included excavation, realignment, widening, bank stabilization and floodwall construction, and construction of regular (e.g. trapezoidal) cross-sections and levees on Warner Creek. Reaches of Novato Creek and Arroyo Avichi were also modified to some degree by the project.

The design capacity of the NCFCP is 3,300 cfs, which is equivalent to the 50-year recurrence interval flood. This level of protection is partially the result of the expansion of upstream reservoir storage at Stafford Dam, which was constructed in 1985. The channel design capacity is also dependent upon the maintenance of the design cross-sections in the modified reaches. Since the project includes a significant tidal reach (i.e., downstream of Diablo Avenue) and much of the upper watershed area is unstable, depositional rates for watershed and tidal sediments in the lower portion of the project are high. The MCFCWCD is responsible for maintenance dredging through the aggrading project reach. Maintenance dredging has been conducted every few years since completion of the project. In 1996, the MCFCWCD dredged 45,000 cubic yards of sediment from a one-mile reach of Novato Creek and a 0.3-mile segment of lower Warner Creek. (Collins 1998)

Upstream of the aggrading reach of Novato Creek, MCFCWCD maintenance efforts are more reflective of the more ecologically-sensitive practices associated with aquatic and riparian habitat protection and enhancement. These practices include targeted removal and/or trimming of obstructing willow and cattail growth and stabilization of streambanks using biotechnical methods, wherever practicable. (Clearwater Hydrology conversation with Elizabeth Lewis, Creek Naturalist, MCFCWCD, August 2001)

In 1997, the MCFCWCD retained a consulting fluvial geomorphologist to conduct a study of sediment sources and geomorphic processes in the Lower Novato Creek Watershed. The study was

commissioned in part to satisfy conditions specified by the RWQCB in its Section 401 Water Quality Certification for the NCFCP and other channel maintenance projects under its jurisdiction. The draft study report was published in 1998 (Collins, ibid). It documented the role of tidal siltation and watershed erosion on aggrading conditions in the lower NCFCP reach. It also identified erosion processes that are active in the mid- and upper reaches of the study area, which extended to Stafford Dam. Bank condition, channel roughness and channel habitat characteristics, including pool frequency/depth and large woody debris occurrence were described and/or quantified.

City of Novato: Stream Management Guidelines (Questa Engineering Corp., 2000) provides a comprehensive assessment of wetland and riparian habitat, water quality and flood control measures for application to the NCFCP and other streams in the City of Novato. The publication inventories habitat types, plant and animal species, and presents guidelines for channel maintenance, biotechnical bank stabilization, channel hydraulic and geomorphic design, riparian revegetation and eco-compatible landscape design. It is an example of the type of watershed management plan that can be developed to guide developers and municipalities in the direction of ecologically sensitive flood control policies and sustainable resource management, including habitat and water quality protection.

f. San Rafael Meadows

San Rafael Meadows is located immediately west of Highway 101 and the Marin County Civic Center. A small perennial creek runs through the neighborhood in a northerly direction and then crosses underneath Highway 101 where it joins the tidal slough paralleling McInnis Parkway. Currently, there is a proposal to develop the old Pacific Gas & Electric Co. (PG&E) property located in the upper watershed and to construct a pipeline which would capture upslope runoff and divert is to a downstream outlet under Merrydale Road. If implemented, this project will reduce both the frequency and severity of flooding in San Rafael Meadows.

E. MARIN COUNTYWIDE PLAN REVIEW

Countywide Plan policies and programs which directly or indirectly address flooding issues fall into two categories:

- Flood control and flood hazard protection
- Stream and Creekside Conservation Areas (SCAs)

Table 1 outlines each of the pertinent flood control and flood hazard protection policies and programs cited in the 1994 *Marin Countywide Plan* and identifies whether they are sufficient in their present form, should be eliminated due to redundancy or lack or relevance, or require some refinement. Policies and programs related to SCAs are evaluated in a similar manner in the Hydrology and Water Quality Technical Background Report. However, a general discussion of SCAs and their significance in flooding and flood control efforts is included below.

Stream Conservation Areas (SCAs) protect the following valuable hydrologic functions pertinent to flooding:

Infiltration and groundwater recharge – In many valley environs in the Countywide Plan area, the principal zone of rainfall infiltration and groundwater recharge is the alluvium (e.g. sands and gravels)

that occupy the valley floor. The restrictions on development within the SCAs, in particular the introduction of new impervious surfaces, maximize the extent of rainfall infiltration and groundwater recharge on the valley floor. This infiltrated and recharge process extends the time over which the rainfall discharges to local stream channels as seepage and groundwater discharge. The natural diversion of this water from the process of storm runoff generation reduces the peak flow rates associated with channel discharges for a given storm event. Maintenance of natural rates of runoff over portions of the watershed eases flooding pressures on hydraulic structures and natural channel reaches located further downstream.

Stream channel stability – SCAs provide protection of riparian vegetation along stream corridors. Riparian vegetation, particularly riparian trees, has a direct impact on the stability of streambanks. When riparian vegetation is removed, the shear strength provided to streambank soils by the root masses of trees and other riparian plants is lost. The streambanks then become more vulnerable to various forms of erosion and failure, e.g. slumping following high flow events, trampling by cattle access. This is not to infer that all corridors with riparian vegetation are stable. If upstream compaction of soils and gully formation occur due to livestock grazing, urbanization, or other detrimental watershed practices, the balance between stream discharge and sediment load can be lost and instabilities can ensue. However, even in such cases, the impact of bank erosion and stream instability is minimized by the aforementioned effects of riparian vegetation along the stream corridor. When streambanks become unstable, entire reaches of a stream channel, at and downstream of the initial instability, can undergo a process of progressive destabilization due to debris obstructions, heightened sediment deposition (e.g. in bar deposits and debris jams) and instream flow deflections. This can reduce the effective flood conveyance in a stream and increase local flood elevations.

F. KEY ISSUES, TRENDS AND OPPORTUNITIES

In general, the extent of the flood hazard in Marin County has been minimized to the extent possible given the political and economic realities of the County's constituent communities. In the majority of cases, recommended infrastructure improvements identified in community master drainage plans have been implemented. It is important to note that in some cases the master plan level of flood protection does not equal that of the 100-year flood. Moreover, with the exception of the community of Santa Venetia, the available options for flood control improvements are limited in their scale and potential efficacy by existing right-of-way and environmental constraints (e.g. Corte Madera Creek and Novato Creek), or by a lack of public consensus (e.g. Lucky Drive). Significant reductions in short to medium-term flood risk appear to be possible in Santa Venetia, if sufficient funding can be secured to complete the stormwater drainage improvements currently planned by MCFCWCD Zone 7. However, in Santa Venetia, levee reconstruction will eventually be required to protect the area from tidal flooding during extreme high tide events, such as occurred in January and December of 1983.

For new development and redevelopment along the urbanized eastern corridor, particularly in areas still drained by quasi-natural streams, the issue of peak flow and water quality mitigation needs to be addressed in a more comprehensive manner by the Department of Public Works, including the MCFCWCD, and the Community Development Agency. At present, the Development Standards outlined in Title 24 of the County Code are administered by the Department of Public Works. These standards consist of specific design specifications and directives that are evaluated at the Precise Plan level of a development project.

FLOODING

The Development Code (Title 22), which comprises both the County Zoning and Subdivision ordinances, guides the initial layout and design approach taken by developers at the Master Plan and Tentative Map stages of a project. The current County Development Code does not include strong enough guidance to the development community to influence a move toward integration of start-at-the-source design features. In combination with similarly strengthened specifications for new construction in the Title 24 Development Standards, the County would be able to influence development projects toward a more ecologically sensitive approach. Such changes could reduce the time and expense of environmental review, as many of the protests of the interested communities and regulatory agencies are associated with undergrounding of drainageways (i.e. replacement with storm drain systems), peak flow increases and water quality and sensitive habitat impacts – all of which could be minimized if the development community utilized more ecologically-sensitive design features at the earliest stages of the planning and environmental review process.

In August 2001, MCFCWCD staff prepared a memorandum that identified several sections of Title 22 which could be modified to conform more closely with project design guidelines outlined in *Start at the Source: Design Guidance Manual for Stormwater Quality Protection* (Bay Area Stormwater Managers Agencies Association (BASMAA) 1999) and *Start at the Source Tools Handbook* (BASMAA/EOA, Inc. 2000). Only one of the recommended sections pertained directly to flooding: Section 22.080 Parking Requirements. For this section, the recommended language comprised two bullet items:

- Reduce impervious area through shared parking
- Encourage the use of pervious surfaces (i.e. Turfblock, porous asphalt, gravel) wherever feasible, especially for overflow parking.

As discussed in the Hydrology and Water Quality Technical Background Report storm drain installations on formerly undeveloped lands outside of the established storm drains networks eliminate small surface drainageways and increase peak flow rates in more significant downstream channels due to decreases in concentration time for runoff. Researchers in urban hydrology have demonstrated that peak flow rates are directly proportional to the percentage of watershed draingeways that are sewered (e.g. Rantz 1971, Wanaanen and Crippen 1977). In particular, peak flows for the more frequent rainstorms (< 2-year event) that are associated with channel morphology increase and the runoff response for these flows becomes much flashier. The result is typically a gradual decline in channel stability, which typically becomes fully apparent when more severe floods (e.g. Jan. 1982, Feb. 1986, January 1997, and Feb. 1998) occur.

When channel instability increases, bank erosion and gully development release large quantities of sediment to the stream system. This sediment may accumulate in large sand/gravel bars, which can then alter local flow patterns and cause further channel destabilization. Then it will eventually deposit in the low gradient reaches of the streams that are confluent with the component bays of the San Francisco Bay Estuary. This downstream sedimentation both reduces the flood conveyance of flood control channels and increases the frequency of required dredging and its disruptive ecological impacts. Indirect costs to maintenance dredging include sediment disposal costs, which can increase dramatically for the more intensively developed urban areas where the sediments may be significantly contaminated with heavy metals and other pollutants. Collateral impacts can also occur in the form of silting of coarser stream gravels that anadramous fish use for spawning.

As noted above, modification of the Development Code is necessary to enact a "start at the source" approach to project design. Such measures are site-specific in the sense that not all measures fit any given site. However, on balance, these site design measures reduce the volume of runoff and peak flows, decrease the significance of the impacts on downstream hydraulic structures and flooding, increase the infiltration of rainfall and groundwater recharge, and reduce the migration of on-site contaminants into receiving waters. The County has three strong regulatory pillars to utilize in promoting modifications to the Development Code: Phase II NPDES stormwater permit requirements (2003); TMDLs for high priority contaminants, including mercury (2004), PCBs and Diazanon (due in 2006-2008); and Rule 4(d) for steelhead (2000). On-site stormwater design is a significant link in the chain of hydrologic influences on peak flow rates and flooding, water quality, and aquatic habitat.

Specifically, implementation of the following recommended actions will assist the County in minimizing the future flood hazard to lands in the Countywide Plan area:

- Explore opportunities to support the replacement of the two NPRR bridge trestles on Novato Creek – the current bridges obstruct the passage of floodwaters and trap debris during significant floods.

- Support the planning and implementation of stream restoration and watershed erosion control projects in the Novato Creek Watershed and other streams confluent with the San Francisco Bay Estuary – reductions in watershed sediment yield will reduce the frequency of channel dredging and other severe and costly forms of stream maintenance that are required to maintain the design flood capacity for flood control projects and local hydraulic structures. Such efforts will also help maintain self-scouring, stable channels. (See Hydrology and Water Quality Technical Background Report for a listing of specific restoration and management projects.)

- Continue MCFCWCD participation in the consensus-building activities that are instrumental in extending the Corte Madera Flood Control Project upstream in an ecologically responsible manner.

- Pursue federal funding for levee reconstruction in the Santa Venetia area – the MCFCWCD has made some initial inquiries with the Corps of Engineers regarding a future flood control project that would include levee reconstruction along lower Las Gallinas Creek. Such outside funding will likely be required due to lack of adequate local funding for such a major engineering project.

- Propose a revenue-sharing program or other creative financing options for the County Flood Control Zones – stress the advantages of such programs to the wealthier zones e.g. reduced County expenditures on disaster relief following levee and/or pump station failures, and less future pressure on the housing market should residents of Santa Venetia and other less well-to-do communities suffer permanent displacement.

- Continue the current, annual levee inspection program to aid in flood risk assessments and the prioritization of capital improvements to levees and stormwater pump stations.

- MCFCWCD should proceed as planned in its review of topographic mapping of channel and floodplain areas along the Novato Creek Flood Control Project. If adjustments are required, this will likely affect flood control and channel stabilization activities along the project reaches.

- Continue to promote habitat-sensitive stream management and maintenance practices; press for mandatory monitoring of bank stabilization and stream restoration projects to enable staff to evaluate the efficacy of different techniques in achieving channel stability and enhancing habitat quality.

- Modify Code Section 23.18 Urban Runoff Pollution Prevention and Title 24: Development Standards of the County Code in the following areas:

  - Strengthen code language in Section 23.18.093 items (b) and (c) regarding BMPs for new developments and redevelopments. Enforce the implementation of site design measures that minimize increases in runoff volume and peak flows. Refer project applicants to the BASMAA publications: Start at the Source: Design Guidance Manual for Stormwater Quality Protection (BASMAA 1999) and Start at the Source Tools Handbook (BASMAA/EOA, Inc. 2000); and enforce the implementation of this approach via the Community Development Agency and MCFCWCD's environmental (e.g. EIR) and precise plan review process. Prohibit the elimination of surface drainageways and their substitution by storm drain systems, wherever surface drainageways can be retained without exacerbating local flooding conditions. For headwaters swales or gullies that drain small watershed areas, minor drainageway re-alignment and/or restoration should be preferred over storm drain installations.

II. MARIN COUNTYWIDE PLAN REVIEW

Existing County policies of the 1994 *Marin Countywide Plan* related to flooding are reviewed in Table 1 and suggestions are provided for those policies that need refinement.

Table 1 – Evaluation of Existing Countywide Plan Flooding Policies and Programs

Environmental Quality Element

RESOURCE CONSERVATION AREAS **1. Flood Control Policies**	
Policy EQ-2.36 Floodplain Management Ordinance. The ordinance for floodplain management in compliance with regulations for the Federal Flood Control Insurance Program should continue to be implemented.	Still applicable. Standards for construction, utilities, and subdivisions are still consistent with existing National Flood Insurance Program (NFIP). Special provisions for coastal areas also in conformance with Local Coastal Plan requirements. One recommended change is to use the proper name of the federal program as noted above.
Policy EQ-2.38 Flood Control Measures. Flood control measures should retain natural features and conditions as much as possible. Compatible uses (agriculture, wildlife habitat, recreation, etc.) of flood ponding areas and seasonal floodways should be promoted.	Needs Refinement. Better definition is needed for "natural features and conditions". For example, natural features should include natural earthen drainageways (rather than large – scale storm drain installation). Also, where natural features are degraded due to erosion, preference should be given to restoration using integrated principles of fluvial geomorphology and hydraulic engineering, and implementation with biotechnical stabilization techniques, rather than culverting, riprapping or other forms of unvegetated structural stabilization.
Policy EQ-2.39 Flood Ponding Areas. Publicly controlled flood ponding areas should be retained. Ponding covenants or easements held by the Flood Control District on property should not be transferred to other properties to allow development within floodways.	Still Applicable. Since this policy appears to bear more directly on minimizing the flood hazard, it should be transferred to the Env. Hazards section

Policy EQ-2.40 Alteration to Floodways, Floodplains and Ponding Areas. Filling or other physical alteration in floodways, floodplains, or ponding areas should be limited to the minimum necessary as determined in development permits issued by the County.	Eliminate. This policy contradicts language in Section 23.09 Floodplain Management which states that no encroachment (including fill) is allowed in a Primary Floodway and is allowed in a Secondary Floodway only to the extent it doesn't increase the risk of local or downstream flooding or interfere with local evacuation of runoff to the stream system. A single policy discussing flooding capacity maintenance in channels and their floodplains should be written, perhaps as a revision to Policy EH-8.6 Flood Runoff. The language in the policy should better conform to the actual language in Title 23.09. Various types of instream and floodway/floodplain fills and encroachments can be discussed this single policy.

2. Bayfront Conservation Areas

Policy EQ-2.64 Land Uses in Floodplains. Areas defined as floodplain should serve the dual purpose of habitat and flood protection. Areas should be evaluated periodically to determine whether increases in the volume and rate of runoff from urbanization or natural forces warrant further flood mitigation measures.	Still Applicable. Provisions to be added to Policy EQ-2.65 should be sufficient to cover associated regulatory constraints on fills and encroachments.
Policy EQ-2.65 100-year Floodplain. The County's regulatory procedures should reflect 100-year floodplain areas as determined by the Federal Emergency Management Agency (FEMA).	Needs Refinement Add detail regarding satisfaction of Title 23.09 Floodplain Management and its restrictions on fills and encroachments of various types in Primary and Secondary Floodways.

THE BUILT ENVIRONMENT

1. General Policies

Policy EQ-3.7 Avoidance of Hazards from Earthquake, Erosion, Landslide, Floods, and Fires. Construction and operations shall be located and designed to avoid or minimize the hazards from earthquake, erosion, landslides, floods, fire, and accidents consistent with policies and programs in the Environmental Hazards Element.	Still Applicable

Land Uses

Policy EQ-3.21 Creekside Development. Along creeks, development must retain the natural vegetation, prevent water pollution, and minimize flood hazards from runoff (see Figure EQ-13).	Needs Refinement. Policy should refer to specific SCA policies in Env. Quality Element as well as Title 23.09 Floodplain Management. In particular, note that SCAs prohibit removal of riparian vegetation and a buffer of 50 ft. outside of the landward edge of the corridor, or 100 ft. from the top of the nearest bank, whichever is greater.

Environmental Hazards Element

Policy EH-3.1 Location of Future Development. New development shall be sited in a manner which avoids or minimizes the potential of hazards from earthquake, erosion, landslide, floods and fire. Development should not be endangered by nor contribute to hazardous conditions on the site or on adjoining properties.	Still Applicable
Program EH-3.1a Protect Review. The Community Development Agency shall continue to review the impact of a project on the site and surrounding properties potentially affected by the development.	Needs Refinement. Add language that discusses the monitoring periods affecting general engineering improvements, which are overseen by County DPW, and monitoring of stormwater quality and the mitigation or restoration components of a project. The water quality and mitigation monitoring will likely also be under the supervision of DPW/MCFCWCD.
Policy EH-8.2 Construction. Improvements should be designed to withstand impact from a tsunami and the debris it will carry. Structural features which could become dislodged or detached (docks, decking, floats, vessels) should be situated where they do not have the potential of becoming potential implements of destruction.	Still Applicable
Program EH-8.2a Implementing Regulations. The County shall continue to implement the regulations of Marin County Code Title 23.09 (Floodplain Management), which establishes Coastal High Hazard Zones with special locational and construction standards for all land uses subject to inundation by a tsunami.	Still Applicable

Policy EH-8.3 Multiple Use. The County should continue to promote the multiple use of areas set aside for flood retention ponding purposes (i.e. agriculture, open space, education, ecology), provided these uses can tolerate occasional flooding.	Still Applicable
Program EH-8.3a Application Review. The County should encourage the multiple use of ponding and encroachment areas designated under Title 23 (Floodplain Management). Through the application review process, the County should also encourage the use of lands reserved for floodplains under the Floodway Zoning provisions of Title 22 (Zoning) .	Still Applicable
Policy EH-8.4 Regulatory Methods of Flood Control. The County should encourage regulatory methods of flood control, rather than construction-related methods of flood control. Regulatory methods reduce the need for flood control projects, minimize losses in areas where flooding is inevitable, and ensure that those who occupy flood hazard areas are aware of the risks and assume responsibility for their actions.	Still Applicable
Program EH-8.4a Flood Hazard Zone Polices and County Code Provisions. The County shall continue to support and enforce policies in the Marin County Code pertaining to special flood hazard zones, including the Coastal High Hazard Zone (Title 23, Floodplain Management), the Bayfront, Floodplain, Tidelands, and Coastal Zones, Title 11 (Watercourse Obstruction), Title 22 (Floodplain Districts), and the provisions of Title 20 (Subdivisions).	Still Applicable

Program EH-8.4b Clarify Zoning Ordinance. The County Community Development Agency should strengthen and clarify references to flood hazard areas occurring along the San Francisco Bay, Tomales Bay, and the Pacific Ocean in the zoning ordinance sections pertaining to the Bayfront Conservation Zone, the Coastal Zone, the Planned District Zones, and the Tidelands Zone.	??
Program EH-8.4c Refer Applications. The County Community Development Agency shall continue to refer all permit applications for proposed construction, substantial improvements and other development to the Department of Public Works to determine whether development is proposed within flood prone areas and therefore subject to the provisions of Title 23.09 (Floodplain Management).	Still Applicable
Program EH-8.4d Restrict Dangerous Uses. The County shall enforce the special location, storage, water supply, sewer, subdivision, and mobile home standards for flood hazard areas identified in Title 23 (Floodplain Management). Title 23 restricts uses that are dangerous to health, safety, and property due to erosion hazards, increases in flood heights or velocities.	Still Applicable
Program EH-8.4e Apply Construction Standards. The County Community Development Agency shall require that uses vulnerable to floods, including facilities that serve these uses, are protected against flood damage at the time of construction. The construction standards of the Marin County Code, including Title 23 (Floodplain Management) shall be applied to protect these uses from flood damage.	Still Applicable

Program EH-8.4f Restrictions in Floodways. The County should support special restrictions in floodways and watercourses. Developments in floodways risk damage from erosion, high velocity flood waters, and potential projectiles from debris carried in the flood waters. Restrictions should prohibit encroachments in watercourses, prohibiting structures within a primary floodway, and restricting development in a secondary floodway or flood fringe that would increase risks to public health and safety in the event of a flood.	Still Applicable
Policy EH-8.5 Zoning Overlays. To minimize flooding hazards, the County should expand the use of floodplain zoning overlays in flood areas.	??
Policy EH-8.6 Flood Runoff. The County should ensure that capacity is maintained in stream channels. The preferred measures for maintaining capacity are: regulating development; and whenever feasible, storing, ponding, or maintenance dredging. The County should control filling, grading, dredging, and other development that may increase flood damage by increasing sedimentation in streams and watercourses and increasing the amount of impervious surface in an area.	Needs Refinement
Program EH-8.6a Enforcing County Codes. The County shall continue to enforce the provisions of Titles 11, 19, 20, 22 and 23, regarding grading, excavation, filling, and dredging.	Still Applicable
Program EH-8.6b Hydrologic and Geologic Studies. The County should require detailed hydrologic and geologic studies in development projects which have the potential for increasing sedimentation of watercourses, increasing impervious surface, or altering natural drainage patterns in order to insure adequate capacity for the safe handling of flood runoff.	Needs Refinement. Add to end: "...for the safe handling of runoff and the hydraulic and geomorphic integrity of the stream system and its aquatic habitat."

Program EH-8.6c Reevaluate Flood Prone Areas. The County should reevaluate flood prone areas, periodically regarding changes to elevations as a result of off-site development or natural forces.	Needs Refinement. Counties and municipalities rarely undertake such re-evaluations due to excessive cost. However, the language of this policy could be altered to support County review of CLOMRs and LOMRs (Letters of Map Revision) that are prepared by property owners in accordance with FEMA guidelines.
Policy EH-8.7 Flood Barriers. The County should prevent the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards in other areas.	Still Applicable
Policy EH-9.2 Notify property Owners. Property owners who are located in areas of possible inundation from failure at one of eight major dams should be notified regarding susceptibility to flood hazard.	Still Applicable. However, if a detailed dambreak and downstream inundation analysis is eventually performed for the Big Rock Dam, the number of dams identified in the policy would be increased to nine.
Program EH-9.2a Public Information Regarding Dam Inundation Areas. Information on the location of dam inundation areas, for the eight major dams, should be made publicly available in the County Community Development Agency.	Still Applicable
Policy EH-I0.1 Rise in Ocean Level. The County will consider the potential for a sea level rise when processing development applications that might be affected by such a rise.	Needs Refinement. Since current rate of sea level rise does not significantly increase flood elevations, add some mention of the periodic County review of the rate of sea level rise in Program EH-10.1a (below).
Program EH-10.1a Modify Construction Standards. The County Community Development Agency should work with the County Flood Control and Water Conservation District and Department of Public Works to prepare a plan for responding to a potential rise in the sea level. The County should consider developing flood control projects and modifying the Marin County Code Chapters 11, 22, and 23 to include construction standards for areas subject to increased flooding from a rise in the sea level.	Needs Refinement. Some form of periodic evaluation of the current status of sea level rise should be conducted by MCFCWCD/DPW/CDA (e.g. every 5 years) in order to determine whether a full scale re-evaluation of County Code and Development Standards is required to accommodate an acceleration in the rate of sea level rise.

Program EH-10.1b Monitoring Stations. The County should cooperate with the United States Geological Survey, the San Francisco Bay Conservation and Development Commission, and other agencies that establish monitoring stations to track the rise in Bay and ocean water levels .	Still Applicable