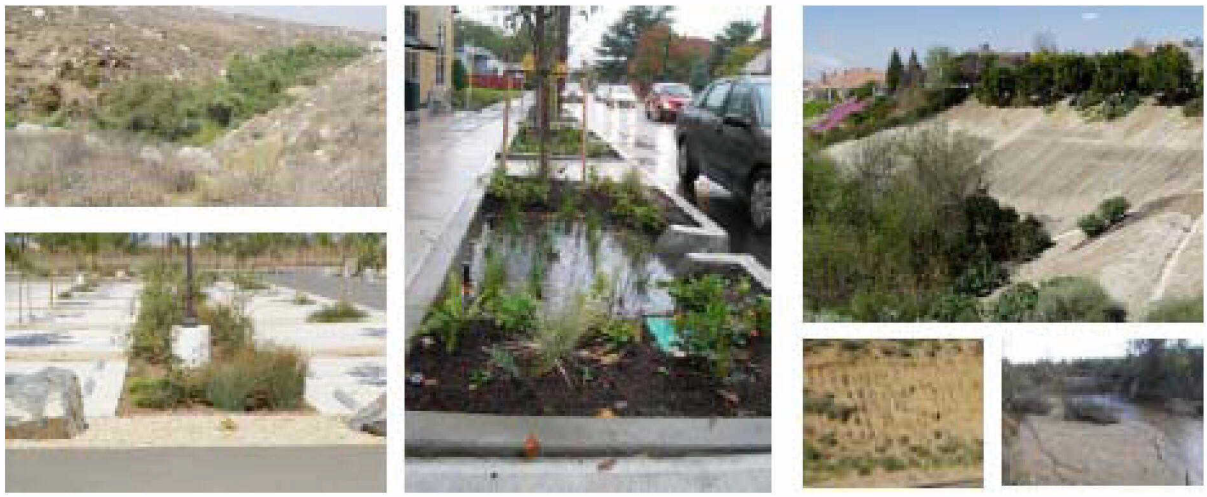
RIVERSIDE ARROYO WATERSHED POLICY STUDY

RECOMMENDATIONS



Submitted to:

County of Riverside Board of Supervisors &
Riverside City Council

Prepared By:

County/City Arroyo-Watershed Committee (CCAC)

November 15, 2006

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ACKNOWLEDGEMENTS

The CCAC was established through the action and support of Supervisor Bob Buster following a request by the Riverside Land Conservancy and citizens concerned about watershed issues, in particular the protection of arroyos and other watercourses.

This report benefited from the support and information provided by staff from the County of Riverside and Riverside City Planning Departments and from the technology teams in the County and City GIS Departments. Staff from several outside agencies were particularly helpful, including the Santa Ana Regional Water Quality Control Board, the California Department of Fish and Game, the Riverside-Corona Resource Conservation District, and the Riverside County Flood Control District. The Santa Ana Watershed Association provided data on observations of least Bell's Vireo and the Riverside Land Conservancy provided staff time for assisting with secretarial duties. The University of California Riverside provided logistical assistance in research for the project, and Mt. San Jacinto College and students assisted with the GIS portion of the project.

Special thanks to Robert Caliva, Legislative aid to Supervisor Bob Buster who has helped the CCAC since its inception, and to Jerry Jolliffe, Riverside County Deputy Planning Director, for helping the CCAC work through some complex planning issues.

The CCAC thanks Frank Heyming for the generous gift of a notebook computer to facilitate the CCAC GIS mapping project.

Finally, the CCAC thanks the following team of CCAC representatives for compiling three years of research into this report: Arlee M. Montalvo, Restoration Ecologist and Plant Population Biologist, PhD Biology, MA Biology/Botany; Cindy Nance, Associate Professor of Geography and GIS, PhD Geography; and Rick Thomas, Watershed Planner, Master of Landscape Architecture and Regional Planning.

Please see Table 2.2, 2.3, and 2.4 for a listing of project participants.

1.0 EXECUTIVE SUMMARY: ARROYO AND WATERSHED POLICY RECOMMENDATIONS

1.1 INTRODUCTION

The County/City Arroyo-Watershed Committee (CCAC) has created a Geographic Information System (GIS) mapping project of arroyos and watercourses in the project area as a GIS Watercourse Layer Map. The digital Watercourse Layer is accompanied by recommendations for proactive and sensitive development that occurs near watercourses and arroyos.

1.2 PURPOSE AND BENEFIT TO THE CITY AND COUNTY OF RIVERSIDE

Recommended policies and practices are intended to assist the Planning Departments of the City and County of Riverside in making land use decisions with watershed implications across adjoining boundaries. They will also assist staff in forming planning liaisons that preserve and protect watersheds, arroyos, and watercourses throughout the project area. Where appropriate, policy recommendations are accompanied by suggested design guidelines. There are numerous benefits to City and County agencies, developers and land owners, and community stakeholders in adopting this approach to managing arroyos and watersheds in the CCAC study area. These include:

1. ***Create dynamic scenarios*** for protecting watercourses and other watershed values described in General Plan vision statements by applying policy recommendations in combination with the new GIS Watercourse Protection Map.
2. ***Reduce the occurrence of code violations*** due to consistent and clear rules across boundaries for developers, land owners, staff, and land use decision-makers.
3. ***Lessen potential for citizen complaints, litigation, and development delays*** over code violations due to consistent and clear rules across boundaries and an approach that is integrative in nature.
4. ***Enhance public safety*** through incorporation of best management practices (BMPs) that reduce downstream flooding, landslides and erosion, and water quality impacts from new and existing development.
5. ***Lower flood management and water quality management costs*** through controlling runoff and water quality at the source while providing multiple benefits that include habitat protection, recreation enhancement, aesthetic improvements, and high quality development.
6. ***Improve neighborhood and community quality of life*** through increased opportunities for recreation, significant protection and enhancement of the aesthetic quality of Riverside, and high quality development.
7. ***Enhance funding opportunities*** for acquiring State and federal funds, including the recently passed Proposition 84 water bond funds, to make flood management and water quality protection improvements that are consistent with the CCAC policy recommendations and design guidelines.

1.3 ARROYO-WATERSHED POLICY AND PLANNING RECOMMENDATIONS

A watershed is a region or area bounded peripherally by a divide and draining ultimately to a particular watercourse or water body, in this case, the Santa Ana River. Watersheds are important sociological and ecological linkages between all living things and the watercourse and landscape in which they are associated. In order to protect watercourses in their natural and semi-natural state, protect water quality and wildlife, restore important overall watershed function in urbanizing areas, and to avoid the need to channelize watercourses, the CCAC makes the following recommendations.

Among the most important are the need for bridging systems and protective setbacks. Setbacks to watercourses and steep arroyos are ungraded and undeveloped buffers between development and watercourses that serve to protect watercourses, riparian areas, and adjacent slopes from a variety of negative impacts. When planning subdivisions, incorporating setbacks and bridging systems rather than culvert pipe and fill crossings over U.S. Army Corps of Engineers-delineated Waters of the U.S. and California Department of Fish and Game (CDFG)-delineated Waters of the State can avoid the need for time consuming permitting processes, and thus provide savings on construction costs.

Recommendation 1: Consistent Illegal Grading Policy

The CCAC recommends that the City and County adopt a consistent policy with respect to illegal grading. The City may wish to consider the addition of higher effective penalties, such as the land use restrictions imposed by the County, to achieve compliance with abatement requests following illegal grading of watercourses, banks, and protective vegetation. In addition, it is important to require property owners to mitigate any damage to a watercourse or its buffering riparian and upland vegetation to encourage compliance. Similarly, the County may wish to consider the addition of effective penalties for any grading begun without a permit. Penalties with a substantial deterrent effect should facilitate the job of code compliance officers in encouraging landowners to comply with existing regulations.

Recommendation 2: Watercourse Layer Preservation Tool

The CCAC is providing the City of Riverside and County of Riverside the GIS Watercourse Layer and Riparian Layer to be combined into a Watercourse Protection Map with the recommendation that this spatial information will be considered and used to "flag" projects prior to issuance of permits on parcels traversed by watercourses.

Recommendation 3: Cooperative Arroyo Planning Areas and Conservation Zoning

A Watercourse Layer that is enforced through a zoning ordinance will protect stream function and riparian habitat from new land use modifications, while providing for additional flood flow capacity unimpeded by manmade constructs. The Watercourse Layer Map can also provide a foundation for establishing County-City Cooperative Arroyo Planning Areas as well as strengthened conservation zoning in both City and County jurisdictions.

Recommendation 4: Model Setback Policy

The CCAC recommends that a flexible model for setback policy be included in the ordinance. The setback model needs to take into account variable topography, slope, the permeability of substrates, flow velocity, and the dynamic nature of stream meandering. The steeper the land, the higher the velocity of runoff, and the lower the filtering of chemical pollutants and sediments carried in runoff. Wildlife habitat, corridor value, and recreational uses also need to be considered. Land uses, slope, substrate type and erosion sensitivity are all important in determining appropriate setbacks.

Recommendation 5: Setbacks to Golf Courses

Adequate setbacks to arroyos and watercourses of at least 50 feet from new golf courses or modifications of existing golf courses should be required because of the copious water, fertilizer, and pesticides used to maintain greens and fairways. Too much direct runoff can also cause failure of banks. Water should not be allowed to drain directly into streams without first being cleansed and allowed to infiltrate through a bioswale or other water quality/water infiltration feature. In addition, turf grasses, including hybrid Bermuda, invade riparian banks and channels and should be setback sufficiently to deter invasion. Furthermore, golf play into riparian habitat is detrimental to sensitive wildlife.

Recommendation 6: Associating Slope, Lot Size, and Setback Distance

CCAC recommends the City and County consider zoning land along all watercourses in a way that provides a minimum lot size and a minimum setback width suitable for extended protection of watercourses. Land divisions should not be approved unless each lot has a suitable building site outside of the required setback to a watercourse and 100 year flood plain.

CCAC suggests modifying the County Land Use Ordinance using a model similar to the City of Riverside's *Title 17 Grading*. In Title 17, a minimum 50-foot protective setback to an arroyo begins at the point where the slope flattens out to less than 30% slope as determined by a **Sectional Slope Analysis** (rather than Average Natural Slope, see glossary). This could be modified so that all structures would be setback far enough so that fuel modification does not have to occur on steep slopes of arroyos or in the protective setbacks.

The CCAC recommends setback width take into consideration the overall topography and geology of arroyos and watercourses. Suggested setback and lot sizes should be determined using the **Sectional Slope Analysis (SSA)** of the parcel, as determined by a qualified engineer. CCAC recommends development of a model that varies setbacks and parcel sizes according to steepness of slope, type of watercourse, underlying substrate, and wildlife value of a watercourse and its corridor such as that presented in Table 1-1.

Table 1-1. Recommended Lot Size and Setback Schedule

Sectional Slope Analysis (% Slope)	Minimum Lot Size (acres)	Minimum Setback from 100-Year Floodplain to Graded Pads (feet)	Minimum Setback from top edge of slope to graded pad when slope > 30% (feet)	Setback w/ Unstable Substrate, Impervious Soil, or Bedrock (feet)	Setback w/ Wildlife Corridor for Terrestrial Species* (feet)	Setback w/ Fuel Modification Zone ** (feet)	Setback w/ Trail (feet)
0 to 15%	1	50	n/a	75 to 100 ft	Add 250 ft	Add 100 ft	Add 25 ft
>15 to 20%	2	50	n/a	75 to 100 ft	Add 250 ft	Add 100 ft	Add 25 ft
>20 to 25%	5	75	n/a	115 to 150 ft	Add 225 ft	Add 100 ft	Add 25 ft
>25 to 30%	10	100	n/a	150 to 200 ft	Add 200 ft	Add 100 ft	Add 25 ft
>30 to 40%	20	150	50	225 to 300 ft	Add 150 ft	Add 100 ft	Add 25 ft
>40%	No Building Allowed						

*Increase from outer edge of minimum setback. If watercourse is deeply incised with steep slopes, add enough distance for wildlife to escape high storm flows even if watercourse is not targeted as major wildlife corridor.

**Increase so that any structure is 100 ft from outer edge of vegetated setback (already adjusted for unstable or impervious substrate) to structures

Recommendation 7: Design Guidelines for Bridging Systems

Bridging systems should provide crossings over rather than within watercourses and should avoid impacts to channels and riparian resources. CCAC recommends that design guidelines for economical and ecological "bridging" systems be studied, prioritized, and incorporated by both the City and County. Crossings should be aesthetically pleasing and open to allow the free movement of water, wildlife, and watercourse maintenance teams.

Recommendation 8: Conservation Easements and Conservation Lots

Conservation lands can be easements or lots in fee title that are dedicated as open space for conservation of native plants, animals, and natural resources. Easement boundaries should conform to setback conditions to preserve the natural boundary of a watercourse and take into consideration the dynamic nature of the watercourse. Only "see through" fencing should be permitted and limited to the outside of setbacks. Fuel modification should occur only in non-sloped portions of easement outside of setback with no planting of invasive species or removal of native species. No lighting of OHV use shall occur within the watercourse area. Homeowner's Associations should employ an experienced non-profit conservation group to manage /maintain the conservation easement. Alternatively, developers can provide for a conservation lot in fee title to a conservation organization with an endowment to finance management of the conservation lot. All new developments must provide for a 100 ft fuel modification zone within the footprint of the developed portions of parcels, and shall not depend on fuel modification within conservation easement and conservation lots.

Recommendation 9: Water Quality Protection

Stormwater detention basins, recharge basins, water quality basins, or similar larger scale water capture devices should be incorporated into projects according to the conditions of the site and project scope. In the event such facilities are used, sensitive design and placement for ecological and aesthetic conditions should be required. If at all possible, such facilities should be designed for multiple purposes such as parks, playgrounds, street medians, or habitat, and so on. Facilities should treat water before entering a watercourse. They should not be in a watercourse. Biofiltration measures should also be incorporated into the site plan and site design, such as the use of engineered bio-swales that incorporate plants that slow and filter urban water runoff before entering an arroyo or watercourse.

Recommendation 10: Arroyos/Watercourses as Neighborhood Amenities

Rather than situating houses with backyards protruding into arroyos or watercourses, and allowing fire clearance on steep slopes, houses should face arroyos or watercourses with the street and trail between homes and top border of arroyo or watercourse. This scenario provides a scenic area to the public and a firebreak between homes and native vegetation while providing protection to arroyo and watercourse resources.

Recommendation 11: Stormwater Management and Runoff Reduction as a Design Element

All new and redeveloping projects in the arroyo planning areas as well as throughout the City and adjacent County areas should incorporate site specific and regional measures to improve stormwater management, increase groundwater recharge, and reduce urban runoff towards a post-development goal of "no net gain in runoff." Some measures include:

- Use of permeable paving materials for many surfaces that require hard materials rather than traditional impervious materials.
- Relocate sidewalks away from roadways or direct their runoff into an open drainage system (vegetated swale) that leads to an infiltration area.
- Build narrower residential streets or restrict parking and sidewalk areas to one side of the road to create open pervious spaces for stormwater infiltration.
- Incorporate low, pervious areas into landscaped parking lot islands and landscaped strips to reduce runoff volume and filter pollutants.
- Use multi-functional open drainage systems in lieu of more conventional curb-and-gutter systems such as a curb and swale system, concave street medians that capture water, and cul-de-sac circles that provide a concave, landscaped circle to capture water.
- Home and public area landscape design that incorporates water capture, permeable areas with vegetation to filter water and recharge groundwater, and other measures including the use of native plant species and/or noninvasive California friendly plant species.
- Controlled irrigation systems that provide only the amount of water required and result in no overspray or runoff.
- Creative capture of rooftop runoff for irrigation and use of green roof designs.

Recommendation 12: Restrict Use of Septic Systems on the Slopes of Arroyos and Watercourses Outside of Graded Pads

CCAC recommends that the City and County require septic systems and leach fields to be located away from sensitive steep slopes of arroyos and watercourses and require generous setbacks (at least 100 feet from leach fields to edge of a watercourse) to prevent groundwater or surface water pollution. In addition, CCAC recommends the requirement of minimum lot sizes of at least two (2) acres along arroyos and other major watercourses in hilly areas and one (1) acre in areas with < 18% slope along watercourses to ensure adequate space for setbacks.

Recommendation 13: Restrict New Sewage Pump Stations Adjacent to Watercourses

To eliminate problematic overflow of sewage from malfunctioning pumping stations, CCAC recommends that all new sewage pumping stations be located away from watercourses. In the event that locations are limited to an area adjacent to a watercourse, provide appropriate Best Management Practices (BMPs) that result in strong protection for watercourses in the event of an accidental sewage overflow.

Recommendation 14: Restrict Fencing in Arroyos and Watercourse Channels

No arroyo, watercourse channel or bank should be fenced or otherwise obstructed. Free flow of water and debris is necessary. Fencing causes debris dams that can dam or divert streams. Watercourses are also important habitat and movement corridors for wildlife. Fencing obstructs free travel of many native animals. The perimeter of arroyos and watercourses should not use fencing that interferes with the free travel of most animals among the segments of networks of open spaces. To eliminate impacts from fencing in sensitive arroyo and watercourse areas, it is important to prohibit fencing across arroyos, require any residential fencing to be placed on graded pads only, and require that any security fencing for public facilities be placed immediately around the facility only considering water flow and wildlife movement needs.

Recommendation 15: Restrict New Golf Course Development within the Boundaries of Arroyos, Watercourses, and Wetlands

New golf courses need to protect wetlands and watercourses. Developers should plan projects such that housing, structures, and greens are outside of the boundaries of arroyos, watercourses and wetlands. Golf courses can have value as firebreaks between homes and native vegetation, but they are problematic to water quality and other beneficial uses. To eliminate impacts to watercourses from golf courses, the CCAC recommends the following:

- Require a minimum 50- to 100-foot setback to watercourses with riparian vegetation for all golf course activities.
- Orient fairways parallel to or away from watercourses to avoid hitting balls into riparian areas.
- Use Best Management Practices (BMPs) and water filtration and infiltration areas to capture, treat, and/or slow runoff before it enters watercourses.
- Utilize Integrated Pest Management measures that reduce the use of chemicals that impact water and habitat quality in watercourses through runoff.

- Use high-efficiency irrigation systems, regionally-appropriate non-invasive landscape species, minimal turf, and other water use efficiency BMPs to reduce on-site water usage and dry weather runoff.
- Encourage and assist existing golf courses to install water quality, stormwater, and water use efficiency Best Management Practices (BMPs) that protect riparian corridors, reduce irrigation and stormwater runoff, and treat runoff water before it enters watercourses.

Recommendation 16: Restrict Domestic Animal and Farm Livestock Keeping in Arroyos and Watercourses

Keeping domesticated animals and livestock in arroyos and watercourses results in significant loss of native vegetation, denuded landscapes that are prone to erosion, and water quality impacts due to concentrated animal wastes. The CCAC recommends that the City and County require review and permits for animal keeping near arroyos and watercourses so that the uses can be analyzed and approved according to site-specific circumstances and probable impacts.

Recommendation 17: Restrict Animal Grazing Farm Stock

Under limited conditions, the grazing of farm stock such as horses, cattle, sheep, and goats or other farm stock (not including hogs) can be acceptable but would require large parcels of land (open range areas, hundreds of acres). Grazing animals compact soils and reduce vegetative cover on slopes of watercourses leading to a decrease in infiltration and increase erosion potential. The CCAC recommends that the City and County require review and permits for animal grazing near arroyos and watercourses so that the uses can be analyzed and approved according to site-specific circumstances and probable impacts.

Recommendation 18: Restrict Nurseries and Agriculture from Placement in Arroyos and Watercourses

Agricultural uses including nurseries, orchards, and other crops often result in significant impacts such as cleared lands, erosion, introduction of non-native invasive species, and runoff water containing pesticides and fertilizers. Placement of these uses should not jeopardize watercourses. Agricultural uses should be avoided or should be very limited in and next to arroyos and watercourses to limit runoff of pesticides and require review and permits for new agricultural land adjacent to arroyos and watercourses so that the uses can be analyzed and approved according to site-specific circumstances and probable impacts. The CCAC also recommends that the City and County encourage existing agricultural uses to install agricultural Best Management Practices (BMPs) that protect riparian corridors, reduce agricultural runoff, and treat runoff water before it enters watercourses.

Recommendation 19: Restrict Telecommunications Towers and Utility Infrastructure within Arroyos and Watercourses

Watercourses are often used inappropriately as conduits for telecommunication and utility infrastructure. Such uses result in increased, inappropriate access to watercourses, habitat damage, and facilities in floodplains that require special flood protection measures. The CCAC recommends that the City and County prohibit telecommunications and utility agency equipment and facilities from being placed in or along arroyos and watercourses and prohibit any new

access to existing or future telecommunication or utility facility or corridor from being placed through or in an arroyo or watercourse. Fuel modification areas should be placed away from watercourses and adjacent slopes and locations of occupied structures should be restricted in accordance with fuel modification requirement of State and Local Governments.

1.4 ARROYO, WATERCOURSE, AND WATERSHED MANAGEMENT NEEDS

- **Development a comprehensive Riverside Arroyo Watershed Management Plan (Plan).** The plan should address the connection between land use decisions and habitat, water quality, stormwater management, and overall watershed function. The necessary challenge will be to incorporate these approaches into the long-term general plan and zoning process within the City and County of Riverside. This should be a multi-objective, stakeholder-based Plan to identify short-term actions and long-term strategies for effective and responsible watershed management.
- **Conduct an "at-risk assessment" regarding planned and potential land use conversions from open space to a developed purpose.** The assessment should take into account potential impacts of such conversions to existing conditions regarding stormwater runoff, water quality, habitat and open space, and recreation needs of the City of Riverside and adjacent County unincorporated areas.
- **Establish various levels of governance and coordination on a watershed basis.** This could include the creation of a decision tree, a multi-agency involvement task force, and the establishment of a stakeholder watershed council
- **Conduct an objective evaluation of the effectiveness of existing protection measures and their implementation.** Assess the City of Riverside's existing grading ordinance, Proposition R, and Measure C, and the County of Riverside's protection measures in protecting arroyo, hillside, and watershed resources in the project area

1.5 NEXT STEPS FOR CCAC

According to the goals in establishing the CCAC, next steps and immediate future roles include:

- Work with City and County staff to refine policy recommendations that further the goal of establishing consistent policies for land use and watershed management in areas that affect both jurisdictions.
- Refine GIS program and documentation and provide to City and County.
- Implementation of Riparian Vegetation Layer within GIS Mapping Project.
- Develop GIS models for delineating watercourse setbacks and riparian buffers.
- Promote programs and educational materials to enhance community awareness about the importance watercourse preservation and methods to achieve a healthy watershed.

2.0 INTRODUCTION

2.1 PROJECT AREA AND BACKGROUND

The project area is within the lower half of the Middle Santa Ana River Watershed Management Area (WMA), and include two subwatersheds and ten tributary watersheds of the Santa Ana River Watershed. The project area specifically includes watercourse networks within the City of Riverside and those that cross County/City boundaries. The area contains a combination of hills, valleys, and old alluvial plains intersected by watercourses that supply water to the Santa Ana River. "Watercourse" is a general term for any channel through which water flows or has flowed (Macdonald 1972) and includes rivers, streams, brooks, and ephemeral drainages (see Figure 2-1). In the project area, a number of watercourses that cross County/City boundaries represent significant tributary-watersheds of a channel network that drains into the Santa Ana River. Although the study area extends north to the Spring Brook Wash and its main tributaries, most of the CCAC's research and mapping efforts focused on the extensive network of watercourses that cross the eastern and southern boundaries of the City of Riverside. Some of the networks extend south as far as Cajalco Road and Lake Mathews, and others extend east to the east-facing slopes of the Box Springs Mountains and the western boundary of the City of Moreno Valley. The major watercourses defined in this study include those listed in Table 2-1 and Figures 2-2, 2-3, 2-4, and 2-5.

Table 2-1. Study Area Watercourses and Associated Tributary-Watersheds, North to South

Watercourse	Tributary-Watershed	Master Drainage Plan*
Spring Brook Wash	Spring Brook Wash	NA (north of University)
Tequesquite Arroyo	Tequesquite Arroyo	Box Springs
Big Springs Arroyo	Tequesquite Arroyo	University Area Above, Box Springs Below
Box Springs Arroyo	Tequesquite Arroyo	Box Springs Below Dam
Sycamore Canyon Creek	Tequesquite Arroyo	Box Springs Below Dam
Castle View Creek/Benedict Castle	Tequesquite Arroyo	Box Springs
Alessandro Arroyo	Alessandro Arroyo	Central Area Below Dam
Prenda Arroyo	Prenda Arroyo	Monroe Below Dam, NA Above Dam
Woodcrest Arroyo	Woodcrest Arroyo	Monroe Below Dam, NA Above Dam
Mockingbird Canyon	Mockingbird Canyon	Southwest Riverside Below Dam, Monroe Above
Harrison Arroyo	Harrison Arroyo	Southwest Riverside Below Dam

Watercourse	Tributary-Watershed	Master Drainage Plan*
McAllister Arroyo	McAllister Arroyo	Southwest Riverside
Praed Arroyo	Praed Arroyo	Southwest Riverside
La Sierra Arroyo	La Sierra Arroyo	Southwest Riverside Above, La Sierra Below
Cajalco Creek	Cajalco Creek	Lake Mathews
Orangecrest East	San Jacinto River	NA
Canyon Springs	San Jacinto River	NA
*NA = plan not available		

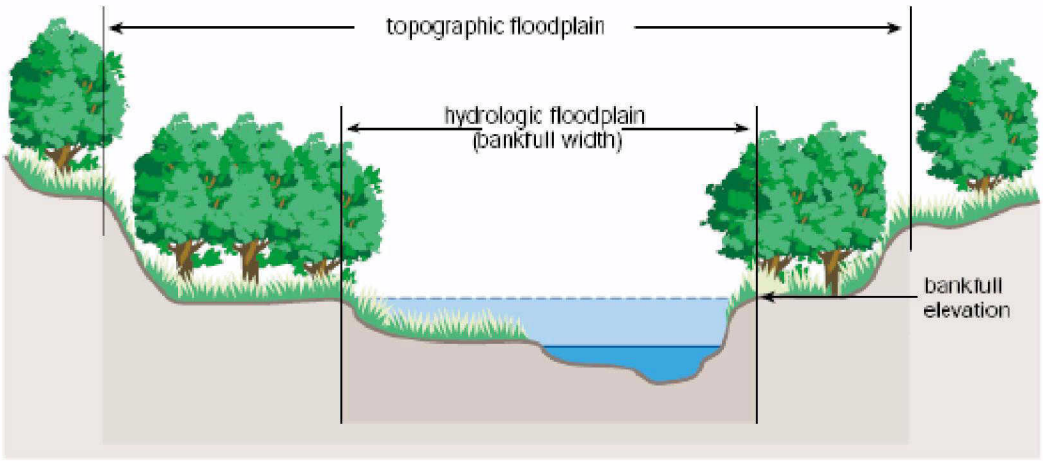


Figure 1.20: Hydrologic and topographic floodplains. The hydrologic floodplain is defined by bankfull elevation. The topographic floodplain includes the hydrologic floodplain and other lands up to a defined elevation.

Figure 2-1. Characteristics of a basic watercourse in cross section. (From NRCS Publication)

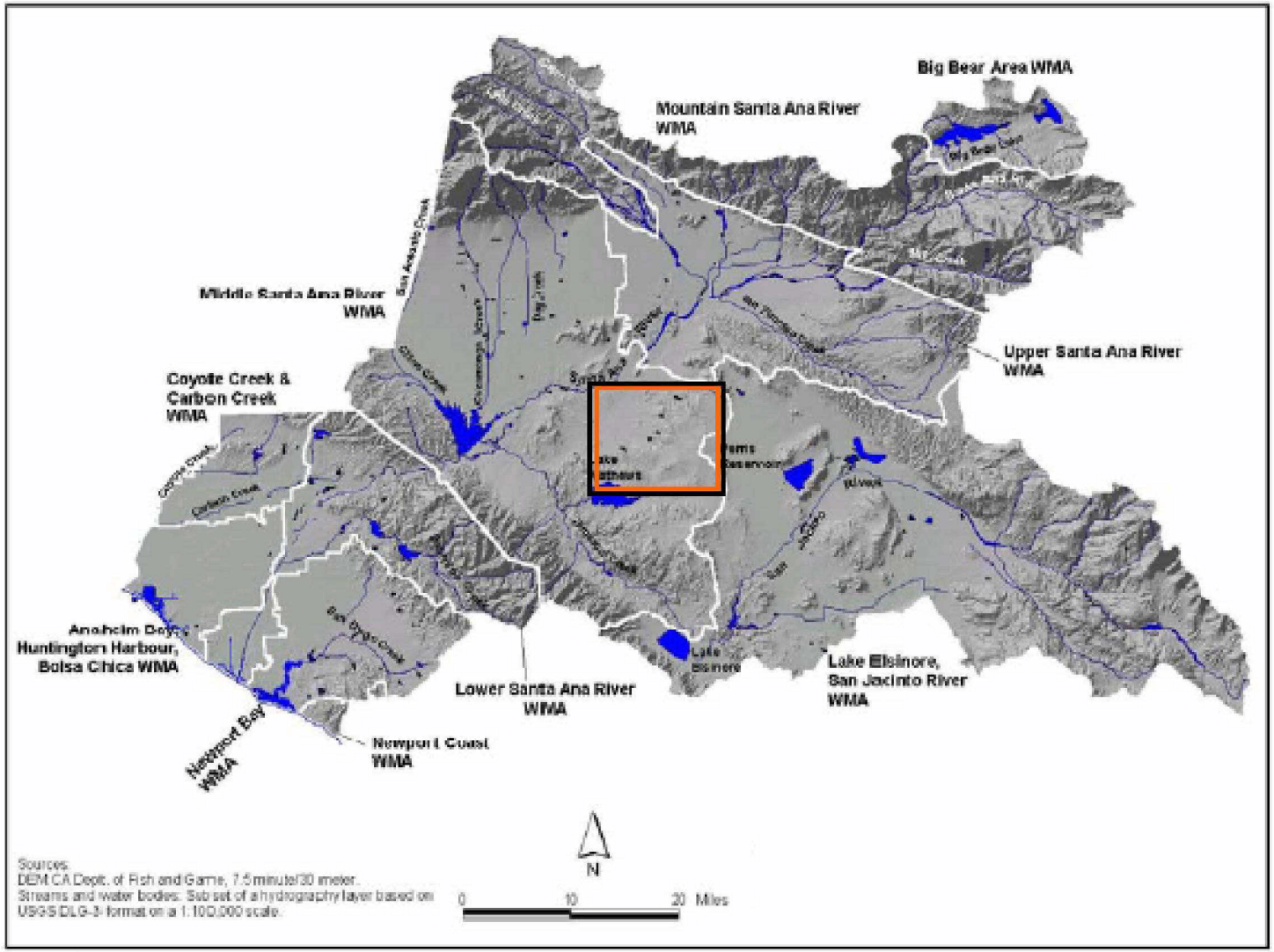


Figure 2-2. Santa Ana Region Watershed Management Areas (WMA) and Project Area. The WMA's represent subwatersheds of the Santa Ana River Watershed. (Region 8 Basin Plan). The project area is in the Middle Santa Ana River WMA, south of the Santa Ana River.

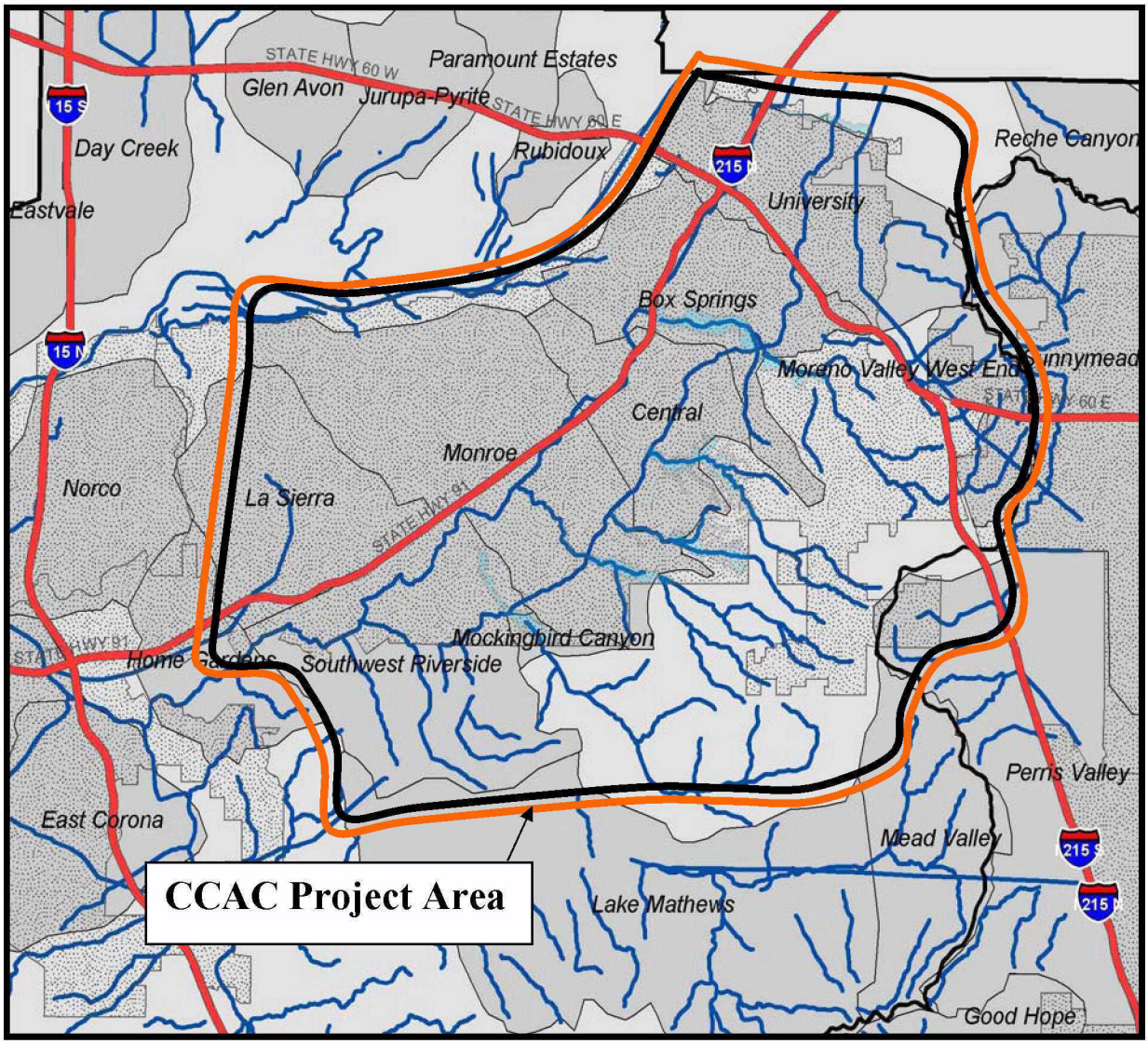


Figure 2-3. Approximate Boundary of Project Area. The project area includes all watercourses and tributary-watersheds that cross the County of Riverside and City of Riverside boundary. The City of Riverside is represented by the stippled area inside the project area. Two Watershed Management Areas (Figure 2-1) and multiple Master Drainage Plan areas (MDP) occur in the project area (Figure 2-4). See Figure 2-4 for clear view of MDP boundaries. USGS blue-line streams are indicated in dark blue. The six delineated arroyos of the City of Riverside are indicated in light blue. See Figure 2-3 for detailed map of the six arroyos. (Map built from CCAC GIS project).

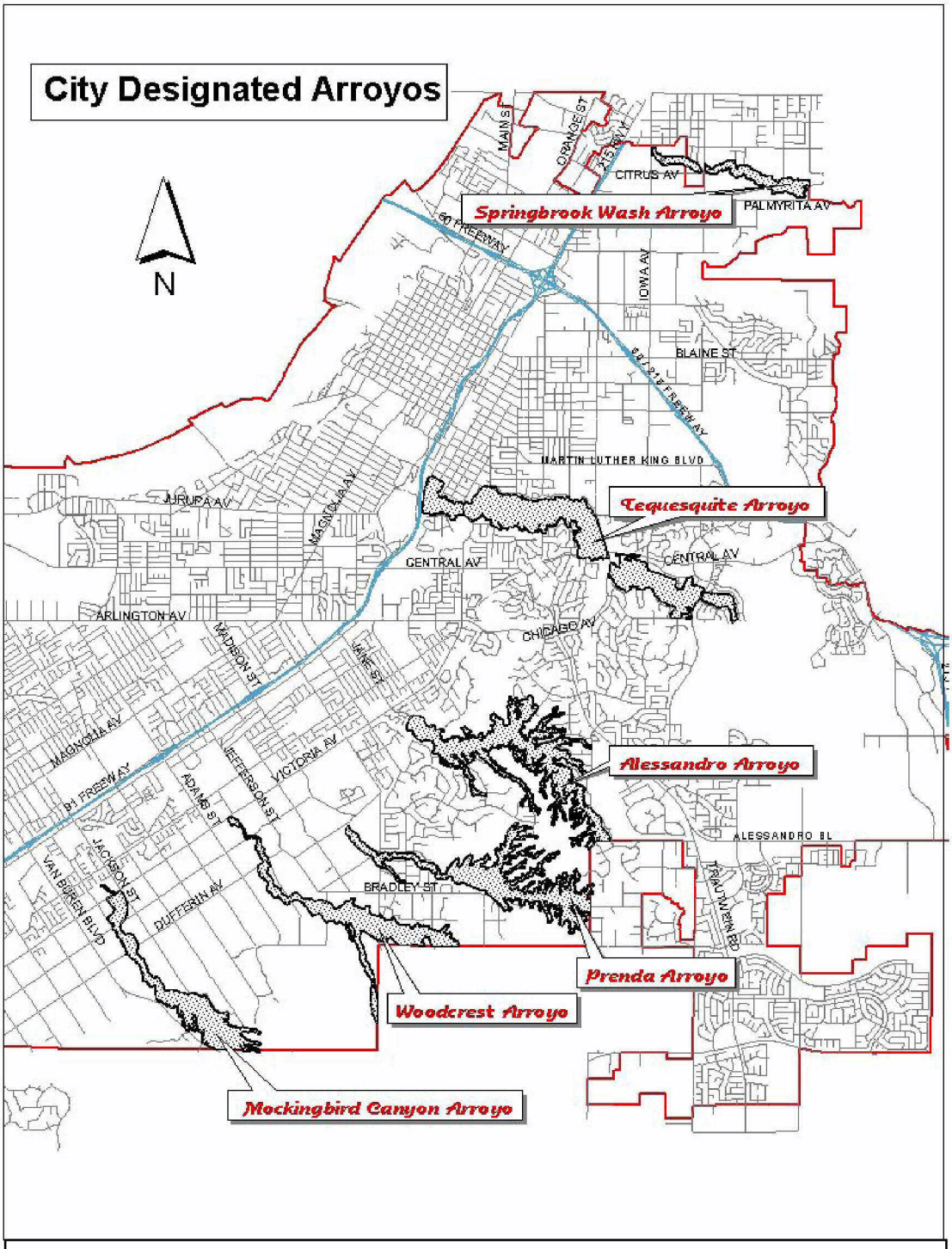


Figure 2-4. Six Major Arroyos as identified and mapped by the City of Riverside. Map provided by Riverside City Planning Department.

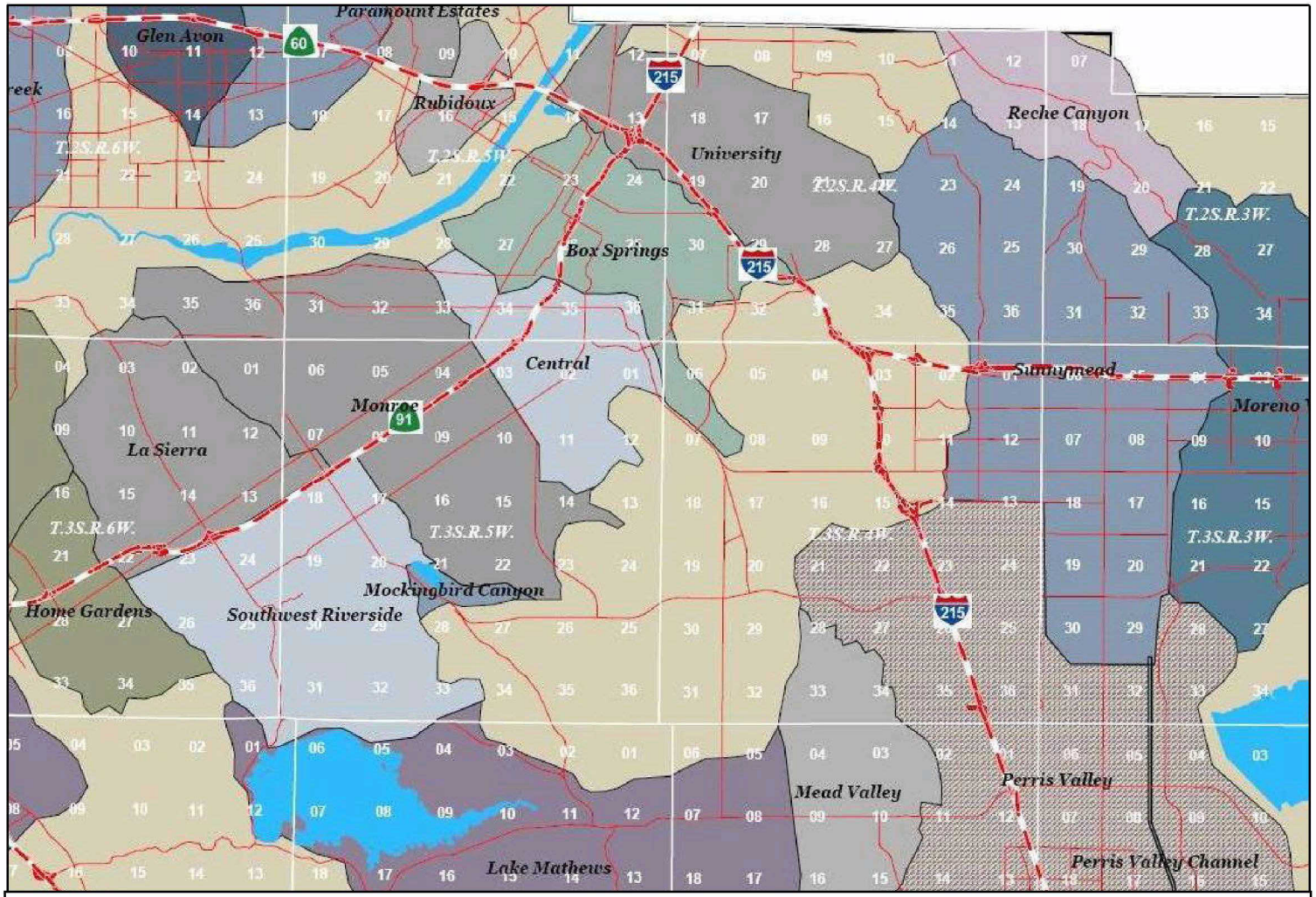


Figure 2-5. Master Drainage Plans in Project Area. A master drainage plan is not available for unlabeled areas (light buff colored) such as over Orangecrest and Woodcrest. See Figure 2-2 for project area. (http://www.floodcontrol.co.riverside.ca.us/districtsite/downloads/Master%20Drainage%20Plans/MDPs.pdf)

2.2 FORMATION OF COUNTY/CITY ARROYO-WATERSHED COMMITTEE

The County/City Arroyo-Watershed Committee (CCAC) was established in an advisory capacity in July 2004 by the County of Riverside Board of Supervisors and in December 2004 by the Riverside City Council. The CCAC was formed to gather information and make recommendations to the relevant planning authorities regarding strategies for the conservation and preservation of arroyos and watersheds located in the City of Riverside and adjacent unincorporated communities within the County of Riverside, all within the Santa Ana River Watershed. A watershed is a region or area bounded peripherally by a divide and draining ultimately to a particular watercourse or water body, in this case, the Santa Ana River. As early as 1869, through his exploration of the Colorado River and the American Southwest, John Wesley Powell recognized important sociological and ecological implications of watersheds and the link between all living things and the watercourse and landscape in which they are associated. Much has changed since his exploration due to the density of human development and the human use of water. Today, a collaborative, multidisciplinary approach by the community is needed to find effective strategies for conservation of watercourses and a healthy watershed.

> ***A WATERSHED is that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community.***
>
> **John Wesley Powell**

The CCAC consists of up to 22 citizens (voting members) representing each elected member of the Board of Supervisors and City Council with most members appointed Fall 2005. County and City staff provide technical and administrative assistance and represent their respective agencies as non-voting participants. Other members of the public and outside agencies have dedicated time and information to the CCAC in developing policy and mapping recommendations. Committee participants are listed in the Tables 2-2, 2-3, and 2-4.

TABLE 2-2. Appointed Representatives to the CCAC (Voting Members)

CITY OF RIVERSIDE	
Ward 1 (Dom Betro)	Rick Thomas
Ward 2 (Andy Melendrez)	Wendy Eads
Ward 3 (Art Gage)	Frank Heyming
Ward 4 (Frank Schiavone)	Dave Wahlquist
Ward 5 (Ed Adkison)	Terry Wold
Ward 6 (Nancy Hart)	Richard Puckett
Ward 7 (Steve Adams)	Don E. Coon
COUNTY OF RIVERSIDE	
District 1 (Bob Buster)	Lee Cussins; Arlee Montalvo
District 2 (John F. Tavaglione)	Dick Frick; Hazel Frick

District 3 (Jeff Stone)	Vacant (not in project area)
District 4 (Roy Wilson)	Cindy Nance
District 5 (Marion Ashley)	Jane Block, Citizen Chair; Kalina Cox

Table 2-3. Staff Representatives to the CCAC (Past and Present, Non-Voting Participants)

CITY OF RIVERSIDE	
Scott Barber	Riverside City Community Development
Troy Brown	Riverside City Manager's Office
Clara Miramontes	Riverside City Planning
John Swiecke	Riverside City Planning
COUNTY OF RIVERSIDE	
Robert Caliva	Legislative Aid, District 1
Art Diaz	Flood Control District
Mekbib Degaga	Flood Control District
Kathy Gifford	Riverside County Executive Office
Jerry Jolliffe	Riverside County Planning
Jeff Letterman	Riverside County GIS
Sam Martinez	Riverside County Environmental Health and Safety
Stuart McKibbin	Flood Control District

Table 2-4. Other Non-Voting Participants in CCAC Activities*
(*These participants have provided their technical expertise to assist CCAC members)

Jennifer Becker	Resident; adhoc committee on code enforcement
Gail Egenes	Riverside Land Conservancy
Shelli Lamb	Riverside-Corona Resource Conservation District
Kim Morgan-Davidson	Past member of CCAC
Len Nunney	UCR Biology and Center for Conservation Biology
Cathy Perring	Past member of CCAC
Diana Ruiz	Riverside-Corona Resource Conservation District
Kerwin Russell	Riverside-Corona Resource Conservation District
Debbie Walsh	CCAC intern, resident County of Riverside
GIS Students	Mt. San Jacinto College

2.3 PURPOSE AND GOALS OF CCAC

The County/City Arroyo-Watershed Committee (CCAC) was formed as an advisory committee to provide guidance, information, and recommendations to the County of Riverside Board of Supervisors and the Riverside City Council on matters related to conservation and preservation of arroyos and watershed resources in the project area.

Goal 1: Provide recommendations to establish consistent policies for land use and watershed management in areas that affect both jurisdictions.

Goal 2: Develop a Geographic Information System (GIS) data compilation of arroyos and other important watercourses as a Watercourse Layer Map together with data layers from a variety of sources, including flood control features, engineered contour lines, U.S. Geological Survey "blue-line streams," and a sensitive bird species in the local riparian habitat.

Goal 3: Develop GIS models to calculate setbacks that would buffer watercourses and riparian areas from adverse effects.

Goal 4: Develop educational materials and workshops to inform the public about the importance of practices that protect the local watershed.

This policy document and its accompanying mapping project represent the first two goals of the CCAC. The CCAC has also worked on Goal 4 by participating in the following activities: 1) collaboration on an article on arroyo protection published in the newsletters of the Riverside-Corona Resource Conservation District and the Riverside Land Conservancy; 2) assisting in organizing a workshop through the University of California Riverside Extension on "Water Quality Basins and Bioswales for the Inland Empire". The workshop introduced developers, planners, and other citizens to methods of low impact development that serve to reduce and clean runoff from storm water and irrigation; and 3) by sharing research and working collaboratively with staff from local departments and external agencies.

3.0 POLICY ANALYSIS AND MAPPING

The CCAC examined City of Riverside ordinances and the proposed 2025 General Plan, the current County of Riverside General Plan and Draft Land Use and Development Ordinance and the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) regarding protection of watercourses, arroyos, and riparian habitat. The following discussion points to some areas that could benefit by a careful analysis by both City and County staff involved in policy review and revisions of General Plan and land use ordinances meant to implement general plan policies and the MSHCP agreement. In Section 4.0, we provide suggested land use policy concepts and practices that will assist the City and County in the development of compatible policies that foster cooperative, consistent, and comprehensive efforts to protect important watersheds, arroyos, and watercourses. A discussion of associated watershed features and functions, such as wetlands, recharge basins, and beneficial uses (as defined by the Santa Ana Regional Water Quality Control Board) is provided together with a glossary (Appendix 7.1). Supporting research on watercourses, ordinances, wetland delineation, other factors important to recommendations about appropriate setbacks, and details about the mapping project are provided in Appendices 7.2-7.15.

3.1 ARROYOS, WATERCOURSES AND DYNAMIC PROCESSES

An arroyo can be defined as a rocky ravine or trench through alluvium with a watercourse at the bottom. Arroyos widely vary in size, from just a few feet wide and deep to a mile or more in width and hundreds of feet deep.

Figure 3-1. Perennial watercourses in the project area. Left, Castleview Creek. Right, Sycamore Canyon Arroyo. Many creeks are fed by springs.

Arroyos contain watercourses which can be dry at the bottom much if the year (i.e., intermittent or ephemeral), flowing most of the year (perennial), or flowing throughout the year (permanent) (Figures 3-1, 3-2). In the field of geomorphology of rivers and fluvial processes, "arroyo" is a term used in the southwestern United States for entrenched channels or cut-and-fill river systems that are named for the processes that form them (Graff 1987, Brierley and Fryirs 2005). Arroyos

are dynamic, changing systems that involve alternating phases of sediment deposition and removal. Watercourses frequently meander over time, such that the position of incision is dynamic. Arroyos and watercourses are influenced by the stormwater runoff conditions of the overall watershed.

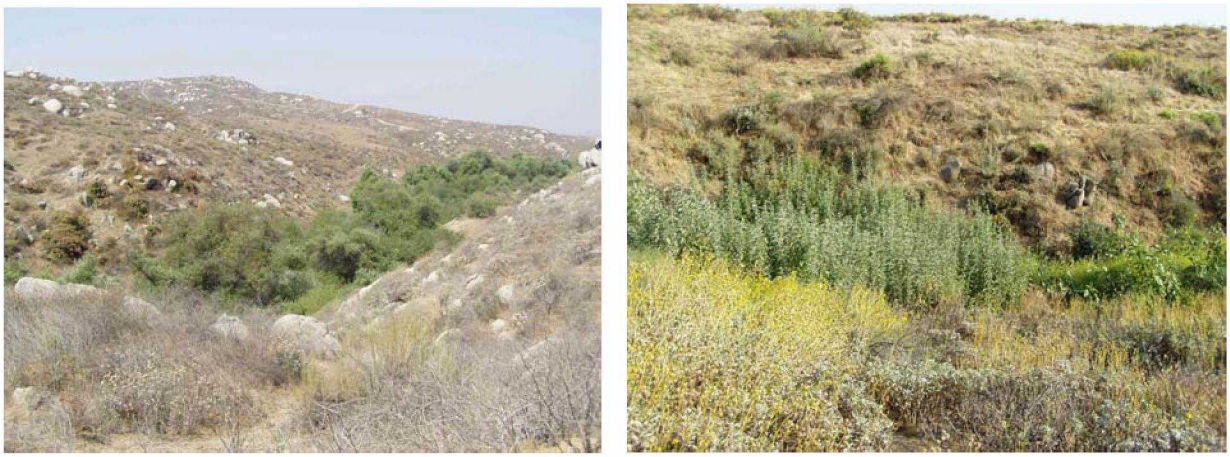


Figure 3-2. Left, Upper portion of the Prenda Arroyo on the County-City boundary has a stream that flows all year long and supports riparian vegetation. Right, Lower tributary is an ephemeral watercourse with water dependent plants.

Development patterns throughout the Riverside project area are the result of innumerable individual site planning decisions that have been made without consideration of the watershed context. The cumulative effects of these urban and rural land use decisions have dramatically altered the landscape of Riverside's arroyos and watercourses and their floodplains. This has resulted in a dramatically different relationship between Riverside's watercourses and receiving waters in the Santa Ana River Watershed. Today, as a result of land use demand, increasingly more sensitive upstream arroyo landscapes that include steeper slopes, important riparian and upland habitat, and habitat corridors are being developed without consideration of the dynamic processes of arroyos and watercourses or the need for protecting groundwater recharge areas.

The CCAC makes the following observations regarding dynamic watercourse features in the project area:

1. **Erosion/Sedimentation** – Erosion and sedimentation are natural processes of watercourses in the project area, but under natural conditions can be a gradual process. Land use changes are altering the natural process of erosion and sedimentation. Urban development, roads, culvert crossings that constrict flows, dams, concrete channels, removal of vegetation, the addition of rip rap or other bank stabilization structures all influence runoff quantity and dynamics. During storm events, the result of these land use changes is larger, higher velocity water flows that can produce high erosion rates and large amounts of sediment deposited downstream of eroded sections.

2. **Infiltration/Recharge** – Open space, native shrubland on slopes above watercourses, riparian vegetation on the banks and borders of watercourses, and soft bottom watercourses provide natural opportunities for stormwater to slow and recharge to groundwater aquifers. Removal of these naturally permeable surfaces continue under traditional development approaches, resulting in less infiltration of rainfall and a less dynamic natural system.
3. **Urban Runoff** – Typical development results in removal of native vegetation and an increase in hard surfaces resulting in a decrease in the infiltration of water, increased runoff carrying sediments, and introduction of other nonpoint sources of urban runoff pollutants into watercourses. "Low impact development" (LID) is a more environmentally sensitive approach to developing land and managing stormwater runoff that takes clues from the natural dynamics of a project site to provide opportunities for permeability, biofiltration, and protection of vegetative cover.

Figure 3-3. Permeable parking and biofiltration strip at Inland Empire Utilities Agency

Policies are needed that allow for sensitive new development and redevelopment which preserve dynamic natural processes of arroyos and other watercourses. Low impact development, green infrastructure, multi-purpose land uses, or other environmentally sensitive development approaches that conform to the natural dynamics of a project site should be incorporated. These include measures which protect soil permeability (e.g., limiting hardscape, using porous paving materials), water quality (i.e. biofiltration, bioswales, vegetated water quality basins), water resources (i.e., on-site stormwater capture, rain gardens, irrigation management), and habitat (i.e., setbacks, use of native and noninvasive plant species). These measures should be incorporated in new development to the maximum extent feasible. In the event more invasive development practices are the only option, appropriate and significant mitigation measures should be required within the affected arroyo or watercourse. Mitigation must compensate for adverse impacts by the development project on the arroyo, watercourse, watershed, habitat, recreation, or public safety including potential increases in the severity of dynamic events, such as floods and an increase in hydromodification (see glossary).

3.2 ARROYO AND WATERCOURSE PROTECTION: A COMPARISON OF CURRENT AND PROPOSED POLICIES OF THE COUNTY AND CITY

There are differences between the County and City in regulations that protect arroyos and watercourses. Currently, the County of Riverside has no specific ordinances in place to protect arroyos and other watercourses. Only minor protection is provided under current ordinances, but proposed draft ordinances afford some additional protection (Appendix 7.7). Section 3.4, Analysis of Grading Codes and Enforcement, provides an analysis of the differences between County and City code enforcement of illegal grading, especially into watercourses.

City of Riverside

The City of Riverside has a grading ordinance in place meant to protect U.S. Geological Survey recognized "blue-line streams," and six major arroyo systems (see Figure 2-2). Current blue-line stream protection measures are weak and the implementation and enforcement of these protection measures have been inconsistent at best. Protection measures for the six major arroyo systems are stronger, but also provide significant opportunities for improved protection. The proposed City of Riverside 2025 General Plan and associated Zoning Ordinance also provide language intended to protect the six identified arroyos, but the language does not adequately provide protection of other important watercourses and their associated values.

City Ordinance No. 6673, Section 1, provides a definition in paragraph 17.08.011 that amends the original Ordinance 6453. The language serves as a model for delineating the boundaries of arroyo protection.

> 17.08.011 Arroyo. "Arroyo" shall mean those areas shown within the limits of the Mockingbird Canyon, Woodcrest, Prenda, Alessandro, Tequesquite, or Springbrook Arroyos and associated tributaries as shown on Exhibits A-F of this Title. The limits of these arroyos and arroyo tributaries shall include all the land within the water course area, the adjacent slopes having an average natural slope of 30% or greater, and all other areas within the boundaries shown on Exhibits A-F of this Title.

The City of Riverside proposed General Plan and Zoning Code would benefit from incorporating aspects laid out explicitly in the County's Draft Land Use and Development Ordinance and by expanding the Watercourse Overlay to incorporate more protections to watercourses.

County of Riverside

In comparison, the County has little current regulation regarding watercourses. Ordinance 457.93 prohibits obstruction or diversion of watercourses during construction projects:

> Under Section 3313.7. Stockpiling. A stockpile is a supply of earth material placed on a site, for a temporary period of time not to exceed 12 months. It shall be authorized in conjunction with an approved construction project and shall not obstruct or divert natural drainage or water courses. It shall be carefully maintained and under no circumstances cause an adverse effect to adjacent properties.

Unlike the City ordinance, County ordinance 457.93 (section 3316.3) makes it clear that construction sites regulated by the ordinance must have a Storm Water Pollutant Prevention Plan (SAWPPP) to protect water quality, and dischargers must file a notice of intent with applicable regulatory agencies.

> Under Section 3316.3: During site construction, construction activities shall be designed and conducted to minimize runoff of sediment and all other pollutants onto public properties, other private properties and into waters of the United States as required by this Section and Riverside County Ordinance No. 754. If practicable, phased grading shall be conducted. Erosion and sediment control measures utilized by the permittee shall not conflict with the requirements of Riverside County Ordinance Nos. 695 and 787. All dischargers who are required to file a Notice of Intent (NOI), under the provisions of the National Pollutant Discharge Elimination System (NPDES) General Permit No. CAS000002, State Water Resources Control Board Order Number

92-08-DWQ, shall develop and implement a Storm Water Pollutant Prevention Plan (SWPPP), a monitoring program, and a reporting plan as required by the Federal Water Pollution Control Act (Clean Water Act) and implementing regulations promulgated by the U.S. Environmental Protection Agency.

The County's *Draft Land Use and Development Ordinance* (October 2006) would afford increased protection to watercourses in its Watercourse Overlay and Open Space Foundation-Water sections (Appendix 7.7 includes sections of the DRAFT *County of Riverside Land Use and Development Ordinance* relevant to this project). In addition, the *Draft County of Riverside Transportation and Land Management Agency Development Manual* (May 2006 version) expresses an intention to protect watercourses and riparian habitat. Both include provisions to implement General Plan objectives regarding watercourses and floodplains such as "… The intent of the County along floodplains and riparian areas it to sustain 'living' riparian habitats to the maximum extent possible…" (see OS 5.1-5.7 of County General Plan). The Development Manual promotes a number of practices that if approved would help to preserve watercourses, for example:

- Various development proposals are to be coordinated so that they do not hinder development potential of upstream properties.
- Large tracts with lots larger than 1 acre are to minimize roads and driveways and locate them away from and parallel to watercourses.
- Natural drainage patterns are to be respected.
- Developments shall implement Best Management Practices (BMPs) to mitigate their impacts to water quality.
- Projects shall comply with the County Water Quality Management Plan (WQMP) to be in compliance with the federal National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Clean Water Act requirements. In the project area, this would be the Santa Ana River Watershed WQMP.
- If projects may affect "waters of the United States", "wetlands" or "jurisdictional streambeds", regulatory constraints must be considered.
- Land divisions will not be approved unless each lot has a suitable building site outside of the 100-year floodplain.

To better protect watercourses, this list should add that "Land divisions will not be approved unless each lot has a suitable building site outside of the required setback to a watercourse as determined by characteristics of the particular site". For recommended setback distances to watercourses, see Section 4.4.

Multiple Jurisdictions- Joint County-City Agreements. The County of Riverside, the City of Riverside, and other cities that signed the landmark Western Riverside County MSHCP, agreed to adopt and implement an ordinance or resolution to protect species associated with riparian-riverine habitats and vernal pools (Appendix 7.11). Providing buffering setbacks from development and avoiding disturbance of watercourses can protect riparian/riverine habitat and their sensitive wildlife. In addition, in the MSHCP Section 6.1.2, mapping of Riparian/Riverine areas and vernal pools is regarded as an important part of the implementation plan. An example of such mapping of sensitive habitat and species is provided in the CCAC GIS Mapping Project and Watercourse Layer Map (section 3.5). Other species in addition to the example of least Bell's vireo could be added by the County and City to the CCAC GIS Mapping Project.

The Western Riverside County MSHCP requires that the County and City "adopt and implement ordinance or resolution to protect species associated with riparian-riverine habitat."

3.3 PAST AND CURRENT ARROYO STUDIES

The dynamic nature of arroyo systems, the results of past arroyo studies, and an understanding of the regulatory framework surrounding arroyos, watercourses, and associated watershed resources (such as wetlands) is important to formulating a sound policy for their conservation and preservation. CCAC is unaware of any watercourse studies for Riverside County. The CCAC is aware of the following three studies of arroyos in the City of Riverside.

Standards for Arroyo Grading and Preservation in Alessandro Heights (1989)

The "Standards for Arroyo Grading and Preservation in Alessandro Heights" was a study prepared in 1989 by Smith, Peroni & Fox and approved by the City of Riverside in 1990. Arroyos in the project area included the Alessandro, Woodcrest, and Prenda Arroyos. The study served as a guide for assembling the City of Riverside's Title 17, Hillside and Arroyo Grading Ordinance. One of the primary recommendations of this study was the provision of setbacks from arroyos that would provide space for trails and open space corridors. It anticipates that a City trail system along arroyos could connect to a County trails network.

Box 3-1. Key Recommendations Identified in Previous Arroyo Studies

1. Create a joint County-City arroyo task force.
2. Establish cooperative arroyo planning areas and arroyo habitat preservation plans.
3. Require setbacks for trail networks, trail access, and open space corridors.
4. Provide setbacks to allow for natural watercourse meanders, and protection of habitat and habitat corridors.
5. Increase protective power of residential conservation zoning.

The Arroyos of Riverside Reconnaissance Study (2001)

The "Arroyos of Riverside Reconnaissance Study" was prepared for the City of Riverside in 2001 by The Dangermond Group in cooperation with the Riverside Land Conservancy and included the following arroyos: Springbrook Wash, Big Springs, Box Springs, Tequesquite, Sycamore, Alessandro,

Prenda, Woodcrest, and Mockingbird. The report examined potential uses for arroyos, focusing on habitat value, recreational trails, wildlife corridors, and education. Also included in this report were physical characteristics of each arroyo, including locations of installed dams, concrete channels, detention basins, parks, or golf courses, and potential effects of adjacent land uses on arroyos. Encroachment threats, natural values, and possible access points for trail systems were also summarized. Several threats to arroyos were identified, including:

- **Habitat Quality** – Fragmentation of natural corridors, loss of habitat, degradation by invasive species.
- **Grading** – Grading of banks of watercourses where cut and fill is adding to sedimentation of channels.
- **Water Quality** – Sedimentation, urban run-off, and loss of vegetative (filtration) cover.
- **Off-Road Vehicles** – Compacting of soil and degradation of fragile systems.
- **Illegal Dumping** – Contributing to health and water quality issues.

A set of important recommendations were made:

1. **Create a special Joint Powers entity to:**
   - Create a Riverside City-County Cooperative Planning Task Force
   - Establish and map the City and County cooperative arroyo planning areas
   - Create preservation plans for the arroyos
2. **Increase the proposed boundaries of the arroyos.** Include a large enough buffer to allow for natural meander and protection of water quality and riparian areas from adjacent human uses. (Note: an optimal buffer between human development and the riparian zone was recommended as 155 feet to allow for stream meander, filtration of animal wastes and fertilizer runoff.)
3. **Re-examine the protective power of the residential conservation zoning designation.** The current zoning and grading ordinances do not provide enough protection for the arroyos.
4. **Investigate the possible access and uses identified in the report when revising trail master plans.**
5. **Study enhancement, protection and restoration of natural habitat of all arroyos.**
6. **Conduct specific studies to determine feasibility of recommended trails.**

These recommendations are as relevant today as they were in 2001. The CCAC is working on aspects of 1, 2, 4, and 5 within its policy study and arroyo/watercourse mapping project.

Springbrook Wash (2003)

The Springbrook Wash study was commissioned through a grant to the Riverside Land Conservancy in late 2003 to examine its potential as a wildlife corridor and community trails corridor. This study recommended finding a solution for improving wildlife crossings under the freeway. Discussions began for collaboration with CalTrans in 2004.

3.4 ANALYSIS OF GRADING CODES AND ENFORCEMENT

There has been an ongoing problem with the grading of watercourses, clearing of riparian vegetation, and obstruction of watercourses in both the City and County (Figures 3-4 and 3-5). Although State and Federal codes apply to illegal activity near and in watercourses, these agencies are not always prepared to respond quickly enough to mitigate or prevent further destruction. While the majority of illegal grading may occur because landowners are simply ignorant of existing ordinances, a small percentage of landowners are aware of land use restrictions impacting their parcel(s) yet choose to proceed with their project while ignoring restrictions. Strict enforcement of codes is necessary at the local level. The CCAC has examined current Riverside County and City ordinances and has recommendations for improvement of enforcement (see Section 4.1).

Figure 3-4. Illegal Grading of Watercourse and Clearing Riparian Vegetation, Woodcrest Arroyo

Effectiveness and Consistency of Grading Code Enforcement

The CCAC has reviewed existing City and County codes that pertain to grading and development of areas in and around arroyos. The rapid development of sensitive areas adjacent to the City has served to highlight past inconsistencies in development policy between the City and unincorporated areas. The recent passage of Policy F-6 by the Board of Supervisors puts in place a defined protocol for addressing illegal grading in the County. Although the County of Riverside does not have a grading policy specifically focused on watercourses, the recently adopted policy strengthens its ability to curb illegal grading in general (see Box 3-2). Fines ranging from approximately $100 to $500 per month, plus administrative costs, are to be imposed on landowners caught grading illegally. More significantly, the County may impose a five (5) year hold on building permits and land use clearances if the landowner does not pay fines and abate the disturbance as required. This provision should provide an effective deterrent to illegal grading undertaken for housing and other development.

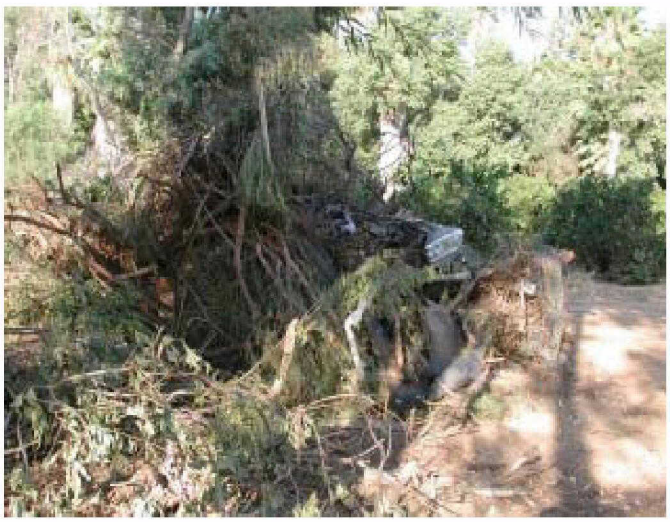


Figure 3-5. Illegal Obstruction of Watercourse, Woodcrest Arroyo

The County is also authorized to retain a contractor to reclaim the property to prevent offsite drainage and slope erosion if the property

has not been restored within 90 days of the Board's issuance of an Order to Abate. This provision is especially important to ensure the timely restoration of disturbed arroyos. In addition, the County recognized that agricultural exemptions for grading permits were increasingly being used to grade and clear parcels for future development. In response, the ordinance granting agricultural exemptions was clarified to prevent inappropriate use of the exemption. The County still does not appear to impose significant penalties for grading begun without a permit when a permit is eventually granted.

The City of Riverside also has in place a protocol to address illegal grading (see Box 3-3). Once grading has begun without a permit, the permit fee increases to three times the amount that it would have cost before commencement of grading. If the proposed grading is not approved, the owner may be required to bring the land back to its original condition. If a violator does not comply with the initial warning letter, the City Attorney may send a letter outlining potential criminal and civil action. The monetary penalty and involvement of the City Attorney should result in a high rate of compliance once illegal activity is reported.

Figure 3-6. Springbrook Wash. A poor history of watercourse protection can be reversed through restoration. This portion of Springbrook Wash was severely damaged and lined with broken concrete.

Box 3-2. Board of Supervisor Policy F-6, Grading Without a Permit

OBJECTIVE:

To reduce or eliminate grading violations and to restore properties to their original ungraded state, policy guidelines are needed to establish a Code Enforcement procedure for abating properties that have been graded without permits.

POLICY:

Ordinance 457.96 Section 11, 3306.03 allows for the Department of Building and Safety to place a five year hold on the issuance of building permits and land use approvals if that property is graded without permits. Any property owner aggrieved by this decision has the right to appeal to the Board of Supervisors. To insure that due process is followed and graded properties are restored to their original ungraded state the following Code Enforcement procedure will be utilized.

PROCEDURE:

1. Upon initial verification that grading without a permit has occurred the following actions will be taken:
   a. A Notice of Violation and a $100 Administrative Citation will be issued to the property owner.
   b. A Notice of Non-compliance will be recorded immediately against the property. The Notice will include language that discloses the five (5) year hold on building permits and land use clearances (Attachment 1).
   c. A flag will be placed on the automated permit issuing system notifying all development related departments of the five (5) year hold on building permits and land use clearances.
   d. If applicable, federal and state resource agency will be notified of the grading violation
   e. A Notice to Abate per Ordinance 725 will be sent certified mail to the property owner and any person(s)s having an interest in the property as determined by a title search (Attachment 2).
2. If the property is not restored to the satisfaction of the Department of Building and Safety so as to prevent offsite drainage and slope erosion within 45 days of the date of the first Notice to Abate a $200 Administrative Citation and a second Notice to Abate will be issued to the property owner.
3. If the property is not restored so as to limit offsite drainage and slope erosion within forty five (45) days of the second Notice to Abate a $500 Administrative Citation will be issued for each subsequent thirty (30) days that the property is not restored to prevent offsite drainage and slope erosion.
4. If within 90 days (90) from the first Notice to Abate the property is not restored so as to limit offsite drainage and slope erosion a hearing will be scheduled before the Board of Supervisors for the abatement of the illegal grading as a public nuisance. At the hearing the property owner will have the opportunity to present evidence and testimony as to why the property should not be restored.
5. If the property has not been restored within 90 days of the Board's issuance of an Order to Abate, the county will retain a county approved contractor to reclaim the property to prevent offsite drainage and slope erosion.
6. [there was no item 6]
7. All costs associated with the abatement action may be recorded against the property in the form of a lien as provided for in Ordinance 725.
8. Upon restoration of the property and payment of the lien the five (5) year hold on building permit issuance and land use approvals will be released.

Box 3-3. City of Riverside Grading Enforcement and Penalties

Title 17. Grading.

Section 17.36.010 Enforcement/Penalties.

A. Where grading is undertaken without a permit, the Public Works Director may order the work stopped by notice in writing served on any person or persons performing such grading or causing such grading to be done. Any such person or persons so notified shall stop such grading until all required permits are obtained.

B. Whenever any work for which a permit is required under the provisions of Chapter 17.12 of this title as determined by the Public Works Director has been commenced without the authorization of a City issued grading permit, the applicable grading permit fee shall be treble the amount of the regular fee as provided for in Chapter 17.24 of this title.

C. In addition to the administrative remedies and penalties imposed by the City Public Works Director pursuant to this title, any violation of this title may be punishable as an infraction, or as a misdemeanor at the discretion of the City Attorney as set forth at Section 16.04.510 of this title.

D. In addition to the requirements of this title, where grading of property is undertaken without required permits, the property owner may be required to restore the land to its pre-graded form or condition as determined by the Public Works Director.

E. The provisions of this title shall apply to all persons who do or cause to be done, or through action or inaction allow or maintain any grading regulated under this title to be done on property without a permit or in a manner contrary to the provisions of an approved grading permit or contrary to the provisions of this title. Persons who are responsible parties include but are not limited to:

1. Property owners or lessees.
2. Contractors who perform the work. (Ord. 6453 § 1, 1998)

link: http://www.riversideca.gov/municipal_code/. Chapter 17.36 ENFORCEMENT/PENALTIES

3.5 MAPPING PROJECT AND WATERCOURSE LAYER MAP

The County/City Arroyo-Watershed Committee (CCAC) formed an ad-hoc committee for integrating mapped features into a Geographic Information System (GIS), hereinafter referred to as the "Mapping Project." The objective of the Mapping Project is to create a comprehensive "Watercourse Layer Map" for the project area and provide that layer, along with the aforementioned policies and planning recommendations, to local agencies: County of Riverside, Flood Control District, and City of Riverside. It is hoped that this Watercourse Layer will be integrated as a Zoning Overlay that serves as a "flag" for identifying parcels impacted by arroyos and other watercourses. See also Appendix 7.12-7.15 for a thorough description of the mapping project.

The goal of the Mapping Project is to acquire existing digital data that can be implemented in an automated mapping environment (Phases I, II, and III) that provides foreknowledge to developers and individual property owners as part of the planning department's application process. Implementation of a Watercourse Layer as part of the zoning ordinances is a proactive and practical solution to land use decisions (see Appendix 7.4 on Model Ordinance). Rather than

a reactive response to periodic flooding and potential flood events (i.e., 100-year flood), a Watercourse Layer will provide a tool to protect public and developer interests by providing sensible setbacks, crossings, and so on, prior to land modification (see example Figure 3-7).

Implementation of a GIS Watercourse Layer provides an opportunity to guide development that is sensitive to the conservation and preservation of arroyos and watercourses. There are many potential applications for a Watercourse Layer Map by a variety of agencies such as for protection of riparian vegetation and sensitive species habitat, trail placement, as well as residents and the constructed environment. A variety of environmental models can be applied to the Watercourse Layer in an integrative approach for land use decisions and, educational materials could be sent to all property owners bordering watercourses. Dynamic environmental models will serve to protect arroyos and watercourses in the project area.

Figure 3-7. Example of translucent buffers provided by setbacks measured from center of watercourse. Left = 25 ft, center = 50 ft, right = 100 ft. In this example, there would be no buffering of the riparian area if a 100 ft setback was measured from the center line. A better model would measure from the edge of the riparian vegetation or top of bank. If contour intervals were shown, it would be possible to illustrate the top of the bank. In this example, the building pads to the right of the watercourse were not set back enough from the top of the bank (aerial from 2003).

Figure 3-8. Massive Erosion. The banks and riparian forest shown in figure 3-6 suffered massive erosion in 2005 (see also Figure 4-4).

Project Description – Phase I, II and III

In Phase I, several hard copy maps with hand-drawn line work of watercourse segments were "heads up" digitized using one-foot aerial photograph images provided by the County as a backdrop. A color scheme was assigned to line types according to source of the data for each watercourse (i.e., RWQCB). These data will be combined, along with named and unnamed watercourses ("blue-lined streams") from the U.S. Geological Survey, into a single Watercourse Layer that can be buffered to various extents as, for instance, setbacks of 50-, 100- and 150-feet from the centerline of a watercourse (see Figure 3-6), or using a GIS model still to be developed, that places the setback line varying distances away from the edge of the riparian area, top of bank, or edge of the 100 ft flood plain. The source of digital data acquired for this project to date, with brief descriptions are provided in Appendix 7.14.

The CCAC decided that the one-foot aerial photographs provided by the County of Riverside for the project area are a level of accuracy (one-foot) that is adequate for calculating bank widths. When combined with 4 ft contour lines, this is sufficient to determine percentage slope by any of several methods. In many cases this can be accomplished from the digital display, without going into the field. Other criteria that are not easily interpreted from aerial photographs need to be verified in the field (Appendix 7.13, Metadata). Field verification with global positioning systems (with greater than 10 meter accuracy) by youth groups or scientists (biologists, geomorphologists, hydrologists or engineers) will provide information necessary to populate the Watercourse Layer database. Consultation with a geomorphologist and hydrologist (or a fluvialgeomorphologist) would be important for targeting difficult segments of watercourses, improving the quality and accuracy of data collected, and for interpretation and assignment to classification fields (refer to Appendix 7.14, Watercourse Layer Data Dictionary).

In Phase II, aerial photographs will be used to "heads up" digitize a Riparian Layer from visible ground vegetation associated with the Watercourse Layer together with photograph collections and site visits. The outer edge of riparian vegetation often coincides with the outer boundary of Waters of the State (see Appendix 7.3 and Figure 4.1). Riparian vegetation provides habitat for many sensitive species protected within the Western Riverside County MSHCP (Appendix 7.11). A minimum setback from the edge of the Riparian Layer will need to be determined depending on the nature of the area and if the area serves or potentially serves as an important wildlife corridor that connects open spaces. The Riparian Layer will have a spatially associated database that can be populated with biological data. Phase III will involve additional data acquisition and updating existing data as they become available, such as hydrological data or satellite images. The calculation of setbacks can then be based on several alternative models.

There are many potential uses for the CCAC compiled digital data in a 3-dimensional model. Most significantly, a 3-dimensional terrain model will provide the basis for modeling downhill movement of water, such as flow and volume. As a combined layer, the Watercourse Protection Map will improve planning decisions regarding watercourse channel steepness of slope, meander incision, sedimentation, and distance from edge of riparian vegetation. In a 3-dimensional model, watercourses, riparian vegetation and surrounding topography will be visibly apparent as a dynamically connected system across a contiguous surface.

3.6 MODEL POLICY/ORDINANCE EXAMPLES FROM OTHER COMMUNITIES

More and more communities in California and across the U.S. are struggling with how to ensure economic development while also protecting natural environments. These concerns are not mutually exclusive. Rather they are linked to each other in nearly every way through community quality of life and amenities offered to residents, although land use and economic development policies don't always recognize such linkages. Development ordinances and regulations often work against these goals through requirements that result in needless impervious cover in the form of wide streets, expansive parking lots, and large lot subdivisions that require excessive clearing and grading (Brown et al. 2000). At the same time, local ordinances often give developers little or no incentive to conserve or protect natural areas that are important for watershed or other natural resource protection. Like other communities, the Riverside area struggles with these issues.

Box 3-4. Common Principles in Communities with Established Arroyo, Riparian, and Watershed Protection Ordinances

1. Land disturbances are limited only to that area necessary to provide for the desired use or development.
2. Native vegetation and habitat is preserved to the maximum extent possible consistent with the use and development allowed.
3. Impervious cover is minimized to the extent possible.

In developing arroyo/watercourse protection policy recommendations for the City and County of Riverside, CCAC has been reviewing policies and development guidelines that are being implemented by other communities in California and elsewhere.

Perhaps more similar to the CCAC's current study is the City of San Jose's Riparian Corridor Policy Study conducted in 1999 that examined General Plan policies meant to promote the preservation of riparian corridors (Jones and Stokes 1999). In this study, a riparian corridor is:

> Any defined stream channels including the area up to the bank full-flow line, as well as all riparian (streamside) vegetation in contiguous adjacent uplands. Characteristic woody riparian vegetation species could include ….willows,… cottonwoods, …alders.

Thus this study covered a subset of what the current CCAC study is covering. The San Jose study explained the rationale behind various policies and made recommendations for design guidelines that would support and implement General Plan policies. Examples of General Plan policies relevant to their study are:

1. Protect important groundwater recharge areas, particularly creeks and creeksides, from urban development;
2. Protect natural riparian corridors outside urban areas from disturbance associated with development by a minimum 150-foot setback from the top bank line, wherever feasible;
3. Preserve significant creeks and natural riparian corridors inside urban areas whenever possible; and

4. When disturbances cannot be avoided, appropriate measures are required to restore or compensate for damage.

The riparian resources of San Jose were inventoried, classified, and examined in terms of potentially competing land uses of development, flood protection, recreation, and habitat preservation. The study provided information important to identifying and managing riparian resources in an environmentally sensitive way. Important concerns included the need to provide:

- Water quality and habitat for fish, invertebrates, and the animals they feed.
- Food, cover, and migration corridors for fish, amphibians, and the birds/other wildlife they feed.
- Cover and food for other wildlife that range between riparian and upland habitats.
- Migration corridors for plants and wildlife during high runoff and high flows.
- Evidence for riparian corridors having a positive influence on economic value of adjacent lands as well as on recreation, aesthetics, and other quality of life was provided.

A map accompanied the text and formed the baseline definition of the riparian corridors, allowing the City to expand and refine the map overtime. As in the current CCAC project, the maps were intended to assist both property owners and the City in making appropriate land-use decisions. Aerial photo interpretation of aerials (1-inch : 200-feet) was used together with limited field reconnaissance and existing information from various reports and documents. Biotic resources were estimated from attributes of riparian vegetation, including composition of dominant species. The study recommended that two important policies be added to the General Plan regarding Riparian Corridors:

1. The City of San Jose should endeavor to preserve, protect and restore riparian corridors within the City's jurisdiction for the protection of vegetation, wildlife, and aquatic habitat values.
2. The City should adopt specific Riparian Corridor Development Design Guidelines with the goal that new development and other related activities within and adjacent to the corridors does not adversely impact biotic resource values of the corridor.

A number of cross-sectional diagrams were presented to illustrate a stream classification system. In addition, several illustrations portrayed types of watercourses and design guidelines for new development, including commercial, residential, and recreational development. For example, trails were placed to the outside of the riparian corridor and roads bridged the corridors. Many appropriate design guidelines were presented in the study, including recreational facilities (such as golf courses, trails design and layout). All are relevant to the CCAC area and are worthy of consideration by the City Council and Board of Supervisors.

Land use policies, ordinances, and design guidelines from various other communities and sources also provide relevance and example for the City of Riverside and County of Riverside. The City of San Jose's Riparian Corridor Policy Study (1994 and 1999), Los Angeles County Zoning Ordinance Significant Ecological Areas (SEA) (2004), Santa Barbara's County Land Inventory (2004), and Santa Cruz City Planning and Community Development Citywide Creeks

and Wetland Management Plan Ordinance (2006) recognize and address the need for Watercourse and Riparian buffers to protect watersheds. The San Francisco Bay Regional Water Quality Control Board (2004) analyzed Local Government Riparian Buffers in the San Francisco Bay Area and found that numerous local agencies have independently drafted ordinances that protect riparian areas and watercourses with buffers. In the San Francisco Bay Regional Water Quality Control Board report, watercourse buffers are established through a variety of planning tools: overlay zoning, General Plan implementation statements, watercourse setback ordinances and conservation easements. In an effort to establish riparian protection regulations to comply with federal and state laws, including the Federal Clean Water Act, Endangered Species Act and the State of California's Porter Cologne and Endangered Species Acts. The responsibility for compliance with these acts has increasingly shifted from federal and state agencies to local agencies. A Watercourse Layer that is enforced through a zoning ordinance will protect stream function and riparian habitat from new land use modification, while providing for additional flood flow capacity unimpeded by manmade constructs in the County of Riverside. Some examples from other areas include:

- Creek/Riparian Area Protection: Fremont, Measure T
  Lafayette Creek Setback Policy
  Oakland Creek Protection Ordinance
  Napa Ordinance on Riparian Areas
  Santa Clara Valley Water District Guidelines and Standards for Land Use Near Streams
  Santa Cruz County Riparian Corridor and Wetlands Protection Ordinance
- Watershed Protection: City of Austin, Texas Watershed Ordinances
  City of Santa Barbara Creek Restoration and Water Quality Improvement Division Programs
  Lower Colorado River (Texas) Authority Watershed Ordinance
  U.S.E.P.A. Model Ordinances
  Center for Watershed Protection
- Multi-Purpose Protection: Portland, Oregon Sustainable Stormwater Program
  Low Impact Development Center
  City of Irvine, Sustainable Travelways "Green Streets" Administrative Guidelines
  City of Santa Monica, Sustainable City Plan
  Boston Metropolitan Area Planning Council, Massachusetts Low Impact Development Toolkit
  U.S. Green Building Council

Relevant excerpts of specific ordinances and programs are incorporated into an example ordinance in Appendix 7.4.

4.0 POLICY RECOMMENDATIONS

The County/City Arroyo-Watershed Committee (CCAC) has created a Geographic Information System (GIS) mapping project of arroyos and watercourses in the project area as a GIS Watercourse Layer Map. As suggested by County staff, the digital Watercourse Layer is accompanied by recommendations for proactive and sensitive development that occurs near watercourses and arroyos within the project area. Recommended policies and practices are intended to assist the Planning Departments of the City and County in making land use decisions with watershed implications across adjoining boundaries, and to assist staff in forming planning liaisons that preserve and protect watersheds, arroyos, and watercourses throughout the project area. Where appropriate, policy recommendations are accompanied by suggested design guidelines. The policy recommendations, in combination with a GIS Model that includes the new Watercourse Layer can be used to create dynamic scenarios for protecting watercourses, among other related watershed values. The Watercourse Layer, as a model, can be expanded to other County/City jurisdictions with similar characteristics. Models for desert areas, especially, would need modification.

In order to protect watercourses in their natural and semi-natural state, protect water quality and wildlife, and to avoid the need to channelize watercourses, the CCAC makes the following recommendations. The need for bridging systems and protective setbacks are paramount. Setbacks to watercourses and steep arroyos are ungraded and undeveloped buffers between development and watercourses that serve to protect watercourses and adjacent slopes from a variety of negative impacts. When planning subdivisions, incorporating setbacks and bridging systems rather than culvert pipe and fill crossings over U.S. Army Corps of Engineers-delineated Waters of the U.S. and California Department of Fish and Game (CDFG)-delineated Waters of the State can avoid the need for the time consuming permitting processes, and thus, avoid extra construction costs.

4.1 GRADING CODES AND ENFORCEMENT

As discussed in Section 3.4, there has been an ongoing problem with the grading of watercourses, clearing of riparian vegetation, and obstruction of watercourses in both the City and County. The rapid development of sensitive areas adjacent to the City has served to highlight past inconsistencies in grading and development policy between the City and County unincorporated areas.

Recommendation 1: Consistent Illegal Grading Policy

The CCAC recommends that the City Council and Board of Supervisors adopt a consistent policy with respect to illegal grading. The City may wish to consider the addition of higher effective penalties, such as the land use restrictions imposed by the County, to achieve compliance with abatement requests following illegal grading of watercourses, banks, and protective vegetation. In addition, it is important to *require* property owners to mitigate any damage to a watercourse or its buffering riparian and upland vegetation to encourage compliance. Similarly, the County may wish to consider the addition of effective penalties for *any* grading begun without a permit. Penalties with a substantial deterrent effect should facilitate

the job of code compliance officers in encouraging landowners to comply with existing regulations.

4.2 WATERCOURSE LAYER MAPPING

As a combined watercourse and riparian layer, the Watercourse Protection will improve planning decisions regarding watercourse channel steepness of slope, meander incision, sedimentation, and distance from edge of riparian vegetation. In a 3-dimensional model, watercourses, riparian vegetation and surrounding topography will be visibly apparent as a dynamically connected system across a contiguous surface.

Recommendation 2: Watercourse Layer Preservation Tool

The CCAC is providing the City of Riverside and County of Riverside the GIS Watercourse Layer and Riparian Layer, and a combined Watercourse Protection Map with the recommendation that this spatial information will be considered prior to issuance of permits on parcels traversed by watercourses. The Watercourse Layer and associated data will prove particularly useful for future parcel development and subdivision. Together with an ordinance that protects watercourses, wetlands and riparian habitat, the Watercourse Layer will provide a significant tool in making land use decisions that preserve and conserve these resources from future land use modifications, natural or unnatural. Addition of the Watercourse Layer as a "flag" on parcels impacted by watercourses will minimize disparities between local agency permit processes, as a result of different setbacks in areas that are annexed from the County. Furthermore, the Watercourse Layer can be used to analyze watercourse change, potentially adverse land use impacts, and thus, support land use planning decisions that protect watercourses and communities from flood events.

Recommendation 3: Cooperative Arroyo Planning Areas and Conservation Zoning

A Watercourse Layer that is enforced through a zoning ordinance will protect stream function and riparian habitat from new land use modifications, while providing for additional flood flow capacity unimpeded by manmade constructs in the County of Riverside. The Watercourse Layer can also provide a foundation for establishing County-City Cooperative Arroyo Planning Areas as well as strengthened conservation zoning in both City and County jurisdiction.

4.3 SETBACKS

Setbacks to watercourses and steep slopes (sides) of arroyos serve a number of functions, including protection of scenic landforms and property, trail corridors, dry-land wildlife corridors, recreation, buffering other land uses from sensitive wildlife habitat, protecting water quality, and preservation of natural functions associated with watersheds and the dynamic nature of streams. This is recognized in the December 2005 *Draft County of Riverside Land Use and Development Ordinance*, Section 17.32.080, which states:

> A. All new development shall be required to establish a setback from the floodway edge based upon a site specific study that addresses public safety, erosion, riparian or wetland buffer, wildlife movement corridor or linkage, and slopes.
>
> B. Watercourse setback areas may be considered for use as greenways, trails and recreational opportunities on a case-by-case basis.

This sets the stage for building a model for determining appropriate setbacks. Development next to arroyos and other watercourses should be set back 100 feet from the outside boundary of the riparian vegetation, the top of the bank, or the 100 year flood plain, whichever is greater. The dripline of the canopy of the existing riparian vegetation is often the official boundary of Waters of the State (Figure 4-1, see 1999 San Jose Riparian Policy Study).

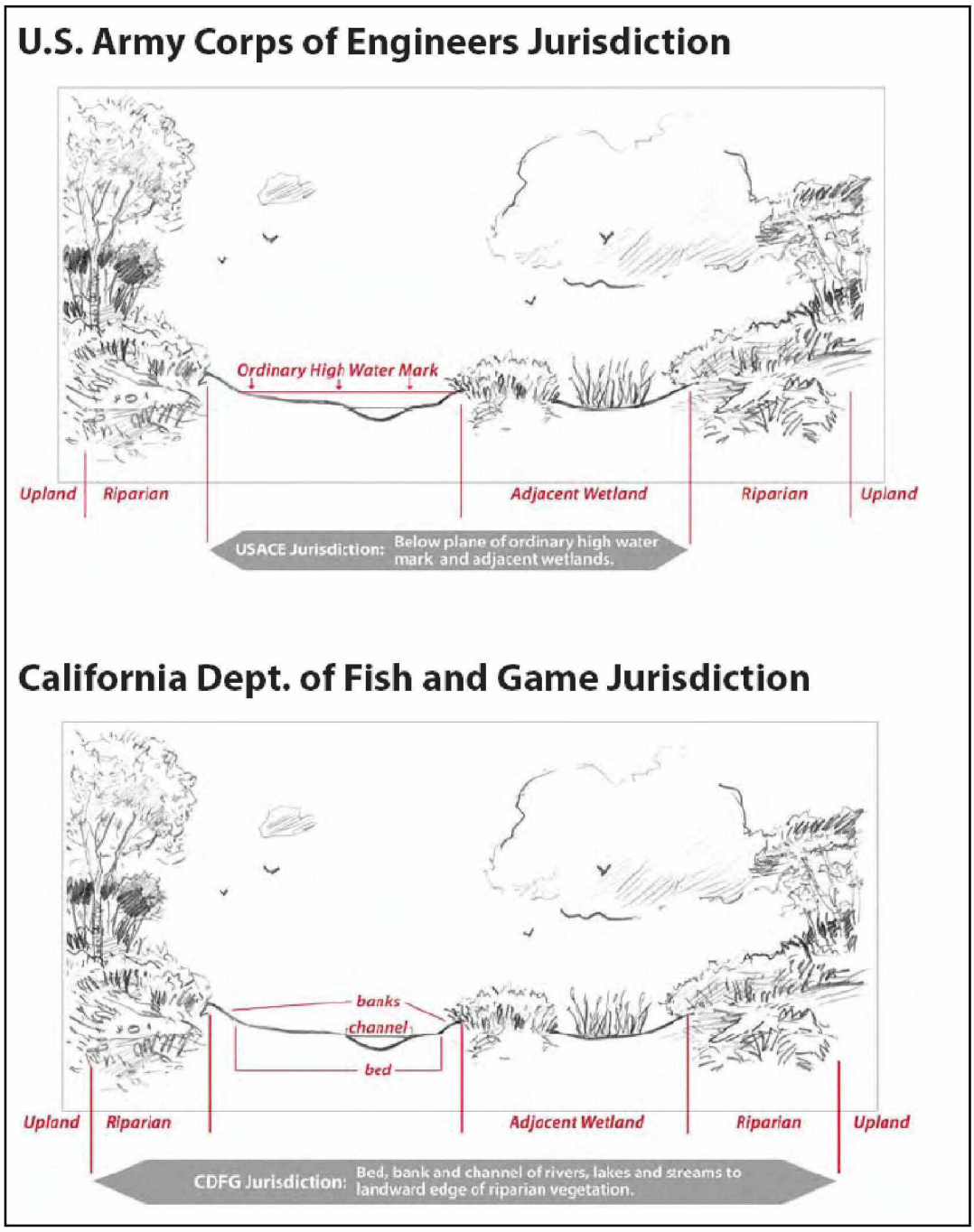


Figure 4-1. Jurisdictional boundaries of Waters of the State (bottom) and Waters of the United States (top). From Permitting Stream and Wetland Projects in Ventura County.

Many issues should be considered in determining the appropriate width of setbacks: fuel modification, placement of features to improve stormwater infiltration and water quality, presence of septic systems and percolation ability, room for management of conservation easements, access for stream monitoring, protection of riparian/riverine habitat, protection of sensitive wildlife habitat on slopes above streams, and trail placement. There should be no septic systems in this setback, no grading, no fencing, no fuel breaks, and plenty of space for protective vegetation to buffer the watercourse from adverse inputs such as unfiltered runoff and pollutants. Vegetated setbacks are known to filter excess nitrogen in runoff that is otherwise a major pollutant of streams and buffers over. In an analysis of many studies, buffers become more efficient filters with increased width, filtering on average 50%, 75% and 90% of nitrogen at about 34, 118 and 134 m, respectively (Mayer et al. 2005).

Figure 4-2. Inappropriate clearing of steep slopes above watercourses promotes erosion and sedimentation of streams.

The State requires that structures have a 100-foot fuel modification zone (horizontal distance). Such fuel modification is dictated to be within the footprint of development, but if a wide setback area contains a trail, that clear area might be logically counted as part of the fuel modification zone. If a trail is included, then the setback needs to incorporate room for the trail without impinging on riparian vegetation, water quality, and sensitive wildlife. If the trail is for equestrian use, large setbacks may be needed to protect water quality. Multiuse trails within a setback need to be placed no closer than 10-feet to the outer edge of riparian forest and top of bank. In areas with a riparian forest, it is preferred to limit the trail to one side of a riparian corridor to protect the integrity of important botanical and wildlife resources (Jones and Stokes 1999). Trail segments should be placed on disturbed areas wherever possible and away from sensitive breeding areas. For watercourses with streams, design crossings should be placed in the least sensitive areas and not exceed one per 500 linear feet (Jones and Stokes 1999). Pedestrian bridges for trail crossings should be constructed over sensitive riparian areas, not through them at ground level.

The California Department of Fish and Game (CDFG) recommends large setbacks for different activities or land use developments. In gently sloping areas, CDFG recommends a 150-foot setback from the outer edge of the canopy of riparian vegetation, especially if the area is occupied by rare, threatened or endangered species. Some local species of terrestrial wildlife need as much as 1,500 feet of upland buffer adjacent to riparian (Jones and Stokes study on riparian buffers.).

Recommendation 4: Model Setback Policy

- Establish a flexible, model setback policy that considers variable topography and dynamic stream conditions (see Table 4-1)

The CCAC recommends that a flexible model for setback policy be included in the ordinance. The setback model needs to take into account variable topography, slope, the permeability of substrates, flow velocity, and the dynamic nature of stream meandering. The steeper the land, the higher the velocity of runoff, and the lower the filtering of chemical pollutants and sediments carried in runoff. Substrate type is also important. Vertical alluvial banks that drop off into an arroyo can be very unstable, experience undercutting and bank collapse during major storm events, and high flow volume and rates (Figure 4-3, 4-4). Due to severe erosion sensitivity, and constant changes in the path of the water (stream meander), such areas should have wider setbacks than areas where channels cut through bedrock. An appropriate setback along highly erosive segments of watercourses could be at least 100 to 150-feet from erosive edges. On the other hand, solid bedrock provides little opportunity for infiltration and cleansing of runoff from adjacent land. If bedrock is extensive, setbacks need to large enough to incorporate a permeable vegetated buffer. Land uses, slope, substrate type and erosion sensitivity need to be considered in determining appropriate setbacks.

The County and City should provide decision rules to determine setback width under different sets of conditions. A number of buffer models are described in by Wenger (1999) in a review of riparian buffer widths. Intuitively, for vegetated slopes/banks climbing out of a 100-year flood plain at a very steep angle (slopes greater than 30 percent), it would be beneficial to preserve the entire steep slope and vegetative cover and enough area to allow migration of the channel as streams erode banks and change

Figure 4-3. Eroding banks resulting in private property loss.

Figure 4-4. Inadequate setbacks and grading result in erosion.

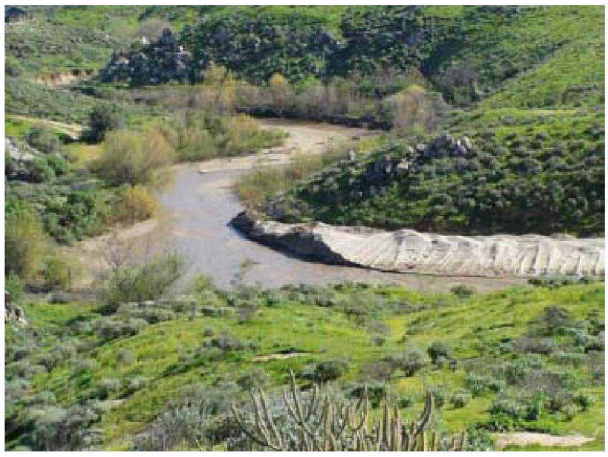


Figure 4-5. Upstream erosion requires sediment removal after storms.

course over time. This would protect and preserve water quality and sensitive riparian/riverine habitat in the long run. Such wide setbacks can sometimes incorporate trails without loss of important buffering capacity.

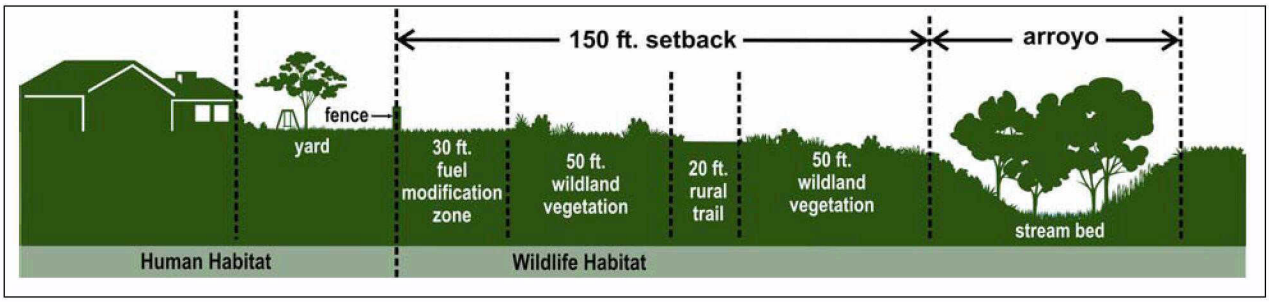


Figure 4-6. Example of protective setback to arroyo that incorporates recreational trail and places a fuel modification zone on flat land within footprint of development. (Figure provided by the Riverside-Corona Resource Conservation District from 2004 Newsletter dedicated to arroyos.)

Title 17 of the Riverside City Ordinance provides this type of model. In this case, the setback begins at the point where the slope flattens out to less than 30 percent "average natural slope." The City requires a 50-foot setback on either side of the arroyo bank from the top edge. For areas with stable, vegetated ground, permeable surfaces, and shallow slopes (<5%) above a solid rock stream channel, a 50-foot setback may be sufficient to protect water quality and guard against erosion. However, if there are impervious surfaces and steeper slopes, or if the riparian area also needs to serve as a wildlife corridor or filter to excess nutrients, there is ample evidence that setback of 150-feet increases the benefit of the buffer (Wenger 1999; Mayer 2005). Likewise, if the channel is cut through vegetated areas with deep, unstable soils, a 50-foot setback may be too narrow to provide adequate protection of developed areas against slope failure as streams meander over time. Depending on the type of vegetation cover and substrate a wider buffer than 50-feet may be needed. In areas with meandering watercourses through unstable substrate, 150-foot setbacks may be appropriate to allow changes in the watercourse over time. Table 3-1 includes CCAC recommendations for setbacks under varying conditions.

Figure 4-7. Denuded arroyo slopes resulting from inappropriate clearing of protective vegetation in "buffer".

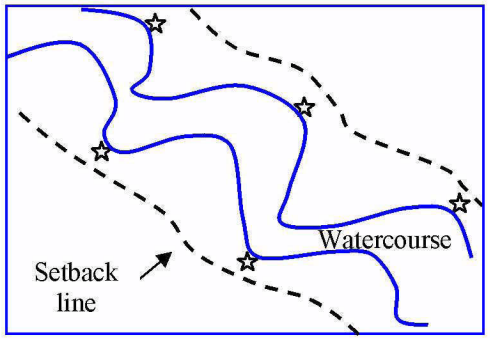
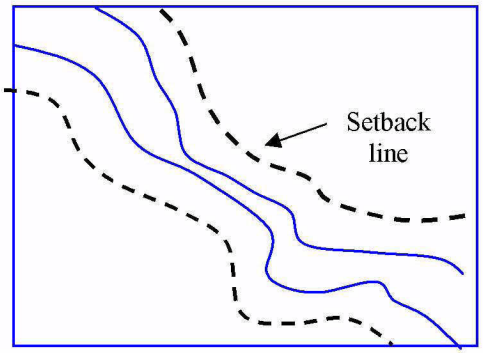
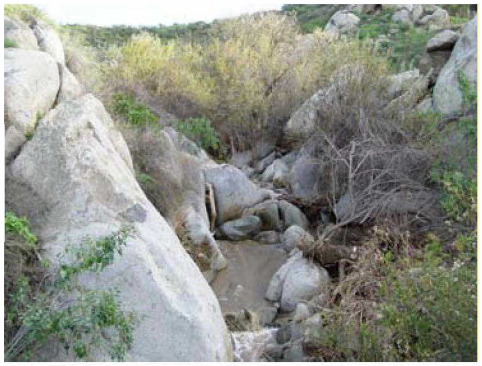
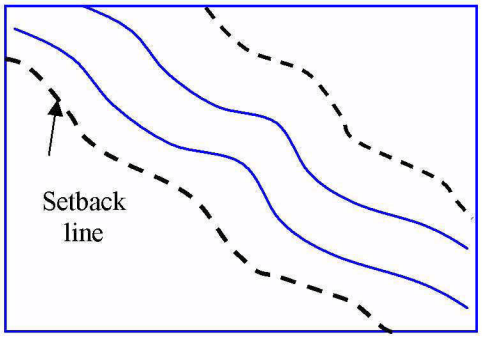
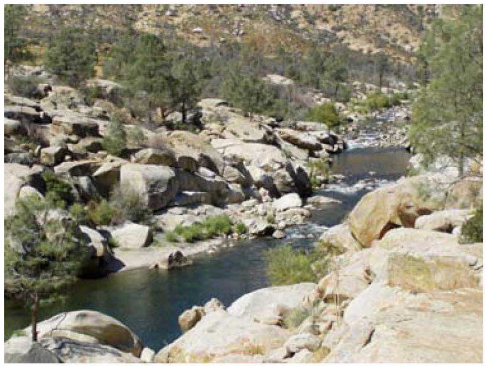
If adopted by the County, a setback model similar to the City of Riverside and California Department of Fish and Game for establishing setbacks to steep-sided arroyos and other watercourses would provide improved protection of arroyos and other watercourses, and facilitate cooperation among agencies. Furthermore, consistent models for setbacks and land use along arroyos and watercourses could provide improved ability to connect City and

County trail networks and avoid difficulties during annexation of unincorporated areas of the County by the City. Of particular concern, when there are inadequate setbacks to the slopes of arroyos or watercourses, homeowners often remove protective vegetation to create fuel breaks along steep slopes adjacent to watercourses. This causes various problems, most significantly severe erosion and sedimentation (Figure 4-7).

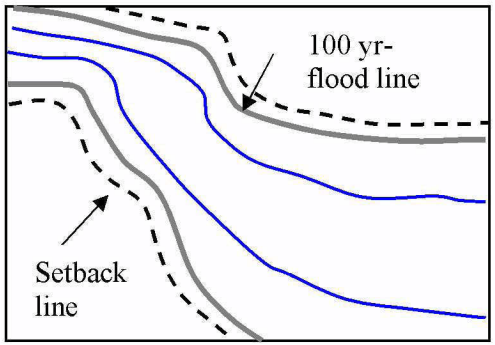
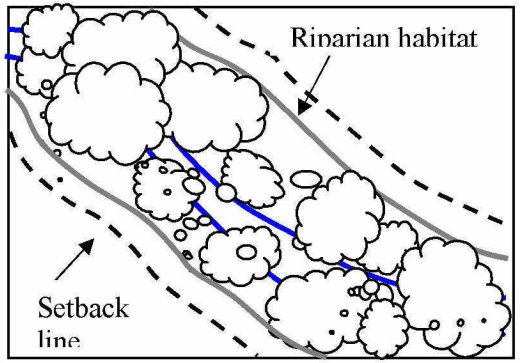
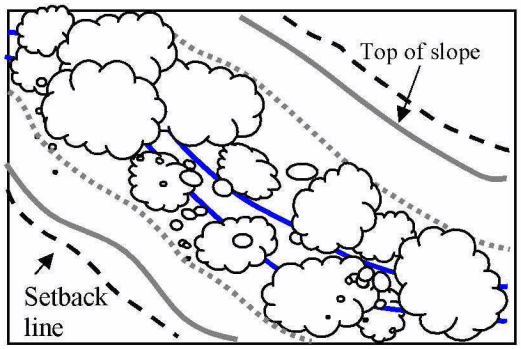
Some of the elements of concern (modified from list provided to CCAC from CDFG) in configuring a model for setback width include:

- Access for management
- Incorporation of linear open spaces
- Integration of trail system. Increase setbacks depending on type of trail. Horse trails may need wide setbacks to mitigate effects of urine and feces on water quality.
- Lighting from neighboring development. Light should not spill into jurisdictional wetlands and riparian areas. "Dark skies" lighting is encouraged.
- Protection of nesting bird locations may sometimes require 200-foot setbacks.
- Vegetation removal on steep banks causes erosion and sedimentation of streams. Vegetation protects soil and increases infiltration of water, thereby cleansing water before it reaches groundwater or streams.
- Fuel modification zones need to be on flatter areas outside of arroyos and watercourses, and preferably outside of setbacks so that steep slopes and buffers retain protective vegetation.
- Protection from flammable structures and fill.
- Decrease invasion of non-native plants into riparian areas.
- Sanitary systems/septic tanks/settling pits--at least 100 to 150-feet from edge of banks, allowing for watercourse meander. Leach fields at least 50 to 100-feet (greater if fractured bedrock exists).
- Irrigation with reclaimed water--no closer than 100 to 150-feet to riparian or jurisdictional area.
- No removal of native vegetation and no planting of exotic vegetation within arroyos or watercourses, or their setbacks

Table 4-1. Watercourse Context and Setback Needs Under Varying Circumstances. Watercourses are blue in diagrams.

Context Diagram	Context and Setback Needs	Photograph
	**Meandering stream with variable channel width** A wide setback to channel of watercourse can allow for changes in meander over time. Measuring setback lines from outer curves of channel, noted with stars, can create more room for channel (cannel is within solid lines, in blue). Example is Alessandro Arroyo.	
	**A confined stream with drop in elevation.** This stream reach is somewhat confined from meandering and erosion. Measuring setback lines from the top of the bank at top of slope would be appropriate, but variation in channel elevation may require multiple setback reference and width. Example is Alessandro Arroyo.	
	**Bedrock lined and edged channel.** There is little ability for runoff to infiltrate, but stream channel (solid lines) is relatively stable and confined. Setback lines can be of uniform width.. Example is Kern River	

32-49

Context Diagram	Context and Setback Needs	Photograph
	**Sandy wash below narrow, upland channel.** Upper end of wash is narrow, grading into a riparian area with steep slopes. Lower end of wash is broad and less confined. Flood plain broadens in lower area. Inner edge of setback can be defined by a combination of 100 yr-flood line, and top of bank, which ever is further from edge of channel. Example is middle Prenda Arroyo	
	**Riparian area along channel with perennial water bordered by flatter slopes.** Here, the beginning of setback would be measured from the edge of the riparian vegetation or the 100 yr-flood line, which ever is greater distance from channel. This is a good condition for establishing a linear park with trail system. Example is middle Alessandro Arroyo	
	**Riparian area with perennial water and steep banks.** Native vegetation on steep slopes protects watercourse and riparian area from excessive runoff and erosion. Setback would begin from top of steep slope where flattens out to < 30 %. Example is upper Prenda Arroyo	

32-50

Recommendation 5: Setbacks to Golf Courses

- Provide adequate setbacks, at least 50 ft, to existing and proposed golf courses adjacent to arroyos and watercourses.

Setbacks to golf courses are important because of the copious water, fertilizer, and pesticides used to maintain greens and fairways. Too much direct runoff can also cause failure of banks. Water should not be allowed to drain directly into streams without first being cleansed and allowed to infiltrate through a bioswale or other water quality/water infiltration feature. In addition, turf grasses, including hybrid Bermuda, invade riparian banks and channels and should be setback sufficiently to deter invasion. Use of poison for gopher and ground squirrel control is also dangerous to wildlife. In addition, setbacks should be wide enough to deter ball play into arroyos and watercourses, especially those with riparian vegetation that is habitat for rare and endangered species of wildlife. Ball play should never be across or towards a riparian area.

Figure 4-8. Bermuda grass invasion. If no setback is provided, Bermuda grass readily invades riparian areas adjacent to golf course.

4.4 SLOPES, SETBACKS, AND MANAGEMENT OF LOT SIZES

In the western United States, a wide range of permitted land uses have been associated with varying steepness of slope. When the slopes are part of a watercourse with riparian vegetation and streams, the CCAC recommends using the more conservative, restrictive land use to adequately protect watercourses and property. A *City of Glendora Hillside Overview* (LSA

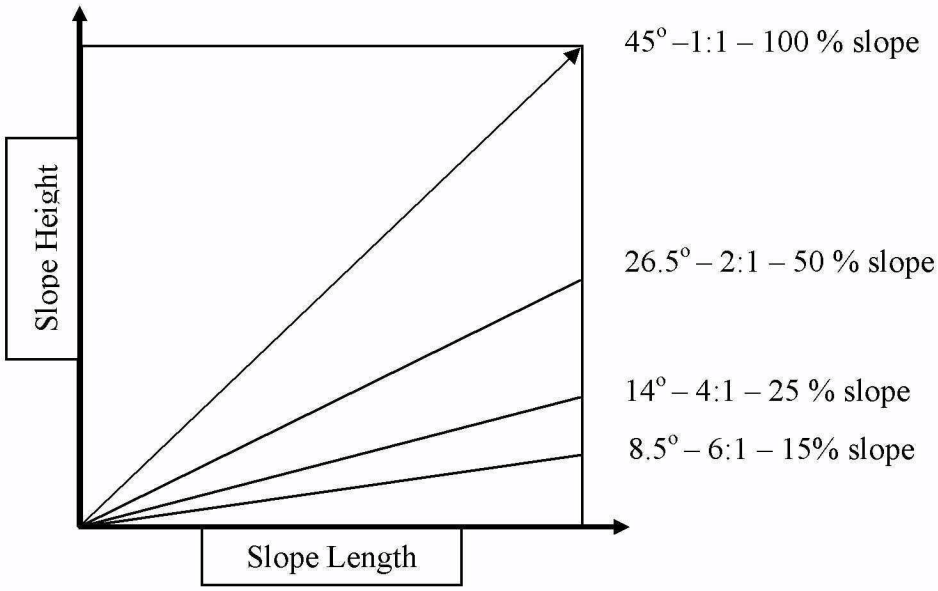


Figure 4-9. Three measures of slope steepness. See glossary for definitions and calculations. *Source: APA Hillside Grading Seminar, May 1991.*

Associates 2002) identified slope problems and land management criteria associated with four categories of slope in Figure 4-10.

Less than 15 percent – These lands are not generally considered to be hillside for management purposes due to the absence of problems related to slope, although rolling land with slopes greater than 5 percent are commonly considered to be hills. Permitted land uses and density/intensity of development are generally determined by underlying zoning.

15 to 25 percent – At about 15 percent, slopes begin to create problems for development. Above 12 to 15 percent, roads must run diagonal rather than perpendicular to slopes, as 12 to 15 percent roads are the steepest that are comfortable and safe to drive on, except for very short distances. Grading becomes difficult at this steepness, as roads and buildings require extensive cut and fill of earth. The more restrictive hillside ordinances prohibit development on slopes in excess of 20 percent, or limit the maximum allowable density to 1 dwelling unit (du)/10 acres (ac), while other ordinances limit density to approximately 1 du/ac or 50 to 75 percent of comparable flat land densities within the underlying zone.

25 to 35 percent – Slope becomes a critical factor in development at this steepness. Large parcels are often required because of the extensive cut and fill needed to create roadways and level building pads. Access between roadways and building pads is difficult, and the design of individual lots and buildings to fit site specific terrain conditions is important. Moderately restrictive ordinances begin prohibiting development or limiting density to 1 du/10 or 20 ac. Where development is permitted, uses are generally limited to single family residential. Other ordinances limit density to approximately 1 du/2 or 3 ac or 25 to 50 percent of comparable flat land densities within the underlying zone.

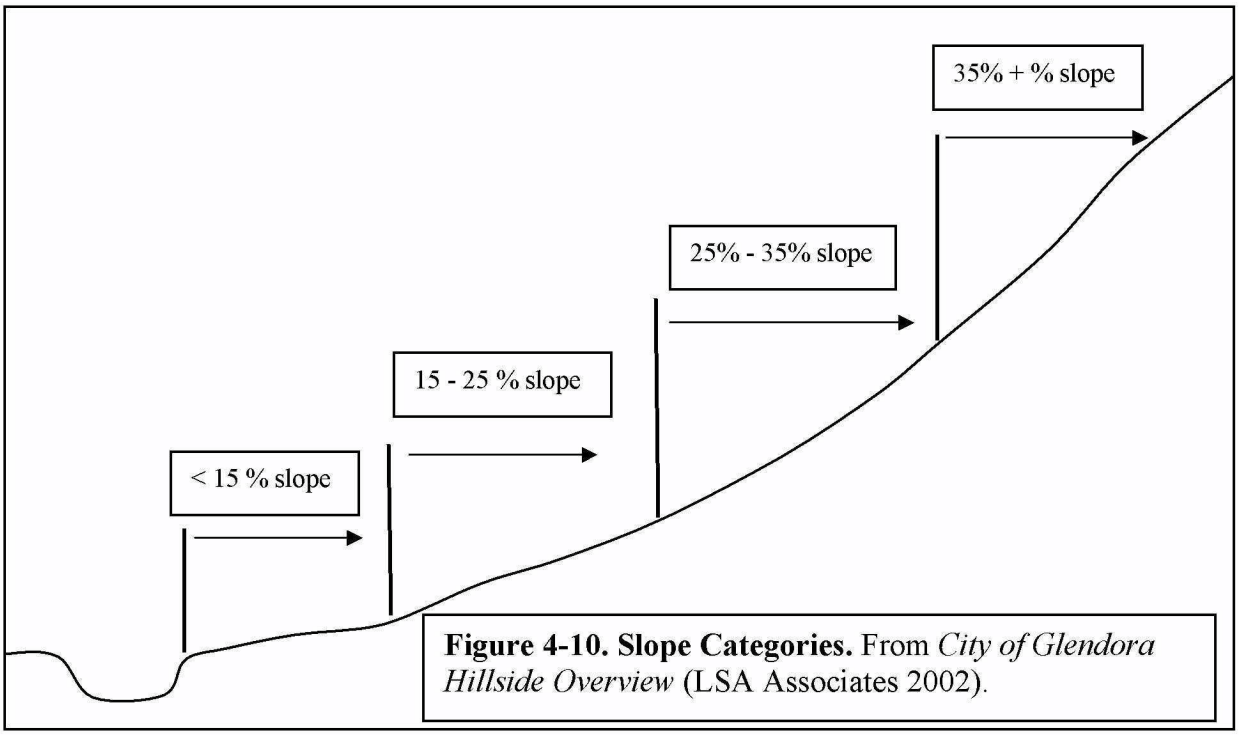


Figure 4-10. Slope Categories. From *City of Glendora Hillside Overview* (LSA Associates 2002).

Over 35 percent – Slope of this steepness is extremely critical. Allowable steepness of cut and fill slopes (50 percent) approaches or exceeds natural slopes, resulting in very large cuts and fills or the need for retaining walls for creating even small flat areas. By and large, roads should not penetrate terrain of this steepness. Because of grading problems, individual sites and homes need to be custom designed. Grading in slopes exceeding 50 percent can result in extreme disturbances, and are generally considered to be un-developable. Only natural building sites within large areas in this steepness category can be developed without extreme disturbance and high costs. Development is prohibited or highly restricted (1 du/40 ac), and uses are limited to single family residential and open space. Where development is permitted, density generally is restricted to 1 du/5 ac or 25 percent of comparable flat land density.

Recommendation 6: Associating Slope, Lot Size, and Setback Distance

A Graded Topographic/Morphological model for determining lot sizes and setbacks to watercourses can protect slopes and banks of arroyos and other watercourses. Lot size along watercourses has a profound influence on the protection of arroyos and other watercourses. CCAC recommends the City and County consider zoning land along all watercourses in a way that provides a minimum lot size and a minimum setback width suitable for extended protection of watercourses.

Recurring problems identified in development plans approved by the City and County currently include:

- Designed grading encroachment into riparian and floodplain zones which impacts hydrological and habitat function as well as endangers residents and property during storm events;
- Use of large areas within a watercourse or floodplain to obtain minimum acreage for maximum density purposes;
- Use of large areas within a watercourse or floodplain to obtain the minimum acreage necessary for a septic system;
- Crowding of long narrow lots that perpendicularly intersect arroyos and watercourses and complicates protection and management of watercourses; and
- Use of setback areas and public lands in complying with fuel modification requirements.

Investigating site characteristics and creative options can be useful. For example, consider transfer of development rights with clustering of structures onto flatter areas, as determined by **Sectional Slope Analysis,** (see glossary), while being careful to avoid density bonuses near watercourses. In addition, houses can be setback so that fuel modification does not have to occur on steep slopes with native vegetation that protects and stabilizes slopes and thereby watercourses.

CCAC suggests modifying the County Land Use Ordinance using a model similar to the City of Riverside's *Title 17 Grading.* In Title 17, a 50-foot protective setback to an arroyo begins at the point where the slope flattens out to less than 30% **Average Natural Slope** (see glossary). This could be modified so that all structures would be setback far enough so that fuel modification

does not have to occur on steep slopes of arroyos or in the protective setbacks. Such a model could be developed in a GIS model, together with alternative models for determining setbacks. In the City ordinance, lot size also increases with steepness of slope, making it easier for maintenance of an adequate setback. In addition, native vegetation is not supposed to be removed outside the graded pads. Limiting lot sizes along steep slopes of arroyos and protecting vegetation on these slopes is a progressive approach to limiting excessive runoff, erosion, and degradation of watercourses.

The CCAC recommends setback width take into consideration the overall topography and geology of arroyos and watercourses. Suggested setback and lot sizes should be determined using the **Sectional Slope Analysis (SSA)** of the parcel, as determined by a qualified engineer. CCAC recommends development of a model that varies setbacks and parcel sizes according to steepness of slope, type of watercourse, underlying substrate, and wildlife value of a watercourse and its corridor.

Table 4-2. Recommended Lot Size and Setback Schedule

Sectional Slope Analysis (% Slope)	Minimum Lot Size (acres)	Minimum Setback from 100-Year Floodplain to Graded Pads (feet)	Minimum Setback from top edge of slope to graded pad when slope > 30% (feet)	Setback w/ Unstable Substrate, Impervious Soil, or Bedrock (feet)	Setback w/ Wildlife Corridor for Terrestrial Species* (feet)	Setback w/ Fuel Modification Zone ** (feet)	Setback w/ Trail (feet)
0 to 15%	1	50	n/a	75 to 100 ft	Add 250 ft	Add 100 ft	Add 25 ft
>15 to 20%	2	50	n/a	75 to 100 ft	Add 250 ft	Add 100 ft	Add 25 ft
>20 to 25%	5	75	n/a	115 to 150 ft	Add 225 ft	Add 100 ft	Add 25 ft
>25 to 30%	10	100	n/a	150 to 200 ft	Add 200 ft	Add 100 ft	Add 25 ft
>30 to 40%	20	150	50	225 to 300 ft	Add 150 ft	Add 100 ft	Add 25 ft
>40%	No Building Allowed						

*Increase from outer edge of minimum setback. If watercourse is deeply incised with steep slopes, add enough distance for wildlife to escape high storm flows even if watercourse is not targeted as major wildlife corridor.

**Increase so that any structure is 100 ft from outer edge of vegetated setback (already adjusted for unstable or impervious substrate) to structures

As land surrounding a watercourse grows steeper and the slope distance increases, lot sizes and setbacks to the watercourse should get larger. Minimum setbacks from the edge of floodplains or top-of-slope include areas with stable, porous substrate and vegetative cover. Setbacks should be increased by 50 to 100%, depending on severity of condition, in areas with unstable substrates, impervious soil, or bedrock. Slope and setback should be linked, but can vary depending on underlying substrate, wildlife corridor needs, and fuel modification requirements

of the site. CCAC recommends that the City and County adopt lot size and setback requirements based on the Lot Size and Setback Schedule presented in Table 4-2.

With some types of agriculture, it may be appropriate to reduce the width of a riparian buffer to 50 ft. However, herds of grazing animals are known to decrease vegetation and compact soils on banks and slopes by watercourses, thus decreasing rainwater infiltration and increasing runoff.

4.5 SENSITIVE ARROYO AND WATERCOURSE CROSSINGS

New road crossings over or through watercourses, especially arroyos, should be discouraged in all new and existing development. A set of new guidelines for necessary crossings is needed to ensure adequate protection of arroyos, watercourses, and watershed resources. It is most important to deter crossing designs that interrupt the natural flow of water within watercourses as well as eliminate the ability for wildlife to use these corridors for movement. New crossing projects should use design techniques and products that allow for a natural free-flowing stream rather than the standard culvert pipes used today. Small culvert pipes that constrict channels and change flow rates are not recommended.

Figure 4-11. Example bridge design that allows unimpeded water flow and movement of wildlife along watercourse.

Recommendation 7: Design Guidelines for Bridging Systems

Bridging systems should provide crossings over rather than within watercourses and should avoid impacts to channels and riparian resources. CCAC recommends that design guidelines for economical and ecological "bridging" systems be studied, prioritized, and incorporated by both the City and County. Crossings should be aesthetically pleasing and open to allow the free movement of water, wildlife, and watercourse maintenance teams.

- Custom bridging systems designed and constructed for the specific physical and aesthetic considerations of the site/crossing should be encouraged as a first priority.
- Large soft-bottomed box culverts and prefabricated bridging systems for road crossings are an acceptable alternative to the custom bridge. There are prefabricated products on the market that can be used to span watercourses in a more sensitive and aesthetic way. These bridge systems are fast and economical and can avoid the need for streambed alterations that require extensive permitting and mitigation.

- Pedestrian bridges should be required for all trail crossings over streams, particularly for stream corridors containing sensitive riparian habitat. Again, many appropriate, attractive prefabricated options are available.
- For very wide stream corridors, a regular bridge may be needed. However, bridges can provide structure needed for utility crossings.

4.6 CONSERVATION EASEMENTS AND CONSERVATION LOTS

CCAC has submitted draft recommendations for the contents of agreements for conservation open space easements in a separate document and is awaiting feedback from City and County staff. A revised draft of recommended language for a conservation open space agreement is in Appendix 7.2. When delineating watercourse easements or lots, create boundaries that include logical, natural topographic configurations rather than confining lot or easement to a static or narrow channel that ignores the dynamic nature of the stream channel. Only "see through" fencing should be installed and only to the outside of setbacks, away from watercourse edge. Any fuel modification (such as thinning of shrubs and mowing of weedy invasive grasses) should be done in a designated fuel modification zone outside the protective setback to a watercourse and should occur on the flatter land and within the footprint of the developed areas, rather than within the conservation zone. Do not include the steep slopes of an arroyo or watercourse in the fuel modification zone. No disking of vegetation should be allowed on steep slopes or within the setback to a watercourse. The steep slopes of an arroyo or watercourse should retain vegetation cover to prevent erosion of the banks and reduce sedimentation of the watercourse. The canopy of the riparian vegetation should not be disturbed. A condition should state that no non-native species shall be planted within the open space areas and that native vegetation shall be conserved. Motorized vehicles should be prohibited (except for maintenance purposes). Lighting should never be directed toward a conservation easement.

It is unusual for a Home Owners Association (HOA) to have the knowledge and ability to properly manage sensitive watercourse sites. CCAC suggests consideration of a policy that if an HOA holds title to a lot traversed by an arroyo or watercourse, Open Space Lot, or Conservation Easement, that it employ an experienced non-profit conservation organization or agency to manage and maintain the lot. Alternatively, the land owner can provide for a Conservation Easement or Conservation Lot in fee title to a conservation organization with an endowment or other mechanism to finance management. It is important that a conservation and management plan (including a draft fire management plan) be properly approved with conditions that protect watercourses prior to recording a tract map.

Recommendation 8: Conservation Easements and Conservation Lots

Conservation lands can be easements or lots in fee title that are dedicated as open space for conservation of native plants, animals, and natural resources.

- Easement boundaries should conform to setback conditions to preserve the natural boundary of a watercourse and take into consideration the dynamic nature of the watercourse.
- Only "see through" fencing permitted and limited to the outside of setbacks, never across channel of watercourse where it could block flow, or between open space areas.

- Fuel modification only in non-sloped portions of easement outside of setback.
- No planting of invasive species or removal of native species.
- No lighting of watercourse area.
- Homeowner's Associations should employ an experienced non-profit conservation group to manage /maintain the conservation easement.
- No OHV use.
- Alternatively, developers provide for a conservation lot in fee title to a conservation organization with an endowment to finance management of the conservation lot.
- No grazing except for fire and weed management under close supervision.

4.7 STORMWATER RUNOFF AND WATER QUALITY STRUCTURES

All types of watercourses need to be protected from increased runoff from development and redevelopment. Watercourses need to be safe from pollution inputs. Vegetated water quality structures (such as detention basins and bio-swales) are being installed in many locations to slow and filter water before it enters a stream within a watercourse or other waterbody. Such structures should be planted with native plants appropriate for site conditions and the local natural conditions. Non-native species that can invade natural watercourses should be prohibited. There is a severe problem with invasive species along watercourses and in wetlands. See Appendix 7.9-710 for lists of appropriate and inappropriate plant species, respectively.

Recommendation 9: Water Quality Protection

- Stormwater detention basins, recharge basins, water quality basins, or similar larger scale water capture devices should be incorporated into projects according to the conditions of the site and project scope. In the event such facilities are used, sensitive design and placement for ecological and aesthetic conditions should be required. If at all possible, such facilities should be designed for multiple purposes such as parks, playgrounds, street medians, or habitat, and so on. Facilities should treat water before entering a watercourse. They should not be in a watercourse.
- Biofiltration measures should be incorporated into the site plan and site design, such as the use of engineered bio-swales that slow and filter urban water runoff before entering an arroyo or watercourse.

Encourage Comprehensive Design Models

Many opportunities exist for improving the relationship between urban land uses and arroyos/watercourses within the CCAC project area. A new comprehensive design model is needed for new and redeveloping areas in and adjacent to arroyos and watercourses that embrace and benefit from the natural character of the site. Communities across the U.S. have adopted new land use policies that provide comprehensive design models and are approving new development/redevelopment that incorporate low impact development and green infrastructure scenarios. These projects not only provide environmental success for those communities, but also are proven financial successes for developers, with economic returns for communities because people have a greater desire to live near natural and scenic spaces.

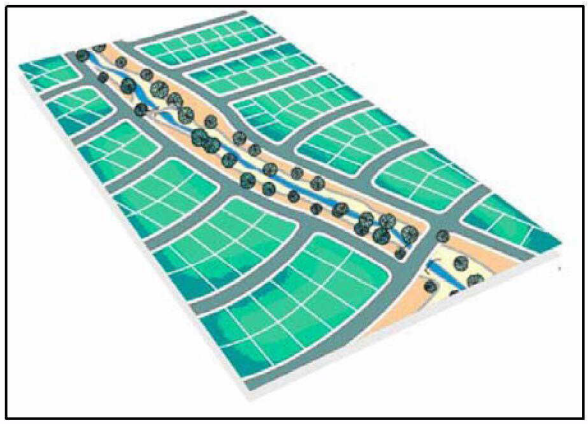


Figure 4-13. SENSITIVE SITE DESIGN, Parallel Streets. Parallel streets running along the watercourse or arroyo provides an opportunity for riparian and watercourse buffers and trail corridors, as well as streets as fuel modification zones. It eliminates all rear yard exposure to the arroyo.

Source: Santa Clara Valley Water District *User Manual: Guidelines and Standards for Land Use Near Streams*

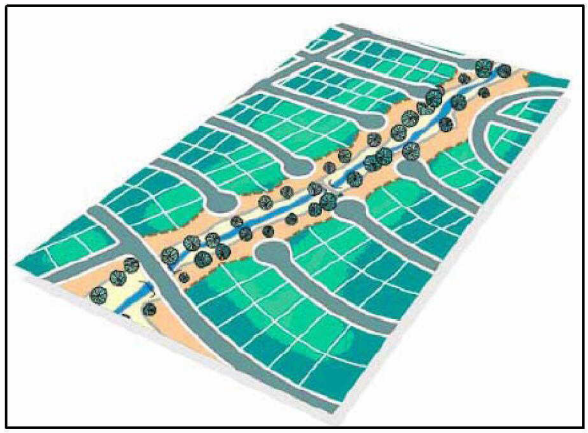


Figure 4-14. SENSITIVE SITE DESIGN, Cul-de-Sacs. Cul-de-sacs perpendicular to the setback buffer eliminates all rear yard exposure to the arroyo but includes some side-yard exposure. Requires additional setback for fuel modification and trail corridor. Provides opportunity for neighborhood runoff capture and biofiltration.

Source: Santa Clara Valley Water District *User Manual: Guidelines and Standards for Land Use Near Streams*

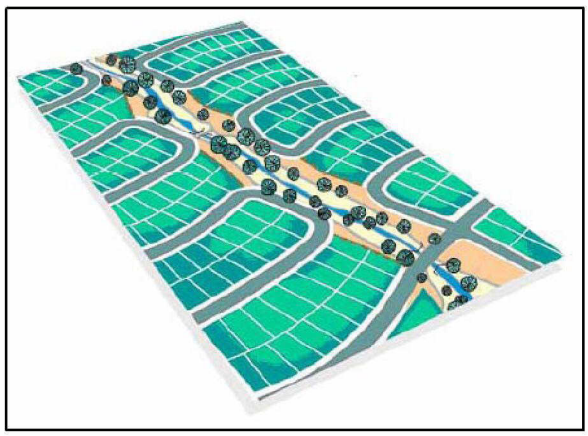


Figure 4-15. SENSITIVE SITE DESIGN, Minor Loop Streets. Minor loop streets eliminate all rear yard exposure to the arroyo but includes some side-yard exposure. Requires additional setback for fuel modification adjacent to side yards but streets can act in such capacity at the loop. Provides neighborhood connection to open space.

Source: Santa Clara Valley Water District *User Manual: Guidelines and Standards for Land Use Near Streams*

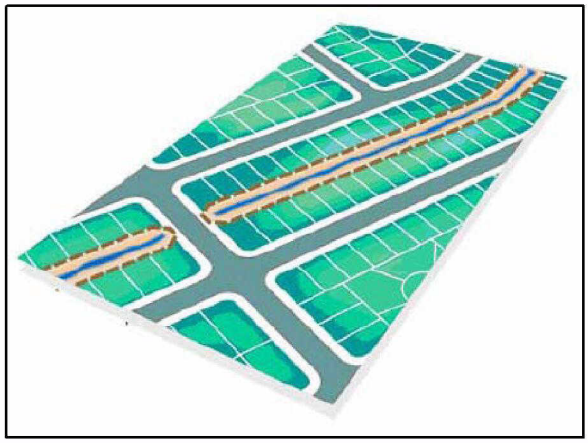


Figure 4-16. HARMFUL SITE DESIGN, Backyard Exposure. Backyard exposure to watercourses and arroyos damages riparian and upland habitat and watershed systems. The arroyo is cut off from the neighborhood allowing it to become a detriment rather than an asset. Requires additional setback for fuel modification and trail corridors.

Source: Santa Clara Valley Water District *User Manual: Guidelines and Standards for Land Use Near Streams*

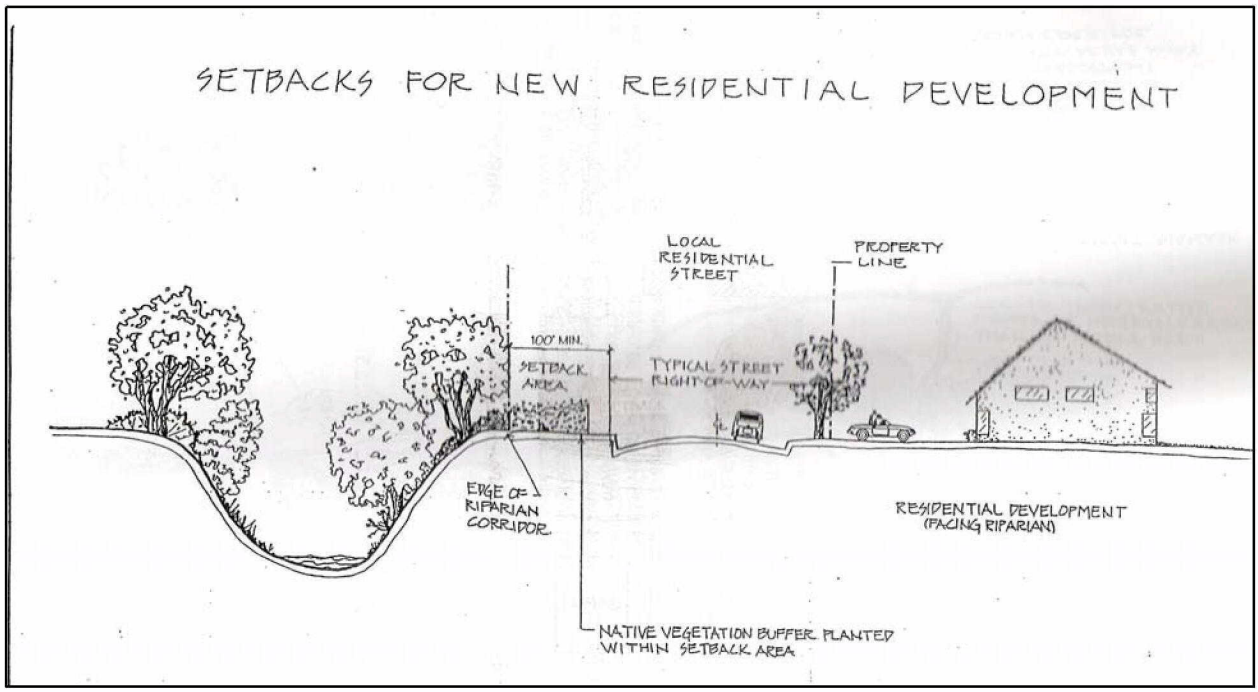


Figure 4-17. Example of sensitive development along arroyos. Source: *Jones and Stokes 1999, Riparian Corridor Policy Study for City of San Jose, California.*

Recommendation 10: Arroyos/Watercourses as Neighborhood Amenities

- Street alignments should be placed between the house and the arroyo/watercourse.
- Open space corridor, park strip, and/or trails should be placed between street and arroyo/watercourse.

Rather than situating houses with backyards protruding into arroyos or watercourses, and allowing fire clearance on steep slopes, houses should face arroyos or watercourses with the street and trail between homes and top border of arroyo or watercourse (see Figure 4-17). This scenario provides a scenic area to the public and a firebreak between homes and native vegetation. Depending on the terrain, trails could be placed on the edge of the firebreak along the top edge of watercourses and meander across watercourses in relatively flat areas or where vegetation is open and the likelihood of

Figure 4-18. An example of permeable paving in parking strips.

disturbing nesting birds is minimized. In this way, homes would face open spaces instead of separation from watercourses by walls. Homeowners would take more pride and ownership of open space. This model should also have provisions for homes along arroyos and watercourses that include placing individual sanitary (septic) systems along the back of the property - as far away from the arroyos or watercourses as possible.

Recommendation 11: Stormwater Management and Runoff Reduction as a Design Element

- Incorporate use of permeable paving materials for parking surfaces, driveways, sidewalks and other surfaces requiring hard materials.
- Disconnect sidewalks by relocating them away from the roadway or directing their runoff into an open drainage system that leads to an infiltration area.
- Build narrower residential streets or restrict parking and sidewalk areas to one side of the road rather than both. The resulting open space creates pervious areas, bioretention facilities, or vegetated bio-swales. Street parking strips can also include permeable paving material.
- Use permeable pavers for emergency stopping areas, crosswalks, sidewalks, road shoulders, on-street parking areas, vehicle crossovers and low-traffic roads.
- Use bioretention cells as rain gardens in landscaped parking lot islands to reduce runoff volume and filter pollutants.
- Use multi-functional open drainage systems in lieu of more conventional curb-and-gutter systems such as a curb and swale system, concave street medians that capture water, and cul-de-sac circles that provide a concave, landscaped circle to capture water.
- Home and public area landscape design that incorporates water capture, biofiltration, and other measures including the use of native plant species and/or noninvasive California friendly plant species.
- Controlled irrigation systems that provide

Figure 4-19. Example of stormwater management and pedestrian crossing.

Figure 4-20. Example of stormwater capture and biofiltration in urban setting.

only the amount of water required and result in no overspray or runoff.

- Retain rooftop runoff in cisterns for later on-lot irrigation use.
- Use green roofs for runoff reduction, energy savings, improved air quality, and enhanced aesthetics.

4.8 RESTRICTED LAND USES FOR WATERCOURSES

Practices that are incompatible with protection of watershed resources, riparian habitat, water quality, and other "beneficial uses" as defined by the Santa Ana Regional Water Quality Control Board should be restricted.

Recommendation 12: Restrict the Use of Septic Systems on the Slopes of Arroyos and Watercourses Outside of Graded Pads

There is a very high density of septic systems in the Santa Ana River watershed. When these systems are positioned in areas with high ground water, multiple watercourses, springs, and either highly porous or impervious soils, the pollution threat can be substantial. Current policy for setbacks is consistent for the County and City except that the minimum lot size is 1 acre in the City, and one half acre in the County. The Uniform Plumbing Code (2006) requires that septic tanks, leach lines, and seepage pits/cesspools be setback from streams and other bodies of water at least 50, 100, and 150 feet respectively. Development plans for both the County and City are examined by the County Department of Environmental Health. Regulations for minimum lot size and setbacks to wells, groundwater, and watercourses may be adequate where percolation through substrate cleanses effluent before entering groundwater, lakes, or streams, but may not be adequate in areas with steep slopes, perched water tables, and multiple or large watercourses. For additional discussion of septic system conditions and needs see Box 3-2 and Appendix 7.8. The installation of septic systems on the slopes of arroyos and watercourses outside of graded pads also causes unnecessary soil disturbance and drainage in the direction of the watercourse. If the ground should become saturated after heavy rains, septic systems on slopes within and next to watercourses can overflow into the watercourse channel. Recommendations to avoid such impacts in these areas include:

- Require septic systems and leach fields to be located away from sensitive steep slopes of arroyos and watercourses and require generous

Box 4-1. Current standards for septic system setbacks in County and City

Minimum lot size for use of septic systems is one (1) acre in the City, and one half (0.5) acre in the County. The minimum setbacks of sewage systems from wells cited by *County* Ordinance No. 682 Section 15 are identical to those cited in City of Riverside Municipal Code Chapter 6.28 Water and Other Wells:

- Sewer, 50 ft
- Watertight septic tank, 100 ft
- Subsurface sewage leach line or leach field, 100 ft
- Cesspool or seepage pit, 150 ft
- Animal or fowl enclosures, 100 ft
- Any surface sewage disposal system discharging 2,000 gal/day or more, 200 ft

In addition, distances to ground water and surface water depend on soil porosity, site slope, so as not to pollute water.

Minimum distances from streams or other water bodies:

- 50 feet to septic tanks
- 100 feet to leach fields
- 150 feet to seepage pits/cesspools feet

(2006 Uniform Plumbing Code). See also Appendix 7.8.

setbacks (at least 100 feet from leach fields to a watercourse) to prevent groundwater or surface water pollution.

- Require a minimum lot size of at least two (2) acres along arroyos and other major watercourses in hilly areas and one (1) acre in areas with < 18% slope to ensure adequate space for setbacks.

Recommendation 13: Restrict New Sewage Pumping Stations Adjacent to Watercourses

For a variety of reasons, sewage pumping stations periodically malfunction. To eliminate problematic overflow of sewage from malfunctioning pumping stations, CCAC recommends the following:

- Locate new sewage pumping stations away from watercourses.
- In the event that locations are limited to an area adjacent to a watercourse, provide appropriate Best Management Practices (BMPs) that result in strong protection for watercourses in the event of an accidental sewage overflow.

Recommendation 14: Restrict Fencing in Arroyos and Watercourse Channels

No arroyo, watercourse channel or bank should be fenced or otherwise obstructed. Free flow of water and debris is necessary. Fencing causes debris dams that can dam or divert streams. Watercourses are also important habitat and movement corridors for wildlife. Fencing obstructs free travel of many native animals. The perimeter of arroyos and watercourses should not use fencing that interferes with the free travel of most animals among the segments of networks of open spaces. To eliminate impacts from fencing in sensitive arroyo and watercourse areas, CCAC recommends the following measures:

- Prohibit fencing across arroyos, watercourses, channels, or banks.
- Require that any residential fencing used in arroyo planning areas be placed on graded pads only.
- Require that any security fencing for public facilities be placed immediately around the facility only and considering water flow and wildlife movement needs.

Recommendation 15: Restrict New Golf Course Development within the Boundaries of Arroyos, Watercourses, and Wetlands.

New golf courses need to protect wetlands and watercourses. Developers should plan projects such that housing and greens are outside of the boundaries of arroyos, watercourses and wetlands. Golf courses can have value as firebreaks between homes and native vegetation, but they are problematic to water quality and other beneficial uses. To eliminate impacts to watercourses from golf courses, the CCAC recommends the following:

- Restrict housing, structures, greens, and landscaping to areas outside the boundaries of arroyos and watercourses.
- Require a minimum 50 to 100-foot setback to watercourses with riparian vegetation for all golf course activities.
- Orient fairways parallel to or away from watercourses.

- Orient driving ranges to avoid hitting balls into riparian areas.
- Use bioswales, infiltration basins, and other water quality and stormwater Best Management Practices (BMPs) to capture, treat, and/or slow runoff before it enters watercourses.
- Utilize Integrated Pest Management measures that reduce the use of pesticides, fertilizers and other additives that impact water and habitat quality in watercourses through runoff.
- Use high-efficiency irrigation systems, regionally-appropriate non-invasive landscape species, minimal turf, and other water use efficiency BMPs to reduce on-site water usage and dry weather runoff.
- Encourage and assist existing golf courses to install water quality, stormwater, and water use efficiency Best Management Practices (BMPs) that protect riparian corridors, reduce irrigation and stormwater runoff, and treat runoff water before it enters watercourses.

Recommendation 16: Restrict Domestic Animal and Farm Livestock Keeping in Arroyos and Watercourses

Keeping domesticated animals and livestock in arroyos and watercourses results in significant loss of native vegetation, denuded landscapes that are prone to erosion, and water quality impacts due to concentrated animal wastes. The CCAC recommends that the City and County:

- Require review and permits for animal keeping near arroyos and watercourses so that the uses can be analyzed and approved according to site-specific circumstances and probable impacts.

Recommendation 17: Restrict Animal Grazing Farm Stock

Under limited conditions, the grazing of farm stock such as horses, cattle, sheep, and goats or other farm stock (not including hogs) can be acceptable but would require large parcels of land (open range areas, hundreds of acres). The CCAC recommends the following measure to ensure that protections are included:

- Require review and permits for animal grazing near arroyos and watercourses so that the uses can be analyzed and approved according to site-specific circumstances and probable impacts.

Recommendation 18: Restrict Nurseries and Agriculture from Placement in Arroyos and Watercourses

Agricultural uses including nurseries, orchards, and other crops often result in significant impacts such as cleared lands, erosion, introduction of non-native invasive species, and runoff water containing pesticides and fertilizers. Placement of these uses should not jeopardize watercourses. Agricultural uses should be avoided or should be very limited in and next to arroyos and watercourses to limit runoff of pesticides and fertilizers and to preserve riparian habitat. The CCAC recommends the following to reduce any impacts from a proposed new agricultural use:

- Require review and permits for new agricultural land adjacent to arroyos and watercourses so that the uses can be analyzed and approved according to site-specific circumstances and probable impacts.
- Encourage and assist existing agricultural uses to install agricultural Best Management Practices (BMPs) that protect riparian corridors, reduce agricultural runoff, and treat runoff water before it enters watercourses.

Recommendation 19: Restrict Telecommunication Towers and Utility Infrastructure within Arroyos and Watercourses

Watercourses are often used inappropriately as conduits for telecommunication and utility infrastructure. Such uses result in increased, inappropriate access to watercourses, habitat damage, facilities in floodplains that require special flood protection measures. The CCAC recommends the following:

- Prohibit telecommunications and utility agency equipment and facilities from being placed in or along arroyos and watercourses.
- Prohibit any new access to existing or future telecommunication or utility facility or corridor from being placed through or in an arroyo or watercourse.
- Require facilities with fuel modification areas that are placed away from watercourses and adjacent slopes.
- Restrict locations of occupied structures to be in accordance with fuel modification requirement of State and Local Governments.

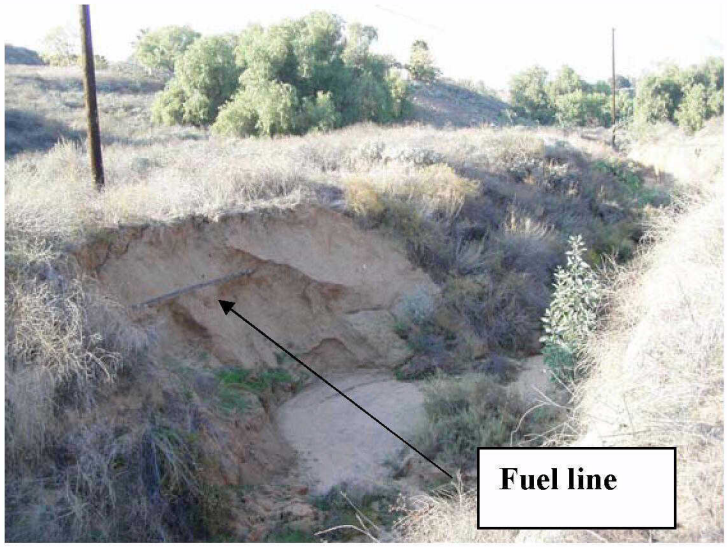


Figure 4-21. Burying utilities along watercourses degrades the site. Erosion can impair the utilities and the watercourse. Site near Watkins Drive.

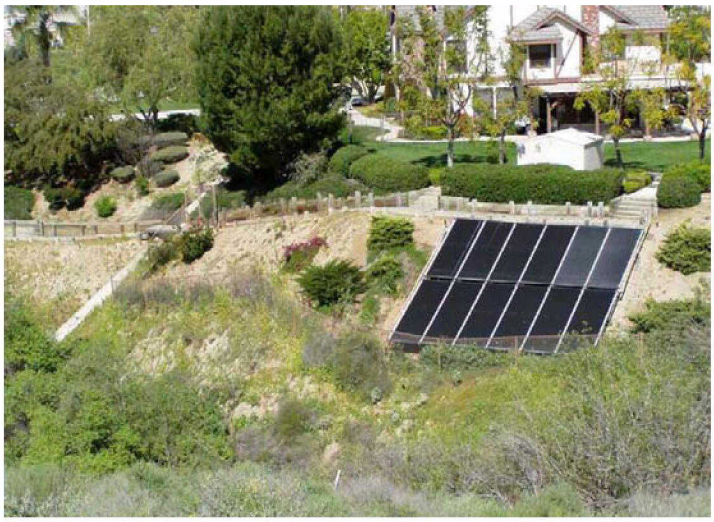


Figure 4-22. Impermeable structures increase runoff and don't belong on slopes of watercourses.

Recommendation 20: Restrict Other Incompatible Operations

Many legal and illegal land uses require operations, technology, materials, and uses that are incompatible with protecting riparian, watercourse, and arroyo resources.

The CCAC recommends that the following uses be prohibited in and adjacent to arroyos and watercourses:

- Prohibit land uses that typically generate litter.
- Prohibit dumping.
- Prohibit off-road vehicle use.
- Prohibit removal of native vegetation.
- Prohibit storage of toxic materials.

4.9 EXCEPTIONS AND EXEMPTIONS TO RECOMMENDED POLICIES

SETBACK EXCEPTIONS

At times it will be appropriate to consider exceptions to the CCAC setback recommendations made in Table 4-2. Exceptions are appropriate only if basic watercourse and riparian habitat protections can be faithfully achieved. The 1999 San Jose Corridor Policy Study guided this section, but further study is needed to tailor the exceptions to the Riverside project area. A draft list of exceptions for the project area includes:

- Sites adjacent to small watercourses or secondary tributaries in which the land use has characteristics that could only adversely affect a watercourse to a distance less than the associated setback width.
- Pre-existing approvals of grading plans for single-family dwellings.
- Sites under redevelopment with uses that are similar to existing use or of significantly less potential to impact a watercourse than the original development, which there is no further decrease in setback, and which occupy less than or equal to the footprint of the previous structure.
- Instances where the land use would protect and enhance the watercourse and habitat to a greater extent than strict adherence to setback width.
- Recreation facilities that are of critical need and for which alternative sites are not available and which include design measures for water quality protection, integrative stormwater management and capture, water use efficiency and runoff capture, appropriate landscape materials and species, etc. as discussed in other recommendations.
- Preexisting parcels of the CCAC recommended lot size that have unusual geometry and/or disproportionately long watercourse frontages.
- Replacement or upgrading of utility or equipment installations which have no significant disturbance to the watercourse or its riparian corridor during construction or operation.
- Development adjacent to a closed culverted section of a watercourse.

If one or more of the above circumstances is present, a reduced setback (up to 25%) may be considered if:

- There is no reasonable alternative which avoids or reduces the encroachment into the setback area.
- The reduced setback will not significantly reduce or adversely impact water quality or a riparian corridor
- Uses are not fundamentally incompatible with riparian habitats
- There is no evidence of stream bank erosion or previous attempts to stabilize the stream banks which could be negatively affected by the proposed development.
- The granting of the exception will not be detrimental or injurious to adjacent and/or downstream or upstream properties or stream function.
- A qualified biologist, stream hydrologist and/or other appropriate professional has confirmed in writing the above conditions as well as a program to achieve habitat protection objectives detailed below.

HABITAT PROTECTION OBJECTIVES (After 1999 San Jose Riparian Corridor Policy Study)

Building, paving and activity setbacks, including reduced setbacks, should always be sufficient to avoid property damage from floods and flood-related erosion and be sufficient to protect habitat values and water quality as follows:

- **Habitat Value:** The habitat value of all riparian/riverine habitats, as provided by the Western Riverside County MSHCP, shall be protected. Shade canopy provided by trees and shrubs is a critical element of riparian quality. Allow no infringement on such habitat such that:
    - New development or activities will not interrupt or threaten the continuity of the riparian habitat and will not preclude restoration of vegetation along a creek channel where upstream and downstream habitats are of good quality.
    - Setbacks are sufficient to protect sensitive species and their habitat from the impacts of human and urban activity. (e.g., noise, lights, pets, traffic)
    - Any encroachment will not significantly reduce the amount of moisture streamside vegetation receives from natural drainage which percolates down from the uplands. On lands adjacent to streams, the vegetation needs rainfall runoff along the banks in order to maintain moist conditions.
    - The ground and vegetation within the riparian corridor remain undisturbed unless disturbance is necessary for resource protection or enhancement purposes or to accommodate a crossing consistent with these guidelines.

- **Protection from Erosion and Stream Meander:** Private property adjacent to or downstream from an eroding and meandering stream channel should be protected from damage due to erosion and sedimentation such that:
    - Buildings and impermeable surfaces should not be constructed where they may be affected by increased flood flows or shifting channels.

- Buildings and impermeable surfaces should not be constructed where they may increase the rate and amount of storm water runoff, erosion and sedimentation. It is particularly important that construction of buildings and impermeable surfaces not be allowed to occur in areas which exceed 15% slope or within the setback to a riparian edge.

- **Water Quality:** Water quality and groundwater recharge should be protected by incorporating conditions which promote:
  - Preservation and control of erosion and sedimentation
  - Preservation of natural drainage systems
  - Protection of wetlands
  - Avoidance of impermeable surfaces on areas mapped as recharge areas
  - Control of site runoff to avoid drainage of toxic or other incompatible substances into the stream and to minimize potential erosion.

EXEMPTIONS TO RECOMMENDED POLICIES

Projects that should be allowed within a watercourse or riparian corridor with an administrative permit following consultation and permitting if required by ACOE, CDFG, or RWQCB include:

- Watercourse and wetland restoration
- Removal of invasive or exotic vegetation
- Removal of hazardous trees
- Channel bank protection and repair
- Other similar riparian habitat improvement projects

Examples of projects that should be allowed within a setback area with an administrative permit include:

- Uses allowed within a riparian corridor
- Upper floor additions to existing structures in zones that allow second floors
- Replacement of existing impermeable developed structures with permeable structures (e.g., permeable paving)
- Replacement of non-native, invasive vegetation with native vegetation

5.0 WATERSHED PLANNING AND MANAGEMENT: RECOMMENDED NEXT STEPS

5.1 ARROYO/WATERSHED MANAGEMENT PLAN

The City of Riverside and adjacent County areas encompasses a series of arroyos characterized by healthy riparian habitat, severely degraded conditions, and channelized watercourses depending on the location. This urbanizing sub-region of the Middle Santa Ana River Watershed Management Area is experiencing rapid development with significant impacts to habitat, water supply, water quality and open space. Development of a comprehensive Riverside Arroyo Watershed Management Plan (Plan) that addresses the connection between land use decisions and habitat, water quality, stormwater management, and overall watershed function is needed. The necessary challenge will be to incorporate these approaches into the long-term general plan and zoning process within the City and County of Riverside. This should be a multi-objective, stakeholder-based Plan to identify short-term actions and long-term strategies for effective and responsible watershed management that incorporates measures such as those proposed in the proceeding chapters of this document. Key elements should include a habitat mitigation plan, identification of water quality BMP sites, a "green streets" approach to transportation, "green building" requirements, landowner and resident education framework, integration with regional trail and open space plans, additional policy recommendations, watershed management organizational structure, and a stakeholder process including public forums and outreach.

5.2 AT-RISK ASSESSMENTS REGARDING LAND USE CONVERSIONS

The CCAC recommends that the City and County conduct an "at-risk assessment" regarding planned and potential land use conversions from open space to a developed purpose. The assessment should take into account potential impacts of such conversions to existing conditions regarding stormwater runoff, water quality, habitat and open space, and recreation needs of the City of Riverside and adjacent County unincorporated areas. The assessment should provide a realistic view of the cumulative impacts of full build-out of the general plans. The assessment should be used to identify appropriate land use measures in the Arroyo/Watershed Management Plan that compensate for short- and long-term impacts to arroyo, watercourse, or hydrologic conditions throughout the arroyo watersheds to the Santa Ana River.

5.3 GOVERNANCE AND COORDINATION OF ARROYO/WATERSHED ACTIVITIES

The CCAC recommends that the City of Riverside and County of Riverside establish various levels of governance and coordination on a watershed basis. This could include the creation of a decision tree, a multi-agency involvement task force, a steering committee, establishment of a stakeholder watershed council, and a foundation to assist in the implementation of programs throughout the City's watersheds.

5.4 EVALUATION: EFFECTIVENESS OF EXISTING PROTECTION MEASURES

The CCAC recommends that the City of Riverside and County of Riverside, in cooperation with a citizen's committee such as the CCAC, jointly conduct an objective evaluation of the effectiveness of existing protection measures and their implementation including, but not limited

to, the City of Riverside's existing grading ordinance, Proposition R, and Measure C, and the County of Riverside's protection measures in protecting arroyo, hillside, and watershed resources in the project area. The committee should identify areas that are working and those areas that may require updating to ensure adequate protection of resources.

5.5 NEXT STEPS FOR CCAC WITH REGARD TO POLICY AND MAPPING

According to the goals in establishing the CCAC, next steps and immediate future roles include:

- Work with City and County staff to refine policy recommendations that further the goal of establishing consistent policies for land use and watershed management in areas that affect both jurisdictions.
- Refine GIS Watercourse Protection mapping project and documentation.
- Provide GIS maps to City and County.
- Develop Riparian Map Layer and combine with Watercourse Layer into Watercourse Protection Map.
- Develop GIS models for delineating watercourse setbacks and riparian buffers.
- Promote programs and educational materials to enhance community awareness about the importance watercourse preservation and methods to achieve a healthy watershed.
- Compile resource file of Best Management Practices.

For an outline of existing projects and projected work by CCAC see Appendix 7.15.

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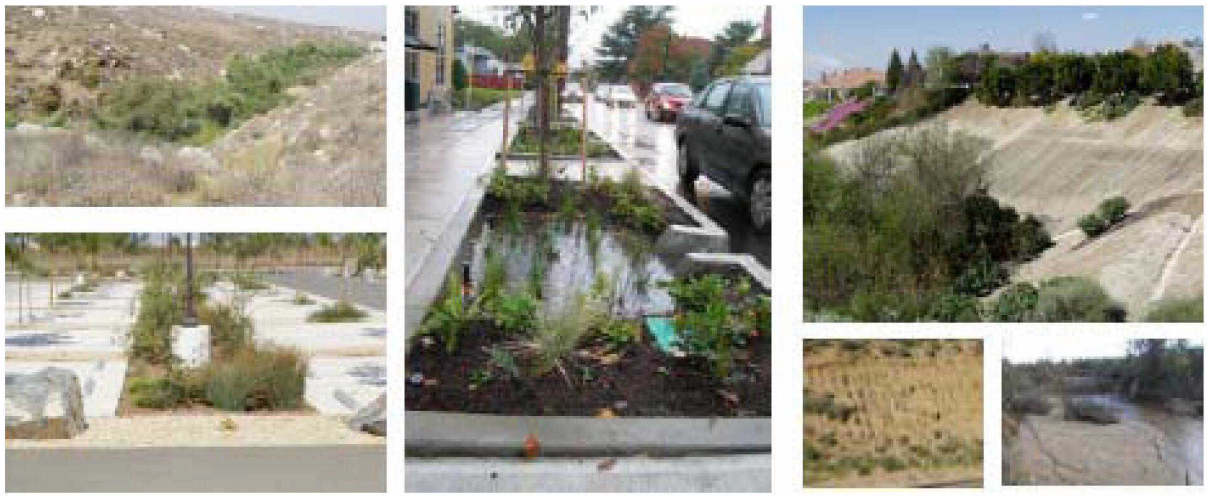
APPENDICES



Submitted to:

County of Riverside Board of Supervisors &
Riverside City Council

Prepared By:

County/City Arroyo-Watershed Committee (CCAC)

November 15, 2006

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APPENDIX 7.1:

GLOSSARY

Aquifer. Geologic formation(s) that is water bearing. A geological formation or structure that stores and/or transmits water, such as to wells and springs. Use of the term is usually restricted to those water-bearing formations capable of yielding water in sufficient quantity to constitute a usable supply for people's uses. *A confined aquifer* is soil or rock below the land surface that is saturated with water. There are layers of impermeable material both above and below it and it is under pressure so that when the aquifer is penetrated by a well or otherwise punctured, the water will rise above the top of the aquifer. *An unconfined aquifer* has its upper water surface (water table) at atmospheric pressure, and thus is able to rise and fall. (Schilling et al. 2005)

Artificial recharge. A process where water is put back into ground-water storage from surface-water supplies such as irrigation, or induced infiltration from streams or wells. (Schilling et al. 2005).

Arroyo. 1) In the English language, an arroyo is often defined as a rocky ravine with a watercourse at the bottom. The watercourse can be dry (i.e., intermittent or ephemeral), or it can have a stream that runs most of the year (perennial) or it can run through out the year (permanent). 2) In Spanish, arroyo refers to a stream or brook. California was once a part of Mexico, and many places, streams, and other landforms were given Spanish names by early colonists, rancheros, and missionaries. 3) Scientific usage: In the field of geomorphology of rivers, the term arroyo is used in the southwestern USA for a landform created from cut-and-fill river systems. The arroyos are named for the processes that form them (Brierley and Fryirs 2005). The resulting landform can be a deeply incised channel through areas with alluvial deposits. The Alessandro, Prenda, and Mockingbird Arroyos are examples of local arroyos.

Average natural slope method of slope analysis. A method of determining average slope for a particular area as per City of Riverside Grading Ordinance, Section 19.04.038

> "Average natural slope" means the average natural inclination of the ground surface of a lot or parcel expressed as a percent and as measured by the following formula:
>
> $$S = \frac{0.002296 \times I \times L}{A}$$
>
> Where: S = average natural slope in percent
> I = natural contour interval in feet
> L = length of natural contours in feet
> A = acres of property (parcel of record existing on November 13, 1979)
> 0.002296 = constant which converts square feet into acres and expresses slope in percent
> The average natural slope shall be computed from photogrametric maps, grading permit plans and other data or evidence approved by the Public Works Department. (Ord. 5585 § 1, 1987)

Average slope. In general, the average slope is the characteristic slope (see slope) over an area of land, measured in percent as the ratio of vertical rise to horizontal distance. In the County, average slope is to be determined based on the most accurate available topographic information.

In the County, unless the slopes on a parcel are clearly less than 15% for residential projects or 10% for commercial and industrial projects, the Sectional Method of determining slope is to be used (see Slope Analysis Sectional Method and Average Slope Sectional Method). The City of Riverside uses Average Natural Slope (see Average Natural Slope).

Average slope, sectional method. In general, this method of slope analysis uses a topographic map to determine the distances between contour lines that correspond to the slope contour limits (e.g., 10%, 15%, 20%, 25%, 30%, 35%, 40% and above). For any purpose for which a slope analysis is required for a project site located in the unincorporated area of Riverside County, the **Sectional Method of Slope Analysis (SSA)** is to be employed **(see Slope Analysis Sectional Method for County requirements)**. Generally, the Sectional Method of Slope Analysis, is a topographic map of a project site whereupon areas of differing ranges of percentage of slope (such as: 0% to 10%, 10% to 15%, 15% to 20%, 20% to 25%, 25% to 35%, and above 35% slope) are depicted, usually using different colors, to clearly show and classify all areas of the site as areas of relatively flat (colored dark to light green, as slope increases), moderate (colored yellow to orange, as slope increases), or steep (colored red to purple, as slope increases) topography. Differing slope ranges are determined and mapped by measuring the width of the spaces between each of the topographic contours on the map, and then delineating polygons on that map that correspond to groupings of spaces that fall into each of the various slope categories. Areas where spaces between contour lines are relatively wide are areas of flatter or less steep topography, and areas where such spaces are relatively narrow have steeper topography. The most accurate slope analyses are performed using a computer program; therefore, for sites with steeper or more complicated topography, computerized slope analyses may be required to ensure accuracy.

Bank. Any embankment, dike, levee, wall or similar feature of natural or man-made origin which adjoins or parallels any watercourse and which has as a function the confinement of the water of said watercourse.

Bankfull Channel. The channel that is formed by the dominant discharge of water through a watercourse. The dominant discharge is that which is equivalent in its effect to the range of discharges that determine the shape and size of a channel. The **bankfull width and depth** are important parameters of a stream channel.

Best Management Practices (or BMP). Initiatives undertaken to reduce or eliminate pollution entering watercourses. They are called Best Management Practices because they employ the "best" practices or technologies for reducing these pollutants, as recognized by the general stormwater management community. BMPs are often grouped into two categories: nonstructural and structural BMPs. ***Nonstructural*** BMPs are changes in behavior or operating procedures to reduce pollution, and include such things as educational programs aimed at homeowners to street sweeping programs in areas of cities to reduce trash on streets. ***Structural*** BMPs are structures that are constructed to remove pollutants from water. They can be as simple as special gardens designed to absorb rainfall, or as complex as large engineered treatment systems capable of removing toxic chemicals. (Arroyo Seco Watershed Management And Restoration Plan: Draft Report 01-15-06)

Bog. A wet area the results when precipitation saturates soil for a season or longer.

Brook. A small stream (Macdonald 1972).

Channel. The stream channel is the conduit for water within a watercourse. The stream can continually adjust its channel shape and path as the amount of water passing through the channel changes. Water and sediment discharges are the principal determinants of the dimensions of a stream channel (width, depth, and meander wavelength and gradient). Physical characteristics of stream channels, such as width/depth ratio and sinuosity, and types of pattern (braided, meandering, straight) are significantly affected by changes in flow rate and sediment discharge, and by the type of sediment load in terms of the ratio of suspended to bed load. A channel is not limited to land covered by minimal or ordinary flow but also includes land covered during times of high water. Diversity in channel morphology and associated sediments, which form the substrate and habitats for ecological assemblages, is a key component and necessary condition for biodiversity. The natural environment is best maintained by allowing stream channels to function normally through erosion, deposition and morphological change. Changes in stream morphology reflect changes in the hydrological balance and runoff and/or in the sediment supply. Stream channels that have been directly modified and engineered will try to regain their natural morphology unless the modifications are continually maintained. http://www.lgt.lt/geoin/doc.php?did=cl_stream

Ephemeral drainage. A watercourse that has flowing water for a short time each year, for as little as one day per year. Many ephemeral drainages flow only during storm events.

Floodplain. The land adjacent to a channel at the elevation of the bankfull discharge, which is inundated on average every 2 of 3 years. The floor of stream valleys, which can be inundated by floods. Ten, 100, and 500 year flood levels are those with a probability of a 10 percent, 1 percent, or 0.2 percent chance, respectively of being equaled in any given year.

Floodplain, 100-year. The one-in-100 year floodplain has a probability of a 0.01 chance per year of being covered with water. A 100-year flood refers to, a flood level with a 1 percent chance of being equaled or exceeded in any given year—it does not mean a flood that occurs every 100 years.

Floodway. Under the National Flood Insurance program, the regulatory floodplain that includes the channel and the portion of the adjacent floodplain (usually the 100-year floodplain) that carries flood waters.

Fluvial—involving streams and rivers.

Fluvial geomorphology. The study of how river systems interact with the geologic features they flow through. Particular aspects include the study of sediment transport by rivers and streams, the location, configuration, and geometry of stream channels and how they change under different conditions, and how man-made developments will affect natural stream channel conditions. (Arroyo Seco Watershed Management And Restoration Plan: Draft Report 01-15-06)

Geomorphic analysis. The measurement of the three-dimensional geometry of landforms traditionally applied to watersheds, drainages, hillslopes, beaches, and other groupings of terrain features. Morphometric parameters have received much attention from hydrologists and geomorphologists for analysis of physical ecosystem processes such as soil erosion, deposition, runoff, stream discharge, sediment yield, and sedimentation of streams. The USGS (Harvey and Eash, 1996) is developing GIS software to precisely calculate a variety of catchment morphometric parameters which include variables such as average basin slope, the basin elongation ratio, compactness ratio, basin relief, and stream density (http://www.basinsoft.com). Some parameters, such as slope length can be used to represent hillslope, basin, and channel properties. Hillslope analysis tools for GIS can be found at: http://www.blm.gov/nstc/ecosysmod/Download/ILASTARTnote.doc

Basin morphometry represents one set of variables recommended for use in watershed hydrologic condition analysis methods developed by the Department of Agriculture and Department of the Interior (McGammon, Rector, and Gebhardt, 1998). Because by contrast with the traditional topographic map based methods, the GIS methods are relatively easy to apply in a consistent way on large areas of landscape, and because they permit summation of terrain characteristics for any region, they can be utilized to provide geomorphometric data and therefore insight into the processes affected by terrain morphology for all types of mapping units.

Headcutting. "The action of a bedscarp or headward erosion of a locally steep channel or gully" (Riley 1998).

Headwater streams. Small streams in the upper parts of the watershed that feed into larger streams.

Hydrogeomorphic (HGM). Clinton administration and National Action Plan included a Hydrogeomorphic Approach for Assessing Wetland Functions (HGM Approach) used in conjunction with Clean Water Act Section 404 regulatory program.

Hydrologic indicators: Observable factors used to indicate the presence of a wetland. For example, the presence of hydrophytic vegetation or hydric soils:

Hydromodification. Defined by Environmental Protection Agency (EPA) as the "alteration of the hydrologic characteristics of surface waters, which in turn could cause degradation of water resources." According to EPA, three general types of habitat modification must be addressed by states as they develop their nonpoint programs: 1) channelization and channel modification; 2) dams; and 3) streambank and shoreline erosion. http://www.ecy.wa.gov/pubs/9926/5f.pdf

Hydromodification/Habitat Modification: Habitat modifications include activities in the landscape, on shore, and in waterbodies that alter the physical structure of aquatic ecosystems and have adverse impacts on aquatic life. Examples of habitat modifications to streams include: removal of streamside vegetation that stabilizes the shoreline and provides shade, which moderates instream temperatures; excavation of cobbles from a stream bed that provide nesting habitat for fish; stream burial; and excessive suburban sprawl that alters the natural drainage patterns by increasing the intensity, magnitude, and energy of runoff waters. Hydrologic

modifications alter the flow of water. Examples of hydrologic modifications include channelization, dewatering, damming, and dredging. http://www.scorecard.org/env-releases/def/cwa_source_class_def.html

Imperviousness / Impermeability. Refers to surfaces that are covered with materials that prevent rainwater from soaking into the ground (prevents infiltration). In a natural setting, most rainwater soaks into the ground before it enters rivers and streams. Infiltration is improved by the presence of plant roots, especially deep rooted shrubs and trees. Once development occurs, much natural soil is covered by hard surfaces such as parking lots, driveways, and rooftops. These surfaces convey all of the rainfall that falls on them into watercourses. This water in turn carries whatever trash or debris has fallen on the hard surfaces. One goal of watershed restoration is to reduce the imperviousness of urban areas. This reduces the amount of pollution entering watercourses, and also reduces the volume of water that drainage systems must be designed to carry. (Arroyo Seco Watershed Management And Restoration Plan: Draft Report 01-15-06)

Infiltration. The movement of water from the land surface into the subsurface layers. Also called percolation.

Incised channel. The path of a stream that has degraded and been cut into the bed of a stream at the valley bottom (such as in arroyo).

Intermittent stream. See ephemeral drainage. A stream that flows off and on during the year, generally following precipitation events.

Key or Keyway. The notch excavated into the side of a gully or stream to anchor a checkdam or other structure.

Meander. "A sinuous channel from in flatter river grades formed by the erosion on one side of the channel (pools) and deposition on the other (point bars)" (Riley 1998).

Nonpoint source pollution. Nonpoint source pollution is water-borne pollution such as trash, metals, and bacteria that does not originate from a single source or location, but is instead generated by the dispersed activities that occur throughout an urban area. Non-point source pollution includes trash that is deposited on streets, metals that wear off of car brake pads, and bacteria from pet waste. This non-point source pollution is then carried into watercourses by rainfall, car washing, over-irrigation, and other events that cause water to flow over impervious surfaces. Because there is no one responsible party for nonpoint source pollution, it is very difficult to regulate and reduce. In urban areas, non-point source pollution is the vast majority of pollution entering watercourses during storm events.

Percolation. The movement of water through the openings or air spaces in a substrate such as rock or soil.

Permeability. The ability of a substrate or other material to allow the passage of a liquid. Permeable materials, such as gravel and sand, allow water to move quickly through them, whereas impermeable materials, such as clay, don't allow water to flow freely.