~~DRAFT~~

Santiago Hills II Planned Community
And
East Orange Planned Community Area 1
Runoff Management Plan

Volume 2: Surface Water Quality

Prepared for

The Irvine Community Development Company

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Prepared by The Irvine Company for Consideration by the City of Orange

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1 INTRODUCTION

This report addresses the potential impacts of the proposed Santiago Hills II Planned Community and East Orange Planned Community Area 1 (the Project) on water quality in local water bodies including Irvine Lake, Peters Canyon Reservoir, Santiago Creek, and Villa Park Reservoir. Potential changes in water quality are addressed for each pollutant of concern based on runoff water quality modeling, modeling of water quality in Peters Canyon Reservoir and Irvine Lake, literature information, and professional judgment. Impacts take into account Project Design Features (PDFs) selected consistent with Orange County's Drainage Area Management Plan (DAMP) and the City of Orange's Local Implementation Plan (LIP). The level of significance of impacts is evaluated based on Significance Criteria that include applicable water quality standards, elements of the applicable water quality control plan for the area, and applicable requirements of relevant National Pollutant Discharge Elimination System (NPDES) permits.

The companion document to this report which addresses the hydrologic effects of the proposed project is entitled, "Santiago Hills II Planned Community and East Orange Planned Community Area 1 Runoff Management Plan, Volume 1: Storm Water Hydrology" (RBF Consulting, 2005~~2004~~, referred to herein as "ROMP Volume 1"). Additional companion documents which address potential impacts to Irvine Lake and Peters Canyon Reservoir are titled: "Irvine Lake Water Quality Model Analysis ~~Draft~~ Report" and "Peters Canyon Reservoir Water Quality Model Analysis Report" (Flow Science, 2004a and 2004b).

2 ENVIRONMENTAL SETTING

2.1 Physical Setting

The Santiago Hills II and East Orange Area 1 project area is located in unincorporated Orange County, within the City of Orange Sphere of Influence. The construction phasing for Santiago Hills II and East Orange Area 1 is anticipated to occur from west to east in three stages: Santiago Hills II Stage 1, Santiago Hills II Stage 2, and East Orange Area 1 (Figure 2-1). The Santiago Hills II development area is generally located east of Jamboree Road, the existing Santiago Hills I development, and Peters Canyon Regional Park; west of SR241/261; and south of Irvine Regional Park. Santiago Hills II Stage 1 and Stage 2 are separated by Santiago Road. Santiago Hills II Stage 1 lies south of Santiago Canyon Road, and Stage 2 lies north of Santiago Canyon Road. SR241/261 separates Santiago Hills II from East Orange Area 1, which lies to the south and east.

East Orange Area 1 is generally bounded by Santiago Canyon Road to the south, the Santiago landfill to the east and north, and SR241/261 to the west. The general project area is bordered by urban development in the City of Orange to the west and the City of Tustin to the southwest. To the east of East Orange Area 1 lies two additional planning areas called East Orange Planned Community Areas 2 and 3. The potential impacts of East Orange Areas 2 and 3 on water quality are discussed in a separate report (GeoSyntec Consultants, 2005~~2004~~).

2.2 Study Area Vegetation, Soils and Land Uses

The watersheds encompassing Santiago Hills Phase II and East Orange Area 1 are undeveloped rangeland comprised of moderately steep upper canyons with reduced gradients in the lower elevations. Natural vegetation growth is limited primarily to annual and scrub grasses with generally poor cover. Soil textures range from relatively impervious clays and clay loam to more pervious sand and sandy loam (Appendix C, Figure C-1).

The Santiago Hills II Planned Community is encompassed by Tentative Tracts 16199 and 16201. East Orange Area 1 is encompassed by Tentative Tract 16514. The Project is envisioned to have three stages. Table 2-1 indicates the breakdown of land uses for each stage. The Study Area has been divided into two areas; areas receiving treatment and areas receiving no treatment. Details of the proposed treatment system are provided in subsequent sections of this report (Section 5).

Approximately 1,227~~230~~ acres of the Project area will drain to new water quality treatment systems that are planned as part of development. This includes 141~~149~~ acres of single-family residences. Condominiums, designated as multi-family residential areas, will encompass approximately 182~~192~~ acres of the development. The Project will provide treatment for approximately 159~~152~~ acres of arterial and State Route roadways, including portions of Santiago Canyon Road, Jamboree Road, State Route 241 and State Route 261. The remaining areas will include a 10-acre elementary school, 37 acres of park, and 700~~689~~ acres of non-impact open space (open space within the developed area).

The remaining 1,127~~124~~ acres within the Project area will not receive any new water quality treatment, including 22~~32~~ acres of existing State Route 241 and 261 as well as 1,105~~092~~ acres of preserved open space. Figure 2-2 illustrates the land use delineations as a function of construction stage.

Table 2-1: Study Area Proposed Land Uses and Areas

Study Area Stages	Land Use Areas (acres)								Total
	Areas Receiving Treatment						Areas w/o Treatment		
	Non-Impact Open Space	Park	Road	SF Res	MF Res	School	Preserved Open Space	Road	
Santiago Hills II Stage 1	534.8~~615.4~~	5.0	81.2~~88.6~~	44.4~~7~~	26.2	0.0	1612.6~~1533.0~~	49.5~~40.4~~	2354
Santiago Hills II Stages 1 & 2	589.3~~9~~	9.4	120.1~~118.6~~	97.0~~102.1~~	98.3~~99.1~~	9.8	1398.7~~1394.3~~	31.5~~30.9~~	2354

Study Area Stages	Land Use Areas (acres)								Total
	Areas Receiving Treatment						Areas w/o Treatment		
	Non-Impact Open Space	Park	Road	SF Res	MF Res	School	Preserved Open Space	Road	
Santiago Hills II Stages 1 & 2 and East Orange Area 1	699.66~~689.1~~	36.6	158.6~~152.2~~	140.5~~148.7~~	181.5~~192.3~~	9.8	1105.0~~1103.5~~	22.2~~6~~	2354

2.3 Receiving Waters and Natural Drainages

This sub-section describes the primary receiving waters and natural drainages that could potentially be affected by dry and wet weather flows from the project. Table 2-2 lists the receiving waters and natural drainages, including emergent marshes, discussed in this section and figures which illustrate the location of these features. For completeness the table also identifies the proposed treatment control PDFs introduced in Section 5.

Table 2-2: Water Features and Figures Showing Locations

Category	Feature	Figure where Identified
Receiving Waters	Peters Canyon Reservoir Irvine Lake Santiago Creek Reach 1	Figures 2-1, 2-2, 2-3, 2-4
Natural Drainages	South Tributary North Tributary ETC-6 Drainage ETC-7 Drainage Black Willow Forest Lacustrine Area Overland Flow Area within Irvine Regional Park ETC-9 Drainage Woody's Tributary	Figure 2-3
Treatment Control PDFs	Extended Detention Basins Treatment Swales Bioretention Hydrodynamic Separator Systems (HSS) Nutrient Source Control	Figure 5-1
Emergent Marshes	Emergent Marshes	Figure 5-2

2.3.1 Receiving Waters and Beneficial Uses

The existing and post-development watershed tributary areas have been divided into five subwatersheds (Figure 2-3 and Figure 2-4) (RBF Consulting, 2005~~2004~~). The first subwatershed, Subwatershed Area A, includes two natural drainages tributary to Peters Canyon Reservoir (PCR). The second subwatershed is located in the northern portion of the project site. This area is designated as Subwatershed Area B and is tributary to Santiago Creek through the Irvine Regional Park in a series of natural channels, open channels, and culverts. The third watershed area, Subwatershed Area C, flows in a natural stream channel through the eastern end of Irvine Regional Park to Santiago Creek. The fourth subwatershed, Subwatershed Area D, is located between Subwatershed Area A and Subwatershed Area B and is also tributary to Santiago Creek. The fifth subwatershed (Subwatershed Area E) is tributary to Irvine Lake.

As described in the ROMP Volume 1, subwatershed areas will change from existing to ultimate conditions to achieve certain runoff management and flood control goals of the various jurisdictional agencies. Some areas once tributary to Peters Canyon Reservoir will be re-routed to the Irvine Lake and Santiago Creek subwatersheds. The subwatershed areas by stage are summarized in Table 2-3.

Table 2-3: Study Area Stages

Study Area Stages	Subwatershed Areas (acres)					Total
	Peters Cyn Reservoir	Santiago Creek			Irvine Lake	
	Subwatershed Area A	Subwatershed Area B	Subwatershed Area C	Subwatershed Area D	Subwatershed Area E	
Santiago Hills II Stage 1	691.5~~779.8~~	251.2~~232.4~~	197.1~~208.6~~	122.1~~40.7~~	1091.6	2354
Santiago Hills II Stages 1 & 2	658.0~~723.2~~	63.0~~47.6~~	275.6~~286.0~~	265.9~~205.6~~	1091.6	2354
Santiago Hills II Stages 1 & 2 and East Orange Area 1	544.4~~612.~~	62.8~~47.6~~	322.9~~338.5~~	273.2~~204.4~~	1150.8~~6~~	2354

Receiving waters for the Project include Peters Canyon Reservoir, Irvine Lake (Santiago Creek Reach 2), and Santiago Creek Reach 1, which includes the Villa Park Flood Control Dam. The Santa Ana Basin Plan (SARWQCB, 1995) lists beneficial uses of major water bodies within this region. Peters Canyon Reservoir, Irvine Lake, and Santiago Creek Reach 1 are listed and have specific beneficial uses assigned to them (Table 2-4).

Irvine Lake (also known as Santiago Reservoir) is owned and operated by the Irvine Ranch Water District (IRWD) and the Serrano Water District for water supply and non-contact recreation. Water in Irvine Lake includes runoff from its 63.1 square mile watershed and imported water from the Metropolitan Water District of Orange County. Irvine Lake was constructed as a water supply reservoir by The Irvine Company in 1933. The Santiago Dam is located at the westerly side of the reservoir and controls outflows from the reservoir to Santiago Creek Reach 1.

Peters Canyon Reservoir is owned by the County of Orange and is operated by the County's Resources and Development Management Department. Upper Peters Canyon Reservoir was originally used to supply agricultural irrigation water to Irvine Ranch, and together with the lower reservoir, was also used to regulate drafts of water taken from Irvine Lake and conservation of stormwater runoff from the Peters Canyon watershed. The Irvine Company dedicated 354 acres of Peters Canyon, inclusive of the reservoir, to the County of Orange in 1992. Today the lower reservoir is typically dry and serves as a flood control basin. While previously the Peters Canyon Reservoir had regular inflows and outflows of water related to its irrigation water uses, it does not experience such flushing currently as it is operated passively to retain periodic storm flows.

Peters Canyon Wash is located downstream of Peters Canyon Reservoir. Prior to construction of PCR, Peters Canyon formed the headwaters of Peters Canyon Wash and runoff naturally flowed into Peters Canyon Wash and the San Diego Creek Watershed. After PCR was constructed (by an earthen dam across Peters Canyon Wash at the southern end of the reservoir), natural discharges to Peters Canyon Wash ceased, and were redirected to Handy Creek (see below). Under the existing conditions, the only discharges to Peters Canyon Wash occur infrequently and are regulated by the County of Orange who control the operation of the PCR outlet works. - The emergency outlet works system, which consists of an outlet tower, trash rack, a 42-inch reinforced concrete pipe (RCP), and flood gates, connects the reservoir to Peters Canyon Wash downstream only when the valve on the outlet works is manually exercised twice annually (pers. comm. John Gietzen, Peters Canyon Dam Operator, OC PFRD) as required by California Department of Water Resources Division of Safety of Dams. ~~Most of the water that is released during these exercises is captured in Lower Peters Canyon Reservoir.~~ In the past, the valve also has been opened to release water to reduce the pond size of the reservoir in conjunction with mosquito abatement by the County. Peters Canyon Wash is tributary to San Diego Creek and Newport Bay. Hydrologic modeling conducted as part of the development of the ROMP indicates that the proposed project will not affect the above operation and therefore the current operational discharges to Peters Canyon Wash will remain the same. Therefore Peters Canyon Wash, although a receiving water for infrequent operational discharges from PCR, is not a receiving water subject to runoff from the proposed project. Thus the analysis of water quality impacts from the proposed project does not include Peters Canyon Wash.[1]

Handy Creek is subject to the natural discharges from PCR. The construction of Santiago Hills I altered the reservoir's spillway to Handy Creek in order to provide peak flood flow attenuation

[1] Moreover, as will be discussed in greater detail in the impacts discussions below, the proposed project will not have a significant impact on the water quality of Peters Canyon Reservoir; and thus will likewise not have a significant impact on any waters downstream of Peters Canyon Reservoir.

downstream. A concrete spillway and 42-inch outlet pipe were constructed at the northern end of the reservoir. Flows that enter the 42-inch pipe or overtop the spillway due to rising water surface in the reservoir during large flood events are conveyed to Handy Creek, which is tributary to Santiago Creek Reach 1.

Santiago Creek downstream of Irvine Lake is a wide, unimproved natural stream or regional floodplain which flows to the impoundment behind the Villa Park Flood Control Dam. It flows only in response to rainfall events except during very wet years when there are releases from Santiago Dam. When biological functions are considered, this reach of Santiago Creek is most appropriately classified as intermittent. The Villa Park Reservoir is an active flood control and water conservation dam operated by the Orange County Flood Control District (OCFCD). It is also ~~currently~~ an inactive water source for the Serrano Water District (SWD) which~~), but SWD~~ plans to eventually use it again as a water source. The Santiago Creek Watershed below Irvine Lake at Villa Park Flood Control Dam is 20.3 square miles and includes Freemont Canyon, Blind Canyon, and Weir Canyon (Figure 2-5). The watershed is mostly undeveloped mountainous terrain.

Table 2-4: Beneficial Uses of Receiving Waters

Water Body	Beneficial Uses[2]							
	MUN	AGR	GWR	REC1	REC2	WARM	COLD	WILD
Peters Canyon Reservoir	E	P		P	P	P		P
Irvine Lake (Santiago Creek Reach 2)[1]	P	P		P	P	P	P	P
Santiago Creek Reach 1[1]	P		P	P	P	P		P

P – Present or potential beneficial use
E – Excepted from MUN designation
[1]Santiago Creek is divided into four reaches. Irvine Lake is Santiago Creek Reach 2. Reach 1 extends below Irvine Lake to the confluence with Santa Ana River Reach 2, and includes the Villa Park Dam reservoir.
[2]Potential beneficial use designations from the Basin Plan include the following:

- MUN – Municipal and domestic supply waters used for community, military, municipal or individual water supply systems
- AGR – Agricultural supply waters used for farming, horticulture, or ranching
- GWR – Groundwater recharge for natural or artificial recharge of groundwater
- REC1 – Water contact recreation involving body contact with water and ingestion is reasonably possible
- REC2 – Non-contact water recreation for activities in proximity to water, but not involving body contact
- WARM – Warm freshwater habitat to support warm water ecosystems
- COLD – Cold freshwater habitat to support coldwater ecosystems or collection of fish or other organisms, including those collected for bait.
- WILD – Wildlife habitat waters that support wildlife habitats

2.3.2 Natural Drainages

As generally described in Section 4.4 of the Runoff Management Plan (ROMP) Volume I, runoff currently flows from the Project area to receiving waters in multiple existing natural channels. The Project proposes preservation and, in some cases, riparian and wetland habitat enhancement, of some of these existing natural drainages. The existing natural drainages tend to be classified as either ephemeral, intermittent drainages, or wetlands. The biological and habitat characteristics of these natural drainages, including the general wetland and riparian function and value (intermittent, ephemeral, etc.), are described fully in the documents summarized in Table 2-5.

Table 2-5: Documentation of Biological and Habitat Characteristics

Technical Document or Report	Natural Drainages Described
Environmental Impact Report 1278, East Orange General Plan, dated 1989	Drainages within SHII and EO Area 1, as well as areas currently proposed as preserved open space
Santiago Hills II Supplement to Final Environmental Impact Report 1278, dated 2000 (SHII 2000 SEIR)	Drainages within the SHII area
The Glenn Lukos Associates Final Conceptual Mitigation and Monitoring Plan For Impacts to Areas within the Jurisdiction of the United States Army Corps of Engineers Pursuant to Section 404 of the Clean Water Act and the California Department of Fish and Game Pursuant to Chapter 1603, dated November 2003, and approved by the Army Corps of Engineer (ACOE) and the California Department of Fish and Game (CDFG)(Final Conceptual Mitigation Plan)	Existing drainages within SHII area, and the North and South Tributary drainages, which are to be restored and enhanced to provide greater wetland and riparian function pursuant to the requirements of the Army Corps of Engineers Section 404 Permit, the California Department of Fish and Game Section 1603 Streambed Alteration Agreement and the SHII SEIR Mitigation Measure B-1
The LSA Associates Biological Resources Report: SHII Supplemental Assessment of the Water Quality Basin/Habitat Restoration, dated November 14, 2003	Existing overland drainage area within Irvine Regional Park between project boundary and the Villa Park Dam flood plain., including area for proposed swale and water quality basin 6A
The LSA Associates Amendment to Biological Resources Report: SHII Supplemental Assessment of Peters Canyon Reservoir Outlets, dated May 19, 2004	Existing drainage area within Peters Canyon Reservoir inundation area at the outlet of existing culverts and in the area proposed for a new storm drain outlet by the ROMP.
The Glenn Lukos Associates Biological Technical Report East Orange Planned Community, dated September 3, 2004	Existing drainages within EO Area 1, the existing drainage between the northwestern boundary of EO Area 1 and Santiago Creek, the northeastern portion of the South Tributary, and the existing drainage between the southeastern boundary of EO Area 1 and Woody's Cove.
The Glenn Lukos Associates Results of Biological Review of Impacts Associated with Hook Ramp Basin, dated March 30, 2005	Tributary area of Basin HR1 (Hook Ramp Basin).
The LSA Associates Supplemental Biological Resources Assessment for Irvine Regional Park and Peters Canyon Storm Drain Outlets--Santiago Hills Phase II, dated April 11, 2005	Drainages into PCR and Irvine Regional Park.

All of these documents have been submitted to the City of Orange under separate cover.

As shown on Figure 2-3 and more fully described in the documents listed above, there are eight (8) existing drainages potentially impacted by the project:

- **The South Tributary**: This drainage originates within Area 1 development Area, and generally runs in a southwesterly~~southeasterly~~ direction, under existing Santiago Canyon Road, through The Nature Conservancy (TNC) Conservation Easement Area under the Eastern Transportation Corridor (ETC), through the SHII development area, and into Peters Canyon Reservoir. This drainage is intermittent[1] in the existing condition from its origination point to a point located within the TNC Conservation Easement Area, then becomes ephemeral[2] as it runs through under the ETC and through the SHII development area to the Jamboree culverts. Downstream of the culverts, the drainages remain ephemeral as they enter the Peters Canyon Reservoir floodplain.

- **The North Tributary**: This drainage is comprised of a main branch and 2 smaller side branches, and originates within Area 1 near the intersection of SR 241 and SR 261. The drainage runs generally southwesterly~~southeasterly~~ from the point or origination, through the SHII development area to the Jamboree culverts. Downstream of the culverts, the drainages remain ephemeral as they enter the Peters Canyon Reservoir floodplain.

- **ETC-6 Drainage**: This drainage originates within Area 1, and runs in a generally northwesterly~~northeasterly~~ direction under the ETC, through the SHII development area, and into the improved portion of Irvine Regional Park, and into Santiago Creek. This drainage is ephemeral in the existing condition.

- **ETC-7 Drainage**: This drainage originates within SHII and flows generally in a northwesterly~~northeasterly~~ direction to a confluence point with ETC-6 Drainage, and from there into Santiago Creek. This drainage is ephemeral in the existing condition.

- **Black Willow Forest Lacustrine Area**: This area is located between the Peters Canyon Regional Park trail west of Jamboree Road and the high water mark for Peters Canyon Reservoir. The lower elevations in this area are within the Peters Canyon Reservoir floodplain and are dominated by southern black willow forest habitat and are considered wetlands which are sustained by groundwater associated with Peters Canyon Reservoir.

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[1] An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.

[2] An ephemeral stream has flowing water only during and for a short duration after precipitation events in a typical year. Ephemeral streambeds are located above the water table year round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.

The area also receives water from sheet flow from surrounding upland areas between the black willow forest habitat area and Jamboree Road.

- ~~Overland~~ **Drainage to Santiago Creek through or around ~~Area within the~~ Irvine Regional Park**: This is the~~an overland~~ drainage area within the project that drains to the north into Santiago Creek by either passing through or around~~unimproved portion of~~ Irvine Regional Park. ~~, which was proposed as a wetland and riparian mitigation site by the County of Orange; however, the wetland and riparian mitigation site did not meet success criteria because sufficient hydrology was not provided to the site. The County performed substitute wetland and riparian mitigation activities, and the site was abandoned. The site currently receives sheet flow during storm events, which passes from a southeasterly direction, through the site, toward the Villa Park Dam floodplain.~~

- **ETC 9 Drainage:** This drainage originates within Area 1 and runs generally in a northerly direction, under the ETC, through preserved open space to Santiago Creek in the unimproved portion of Irvine Regional Park. This drainage is ephemeral in the existing condition.

- **Woody's Tributary**: This drainage originates within NCCP preserved open space and runs generally in an easterly direction, along and under Santiago Canyon Road, to Woody's Cove in Santiago Reservoir (Irvine Lake). This drainage, which is identified as "R-11" in the jurisdictional delineation of the Glenn Lukos Associates Biological Technical Report East Orange Planned Community, has several side branches, and is intermittent and ephemeral in the existing condition.

SHII Drainages (The South Tributary, the North Tributary, ETC-6 Drainage and ETC-7 Drainage)

The drainages in the Santiago Hills II development area have received environmental clearance and resource agency permits allowing modification and/or fill in connection with the SHII project. EIR 1278 and the SHII 2000 SEIR provided the environmental clearance. ACOE and CDFG have issued permits under Clean Water Act Section 404 and California Fish and Game Code Section 1603, and the Regional Water Quality Control Board has issued Clean Water Act Section 401 certification for the ACOE Section 404 Permit. The drainages permitted for modification or impacts include: the North Tributary, the South Tributary, ETC-6 Drainage and ETC-7 Drainage, as well as all other minor on-site drainages.

Pursuant to these clearances and permits, ETC-6 Drainage and ETC-7 Drainage (see Figure 2-3) will be filled within the SHII development area. Flows from the Santiago Hills II development area that currently flow into the downstream, preserved ephemeral portions of these drainages, will be diverted into the storm drain system in the post-development condition. These impacts have been mitigated and permitted pursuant to the environmental clearances and permits, including SHII 2000 SEIR Mitigation Measure B-1.

In the post-development condition, the South Tributary (see Figure 2-3) is set aside for preservation and enhancement, and is to be replanted and supplied primarily with wet weather flows. The North Tributary (see Figure 2-3) has been permitted for impact, re-grading, and planting as a part of the SHII project, in order to implement the creation, enhancement and restoration requirements set forth in the SHII 2000 SEIR and the permits. Specifically, pursuant to SHII 2000 SEIR Mitigation Measure B-1 and the resource agency permits, Glenn Lukos Associates prepared The Final Conceptual Mitigation Plan dated November 2003 approved by the ACOE and CDFG (Glenn Lukos Associates, 2003). This plan stipulates that mitigation of jurisdictional impacts within the SHII development area shall be provided by the creation of emergent marsh, riparian scrub, and oak and sycamore upland buffer areas within the North and South Tributaries (together, referred to as the Peters Canyon Tributaries").

Pursuant to the Final Conceptual Mitigation Plan, the project will convert the Peters Canyon Tributaries to a series of emergent marshes (Basins C3C1 through C7, A2, B2, B3, and B4) that will be connected by swales and channels with gently sloping banks (Figure 5-2). Although these swales and channels are not intended to provide treatment, the general concept is similar to treatment swales illustrated in Figure 5-5. The goal of the emergent marshes is to convert the currently degraded ephemeral portion of the South Tributary and the ephemeral North Tributary into a system that will provide additional wetland riparian hydrologic, biogeochemical, and habitat functions within the Santiago Hills II site. The emergent marshes will be designed to support wetland vegetation, such as bulrush, and some cattail. The wetland vegetation will quickly transition to riparian scrub species in higher elevations, and then will transition to coast live oak-sycamore riparian woodland in more upland buffer areas around the basins.

A total of 1.41 acres of existing emergent marsh will be preserved and enhanced (Emergent Marsh A/B series) and 2.0.8 acres of emergent marsh will be created upland (Emergent Marshes C3 – C7) for a total of 3.4 acres of emergent marshes[1].Marsh C series). The C and series emergent marshes will be created through segregated grading so as to retain and replace the more infiltrative Mocho loam soil. The enhanced and created emergent marshes will be seeded and planted with a variety of native trees, shrubs, herbs, and grasses. In addition, vegetated buffers averaging 100 feet around the enhanced/created emergent marsh complexes will increase the overall long-term success and functional capacity of the habitat mitigation feature.

As described in the water balance provisions of the Final Conceptual Mitigation Plan, the mitigation area vegetation will be dependent upon wet and dry weather runoff from developed areas of SHII, which will be treated in treatment control BMPs sized in compliance with the DAMP/LIP sizing requirements. Therefore, the project is designed to convey runoff from development, after treatment, to the North and South Tributaries. The emergent marshes will be designed to detain and release or infiltrate runoff over 48 hours. During dry weather months, this runoff is expected to infiltrate within the mitigation areas and is not expected to flow downstream to the Jamboree culverts (outlet points 2, 2A and 2B as defined in the ROMP Volume 1).

[1] The total emergent marsh area (3.4 acres), represents the area inundated during design water quality storm, and does not correspond to the area that is expected to sustained wetland vegetation, which is 1.9 acres.

Black Willow Forest Lacustrine Area

This drainage area is located just downstream of the proposed storm drain pipe under Jamboree Road proposed to be constructed by the project to protect Jamboree Road from inundation for the 100-year storm event (outlet point 2C) (see Figure 2-3). In the post development condition, this area will receive storm flows from developed areas after the flows have been treated in water quality BMPs included in the project as project design features.

Flows to Santiago Creek Within and Around Irvine Regional Park

As discussed in ROMP Volume 1, the drainage concept proposes that portions of the watershed currently tributary to the park will be diverted to Area C (Concentration Point 3) and Area D (Concentration Point 4). Concentration Point C is east of, and outside of the park. Concentration Point 4 is located west of, and outside the developed area of the park within the Villa Park Dam Inundation Area. Thus, all flows are still tributary to Santiago Creek, but will be diverted around the improved portions of the Park, either to the east of the park, outside of the park boundaries (Concentration point 3) or to the west of the park, outside of the improved park areas within the Villa Park Dam inundation area(Concentration Point 4) (Figure 5.1, ROMP Volume 1).

Overland Drainage Area within Irvine Regional Park

The overland drainage area within Irvine Regional Park is an area within the unimproved portion of the park north of Santiago Canyon Road and west of the park entrance (Figure 2-3). This area is partially within the Villa Park Dam inundation area. The area is subject to ephemeral sheet flows and was the site of a prior County of Orange off-site wetland and riparian mitigation project for the Frank R. Bowerman landfill. The intended mitigation site was installed in 1990. However, in 1996 monitoring report (P&D Environmental Services) indicated that hydrology was not appropriate to sustain the site as designed, and in 1998 ACOE found that the site did not meet success criteria. The County performed substitute mitigation activities at that time. The drainage area is dominated by disturbed areas and floodplain mixed sage scrub, with some mule fat scrub, ornamental planting, ruderal area, and a very small area of southern black willow forest. *See*, Biological Resources Report: SHII Supplemental Assessment of the Water Quality Basin/Habitat Restoration, dated November 14, 2003, LSA Associates. The prior mitigation site comprises the mixed scrub and disturbed area, and this area includes several western sycamore trees planted at regular intervals throughout this area as part of the previous mitigation effort.

The soils in the overland drainage area within Irvine Regional Park are extremely permeable, and infiltrate water quickly. This condition contributed to the failure of the wetland and riparian mitigation plan.

The project proposes to construct a swale and Extended Detention Basin 6A located within Irvine Regional Park (Figure 2-3). The proposed storm drain system is proposed to deliver storm flows from the Stage II portion of the SHII development area to the swale and the Extended Detention Basin (outlet point 4). The analysis of anticipated dry weather flows, provided in Section 7.5, indicates that little, if any, additional dry weather flows from the project would enter Basin 6A.

The ETC-9 Drainage

As described in the Glenn Lukos Associates Biological Technical Report East Orange Planned Communities dated September 3, 2004 (Glenn Lukos Associates, 2004), the ETC-9 Drainage is ephemeral in nature and currently supports upland habitats including mixed sage scrub, as well a limited amounts of drier-adapted riparian habitat species, including such as mulefat, mugwort, and basket rush (Figure 2-3). This drainage also supports coast live oak and sycamore riparian woodland.

As described in the GLA Biotech Report, that portion of the ETC-9 Drainage within the Area 1 development area is proposed for fill. Downstream of the Area 1 development area, the ETC-9 Drainage is not proposed for habitat modification or fill. The project proposes to convey runoff, after treatment in extended detention basins and other water quality BMPs, to this portion of ETC-9 Drainage (outlet point 3). The analysis of anticipated dry weather flows, provided in Section 7.5, indicates that little, if any, dry weather flows from the project would enter the ETC-9 Drainage.

Woody's Tributary

Currently, Woody's Tributary has intermittent and ephemeral reaches, receiving both storm flows and at least seasonal groundwater seepage (Figure 2-3). Because the drainage receives water in excess of storm flows, the drainage supports a predominance of riparian species and some wetland plants, which are indictors of moderate to abundant water (as compared with the adjacent uplands or ephemeral streams). Dominant plants include: willow and mulefat species, with some areas of cattail, bulrush and other wetland species.

The development of the East Orange Area 1 would result in the fill of certain branches of Woody's Tributary, as described in the GLA Biotech Report. Downstream of the Area 1 development area, Woody's Tributary is not proposed for habitat modification or fill. The storm drainage system for East Orange Area 1 proposes to convey runoff, after treatment in Extended Detention Basin 6G and other BMPs, to this portion of Woody's Tributary (outlet point 6~~3~~). The analysis of anticipated dry weather flows, provided in Section 7.5, indicates that little, if any, dry weather flows from the project would enter Woody's Drainage.

2.4 Existing Receiving Water Quality

Although certain constituents (see below) in Peters Canyon Reservoir, Irvine Lake, and Reach 1 of Santiago Creek occasionally have been shown to exceed some water quality objectives, these water bodies are not listed as impaired in the 2002 303(d) list compiled by the California State Water Resources Control Board. Santiago Creek is tributary to the Santa Ana River in Reach 2. Santa Ana River Reaches 1 and 2 are also not listed as having water quality impairments in the 2002 303(d) list.

2.4.1 Irvine Lake

Water enters Irvine Lake from various sources: flows imported by the water districts from Lake Mathews via the Municipal Water District of Orange County's pipelines, Limestone Creek and

Santiago Creek flows, storm flows from the local watershed, and rainfall directly into the lake. Areas within the Irvine Lake watershed have historically been used, or are currently used, for mining, solid waste disposal, and rural residential land uses. In-lake water quality data collected monthly by IRWD from November 1997 to March 2002 are summarized in Table 2-6. As shown in Table 2-6, some of the observed dissolved oxygen (DO) concentrations do not meet Basin Plan water quality objectives, and it appears that a few of the total lead concentrations exceeded chronic California Toxics Rule (CTR) criteria. Algal blooms leading to oxygen deficiency in the hypolimnion (lower levels) of the lake may lead to taste and odor problems and additional water treatment costs. Data from 2002 indicate that oxygen depletion in the deep water occurred from May through July. Existing water quality conditions and effects of the project on water quality in Irvine Lake have been evaluated by Flow Science using a lake model called "DYRESM-WQ" (Flow Science, 2004a).

Total and fecal coliform data collected by the Serrano Water District in Irvine Lake from December 2002 to July 2004 are summarized in Table 2-7. These data are mostly dry weather data, but also include a few wet weather events. Total coliform ranged from none detected to 9,000 most probable number per 100 milliliters (MPN/100 mL); while fecal coliform ranged from none detected to 2,200 MPN/100 mL. The fecal coliform log mean is less than the Basin Plan objectives for primary contact recreation (fecal coliform). However, Table 2-7 indicates that total coliform concentrations have exceeded Basin Plan water quality objectives for water supply (MUN).

Wet weather pathogen data collected by the Serrano Water District in the tributaries to Irvine Lake, Santiago Creek Reach 3 and Limestone Creek, are listed in Table 2-8. Total coliform ranged from 500 to 80,000 MPN/100 mL; while fecal coliform ranged from 13 to 700 MPN/100 mL.

Table 2-6: Water Quality Data Collected by IRWD in Irvine Lake

Constituent	Units	Sample Size[1]	Non detects	Mean[2]	Range	Basin Plan Criteria	CTR Criteria[4]	
							Acute	Chronic
TSS	mg/L	173	1	8	ND[3] - 40	Shall not cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors	-	-
TDS	mg/L	30	0	514	382 - 668	730 mg/L	-	-
pH	unit less	295	0	8	6.7 - 8.8	Shall not be raised above 8.5 or depressed below 6.5 as a result of controllable water quality features	-	-
Hardness (CaCO3)	mg/L	23	0	320	298 - 350	Hardness < 360 mg/l (CaCO3)	-	-
Conductivity	umhos/cm	273	0	837	488 - 2090	-	-	-
Total Fe	ug/L	299	0	379.0	21 - 2090	-	-	-
Total Mn	ug/L	299	1	122	ND - 1897	-	-	-
DO	mg/l	238	0	7	0.1 - 13	Shall not be depressed below 5 mg/L for waters designated as WARM or 6 mg/L for waters designated as COLD. Waste discharges shall not cause the median DO concentrations to	-	-

Constituent	Units	Sample Size[1]	Non detects	Mean[2]	Range	Basin Plan Criteria	CTR Criteria[4] Acute	CTR Criteria[4] Chronic
						fall below 85% of saturation or the 95th percentile concentration to fall below 75% of saturation within a 30-day period		
Total Ammonia-N	mg/l	2	0	0.28	.27 - .28	Narrative objectives for Algae & Color; 10 mg/L for Nitrate-N; 6 mg/L TIN (NH3+NO2+NO3)	-	-
TKN	mg/l	35	34	1.0	ND - 1.08		-	-
Nitrate-N	mg/l	4	0	0.09	0.02 - 0.12		-	-
Nitrite-N	mg/l	4	0	0.01	0 - 0.03		-	-
Phosphorus	mg/l	35	30	0.11	ND - 0.41		-	-
Chlorophyll-a	ug/l	5	0	16	12.2 - 19.5	Water discharges shall not contribute to excessive algal growth	-	-
Total Cu	ug/l	56	0	9	1.25 - 52.9	Toxic substances shall not be discharged to levels that will adversely affect beneficial uses	39	24
Total Pb	ug/l	56	5	1.4	ND - 14.5		330	13
Total Zn	ug/l	56	5	20	ND - 64.2		300	300

[1]Samples collected at various locations and depths in Irvine Lake
[2] In cases were non detects were recorded, the detection limits were used to determine the mean value
[3] ND = Non Detect
[4] CTR criteria for a hardness of 298 mg/L as CaCO3, the minimum measured values

Table 2-7: Pathogen Data Collected by the Serrano Water District in Irvine Lake

Constituent	Units	Sample Size[1]	Non detects	Log Mean	Range	Basin Plan Criteria
Total Coliform	MPN/100 mL	64	10	29	ND – 9,000	Single Sample <100 MPN/100 mL (MUN)
Fecal Coliform	MPN/100 mL	59	42	5	ND – 2,200	Log mean <200 MPN/100/mL based on 5 or more samples/30 day period, and not more than 10% of the samples exceed 400 MPN/100 mL for any 30-day period. (REC-1)

[1] Source: McGuire Environmental Consultants

Table 2-8: Pathogen Data Collected by the Serrano Water District Upstream of Irvine Lake

Sample Date[1]	Santiago Creek Reach 3 Total Coliform (MPN/100 mL)	Santiago Creek Reach 3 Fecal Coliform (MPN/100 mL)	Limestone Creek Total Coliform (MPN/100 mL)	Limestone Creek Fecal Coliform (MPN/100 mL)
2/18/03	500	40	1700	<20
3/17/03	80,000	700	900	13
4/17/03	500	4	500	170
2/27/04	--	--	900	240
3/2/04	≥1600	130	--	--
Log Mean	2,378	62	911	57

[1] Source: McGuire Environmental Consultants.

2.4.2 Peters Canyon Reservoir

In contrast to Irvine Lake, Peters Canyon Reservoir is quite small and shallow, and for all but the wettest years, is a "closed" system in which the reservoir experiences little or no releases. The only inflow is from the tributary watershed; imported water is not stored in PCR. Because of these factors, water quality in the Peters Canyon Reservoir is currently considered poor. Water quality and sediment data in Peters Canyon Reservoir were obtained from Orange County (1992-1998), USEPA's STORET database which includes profiles of temperature and dissolved oxygen as a function of depth (1994-2001), and sediment data collected by Horne and Roth (Appendix E). The data collected by Orange County summarized in Table 2-9 includes eleven samples collected from 7/92 through 8/00 at the intake tower (5 samples) or the northwest arm or center of the reservoir (3 samples at each location). Hardness in the reservoir was measured at 200 and 740 milligrams per liter (mg/L) as calcium carbonate ($CaCO_3$) for the two samples in which hardness was measured. Total suspended solids concentration in the reservoir was generally below 10 mg/L. Total copper ranged from non-detect to 10 micrograms per liter (ug/L) with values typically around 2 ug/L. Total lead ranged from below detection to 0.002 ug/L. Total zinc was below detection. TKN measurements averaged 10~~9.8~~ mg/L, total phosphorus 0.53 mg/L, and nitrate + nitrite-N was generally below 0.05 mg/L.

Table 2-9: **Water Quality Data Collected by Orange County in PCR**

Constituent	Units	Sample Size[1]	Non detects	Mean[2]	Range	Basin Plan Criteria	CTR Criteria[4]	
							Acute	Chronic
TSS	mg/l	11	9	9.1	ND[3] - <27	Shall not cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors	-	-
Hardness (CaCO3)	mg/l	2	0	470	200 - 740	-	-	-
Conductivity	umhos/cm	11	0	2185	1450 - 2870	-	-	-
TKN	mg/l	11	0	10	0.5 - 99	Narrative objectives for Algae & Color; DO shall not be depressed below 5 mg/L for waters designated as WARM	-	-
Nitrite + Nitrate-N	mg/l	7	6	0.06	ND - 0.13		-	-
Phosphorus	mg/l	8	0	0.5	0.03 - 2.2		-	-
Total Cu	ug/L	9	3	3.5	ND - 10	Toxic substances shall not be discharged to levels that will adversely affect beneficial uses	27	17
Total Pb	ug/L	9	7	2.112	ND - <3		200	7.7
Total Zn	ug/L	9	7	7.79	ND - <10		220	220

[1] Samples collected at various locations in PCR and at various depths
[2] In cases were non detects were recorded, the detection limits were used to determine the mean value
[3] ND = Non Detect
[4] CTR criteria for a hardness of 200 mg/L as CaCO3, the minimum measured values

In addition, GeoSyntec Consultants collected water quality data in PCR in August 2003 (Table 2-10), and water quality and sediment data in PCR in September 2003 and April 2004 (Table 2-10 and Table 2-11). The GeoSyntec monitoring data are provided in Appendix D. The Secchi depth in the August sampling round was about 3 feet. Field staff also reported a strong sulphur odor during this sampling event. Although Secchi depth was not measured in the second sampling round in September, visibility was limited by an observed algal bloom. During the spring 2004 event in April, the clarity of the reservoir was significantly improved as Secchi depth was comparable to the water depth at each of the 3 sampling locations. Thus water clarity was significantly poorer in the two fall sampling rounds compared with the spring sampling round.

Salinity was measured in the field as conductivity and in the lab as total dissolved solids. Conductivity values in the fall (5.1 to -5.4 microsiemens per centimeter (mS/cm)) were higher than in the spring (3.4 to 3.5 mS/cm). TDS values typically ranged between 3,~~500 to 4,~~000 to 4,200 mg/L which exceeds the Basin Plan water quality objective of 720 mg/L.

During the fall sampling rounds, the dissolved oxygen (DO) profiles had higher DO at the surface and lower DO at depth. The effect was most pronounced in September when the surface DO was quite elevated at about 20 mg/L and the near-bottom DO was about 9 mg/L. The lowest DO observed during these events was about 2.5 mg/L at 8 foot depth taken during the August sampling event. This could reflect the effects of thermal stratification. In contrast, the DO measured during the April 2004 sampling event was uniformly low and ranged from about 4.6 mg/L near the water surface to about 3.7 mg/L near the bottom of the reservoir. The high near-surface DO in the September sampling round was due to the relatively high algal concentrations (see below) and the associated photosynthetic production of oxygen in the near surface waters. As indicated in Table 2-10, some observed DO concentrations do not meet the Basin Plan water quality objectives.

Chlorophyll-a concentrations were highest (approximately 160~~0.15~~ to 210 ug~~0.2 mg~~/L) during the September sampling round and lowest (0.~~000~~5 to 11 ug~~0.001 mg~~/L) during the April sampling round.

Table 2-10: Water Quality Data Collected by GeoSyntec in PCR

Constituent	Units	Sample Size[1]	Non detects	Mean[2]	Range	Basin Plan Criteria	CTR Criteria[4] Acute	CTR Criteria[4] Chronic
TDS	mg/l	15	0	3647	3000 - 4200	720	-	-
DO	mg/l	15	0	7.20	2.53 - 19.90	Shall not be depressed below 5 mg/L for waters designated as WARM or 6 mg/L for waters designated as COLD. Waste discharges shall not cause the median DO concentrations to fall below 85% of saturation or the 95th percentile concentration to fall below 75% of saturation within a 30-day period	-	-
Salinity	percent	6	0	0.30	0.30	-	-	-
Conductivity	mS/cm	15	0	4.18	3.4~~4~~ - 5.4~~0~~	-	-	-
Ammonia-N	mg/l	15	14	0.20	ND[3] - 1.50	Narrative objectives for Algae & Color; DO shall not be depressed below 5 mg/L for waters designated as WARM	-	-
TKN	mg/l	15	0	1.94	0.56 - 4.40		-	-
Nitrate-N	mg/l	15	15	ND[3]	ND		-	-
Nitrite-N	mg/l	15	15	ND	ND		-	-
Total Nitrogen	mg/l	15	0	1.94	0.56 - 4.40		-	-
~~Phosphorus~~Phosphorus	ug/l	15	0	121~~12~~ ~~0.67~~	73 - 480		-	-
Chlorophyll-a	ug/l	15	0	41	0.50 - 210	Water discharges shall not contribute to excessive algal growth	-	-
Iron (USEPA 200.2)	mg/l	15	3	0.17	ND - 0.59	-	-	-

Constituent	Units	Sample Size[1]	Non detects	Mean[2]	Range	Basin Plan Criteria	CTR Criteria[4]	
							Acute	Chronic
Iron (Filtration Metals)	mg/l	15	15	ND	ND		-	-
Manganese (USEPA 200.2)	mg/l	15	0	0.58	0.28 - 2.10		-	-
Manganese (Filtration Metals)	mg/l	15	2	0.51	ND - 2.20		-	-

[1] Samples collected at various locations in PCR and at various depths
[2] In cases were non detects were recorded, the detection limits were used to determine the mean value
[3] ND = Non Detect

In summary, the DO, chlorophyll-a, and Secchi depth data illustrated the presence and effects of algal blooms in the fall sampling rounds specifically reduction in visibility, increased near-surface DO due to photosynthesis, and decreased DO with depth, with the lowest observed DO of about 3 mg/L in the August sampling round. Temperature data indicated some thermal stratification during this sampling event. In contrast, the DO and chlorophyll-a data during the spring sampling round indicated relatively well mixed conditions with uniformly low DO and chlorophyll-a.

Total nitrogen was highest during the fall sampling rounds with concentrations during the September round reaching about 4 to 4.5 mg/L. During the spring round, total nitrogen concentrations were about 0.5 to 1 mg/L. TKN concentrations were higher in the fall sampling rounds, ranging from about 2 to 4 mg/L, compared with the spring sampling round when concentrations ranged from about 0.5 to 1.5 mg/L. Nitrate-N and nitrite-N were not detected; however, the method detection limits were elevated because of matrix interferences associated with high sulfate.

In contrast to total nitrogen, total phosphorus concentrations were consistently around 73 ug/L~~0.07~~ to 130 ug~~0.13 mg~~/L during all three sampling rounds. The exception was the near-bottom measurement of 480 ug~~0.5 mg~~/L during the August sampling round, which most likely reflected release from sediments (see manganese discussion below). A similar effect was seen for total nitrogen during this same sampling round.

Manganese is an important constituent in lake water quality because it tends to be released from sediments during low DO conditions. Manganese was generally less than 0.5 mg/L, except at the near-bottom depth during the August sampling round when it was measured at 2.1 mg/L. This suggests that the weak stratification at this time was sufficient to reduce DO to the point where certain chemicals, including nutrients and manganese, were being released from the sediments.

Sediment cores were obtained during the third sampling round in April 2004. Core penetration was limited to the softer organic layer whose depth varied from about 4.5 feet at the Outlet Tower to 2.5 feet at Station 3 with refusal reached at the underlying consolidated clay layer. Samples were analyzed in the laboratory for wet weight pollutant concentrations for comparison with Total Threshold Limit Criteria (TTLC). Dry weight concentrations were then calculated based on the wet weight concentrations and moisture content of the sample. The data indicate that nutrients are accumulating in the sediments. Total nitrogen in the sediments ranged between about 140 to 540 mg/kg (dry weight) except for the near-surface value of 760 mg/kg measured at

Station 3 located in the central portion of PCR. Total phosphorus profiles tended to be variable with depth, with concentrations ranging between 370 to 2,100 mg/kg (dry weight). At the Outlet Tower, higher concentrations of total phosphorus tended to correspond to depths where total nitrogen was also somewhat elevated. Organics also are elevated in the sediments. Total organic carbon (TOC) in the cores tended to be highest near the surface with levels ranging from non detect to 35,000 milligrams per kilogram (mg/kg- dry weight) at the Outlet Tower and at Station 3 (central PCR). The highest TOC concentrations at Station 2 located in the northwest portion of PCR was 15,000 mg/kg (dry weight) at a 2-foot depth. The prevalent organic layer in PCR will be discussed in later sections which address the fate of metals discharged to PCR.

Selenium data were obtained from the analysis of cores at three locations in PCR. Of a total of 15 samples, only two were above the wet weight reporting limit of 2 mg/kg. The two detects were at wet weight concentrations of 2.6 mg/kg at 1 foot sediment depth at the Outlet Tower, and a concentration of 2.1 mg/kg from a surficial bottom sample at the station located near the center of PCR. The estimated dry weight concentrations are 4.7 and 7.8 mg/kg, respectively. Sediment cores were obtained during the third sampling round in April 2004. Core penetration was limited to the softer organic layer whose depth varied from about 4.5 feet at the Outlet Tower to 2.5 feet at Station 3 with refusal reached at the underlying consolidated clay layer. Total organic carbon (TOC) in the cores tended to be highest near the surface with levels ranging from 10,000 to 11,000 milligrams per kilogram (mg/kg) (dry weight) at the Outlet Tower and at Station 3 (central PCR). The highest TOC concentrations at Station 2 located in the northwest portion of PCR was 9,500 mg/kg at 2-foot depth. By comparison, TOC was measured at 15,000 mg/kg along the shoreline west of the Outlet Tower in an area where cattails were growing. The prevalent organic layer in PCR will be discussed in later sections which address the fate of metals discharged to PCR.

Selenium data were obtained from the analysis of cores at three locations in PCR. Of a total of 15 samples, only two were above the detection limit of 0.58 mg/kg. The two detects were a concentration of 2.6 mg/kg at 1-foot sediment depth at the Outlet Tower, and a concentration of 2.1 mg/kg from a surficial bottom sample at the station located near the center of PCR. Other selenium data for comparison includes unpublished IRWD sediment data at the San Joaquin Marsh, where data from 5 rounds of sampling in Ponds A, 1, 4, and 5 were all below the 1 mg/kg detection limit. The State Water Resources Control Board also funded a study "Sources of Selenium, Arsenic, and Nutrients in the Newport Bay Watershed" (Hibbs and Meixner, 2003). Two samples collected in San Diego Creek had concentrations of 2.1 and 2.2 mg/kg. Two samples obtained in Peters Canyon Wash below Como Channel had concentrations of 1.2 mg/kg in the channel and 0.46 mg/kg for a sample taken on the bank of the channel. There are no sediment criteria for selenium in California, however the US Department of Interior (1998) has established ranges for no effects (<1 mg/kg), levels of concern (1 – 4 mg/kg), and toxicity threshold (> 4 mg/kg). The 2 detects in PCR were in the level of concern range, which is defined as "concentrations in this range rarely produce discernible adverse effects but are elevated above typical background concentrations". On this basis it was determined that the observed selenium in the sediments of PCR is not accumulating to levels that would contribute to bioaccumulation in aquatic biota or other wildlife.

Table 2-11: Sediment Quality Data Collected by GeoSyntec in PCR

Constituent	Units	Sample Size[1]	Non Detects~~detects~~	Range (wet weight)~~Mean~~[2]	Range[2] (dry weight)
Ammonia-N	mg/kg	15	0	12 – 29 ~~36~~	15 – 61
Phosphorus	mg/kg	19~~15~~	0	270 – 950 ~~1131~~	370 – 2100
Nitrate-N	mg/kg	19~~15~~	19~~15~~	ND[3]	~~ND~~
Nitrite-N	mg/kg	19~~15~~	19~~15~~	ND	~~ND~~
Total Nitrogen	mg/kg	19~~15~~	0	110 – 800 ~~365~~	140 – 760
TKN	mg/kg	19	0	110 – 800 ~~365~~	140 – 750
Total Organic Carbon	mg/kg	19	8~~11~~	ND – 11000 ~~11900~~	ND ~~6700~~ 35000
Volatile Organic Compounds	ug/kg	15	15	ND	ND
Total Cu	mg/kg	15	0	4.5 – 33~~12~~	5.5 – 53~~4.5 – 33~~
Total Pb	mg/kg	15	0	2.7 – 10~~6.1~~	3.3 – 22~~2.7 – 10~~
Total Zn	mg/kg	15	0	20 – 68	25 -220~~20 – 68~~
Total Se	mg/kg	15	13	ND - 2.6~~0.8~~	ND – 7.8~~-2.6~~

[1] Samples collected at various locations in PCR and at various depths
[2] Dry weight concentrations were not calculated for wet weight concentrations that were not detected
ND = Non Detect

Dr. Alex Horne conducted additional selenium sampling to evaluate the potential effects of selenium on the ecology of PCR. For this purpose, Dr. Horne measured selenium concentrations in wetland plants, insects, crustaceans, mosquitofish, water, and sediments within the wetland fringe around the reservoir (Horne, 2005). Sample collection focused on three locations: 1) at the dam near the south shore, 2) near the western shore of PCR, and 3) at the boat launch near the parking lot. Results from the study, summarized in Table 2-12, indicate that selenium concentrations in the wetland waters were at the lower end of the marginal risk levels (2-5 ug/L). Measured concentrations in wetland sediments, bulrush and cattail biomass and seeds, dragon fly larvae (although only one sample), crayfish, and mosquito fish were generally below the USEPA proposed standards for fish and suggested guidelines provided by USGS. Open-water sediments tended to exhibit the highest selenium concentrations, ranging from less than 2 to 17 mg/kg (dry weight).

Table 2-12: Selenium Data Collected by Alex Horne Associates in PCR

Medium or Organism Type	Units	Sample Size[1]	Mean[2]	Range[2]	Guideline Values[3,4]
Water in wetlands	ug/kg	3	2	0.9-2.9	<2[3] or <5[3]
Wetlands sediments	mg/kg	2	1	0.5-1.9	< 2[3]
Open-water sediments	mg/kg	31	6	<2-17	< 2[3]
Bulrush & cattail stems, leaves & rhizomes	mg/kg	16	0	0.1-0.45	< 3[3]
Bulrush & cattail seeds	mg/kg	5	0	0.14-0.36	< 3[3]
Macrophyte root hairs	mg/kg	3	3	0.7-7.6	< 3[3]
Dragonfly larvae	mg/kg	1	1	Na[1]	< 3[3]
Crayfish	mg/kg	2	2	0.96-3.6	< 2[3]
Mosquitofish	mg/kg	2	3	2.8-3.1	< 7.91[4], < 4[3]

[1]All samples were composites of several individual plants or animals either to give a more representative sample or to provide enough biomass for analysis
[2]Values are presented as dry weight concentrations
[3]Based on suggested guidelines from USGS (Presser et al., 2004)
[4]Proposed standard fish (USEPA, 2004a)

On this basis it was determined that the observed selenium in the various media, and especially in food chain items such as bulrush and cattail seeds, is not accumulating to levels that would adversely affect aquatic biota or other wildlife.

[2]In cases were non detects were recorded, the detection limits were used to determine the mean value
[3]ND = Non Detect

Total nitrogen in the sediments ranged between about 140 to 540 mg/kg except for the near-surface value of 760 mg/kg measured at Station 3 located in the central portion of PCR. Total phosphorus profiles tended to be variable with depth, with concentrations ranging between about 500 to 2,000 mg/kg. At the Outlet Tower, higher concentrations of total phosphorus tended to correspond to depths where total nitrogen was also somewhat elevated.

The existing water quality conditions have been modeled by Flow Science (Flow Science, 2004b). The model results and field measurements indicate that currently the reservoir has high total dissolved solids concentrations, and seasonally exhibits very low dissolved oxygen concentrations. Because Peters Canyon Reservoir only outflows during very wet years, it is essentially a closed system for the period between outflows. Water quality degrades over time for so long as the system remains closed. This cyclical accumulation of pollutants within the reservoir will continue, even in the absence of any changes within the watershed tributary to the reservoir. Nevertheless, Flow Science evaluated the effects of the Project on Peters Canyon Reservoir using the DYRESM-WQ Model (Flow Science, 2004b).

2.4.3 Santiago Creek

Water quality data for Santiago Creek Reach 1 were obtained from the USEPA STORET database and provided by the Orange County Environmental Management Agency (Table 2-12). The station closest to the Project downstream of Irvine Lake, referred to as the Submerged Dam Station (station code SOSE08), is located about 0.6 miles downstream of Villa Park Dam. Because this station is located below a dam impoundment, the water quality data are not considered generally representative of the water quality in Santiago Creek above the dam. Also, the data contains only two monitoring events during storm flows, one in 1980 and one in 1995.

Water quality data collected by the Serrano Water District in Villa Park Reservoir between January 2001 and April 2004 are summarized in Table 2-13. The data indicate that TDS and hardness consistently exceed Basin Plan water quality objectives. Some of the total coliform concentrations are above the single sample Basin Plan water quality objectives. Also, although it is difficult to determine based on the summary data shown in the table, it appears likely that there are occasional exceedances of the fecal coliform water quality objective. Lastly, the data indicate that there have been exceedances of acute and chronic CTR criteria for copper.

Table 2-13: Water Quality Data Provided by the Orange County Environmental Management Agency in Santiago Creek, Reach 1

Constituent	Units	Sample Size[1]	Non detects	Mean	Range	Basin Plan Criteria	CTR Criteria[2]	
							Acute	Chronic
TDS	mg/L	1	0	620	-	-	-	-
pH	unit less	2	0	7.8	7.4 - 8.1	Shall not be raised above 8.5 or depressed below 6.5 as a result of controllable water quality features	-	-
Hardness (CaCO3)	mg/L	2	0	279	241 - 317	Hardness < 600 mg/l (CaCO3) (Reach 1)	-	-
Conductivity	umhos/cm	1	0	940	-	-	-	-
DO	mg/l	2	0	10.7	9.1 - 12.2	Shall not be depressed below 5 mg/L for waters designated as WARM or 6 mg/L for waters designated as COLD. Waste discharges shall not cause the median DO concentrations to fall below 85% of saturation or the 95th percentile concentration to fall below 75% of saturate	-	-
Ammonia-N	mg/l	1	0	0.0013	0.0013	Narrative objectives for Algae & Color; 10 mg/L for Nitrate-N	-	-
TKN	mg/l	1	0	1.8	1.8		-	-
Nitrate-N	mg/l	2	0	0.51	0.23 - 0.79		-	-
Phosphate-P	mg/l	1	0	0.19	0.19		-	-
Total Cu	ug/l	1	0	5.0	5.0	Toxic substances shall not be discharged to levels that will adversely affect beneficial uses	31	20
Total Pb	ug/l	1	0	5.0	5.0		250	9.7
Total Zn	ug/l	1	0	20	20		250	250

[1]Monitoring location about 0.6 miles downstream of Villa Park Dam
[2] CTR criteria for a hardness of 241 mg/L as CaCO3

Table 2-14: Water Quality Data Collected by the Serrano Water District in the Villa Park Reservoir

Constituent	Units	Sample Size[1]	Non detects	Mean	Range	Basin Plan Criteria	CTR Criteria	
							Acute	Chronic
TDS	mg/L	31	0	1683	1200 - 2700	600 mg/L	-	-
Turbidity	NTU	40	1	22	ND - 250	Natural Turbidity / Max Increase: 0-50 NTU 20%; 50 - 100 NTU 10 NTU; >100 NTU 10%. All inland surface waters of the region shall be free of changes in turbidity which adversely affect beneficial uses	-	-
Hardness (CaCO3)	mg/l	12	0	1048	807 - 1400	Hardness < 600 mg/l (CaCO3)	-	-
Nitrate-N	mg/l	1	0	0.52	0.52	10	-	-
Total Cu	ug/L	22	9	18	ND - 110	Toxic substances shall not be discharged to levels that will adversely affect beneficial uses	31	20
Total Pb	ug/L	2	2	ND	ND		250	9.7
Total Zn	ug/L	11	8	53	ND - 109		250	250

Constituent	Units	Sample Size[1]	Non detects	Mean	Range	Basin Plan Criteria	CTR Criteria	
							Acute	Chronic
Total Coliform	MPN/ 100 mL	50	9	86	ND - ≥16,000	Single Sample<100 MPN/100 mL (MUN)	-	-
Fecal Coliform	MPN/1 00 mL	48	26	8	ND - 800	Log mean <200 MPN/100/mL based on 5 or more samples/30 day period, and not more than 10% of the samples exceed 400 MPN/100 mL for any 30-day period.(REC-1)	-	-

[1] Source McGuire Environmental Consultants
[2]CTR criteria for a hardness of 241 mg/L as $CaCO_3$

3 REGULATORY SETTING

3.1 Clean Water Act

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

In addition, the CWA requires the States to adopt water quality standards for water bodies and to have those standards approved by the USEPA. Water quality standards consist of designated beneficial uses for a particular water body (e.g. wildlife habitat, agricultural supply, fishing etc.), along with water quality criteria necessary to support those uses. Water quality criteria are prescribed concentrations or levels of pollutants – such as lead, suspended sediment, and fecal coliform bacteria – or narrative statements which represent the quality of water that support a particular use. Because California had not established a complete list of acceptable water quality criteria, USEPA promulgated the California Toxics Rule ("CTR") (40 CFR 131.38), establishing numeric water quality criteria for certain toxic pollutants in waters with human health or aquatic life designated uses.

Water bodies not meeting water quality standards are listed as~~deemed~~ "impaired" by the State Water Board and, under CWA Section 303(d), are placed on a list of impaired waters for which a Total Maximum Daily Load (TMDL) must be developed for the impairing pollutant(s). A TMDL is an estimate of the total load of pollutants, from point, non-point, and natural sources, that a water body may receive without exceeding applicable water quality standards (with a "factor of safety" included). Once established, the TMDL is allocated among current and future pollutant sources as load and/or wasteload allocations. ~~to the water body.~~

Currently, although receiving waters subject to discharges from the proposed Project occasionally exceed some water quality objectives, they are not included on the 303(d) list. The only impaired section of any water body in the general vicinity of the Project area that is on the 303(d) list is Reach 4 of Santiago Creek which is located upstream of the Project, and is not a receiving water for the Project area. The impairment for Reach 4 is designated for TDS, salinity, and dissolved chloride levels. There area no listed impairments in Santiago Creek or the Santa Ana River downstream of the Project.

3.2 MS4 Permit

In 2002, the Santa Ana Regional Water Quality Control Board (SARWQCB, 2002), issued a NPDES Permit (Order No. R8-2002-0010) for discharges of urban runoff in public storm drains in northern Orange County. The Permittees are the County of Orange, the Orange County Flood Control District, and the northern Orange County cities, including the City of Orange, (collectively "the Co-Permittees"). This permit regulates stormwater discharges from municipal separate storm sewer systems (MS4s) in the Project area. The NPDES permit details requirements for new development and significant redevelopment projects, including specific sizing criteria for treatment Best Management Practices (BMPs). The following describes pertinent portions of the Permit that address:

- Receiving water limitations (Section IV)
- Technology-based standards including MEP and BAT/BCT (Section XII.B), and
- Local implementation.

3.2.1 Receiving Water Limitations

Section IV of the NPDES Permit contained receiving water limitations for discharges from MS4s. This section states:

> "Discharges from MS4s shall not cause or contribute to exceedances of receiving water quality standards (designated beneficial uses and water quality objectives) for surface waters or groundwaters."

To implement the requirements of the NPDES permit, including the Receiving Water Limitations, the Co-Permittees have developed a 2003 DAMP that includes a New Development and Significant Redevelopment Program (OCPFRD, 2003). The MS4 Permit states in pertinent part:

> "The DAMP and its components shall be designed to achieve compliance with receiving water limitations. It is expected that compliance with receiving water limitations will be achieved through an iterative process and the application of increasingly more effective BMPs. The permittees shall comply with Sections III.2 and IV of this order through timely implementation of control measures and other actions to reduce pollutants in urban storm water runoff in accordance with the DAMP and other requirements of this order, including any modifications thereto."

3.2.2 Technology-based Standards

Section XII.B of the 2002 municipal separate storm sewer system (MS4) NPDES Permit required the Permittees to review Appendix G of the 1993 Drainage Area Management Plan (DAMP) and to submit for review and approval by the SARWQCB a revised Water Quality

Management Plan (WQMP) that specifies BMP requirements for new development and significant redevelopment.[1] Section XII.B.1 identifies the project categories that must incorporate treatment control BMPs sized to meet the requirements of permit section XII.B.3.[2] Section XII.B.2 encouraged the Permittees to allow the implementation of regional and/or watershed management programs to address runoff from new development and significant redevelopment, and stated the following, which applies to the requirement for the Permittees to revise the DAMP and develop a revised WQMP:

> "The goal of the WQMP is to develop and implement practicable programs and policies to minimize the effects of urbanization on site hydrology, urban runoff flow rates or velocities and pollutant loads. This goal may be achieved through watershed-based structural treatment controls, in combination with site-specific BMPs. The WQMP shall reflect consideration of the following goals, which may be addressed through on-site-and/or watershed-based BMPs.
>
> "a. The pollutants in post-development runoff shall be reduced using controls that utilize best available technology (BAT) and best conventional technology (BCT).
>
> "b. The discharge of any listed pollutant to an impaired waterbody on the 303(d) list shall not cause an exceedance of receiving water quality objectives."

Pursuant to Section XII.B of the Permit, the Permittees (including the County of Orange and the City of Orange) prepared a Model WQMP and submitted it to SARWQCB for review and approval. On September 26, 2003, the board of SARWQCB authorized the agency's Executive Officer to approve the Model WQMP, with slight revisions. By letter dated September 30, 2003, the Executive Officer issued that approval, as indicated in Appendix K to this report.

The NPDES Permit is governed by the Maximum Extent Practicable (MEP) standard of the federal Clean Water Act, as indicated by Section XIX.2 which states:

> "The purpose of this [NPDES Permit] Order is to require the implementation of best management practices to reduce, to the maximum extent practicable, the discharge of pollutants from the MS4 in order to support reasonable further progress towards attainment of water quality objectives."

The 2002 MS4 Permit also incorporates the BAT and BCT Clean Water Act technology standards to be reflected in the revised WQMP (i.e., Model WQMP). However, BAT and BCT are not defined by the Permit. Federal law specifies factors relating to the assessment of BAT including: age of the equipment and facilities involved; the process employed; the engineering aspects of the application of various types of control techniques; process changes; the cost of achieving effluent reduction; non-water quality environmental impacts (including energy

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[1] The revised WQMP developed by the County and the Cities and approved by the Regional Board is the "Model WQMP." As described in the DAMP and Model WQMP, project-specific WQMPs prepared by project owners/developers are "Project WQMPs."
[2] The 2003 DAMP and Model WQMP refer to this list of project categories as "Priority Projects."

requirements); and other factors as the Administrator deems appropriate. Clean Water Act §304(b)(2)(B). Factors relating to the assessment of BCT include: reasonableness of the relationship between the costs of attaining a reduction in effluent and the effluent reduction benefits derived; comparison of the cost and level of reduction of such pollutants from the discharge from publicly owned treatment works to the cost and level of reduction of such pollutants from a class or category of industrial sources; the age of the equipment and facilities involved; the process employed; the engineering aspects of the application of various types of control techniques; process changes; non-water quality environmental impact (including energy requirements); and other factors as the Administrator deems appropriate. Clean Water Act §304(b)(4)(B).

The Administrator of U.S. EPA has not issued regulations specifying BAT or BCT for urban runoff. However, as indicated in the revised DAMP, "all priority projects shall design, construct, and implement structural Treatment Control BMPs that meet the design standards in this section and achieve the appropriate standard, as specified in the Third Term Permits…." (Quantity Design Standard for Treatment Control BMPs (page 7.II-33)). The Permittees considered the "appropriate standard" of the NPDES Permit when updating the DAMP and preparing the model WQMP. Those standards include BAT and BCT as they are referenced in the NPDES Permit.

The New Development and Significant Redevelopment Program of the DAMP provides a framework and a process for following the NPDES permit requirements and incorporates watershed protection/stormwater quality management principles into the Co-Permittees' General Plan process, environmental review process, and development permit approval process. The New Development and Significant Redevelopment Program includes a Model Water Quality Management Plan (WQMP) that defines requirements and provides guidance for compliance with the NPDES permit requirements for project-specific planning, selection, and design of BMPs in new development or significant redevelopment projects.

3.2.3 Local Implementation Plan

Under the Local Implementation Plan (LIP) developed by the City of Orange to describe its stormwater management program, new development and significant redevelopment are required to comply with the Model WQMP and the DAMP. The Model WQMP and the DAMP are programmatic documents that outline a comprehensive stormwater management program intended to achieve compliance with the MS4 permit.

Per the requirements of the DAMP and MS4 Permit, each local jurisdiction, including the City of Orange, has adopted a Local Implementation Plan (LIP) for compliance with the DAMP/MS4 permit. The LIP contains a component on new development and redevelopment based upon the model program contained in the DAMP. Using its local LIP as a guide, the City of Orange will approve project-specific WQMPs as part of the development plan and entitlement approval process for discretionary projects, and prior to issuing permits for ministerial projects. The information in this report will serve as the technical basis for the project-specific WQMP for the Santiago Hills Planned Community and East Orange Planned Community Area 1 Project, providing the direction and foundation for later preparation of the project-level WQMP prior to issuance of grading permits.

One of the requirements for WQMPs pursuant to the City's program is that all priority new development and significant redevelopment projects are required to develop and implement a project WQMP that addresses:

- Regional or watershed programs (if applicable)
- Routine structural and non-structural Source Control BMPs
- Site Design BMPs (as appropriate)
- Treatment Control BMPs (Treatment Control BMP requirements may be met through either project specific (on-site) controls or regional or watershed management controls that provide equivalent or better treatment performance
- The mechanism(s) by which long-term operation and maintenance of all structural BMPS will be provided

The DAMP/LIP is consistent with the technology-based standards set by the MS4 Permit, including the Maximum Extent Practicable Standard (MEP), as well as consideration of the technology-based standard goals included in Section XII.B.2 that are applicable to point source discharges - Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology (BAT/BCT). MEP is a technology-based standard established by Congress in CWA section 402(p)(3)(B)(iii) that MS4 discharges must meet. The Orange County MS4 Permit defines "Maximum Extent Practicable" as "the maximum extent feasible, taking into account considerations of synergistic, additive, and competing factors, including but not limited to, gravity of problem, technical feasibility, fiscal feasibility, public health risks, societal concerns, and social benefits." Compliance with the MS4 Permit and DAMP/LIP requirements for site design, source control, and treatment control BMPs satisfies the MEP standard.

In addition to other BMPs, the LIP requires treatment control BMPs to be implemented for all priority projects, defined to include all projects meeting any of the following criteria:

1. Residential development of 10 units or more.

2. Commercial and industrial development greater than 100,000 square feet (including parking area).

3. Automotive repair shops.

4. Restaurants where the land area of development is 5,000 square feet or more (including parking area).

5. Hillside development on 10,000 square feet or more, which are located on areas with known erosive soil conditions or where natural slope is 25 percent or more.

6. Impervious surface of 2,500 square feet or more located within, directly adjacent to (within 200 feet), or discharging directly to receiving waters within Environmentally Sensitive Areas.

7. Parking Lots 5,000 square feet or more, or with 15 parking spaces or more, and potentially exposed to urban runoff.

8. All significant redevelopment projects, where significant redevelopment is defined as the addition of 5,000 or more square feet of impervious surface on an already developed site.

Project-based treatment BMPs in a WQMP must meet certain criteria as per the LIP, including specified design criteria and other selection factors based on the pollutants of concern expected from a project site. Primary pollutants of concern are those pollutants that are anticipated or potential pollutants in runoff from the project based on proposed land uses, and which have also been identified as causing impairment of receiving waters on the most recent 303(d) list. Other pollutants of concern are those pollutants that are anticipated or potential pollutants that have not been identified as causing impairment of receiving waters. Pollutants of concern for the Project are identified in Section 4.1 and Appendix A.

The DAMP/LIP includes sizing criteria for both volume-based and flow-based BMPs. The sizing criteria options for volume-based BMPs, such as extended detention basins, are as follows:

1. The volume of runoff produced from a 24-hour, 85^{th} percentile storm event, as determined from the local historical rainfall record; or,

2. The volume of annual runoff produced by the 85^{th} percentile, 24-hour rainfall event, determined as the maximized capture stormwater volume for the area, from the formula recommended in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87 (WEF, 1998); or,

3. The volume of annual runoff based on unit basin storage volume, to achieve 80% or more (Santa Ana Regional Board region) volume treatment by the method recommended in California Stormwater Best Management Practices Handbook – Industrial/Commercial (1993); or,

4. The volume of runoff, as determined from the local historical rainfall record, that achieves approximately the same reduction in pollutant loads and flows as achieved by mitigation of the 85^{th} percentile, 24-hour runoff event.

Flow-based BMPs such as vegetated swales and hydrodynamic separation systems (HSS) units must be designed to infiltrate or treat the maximum flow rate generated from one of the following scenarios:

1. The maximum flow rate of runoff produced from a rainfall intensity of 0.2-in of rainfall per hour for each hour of a storm event.

2. The maximum flow rate of runoff produced by the 85^{th} percentile hourly rainfall intensity, as determined from the local historical rainfall record, multiplied by a factor of two.

3. The maximum flow rate of runoff, as determined from the local historical rainfall record that achieves approximately the same reduction in pollutant loads and flows as achieved by mitigation of the 85th percentile hourly rainfall intensity multiplied by a factor of two.

All of the HSS units were sized using flow-based method 1~~2~~ above. The treatment BMPs proposed for the Project were sized and configured to capture at least 80% of the average annual runoff volume as determined by a continuous hydrologic model (see Appendix C for further detail). This is equivalent to capturing the runoff volume as determined using the method recommended in California Stormwater Quality Association Stormwater Best Management Practice Handbook, New Development and Redevelopment (CASQA, 2003).

3.3 NPDES Construction General Permit

Pursuant to the CWA Section 402(p)(3)(A), requiring regulations for permitting of certain stormwater industrial discharges, the State Water Resources Control Board (SWRCB) has issued a statewide general NPDES Permit for stormwater discharges from construction sites. The initial permit was adopted in August, 1999 as NPDES No. CAS000002 California Water Resources Control Board Resolution No. 2001-046. The permit was modified in April 26, 2001 as Modification of Water Quality Order 99-08-DWQ State Water Resources Control Board (SWRCB) National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Construction Activity.

Under this Construction General Permit, discharges of stormwater from construction sites with a disturbed area of one or more acres (effective March 2003) are required to either obtain individual NPDES permits for stormwater discharges or be covered by the Construction General Permit. Coverage under the Construction General Permit is accomplished by completing and filing a Notice of Intent with the SWRCB, and implementing its provisions. Each applicant under the Construction General Permit must ensure that a Stormwater Pollution Prevention Plan (SWPPP) is prepared prior to grading and implemented during construction. The primary objective of the SWPPP is to identify, construct, implement, and maintain BMPs to reduce or eliminate pollutants in stormwater discharges and authorized non-stormwater discharges from the construction site during construction.

3.4 General Waste Discharge Requirements for Non-Stormwater Discharges Associated with Construction

The Santa Ana Regional Water Quality Control Board has issued General Waste Discharge Requirements (WDRs) under Order No. 98-670-007, NPDES No. CMG 998001 governing non-stormwater construction-related discharges from activities associated with project development within the Project development areas. This permit addresses discharges from activities such as dewatering, water line testing, and sprinkler system testing. The discharge requirements include provisions mandating notification, sampling and analysis, and reporting of dewatering and testing-related discharges. The General WDRs authorize such construction related activities so long as all conditions of the permit are fulfilled.

3.5 Basin Plan

The Water Quality Control Plan for the Santa Ana River Basin (Santa Ana Basin Plan) (SARWQCB, 1995 as amended) designates beneficial uses and water quality objectives for waterbodies within the region. Specific objectives are provided for the larger water bodies within the region as well as general objectives for ocean waters, bays and estuaries, inland surface waters (including wetlands), and groundwater. In general, the narrative objectives require that degradation of water quality does not occur due to increases in pollutant loads that will substantially impact the designated beneficial uses of a water body. See Table 2-4 for the beneficial uses of applicable receiving waters. For example, the Santa Ana Basin Plan requires that "Inland surface waters shall not contain suspended or settleable solids in amounts which cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors". Water quality criteria from the Basin Plan are compared to model results in Section 7 in order to assess potential pollutant impacts.

3.6 California Toxics Rule

The California Toxics Rule (CTR) is a federal regulation issued by the USEPA providing water quality criteria for toxic constituents in California waters with human health or aquatic life designated uses in the State of California. CTR criteria are applicable to the receiving water body and therefore must be calculated based upon the probable hardness values of the receiving waters for evaluation of acute (and chronic) toxicity criteria. At higher hardness values for the receiving water, copper, lead, and zinc are more likely to be complexed (bound with) components in the water column, reducing. This in turn reduces the bioavailability and potential toxicity of these metals.

Due to the intermittent nature of stormwater runoff (especially in Southern California), the acute criteria are considered to be more applicable to stormwater conditions than chronic criteria and therefore are used in assessing Project impacts. For example, the average storm duration in the Santiago Dam rainfall record is 11.4 hours. Acute criteria represent the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time without significant risk of harm; chronic criteria equal the highest concentration to which aquatic life can be exposed for an extended period of time (four days) without significant risk of harm.

The Basin Plan objectives and the CTR criteria do not apply directly to discharges of stormwater runoff, but rather apply within the specified receiving waters. Discharges from MS4s shall not cause or contribute to exceedances of receiving water quality standards (designated beneficial uses and water quality objectives) for surface waters or groundwaters. Therefore, these criteria can provide a useful benchmark to assess the potential for the Project discharges to affect the water quality of receiving waters. In this document, these criteria are used as benchmarks to evaluate the potential environmental impacts of stormwater runoff to the local receiving waters.

4 POLLUTANTS OF CONCERN, HYDROLOGIC CONDITIONS OF CONCERN, AND SIGNIFICANCE CRITERIA

4.1 List of Pollutants of Concern

The pollutants of concern for the water quality analysis have been chosen based upon the regulations described above and the pollutants that are anticipated or potentially could be generated by the Project (based on the proposed land uses) that have been identified by regulatory agencies as potentially adversely affecting beneficial uses in the receiving water bodies or that could adversely affect receiving water quality. Appendix A lists the pollutants of concern, the basis for their selection, and the significance criteria that will be applied for each.

As mentioned above, the receiving waters for the Project are not identified as impaired on the 2002 303(d) list and thus have no 303(d) listed constituents that would be identified as primary pollutants of concern per the DAMP/LIP.

The following pollutants were chosen as pollutants of concern for purposes of evaluating water quality impacts based on three jointly applied criteria: (1) pollutants that are prevalent in urban storm water and have the potential to impair surface receiving waters, (2) regulatory requirements and guidance, including the MS4 Permit and the DAMP, and (3) water quality conditions of concern specific to Peters Canyon Reservoir. As identified in Table 7.1-3 of the DAMP, pollutants anticipated in runoff from the land uses included in the Project include the following:

Sediments (TSS and Turbidity) – Excessive erosion, transport, and deposition of sediment in surface waters is a significant form of pollution resulting in water quality problems. Sediment imbalances impair designated uses. Excessive sediment can impair aquatic life by filling interstitial spaces of spawning gravels, impairing fish food sources, filling rearing pools, and reducing beneficial habitat structure in stream channels. In addition, excessive sediment can cause taste and odor problems in drinking water supplies and block water intake structures.

Nutrients (Nitrogen and Phosphorus) – Nutrients are inorganic forms of nitrogen and phosphorus. There are several sources of nutrients in urban areas, mainly fertilizers in runoff from lawns, pet wastes, failing septic systems, and atmospheric deposition from industry and automobile emissions. Nutrient over-enrichment is especially prevalent in agricultural areas where manure and fertilizer inputs to crops significantly contribute to nitrogen and phosphorus levels in streams and other receiving waters. Eutrophication due to excessive nutrient input can lead to changes in periphyton, benthic, and fish communities; extreme eutrophication can cause hypoxia or anoxia, resulting in fish kills. As a result of eutrophication, surface algal scum, water discoloration, and the release of toxins from sediment can occur.

Trace Metals (Copper, Lead, and Zinc) – The primary sources of trace metals in stormwater are typically commercially available metals used in transportation, buildings, and infrastructure. Metals are also found in fuels, adhesives, paints, and other coatings. Copper, lead, and zinc are the most prevalent metals typically found in urban runoff. Other trace metals, such as cadmium, chromium, and mercury, are typically not detected in urban runoff or are detected at very low levels (LA County, 2000). Metals are of concern because of toxic effects on aquatic life and the potential for ground water contamination. High concentrations of certain metals can bioaccumulate in fish and shellfish and affect beneficial uses of a waterbody.

Pathogens (Bacteria, Viruses, and Protozoa) – Elevated pathogens are typically caused by the transport of animal or human fecal wastes from the watershed. Runoff that flows over land such as urban runoff can mobilize pathogens, including bacteria and viruses. Even runoff from natural areas can contain pathogens (e.g., from wildlife). Other sources of pathogens in urban areas include pets and leaky sanitary sewer pipes. The presence of pathogens in runoff can impair receiving waters and contaminate drinking water sources. Elevated pathogens are typically caused by the transport of animal or human fecal wastes from the watershed. Historically an indicator organism such as fecal coliform has been used for pathogens due to the difficulty of monitoring for pathogens directly. More recently, the scientific community has questioned the use of indicator organisms, as scientific studies have shown no correlation between indictor and pathogen levels and therefore total and fecal coliform may not indicate a significant potential for causing human illness (Paulsen and List, 2003).

Petroleum Hydrocarbons (Oil and Grease and PAHs) – The sources of oil, grease, and other petroleum hydrocarbons in urban areas include spillage of fuels and lubricants, discharge of domestic and industrial wastes, atmospheric deposition, and runoff. Runoff can be contaminated by leachate from asphalt roads, wearing of tires, and deposition from automobile exhaust. Some petroleum hydrocarbons, such as polycyclic aromatic hydrocarbons (PAHs), can accumulate in aquatic organisms from contaminated water, sediments, and food and can be toxic to aquatic life at low concentrations. Hydrocarbons can persist in sediments for long periods of time and can result in adverse impacts on the diversity and abundance of benthic communities. Hydrocarbons can be measured as total petroleum hydrocarbons (TPH), oil and grease, or as individual groups of hydrocarbons, such as PAHs.

Pesticides – Pesticides (including herbicides, insecticides, and fungicides) are chemical compounds commonly used to control insects, rodents, plant diseases, and weeds. Pesticide applications can result in runoff containing toxic levels of active ingredients.

Trash & Debris – Improperly disposed or handled trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic debris (such as leaves, grass cuttings, and food waste) can accumulate on the ground surface where it can be entrained in urban runoff. The presence of trash and debris can have a significant impact on the recreational value of a water body and aquatic habitat. Excess organic matter such as food wastes in urban trash can create a high biochemical oxygen demand in a stream and thereby lower its water quality. Also, in areas where stagnant water exists, the presence of excess organic matter can promote septic conditions resulting in the growth of undesirable organisms and the release of odorous and hazardous compounds such as hydrogen sulfide.

4.2 Other Pollutants

The DAMP includes two additional categories of pollutants of concern that are associated with urban runoff – organic compounds and oxygen-demanding compounds. The pollutants in these two categories are largely subsumed by the categories above.

Organic compounds include a wide range of chemicals such as pesticides, hydrocarbons, and solvents. As the Project does not include industrial land uses, industrial chemicals are not likely to be contained in the runoff, except via spills associated with construction or maintenance activities. During the construction phase of the Project, the Construction Stormwater Pollution Prevention Plan (SWPPP) will address the proper storage and disposal of solvents and other organic compounds, as well as spill response. Post construction, spills will be contained with the drainage system and remediated per applicable regulatory requirements. Hydrocarbons and pesticides are potential sources of pollution for the Project and are believed to be the primary types of organic compounds likely to be present. As hydrocarbons and pesticides are addressed individually in this document, the general category of organic compounds is addressed through assessment of these constituents.

Oxygen-demanding substances are compounds that can be biologically degraded by microorganisms in receiving waters. Compounds such as organic food wastes in trash and anhydrous ammonia in fertilizer are examples of the oxygen-demanding compounds that may be present in urban runoff. Ammonia is typically detected at very low levels in urban runoff, likely due to the oxidation of ammonia to nitrate by bacteria in soil (nitrates are typically detected at higher concentrations than ammonia in urban runoff and do not exert an oxygen demand). Oxygen demand can be measured as "five-day biochemical oxygen demand" (BOD_5). This test involves the measurement of the dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter. The mean BOD_5 of data collected by Los Angeles County in support of their MS4 Permit over a six year period, for runoff from open space and high density single-family residential land uses, was 12 mg/L and 16 mg/L, respectively (Los Angeles County, 2000). In contrast, the typical BOD_5 concentration in a medium strength untreated domestic wastewater is 220 mg/L and, after secondary treatment, is 30 mg/L (Metcalf and Eddy, 1979). As nutrients and trash are addressed individually in this document, the general category of oxygen-demanding substances is addressed through assessment of these constituents.

Total dissolved solids (TDS) are not commonly of concern in runoff from urban development, but are of concern for the Project areas that are tributary to Peters Canyon Reservoir. Because the reservoir currently experiences flow-through only in response to major wet season events (most recently, the 1997-1998 El Nino event), concentrations of salts are accumulating in the reservoir over time (Flow Science, 2004b). As a result, high salinity levels exist within the reservoir. These conditions will continue to worsen in the future, even in the absence of development within the watershed, until there is a year when sufficient rainfall results in significant reservoir flushing. Given these waterbody-specific concerns, TDS is considered a pollutant of concern for Peters Canyon Reservoir, but not for Irvine Lake, Santiago Creek, or Villa Park Reservoir.

Some other pollutants that are listed in the Basin Plan, but are not of concern in urban runoff, include un-ionized ammonia, cadmium, and boron. Un-ionized ammonia is a pollutant typical of wastewater treatment plant discharges but not of urban runoff. Cadmium, as mentioned above, was detected in only three percent of the monitoring data collected by Los Angeles County for residential land uses (Los Angeles County, 2000). Boron is not considered a problem in drinking water until concentrations of 20 to 30 mg/L are reached (SARWQB, 1995). The Basin Plan objective for boron is 0.75 mg/L in surface waters to protect irrigation supplies for citrus crops. The mean boron concentration in residential runoff measured by Los Angeles County was 0.13 mg/L (Los Angeles County, 2000). Therefore, these constituents are not considered a pollutant of concern for the Project.

The Basin Plan also contains a narrative objective prohibiting color-, taste-, or odor-producing substances that cause a nuisance or adversely affect beneficial uses. Undesirable tastes and odors in water may be a nuisance and may indicate the presence of a pollutant(s). Odor associated with water can result from decomposition of organic matter or the reduction of inorganic compounds, such as sulfate. Other potential sources of odor causing substances, such as industrial processes, will not occur as part of the Project. Color in water may arise naturally, such as from minerals, plant matter, or algae, or may be caused by industrial pollutants. The Project will contain no industrial uses. Therefore, color-, taste-, or odor-producing substances are not a pollutant of concern for the Project.

Based on the consideration of those pollutants that are anticipated to be generated by the Project in combination with their potential to impact water quality standards, the following pollutants were identified as pollutants of concern for the Project:

- Sediment (Total Suspended Solids and Turbidity)
- Nutrients (Nitrogen and Phosphorus)
- Trace Metals (Copper, Lead, and Zinc)
- Pathogens (Bacteria, Viruses, and Protozoa)
- Hydrocarbons (Oil and Grease, Polycyclic Aromatic Hydrocarbons)
- Pesticides
- Trash and Debris
- Total Dissolved Solids

4.3 Hydrologic Conditions of Concern

The project may impact certain natural drainages that are downstream of Santiago Hills II and East Orange Area 1 development areas and storm drain facility discharge points. Common impacts to the hydrologic regime resulting from development include increased stormwater runoff volumes and velocities; increased runoff flow frequencies, duration, and peaks; faster time to reach peak flows; and the introduction of dry weather flows to areas that currently receive only wet weather storm flows. Under certain circumstances, changes could also result in the reduction in the amount of available sediment for transport and storm flows could fill the sediment-carrying capacity by eroding a downstream natural channel. These changes have the potential to impact downstream channels and habitat integrity. According to the DAMP/LIP, a change to a project site's hydrologic regime would be considered a condition of concern if the change would have a significant impact on downstream natural channels and habitat integrity, alone or in conjunction with impacts of other projects.

Volume I of the ROMP analyzes potential impacts and appropriate mitigation for post-development increased stormwater runoff peak flows and sediment yield.

With respect to the introduction of low flows, there is a potential that these increases in flows to natural drainages from the proposed storm drain facilities after treatment could change habitat types within intermittent and ephemeral drainage courses.

4.4 Significance Criteria

Pollutants of Concern

Appendix A provides the criteria for evaluating the significance of a potential impact for each pollutant of concern. These criteria can be summarized as follows.

- *Loads and Concentration Comparisons* - Comparison of post-development versus pre-development water quality concentrations and loads indicates a potential for significant adverse effects.

- *Permit Standards* – Satisfaction of MS4 NPDES Permit requirements for new development, as defined in the DAMP/LIP and construction-related requirements of the General Construction Permit, establishes compliance with water quality permitting requirements applicable to runoff.

- *Water Quality Standards* - Comparison of post-development water quality concentrations in the runoff discharge with benchmark receiving water quality criteria as provided in the Basin Plan and the CTR facilitates analysis of the potential for runoff to cause or contribute to exceedances of receiving water quality standards. The water quality criteria are considered benchmarks for comparison purposes only, as such criteria apply within receiving waters as opposed to directly to runoff discharges.

The application of the criteria to a decision regarding significance requires an integrated or "weight of evidence" approach, rather than a decision based on any one of the individual criterion.

Hydrologic Conditions of Concern

The significance criteria for hydrologic conditions of concern is based on comparison of post-development versus pre-development hydrology to determine the potential for adverse changes in post-development hydrology affecting habitat in natural drainage systems.

4.5 Thresholds for Significance

CEQA Standard - CEQA requires that any potentially substantial increases to pollutant concentrations and/or loads resulting from development be evaluated for significant adverse impacts to receiving water quality. This report analyzes such potential changes based on the results of water quality modeling and qualitative assessments that take into account water quality controls or BMPs that are considered Project Design Features.

Any increases of pollutant concentrations or loads resulting from development of the project site are considered an indication of a potentially significant adverse impact. If post-development pollutant loads and concentrations, with treatment in the BMPs specified as PDFs (including water quality detention basins), are predicted to remain the same or to be reduced compared with existing conditions, it is concluded that the project will not cause a significant adverse impact to the ambient water quality of the receiving waters for that pollutant. If pollutant loads or concentrations are predicted to increase, the potential impacts are assessed by: (1) evaluating compliance of the project PDFs with the MS4 Permit, DAMP/LIP, and General Construction Permit requirements, and (2) by evaluating the magnitude of the potential increase in pollutant load and/or concentration and through comparison to relevant benchmarks including water quality objectives and criteria.

Water Quality Criteria – Certain narrative and numeric water quality objectives contained in the Santa Ana Basin Plan apply to the Project's receiving waters. Water quality criteria contained in the CTR provide concentrations that are not to be exceeded in receiving waters more than once in a three-year period for waters designated with aquatic life or human health related uses. Projections of runoff water quality are compared to the acute form of the CTR criteria, as storm water runoff is associated with episodic events of limited duration, whereas chronic criteria apply to longer-term exposures (i.e., 4-days) which do not describe typical storm events in the Project area, which last approximately 11 hours on average. Chronic CTR criteria are included in the report for comparison purposes only.

MS4 Permit Requirements for New Development (DAMP) – Among other things, the MS4 Permit requires that discharges from MS4s shall require controls to reduce discharges of pollutants to the Maximum Extent Practicable, and also incorporates the BAT and BCT technology standards of the Clean Water Act. MS4 requirements including its applicable standards are met when new development complies with the DAMP/LIP. Under the DAMP/LIP, the effectiveness of storm water treatment controls is primarily based on two factors - the amount of runoff that is captured by the controls and the selection of BMPs to address identified pollutants of concern. Selection and numerical sizing criteria for new development treatment controls are included in the MS4 Permit and the DAMP/LIP. If the Project PDFs meet these criteria, and other source control and site design BMPs required by the DAMP/LIP are implemented, it is concluded that BMPs are sufficient to satisfy NPDES requirements and protect water quality. DAMP/LIP requirements also include a requirement to prepare a drainage study report identifying the project's hydrologic conditions of concern. Where downstream conditions of concern have been identified, the drainage study shall establish that pre-project hydrologic conditions affecting downstream conditions of concern would be maintained by the proposed Project PDFs.

Construction General Permit - All development projects which disturb one or more acres are required to obtain coverage under the State Water Quality Control Board's General Permit for Discharges of Storm Water Associated with Construction Activity (Construction General Permit 99-08-DWQ). The Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP) that describes erosion and sediment control BMPs as well as material management/non-stormwater BMPs that will be used during the construction phase of development. The threshold of significance during the construction phase of a project is implementation of BMPs consistent with Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology (BAT/BCT), as required by the Construction General Permit, Section 8 of the DAMP, and Section A-8 of the LIP.

Hydrologic Conditions of Concern - The threshold of significance for hydrologic conditions of concern is whether the project will alter the pre-project hydrologic conditions within preserved natural drainages in a manner that adversely affects downstream habitat, taking into consideration the incorporation of the Project PDFs.

Cumulative Impacts Analysis – CEQA requires a reasonable analysis of the cumulative impacts of a proposed project together with past, present, and reasonably anticipated future related projects that could produce cumulative impacts with the proposed project.

5 PROJECT DESIGN FEATURES

The watershed protection principles and policies discussed in MS4 Permit Section XII.A.4 and DAMP Section 7.4.4 were considered in selection and design the Project Design Features (PDFs) described below (including such measures as use of biofiltration as a treatment control, maximization of pervious areas (landscaped and open space), and use of energy dissipation devices in areas potential susceptible to erosion).

5.1 Site Design BMPs

Project Design Features (PDFs) can be grouped into three categories: site design, source control, and treatment control. Site design BMPs are practices designed to minimize runoff and the introduction of pollutants in stormwater runoff. Site design principles that will be taken into account for the Santiago Hills II and East Orange Area 1 Project are listed below. The implementation of these site design principles results in lower runoff rates and reductions in runoff volume, and to the extent that these principles were captured in the runoff modeling, the size of the treatment control BMPs were reduced.

Minimize Impervious Area and Impervious Area Directly Connected to Storm Drains

- Minimize impervious areas by incorporating landscaped areas over substantial portions of the Project. Single-family residential landscape areas will be determined by zoning agreements, village setback/parkway standards, and design objectives;

- Minimize directly connected impervious area by draining parking lots to landscaped areas or bioretention facilities to promote filtration and infiltration of stormwater, if landscaping slopes are less than 2 percent and the project is not adjacent to steep slopes;
- Utilize vegetated areas, e.g., setbacks, end islands, and median strips, for biofiltration and bioretention of nuisance and storm runoff flows from parking lots;
- Increase building density (number of stories above or below ground, build up rather than out);

Selection of Construction Materials and Design Practices

- Select building material for roof gutters and downspouts that do not include copper or zinc;
- Construct streets, sidewalks, and parking lot aisles to the minimum widths specified in the City Land Use Code and in compliance with regulations for the Americans with Disabilities Act and safety requirements for fire and emergency vehicle access;
- Construct on-site detention facilities to increase opportunities for settling of pollutants and infiltration. Multiple extended detention basins will be incorporated in the development;

Conserve Natural Areas

- Preserve existing riparian areas along Santiago Creek;
- Preserve 700~~633~~ acres of open space within the development (non-impact areas);
- Preserve 1,105~~092~~ acres of open space within the Project boundary outside of the development (preserved open space);
- Concentrate or cluster development on the least environmentally sensitive portions the Project site while leaving the remaining land in a natural, undisturbed condition;
- Use natural drainage systems to the maximum extent practicable or create drainages (e.g., vegetated swales) that mimic natural conveyances and allow for stormwater infiltration as well as pollutant removal;
- Maximize canopy interception and water conservation by preserving existing native trees and shrubs in natural open space areas and including native or drought tolerant plants in development plant palettes per project WQMP.

Protect Slopes and Channels

- Protect slopes: minimize erosion potential with vegetative cover, route flows safely from or away from steep and or sensitive slopes, stabilize disturbed slopes;

- Protect channels: control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems, stabilize channel crossings, ensure that increases in runoff velocity and frequency caused by the Project do not erode the channel, install energy dissipaters, such as riprap, at the outlets of storm drains or conveyances.

5.2 <u>Source Control BMPs</u>

Effective management of wet and dry weather water quality begins with limiting pollutant sources. The following source control BMPs will be implemented in order to minimize the amount of pollutants in dry weather (nuisance) flows and in stormwater runoff from the Project. These source control BMPs were selected based on the land uses included in the Project: single and multi-family residential, a school, roadways, parks, and open space.

5.2.1 Non-Structural Source Control BMPs

N1: Education for property owners, tenants and occupants - Practical information materials will be provided to the first residents/occupants/tenants on general housekeeping practices that contribute to the protection of stormwater quality. At a minimum, these materials will cover the following topics:

1. The use of chemicals (including household type) that should be limited to the property, with no discharge of specified wastes via hosing or other direct discharge to gutters, catch basins, and storm drains.

2. The proper handling of material such as fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals.

3. The environmental and legal impacts of illegal dumping of harmful substances into storm drains and sewers.

4. Alternative household products which are safer to the environment.

5. Household hazardous waste collection programs.

6. Used oil recycling programs.

7. Proper procedures for spill prevention and clean up.

8. Proper storage of materials which pose pollution risks to local waters.

9. Carpooling programs and public transportation alternatives to driving.

10. The potentially negative impacts that waterfowl can have on water quality in PCR and Irvine Lake, coupled with – "Don't Feed the Waterfowl!" messaging.

N2: Activity restrictions (Conditions, Covenants, and Restrictions) – Conditions, Covenants, and Restrictions (CC&Rs) will be prepared for the purpose of surface water quality protection, or alternatively, use restrictions will be developed through lease forms. Water quality-related elements that will appear in the CC&Rs are included in Appendix L.~~terms.~~

N3: Common area landscape management - Ongoing maintenance will be consistent with County Water Conservation Resolution or city equivalent.

A special Supplemental Fertilizer Program will be implemented for landscaped common areas of multi-family residential and park land use areas, generally depicted in Figure 5-1 as green hatched areas, to control nutrient loads in runoff (Table 5-3) (see also Appendix H). The components of the Supplemental Fertilizer Program include:

1. For multi-family residential areas, Design Guidelines will be prepared for the merchant builder, which stipulate a plant palette as well as an allowable turf grass percentage for sub-association areas.

2. A maintenance manual for multi-family residential common sub-association areas will stipulate the type of allowable fertilizers and schedule of application.

3. The plant palette for the neighborhood park will focus on adaptable native and drought resistant materials requiring little supplemental fertilization. The Irvine Company will provide the City with fertilization guidelines for turf grass with regards to type of material and schedule of application.

4. Reduced turf grass area as a percentage of overall landscape area will be used in all of the common areas.

5. For all of the land use categories, Maintenance Guidelines will specify high quality, slow-release fertilizers. Moreover, the Guidelines will stipulate the fertilizer application schedule, with no applications from October 15 to April 1, and 'never' when rain is in a two-week forecast.

Table 5-1 summarizes the landscape acreages of concern for the target nutrients in the Peters Canyon Reservoir watershed and the potential fertilization schedule adjustments to reduce nitrate/TKN loading below standard practice annual fertilization programs.

Table 5-1: Total Actual Nitrogen Application – Turf Grass Landscape Areas of Concern

Land Use Gross Area	Net Turf Area (acres)	Standard Practice Annual Fertilization Program[1] (lbs actual nitrogen)	Modified Annual/ Slow Release Program[2] (lbs actual nitrogen)	Total Actual Nitrogen Application Reduction[3]
Park Site (5 acres)	2.3[4]	400	300	25%
Single-Family Residential (44 acres)	5.3[5]~~6.7[5]~~	N/A	N/A	N/A
Multi-Family Residential (27~~44.6~~ acres)	1.2[6]~~5[6]~~	261	195	25%

[1]Based on minimum four (4) times per calendar year of 16-6-8 Best Turf Supreme applied at 174 lbs/acre/year of actual nitrogen. The standard annual fertilization program will typically include one or more applications during the wet season. The greater water solubility of normal release fertilizers could result in a higher potential of offsite nutrient delivery.

[2]Based on two (2) times per year (i.e., April, late September application) of 25-5-5 Best Super Turf with polyon coating with actual nitrogen applied at 130 lbs/acre/year. The high quality slow release program would have no applications during the rainy season and is a combination of quick and slow release fertilizers, i.e., the slow release fertilizer granules do not dissolve in the presence of excess moisture due to special coatings.

[3]These reductions are a conservative estimate based on the assumption that the single family residents' application of fertilizer is unchanged from normal practices. There are, however, several opportunities to affect this result through recommendations provided to homeowners through the required ICDC Single Family Design Guidelines and subsequent education programs carried out by the homeowners association. The reductions also do not take into account the benefit of adjusting the fertilization schedule to avoid wet season application and the potential for use of a urea formaldehyde based slow release fertilizer which could be applied once per year in the spring and is activated by temperature and not moisture alone.

[4]Based on current preliminary plan.

[5]Based on 30% landscape coverage of gross area and subsequent 40% turf coverage of total landscape area.

[6]Based on 30% landscape coverage of gross area and subsequent 15% turf coverage of total landscape area. (Similar projects will typically have 10% turf coverage; however, a more conservative estimate has been applied here.)

N4: BMP maintenance – Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural source control and treatment control BMPs within their boundaries. The City of Orange is proposed to be responsible for maintenance of Extended Detention Basin E. The City will have the right, but not the duty, to inspect and maintain the other BMPs if they are not being properly maintained by the HOA, at the expense of the HOA. Caltrans~~The County~~ is responsible for maintaining ~~proposed to maintain~~ Extended Detention Basins 2A, 2B, and HR1~~Basin 6A~~. An amendment of the IRWD Natural Treatment System (NTS) Master Plan will be requested that would alter these maintenance responsibilities for some or all of the extended detention basins. If IRWD approves an amendment to the NTS Master Plan to incorporate some or all of the basins into the Master Plan and O&M program, then IRWD will own and maintain those basins that are incorporated.

N11: Common area litter control - The HOA will conduct litter patrol, empty trash receptacles in common areas, and note trash disposal violations by tenants/homeowners or businesses and report the violations to the owner/HOA for investigation.

N14: Common area drainage facility inspection - Privately-owned drainage facilities will be inspected each year and, if necessary, cleaned and maintained prior to the storm season, no later than October 15th each year. Drainage facilities include catch basins and inlets, extended detention basins, and open drainage channels.

N15: Street sweeping private streets and parking lots - Streets will be swept prior to the storm season in late summer/early fall, no later than October 15th each year. Parking lots shall be swept weekly at a minimum, weather permitting.

5.2.2 Structural Source Control BMPs

Provide Storm Drain Stenciling and Signage - All storm drain inlets and catch basins, constructed or modified, within the Project area will be stenciled or labeled. Signs which prohibit illegal dumping will be posted at public access points along channels and creeks within the Project area. Legibility of stencils and signs shall be maintained.

Trash Area Design – Trash areas will be paved, designed not to allow run-on, screened or walled to prevent off-site transport of trash; and covered to minimize direct precipitation. Common area litter control will include a litter patrol, covered trash receptacles, emptying of trash receptacles in a timely fashion, and noting trash violations by tenants/homeowners and reporting the violations to the owner/HOA for investigation. Connection of trash area drains to the municipal storm drain system is prohibited.

Efficient Irrigation - Advanced, centrally managed, irrigation controllers that ~~The timing and application methods of irrigation water will~~ minimize ~~the~~ runoff of excess irrigation water into the stormwater conveyance system will be installed to irrigate public areas such as parks, the rights-of-way of arterial roads, and common areas maintained by the Home Owners Association(s) (inclusive of the landscaped parkway (between the curb and sidewalk) within neighborhoods at the proposed project)). These areas constitute the majority of landscaped areas in the proposed development.

The dry weather flow estimates presented subsequently in this report are based on irrigation control effectiveness studies conducted by the IRWD where approximately one third of the households installed advanced controllers. So the proposed PDF will result in a larger reduction in dry weather flows than projected based upon the IRWD information, meaning that the projected dry weather flows contained in this report are conservative and are likely to be higher than will actually result with the proposed project development given this PDF.

Protect Slopes and Channels - Stormwater BMPs will be included to decrease the potential for erosion of slopes and/or channels, and may include appropriate conveyance structures, landscaping, etc.

Hillside Landscaping - Hillside areas that are disturbed by project development shall be landscaped with deep-rooted, drought tolerant plant species selected for erosion control.

5.3 Treatment Control BMPs

Priority projects within Orange County, including Santiago Hills II and East Orange Area 1, are required to remove pollutants of concern from stormwater runoff through the incorporation and implementation of treatment control BMPs. To meet this requirement, development projects shall implement a single or combination of stormwater treatment BMPs that will address the pollutants of concern. Treatment BMPs set forth in the DAMP/LIP are listed in Table 5-2 along with the pollutants of concern addressed by each.

Table 5-2: Treatment Control BMP Selection Matrix[1,2]

Pollutant of Concern	Treatment Control BMP Categories					
	Biofilters	Detention Basins	Infiltration Basins	Wetponds or Wetlands	Filtration	Hydrodynamic Separator Systems
Sediment/Turbidity	H/M	M	H/M	H/M	H/M	H/M (L for Turbidity)
Nutrients	L	M	H/M	H/M	L/M	L
Trace Metals	M	M	H	H	H	L
Pathogens	U	U	H/M	U	H/M	L
Petroleum Hydrocarbons	H/M	M	U	U	H/M	L/M
Pesticides	U	U	U	U	U	L
Trash & Debris	L	M	U	U	H/M	H/M

[1]DAMP Table 7-II-6, except for the Trace Metals treatment performance, which was taken from the California Stormwater Best Management Practices Handbook for New Development and Redevelopment (CASQA, 2003)
[2]H, M, L, and U indicate high, medium, low, and unknown removal efficiency.

As currently planned, stormwater runoff from all urban areas within the Project will be routed to one of seven drainages located within Subwatersheds A, C, D and E (Figure 2-4). Runoff from each of the drainages will be routed through a separate treatment system consisting of at least one, and often more than one, of the following BMPs:

- Extended detention basins
- Treatment swales
- Bioretention
- Hydrodynamic Separator Systems (HSS) (Continuous Deflection Separation (CDS) units, or equivalent).

The proposed HSS units for the project have been modeled as CDS; therefore the terms HSS unit and CDS unit are used interchangeably herein. However, an HSS unit providing equivalent treatment may be substituted for a CDS unit.

Collectively, the water quality treatment control PDFs will treat the pollutants of concern in runoff from the 1,227~~228~~-acre primary impact boundary and associated non-impact open space (Table 2-1) and existing untreated roadway area. The extended detention basins, treatment swales, and HSS units will be designed to operate off-line, receiving dry weather flows, small storm flows, and the initial portion of large storm flows from a low-flow diversion structure in the storm drain. The proposed treatment control PDFs are illustrated in Figure 5-1, are summarized in Table 5-3, and are described below. Table 5-3 shows that a treatment train approach is utilized in each drainage area that, when combined with source and site design measures, effectively addresses the pollutants of concern.

The key design criteria for each type of treatment control PDF are summarized in Table 5-4 and the estimated capacity of each extended detention basin is listed in Table 5-5. Additional design guidelines that will enhance the performance of the treatment control PDFs are listed in Table 5-6. The ultimate location may vary when the project WQMP is prepared. Figure 5-2 provides greater detail on the treatment systems located in Subwatershed Area A.

The water quality basins will incorporate dry extended detention to provide water quality treatment for storm flows. Dry extended detention basins are designed with outlets that detain the runoff volume from the water quality design storm (e.g., the 85th percentile 24-hour event) for some minimum time (in this case 36 hours) to allow particles and associated pollutants to settle out. The water quality basins will also incorporate wetland vegetation in a low-flow channel in the bottom of the basin for the treatment of dry weather flows and small storm events. Wetland vegetation provides one of the most effective methods for pollutant removal and are promoted for use for nutrient removal by the SARWQCB in the Basin Plan. As runoff flows through the wetland vegetation, pollutant removal is achieved through settling and biological uptake of nutrients and dissolved pollutants within the wetland. These basins are not designed or anticipated to contain ponded, standing water for periods in excess of 36 to 48 hours.

The drainage descriptions below include a description of the natural and constructed drainage features, such as the emergent marshes and vegetated swales, which will receive flows from the treatment control PDFs. Swales that are proposed as a treatment control PDF are called "treatment swales". Vegetated swales that are incorporated into the drainage plans but are not proposed as a treatment control PDF are called "vegetated swales" and are not illustrated on Figure 5-1.

Conceptual illustrations of the various treatment control PDFs are provided in Figures 5-3, 5-4, 5-5 and 5-6. Photographs of existing bioretention BMPs are provided in Figure 5-7. The locations of each PDF in the drainage systems are also illustrated in Figures 11.1 through 11.6 in Volume I of the ROMP.

5.3.1 Drainage 1

Drainage 1 is located within Subwatershed Area A in the southwestern portion of Santiago Hills II Stage 1, east of Jamboree Road (Figure 2-4). Approximately 12.6 acres of condominiums ("Triplex Area") within the tributary area of Extended Detention Basin A1 will drain to on-site bioretention located in the common landscape areas. The bioretention is designed to provide volume reduction through evapotranspiration and water quality treatment through infiltration into the subsurface. Treated flows from the bioretention areas will be collected in an under drain system. The bypassed and treated flows from the bioretention facility ~~where they~~ will ~~ultimately flow to PCR. Bypassed flows will~~ be diverted to Extended Detention Basin A1, which~~.~~

~~Extended Detention Basin A1~~ will also receive stormwater runoff from the ~~an~~ adjacent residential and roadway areas. Bypassed and treated~~area. Treated~~ flows from Extended Detention Basin A1 will be conveyed through a ~~the~~ storm drain to a natural channel and then to PCR. Emergent Marsh A2 will receive runoff from the adjacent roadway and the~~is~~ tributary open space area. Runoff from the roadway will be pretreated in CDS Unit A2. All flows exiting Emergent Marsh A2 will be routed through Vegetated Swale A2 before crossing beneath Jamboree Road through an existing culvert. Flows will then be conveyed to PCR through an existing natural channel~~a vegetated swale.~~

5.3.2 Drainage 2

Drainage 2 is also located within Subwatershed Area A in the western portion of Santiago Hills II Stage 1, east of Jamboree Road (Figure 2-4). Runoff from an area of single-family homes and roadway will be conveyed~~drain through a HSS unit~~ to Extended Detention Basin B1. Extended Detention Basin B1 drains to a series of emergent marshes (B2, B3, B4) which are connected by~~through~~ a series of vegetated swales that ~~swale and~~ ultimately flow towards ~~discharge to~~ PCR. Due to the slope and topography of Emergent Marsh B4, it does not have any storage capacity and was thus modeled as a vegetated swale.

Emergent Marsh B3 will also receive flows from a large area east of SR 241 which includes predominately preserved open space along with some roadway. The area is characterized by steep slopes and clay soils and contributes significant runoff volumes that could potentially flood the emergent marshes~~Emergent Marshes~~. To protect the beneficial uses of Emergent Marsh B3 and the subsequent marshes, all roadways that are upstream of the emergent marsh will be pretreated. Runoff ~~runoff~~ from ~~this area will be captured and delayed in~~ the eastern~~bottom~~ portion of SR-241 within Drainage 2 will be treated in Extended Detention ~~a flood control basin (~~Basin HRI, which will be operated by Caltrans. A~~No. 3), proposed for the Project. The outlet of the bottom~~ portion of ~~Basin No. 3 will be designed so that~~ the runoff generated from SR-261 that is tributary to Emergent Marsh B3~~water will be released over a 72- hour period. In that way the subsequent emergent marshes~~ will be treated in Vegetated Swales S1 and S2. The bypassed and treated flows~~have sufficient time to drain prior to receiving the runoff from the large open space area. Flows~~ from Extended Detention Basin HRI, Vegetated Swale S1 and Vegetated Swale S2~~No. 3~~ will be routed through CDS Unit B3~~a HSS unit~~ prior to entering Emergent Marsh B3.

5.3.3 Drainage 3

Drainage 3 will be located within Subwatershed Area A, north of Drainage 1 and 2 (Figure 2-4). The drainage~~drainages~~ will be located in Santiago Hills II Stage 1~~,~~ and ~~D will be located in Stage 2, northeast of Chapman Road. Collectively, the drainages~~ will receive runoff from single-family residences, multi-family residences, roadway, and internal open space. The upper-most basin in the drainage is Extended Detention Basin 2B~~D~~ which will be located ~~in Santiago Hills Stage 2,~~ northeast of Chapman Road. ~~The remaining area of Drainage 3 will be located in Santiago Hills II, Stage 1.~~ Treated and bypassed flows from Extended Detention Basin 2B~~D~~ will be discharged to the TR16199 ~~a~~ storm drain along ~~tributary to PCR, while bypassed flows will be combined~~ with the runoff from an open space area ~~areas~~ directly tributary to Extended Detention Basin ~~Emergent Marsh~~ C1. The flows will then be routed through CDS Unit C1.

Treated flows from CDS Unit ~~, which will be treated in one of two HSS units. Flows from Emergent Marsh~~ C1 will be conveyed to Emergent Marsh C3 through a natural drainage channel. Emergent Marsh C3 also will receive flows from Extended Detention Basin ~~Emergent Marsh~~ C2 (~~,~~ which does not receive drainage from developed area)~~,~~ and runoff from additional developed tributary area pretreated in CDS Unit C3~~a HSS unit~~. Flows from Emergent Marsh C3 will be diverted to Emergent Marsh C4 through a pipe.

The tributary area of Emergent Marsh C4 includes bioretention in the common areas of two multi-family residential land use areas. Treated flows and overflows~~Overflows~~ from each of the bioretention areas will combine with runoff from the remaining tributary area and~~, where it~~ will then be diverted ~~through a HSS unit and in~~to Extended Detention Basin C8 prior to entering Emergent Marsh C4. Extended Detention Basin C8 will also receive ~~Underflow from the bioretention areas will be discharged to PCR through~~ the treated flows from Extended Detention Basin C1 and the treated and bypassed flows from Emergent Marsh C3~~storm drain system~~. Flows from Emergent Marsh C4 will be conveyed to Emergent Marsh C5 through a vegetated swale. Emergent Marsh C5 will receive additional bypass flows from Extended Detention Basin ~~Emergent Marsh~~ F2 and the tributary open space areas.

High~~Treated~~ flows in the TR16199 storm drain that bypass ~~from~~ Extended Detention Basin C8~~F1~~ will combine with runoff from the open space area immediately tributary~~flow~~ to Extended Detention Basin F2. The combined flows will then be diverted~~PCR~~ through CDS Unit F2~~the storm drain~~. Bypassed flows from the CDS unit will be conveyed through the existing storm drain along Jamboree Road and ultimately to PCR. Treated flows will be discharged to Extended Detention Basin F2. Flows from Extended Detention Basin ~~Extended Detention Basin F1 will be routed through a HSS unit before entering Emergent Marsh F2. Flows from Emergent Marsh~~ F2 will be routed to Emergent Marsh C5 through a pipe. Flows from Emergent Marsh C5 will be conveyed in vegetated swales to Emergent Marshes C6 and C7. All flows exiting Emergent Marsh C7 will ultimately discharge to PCR,

Extended Detention Basin E receives flows from a park area. Bypassed and treated flows from Extended Detention Basin E will also discharge to the existing Jamboree Road storm drain, flows from which enter an existing natural channel that flows to PCR~~is then tributary to PCR~~.

5.3.4 Drainage 4

Extended Detention Basins in Drainage 4 are located in Santiago Hills II Stage 1, along Jamboree Road within Subwatershed Area A. ~~Extended Detention Basin E will receive runoff from a park area that has first been routed through a HSS unit. Flows from Extended Detention Basin E will be discharged to PCR through the storm drain.~~ The ~~remaining~~ treatment system within Drainage 4 will consist of three extended detention basins and a treatment swale. Extended Detention Basin G1 will receive flows from a single family residential area~~through a HSS unit~~. Treated flows will discharge to the existing storm drain that parallels Jamboree Road, while bypassed flows will be conveyed and treated in a vegetated swale before discharging into Extended Detention Basin G2. Extended Detention Basin G2 will also receive flows from a residential area.~~a pipe to~~ Extended Detention Basin G3 will receive runoff from a predominately open space area. Treated and ~~. Extended Detention Basin G3 will also receive~~ bypassed flows from Extended Detention Basins G2 and G3 will be conveyed in the existing Jamboree Road storm drain system through the existing Jamboree Road culvert, flows from which enter into a natural channel that flows~~pipe. A HSS unit will also be utilized upstream of Extended Detention Basin G2. Extended Detention Basin G3 is tributary~~ to PCR.

5.3.5 Drainage 5

Runoff generated from the Santiago Hills II, Stage 2 (Subwatershed Area D, tributary to Santiago Creek) will be treated in one of three extended detention basins located in Drainage 5. These basins include Extended Detention Basins 2A, 6A1, and 6A2. The basins are not configured in series and treat only their respective tributary areas. Treated and bypassed flows from each of the three basins will be combined and conveyed to Santiago Creek through a storm drain that parallels Jamboree Road. The storm drain also receives flows from existing development located northwest of the Project. Flows from the storm drain will be diverted through CDS Unit 6A prior to flowing towards Santiago Creek.
~~Runoff generated from the Santiago Hills II, Stage 2 (Subwatershed Area D, tributary to Santiago Creek) will be treated in a vegetated swale and a series of extended detention basins located in Drainage 5. Extended Detention Basin H1 will receive runoff from a small portion of Chapman Road. Flows bypassed around the extended detention basin will be discharged through a conveyance pipe to a HSS unit and then a treatment swale before reaching Extended Detention Basin 6A. Extended Detention Basin 6A is a large basin located outside of the project area, just north of existing residences. It will receive the majority of runoff generated from Santiago Hills II Stage 2 and will ultimately discharge to Santiago Creek.~~

5.3.6 Drainage 6 and 7

Stormwater runoff generated in East Orange Area 1 will be treated in either Drainage 6 or Drainage 7. Drainage 6 is located along the western-most portion of East Orange Area 1, just east of SR 241, within Subwatershed Area C tributary to Santiago Creek. The treatment system in the drainage consists of three extended detention basins: J, 6D1, and 6D2. Low flows from the tributary area~~Tributary area low flows~~ will be directed to Extended Detention Basin 6D1 which will discharge to Extended Detention Basin 6D2 along with additional tributary area low flows. Treated flows from all three extended detention basins will join the bypassed flows in the storm drain, which will ultimately discharge to Santiago Creek.

Extended Detention Basin 6G will receive flows from Drainage 7 which consists of a park and a high density residential area located in the southern-most portion of East Orange Area 1 (Subwatershed Area E, tributary to Irvine Lake). Treated and bypassed flows will be conveyed through a natural channel to Irvine Lake.

Table 5-3: Treatment Control PDFs, Nutrient Source Control, and Receiving Waters

Drainage	Extended Detention Basin(s)	HSS Units	Treatment Swale	Bioretention	Nutrient Source Control	Receiving Water
1	✓	✓		✓	✓	Emergent Marsh A2/ PCR
2	✓	✓	✓			Emergent Marshes B2-B4/PCR
3	✓	✓		✓	✓	Emergent Marshes C3~~C1~~-C7/PCR
4	✓	~~✓~~	✓		✓	PCR
5	✓	✓	~~✓~~		✓	Santiago Creek
6	✓				✓	Santiago Creek
7	✓				✓	Irvine Lake

Table 5-4: Treatment Control PDF Key Design Criteria

Treatment Control PDF	Key Design Criteria
Extended Detention Basin	1. 36-hour draw down time 2. Volume (see Table 5-5)
HSS Unit	1. The~~Design flow is the~~ maximum flow rate of runoff produced from a ~~by the 85th percentile hourly~~ rainfall intensity of 0.2-in of~~, as determined from the local historical~~ rainfall per hour for each hour of a storm event.~~record, multiplied by a factor of two.~~
Treatment Swale	1. Maximum 4-inch flow depth 2. Minimum 9 minute hydraulic retention time
Bioretention	1. 6-inch ponding depth 2. 12-inch root zone depth 3. Various soil properties (see Appendix C Table C-3)

Table 5-5: Extended Detention Basin Capacity

Basin ID	Volume (acre-ft)	Surface Area (acres)
A1	1.7~~8~~	0.47~~45~~
B1	0.2	0.12~~14~~
C1~~D~~	1.2~~0.6~~	0.32~~16~~
C2~~E~~	0.2	0.08~~10~~
C8~~F1~~	1~~0~~.2	0.23~~16~~
~~EG1~~	0.1~~3~~	0.05~~13~~
G1~~G2~~	0.2~~1~~	0.13~~08~~

Basin ID	Volume (acre-ft)	Surface Area (acres)
G2G3	0.15	0.0625
G3H1	0.35	0.1425
F2	1.0	0.40
HR1	2.2	1.74
2A	1.1	0.44
2B	1.7	0.35
6A1	5.7	1.05
6A2	7.5	1.26
J	0.6	0.37
6A	8.5	4.38
6D1	2.1	0.40
6D2	5.0	0.90
6G	10.0	1.55

Table 5-6: Other Treatment Control PDF Design Guidelines

Treatment Control PDF	Design Guidelines[1]
Extended Detention Basin	1. Length to width ratio of at least 1.5:1 where possible. 2. Basin depths optimally range from 2 to 5 feet. 3. Include energy dissipation in the inlet design to reduce resuspension of accumulated sediment. 4. A maintenance ramp and perimeter access should be included in the design to facilitate access to the basin for maintenance activities and for vector surveillance and control. 5. Safety is provided either by fencing the facility or by managing the contours of the basin to eliminate drop offs and other hazards. Earthen side slopes should not exceed 3:1 (H:V) and should terminate on a flat safety bench area. Landscaping can be used to impede access to the basin. The primary spillway opening must not permit access by small children. Outfall pipes above 48 inches in diameter should be fenced.
Treatment Swale	1. Longitudinal slope should not exceed 2.5%. 2. Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope. 3. The maximum bottom width should not exceed 10 feet unless a dividing berm is provided. 4. The side slopes should be no steeper than 3:1 (H:V). 5. A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season is preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.
Bioretention	1. Recommended minimum dimensions are 15 feet by 40 feet, although the preferred width is 25 feet. Excavated depth should be 4 feet. 2. Approximately 1 tree or shrub per 50 ft2 of bioretention area should be included. 3. Cover area with about 3 inches of mulch.

[1]Source: CASQA, 2003.

In summary, the combination of proposed site design, source control, and treatment controls have been selected to address the pollutants of concern from each source area and to protect beneficial uses of receiving waters.

5.4 Hydrologic Impacts Control PDF

As discussed in Section 2.3.2 and depicted in Figure 2-3, runoff from project areas will flow through several existing natural drainages. The purpose of this PDF is to ensure that the flow from the project does not have a significant adverse impact on these natural drainage areas where preservation of the pre-project character of the natural drainage is proposed. This PDF applies to the ETC-9 drainage and Woody's drainage.[1] As a part of the storm drain improvement plans for development areas relative to ETC-9 and Woody's drainages, final design of the storm drain systems will be such that low flows (inclusive of dry weather flows) from the project areas will not be discharged to the natural drainages, but will be diverted around the natural drainages.

6 WATER QUALITY MODELING APPROACH

6.1 Model Description

A water quality model was used to estimate pollutant loads and concentrations for pre-development conditions, post-development conditions, and post-development conditions with PDFs for each stage of the Project. The model is one of the few models that takes into account the observed variability in stormwater hydrology and water quality. This is accomplished by characterizing the probability distribution of observed rainfall event depths, the probability distribution of event mean concentrations, and the probability distribution of the number of storm events per year. These distributions are then sampled randomly using a Monte Carlo Approach to develop estimates of mean annual loads and concentrations.

To assess the potential impact of the proposed development on Peters Canyon Reservoir, the water quality model included the effects of the ~~bottom portion of Basin No. 3 being used to delay runoff from entering Emergent Marsh B3, the~~ emergent marshes, and the vegetated swales that connect the marshes on reductions in runoff volume and pollutant loads. Although these project features are not proposed as treatment control PDFs, it is important to include their natural effects on runoff volumes and pollutant loads so that an accurate analysis of future conditions can be made.

Additional information on the modeling approach and PDF removal efficiencies is provided in Appendix B and Appendix C. The following summarizes major features of the water quality modeling approach:

- *Rainfall Data*: The water quality model estimates the volume of runoff from storm events. The storm events were determined from 52 years (1949-2000) of hourly rainfall data measured at the NCDC Santiago Dam rain gauge. Missing data was filled in through correlation to nearby rain gauges. The rainfall analysis that is incorporated in the water quality model requires rainfall measurements at one hour intervals and a long period of record that is at least 20-30 years in length. The NCDC gage was discontinued in 2001 and daily rainfall data are currently being collected manually at Santiago Dam, however daily data are not suitable for conducting the rainfall analysis.

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[1] This PDF does not apply to natural drainage areas where alteration of habitat is proposed as part of the project, which includes the Peters Canyon Tributaries (inclusive of the emergent marshes) ~~and the Irvine Regional Park drainage area (inclusive of Extended Detention Basin 6A)~~ (see further Section 2.3.2). Should resource agencies or other government agencies identify ETC-9 or Woody's drainages as areas desirable for mitigation (with accompanying hydromodification), then the Natural Drainages PDF will not apply and requirements established by the resource or other agencies to ensure success of mitigation areas will apply instead.

- *Land Use Runoff Water Quality*: The water quality model estimates the concentration of pollutants in runoff from storm events based on existing and proposed land uses. The pollutant concentrations for various land uses, in the form of Event Mean Concentrations (EMCs), were estimated from data collected in Los Angeles County. The Los Angeles County database was chosen for use in the model because: (1) it is an extensive database that is quite comprehensive, (2) it contains monitoring data from land use specific drainage areas, and (3) the data is representative of the semi-arid conditions in southern California. Other data sources include the stormwater data collected by Orange County; however, the Orange County data are taken primarily in streams and reflect mix land use catchments. Consequently the Orange County data is not suitable as input to the water quality modeling. Of note it that the percent imperviousness estimates utilized in the model for multi-family residential areas are likely higher than what will be seen in the ultimate conditions; thus this factor makes the model results more conservative.

- *Nutrient Source Control Effectiveness:* The nutrient source control PDF (a 25% reduction in typical fertilizer application in the landscaped common areas of multi-family residential and park land use areas) was assumed to decrease the nitrate-nitrogen and TKN event mean concentrations in runoff from those areas by 25% (Green, 2004).

- *Pollutant Load*: The pollutant load associated with each storm is estimated as the product of the storm event runoff times the event mean concentration. For each year in the simulation, the individual storm event loads are summed to estimate the annual load. The mean annual load is then the average of all the annual loads.

- *PDFs modeled*: The modeling considers the structural treatment control PDFs and does not take into account the extensive suite of site design and source control PDFs, aside from the nutrient source control PDF, which also would improve water quality. Additionally, CDS Unit 6A is not accounted for in the model. The proposed CDS unit will only receive runoff from the existing development northwest of Subwatershed D which was not modeled. However, the addition of CDS Unit 6A would provide water quality benefits for Santiago Creek by treating runoff from existing development. Also any water quality benefits that may be occurring (such as removal of sediment in the water column) from existing basin ETC-1 have not been accounted for in the model. In this respect, the modeling results are conservative, i.e., tend to overestimate pollutant loads and concentrations.

- *Treatment Effectiveness*: The water quality model estimates mean pollutant concentrations and loads in stormwater following treatment in the structural BMPs. The amount of stormwater runoff that is captured by the treatment BMP was calculated for each storm event, taking into consideration the intensity of rainfall, duration of the storm, duration between storm events, basin size, and drain time. The treatment effectiveness for treatment BMPs was based on the International Stormwater BMP Database (ASCE/USEPA, 2004). The International Stormwater BMP Database was used because it is a robust, peer-reviewed database that contains a wide range of BMP effectiveness studies that are reflective of diverse land uses.

- *Monte Carlo Approach*: The water quality model uses a Monte Carlo modeling approach that incorporates the observed variability in stormwater precipitation, runoff and water quality. The water quality model generates a statistical description of stormwater runoff volume, pollutant concentrations and loads.

- *Bypass Flows*: The water quality model takes into account conditions when the treatment facility is full and flows bypass the facilities.

- *Representativeness to Local Conditions*: The water quality model utilizes runoff water quality data obtained from tributary areas that have a predominant land use, and as measured prior to discharge into a receiving water body. Currently such data are available from stormwater programs in LA County, San Diego County, and Ventura County, although the amount of data available from San Diego County and Ventura County is small in comparison with the LA County database. Such data are often referred to as "end-of-pipe" data to distinguish them from data obtained in urban streams, for example. The water quality model does not use Orange County stormwater monitoring data because they are collected in-stream and therefore reflects mixed land uses and generally quite large tributary areas. The Orange County data also reflect the effects of sediment resuspension which, depending on the flows, can elevate sediment concentrations and affect the distribution between dissolved and particulate associated pollutants. A comparison between the urban and agricultural land use water quality data used in the model and the instream water quality data collected by Orange County indicates that the land use specific water quality data used in the model tends to bracket that collected by Orange County, which is reasonable given that the Orange County data reflects mixed land uses. This comparison indicates that the data used in the model are reasonable for replicating the effects of urbanization and agriculture in Orange County.

6.2 Area Modeled

The modeled project areas tributary to Peters Canyon Reservoir, Santiago Creek, and Irvine Lake for each stage of the Project are summarized in Tables 6-1, 6-2, and 6-3 and are illustrated in Figure 2-3 (existing condition) and Figure 2-4 (ultimate condition). The entire 2,354-acre project area (including the preserved natural areas and associated roadways) was modeled to assess potential water quality impacts.

Table 6-1: Modeled Areas & Receiving Waters- Santiago Hills II Stage 1

Receiving Water	Land Use Areas (acres)						Total Area (acres)
	Open Space	Park	Road	SF Res	MF Res	School	
Peters Canyon	534.8~~615.1~~	5.0	81.2~~88.6~~	44.4~~7~~	26.2	0.0	692~~780~~
Santiago Creek	549.1~~469.3~~	0.0	19.8~~12.4~~	1.6~~0~~	0.0	0.0	570~~482~~
Irvine Lake	1063.5~~6~~	0.0	28.1~~0~~	0.0	0.0	0.0	1092
Totals	2147.4~~2148.1~~	5.0	129.1~~127.3~~	46.0~~2~~	26.2	0.0	2354

Table 6-2: Modeled Area & Receiving Waters – Santiago Hills II Stages 1 & 2

Receiving Water	Land Use Areas (acres)						Total Area (acres)
	Open Space	Park	Road	SF Res	MF Res	School	
Peters Canyon	506.3~~540.1~~	5.0	76.6~~90.1~~	43.9~~44.0~~	26.2~~44.0~~	0.0	658~~723~~
Santiago Creek	418.1~~380.5~~	4.4	46.9~~31.4~~	53~~58~~.1	72~~55~~.1	9.8	604~~539~~
Irvine Lake	1063.5~~6~~	0.0	28.1~~0~~	0.0	0.0	0.0	1092
Totals	1988.0~~1984.2~~	9.4	151.6~~149.5~~	97.0~~102.1~~	98.3~~99.1~~	9.8	2354

Table 6-3: Modeled Areas & Receiving Waters – Ultimate Built Out Condition

Receiving Water	Land Use Areas (acres)						Total Area (acres)
	Open Space	Park	Road	SF Res	MF Res	School	
Peters Canyon	392.4~~429.0~~	5.0	76.6~~90.2~~	43.9~~44.0~~	26.5~~44.6~~	0.0	544~~613~~
Santiago Creek	372.9~~333.6~~	13.2	72.5~~53.4~~	96.5~~103.8~~	93.9~~76.7~~	9.8	659~~591~~
Irvine Lake	1039.3~~1029.9~~	18.7	31.7~~1~~	0.0	61.1~~70.9~~	0.0	1151
Totals	1804~~1792~~.5	36.9	180.9~~175.3~~	140.5~~147.7~~	181.5~~192.2~~	9.8	2354

6.3 Pollutants Modeled

The appropriate form of data used to address water quality are flow composite storm event samples, which are measures of the average water quality during the event. To obtain such data usually requires automatic samplers that collect data at a frequency that is proportionate to flow rate. The pollutants for which there are sufficient flow composite sampling data in the Los Angeles County database are:

- Total Suspended Solids (sediment)
- Total Phosphorus
- Nitrate
- Total Kjeldahl Nitrogen
- Total Phosphorus
- Dissolved Copper
- Total Lead
- Dissolved Zinc
- Total Dissolved Solids

The other pollutants of concern - pathogens, hydrocarbons, pesticides, and trash and debris - are not amenable to this type of sampling either because of short holding times (e.g., pathogens), difficulties in obtaining a representative sample (e.g., hydrocarbons), low detection levels (e.g., pesticides), or cost. These pollutants were addressed qualitatively using literature information and best professional judgment due to the lack of statistically reliable monitoring data for these pollutants (see Section 6.4 below).

6.4 Pollutants Addressed Without Modeling

The following pollutants of concern were addressed based on literature information and professional judgment because available data were not deemed sufficient for modeling:

- Pathogens (Bacteria, Viruses, and Protozoa)
- Hydrocarbons (Oil and Grease, Polycyclic Aromatic Hydrocarbons)
- Pesticides
- Trash and Debris

Human pathogens are usually not directly measured in stormwater monitoring programs because of the difficulty and expense involved; rather, indicator bacteria such as fecal coliform or E. coli are measured. These indicators are not very reliable indicators of the presence of pathogens in stormwater, in part because stormwater tends to mobilize pollutants from many sources, some of which contain non-pathogenic bacteria. For this reason, and because holding times for bacterial samples are necessarily short, most stormwater programs do not collect flow-weighted composite samples that potentially could produce more reliable statistical estimates of concentrations. Fecal coliform or *E. coli* are typically measured with grab samples, making it difficult to develop reliable EMCs. Total coliform and fecal bacteria (fecal coliforms, fecal streptococcus, and fecal enterococcus) were detected in stormwater samples tested in Los Angeles County at highly variable densities (or most probable number, MPN) ranging between several hundreds to several million cells per 100 ml (Los Angeles County, 2000).

Hydrocarbons are difficult to measure because of laboratory interference effects, and sample collection issues (hydrocarbons tend to coat sample bottles). Hydrocarbons are typically measured with single grab samples, making it difficult to develop reliable EMCs.

Pesticides in urban runoff are often at concentrations that are below detection limits for most commercial laboratories and therefore there are limited statistically reliable data available on pesticides in urban runoff. Pesticides were not detected in Los Angeles County monitoring data for land use-based samples, except for diazinon and glyphosate which were detected in less than 15 percent and 7 percent of samples, respectively (Los Angeles County, 2000).

Trash and debris sampling is not typically included in routine stormwater monitoring programs. Several studies conducted in the Los Angeles River basin have attempted to quantify trash generated from discrete areas, but the data represent relatively small areas or relatively short periods, or both.

7 WATER QUALITY IMPACT ASSESSMENT

In this section model results for each pollutant are evaluated in relation to the following significance criteria: (1) comparison of post-development versus pre-development water quality concentrations and loads and (2) MS4 Permit requirements for new development as defined in the DAMP/LIP. Predicted runoff pollutant concentrations in the post-development with PDFs condition, including the range of concentrations predicted in the discharges to the various emergent wetlands, are compared with benchmark receiving water quality criteria as provided in the Basin Plan and the CTR. The water quality criteria are considered benchmarks for comparison purposes only, since they do not apply directly to runoff, but the comparison provides useful information to evaluate potential impacts. Because water quality criteria are established in order to protect the beneficial uses of receiving waters, results predicting no exceedance of applicable water quality criteria are also deemed to be protective of beneficial uses.

The modeled pollutant impact assessment is presented in Section 7.1 and the quantitative analyses of the remaining pollutants of concern follow in Section 7.2. Analyses of dry weather impacts and compliance with NPDES Permit requirements and construction-related requirements of the Construction General Permit follow the pollutant-by-pollutant impact assessment. Also included is a discussion of other considerations, including operation and maintenance, vector control, bioaccumulation of pollutants, hydrologic impacts, and cumulative impacts.

7.1 Impact Assessment for Modeled Pollutants of Concern

Results from the water quality model for significance criteria (1) are reported in a series of tables organized by pollutant. There are two tables for each pollutant (there is only one table for runoff volume), one showing changes in mean annual pollutant loads (lbs/yr) and one showing changes in mean concentrations. Projections are made for two conditions for each stage of development: (1) the existing condition and (2) the developed condition with the PDFs. The tables are further subdivided to show the changes associated with the portions of the Project tributary to each of the receiving water bodies and for the Project as a whole.

Following the tables for comparison of post-development versus pre-development water quality loads and concentrations for each pollutant (except runoff volume) is a table comparing the post-development with PDFs runoff quality to the benchmark water quality criteria. Separate tables are also provided showing the predicted TSS, nutrient, and trace metal loads and concentrations~~metals~~ in water discharged~~discharges~~ to the emergent marshes.

The following discussion focuses on the ultimate built condition unless otherwise noted.

7.1.1 Stormwater Runoff Volumes

Table 7-1 shows the predicted changes in stormwater runoff volumes. With development, runoff volumes are expected to generally increase with development to ~~Peters Canyon Reservoir,~~ Santiago Creek~~,~~ and Irvine Lake in the ultimate project condition, primarily because of ~~due to diversions accomplished by the proposed storm drainage system and~~ the increase in impervious area over the undeveloped existing condition. By contrast runoff volumes to Peters Canyon Reservoir in the ultimate condition is projected to essentially remain unchanged due to diversions accomplished by the proposed storm drainage system. Average annual storm runoff volumes are predicted to increase for the overall project area.

In general changes in runoff volume could affect water levels in PCR or Irvine Lake which in turn could affect water quality. This could be particularly of concern in PCR which is relatively small and in which, therefore, water levels are more sensitive to changes in runoff volume. However, these results indicate that for the ultimate condition, the effects of runoff volume on water levels in PCR will be minimal, and therefore the secondary effect on water quality also would be minimal.

Project PDFs include site design, source control and treatment control BMPs in compliance with the requirements of the MS4 Permit and the DAMP/LIP. Most of the site design PDFs, especially the minimization of impervious area and the conservation of approximately 1,105~~092~~ acres of natural areas within the project site, reduce the impacts of the proposed development on increases in stormwater runoff volume. The treatment control PDFs will allow for some runoff volume reduction as well.

Runoff to PCR – Potential impacts from an increased volume of runoff entering PCR include: (1) a potential increase in the frequency and duration of overflow events into Handy Creek with the potential for additional erosion or flooding, and (2) a potential increase in the elevation and surface area of the reservoir such that there is an increase in mosquito breeding habitat. The runoff volume to Peters Canyon Reservoir is predicted to increase by about 26~~23~~ acre-feet/year on average in the Stage 1~~II~~ development condition (Table 7-1).

It is important to note that the proposed PDFs treat existing roadways, including portions of the Caltrans SR 241 and SR 261. With respect to flow, the modeling results of these areas indicate that the treatment PDFs reduced the volume of runoff into PCR from these facilities on average by about 5.9~~3~~ acre-ft/yr.

According to the PCR Capacity Curve (Figure 4 presented in the Flow Science Report), the volume of PCR ranges from a minimum of about 200 acre-ft, corresponding to elevation 532 (all elevations refer to NAVD 1988 datum) to about 400 acre-ft corresponding to the elevation of about 537 ft. A water level elevation of 537 ft around mid-April prompts the County to release water to Peters Canyon Wash in order to reduce the potential for mosquito breeding. At the elevation of the invert of the 42-inch outlet to Handy Creek (approximately 539.6 ft), the volume of PCR is about 500 acre-ft and the surface area is about 50 acres.

The predicted mean annual runoff volume of 26~~23~~ acre-ft/year in Stage 1 ~~& 2~~ thus represents a maximum change of about 13~~12~~ percent during conditions when the reservoir is very low (200 acre-ft), and about 5 percent if the reservoir volume corresponds to when the water surface is just at the invert of the 42-inch outlet to Handy Creek. The actual change in water surface elevation must take into account factors that affect the PCR water balance, including inflow, evaporation, and other losses. Flow Science took these and other factors into ~~in~~ account in applying the DYNRES-WQ model modeled for the 20-month period from January, 2002 through September, 2003. Figure 7-1 shows the predicted water surface elevation (project condition) as determined by the Flow Science modeling compared to the measured water surface elevation, labeled as existing condition. The figure shows that the reservoir water levels declined through most of 2002, then rose during the wet season from about mid-November 2002 through March

2003. The maximum change in water level attributed to the project occurred at the end of the wet season when the water level was increased by about 0.5 feet, corresponding to an elevation of about 532 feet, well below the elevation of 537 feet corresponding to when there are mosquito breeding concerns, and the small increase in elevation will not affect flows to Handy Creek.

The change will be larger during wet years and smaller during dry years. A worst case condition is the El Nino Water Year 1998 when the total rainfall exceeded 30 inches. An approximate analysis of these conditions indicated that the project added approximately 125 acre-ft/yr of inflow into PCR, but would not substantially change the already high water surface elevations associated with the pre-development case.

During Stage 2, the runoff volume being discharged to PCR is decreased from 120 acre-ft/year to 110 acre-ft/year due to the addition of Extended Detention Basin HR1 and the diversion of project area away from PCR. By the ultimate conditions, runoff volumes being discharged to PCR are expected to be slightly less that what is currently flowing to the reservoir.

In conclusion, these analyses indicate that the additional runoff from the proposed development, even for worst-case conditions, will not significantly affect water surface elevations that could prompt releases to PCR to avoid mosquito problems, or substantially increase flows down Handy Creek.

Runoff to Santiago Creek - The runoff volume to Santiago Creek is predicted to increase by approximately 185~~110~~ acre-feet on average in the ultimate condition. The project ~~As discussed in the ROMP Volume I, Section 5.6 (see Table 5.10), the~~ area tributary to Santiago Creek and the Villa Park Dam from the Project in the ultimate condition is 659~~615.4~~ acres. The total area tributary to Santiago Creek below Irvine Lake comprises 50,549 acres; therefore, the Project area is 1.2 percent of the total watershed area. Santiago Creek is a wide braided stream with cobble substrate and therefore not easily subject to erosion and downcutting. This increase in volume is minor compared to the runoff volumes from the entire watershed and will not adversely impact Santiago Creek or Villa Park Reservoir.

Runoff to Irvine Lake - The runoff volume to Irvine Lake is predicted to increase by approximately 50 acre-feet on average in the ultimate condition. Irvine Lake is a large reservoir designed to have a maximum normal operating volume of 25,000 acre-ft, and typically ranges from 3,000 to 21,000 acre-feet. Therefore, an average increase of 50 acre-feet is negligible.

Table 7-1: Average Annual Stormwater Runoff Volumes

Modeled Area	Site Condition	Average Annual Runoff Volume: Santiago Hills II Stage 1 (acre-feet)	Average Annual Runoff Volume: Santiago Hills II Stage 1 & 2 (acre-feet)	Average Annual Runoff Volume: Santiago Hills II Stage 1 & 2 and East Orange Area 1 (acre-feet)
Peters Canyon Reservoir	Existing	94~~97~~	94~~97~~	94~~97~~
	Dev w/ PDFs	120	110~~120~~	91~~110~~
	Change	26~~23~~	16~~23~~	-3~~13~~
Santiago Creek	Existing	15~~10~~	15~~10~~	15~~10~~
	Dev w/ PDFs	23~~13~~	130~~75~~	200~~120~~
	Change	8~~3~~	115~~65~~	185~~110~~
Irvine Lake	Existing	130	130	130
	Dev w/ PDFs	130	130	180
	Change	0	0	50
Total Project Area	Existing	239~~240~~	239~~240~~	239~~240~~
	Dev w/ PDFs	273~~260~~	370~~320~~	471~~400~~
	Change	34~~20~~	131~~80~~	232~~160~~

7.1.2 Total Suspended Solids

Table 7-2 shows the predicted average annual total suspended solids (TSS) loads for the three stages of development. Average annual TSS concentration results are shown in Table 7-3. Table 7-3Table 7-4 compares the predicted average annual TSS concentrations with Basin Plan narrative criteria.

Potential Impacts on PCR and Emergent Marshes- Based on the modeling results, TSS loads in stormwater runoff from the developed portion of the project area at ultimate build out would be reduced by about 12.7~~11.6~~ tons/yr, from 18 tons/yr to 5.3~~7.4~~ tons/yr. This reduction includes approximately~~Approximately~~ 0.4~~5~~ tons of TSS generated from ~~are loads associated with~~ existing Caltrans facilities and existing local arterials (with the exception of ETC-1 which is not accounted for in the model).

These loads ~~only~~ represent ~~only~~ watershed sources, in contrast to sediment that is mobilized by erosion of tributary drainages. The latter is likely to be the major source of sediments entering PCR. Average annual TSS concentrations (again, not accounting for existing in-channel erosion) in stormwater runoff into PCR is projected be about 43~~49~~ mg/L, just below~~within~~ the range of values typically observed in stormwater runoff (50-150 mg/L, based on LA County data) and is much lower than TSS levels commonly found in alluvial streams during storm events in Orange County.

Table 7-5 indicates projected TSS loads and concentrations entering each of the emergent marshes. The concern for the emergent marshes is that sediment loads could affect the marsh functions by partially filling the marsh areas or possibly adversely affecting the vegetation. Estimates of annual sediment volume entering the marshes indicate that the volumes range from about 2 to 48 ~~25~~ cubic feet or less than 2 ~~1~~ cubic yards. Given the areas of the marshes, such volumes will not cause any material filling of the emergent marshes. TSS concentrations entering the emergent marshes will vary and are predicted to range between about 30~~50~~ to 130~~230~~ mg/L, which ~~but such levels are not exceptional to wetlands and~~ should not adversely affect habitat and associated beneficial uses. Consequently, these TSS levels are not likely to cause a nuisance or adversely affect beneficial uses.

Potential Impacts to Santiago Creek – TSS loads to Santiago Creek will increase from about 3 ~~2~~ tons/yr to about 12~~10~~ tons/yr. Although this is a large percent increase, the contribution from the developed area is small compared to current sediment loads in Santiago Creek. Santiago Creek is a broad braided stream reflective of high sediment loads with a watershed that is much larger than the area that will be developed that is tributary to Santiago Creek. Also as mentioned above, these load estimates are watershed sources only and do not include the effects of sediments that derive from in-stream erosion. This latter source is much larger than the watershed sources and is the likely the principal source of sediments transported in the Santiago Creek system. TSS concentrations entering Santiago Creek are projected to be about 45~~60~~ mg/l which, as discussed above, is relatively low for urban runoff and is likely to be much less that TSS levels in Santiago Creek. (Available data for Santiago Creek either above or below Santiago Dam does not include TSS.) Consequently, TSS levels are not likely to cause a nuisance or adversely affect beneficial uses.

Potential Impacts to Irvine Lake - TSS loads to Irvine Lake from EO Area1 are not projected to change substantially because most of the area tributary to Irvine Lake remains open space. TSS concentrations are projected to decrease to about 140 mg/l, which compares to measured TSS concentrations ranging from non detect to ~~a TSS range of about 0.8~~ 40 mg/l in Irvine Lake (Table 2-6). Runoff concentrations may be reduced as water flows along the vegetated portions of the tributary leading to Woody's Cove. There is likely to be a small turbid plume in Irvine Lake during stormwater conditions, but this plume will be essentially similar to the pre-development condition. However, TSS levels are not likely to cause a nuisance or adversely affect beneficial uses.

PDFs - Project PDFs include site design, source control, and treatment control BMPs in compliance with the requirements of the MS4 Permit and the DAMP/LIP, but only treatment control BMPs (excluding CDS Unit 6A) have been modeled. Site design PDFs include the preservation of large amounts of natural areas, which will continue to provide higher levels of sediment to receiving waters than the permanently stabilized development areas. The treatment control HSS units and extended detention basins will effectively reduce TSS in the runoff from the proposed development.

In summary, based on the above impact analysis, the effect of the Project on TSS loads and concentrations is determined to be less than significant.

Table 7-2: Average Annual TSS Loads

Modeled Area	Site Condition	Average Annual TSS Load: Santiago Hills II Stage 1 (tons)	Average Annual TSS Load: Santiago Hills II Stages 1 & 2 (tons)	Average Annual TSS Load: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (tons)
Peters Canyon Reservoir	Existing	18	18	18
	Dev w/ PDFs	7.9~~.1~~	7~~8~~.4	5.3~~7.4~~
	Change	-10.1~~8.9~~	-10~~9~~.6	-12.7~~-10.6~~
Santiago Creek	Existing	2.8~~4~~	2.8~~4~~	2.8~~4~~
	Dev w/ PDFs	4.2~~1.9~~	9.7~~.0~~	12~~9.9~~
	Change	1.4~~-0.5~~	~~4.~~6.9	9.2~~7.5~~
Irvine Lake	Existing	35	35	35
	Dev w/ PDFs	35~~36~~	36~~35~~	35~~34~~
	Change	0~~1~~	1~~0~~	0~~-1~~
Total Project Area	Existing	55.8~~56~~	55.8~~56~~	55.8~~56~~
	Dev w/ PDFs	47.1	53.1~~51~~	52.3
	Change	-8.7~~9~~	-2.7~~5~~	-3.5~~4~~

Table 7-3: Average Annual TSS Concentrations

Modeled Area	Site Condition	Average Annual TSS Concentration: Santiago Hills II Stage 1 (mg/L)	Average Annual TSS Concentration: Santiago Hills II Stages 1 & 2 (mg/L)	Average Annual TSS Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (mg/L)
Peters Canyon Reservoir	Existing	140	140	140~~150~~
	Dev w/ PDFs	49~~58~~	50~~52~~	43~~49~~
	Change	-91~~82~~	-90~~88~~	-97~~101~~
Santiago Creek	Existing	140~~150~~	140~~150~~	140~~150~~
	Dev w/ PDFs	130~~110~~	56~~69~~	45~~61~~
	Change	-10~~40~~	-84~~81~~	-95~~89~~
Irvine Lake	Existing	200	200	200
	Dev w/ PDFs	200	200	140
	Change	0	0	-60
Total Project Area	Existing	170	170	170
	Dev w/ PDFs	130	100~~115~~	82~~93~~
	Change	-40	-70~~55~~	-88~~77~~

Table 7-4: Comparison of Modeled TSS Concentrations with Water Quality Criteria

Modeled Area	Average Annual TSS Concentration: Santiago Hills II Stage 1 (mg/L)[1]	Average Annual TSS Concentration: Santiago Hills II Stages 1 & 2 (mg/L)[1]	Average Annual TSS Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (mg/L)[1]	Santa Ana Basin Plan Water Quality Objectives	California Toxics Rule Criteria
Peters Canyon Reservoir	49~~58~~	50~~52~~	43~~49~~	TSS levels shall not cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors	NA
Santiago Creek	130~~110~~	56~~69~~	45~~61~~	TSS levels shall not cause a nuisance or adversely affect beneficial uses as a result of controllable water	NA

Modeled Area	Average Annual TSS Concentration: Santiago Hills II Stage 1 (mg/L)[1]	Average Annual TSS Concentration: Santiago Hills II Stages 1 & 2 (mg/L)[1]	Average Annual TSS Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (mg/L)[1]	Santa Ana Basin Plan Water Quality Objectives	California Toxics Rule Criteria
				quality factors	
Irvine Lake	200	200	140	TSS levels shall not cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors	NA

[1]Modeled concentration for developed conditions with PDFs.
NA – not applicable

Table 7-5: Comparisons of the Emergent Marsh Influent TSS Loads and Concentrations with Water Quality Criteria

Emergent Marsh ID	Average Annual TSS Concentrations: Santiago Hills II Stages 1~~ & 2~~ (mg/L)[1]	Average Annual TSS Loads: Santiago Hills II Stages 1~~ & 2~~ (tons/year)[1]	Santa Ana Basin Plan Water Quality Objectives
A2	45~~59~~	0.2	TSS levels shall not cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors
~~B2~~B2	65~~100~~	0.3~~2~~	
~~B3~~B3	130~~92~~	2.4~~3.3~~	
B4~~B4~~	79~~52~~	2.2~~0.9~~	
~~C1~~C1	94~~79~~	3.5	
~~C2~~C2	52~~230~~	0.2~~1~~	
~~C3~~C3	30~~81~~	0.7~~9~~	
~~C4~~C4	30~~85~~	0.4~~8~~	
~~C5~~C5	54~~92~~	0.1~~5~~	
~~C6~~	~~110~~	~~0.2~~	
~~C7~~	~~190~~	~~0.3~~	
~~F2~~	~~86~~	~~0.6~~	

[1]Modeled concentrations and loads for developed conditions with PDFs.

7.1.3 Nutrients

Table 7-6 shows the mean annual nutrient loads for the three stages of development.

Potential Impacts to PCR and Emergent Marshes - Nutrient loads to PCR are important because, except during very wet years, PCR is a closed system whereby nutrients which enter the reservoir tend to accumulate, especially in the sediments, and under anoxic conditions may be recycled into the water column. Stage 1 2 is the stage of interest because it represents the worst case nutrient loadings to PCR. Stages 2 and Stage 3 involves changes in the storm drain system that reduce the tributary area to PCR thus reducing the loads to PCR. Results for Stage 12 show nitrate-nitrogen loads slightly less than pre-development loads; an increase in TKN loads of 130150 lbs/year and an increase in TP loads of 2224 lbs/year. These changes include reductions in nutrient loads from existing roadways, including an estimated reduction in TP loads of 4.7 lbs/yr, nitrate-nitrogen loads of 4.67 lbs/yr, and TKN loads of 1724 lbs/yr.

The significance of the changes in load depends on the extent to which the nutrients are available for utilization by the algae which consume nutrients in the process of photosynthesis. Both nitrogen and phosphorus are utilized by algae in photosynthesis, but often one of the nutrient species is less available and this nutrient is said to be the limiting nutrient. Although other factors, such as light transmittance or trace metals concentrations may limit algal photosynthesis, the nitrogen and phosphorus data obtained in PCR suggest that the system is nitrogen-limited (For further details, see letter from Dr. Alex Horne, a specialist in limnology with specific knowledge of PCR, contained in Appendix F.) Of the nitrogen species, the inorganic forms are more readily able to be metabolized by algae. The inorganic forms of nitrogen include nitrate-nitrogen, nitrite-nitrogen, and ammonia. Nitrite-nitrogen is readily converted to nitrate-nitrogen in aerobic conditions, and therefore is rarely detected in runoff.

TKN consists of dissolved and particulate organic nitrogen and inorganic nitrogen in the form of ammonia (NH_3-N). Ammonia is a relatively bioavailable form of nitrogen but tends to be a small fraction of TKN in urban runoff. For example, data from mixed and multifamily residential areas in Los Angeles County indicate that NH_3-N is about 20 percent of TKN. The remaining approximately 80 percent of TKN is dissolved or particulate organic nitrogen and may include plant and animal proteins and animal urine and fecal matter. The organic portion of TKN is generally considered less bioavailable than the inorganic forms of nitrogen, and therefore the significance of the increase in TKN loading is dependent on the extent to which this form of nitrogen accumulates in the sediments and is either sequestered there or is transformed into a more bioavailable form and recycled back into the water column. This effect, which is dependent on anoxic conditions near the bottom of the reservoir, was evaluated by Flow Science in a reservoir water quality model (Flow Science, 2004b).

As indicated in Table 7-6, loads of nitrate-N delivered in runoff to PCR are predicted to decrease by about 2010 lbs/year, while the mean annual Total Kjeldahl Nitrogen (TKN) load is projected to increase by about 130150 lbs/year for Stage 1. However, as pointed out above, the majority of TKN is organic nitrogen and less bioavailable. The projected increase in phosphorus loads is less relevant given that PCR is considered nitrogen limited.

The mean total nitrogen concentration observed in the most recent monitoring of PCR was about 1.9 mg/l (Table 2-10). The projected total nitrogen under post-development conditions, assumed equal to nitrate-nitrogen and TKN, ~~also~~ is about 1.7~~9~~ mg/L (Table 7-7). Thus the proposed development will likely not significantly affect TN concentrations in PCR. Table 7-8 compares mean nutrient concentrations with Basin Plan narrative criteria for algal growth and dissolved oxygen. The cumulative significance of changes in nutrient loads and concentrations and compliance with the narrative criteria were evaluated as part of the lake modeling conducted by Flow Science, and is discussed in Subsection 7.6 Cumulative Impacts.

Tables 7-9 through 7-11 summarize nutrient loads and concentrations in runoff to the various emergent marshes. Nutrients are effectively utilized by the vegetation in the marshes and providing nutrients is considered beneficial.

Potential Impacts to Santiago Creek - Nutrient loads to Santiago Creek are predicted to increase compared to projected pre-development loads. Such increases, although large relative to predevelopment conditions, are likely to be quite small compared to background loads in Santiago Creek. This is because the developed tributary area to Santiago Creek represents only about one percent of the total tributary area to Santiago Creek (exclusive of the watershed area above Santiago Dam). Projected nutrient concentrations are similar to the pre-development conditions (Table 7-7) and are quite similar to the measured nutrient data downstream of Villa Park Dam as reported by USEPA (Table 2-13~~12~~). For example, the projected nitrate-nitrogen concentration in the runoff ranges from 0.7 mg/L for Stage 1 to ~~is~~ 0.6 mg/l for Stage 3, compared to the observed concentrations of 0.23 mg/l and 0.79 mg/l.

Potential Impacts to Irvine Lake - Mean annual nutrient loads to Irvine Lake are predicted to increase as shown in Table 7-6. Although these increases are relatively large compared with the loads associated with the same source area in the pre-development conditions, the absolute loads compared with loads from all sources entering Irvine Lake are small because the East Orange Area 1 is very small when compared with the 63.1~~62~~-square mile watershed of Irvine Lake. Also this drainage area is primarily national forest which can be a significant source of~~with some development, and~~ nutrient loads. ~~from forested areas can be large.~~

Model results for the ultimate stage of development predict a decrease in nitrate-N concentrations in the post-developed condition, with a concentration of 0.9 mg/L for treated discharge into Irvine Lake, which is well below the drinking water quality criteria of 10 mg/L (Table 7-8). Total nitrogen (estimated as TKN plus nitrate-N) is approximately 2.0 mg/L as N for runoff to Irvine Lake after treatment. These concentrations are below the Basin Plan Total Inorganic Nitrogen criteria of 6 mg/L in Irvine Lake. Total phosphorus concentrations are not expected to significantly change after development with PDFs.

These increases in nutrient loads are considered insignificant in light of DAMP compliance and Basin Plan criteria and because much of the increase is associated with the less bioavailable forms of nutrients (TKN) or with nutrients that are considered not limiting (total phosphorus).

PDFs - Project PDFs include site design, source control, and treatment control BMPs in compliance with the requirements of the MS4 Permit and the DAMP/LIP, but only treatment control BMPs (excluding CDS Unit 6A) and the Supplemental Fertilizer Manage Program source control PDFs were included in the model. Site design PDFs will minimize increases in nutrients through the preservation of natural areas and the use of native or drought tolerant plants in development plant palettes. Source control PDFs that target nutrients include educational materials on the proper handling of fertilizers and pet waste management, the use of efficient irrigation systems and a special Supplemental Fertilizer Management Program in common areas. (For more detail, see discussion of Supplemental Fertilizer Management Program under Source Controls). This special fertilizer program will significantly reduce the nutrient concentration in runoff from the common areas. The treatment control extended detention basins will also reduce nutrients in the runoff from the entire proposed development.

In summary, based on the comprehensive site design, source control, and treatment control strategy, the comparison with available monitoring data, and the results of the reservoir modeling performed by Flow Science, potential impacts associated with nutrients are predicted to be less than significant.

Table 7-6: Average Annual Nutrient Loads

Modeled Area	Site Conditions	Average Annual Loads: Santiago Hills II Stage 1 (lbs)			Average Annual Loads: Santiago Hills II Stages 1 & 2 (lbs)			Average Annual Loads: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (lbs)		
		Total P	Nitrate-N	TKN	Total P	Nitrate-N	TKN	Total P	Nitrate-N	TKN
Peters Canyon Reservoir	Existing	5556	190200	260270	5556	190200	260270	5556	190200	260270
	Dev w/ PDFs	7775	170180	390400	7080	160190	360420	6077	120170	300400
	Change	2219	-20	130	1524	-3010	100150	521	-7030	40130
Santiago Creek	Existing	96.2	3025	4232	96.2	3025	4232	96.2	3025	4232
	Dev w/ PDFs	148.5	4421	6436	9653	230110	540300	13090	290180	740520
	Change	52.3	144	224	8746.8	20085	498268	12183.8	260155	698488
Irvine Lake	Existing	60	350	350	60	350	350	60	350	350
	Dev w/ PDFs	59	350	350	60	350	350	91	450	520
	Change	-1	0	0	0	0	0	31	100	170
Total Project Area	Existing	124120	570	652650	124120	570	650	124120	570	652650

Modeled Area	Site Conditions	Average Annual Loads: Santiago Hills II Stage 1 (lbs)			Average Annual Loads: Santiago Hills II Stages 1 & 2 (lbs)			Average Annual Loads: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (lbs)		
		Total P	Nitrate-N	TKN	Total P	Nitrate-N	TKN	Total P	Nitrate-N	TKN
	Dev w/ PDFs	1501 40	5645 50	8047 90	2261 90	7406 50	1250 1100	2812 60	8608 00	1560 1400
	Change	2620	-620	1521 40	1027 0	1708 0	6004 50	1571 40	2902 30	9087 50

Table 7-7: Average Annual Nutrient Concentrations

Modeled Area	Site Conditions	Average Annual Concentrations: Santiago Hills II Stage 1 (mg/L)			Average Annual Concentrations: Santiago Hills II Stages 1 & 2 (mg/L)			Average Annual Concentrations: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (mg/L)		
		Total P	Nitrate-N	TKN	Total P	Nitrate-N	TKN	Total P	Nitrate-N	TKN
Peters Canyon Reservoir	Existing	0.2	0.78	1.0	0.2	0.78	1.0	0.2	0.78	1.0
	Dev w/ PDFs	0.2	0.56	1.23	0.23	0.56	1.23	0.23	0.56	1.23
	Change	0.0	-0.2	0.23	0.01	-0.2	0.23	0.01	-0.2	0.23
Santiago Creek	Existing	0.2	0.78	1.0	0.2	0.78	1.0	0.2	0.78	1.0
	Dev w/ PDFs	0.2	0.76	1.0	0.3	0.76	1.5	0.23	0.6	1.46
	Change	0.0	-0.02	0.0	0.1	-0.02	0.5	0.01	-0.12	0.46
Irvine Lake	Existing	0.2	1.0	1.0	0.2	1.0	1.0	0.2	1.0	1.0
	Dev w/ PDFs	0.2	1.0	1.0	0.2	1.0	1.0	0.2	0.9	1.1
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1
Total Project Area	Existing	0.2	0.9	1.0	0.2	0.9	1.0	0.2	0.9	1.0
	Dev w/ PDFs	0.2	0.8	1.1	0.2	0.7	1.2	0.2	0.7	1.23
	Change	0.0	-0.1	0.1	0.0	-0.2	0.2	0.0	-0.2	0.23

Table 7-8: Comparison of Modeled Nutrient Concentrations with Water Quality Criteria

Modeled Area	Nutrient	Average Annual Concentration: Santiago Hills II Stage 1 (mg/L)[1]	Average Annual Concentration: Santiago Hills II Stages 1 & 2 (mg/L)[1]	Average Annual Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (mg/L)[1]	Santa Ana Basin Plan Water Quality Objective[2]
Peters Canyon Reservoir	Total P	0.2	0.2~~3~~	0.2~~3~~	NA
	Nitrate-N[3]	0.5~~6~~	0.5~~6~~	0.5~~6~~	NA
	TKN[3]	1.2~~3~~	1.2~~3~~	1.2~~3~~	NA
Santiago Creek	Total P	0.2	0.3	0.2~~3~~	NA
	Nitrate-N[3]	0.7~~6~~	0.7~~6~~	0.6	10 mg/L as Nitrate-N
	TKN[3]	1.0	1.5	1.4~~6~~	NA
Irvine Lake	Total P	0.2	0.2	0.2	NA
	Nitrate-N[3]	1.0	1.0	0.9	10 mg/L as Nitrate-N
	TKN[3]	1.0	1.0	1.1	NA

[1]Modeled concentration for developed conditions with PDFs.
[2]There are no CTR criteria for nitrogen.
[3]Total nitrogen concentrations, estimated as the sum of Nitrate-N plus TKN (organic nitrogen plus ammonia), is 2 mg/L, which is less than the total inorganic nitrogen (the sum of ammonia, nitrate, and nitrite) criteria of 6 mg/L.
[4]~~See Appendix A.~~
NA – not applicable.

Table 7-9: Comparison of Emergent Marsh Influent Total Phosphorus Loads and Concentrations with Water Quality Criteria

Emergent Marsh ID	Average Annual Total Phosphorous Concentrations: Santiago Hills II Stages 1 ~~& 2~~ (mg/L)[1]	Average Annual Total Phosphorous Loads: Santiago Hills II Stages 1 ~~& 2~~ (lbs/year)[1]	Santa Ana Basin Plan Water Quality Objectives
A2	0.3	2.4~~1.7~~	NA
~~B2~~B2	0.3	2.5~~1.3~~	
~~B3~~B3	0.2	8.4~~15~~	
B4~~B4~~	0.2	12~~6.8~~	
~~C1~~C1	0.2~~3~~	2.5~~3~~	
~~C2~~C2	0.2~~1~~	2.0~~.1~~	

Emergent Marsh ID	Average Annual Total Phosphorous Concentrations: Santiago Hills II Stages 1 & 2 (mg/L)[1]	Average Annual Total Phosphorous Loads: Santiago Hills II Stages 1 & 2 (lbs/year)[1]	Santa Ana Basin Plan Water Quality Objectives
C3C3	0.23	115.7	
C4C4	0.23	5.7	
C5C5	0.3	1.12.8	
C6	0.3	1.1	
C7	0.2	0.6	
F2	0.3	3.5	

[1]Modeled concentrations and loads for developed conditions with PDFs.

Table 7-10: Comparison of Emergent Marsh Influent Nitrate-N Loads and Concentrations with Water Quality Criteria

Emergent Marsh ID	Average Annual Nitrate-N Concentrations: Santiago Hills II Stages 1 & 2 (mg/L)[1]	Average Annual Nitrate-N Loads: Santiago Hills II Stages 1 & 2 (lbs/year)[1]	Santa Ana Basin Plan Water Quality Objectives
A2	0.34	2.74	NA
B2B2	0.6	4.42.3	
B3B3	0.75	2736	
B4B4	0.75	3617	
C1C1	0.5	5.545	
C2C2	0.61.2	4.81.0	
C3C3	0.65	2612	
C4C4	0.5	149.7	
C5C5	0.65	5.3.1	
C6	0.6	2.5	
C7	0.9	2.7	

Emergent Marsh ID	Average Annual Nitrate-N Concentrations: Santiago Hills II Stages 1 ~~& 2~~ (mg/L)[1]	Average Annual Nitrate-N Loads: Santiago Hills II Stages 1 ~~& 2~~ (lbs/year)[1]	Santa Ana Basin Plan Water Quality Objectives
~~F2~~	~~0.5~~	~~6.6~~	

[1]Modeled concentrations and loads for developed conditions with PDFs.

Table 7-11: Comparison of Emergent Marsh Influent TKN Loads and Concentrations with Water Quality Criteria

Emergent Marsh ID	Average Annual TKN Concentrations: Santiago Hills II Stages 1 ~~& 2~~ (mg/L)[1]	Average Annual TKN Loads: Santiago Hills II Stages 1 ~~& 2~~ (lbs/year)[1]	Santa Ana Basin Plan Water Quality Objectives
A2	1.1~~5~~	8.6~~2~~	NA
~~B2~~B2	~~2.~~1.9	15~~8.0~~	
~~B3~~B3	1.0	40~~74~~	
~~B4~~B4	1.0	57~~34~~	
~~C1~~C1	1.1	12~~97~~	
~~C2~~C2	1.3~~0~~	11~~0.8~~	
~~C3~~C3	1.3~~2~~	57~~26~~	
~~C4~~C4	1.2~~6~~	30	
~~C5~~C5	1.2~~5~~	5.9~~15~~	
~~C6~~	~~1.5~~	~~5.7~~	
~~C7~~	~~1.1~~	~~3.4~~	
~~F2~~	~~1.2~~	~~15~~	

[1]Modeled concentrations and loads for developed conditions with PDFs.

7.1.4 Copper, Lead, & Zinc

Projected loads and concentrations for the trace metals copper, lead, and zinc for the three stages of development are presented in Tables 7-12 through 7-17. Where possible, the projections are for the dissolved form of the metal, as it is the dissolved form to which the CTR criteria apply. However, due to consistently low concentrations of dissolved lead in the available stormwater runoff data, it was not possible to develop reliable EMC parameters for most land uses for modeling the dissolved fraction of lead. This pollutant was therefore modeled as the total recoverable metal. Copper, lead, and zinc are the most prevalent metals typically found in urban runoff. Other trace metals, such as cadmium, chromium, and mercury, are typically not detected in urban runoff or are detected at very low levels (LA County, 2000).

Potential Impacts on PCR and Emergent Marshes – Projected mean annual stormwater runoff loads entering PCR during Stage 1 (worst case stage for metal loading) are essentially unchanged for dissolved copper, increase by about 0.5 lbs for total recoverable lead, and decrease for dissolved zinc. As discussed in Section 7.7.3 the saline nature of PCR, coupled with the organic bottom sediments, are likely to significantly limit the bioavailability and potential for recycling of trace metals in PCR. These results also reflect reduction in trace metals from approximately 41~~120~~ acres of existing roadways~~off-site road areas~~ of about 1 lb/yr for dissolved copper and about 10~~15~~ lbs/yr for dissolved zinc.

Trace metal concentrations are projected to decrease slightly for dissolved copper, increase for total recoverable lead, and significantly decrease for dissolved zinc. Projected concentrations are compared to the CTR criteria in Table 7-18. The CTR criteria are based on minimum observed hardness values in Peters Canyon Reservoir, Irvine Lake, and Santiago Creek (Table 7-22). This comparison shows that all of the trace metal concentrations are below the CTR acute and chronic criteria for aquatic life.

The projected trace metal loads and concentrations for discharges to the emergent marshes are provided in Table 7-19 through Table 7-21. The mean annual loads are generally less than 1 lb, with a few exceptions for dissolved zinc. As with PCR, the trace metals entering the emergent marshes will have a tendency to bind to organic matter that collects in wetlands systems as vegetation dies and decays. These metals are likely to be bound in the sediments and would thereby be limited in terms of entering the food chain of aquatic and terrestrial biota in the marsh. Projected concentrations are less than the CTR criteria for all three metals. The CTR criteria are based on the lowest hardness values observed in each of the receiving waterbodies. Data collected at Peters Canyon Reservoir, Irvine Lake, and Santiago Creek were analyzed to determine the lowest hardness value. The hardness value used to estimate the CTR criteria was obtained from data in Santiago Creek.

Potential Impacts to Santiago Creek – Trace metals loads are projected to increase for all three metals modeled, but the contribution of metals loads to Santiago Creek from the proposed development is likely to be small relative to the contribution from the much larger watershed tributary to Santiago Creek. These sources would be primarily natural sources of trace metals. For example, total lead observed in Santiago Creek (albeit only one sample) was 5 mg/l (Table 2-13~~12~~) and the projected mean annual total recoverable lead concentration is about 5.2~~3~~ mg/l for Stage 2. Given the much larger flows entering Santiago Creek from the watershed, it is reasonable to assume that the loads from the proposed development will be much smaller than background loads. Projected concentrations are less than the CTR criteria for all three metals. The CTR criteria are based on the lowest hardness values observed in Santiago Creek.

Potential Impacts to Irvine Lake - Trace metals loads entering Irvine Lake from East Orange Area 1 are projected to increase for dissolved copper, total recoverable lead, and dissolved zinc. As with Santiago Creek, the increases associated with the project are likely to be small relative to background trace metal loads entering Irvine Lake from the much larger and mostly undeveloped upstream watershed. Projected concentrations are less than the CTR criteria for all three metals. The CTR criteria are based on the lowest hardness values observed in Irvine Lake.

PDFs - Project PDFs include site design, source control and treatment control BMPs in compliance with the requirements of the MS4 Permit and the DAMP/LIP. Specific site design PDFs that will minimize increases in trace metals include directing drainage from impervious areas to landscaped areas or bioretention facilities and the selection of building material for roof gutters and downspouts that do not include copper or zinc. Source control PDFs that target metals include education for property owners, BMP maintenance, and street sweeping private streets and parking lots. As shown in the tables below, the treatment control extended detention basins will also reduce trace metals in the runoff from the proposed development when compared to the developed condition without PDFs.

In summary, based on the comprehensive site design, source control, and treatment strategy and the comparison with the water quality benchmark values, the Project is not expected to have significant impacts resulting from trace metals.

Table 7-12: Average Annual Dissolved Copper Loads

Modeled Area	Site Condition	Average Annual Dissolved Copper Load: Santiago Hills II Stage 1 (lbs)	Average Annual Dissolved Copper Load: Santiago Hills II Stages 1 & 2 (lbs)	Average Annual Dissolved Copper Load: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (lbs)
Peters Canyon Reservoir	Existing	3.4~~3~~	3.4~~3~~	3.4~~3~~
	Dev w/ PDFs	3.2~~5~~	2.9~~3.6~~	2.5~~3.4~~
	Change	-0.2	-0.5~~3~~	-0.9~~1~~
Santiago Creek	Existing	0.5~~3~~	0.5~~3~~	0.5~~3~~
	Dev w/ PDFs	0.9~~6~~	4.1~~.9~~	~~3.~~5.6
	Change	0.4~~3~~	3~~1~~.6	5.1~~3.2~~
Irvine Lake	Existing	2.2	2.2	2.2
	Dev w/ PDFs	2.2	2.2	3.2~~1~~
	Change	0.0	0.0	1.0~~.9~~
Total Project Area	Existing	6.1~~5.8~~	6.1~~5.8~~	6.1~~5.8~~
	Dev w/ PDFs	6.3	9.2~~7.8~~	11.3~~10.1~~
	Change	0.2~~5~~	3.1~~2.0~~	5.2~~4.3~~

Table 7-13: Average Annual Dissolved Copper Concentrations

Modeled Area	Site Condition	Average Annual Dissolved Copper Concentration: Santiago Hills II Stage 1 (ug/L)	Average Annual Dissolved Copper Concentration: Santiago Hills II Stages 1 & 2 (ug/L)	Average Annual Dissolved Copper Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (ug/L)
Peters Canyon Reservoir	Existing	13	13	13
	Dev w/ PDFs	10~~11~~	10~~11~~	10~~11~~
	Change	-3~~2~~	-3~~2~~	-3~~2~~
Santiago Creek	Existing	13~~11~~	13~~11~~	13~~11~~
	Dev w/ PDFs	14~~17~~	12~~9.5~~	10~~11~~
	Change	1~~6~~	-1~~.5~~	-3~~0~~
Irvine Lake	Existing	6.3	6.3	6.3
	Dev w/ PDFs	6.3	6.3	6.7~~5~~
	Change	0.0	0.0	0.4~~2~~
Total Project Area	Existing	9.4~~1~~	9.4~~1~~	9.4~~1~~
	Dev w/ PDFs	8.6~~9.0~~	9.2~~8.8~~	8.9~~.1~~
	Change	-0.8~~1~~	-0.2~~3~~	-0.5

Table 7-14: Average Annual Total Recoverable Lead Loads

Modeled Area	Site Condition	Average Annual Total Lead Load: Santiago Hills II Stage 1 (lbs)	Average Annual Total Lead Load: Santiago Hills II Stages 1 & 2 (lbs)	Average Annual Total Lead Load: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (lbs)
Peters Canyon Reservoir	Existing	1.1	1.1	1.1
	Dev w/ PDFs	1.6	1.5~~7~~	1.2~~6~~
	Change	0.5	0.4~~6~~	0.1~~5~~
Santiago Creek	Existing	0.2~~1~~	0.2~~1~~	0.2~~1~~
	Dev w/ PDFs	0.3~~2~~	1.8~~0~~	2.5~~1.7~~
	Change	0.1	1.6~~0.9~~	2.3~~1.6~~

Modeled Area	Site Condition	Average Annual Total Lead Load: Santiago Hills II Stage 1 (lbs)	Average Annual Total Lead Load: Santiago Hills II Stages 1 & 2 (lbs)	Average Annual Total Lead Load: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (lbs)
Irvine Lake	Existing	1.3	1.3	1.3
	Dev w/ PDFs	1.3	1.3	1.8
	Change	0.0	0.0	0.5
Total Project Area	Existing	2.6	2.6	2.6
	Dev w/ PDFs	3.1	4.6~~0~~	5.6~~2~~
	Change	0.5	2.0~~1.4~~	3.0~~2.6~~

Table 7-15: Average Annual Total Recoverable Lead Concentrations

Modeled Area	Site Condition	Average Annual Total Lead Concentration: Santiago Hills II Stage 1 (ug/L)	Average Annual Total Lead Concentration: Santiago Hills II Stages 1 & 2 (ug/L)	Average Annual Total Lead Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (ug/L)
Peters Canyon Reservoir	Existing	4.3	4.3	4.3
	Dev w/ PDFs	4.9~~5.1~~	4.9~~5.2~~	5.0~~3~~
	Change	0.6~~8~~	0.6~~9~~	0.7~~1~~
Santiago Creek	Existing	4.4~~2~~	4.4~~2~~	4.4~~2~~
	Dev w/ PDFs	4.4~~7~~	5.2~~4.9~~	4.6~~5.3~~
	Change	0.0~~5~~	0.8~~7~~	0.2~~1.1~~
Irvine Lake	Existing	3.7	3.7	3.7
	Dev w/ PDFs	3.7	3.7	3.8
	Change	0.0	0.0	0.1
Total Project Area	Existing	4.0	4.0	4.0
	Dev w/ PDFs	4.2~~4~~	4.6~~5~~	4.4~~7~~
	Change	0.2~~4~~	0.6~~5~~	0.4~~7~~

Table 7-16: Average Annual Dissolved Zinc Loads

Modeled Area	Site Condition	Average Annual Dissolved Zinc Load: Santiago Hills II Stage 1 (lbs)	Average Annual Dissolved Zinc Load: Santiago Hills II Stages 1 & 2 (lbs)	Average Annual Dissolved Zinc Load: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (lbs)
Peters Canyon Reservoir	Existing	20	20	20
	Dev w/ PDFs	1416	1317	1116
	Change	-64	-73	-94
Santiago Creek	Existing	3.32.2	3.32.2	3.32.2
	Dev w/ PDFs	5.13.3	207.9	2716
	Change	1.81	165.7	23.713.8
Irvine Lake	Existing	18	18	18
	Dev w/ PDFs	18	18	24
	Change	0	0	6
Total Project Area	Existing	41.340	41.340	41.340
	Dev w/ PDFs	37.1	5142	6256
	Change	-4.23	9.72	20.716

Table 7-17: Average Annual Dissolved Zinc Concentrations

Modeled Area	Site Condition	Average Annual Dissolved Zinc Concentration: Santiago Hills II Stage 1 (ug/L)	Average Annual Dissolved Zinc Concentration: Santiago Hills II Stages 1 & 2 (ug/L)	Average Annual Dissolved Zinc Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (ug/L)
Peters Canyon Reservoir	Existing	7977	7977	7977
	Dev w/ PDFs	4451	4351	4451
	Change	-3526	-3626	-3526
Santiago Creek	Existing	8070	8070	8070
	Dev w/ PDFs	8194	5839	5049
	Change	124	-2231	-3021

Modeled Area	Site Condition	Average Annual Dissolved Zinc Concentration: Santiago Hills II Stage 1 (ug/L)	Average Annual Dissolved Zinc Concentration: Santiago Hills II Stages 1 & 2 (ug/L)	Average Annual Dissolved Zinc Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (ug/L)
Irvine Lake	Existing	50	50	50
	Dev w/ PDFs	50	50	50
	Change	0	0	0
Total Project Area	Existing	63~~62~~	63~~62~~	63~~62~~
	Dev w/ PDFs	50~~53~~	51~~48~~	49~~50~~
	Change	-13~~9~~	-13~~14~~	-14~~12~~

Table 7-18: Comparison of Modeled Metals Concentrations with Water Quality Criteria

Modeled Area	Trace Metal	Average Annual Concentration: Santiago Hills II Stage 1 (µg/L)[1]	Average Annual Concentration: Santiago Hills II Stages 1 & 2 (µg/L)[1]	Average Annual Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (µg/L)[1]	California Toxics Rule Criteria[2] (µg/L)	
					Acute	Chronic
Peters Canyon Reservoir	Dissolved Copper	10~~11~~	9.8~~11~~	10~~11~~	26	16
	Total Recoverable Lead	4.9~~5.1~~	4.9~~5.2~~	5.0~~3~~	200	7.7
	Dissolved Zinc	44~~51~~	43~~51~~	44~~51~~	210	210
Santiago Creek	Dissolved Copper	14~~17~~	12~~9.5~~	10~~11~~	31	19
	Total Recoverable Lead	4.4~~7~~	5.2~~4.9~~	4.6~~5.3~~	250	9.7
	Dissolved Zinc	81~~94~~	58~~39~~	50~~49~~	250	250

Modeled Area	Trace Metal	Average Annual Concentration: Santiago Hills II Stage 1 (µg/L)[1]	Average Annual Concentration: Santiago Hills II Stages 1 & 2 (µg/L)[1]	Average Annual Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (µg/L)[1]	California Toxics Rule Criteria[2] (µg/L)	
					Acute	Chronic
Irvine Lake	Dissolved Copper	6.3	6.3	6.75	38	23
	Total Recoverable Lead	3.7	3.7	3.8	330	13
	Dissolved Zinc	50	50	50	300	300

[1]Modeled concentration for developed conditions with PDFs.
[2]Hardness = 200 mg/L as $CaCO_3$ in Peters Canyon Reservoir, hardness = 298 mg/L in Irvine Lake, and hardness = 240 mg/L in Santiago Creek based on monitoring data.

Table 7-19: Comparison of Emergent Marsh Influent Dissolved Copper Loads and Concentrations with Water Quality Criteria

Emergent Marsh ID	Average Annual Dissolved Copper Concentration: Santiago Hills II Stages 1 & 2 (ug/L)[1]	Average Annual Dissolved Copper Loads: Santiago Hills II Stages 1 & 2 (lbs/year)[1]	California Toxics Rule Criteria[2] (µg/L)
A2	2419	0.21	26 (acute) 16 (chronic)
B2B2	1514	0.1	
B3B3	9.112	0.48	
B4B4	8.69.2	0.53	
C1C1	1315	1.3	
C2C2	132.0	0.10	
C3C3	8.614	0.43	
C4C4	7.915	0.23	
C5C5	7.314	0.1	
C6	12	0.1	
C7	6.2	0.0	
F2	15	0.2	

[1]Modeled concentrations and loads for developed conditions with PDFs.
[2]Hardness = 200 mg/L as $CaCO_3$ in Peters Canyon Reservoir

Table 7-20 Comparison of Emergent Marsh Influent Total Recoverable Lead Loads and Concentrations with Water Quality Criteria

Emergent Marsh ID	Average Annual Total Recoverable Lead Concentrations: Santiago Hills II Stages 1 ~~& 2~~ (ug/L)[1]	Average Annual Total Recoverable Lead Loads: Santiago Hills II Stages 1 ~~& 2~~ (lbs/year)[1]	California Toxics Rule Criteria[2,3] (µg/L)
A2	5.3~~8~~	0.0	200 (acute) 7.7~~5.3~~ (chronic)
~~B2~~B2	6.9~~7~~	0.1~~0~~	
~~B3~~B3	4.5~~2~~	0.2~~3~~	
~~B4~~B4	4.5~~2~~	0.2~~1~~	
C1	4.8	0.4	
C2	3.2	0.0	
~~C3~~C3	5.2~~4.8~~	0.2~~1~~	
~~C4~~C4	5.1~~8~~	0.1	
~~C5~~C5	4.9~~5.6~~	0.1	
~~C6~~	~~5.3~~	~~0.0~~	
~~C7~~	~~4.1~~	~~0.0~~	
~~F2~~	~~5.2~~	~~0.1~~	

[1]Modeled concentrations and loads for developed conditions with PDFs.
[2]Hardness = 200 mg/L as $CaCO_3$ in Peters Canyon Reservoir
[3]Sourece of Total Pb criteria: (CVRWQCB, 2003).

Table 7-21: Comparison of Emergent Marsh Influent Dissolved Zinc Loads and Concentrations with Water Quality Criteria

Emergent Marsh ID	Average Annual Dissolved Zinc Concentration: Santiago Hills II Stages 1 & 2 (ug/L)[1]	Average Annual Dissolved Zinc Loads: Santiago Hills II Stages 1 & 2 (lbs/year)[1]	California Toxics Rule Criteria[2] (µg/L)
A2	120~~100~~	0.6	210 (acute) 210 (chronic)
~~B2~~B2	59~~66~~	0.5~~3~~	
~~B3~~B3	37~~40~~	1.4~~2.9~~	
~~B4~~B4	35~~36~~	1.9~~2~~	
~~C1~~C1	42~~40~~	0.4~~3.5~~	

Emergent Marsh ID	Average Annual Dissolved Zinc Concentration: Santiago Hills II Stages 1 & 2 (ug/L)[1]	Average Annual Dissolved Zinc Loads: Santiago Hills II Stages 1 & 2 (lbs/year)[1]	California Toxics Rule Criteria[2] (µg/L)
~~C2~~C2	55~~32~~	0.5~~0~~	
~~C3~~C3	35~~40~~	0.9	
~~C4~~C4	33~~40~~	0.3~~8~~	
~~C5~~C5	33~~40~~	0.2~~4~~	
~~C6~~	~~38~~	~~0.2~~	
~~C7~~	~~35~~	~~0.1~~	
~~F2~~	~~40~~	~~0.5~~	

[1]Modeled concentrations and loads for developed conditions with PDFs.
[2]Hardness = 200 mg/L as $CaCO_3$ in Peters Canyon Reservoir

Table 7-22: Stream Gauge Information and Minimum Observed Hardness Values

Water Body	Gauge Location	Monitoring Agency	Number of Samples	Minimum Observed Hardness ($CaCO_3$)
Santiago Creek	0.6 miles downstream of Villa Park Dam (SOSE08)	USEPA	7	241
Peters Canyon Reservoir	PCR Intake Tower	Orange County	2	200
Irvine Lake	Irvine Lake Pipeline @ Irvine Park	IRWD	24	298

7.1.5 Total Dissolved Solids

Total dissolved solids (TDS) are not commonly of concern in runoff from urban development, but are of concern for the Project areas that are tributary to Peters Canyon Reservoir. Because the reservoir currently experiences flow-through only in response to major wet season events (most recently, the 1997-1998 El Nino event), concentrations of salts are accumulating in the reservoir over time (Flow Science, 2004b). As a result, high salinity levels exist within the reservoir. These conditions will continue to worsen in the future, even in the absence of development within the watershed, until there is a year when sufficient rainfall results in significant reservoir flushing. Given these waterbody-specific concerns, TDS is considered a pollutant of concern for Peters Canyon Reservoir, but not for Irvine Lake, Santiago Creek, or Villa Park Reservoir.

Table 7-23 shows the predicted average annual total dissolved solids (TDS) loads for the two final stages of development for the area tributary to Peters Canyon Reservoir. Average annual

TDS concentration results are shown in Table 7-24. Based on the modeling results, TDS loads and concentrations in stormwater runoff from the developed portion of the project area in each stage will decrease. Average annual TDS concentrations in stormwater runoff from the Peters Canyon Reservoir project area after treatment would range from 620~~690~~ mg/L for Stage 1 to 540~~580~~ mg/L for Stage 3, which is below the Basin Plan Water Quality Objective of 720 mg/L for Peters Canyon Reservoir and much less than the range of observed TDS concentrations of 3,000 to 4,200 mg/L (Table 7-25). PDFs targeting TDS include treatment controls such as extended detention basins, vegetated swales, bioretention areas, and source controls such as efficient irrigation systems.

In summary, due to compliance with the DAMP and as confirmed by comparison to the Basin Plan standards, TDS impacts to Peters Canyon Reservoir are insignificant.

Table 7-23: Average Annual TDS Loads

Modeled Area	Site Condition	Average Annual TDS Load: Santiago Hills II Stage 1 (tons)	Average Annual TDS Load: Santiago Hills II Stages 1 & 2 (tons)	Average Annual TDS Load: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (tons)
Peters Canyon Reservoir	Existing	110~~120~~	110~~120~~	110~~120~~
	Dev w/ PDFs	100	92~~100~~	66~~89~~
	Change	-10~~20~~	-18~~20~~	-44~~31~~

Table 7-24: Average Annual TDS Concentrations

Modeled Area	Site Condition	Average Annual TDS Concentration: Santiago Hills II Stage 1 (mg/L)	Average Annual TDS Concentration: Santiago Hills II Stages 1 & 2 (mg/L)	Average Annual TDS Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (mg/L)
Peters Canyon Reservoir	Existing	870~~890~~	870~~890~~	870~~890~~
	Dev w/ PDFs	620~~690~~	620	540~~580~~
	Change	-250~~200~~	-250~~270~~	-330~~310~~

Table 7-25: Comparison of Modeled TDS Concentrations with Water Quality Objective

Modeled Area	Average Annual TDS Concentration: Santiago Hills II Stage 1 (mg/L)[1]	Average Annual TDS Concentration: Santiago Hills II Stages 1 & 2 (mg/L)[1]	Average Annual TDS Concentration: Santiago Hills II Stages 1 & 2 and East Orange Area 1 (mg/L)[1]	Santa Ana Basin Plan Water Quality Objectives (mg/L)	Range of Observed Concentrations in PCR (mg/L)
Peters Canyon Reservoir	620690	620	540580	720	3000 - 4200

[1]Modeled concentration for developed conditions with PDFs.

7.2 Impact Assessment for Pollutants and Basin Plan Criteria Addressed Without Modeling

7.2.1 Turbidity

Turbidity is a measure of suspended matter that interferes with the passage of light through the water (Sawyer et al, 1994). The turbidity may be caused by a wide variety of suspended materials, which range in size from colloidal to coarse dispersions, depending upon the degree of turbulence. In lakes or other waters existing under relatively quiescent conditions, most of the turbidity will be due to colloidal and extremely fine dispersions. In rivers under flood conditions, most of the turbidity will be due to relatively coarse dispersions.

Turbidity may be caused by a wide variety of materials. Erosion of clay and silt soils may contribute to in-stream turbidity. Organic materials reaching rivers serve as food for bacteria, and the resulting bacterial growth and other microorganisms that feed upon the bacteria produce additional turbidity. Nutrients in runoff may stimulate the growth of algae, which also contribute to turbidity.

Discharges of turbid runoff are primarily of concern during the construction phase of development. Construction-related impacts are addressed in Section 7.6 below.

In the post-development condition, placement of impervious surfaces will serve to stabilize soils and to reduce the amount of erosion that may occur from the Project area, during storm events and will therefore decrease turbidity in the runoff from the Project area. Project PDFs include source control and treatment control BMPs in compliance with the requirements of the MS4 Permit and the DAMP/LIP. Based on implementation of the Project PDFs and the construction-related controls outlined in Section 7.6, runoff discharges from the Project should not cause increases in turbidity which would result in adverse affects to beneficial uses in the receiving waters. Based on these considerations, the impacts of the Project on turbidity are considered less than significant.

7.2.2 Pathogens

Pathogens are viruses, bacteria, and protozoa that can cause illness in humans. Identifying pathogens in water is difficult as the number of pathogens is exceedingly small requiring sampling and filtering large volumes of water. Traditionally water managers have relied on measuring "indicator bacteria~~pathogen indicators~~", such as total and fecal coliform, as an indirect measure of the presence of pathogens. Although such indicators were considered reliable for sewage samples, indicator organisms are not necessarily reliable indicators of viable pathogenic viruses, bacteria, or protozoa in stormwater because coliform bacteria, in addition to being found in the digestive systems of warm-blooded animals, are also found in plants and soil. Certain indicator bacteria~~pathogen indicators~~ can multiply in the field if the substrate, temperature, moisture, and nutrient conditions are suitable. In a review of the Los Angeles Basin Plan Administrative Record, Paulsen and List summarize the debate over the use of pathogenic indicators and point out that scientific studies show no correlation between pathogens and therefore may not indicate a significant potential for causing human illness (Paulsen and List, 2003). In a recent field study conducted by Schroeder et. al., pathogens (in the form of viruses, bacteria, or protozoa) were found to occur in 12 of 97 samples taken, but the samples that contained pathogens did not correlate with the concentrations of indicator organisms (Schroeder et. al. 2002).

There are numerous sources of indicator bacteria~~pathogen indicators~~, including birds and other wildlife, as well as domesticated animals and pets, soils, and plant matter. Anthropogenic sources, which are the focus of the Project PDFs, may include poorly functioning septic systems, cross-connections between sewer and storm drains, and the utilization of outdoor areas for human waste disposal by people without access to indoor sanitary facilities.

It is recognized that natural levels of bacteria area present~~The Orange County Public Health Laboratory conducting a monitoring study in 1998~~ in the project area receiving waters and that control of such natural ~~San Juan Creek watershed to help determine the~~ sources is not required nor desired ~~of pathogen indicators during dry weather conditions (Moore et al, 2002). Monitoring stations were located in the ocean, in creeks in the San Juan Creek watershed, and in storm drains. One finding of the study was that, "the highest concentrations of fecal coliforms and *Enterococcus* were found in the storm drains as compared to the creeks and ocean sampling sites. Samples taken from creek sites distant to human habitat also had low to moderate levels of bacteria, suggestive of fecal contamination~~ by regulatory agencies. For example, the ~~non-human sources". The recent draft of the~~ San Diego Basin RWQCB Bacteria-Impaired Waters TMDL intends to make provisions~~allow for a certain number of exceedances per year to account~~ for background levels of ~~in~~ bacteria associated with non-urban sources (SDRWQCB, 2004).

Data collected from ~~Because of the effects of wildlife on pathogen indicators, it is not uncommon to find exceedances of pathogen indicator standards in~~ undeveloped watersheds or watersheds with little development indicate that bacterial standards are often exceeded~~. Indeed, it is uncommon to not find occasional exceedances~~. For example, data obtained by Serrano Water District in Santiago Creek Reach 3 (upstream of Irvine Lake, a largely undeveloped watershed) on 3/17/03 shows a total coliform concentration of 80,000 MPN/100 mL (compared to MUN water quality criteria of 100 MPN/100 mL) and a corresponding concentration of fecal coliform of 700 MPN/100 mL (compared to REC 1 water quality criteria of 400 MPN/100 mL). USEPA has recognized that routine exceedances of ambient water quality criteria due to natural sources of pollution occur. In response, USEPA has recommended changes to designated uses as the most appropriate way to address these situations (Paulsen and List, 2003).

EPA has compiled an extensive database on stormwater data collected as part of its program to regulate stormwater (Pitt et al, 2003). These data were drawn from 65 programs in 17 states throughout the United States. The data indicate that median fecal concentrations range from about 4500 to 7700 MPN/100 mL for a range of commercial and residential land uses, compared to a median value of around 3000 MPN/100 mL for open space and vacant land. These data represent urban areas that in general do not have source and treatment controls, and therefore are not indicative of runoff from the proposed development. Also these data indicate that wildlife can be a very important source of pathogens and/or indicator bacteria~~pathogen indicators~~ such as fecal coliform. The proposed Project, by converting some open land use to urban land use, would potentially reduce the contribution of bacteria from terrestrial wildlife. On the other hand, waterfowl in Irvine Lake and PCR could be an important local source of fecal contamination which would not be affected by the Project. Additionally, another study, conducted by PBS&J in coastal watersheds near Laguna Beach in Orange County (PBS&J, 1999) found that indicator bacteria concentrations in receiving waters downstream from the developed/urban watersheds were not significantly different than concentrations in receiving waters downstream from undeveloped watersheds. These studies support the conclusion that the development of the proposed project is not expected to result in appreciably higher indicator bacteria levels in receiving waters relative to undeveloped conditions.

The major source of fecal coliforms from the Project would likely be pet wastes, and wildlife or vectors living in the storm drain itself. Other sources of pathogens and indicator bacteria~~pathogen indicators,~~ such as cross connections between sanitary and storm sewers, are unlikely given modern sanitary sewer installation methods and inspection and maintenance practices.

The levels of bacteria in runoff from the proposed project will be reduced by virtue of the following:

- Source Controls
- Extended Detention Basins with low-flow wetlands
- Bioretention Areas
- Natural Attenuation in Emergent Marshes, PCR, Irvine Lake, and Villa Park Reservoir

The most effective means of controlling pet wastes and wastes from human interaction with wildlife is through source control, specifically education of pet owners, education regarding feeding of waterfowl near waterbodies, providing products and disposal containers that encourage and facilitate cleaning up after pets, and storm drain cleaning practices. These and other litter control BMPs are described in Section 5 Project Design Features.

Although, there are limited data on the effectiveness of extended detention basins to treat indicator bacteria~~pathogen indicators~~, the treatment processes known to be occurring in extended detention basins involve sunlight (ultraviolet light) degradation, sedimentation, and infiltration, all of which can reduce pathogen levels. Many of the proposed detention basins are to be located on relatively infiltrative soils and pathogen removal by filtration is a common and effective practice in wastewater treatment. The Center for Watershed Protection maintains a National Pollutant Removal Performance Database that indicates that removal performance for various types of extended detention basins ranges between 70 to 80 percent (CWP, 2000).

In addition to treatment by extended detention, bioretention areas are proposed for common area landscaping in multifamily residential areas. Bioretention relies on infiltration for hydrologic control and filtration through the soil column for water quality treatment. Again, filtration is one of the more effective means of treating indicator bacteria~~pathogen indicators~~ (Table 5-2). The City of Austin, Texas conducted a number of studies on the effectiveness of sedimentation/filtration treatment systems for treating stormwater runoff (City of Austin, 1990; CWP, 1996). Most of the structures were designed to treat ½ inch of runoff. Data from four sand filters indicated a range of removals from 37 percent to 83 percent for fecal coliform, and 25 percent to 81 percent for fecal streptococci. Research on the use of filtration to remove bacteria also has been conducted in Florida by the Southwest Florida Water Management District (Kurz, 1999). Significant ($p<0.05$) reductions in total and fecal coliform bacteria and the other indicators were observed between inflow and outflow samples for sand filtration. Percent reductions were measured using flow-weighted sampling techniques. Total coliform bacteria removals were less than 70 percent, and fecal coliform bacteria reduction varied from 65 percent to 100 percent. In a literature summary, EPA reported typical pathogen removal for infiltration basins and trenches as 65 to 100 percent (USEPA, 1993).

Following treatment in the bioretention areas and extended detention basins, treated runoff in the North and South Tributary Areas will enter a series of emergent marshes connected by bioswales. Natural attenuation of bacteria also will occur in these areas as marshes generally exhibit bacteria attenuation between 80 - 99 percent (Kadlec and Knight, 1996). Regional monitoring data indicate that wetlands can be effective in treating pathogens. Although at a much larger scale than envisioned here, data from the last two years from the IRWD San Joaquin Marsh shows reduced ~~pathogen~~ indicator bacteria levels of about 50 percent during dry weather. Natural attenuation processes also will occur in the reservoirs (Peters Canyon Reservoir, Villa Park Dam, and Irvine Lake). Attenuation in Irvine Lake will further ensure that current bacteria levels in the raw water supply for the Serrano Water District's Walter E. Howiler, Jr. Filtration Plant (WHFP) and IRWD will not be increased by virtue of the project.

In summary, the proposed project, consistent with the DAMP/LIP requirements, includes a comprehensive set of source and treatment control PDFs selected to manage indicator bacteria. With this~~pathogen indicators. This~~ series of PDFs, the Project would not ~~will~~ result in appreciable changes in pathogen ~~bacteria~~ levels in the receiving waters compared to existing conditions, and potential water quality impacts related to pathogens~~that~~ are considered less than significant. ~~Additional attenuation of bacteria levels will occur as a result of natural processes that occur in PCR, Irvine Lake, and Villa Park Reservoir.~~

7.2.3 Hydrocarbons

Various forms of hydrocarbons (oil and grease) are common pollutants associated with urban runoff; however, these pollutants are difficult to measure and are typically measured with grab samples, making it difficult to develop reliable EMCs for modeling. Based on this consideration, hydrocarbons were not modeled but are addressed qualitatively.

Hydrocarbons are a broad class of compounds, most of which are non-toxic. Hydrocarbons are hydrophobic (low solubility in water), have the potential to volatilize, and most forms are biodegradable. A subset of hydrocarbons, Polynuclear Aromatic Hydrocarbons (PAHs) can be toxic depending on the concentration levels, exposure history, and sensitivity of the receptor organisms. Of particular concern are those PAHs compounds associated with transportation related combustion products.

The concentration of hydrocarbons is expected to increase slightly under post-development conditions, but the increase will not be significant due to treatment of stormwater runoff in the PDFs. This predicted increase results from the increase in roadways and vehicle use in the Project area. The Project PDFs are expected to prevent appreciable increases in hydrocarbon concentrations from occurring through removal of this pollutant. Because of the nature of the development (primarily residential), the major source of hydrocarbons will be from roads, driveways and parking areas. Source control PDFs that address petroleum hydrocarbons include educational materials on used oil programs, carpooling, and public transportation alternatives to driving; BMP maintenance; and street sweeping private streets and parking lots. Although vehicle emissions and leaks are the primary source of hydrocarbons in urban areas, it is anticipated that vehicles in the proposed development will in general be well maintained and newer models which will help to limit emissions and leaks. Lastly, the oil adsorption mats in the HSS units and vegetation and soils within the extended detention basins will adsorb and biodegrade the low levels of emulsified oils in stormwater runoff, preventing visible film in the discharge or the coating of objects in the receiving water.

The majority of PAHs in stormwater adsorb to the organic carbon fraction of particulates in the runoff, including soot carbon generated from vehicle exhaust (Ribes et al, 2003). For example, a stormwater runoff study by Marsalek et. al. (1997) found that the dissolved phase PAHs represented less than 11 percent of the total concentrations. Consequently extended detention basins, such as those proposed herein as PDFs, which are designed to treat pollutants through settling, adsorption, and biologically mediated processes, should be effective at treating PAHs.

Los Angeles County conducted PAH analyses on 27 stormwater samples from a variety of land uses in the period 1994 - 2000 (Los Angeles County, 2000). For those land uses where results above detection levels were sufficient to estimate statistics, the mean concentrations of individual PAH compounds ranged from 0.04 to 0.83 µg/L. The reported means were less than acute toxicity criteria available from the literature (Suter and Tsao, 1996). Moreover, the Los Angeles County data do not account for any treatment, whereas the treatment in the Project's PDFs should result in a reduction in hydrocarbon concentrations inclusive of PAHs.

The potential for bioaccumulation of hydrocarbons is low because of a strong tendency to bind to sediments. The data indicate that the sediments in the bottom of the reservoirs are highly organic, and therefore suitable for providing sorption sites for organic compounds that have a high binding capacity such as PAHs. Moreover the bioavailability of sediment-associated PAHs has been shown to decline with increased contact time (USEPA, 2000a and 200b). The implication of this observation is that the compounds become more tightly bound with increased contact time.

This makes it very unlikely that impacts will occur to receiving waters due to hydrocarbon loads or concentrations. On this basis, the effect of the Project on petroleum hydrocarbon levels in local water bodies is considered less than significant.

7.2.4 Pesticides

Pesticides can be of concern where past farming practices involved the application of persistent organochlorine pesticides, including DDT. This project does not include past land uses that would involve intensive agriculture and pesticide applications. The focus therefore is on the post-development condition, where pesticides will be applied to common landscaped areas and residential lawns and gardens. Pesticides that have been commonly found in urban streams include the organophosphate pesticides chlorpyrifos and diazinon (Katznelson and Mumley, 1997). USEPA has recently banned the pesticides diazinon and chlorpyrifos (commonly used urban pesticides) for most urban applications. USEPA agreed to phase out and cancel all residential uses of diazinon in December 2000. All outdoor residential use product registrations must be cancelled and retail sale must end by December 31, 2004 (USEPA, 2004b). USEPA banned virtually all homeowner uses of chlorpyrifos in June 2000, except ant and roach baits in child resistant packaging (USEPA, 2002). Per the USEPA mandate, these pesticides will not be used for landscape maintenance in the post-development conditions of the Project.

Source control measures such as education programs for owners, occupants, and employees in the proper application, storage, and disposal of pesticides are the most promising strategies for controlling the pesticides that will be used post-development. Structural controls are typically not as effective due to the persistent nature of many pesticides; also these compounds generally exhibit varied potential for biodegradation. However, most pesticides are relatively insoluble in water and therefore tend to adsorb to the surfaces of sediment, which may settle out of the water column in the extended detention basins. Sedimentation should achieve some removal of pesticides from stormwater in the PDFs as TSS is reduced, as indicated in Section 7.1.2.

While pesticides are subject to degradation, they vary in how long they maintain their ability to eradicate pests. Some break down almost immediately into nontoxic byproducts, while others can remain active for longer periods of time. While pesticides that degrade rapidly are less likely to adversely affect non-targeted organisms, in some instances it may be more advantageous to apply longer-lasting pesticides if it results in fewer applications or smaller amounts of pesticide use. Careful consideration will be made as to the appropriate type of pesticides for use on and around non-single family homes of the Project site. While some increase in pesticide use is likely to occur as the result of development due to maintenance of landscaped areas, particularly in the residential portions of the development, careful selection, storage and application of these chemicals for use in common areas will help prevent water quality impacts from occurring. Additionally, removal of sediments in the PDFs will also remove sediment-adsorbed pesticides.

The potential for bioaccumulation of pesticides, discussed in Section 7.7.3 below, is low because of the strong tendency to bind to sediments. For example, chlorpyrifos tends not to remain in aqueous solution or suspension but tends to bind to the organic and clay fractions of sediments (USEPA, 2000). The data indicate that the sediments in the bottom of the reservoirs are highly organic, and therefore suitable for providing sorption sites for organic compounds that have a high binding capacity.

Based on the incorporation of site design, source control, and treatment control BMPs recommended by the DAMP/LIP, potential impacts associated with pesticides are predicted to be less than significant.

7.2.5 Trash and Debris

Urban development tends to generate significant amounts of trash and debris. Trash refers to any human-derived materials including paper, plastics, metals, glass and cloth. Debris is defined as any organic material transported by stormwater, including leaves, twigs, and grass clippings (DLWC, 1996). Debris can be associated with the natural condition. Trash and debris is often characterized as material retained on a 5-mm mesh screen. It contributes to the degradation of receiving waters by imposing an oxygen demand, attracting pests, disturbing physical habitats, clogging storm drains and conveyance culverts and mobilizing nutrients, pathogens, metals, and other pollutants that may be attached to the surface. Sources of trash in developed areas can be both accidental and intentional. During wet weather events, gross debris deposited on paved surfaces can be transported to storm drains, where it is eventually discharged to receiving waters. Trash and debris can also be mobilized by wind and transported directly into waterways. Trash and debris can also be mobilized by wind and transported directly into waterways. Trash and debris can impose an oxygen demand on the water body as organic matter decomposes.

Urbanization could significantly increase trash and debris loads if left unchecked. However, the Project PDFs, including source control and treatment BMPs, will minimize potential adverse impacts from trash and debris. Source controls such as street sweeping, public education, fines for littering, and storm drain stenciling can be effective in reducing the amount of trash and debris that is available for mobilization during wet and dry weather events. Common area litter control will include a litter patrol, covered trash receptacles, emptying of trash receptacles in a timely fashion, and noting trash violations by tenants/homeowners or businesses and reporting the violations to the owner/HOA for investigation. Catch basin inserts will be provided for parking lots. The extended detention basins will have trash racks to prevent entry of larger materials into the structural BMPs in order keep maintenance costs in check (i.e., it is easier to remove trash from racks as opposed to the extended detention basins themselves). The Project's PDFs will prevent or remove floating materials, including solids, liquids, foam, or scum, from runoff discharges and will prevent impacts on dissolved oxygen in the receiving water due to decomposing debris. The proposed HSS units are effective at trapping trash and debris. Based on these considerations, trash and debris from the Project is not expected to significantly impact the receiving waters of the Project.

7.3 Summary

Post-development runoff volume is predicted to increase on average to PCR for Stage 1 and Stage 2. ~~, Santiago Creek, and Irvine Lake.~~ This will have the effect of slightly increasing water levels in PCR, but not sufficiently to cause an increase in peak outflows to Handy Creek or to require drawing down the reservoir for mosquito control. The increase in runoff volume will also reduce TDS concentrations in the reservoir. By Stage 3, post-development runoff volumes are predicted to slightly decrease (below existing conditions) to PCR due to grading that will divert tributary area away from the lake. For all stages of the project, runoff volumes are predicted to increase to Santiago Creek and Irvine Lake. The increased volume into Santiago Creek is negligible given the size of the watershed contributing flow to Santiago Creek, compared to the propose size of the project development. Moreover Santiago Creek is a broad, braided stream with large cobbles and boulders and therefore is quite stable and would strongly resist erosion and downcutting. The volume increase to Irvine Lake is very small ~~compared to the volume of water~~ in the context of the overall water balance for Irvine Lake.

With the exception of TSS and TDS, loads of the modeled pollutants are predicted to increase under proposed conditions when compared to existing conditions for the total project area. TDS, as mentioned above, will be ~~slightly~~ reduced in PCR during all stages because of the increased ~~increase~~ volume. TDS in Santiago Creek and Irvine Lake will remain unchanged given the flows and volume of water in the creek and lake, respectively.

TSS loads to PCR will be reduced, but these loads are small compared with loads associated with stream erosion. The main factor affecting sedimentation in PCR has been historical incision caused by increased runoff from off-site development. The reduction in TSS loads therefore will have little effect on sedimentation in PCR. Loads to Santiago Creek are projected to increase, but the absolute increase is small compared to existing sediment transport in Santiago Creek and is below levels commonly observed in stormwater runoff. TSS loads to Irvine Lake are projected to remain about the same. Concentrations of both TSS and TDS are predicted to decrease to all receiving waters and are bellow applicable numeric water quality criteria.

Nutrient load changes are most important for the limiting nutrient (namely nitrogen) and for the inorganic forms of nitrogen (e.g., nitrate) compared to the forms that are primarily organic (e.g., TKN). Nitrate loads to PCR are projected to decrease, whereas TKN loads are projected to increase. Approximately 20 percent of the TKN loads are inorganic (ammonia) which is bioavailable. Flow Science modeling of water quality in PCR has indicated that these load changes do not significantly affect the algal dynamics and DO compared to the pre-development case. Loads to Santiago Creek and ultimately VPD are projected to increase for both nitrate and TKN. Although these load increases are relatively large for the project area, the absolute increases are likely to be small given the size of the Santiago Creek and VPD watershed (about 55,000 acres) compared to the size of the portion of the Project that is tributary to Santiago Creek (about 659~~615~~ acres, or about 1 percent of the total watershed). Moreover, runoff from undeveloped vegetated watersheds have nutrient loads that can be comparable or even larger than loads from urbanized areas. Nutrient loads to Irvine Lake also increase for all constituents, but again the increases are small compared to load contributions from the overall watershed which has an area of approximately 63.1~~62~~ square miles. Mean concentrations of nitrates area predicted to decrease and all nutrient concentrations are bellow applicable numeric water quality criteria for all receiving waters.

Trace metal loads (i.e., loads for copper, lead, and zinc) to PCR are relatively unchanged. Loads to Santiago Creek do increase, but again on a watershed scale, the increase is considered small. Loads to Irvine Lake also increase but again the project loads are likely to be small compared to other sources in the watershed. Concentrations of dissolved copper and zinc are predicted to decrease and all metal concentrations are predicted to be below applicable numeric water quality criteria for all receiving waters.

There is concern that increased loads could lead to accumulation of contaminants in the sediments and ultimately re-introduction into the food chain and bioaccumulation. However, the water and sediment conditions in PCR would appear to promote coagulation and settling, and sequestering of organic compounds and trace metals in the rich organic bottom sediments. Bioaccumulation in Irvine Lake is remote given the magnitude of loads and the fact that Irvine Lake is well flushed by comparison to PCR. Villa Park Reservoir also has a reasonable "thru flow" which will limit the potential for bioaccumulation.

~~Mean concentrations are predicted to decrease for total suspended solids, nitrates, dissolved zinc, and total dissolved solids. The modeled concentrations in runoff from developed areas with PDFs are below all applicable numerical water quality criteria.~~

Concentrations of hydrocarbons and pesticides are expected to increase, while concentrations of ~~pathogens and~~ trash and debris may increase under proposed conditions when compared to existing conditions, and concentrations of pathogens are not expected to appreciably change. None~~but none~~ of the qualitatively assessed pollutants are expected to significantly impact receiving waters due to the implementation of the Project PDFs in compliance with the MS4 Permit and the DAMP/LIP. Therefore potential impacts from the Project on receiving water quality and beneficial uses are not expected to be significant.

7.4 MS4 Permit Requirements for New Development as Defined in the DAMP

Project PDFs include site design, source control, and treatment control BMPs in compliance with the requirements of the Orange County NPDES Permit (Order No. R8-2002-0010) and the City of Orange LIP. As described in the Regulatory Setting (Section 3), the MS4 Permit requires that discharges from MS4s shall not cause or contribute to exceedances of receiving water quality standards, and also contains MEP, BAT and BCT technology standards.

The principal objective of Site Design BMPs is to prevent pollution of stormwater by minimizing the introduction of pollutants and conditions of concern that may result in significant impacts generated from site runoff to the storm water conveyance system. One approach to achieve this objective is to reduce stormwater runoff flows and volumes and reduce pollutants through appropriate Site Design BMPs. The City of Orange LIP requires that Site Design BMPs be considered for all projects. Site Design BMPs included in the Project are listed in Table 7-26.

Table 7-26: Implementation of Site Design BMPs

CITY OF ORANGE LIP SITE DESIGN BMP TECHNIQUES	PROJECT PDF
1. Minimize Impervious Area/Maximize Permeability (C-Factor Reduction).	• Minimize impervious areas by incorporating landscaped areas over substantial portions of the Project. Single family residential landscape areas will be determined by zoning agreements, village setback/parkway standards, and design objectives. • Utilize vegetated areas, e.g., setbacks, end islands, and median strips, for biofiltration and bioretention of nuisance and storm runoff flows from parking lots. • Increase building density (number of stories above or below ground; build up rather than out). • Construct streets, sidewalks, and parking lot aisles to the minimum widths specified in the City Land Use Code and in compliance with regulations for the Americans with Disabilities Act and safety requirements for fire and emergency vehicle access.
2. Minimize Directly Connected Impervious Areas (DCIAs) (C-Factor Reduction).	• Minimize directly connected impervious area by draining parking lots to landscaped areas or bioretention facilities to promote filtration and infiltration of stormwater, if landscaping slopes are less than 2 percent and the project is not adjacent to steep slopes; or treat with catch basin inserts. • Use natural drainage systems to the maximum extent practicable or create drainages (e.g., vegetated swales) that mimic natural conveyances and allow for stormwater infiltration as well as pollutant removal. • Maximize canopy interception and water conservation by preserving existing native trees and shrubs in natural open space areas and including native or drought tolerant plants in development plant palettes per project WQMP.

CITY OF ORANGE LIP SITE DESIGN BMP TECHNIQUES	PROJECT PDF
3. Create Reduced Discharge Areas (Runoff Volume and Pollutant Reduction).	• Select building material for roof gutters and downspouts that do not include copper or zinc. • Construct onsite detention facilities to increase opportunities for settling of pollutants and infiltration. Bioretention areas, multiple extended detention basins, and vegetated swales will promote reduced runoff volumes. • Protect slopes: minimize erosion potential with vegetative cover, route flows safely from or away from steep and or sensitive slopes, stabilize disturbed slopes. • Protect channels: control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems, stabilize channel crossings, ensure that increases in runoff velocity and frequency caused by the Project do not erode the channel, install energy dissipaters, such as riprap, at the outlets of storm drains or conveyances.
4. Conserve Natural Areas (C-Factor Reduction).	• Preserve existing riparian areas along Santiago Creek. • Preserve 699~~633~~ acres of open space within the development (non-impact areas). • Preserve 1,105~~092~~ acres of open space within the Project boundary outside of the development (preserved open space). • Concentrate or cluster development on the least environmentally sensitive portions the Project site while leaving the remaining land in a natural, undisturbed condition.

The City of Orange LIP requires Priority Projects to implement all Source Control BMPs (routine non-structural and routine structural) unless not applicable to the project. Routine structural Source Control BMPs are low-technology practices designed to prevent pollutants from contacting stormwater runoff or to prevent discharge of contaminated runoff to the storm drainage system. Routine non-structural Source Control PDFs included in the Project are listed in Table 7-27. Routine structural Source Control PDFs are listed in Table 7-28.

Table 7-27: Routine Non-Structural Source Control PDFs

Identifier	Name	Check One		If not applicable, state brief reason
		Included	Not Applicable	
NI	Education for Property Owners, Tenants, and Occupants	X		
N2	Activity Restrictions	X		

Identifier	Name	Check One		If not applicable, state brief reason
		Included	Not Applicable	
N3	Common Area Landscape Management	X		
N4	BMP Maintenance	X		
N5	Title 22 CCR Compliance (How development will comply)		X	No industrial/commercial development
N6	Local Water Quality Permit Compliance		X	No fuel dispensing areas
N7	Spill Contingency Plan		X	No industrial/commercial development
N8	Underground Storage Tank Compliance		X	No underground storage tanks
N9	Hazardous Materials Disclosure Compliance		X	No industrial/commercial development
N10	Uniform Fire Code Implementation		X	No industrial/commercial development
N11	Common Area Litter Control	X		
N12	Employee Training		X	No industrial/commercial development
N13	Housekeeping of Loading Docks		X	No industrial/commercial development
N14	Common Area Catch Basin Inspection	X		
N15	Street Sweeping Private Streets and Parking Lots	X		
N17	Retail Gasoline Outlets		X	No retail gasoline outlets

Table 7-28: Routine Structural Source Control PDFs

Name	Check One		If not applicable, state brief reason
	Included	Not Applicable	
Provide Storm Drain System Stenciling and Signage	X		
Design Outdoor Hazardous Material Storage Areas to Reduce Pollutant Introduction		X	No industrial/commercial development

Name	Check One		If not applicable, state brief reason
	Included	Not Applicable	
Design Trash Storage Areas to Reduce Pollutant Introduction	X		
Use Efficient Irrigation Systems and Landscape Design	X		
Protect Slopes and Channels	X		
Requirements Applicable to Individual Project Features			
Loading Dock Areas		X	No industrial/commercial development and no retail gasoline outlets
Maintenance Bays		X	
Vehicle Wash Areas		X	
Outdoor Processing Areas		X	
Equipment Wash Areas		X	
Fueling Areas		X	
Hillside Landscaping	X		
Wash Water Controls for Food Preparation Areas		X	No outdoor food preparation areas
Community Car Wash Racks		X	No multi-family housing

Treatment control PDFs include HSS units, treatment swales, extended detention basins, and bioretention areas in seven drainage series that will treat runoff from all urban areas of the Project. Sizing criteria contained in the MS4 Permit and the DAMP will be met for the treatment systems. The proposed water quality PDFs were sized and configured to capture 80 percent or more of the average annual runoff volume as determined by a hydrologic model (see Appendix C for further detail). This is equivalent to capturing the volume of annual runoff based on the unit basin storage volume, to achieve 80 percent or more volume treatment by the method recommended in California Stormwater Quality Association (CASQA) Stormwater Best Management Practice Handbook: New Development and Redevelopment (2003).

In summary, the proposed site design, source control, and treatment control PDFs have been selected for each source area based on:

- effectiveness for treating pollutants of concern, resulting in insignificant water quality impacts,
- sizing and outlet design consistent with the DAMP requirements,
- additional design guidance consistent with the California BMP Handbook: New Development and Redevelopment, other literature, and best professional judgment,
- hydrologic and water quality modeling to verify performance,
- meeting mean annual percent capture criteria contained in the California BMP New Development Manual, and
- providing specific O&M requirements to inspect and maintain the facilities.

On this basis, the proposed PDFs meet the MS4 Permit requirements for new development.

7.5 Dry Weather Impacts

The above discussion focused on the changes in hydrology and water quality during storm events. However, hydrologic and water quality effects during dry weather conditions also are important, especially given that much of the dry weather flows in this region are of anthropogenic origin.

7.5.1 Dry Weather Flow Quantity

The quantity of dry weather flows from urban sources such as private car washing and excess irrigation is variable and not easily quantifiable. Literature indicates a wide range of dry weather discharges. Information from IRWD suggests an average dry weather flow from urban areas of 0.130 gallons per minute (gpm) per acre (IRWD, 2004). Hamilton (2000) assumed dry weather flows of 0.15 gpm per acre in a water balance study for Orange County. Reeves et al. (2004) reported dry weather flows in residential catchments in Orange County ranging from 0.035 to 0.63 gpm per acre. Dry weather flow estimates in Santa Monica indicated a range of flows between 0.037 and 0.081 gpm per acre.

Dry weather flows were estimated for the Project using measured data collected as part of the IRWD Residential Runoff Reduction (R3) Study. This study included five residential catchments ranging in area from about 60-180 acres located in the Northwood Village in the City of Irvine. These data are therefore representative of the climate and type of development envisioned for the proposed project. The five catchments consisted of three control catchments, a catchment where public education on irrigation control practices was applied, and a retrofit catchment where education plus ET irrigation controllers were applied. In the retrofit catchment, approximately 20% of the residents agreed to use the ET controllers; ET controllers also were installed at 26 common area landscaping sites. The data used to estimate dry weather flows herein are from the retrofit catchment. An analysis of the frequency distribution of daily flows for the period from November 2000 to December 2002 is presented in Appendix G.

These results were used to estimate the dry weather flows from the single family residential land uses in the proposed project. The dry weather discharge rate for multi-family land use areas was assumed to be one-half of the single family rate, while the rate for commercial land use areas was assumed to be one-tenth of the single family rate. No dry weather flows were assumed to occur in open space, park, and school land use areas. These assumptions are conservative in that estimates of dry weather flows provided herein are likely to be higher than will actually ~~will~~ occur in the Project, where installation of advanced irrigation controllers will be more complete than achieved in the retrofit catchment.

The median (50th percentile) estimated dry weather Project flows, based on the 26-month study period, are summarized by drainage area in Table 7-29. These estimated flows are very low and therefore will likely infiltrate in the treatment PDFs and/or emergent marshes and vegetated swales. Therefore, little if any dry weather flows are predicted to leave the Project area and effects on habitat and erosion of natural drainages is projected to be less than significant.

Table 7-29: Estimated Dry Weather Flows

Subwatershed Area	Natural Drainage	Median Estimated Flow (gpm)	Median Estimated Flow (cfs)
A	South Tributary	0.9~~8~~	0.002
A	North Tributary	8.4~~7~~	0.019
B & D	Overland Drainage Area within Irvine Regional Park	4.1~~0~~	0.009
C	ETC-9	2.3~~4~~	0.005
E	Woody's Drainage	1.3~~6~~	0.003

7.5.2 Dry Weather Flow Quality

Because little if any dry weather flows are expected to leave the proposed project boundaries, the focus of the dry weather flow water quality assessment is on the emergent marshes and PDFs inside the project boundaries. Dry weather flows are typically low in sediment because the flows are relatively low and coarse suspended sediment tends to settle out or is filtered out by vegetation. As a result~~consequence~~, pollutants that tend to be associated with suspended solids (e.g., phosphorus, some trace metals, and some pesticides) are typically found in very low concentrations in dry weather flows. Therefore, the focus is~~The focus of this discussion is therefore~~ on pollutants that tend to be dissolved (~~,~~ e.g., nitrate and trace metals, or pollutants that are associated with fine particulates that are ~~as small as to be~~ effectively transported, such as indicator bacteria).
~~e.g., pathogens and oil and grease.~~

In order to minimize the potential generation and transport of dissolved pollutants, landscaping in public and common areas will utilize native vegetation that requires little watering and chemical application. Landscape watering in common areas will be controlled utilizing evapotranspiration sensors to minimize excess watering. In addition, educational programs and materials will emphasize appropriate car and equipment washing locations (on pervious surfaces) and techniques (minimizing usage of soap and water), encourage low impact landscaping and appropriate watering techniques, and discourage driveway and sidewalk washing in accordance with County and City ordinances. Fertilizer and pesticide usage in most common areas will be consistent with County Management Guidelines for Use of Fertilizers (DAMP Section 5.5) or the

City equivalent. Also, slow release, high quality fertilizers will be utilized that result in a 25 percent reduction in fertilizer application to multi-family residential and park land use areas and fertilizer application will not be allowed between October 15th and April 1st. Illegal dumping will be discouraged by stenciling storm drain inlets and posting signs that illustrate the connection between the storm drain system and the receiving waters and natural systems downstream.

The extended detention basins will also incorporate wetland vegetation in a low-flow channel along the bottom of the basin for the treatment of dry weather flows and small storm events. Water cleansing is a natural function of wetland vegetation, offering a range of treatment mechanisms. Sedimentation of particulates is the major removal mechanism. However the performance is enhanced as plant materials allow pollutants to come in contact with vegetation and soils containing bacteria that metabolize and transform pollutants, especially nutrients and trace metals. Plants also take up nutrients in their root system. Some pathogens would be removed through ultraviolet light degradation. Any oil and grease will be effectively adsorbed by the vegetation and soil within the low-flow portion of the extended detention basin. Dry weather flows and small storm flows will tend to infiltrate into the bottom of the basin after receiving treatment in the low-flow wetland vegetation. The extended detention basins will not be designed to have open pools of standing water.

The principal anthropogenic sources of pathogens into dry weather flows is leaking septic systems, cross-connections between sanitary sewers and storm drains, or leakage from the sanitary sewer system into groundwater, which feeds the dry and non-storm flows. However, the Santiago Hills II and East Orange Area 1 Project will be new development with new storm drains and sanitary sewer systems, which is expected to have minimal if any leakage. Proper design, inspection during the installation of the sanitary sewer, and control of significant fat/oil/grease (FOG) from various sources (e.g., food services) -will ensure the absence of leaks or overflows from the sanitary sewer system into the MS4 system.

7.5.3 Summary

On this basis, Project impacts related to dry weather runoff on hydrology and water quality are adequately controlled and are considered less than significant.

7.6 Construction-Related Impacts

The potential impacts of construction on water quality focus primarily on sediments (TSS and turbidity) and pollutants that might be associated with sediments (e.g., phosphorus). Although not a pollutant of concern, selenium is elevated in the Chino Soil series located in the heart of the historic “Swamp of the Frogs” in the neighboring San Diego Creek watershed (Meixner et. al., 2004). This area, located around the confluence of Peters Canyon Wash and San Diego Creek, is hypothesized as the historical location of a peat bog where reducing conditions resulted in sequestering and concentrating selenium. With development and drainage of the swamp, ground water levels have been reduced such that oxygen has been allowed to enter previously reduced hydric soils, mobilizing the selenium (Meixner et. al., 2004). Under these conditions, recharge water leaches selenium from the Chino soils in the vadose zone and carries the selenium into the groundwater, which then can enter surface waters through springs and shallow groundwater interflow. No comparable conditions are known to exist in the Project Area, and therefore the potential for increased selenium discharges associated with construction activities is considered less than significant.

Construction-related activities that are primarily responsible for sediment releases are related to exposing soils to potential mobilization by rainfall/runoff and wind. Such activities include removal of vegetation from the site, grading of the site, and trenching for infrastructure improvements. Environmental factors that affect erosion include topographic, soil, and rainfall characteristics. Non sediment-related pollutants that are also of concern during construction relate to construction materials and non-stormwater flows and include waste construction materials; chemicals, liquid products, and petroleum products used in building construction or the maintenance of heavy equipment; and concrete-related waste streams.

Construction impacts will be minimized through compliance with the Construction General Permit. This permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP), which must include erosion and sediment control BMPs that will meet or exceed measures required by the Construction General Permit, as well as BMPs that control the other potential construction-related pollutants. A SWPPP will be developed as required by, and in compliance with, the Construction General Permit and City of Orange Standard Conditions. Erosion control BMPs are designed to prevent erosion, whereas sediment controls are designed to trap sediment once it has been mobilized. The General Permit requires the SWPPP to include a menu of BMPs to be selected and implemented based on the phase of construction and the weather conditions. BMPs to be included in this menu include, among others: slope stabilization using rock or vegetation, re-vegetation, hydro-seeding or using tackifiers on exposed areas, installation of energy dissipators, drop structures, catch basin inlet protection, construction materials management, and cover and containment of construction materials and wastes.

The SWPPP will be designed and implemented to address site-specific conditions related to Project construction. The SWPPP will identify the sources of sediment and other pollutants that may affect the quality of storm water discharges and describe and ensure the implementation and maintenance of BMPs to reduce or eliminate sediment and other pollutants in storm water as well as non-storm water discharges. The Project will exceed the Construction General Permit minimum requirements by installing and maintaining temporary desilting basins designed to accommodate at least a 10-year storm, releasing the storm volume over a 24 to 48 hour period. Through maintenance of the basins, the construction contractor shall ensure that the sediment capacity of the basins remain at 50 percent or greater of their design sediment capacity.

The significance criterion during the construction phase of the Project is the implementation of Best Management Practices consistent with Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology (BAT/BCT), as required by the Construction General Permit and Section 8 of the DAMP. The Project will reduce or prevent erosion and sediment transport and transport of other potential pollutants from the Project site during the construction phase through preparation of a SWPPP and implementation of BMPs meeting BAT/BCT in order to prevent or minimize environmental impacts and to ensure that discharges during the construction phase of the Project will not cause or contribute to any exceedance of water quality standards in the receiving waters. Construction on the Project site may require dewatering. For example, dewatering may be needed if water has been standing on-site and needs to be removed for construction, vector control or other reasons. Further, dewatering may be necessary if groundwater is encountered during grading, or to allow discharges associated with testing of water lines, sprinkler systems and other facilities.

In general, the General Construction Permit authorizes construction dewatering activities and other construction related non-stormwater discharges as long as they (a) comply with Section A.9 of the General Permit, (b) do not cause or contribute to violation of any water quality standards, (c) do not violate any other provisions of the General Permit, (d) do not require a non-stormwater permit as issued by some RWQCBs, and (e) are not prohibited by a Basin Plan provision. Full compliance with applicable local, state and federal water quality standards by the applicant would assure that potential impacts from dewatering discharges would be mitigated fully.

The Project will implement an additional project design feature to protect receiving waters from dewatering and construction related non-storm water discharges. Such discharges will be implemented in compliance with the General Waste Discharge Requirements issued by the Santa Ana Regional Water Quality Control Board under Order No. 98-67-0007, NPDES No. CAG998001 (WDRs). These WDRs include provisions requiring notification, testing and reporting of construction related non-storm water discharges associated with dewatering and other construction activities. Compliance with these WDRs constitutes a PDF for the Project, further assuring that the impacts of these discharges are fully mitigated.

On this basis, the impact of construction-related runoff from the Project is considered less than significant.

7.7 Other Considerations

7.7.1 Operation and Maintenance

Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. The City of Orange will maintain Extended Detention Basin E. The City and the Water Districts will have the right, but not the duty, to inspect and maintain the other BMPs at the expense of the HOA if they are not being properly maintained by the HOA. Caltrans will assume responsibility for the inspection and maintenance of ~~The County is proposed to maintain~~ Extended Detention Basins 2A, 2B,~~Basin 6A. An amendment of the IRWD Natural Treatment System (NTS) Master Plan will be requested that would alter these maintenance responsibilities for some or all of the extended detention basins. If IRWD approves an amendment to the NTS Master Plan to incorporate some or all of the basins into the Master Plan and O&M program, then IRWD will own~~ and HR1 as well as Vegetated Swales S1 and S2. ~~maintain those basins that are incorporated.~~

Table 7-30 lists the agency responsible for operation and maintenance (O&M) activities for the treatment control PDFs, water features, and flood control facilities and the frequencies at which O&M activities will be conducted.

Table 7-30: Water Quality, Mitigation, and Flood Control Operation and Maintenance Responsibility

Treatment Control BMP/ Feature Type	Function	BMP/ Feature ID	Entity Responsible for Long-Term Maintenance/ Funding	Operation & Maintenance Category	Activities	Frequency	Typical Maintenance Equipment
Extended Detention Basin	Water Quality Treatment Control	2A 2B HR1~~6A~~	• Caltrans will be responsible for the inspection and maintenance of the basin that are within their right of way. ~~• Orange County~~ ~~• Basin 6A is located within the NCCP reserve area. NCCP restrictions will apply to maintenance of this facility.~~ • ~~An amendment of the IRWD Natural Treatment System (NTS) Master Plan will be requested that would alter these maintenance responsibilities for this extended detention basin and others. If IRWD approves an amendment to the NTS Master Plan to incorporate some or all of the basins into the Master Plan and O&M program, then IRWD will own and maintain those basins that are incorporated.~~	Routine Facility Maintenance	• Facility inspection • Trash and debris removal • Minor sediment removal • Vector Control	• Annually prior to wet season. • After major storm events (>0.75 in/24 hrs) if spot checks of some basins indicate widespread damage/ maintenance needs. • Remove minor sediment accumulation from inlet or outlet when affecting inlet/outlet conditions.	• Pickup truck • Stakebed truck • Backhoe/ dump truck
		E	• City of Orange				
		A1 B1 C1 C2 C8 ~~D~~ ~~F1~~ G1 G2 G3 F2 6A1 6A2~~H1~~	• Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. • The City will have the right, but not the duty, to inspect and maintain the BMPs if they are not being properly maintained by the HOA, at the expense of the HOA. • An amendment of the IRWD Natural Treatment System (NTS) Master Plan will be requested that would alter these maintenance responsibilities for some or all of the extended detention basins. If IRWD approves an amendment to the NTS Master Plan to incorporate some or all of the basins into the Master Plan and O&M program, then IRWD will own and maintain those basins that are incorporated.	Vegetation/ Landscape Maintenance	• Integrated Pest/Plant Management • Minor Vegetation Removal/ Thinning • Irrigation System Adjustment	• Monthly (or as dictated by agreement between HOA and landscape contractor)	• Pickup truck • Stakebed truck

Treatment Control BMP/ Feature Type	Function	BMP/ Feature ID	Entity Responsible for Long-Term Maintenance/ Funding	Operation & Maintenance Category	Activities	Frequency	Typical Maintenance Equipment
		6D1 6D2 J 6G	• Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. • The City and the Water Districts will have the right, but not the duty, to inspect and maintain the BMPs if they are not being properly maintained by the HOA, at the expense of the HOA. • These basins are outside of the current IRWD service area. If the service area is amended to incorporate East Orange Area 1, an amendment of the IRWD Natural Treatment System (NTS) Master Plan will be requested that would alter these maintenance responsibilities for some or all of the extended detention basins. If IRWD approves an amendment to the NTS Master Plan to incorporate some or all of the basins into the Master Plan and O&M program, then IRWD will own and maintain those basins that are incorporated.	Major Maintenance	• Structural repairs • Major vegetation removal/ planting • Major sediment removal	• As needed (infrequently) • Major sediment removal as needed; approximately every 10 years for basins not preceded by HSS unit, every 20 years for basins preceded by HSS unit.	• Pickup truck • Backhoe/ dump truck • Crane/crew truck
Hydrodynamic Separator Systems	Water Quality Treatment Control	CDS-A2 CDS-B3 CDS-C1 CDS-C3 ~~CDS-C4~~ ~~CDS-E~~ CDS-F2 ~~CDS-G1~~ ~~CDS-G2~~ CDS-6A	• Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. • The City will have the right, but not the duty, to inspect and maintain the other BMPs if they are not being properly maintained by the HOA, at the expense of the HOA.	Routine Facility Maintenance	• Facility inspection • Trash, debris, and sediment removal • Vector Control	• Inspect quarterly until accumulation of trash, debris, and sediment in unit is known. • Cleanout of solids within the unit's sump should occur at 75% of the sump capacity.	• Pickup truck • Vactor truck
				Major Maintenance	• Structural repairs	• As needed (infrequent)	• Crane/crew truck
Treatment Swales	Water Quality Treatment Control	VS-G1	• Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. • The City will have the right, but not the duty, to inspect and maintain the other BMPs if they are not being properly maintained by the HOA, at the expense of the HOA.	Routine Facility Maintenance	• Facility inspection • Trash and debris removal • Minor sediment removal • Vector Control	• Annually prior to wet season. • After major storm events if spot checks of some basins indicate widespread damage/ maintenance needs. • Remove minor sediment accumulation from inlet or outlet when affecting inlet/outlet conditions.	• Pickup truck

Treatment Control BMP/ Feature Type	Function	BMP/ Feature ID	Entity Responsible for Long-Term Maintenance/ Funding	Operation & Maintenance Category	Activities	Frequency	Typical Maintenance Equipment
		VS-S1 VS-S2	• Caltrans will be responsible for the inspection and maintenance of the swales that are within their right of way.	Vegetation/ Landscape Maintenance	• Integrated Pest/Plant Management • Minor Vegetation Removal/ Thinning	• Monthly (or as dictated by agreement between HOA and landscape contractor)	• Pickup truck • Stakebed truck
				Major Maintenance	• Major vegetation removal/ planting • Major sediment removal	• As required (annually or less frequently)	• Pickup truck • Stakebed truck
~~Treatment Swales~~	~~Water Quality Treatment Control~~	~~VS-G1~~ ~~VS-H1~~	~~• Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries.~~ ~~• The City will have the right, but not the duty, to inspect and maintain the other BMPs if they are not being properly maintained by the HOA, at the expense of the HOA.~~	~~Routine Facility Maintenance~~	~~• Facility inspection~~ ~~• Trash and debris removal~~ ~~• Minor sediment removal~~ ~~• Vector Control~~	~~• Annually prior to wet season.~~ ~~• After major storm events if spot checks of some basins indicate widespread damage/ maintenance needs.~~ ~~• Remove minor sediment accumulation from inlet or outlet when affecting inlet/outlet conditions.~~	~~• Pickup truck~~
				~~Vegetation/ Landscape~~	~~• Integrated~~	~~• Monthly (or as dictated by~~	~~• Pickup truck~~

Treatment Control BMP/ Feature Type	Function	BMP/ Feature ID	Entity Responsible for Long-Term Maintenance/ Funding	Operation & Maintenance Category	Activities	Frequency	Typical Maintenance Equipment
				Maintenance	Pest/Plant Management • Minor Vegetation Removal/ Thinning	agreement between HOA and landscape contractor)	• Stakebed truck
				Major Maintenance	• Major vegetation removal/ planting • Major sediment removal	• As required (annually or less frequently)	• Pickup truck • Stakebed truck
Bioretention Areas	Water Quality Treatment Control	BR-A1 BR-C4a BR-C4b	• Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. • The City will have the right, but not the duty, to inspect and maintain the other BMPs if they are not being properly maintained by the HOA, at the expense of the HOA.	Routine Facility Maintenance	• Facility inspection • Trash and debris removal • Minor sediment removal	• Annually prior to wet season. • After major storm events if spot checks of some basins indicate widespread damage/ maintenance needs. • Remove minor sediment accumulation from inlet or outlet when affecting inlet/outlet conditions.	• Pickup truck

Treatment Control BMP/ Feature Type	Function	BMP/ Feature ID	Entity Responsible for Long-Term Maintenance/ Funding	Operation & Maintenance Category	Activities	Frequency	Typical Maintenance Equipment
				Vegetation/ Landscape Maintenance	• Integrated Pest/Plant Management • Minor Vegetation Removal/ Thinning • Irrigation System Adjustment • Mulching	• Monthly (or as dictated by agreement between HOA and landscape contractor)	• Pickup truck • Stakebed truck
				Major Maintenance	• Major vegetation removal/ planting	• As needed (infrequently)	• Pickup truck • Stakebed truck
Emergent Marshes and connecting Vegetated Swales	Wetland and Riparian Mitigation	A2 B2 B3 B4 C1 C2 C3 C4 C5 C6 C7 F2 VS-B3 VS-B4 VS-C4 VS-C5 VS-C6	No long term maintenance required. Short-term access for establishment and maintenance of the emergent marshes will be necessary consistent with the HMMP.	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Treatment Control BMP/ Feature Type	Function	BMP/ Feature ID	Entity Responsible for Long-Term Maintenance/ Funding	Operation & Maintenance Category	Activities	Frequency	Typical Maintenance Equipment
Flood Control Basins	Peak Flow Reduction	ETC Basin 1*	• Caltrans will be responsible for the inspection and maintenance of this basin that is currently within their right of way.	Per Caltrans	Per Caltrans	Per Caltrans	Per Caltrans

*No credit was taken for this facility in hydrology or water quality calculations

Flood Control Basins	Peak Flow Reduction	ETC Basin 1	Caltrans will be responsible for the inspection and maintenance of this basin that is currently within their jurisdiction.	Routine Facility Maintenance	•Facility inspection •Trash and debris removal •Minor sediment removal	•Annually prior to wet season. •After major storm events if spot checks of some basins indicate widespread damage/ maintenance needs. •Remove minor sediment accumulation from inlet or outlet when affecting inlet/outlet conditions.	•Pickup truck •Stakebed truck •Backhoe/ dump truck
		Basin 2 Basin 3	•Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries. •The City will have the right, but not the duty, to inspect and maintain the other BMPs if they are not being properly maintained by the HOA, at the expense of the HOA.	Vegetation/ Landscape Maintenance	•Integrated Pest/Plant Management •Minor Vegetation Removal/ Thinning •Irrigation System Adjustment	•Annually prior to wet season.	•Pickup truck •Stakebed truck

					Major Maintenance	• Structural repairs • Major vegetation removal/ planting • Major sediment removal	• As needed (infrequent) • Major sediment removal approximately every 10 – 20 years.	• Pickup truck • Backhoe/ dump truck • Crane/crew truck

Maintenance of the emergent marshes will occur over the first five years after construction to ensure the success of the revegetation planting. The project monitor will monitor all aspects of the revegetation in an effort to detect any problems at an early stage. During this initial five-year period, the following general maintenance task will be performed:

- Plant Inspection
- Irrigation Water Volume and Frequency
- General Irrigation System Inspection
- Trash and Debris Removal
- Weed Control
- Pest Control
- Plant Replacement

The emergent marshes will not be maintained in the long-term, per ACOE and CDFG requirements. The management and monitoring activities described in the Final Conceptual Mitigation Plan will be the responsibility of The Irvine Company.

7.7.2 Monitoring

The anticipated water quality performance of the proposed treatment controls is based on extensive monitoring of structural water quality controls conducted in California and in the United States. A key database used is USEPA's Nationwide BMP Database which contains monitoring data from approximately 200 BMP studies, 41 of which were conducted in California. With respect to controls intended for this project, the database includes 24 studies on detention basins, 32 studies on bioswales, and 16 studies on hydrodynamic separator systems. GeoSyntec Consultants helped develop this database, statistical tools and guidance for using the database, and also guidance on consistent monitoring approaches to improve the comparability of data (GeoSyntec Consultants et al, 2001). This data set provides a statistically robust basis for estimating performance of BMPs that is only possible by pooling large data sets that have been collected over a number of years.

The primary responsibility for monitoring the performance of structural stormwater controls is the MS4 co-permittees which have a monitoring responsibility as part of their NPDES Permit requirements. Moreover, the MS4 Permit Holders in Southern California have formed a cooperative monitoring program that is administered by the Southern California Coastal Water Resources Research Project (SCCWRRP). This arrangement helps ensure that monitoring is conducted using approved methods and protocols, is directed at priority issues, and is conducted by experienced agencies. Another important and relevant monitoring program is planned to be conducted by the Irvine Ranch Water District as part of the Natural Treatment System Master Plan. Information and data from these and other programs will be incorporated in the designs of the proposed facilities during the project design phase.

Given that stormwater control performance requires large data sets that require a number of years to obtain, and that the MS4 and other agencies are required and/or committed to supporting such monitoring in Southern California, it is not considered appropriate for the proponent to undertake such monitoring. Rather the focus on monitoring relies on visual inspections by trained maintenance personnel to ensure that facility performance is maintained. The scope of these activities is provided in Table 7-30.

7.7.3 Vector Control

The primary vector concern is the extent to which the water quality PDFs could contribute to mosquito breeding. The HSS units do contain standing water at times and would receive routine application of biochemical pesticides, in either tablet or granular applications. Such applications have been shown to be effective in controlling mosquito breeding in the HSS units.

Although standing water is not expected to remain in the extended detention basins for more than 36 to 48 hours, the wetland vegetation in the low-flow channels of the extended detention basins may attract nuisance insects or animals, including mosquitoes, flies, rodents and waterfowl (a nuisance in excessive numbers only). The potential for public health effects from these insects or animals is considered to be relatively low, based on experience at existing water quality treatment wetlands where vector control plans are implemented.

The primary vector issue for the wetland vegetation in the low-flow channels of the extended detention basins is mosquitoes. A number of abatement measures are proposed to minimize mosquito habitat and mosquito populations including habitat reduction (design limitations on standing water), biochemical pesticides (i.e., the bacteria *Bacillus sphaericus* [Bs] and *Bacillus thuringiensis israeliensus* [Bti]), and biological controls (e.g., mosquito fish). If these primary methods of control are unsuccessful in maintaining vector populations below nuisance levels, additional measures will be taken and could include: increased biochemical pesticide application, trapping and killing pests, and chemical pesticide application.

While vector control of other pests is important, such as for flies, rodents and over-abundant waterfowl, the potential for public health effects from these pests is generally regarded to be low. Controlling these pests is relatively easy and the likelihood of vector-borne outbreaks associated with these pests is considered minimal.

BMP designs and O&M procedures will be reviewed and approved by the Vector Control District prior to submittal of the final Project WQMP.

7.7.4 Pollutant Bioaccumulation

Bioaccumulation is defined as "the accumulation of contaminants in the tissue of organisms through any route, including respiration, ingestion, or direct contact with contaminated water, sediment, pore water, or dredged material" (USEPA, 2000a). Where pollutants have a tendency to settle, those pollutants could accumulate in the sediments within the treatment PDFs and possibly in the downstream emergent marshes, and ultimately PCR and Irvine Lake. Chemicals identified as a concern for sediment quality assessment because of their ability to accumulate in the tissue of organisms are often referred to as bioaccumulative compounds (USEPA, 2000a). These chemicals include certain trace metals (e.g., copper, lead, zinc and selenium), high molecular weight PAHs, and a number of pesticides. Selenium is not a pollutant of concern as it is typically undetected in urban runoff (LA County, 2000). A study by Dr. Horne investigated selenium concentrations in various media in PCR. The results from the study indicate that detectable concentrations of selenium in wetland sediments, bulrush and cattail biomass and seeds, dragon fly larvae, crayfish, and mosquito fish were generally below the USEPA proposed standards for fish and suggested guidelines provided by USGS (see Table 2-12), indicating that selenium is not accumulating to levels that would adversely affect aquatic biota or other wildlife (Horne, 2005).

Factors that would affect the extent of bioaccumulation, if any, would include:

- The bioavailability of the pollutant;
- Conditions in the sediments (e.g., pH, acid-volatile sulfide concentration, organic content) that affect the form and bioavailability of the pollutant;
- The efficiency of the exposure pathways by which pollutants in sediments could enter the food chain, (e.g., through the plant community);
- The type of habitat, organisms attracted to that habitat, and their feeding habits; and
- Design and maintenance considerations.

The potential for bioaccumulation will be minimized first by the effectiveness of the proposed water quality PDFs which will limit the discharge of bio-accumulative chemicals to receiving waters. Proposed source control PDFs will specifically target bio-accumulative chemicals. Specifically, pesticide applications on common landscaped areas will be managed to minimize the amount of pesticides applied. Also irrigation methods will be utilized to reduce runoff of applied irrigation. With respect to private landscaping activities, public education efforts will focus on informing residents of the potential toxic and bioaccumulative pollutants that they may have in their possession and how to properly store, use, and dispose of these materials to minimize environmental impacts.

The potential for bioaccumulation impacts will be minimized through the design and operation of the treatment systems. The treatment systems, by incorporating HSS units and/or extended detention basins upstream of the emergent marshes, PCR, Irvine Lake, and Santiago Creek, will minimize the discharge of settleable solids to these water bodies. The HSS units achieve sediment retention through screening and each extended detention basin that is not preceded by a HSS unit would contain a forebay designed to capture coarse solids and associated pollutants. These facilities also would be designed to facilitate routine removal of sediments based on accumulation. Such measures will minimize the amount of settleable solids entering the downstream emergent marshes, PCR, and Irvine Lake and will minimize the potential accumulation of sediments and pollutants associated with those sediments in these water bodies. In turn, the potential for those pollutants to enter the food chain will be limited.

Conditions within the emergent marshes and the reservoirs also will minimize the potential for bioaccumulation to occur. The emergent marsh areas will be seasonal wetlands and water storage during the wet portion of the year will be limited by a 48-hour drain time and infiltration. The emergent marshes will not incorporate large open water habitat for waterfowl.

The potential for bioaccumulation of metals in the reservoirs will be affected by their water and sediment chemistry. Although trace metals loads to the reservoirs are projected to increase, the overall magnitude of those loads is small. Moreover, the bioavailability of the discharges will be significantly decreased because of the existing water and sediment conditions in the reservoirs. The bio-available form of trace metals is often referred to as the total dissolved form; however, only a small fraction of the total dissolved metals discharged to the reservoirs will be in a bio-available form. This is because, in PCR, a high TDS concentration (typically in the range of 3,000-4,000 mg/L) and in the all of the reservoirs, the presence of other inorganic compounds that will react with the metals to form dissolved inorganic complexes (e.g., cupric chloride complexes). Organic complexes also may form with natural organic matter. Research has indicated that complexation can reduce the toxicity and bioavailability of trace metals such as copper such that "the bioavailable concentration of copper can be 1 percent of the total dissolved concentrations" (Timperley, 1999).

The above discussion addresses bioaccumulation through direct exposure of an organism in the water column. While there also is the potential for bioaccumulation in bottom sediments, the bioavailability of compounds in the reservoir sediments also will be limited. Sediments in the reservoirs have elevated levels of sulfur and are high in organic matter. The amount of bioavailable copper, and other trace metals, is controlled in large part by the concentration of sulfides in the sediments. Consequently the trace metals will tend to form complexes with the sulfides in the sediment, which will significantly reduce the potential for trace metals entering the food chain and bio-accumulating in aquatic and terrestrial organisms.

The potential for bioaccumulation of organic compounds, including pesticides and hydrocarbons, is significantly reduced because many organic compounds have a strong tendency to bind to sediments. For example, chlorpyrifos tends not to remain in aqueous solution or suspension but tends to bond to the organic and clay fractions of sediments (USEPA, 2000a and 2000b). The data indicate that the sediments in the bottom of the reservoirs are highly organic, and therefore suitable for providing sorption sites for organic compounds that have a high binding capacity. A similar propensity to bind to organic sediments is observed for the individual chemicals contained within the class of hydrocarbons referred to as PAHs. Moreover, the bioavailability of sediment-associated PAHs has been shown to decline with increased contact time (USEPA, 2000a and 2000b). The implication of this observation is that the compounds become more tightly bound with increased contact time.

On the basis of the anticipated effectiveness of the water quality PDFs and the conditions in the reservoirs and the emergent marshes which will minimize the bioavailability of pollutants, the effect of the Project on bioaccumulation in the receiving water bodies is considered less than significant.

7.7.5 Impacts to Irvine Lake as a Water Supply and Drinking Water Source

Irvine Lake is a drinking water supply and provides raw water to the Walter E. Howiler, Jr. Filtration Plant (WHFP) which is owned and operated by the Serrano Water District. There may be a concern that the Project will adversely affect the water quality in Irvine Lake, and possibly the quality of the raw water supply to WHFP and ultimately the quality of finished water from WHFP. The constituents of concern regarding the water supply are different from those previously discussed as the major issues are the formation of disinfection byproducts, the presence of pathogenic bacteria and viruses, and the presence of pathogenic protozoa such as *Giardia* and *Cryptosporidium*. Disinfection byproducts are formed by the reaction of chlorine used in the disinfection process with organic compounds such as contained in suspended particulates and algae. Thus constituents of concern include pathogenic bacteria, viruses, and protozoa; and organic compounds associated with suspended particulate matter or suspended algae.

The Serrano Water District is conducting a watershed sanitary survey in compliance with the Surface Water Treatment Rule to supplement the sanitary survey update conducted in 2001 for Villa Park Reservoir and Irvine Lake. The Surface Water Treatment Rule was enacted by the Environmental Protection Agency in 1989 and is enforced by the California Department of Health Services (DHS) to protect the public from waterborne diseases. In California, public water systems are required to submit a watershed sanitary survey every five years. The sanitary survey must document all possible sources of contamination to the drinking water sources located in the watershed.

The purpose of the update is to supplement the August 2001 update to the 1996 Santiago Reservoir/Villa Park Reservoir Watershed Sanitary Survey for the Serrano Water District. The update will address potential impacts to water quality that may result from proposed development in the watershed. The 2001 update recommended that the Serrano Water District should "work closely with The Irvine Company to ensure that the proposed developments in the watershed implement adequate control/mitigation measures to ensure that the reservoir water quality is not adversely affected."

The Serrano Water District has initiated discussions with the DHS to make DHS aware that a supplemental sanitary survey is being conducted to address additional sources in the watershed, including the proposed project. The District is requesting that, upon receipt and review of the sanitary survey, DHS provide a finding regarding the potential effects of the proposed project on the continued utilization of Irvine Lake as a drinking water supply source.

Surface water is delivered to the WHFP by gravity from Santiago Reservoir. The WHFP utilizes conventional chlorine disinfection, but as the water enters the filtration plant it can receive pre-treatment, such as the addition of powdered activated carbon (PAC), during certain times of the year (primarily late summer) to adsorb organic compounds that cause taste and odor and promote the formation of disinfection byproducts. This is the time of the year when algal blooms can occur in the reservoir, and the pre-treatment is a means of controlling the adverse effects of algal blooms on taste and odor. The effects of the proposed project on enhancing the algal blooms has been evaluated by Flow Science by modeling the algal dynamics in Irvine lake using the Dynamic Reservoir Model – Water Quality (DYRESM-WQ). Their results indicate that the algal blooms, characterized by chlorophyll-a levels, will not increase in duration or magnitude compared to the pre-development conditions. Turbidity increases also are of concern as suspended sediments can help “shield” *Giardia* and *Cryptosporidium* cysts and make them more difficult to treat. However, the proposed project is projected to actually reduce the level of TSS compared to pre-development conditions. Thus is it reasonable to conclude that the proposed project will not increase the concentration of organics and suspended solids in the water supply to the WHFP, and effects on treatability of the water supply and on the water quality of the finished water will be less than significant.

A second issue is whether the project could result in direct increases of *Giardia* and *Cryptosporidium* cysts. Currently the DHS uses total coliform levels as a rough guide to the presence of *Giardia* and *Cryptosporidium* cysts. Data on total coliform in the Irvine Lake is presented in Appendix A of the supplemental Sanitary Survey indicate that total coliform in Irvine Lake can be as high as 10,000 MPN/100 ml. Based on these data, the California Department of Health Services has recommended that the WHFP upgrade to a 4-log Giardia and 5-log virus removal/deactivation. It was reported in the 2003 Department of Health Services Water Service Inspection Report (DHS, 2003) that total log reductions are currently adequate to achieve the required 4-log Giardia and 5-log virus removal. (The WHFP was originally approved for 3-log Giardia and 4-log virus removal/deactivation.) The effects of the proposed project on bacteria levels in the dry and wet weather discharges to Irvine lake was determined to be less than significant based on the development of a WQMP in compliance with the County DAMP and City of Orange LIP whereby bacteria was selected as a constituent of concern and an array of source and treatment type BMPs suitable for treating bacteria were selected as part of the WQMP. This determination did not include the provision for bacteria die-off that will occur in the reservoir, especially given the reservoir size and the location and depth of the water supply inlet relative to the point of discharges from the proposed project. The effects of die-off of bacteria in urban runoff has recently been documented in a study of bacteria levels at beaches in Huntington Beach, where the researchers concluded that the prime source of elevated bacteria levels was bird droppings in nearby saltwater marsh (Grant et al, 2001).

In summary, the development of a robust WQMP using the guidance provided in this report and that complies with local DAMP/LIP requirements, the results of the GeoSyntec water quality modeling for nutrients discharged from the project and the projected effects of those nutrients on water quality in Irvine lake as conducted by Flow Science, indicate that the effects of the proposed project on disinfection byproducts and pathogenic bacteria on the water supply to the WHFP are less than significant.

7.8 Hydrologic Impact Analysis

ROMP Volume I describes the storm drainage system for the Project, which includes: 1) an on-site storm drain system to collect high flows from the developed areas; and, 2) a low-flow water quality system to divert initial storm flows and dry weather flows from the developed area to the treatment PDFs. Within the Project's drainage system, there will be eight primary outlet points where high and low flows will be delivered to natural drainages.

7.8.1 SHII Drainages (The South Tributary, the North Tributary, ETC-6 Drainage and ETC-7 Drainage)

In accordance with prior environmental clearances and resource agency permits, portions of the ETC-6 and ETC-7 drainages will be filled within the SHII development area, and runoff from the project area will be diverted away from the downstream, preserved portions of these drainages into the storm drain system. These impacts to the ETC-6 and ETC-7 Drainages have been fully mitigated pursuant to the Final Conceptual Mitigation Plan by recreation, enhancement, restoration and preservation of the Peters Canyon Tributaries.

With respect to the Peters Canyon Tributaries, a water balance study has been prepared as a part of the Final Conceptual Mitigation Plan. As the water balance demonstrates, the emergent marshes and upland and riparian buffer areas required to be created, enhanced, restored and preserved within the Peters Canyon Tributaries pursuant to SHII 2000 SEIR Mitigation Measure B-1 and the Final Conceptual Mitigation Plan are dependent upon the introduction of wet weather flows for survival and to meet success criteria. Therefore, the addition of dry weather flows and additional runoff volume is not a potential impact to these areas.

7.8.2 Black Willow Forest Lacustrine Area

The proposed storm drain system will deliver storm flows, after treatment in extended detention basins and other BMPs, to the Black Willow Forest Lacustrine Area. Low flows will not be conveyed through this proposed storm drain facility. Because the area at the outlet point is currently a wetland area, the introduction of additional storm flow in this area is not a potential impact to the Black Willow Forest Lacustrine Area.

7.8.3 Flows from Developed Areas in Vicinity of ~~Overland Flow Area within~~ Irvine Regional Park

As discussed in ROMP Volume 1, the drainage concept proposes that portions of the watershed containing flows from proposed development areas currently tributary to the park will be diverted to Area C (Concentration Point 3) and Area D (Concentration Point 4). Concentration Point C is east of, and outside of the park. Concentration Point 4 is located west of, and outside the developed area of the park within the Villa Park Dam Inundation Area. Thus, all flows are still tributary to Santiago Creek, but will be diverted around the improved portions of the Park, either to the east of the park (Concentration point 3) or the west of the park (Concentration Point 4) (Figure 5.1, ROMP Volume 1).

~~The proposed storm drain facilities constructed with the SHII project would deliver both dry weather flows and storm flows to the overland flow area within Irvine Regional Park, after treatment in extended detention basins and other water quality BMPs. The introduction of dry weather flows and substantial increases in runoff volumes could result in potential adverse impacts to the existing upland habitat, such as the sage scrub habitat, within this drainage area. However, the dry weather flows and additional runoff volumes will benefit the disturbed and mixed floodplain scrub habitat in the area of the failed mitigation site, and will provide additional flows to aid survival of the western sycamores planted in this area. The LSA SHII Supplemental Assessment of the Water Quality Basin/Habitat Restoration, dated November 14, 2003, sets forth all measures required to fully mitigate impacts of providing dry weather and additional runoff to upland habitat types in the overland flow area within Irvine Regional Park. In addition, the ROMP Volume I proposes a design for the storm drain pipes and extended detention basin that will distribute water to the portion of the drainage area in need of such flows: the area where the sycamores are located. Due to the extremely permeable soils, dry weather runoff and runoff from smaller storm events is expected to quickly infiltrate in the proposed Extended Detention Basin 6A, and will not leave the basin. As a result of these~~

~~measures and design features, all impacts of the project on the overland flow area within Irvine Regional Park are less than significant.~~

7.8.4 ETC-9 Drainage

In the absence of appropriate controls, low flows (inclusive of dry weather flows) would be delivered to the ETC-9 Drainage in the post-development condition, after treatment in extended detention basins and water quality BMPs. As discussed above, it is anticipated that little if any dry weather flows would leave the project boundaries. The introduction of low flows could adversely impact the ETC-9 drainage, which is currently ephemeral, and its drier-adapted riparian habitat species and oak trees. However, pursuant to the PDF discussed in Section 5.4 above (Natural Drainage PDF), storm drain improvement plans for East Orange Area 1 will be designed to eliminate conveyance of low flows to the natural drainage. Potential facilities that could eliminate or maintain pre-development conveyance of low flows to the natural drainage include a dry weather runoff/high flow diversion system, and/or infiltration/exfiltration design elements.

ETC-9 is not currently identified in the GLA Biotech Report as a potential wetland/riparian mitigation site. However, should full environmental analysis by the local lead agency and the resource agencies determine that ETC-9 is an appropriate area for wetland and riparian creation, restoration or enhancement the Natural Drainage PDF would not apply and requirements established by the resources agencies to allow achievement of success criteria would apply instead.

7.8.5 Woody's Tributary

In the absence of appropriate controls, low flows (inclusive of dry weather flows) would be delivered to the Woody's Tributary in the post-development condition. Woody's Tributary is an intermittent drainage that currently supports wetland and riparian habitat species. In addition, the East Orange Biotech Report identified Woody's Tributary as a potential mitigation site for other wetland/riparian impacts associated with the development of Area 1. Therefore, the introduction of dry weather flows to Woody's Tributary may be a potential adverse impact to the preserved natural drainage, but might also be a potential benefit associated with the development of East Orange Area 1. Pursuant to dry weather analyses presented above, it is predicted that little if any appreciable dry weather flows will leave the project.

In the event that, after full environmental analysis by the local lead agency and the resource agencies, these agencies determine that Woody's Tributary is an appropriate area for wetland and riparian creation, restoration or enhancement the Natural Drainage PDF would not apply and requirements established by the resource agencies to ensure success criteria are met would apply instead.

However, in the event that the local lead agency and the resource agencies determine that Woody's Tributary is not an appropriate area for wetland and riparian creation, restoration or enhancement, then the Natural Drainage PDF shall apply. In this situation, pursuant to the PDF discussed in Section 5.4 above, storm drain improvement plans for East Orange Area 1 would be designed to eliminate conveyance of low flows to the natural drainage. Potential facilities that could eliminate conveyance of low flows to the natural drainage include a dry weather runoff/high flow diversion system, and/or infiltration/exfiltration design elements.

7.8.6 Santiago Creek Reach 1

Although not a local natural drainage, project discharges could also potentially affect the hydrologic regime of Santiago Creek Reach 1. As discussed in Section 2.3.1 Santiago Creek Reach 1 is considered an intermittent stream in that discharges from Irvine Lake during wet years provide for biological functions similar to that which would be achieved if the Creek were subject to groundwater inflow. The analysis of dry weather flow discharges from the project indicates that dry weather flows are expected in little if any appreciable quantities~~will be limited~~ by the utilization of irrigation controls and native drought resistant vegetation in common landscaped areas, and any excess dry weather flows will likely infiltrate in proposed treatment controls. On this basis, the intermittent character of Santiago Creek will be preserved.

7.9 Cumulative Impact Analysis

The cumulative impact analysis is focused on the potential effects of the proposed Santiago Hills II Planned Community and East Orange Planned Community Areas 1, 2 and 3 on water quality in Irvine Lake, Peters Canyon Reservoir, Santiago Creek below Irvine Lake, and Villa Park Reservoir, taking into account other existing sources of pollutants outside of the project area, including the contribution of pollutants entering PCR from Santiago Hills I and the contribution of pollutants to Irvine Lake from existing development in inflows from Santiago Creek.

Additionally, compliance of this project and future projects with the MS4 Permit, the DAMP/LIP, and the Construction General Permit constitutes compliance with a regional mitigation program intended to address cumulative water quality impacts and to assure mitigation of those impacts to a level of insignificance.

7.9.1 Irvine Lake

Flow Science modeled the impacts of all of the East Orange Planned Community development (all three planning areas, East Orange 1, 2, and 3) on water quality in Irvine Lake (Flow Science, 2004a). Flow Science applied the Dynamic Reservoir Model – Water Quality (DYRESM-WQ), a one dimensional model that predicts temperature, salinity, and water quality profiles over time. The model predicts water quality in the reservoir based on several processes, including surface aeration, phytoplankton photosynthesis and respiration, biochemical and sediment oxygen demand, nitrification and de-nitrification, and oxidation of reduced forms of iron and manganese.

Flow Science calibrated the DYRESM model for the period January 2002 through April 2003. Data input included lake morphology, volumes and quality of inflows and outflows, lake stage, and climatic conditions. The model was calibrated for stage, temperature, and water quality using data provided by IRWD and the Serrano Water District. The calibrated model was then applied to predict changes in water quality associated with the proposed Project. The calibrated model was also used to simulate water quality in Irvine Lake during 1998, a wet year, and 2000, a dry year. An additional simulation considered a hypothetical condition of a dry year (2000) with a significant flood inflow.

GeoSyntec Consultants assisted Flow Science by providing estimates of daily flows and concentrations for the period simulated for two conditions: existing conditions and ultimate buildout conditions.

The model results and field data indicated that Irvine Lake becomes stratified in the late spring which leads to low DO conditions near the bottom of the Lake during the months of May through July. In turn, the reducing conditions lead to elevated levels of dissolved iron and manganese that are released from the sediments. While nutrients from the Project could affect DO in the lake, the model results indicated very little change in water quality in Irvine Lake under the post-development condition, and it was concluded therefore that the potential effect of the development on lake water quality would be minimal. This conclusion is further substantiated by the fact that the volume of runoff from the proposed development is quite low compared to imported water into Irvine Lake and inflow from the large Santiago Creek watershed.

7.9.2 Peters Canyon Reservoir

The Santiago Hills II portion of the Project will discharge to either Peters Canyon Reservoir or Santiago Creek. Conditions in Peters Canyon Reservoir are affected by discharges from a variety of sources, including anthropogenic sources associated with existing development (Santiago Hills I), and natural sources such as waterfowl, and other wildlife. These sources, along with sources of pollutants from the undeveloped portion of the watershed, establish a baseline condition.

Flow Science has addressed the existing water quality in Peters Canyon Reservoir and estimated changes in water quality that may occur as a result of the Project (Flow Science, 2004b). With the Project development, Peters Canyon Reservoir watershed will be essentially "built out" per the applicable general plans. Water quality in Peters Canyon Reservoir was also evaluated by Flow Science using the DYRESM reservoir model. The model results and field measurements indicate that the reservoir currently exhibits poor water quality primarily because PCR is essentially a closed system during all but very wet periods. Thus pollutants accumulate and recycle in the reservoir and water quality continues to degrade until there is a major wet year such as an El Nino which causes the reservoir to spill and temporarily flushes out the system. After the flushing event, the cycle of nutrient and salinity accumulation will begin again.

The Flow Science model results indicate that the effects of the proposed development on water quality in PCR will be slight. Salinity will decrease. Reservoir loadings of nitrogen and phosphorus are predicted to result in no significant differences in the dissolved oxygen depletion zone. No significant differences in the time or duration of low dissolved oxygen conditions are predicted to occur in the post-development condition when compared to the pre-development condition. Since the Project represents build out of the PCR watershed, no cumulative impacts to PCR are anticipated.

The Flow Science modeling also included modeling water surface elevation changes for the 15 month modeling period (January 2002 through April 2003). For Water Year 2003, the total rainfall as recorded at Santiago Dam was about 18 inches, during which the maximum increase in water surface elevation in PCR was less than a foot. Thus, under typical conditions, peak increases in surface water elevation in PCR will be minimal, and will not cause increased peak flows to Handy Creek, nor require drawing down the reservoir to minimize mosquito breeding.

7.9.3 Santiago Creek and Villa Park Reservoir

The potential for cumulative effects on Santiago Creek and Villa Park Reservoir relate only to the Santiago Hills II development, as runoff from East Orange Areas 1, 2 and 3 flows into Irvine Lake, where water quality within the lake as a whole is unaffected, and as most water from Irvine Lake is utilized by Serrano Water District and IRWD for water supply and not released downstream to Santiago Creek and Villa Park Reservoir. Effects of the Project on hydrology in Santiago Creek and Villa Park Reservoir are limited given that the portion of Santiago Hills II that will contribute flow to Santiago Creek is only about 1 percent of the total watershed. Hydrologic effects are limited because Santiago Creek is a wide braided stream with cobble substrate and therefore not easily subject to erosion and downcutting. Cumulative effects on water quality also are considered less than significant because the absolute increases in loads to Santiago Creek from the project are considered small compared with background loads in the larger watershed, and will not affect beneficial uses.

8 APPROACH FOR DEVELOPING PROJECT-SPECIFIC WQMP

The information in this report will serve as the technical basis for the project-specific WQMP for the Santiago Hills Planned Community and East Orange Planned Community Area 1 Project, providing the direction and foundation for later preparation of the project-level WQMP prior to issuance of grading permits. Building upon this basis, the following activities will complete the Project WQMP:

- *Site assessment*: Document site specifics such as location, size, intended land uses, drainage, conditions of the surrounding areas, etc., by reference to this report and in consideration of final design plans.

- *Identification of pollutants and hydrologic conditions of concern*: Pollutants of concern identified in this report will be used to develop a project specific WQMP.

- *Incorporate Site Design BMPs as Appropriate*: By reference to this study, identify design principles suited to the development project that will reduce stormwater runoff volumes, prevent or limit the generation of pollutants, and preserve natural areas and protect slopes and channels of the project area.

- *Incorporation of Source Control BMPs*: By reference to this study, implement all appropriate source control measures in order to prevent or limit the generation of pollutants on the project site and mobilization and transport of pollutants.

- *Selection of regional or project–based approach to Treatment Control BMPs*: By reference to this study, determine whether on-site treatment controls or participation in a regional program will be the selected method of improving the water quality of discharges from the project site.

- *Selection, sizing, and incorporation of Treatment Control BMPs*: By reference to this study, incorporate on-site or contribute to regional controls that will provide treatment to stormwater runoff from the project site.

- *Provide proof of ongoing stormwater BMP maintenance*: By reference to this study and the Santiago Hills II and East Orange Area 1 ROMP Volume I, prepare an O&M Plan and ensure a mechanism is in place that will provide ongoing long-term maintenance of all structural and non-structural BMPs.

This report addresses these same points at a planning level of detail, and will form the basis for the development of the project-specific WQMP.

9 CONCLUSIONS

This report addressed the potential effects of the proposed Santiago Hills II and East Orange Area 1 Development Project on water quality in Santiago Creek and Villa Park Reservoir, Irvine Lake, Peters Canyon Reservoir, and enhanced or constructed jurisdictional emergent marshes. The following are the conclusions regarding the significance of potential impacts for the runoff volume and pollutants of concern under wet and dry weather conditions.

- *Runoff Volume*: Runoff volume is projected to increase overall with the proposed development. However, flows to PCR during Stage 3 are expected to slightly decrease.~~The increase in runoff to PCR will reduce salinity and will increase nutrient loads.~~ In Irvine Lake, where the tributary watershed is quite large, the additional runoff volume will have no effect on water quality. The impacts of runoff volume on flooding and sediment yield are addressed in Volume I of the ROMP.

- *Sediments*: BMPs complying with the MS4 Permit, Construction General Permit, General WDRs for Non-Storm Water Construction-related Discharges, and DAMP will be incorporated into the Project to address sediment in both the construction phase and post-development. Mean total suspended solids concentrations are predicted to be less in the post-development condition than in the existing conditions. Turbidity in stormwater runoff will be controlled through implementation of a Construction SWPPP and will be permanently reduced through the stabilization of erodible soils with development. On this basis runoff from the project is not expected to exceed water quality standards or adversely affect beneficial uses and the impact of the Project on suspended sediments is considered less than significant.

- *Nutrients*: BMPs complying with the MS4 Permit, Construction General Permit, and DAMP will be incorporated into the Project to address nutrients during construction and post-development. Among source controls is the plan to select vegetation types and utilize high quality, slow release fertilizers in common area landscaping. Nitrate-nitrogen loads from the

Project to Peters Canyon Reservoir are predicted to decrease, while total phosphorus loads and TKN loads will increase. Comparisons to Basin Plan Criteria indicate no exceedances for total phosphorus, TKN, or nitrate-nitrogen. Further, with respect to Irvine Lake and PCR, the modeling conducted by Flow Science indicates that the water quality in these reservoirs will not be significantly impacted by runoff discharges from the Project. On this basis, the impact of the Project on nutrients is considered less than significant.

- *Trace Metals*: BMPs complying with the MS4 Permit, Construction General Permit, and DAMP will be incorporated into the Project to address trace metals in both the construction phase and post-development. Mean concentrations of ~~dissolved copper and~~ total recoverable lead are predicted to increase relative to predicted concentrations under existing conditions, while dissolved zinc and copper concentrations are predicted to decrease. Post-development mean concentrations of copper, lead, and zinc are predicted to be well below CTR criteria. Analysis of the potential for metals to affect sediment and cause bioaccumulation in aquatic and terrestrial organisms concluded that the potential for bioaccumulation, given the water quality PDFs and the existing water and sediment chemistry in the receiving waters, was limited. On this basis, the impact of the Project on trace metals is considered less than significant.

- *Pathogens*: Pathogen sources include both natural and anthropogenic sources. The natural sources include bird and mammal excrement. Anthropogenic sources include leaking septic and sewer systems, and pet wastes. The Project will not include septic systems and the sewer system will be designed to current standards which minimizes the potential for leaks. Pet wastes are a primary source of concern. The proposed PDFs incorporate a comprehensive array of source controls to address pet wastes and other potential sources of pathogens and are consistent with the DAMP guidance. This array of controls, including HSS, bioretention, vegetated swales, and extended detention basins will effectively treat bacteria. In addition, natural processes in the emergent marshes and the reservoirs will provide natural attenuation of bacteria. Additionally, recent studies indicate that ~~On this basis, the impacts of the Project on pathogens and~~ pathogen levels from developed versus undeveloped watersheds~~indicators~~ are virtually indistinguishable in receiving waters. On this basis, it is determined that the Project would not result in appreciable changes in pathogen levels in the receiving waters compared to existing conditions, and potential impacts are therefore considered less than significant.

- *Hydrocarbons*: Hydrocarbon concentrations will increase with development because of vehicular emissions and leaks. In stormwater runoff hydrocarbons are often associated with soot particles that can combine with other solids in the runoff. Such materials are subject to treatment in the proposed HSS units, extended detention basins and treatment swales. Source control BMPs incorporated in compliance with the MS4 Permit, the General Construction Permit, and the DAMP will also minimize the presence of hydrocarbons in runoff. On this basis, hydrocarbons area not expected in project runoff at levels that would exceed water quality standards or adversely affect beneficial uses, and the impact of the Project on hydrocarbons is considered less than significant.

- *Pesticides*: Pesticides in runoff are likely to increase with development as a result of landscape applications. Proposed pesticide management practices include source control, treatment in extended detention basins, and advanced irrigation controls in compliance with the requirements of the MS4 Permit and the DAMP. On this basis, pesticides are not expected in project runoff at levels that would exceed water quality standards or adversely affect beneficial uses, and the impact of the Project on pesticides is considered less than significant.

- *Trash and debris*: Trash and debris in runoff are likely to increase with development if left unchecked. However, the Project PDFs, including source control and treatment BMPs incorporated in compliance with the MS4 Permit and the DAMP, will minimize the adverse impacts of trash and debris. Source controls such as street sweeping, public education, fines for littering, and storm drain stenciling can be effective in reducing the amount of trash and debris that are available for mobilization during wet and dry weather events. Trash and debris will be captured on trash racks in the extended detention basins and in the HSS units, which are very effective at trapping trash and debris. Trash and debris are not expected to adversely affect beneficial uses, and the project will have less than significant impacts on ~~significantly impact~~ receiving waters due to the implementation of the Project PDFs.

- *Oxygen Demanding Substances*: Oxygen demanding substances are compounds that can be biologically degraded through aerobic processes. Nutrients in fertilizers and food wastes in trash are examples of the most likely oxygen demanding compounds to be present on the project site. As quantitative analysis shows, nutrients in stormwater runoff (nitrate, TKN, and total Phosphorus) are not expected to significantly adversely affect stormwater after the Project development. In addition, BMPs for application, use, and management of fertilizers during and after construction will be a part of the Project SWPPP and WQMP. With incorporation of these BMPs, the Project will comply with DAMP and MS4 Permit requirements, runoff is not expected to exceed water quality standards or adversely affect beneficial uses, and the Project impacts with respect to oxygen demanding substances would be less than significant.

- *Total Dissolved Solids*: Total dissolved solids loads and concentrations in stormwater runoff to Peters Canyon Reservoir from the developed portion of the project area will decrease. Average annual TDS concentrations in stormwater runoff from the Peters Canyon Reservoir project area after treatment would range from 618~~690~~ mg/L for Stage 1 to 539~~580~~ mg/L for Stage 3, which is below the Basin Plan Water Quality Objective for Peters Canyon Reservoir. On this basis, the impact of the Project on total dissolved solids is considered less than significant.

- *Cumulative Impacts*: Irvine Lake and PCR are subject to algal blooms and periods of low dissolved oxygen which may lead to drinking water taste and odor problems, and treatment requirements. These problems stem from a number of factors including thermal stratification, nutrient input, water balance and residence times, and how the reservoirs are operated. With respect to the Project, the main concern is the effect of the Project on nutrient loads to these reservoirs. Such loads will be controlled by various PDFs and, based on water quality modeling conducted by Flow Science, are not expected to impact the water quality in Irvine Lake and PCR. Compliance of this Project and future projects with the MS4 Permit, the DAMP/LIP, and the Construction General Permit constitutes compliance with a regional mitigation program intended to address cumulative water quality impacts and to assure mitigation of those impacts to a level of insignificance.

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