Technical Memorandum 4
Inventory and Analysis of Existing Major Control Programs and Structural Measures

Throughout the Santa Ana River watershed, cities, counties, and other agencies manage programs and implement control measures that directly or indirectly address waterborne bacteria and pathogens. This memorandum provides a summary and description of the programs and control measures researched as part of Phase I of the Stormwater Quality Standards Study Task Force's efforts to support the Regional Board's triennial review of Basin Plan water quality standards. The summary includes information collected publicly owned treatment works (POTW) discharges, and municipal separate storm sewer system (MS4) source control and treatment control programs.

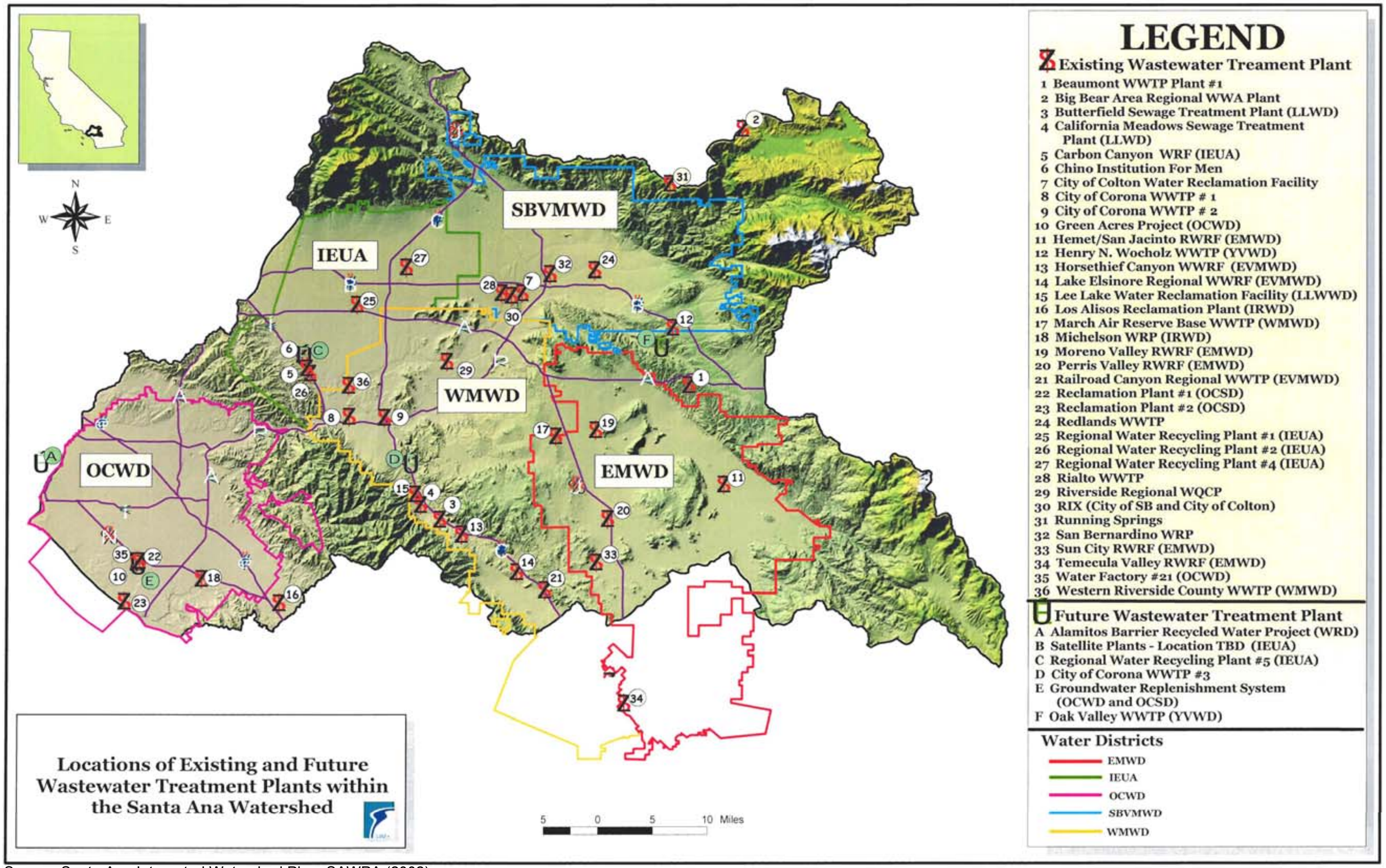
Publicly Owned Treatment Works Discharge Characteristics and Reclamation Requirements

According to the Santa Ana Integrated Watershed Plan (SAWPA, June 2002), there are 37 operational publicly owned treatment works (POTW) in the Santa Ana Watershed and 5 plants currently planned for construction. Figure 1 shows the POTWs within the Santa Ana basin.

There are 42 operational and planned plants that range in design discharge capacity from 0.08 million gallons per day (MGD) to 151 MGD:

- 24 plants produce advanced or tertiary treated effluent (Title 22 level of treatment as discussed in Section 4.1.1)
- 7 produce discharge at a level receiving only secondary treatment (without tertiary)
- 11 produce a combination of primary, secondary, and tertiary treated effluent, depending on effluent receiving water

In order to describe potential bacteria contributions from POTWs within the watershed, an effort was made to characterize the level of treatment provided for facilities discharging to inland receiving waters. Of the 42 facilities mentioned previously, 6 discharge directly to a receiving water, and 15 discharge to a receiving water in combination with some effluent recycling. Effluent from the remaining plants is either discharged to the Pacific Ocean, into aquifers for groundwater recharge, or fully recycled.



Source: Santa Ana Integrated Watershed Plan, SAWPA (2002)

Figure 1
POTWs Within the Santa Ana Basin

All 6 plants discharging to inland receiving waters provide either tertiary treatment (5) or a combination of secondary and tertiary treated effluent (1, Western Riverside County Regional WWTP).

Of the 15 facilities that discharge to receiving waters in combination with effluent recycling, 11 provide tertiary treatment, 1 provides secondary treatment (Hemet/San Jacinto RWRF), and 3 provide a combination of secondary and tertiary treated effluent.

There are 7 facilities in the watershed that provide only secondary treated effluent, of which only 1 discharges to an inland receiving water (Hemet/San Jacinto). The remaining facilities provide water for recycling or groundwater recharge.

In summary, of the 21 facilities that discharge to inland receiving waters, or discharge in combination with recycling, all except one provide tertiary treated effluent consistent with Title 22 effluent requirements. This level of treatment minimizes or eliminates the bacteria and pathogen load of these point sources to the Santa Ana Watershed. Many of these facilities produce all or a substantial portion of the downstream receiving water's dry weather flow regime.

Recycled Water Regulation (Title 22 Requirements)

The State Water Resources Control Board (SWRCB), through the Porter-Cologne Water Quality Control Act, is responsible for formulating and adopting state policy for water reclamation, policy that does affect inland water body water quality criteria. The California Department of Health Services (DHS) is responsible for establishing uniform statewide reclamation criteria to ensure that the use of recycled water is not detrimental to public health, criteria that protect beneficial uses.

There are no federal standards governing wastewater reclamation and reuse in the United States, although the EPA has sponsored the preparation of Guidelines for Water Reuse. Many states, including California, have developed wastewater reclamation regulations. In all cases, the regulations have been established with the objective of protecting public health and allowing for the safe use of recycled wastewater. The DHS established water quality criteria, treatment process requirements, and treatment reliability criteria for reclamation operations, which are set forth in Title 22, Division 4, Chapter 3, of the California Code of Regulations (CCR) Water Recycling Criteria.

The existing criteria address treatment requirements for recreational impoundments. Many inland water bodies within the watershed that receive POTW discharges have been considered non-restricted recreational impoundments. Since POTW discharges make up all or the majority of dry-weather flows within these receiving streams, Title 22 disinfection requirements for recreational impoundments have been applied to NPDES Permits when the dilution is less than 20:1 (receiving water flow: wastewater flow). The dilution criterion serves to relax effluent standards during large storm events. The treatment requirements are based on the expected degree of human contact with wastewater. Treatment requirements are expressed as treatment process requirements (e.g., bio-oxidation, coagulation) as well as performance standards (e.g., disinfection standards and contaminant reduction). The existing Title 22 standards are among the most stringent standards for public health protection. To be considered adequately disinfected, the median number of coliform organisms in the wastewater may not exceed a most probable number (MPN) of 2.2 per 100 milliliters (mL) over a seven-day period. The waste discharge requirements for the Inland Empire Utilities Agency's Regional Pants 1 & 4 [Order No. 01-1, NPDES Number CA0105279] show how these standards are incorporated:

- The discharge shall at all times be an adequately filtered and disinfected wastewater (tertiary treated effluent) if the flow in the receiving water is less than that required for a dilution of 20:1 (receiving water flow: wastewater flow) at the point of discharge. Filtered wastewater means an oxidized, coagulated, and clarified wastewater which has been passed through natural undisturbed soils or filter media, such as sand or diatomaceous earth (or equivalent as determined by the State Department of Health Services). The discharge shall be considered adequately filtered if the turbidity does not exceed an average of 2.0 turbidity units nor exceeds 5.0 turbidity units more than 5 percent of the time during any 24-hour period. The discharge shall be considered adequately disinfected if the median number of coliform organisms does not exceed 2.2 per 100 milliliters and the number of coliform organisms does not exceed 23 per 100 milliliters in more than one sample within any 30-day period. The median value shall be determined from the bacteriological results of the last 7-days for which analyses have been completed.

- The discharge of secondary treated wastewater when the flow in the receiving water results in a dilution of 20:1 (receiving water flow: wastewater flow) or more at the point of discharge shall be an adequately disinfected and oxidized wastewater. The discharge shall be considered adequately disinfected if at some location in the treatment process, the median number of coliform organisms does not exceed 23 per 100 milliliters. The median value shall be determined from the bacteriological results of the last 7-days for which analyses have been completed. The discharge shall be considered adequately oxidized if it complies with the average weekly and average monthly effluent limitations for BOD and suspended solids as specified in Discharge Specification A.1.a. The discharger shall make provisions for the measurement of the receiving water flow at a suitable location upstream of the discharge point and determine whether a 20:1 dilution exists before discharging secondary treated effluent. A dilution of 20:1 or more is required at the point of discharge.

Title 22 requirements were adopted in 1978. POTWs operating prior to 1978 began constructing facilities to meet Title 22 requirements at that time. It is believed that all of the inland POTWs completed improvements to meet Title 22 requirements by the mid-1990s and all treatment plants constructed since then have been designed to meet these requirements.

Considering inland POTW discharges as discharging to recreational impoundments, Title 22 requirements provide for protecting human contact recreation with POTW discharge channels and receiving streams.

Not all POTWs in the Santa Ana Basin discharge to recreational impoundments. POTWs that discharge to groundwater recharge basins as opposed to surface waters are not required to meet Title 22 standards. These POTWs still provide treatment to secondary levels. In groundwater recharge basins, soils may provide additional treatment of effluent by natural bacteria reduction.

Urban Runoff Control Measures and BMPs

Source Control Measures

All cities and counties in the Santa Ana River Watershed implement municipal separate storm sewer system (MS4) water quality programs aimed at reducing the amount of pollutant discharges in stormwater runoff. The programs are required by MS4 discharge permits issued under the National Pollutant Discharge Elimination System (NPDES) by the Santa Ana Regional Water Quality Control Board. The counties implementing such programs include San Bernardino County, Riverside County, and Orange County. These counties serve a leadership role (principal permittee role) for large, area-wide groups of city MS4 permittees.

The MS4 programs currently implemented within the Santa Ana River Watershed have broad program elements in common that can directly or indirectly provide some reduction of bacteria and pathogens within urban (both dry and wet weather) runoff. Recent annual reports for the MS4 programs were reviewed to identify and summarize program elements and innovative measures aimed at controlling pollutants within stormwater discharges. The annual reports reviewed included:

- San Bernardino County Stormwater Program Annual Report FY2002-2003
- Riverside County Flood Control and Water Conservation District, County of Riverside and Cities of Riverside County 2003 Annual Progress Report
- Unified Annual Progress Report; Program Effectiveness Assessment 2002-2003 Reporting Period, published jointly by the County of Orange, the Cities of Orange County, and the Orange County Flood Control District

The three MS4 programs consist of common elements/programs aimed at reducing pollutant discharges. These program elements include the following:

- Illegal Discharge/Illicit connection control
- Industrial/Commercial Source Program
- New Development/Redevelopment (including construction)
- Public Agency (Municipal) Activities
- Public information/participation
- Water Quality Monitoring

The above listed programs function through the implementation of best management practices (BMPs) defined by each MS4 program. The BMP measures included in these programs are intended to reduce the loading of the following type of pollutants:

- Bacteria
- Sediments and total suspended solids
- Nutrients and fertilizers
- Pesticides and herbicides
- Other pollutants generated from municipal, industrial, commercial and household activities.

Of the listed MS4 program elements, the following BMPs directly address bacteria/pathogen control. These include:

- Public education regarding pet waste management

  Outreach efforts to educate pet owners of the impact of pet waste on water quality is a component of each County MS4 program. Pet waste management includes emphasizing the direct impact that unmanaged pet waste has in introducing bacteria to the storm drain. All pet wastes are required to be collected and properly disposed. Pet owners are encouraged to bring a plastic bag when walking pets at the park. Pet wastes are to be disposed in the trash or through the sanitary sewer system. Many parks trails also have containers to dispense pet waste collection bags.

- Practices to identify and rectify septic system problems

  Area MS4 permits require that the MS4 programs determine a mechanism to address septic failures. Plans and programs to locate and address failed septic systems have been developed. Homeowner education is conducted to emphasize the need for regular operation and maintenance of septic systems and notify system owners when sewer service is newly available in older residential areas.

  As part of Orange County's assessment of its stormwater program, an assessment was conducted on it septic systems. Septic systems are located throughout the County but are of greatest concentration in the Santa Ana River watershed. Based upon a survey of septic system owners, a failure rate of 1.25% was determined. This failure rate was similar to a finding in Oregon. Literature reviews indicate that the most prevalent reason for failure is due to poor operation and maintenance. Excessive water use or insufficient system capacity is also a reason for system failure.

  An analysis was also conducted to predict the mass loading resulting from failed septic system failures. Study results show that failed septic systems are a marginal contributor to pathogen indicators and do not represent a significant source of constituents of concern to Orange County receiving waters.

- Portable toilet pollution prevention program

  Portable toilets are used at parks, construction sites, parks and recreational areas, and temporary events. Improper operation and maintenance of these units can have direct impact on receiving waters. Area MS4 permits require that the MS4 programs develop BMPs to properly manage portable toilets, aimed at preventing accidental discharges and providing for proper handling of wastes, as well as proper cleaning procedures. BMPs for proper portable toilet management have been developed.

As part of Orange County's annual review of its stormwater program, an assessment was conducted on practices and impacts associated with the maintenance, use and oversight of portable toilets. The assessment identified a small number of formal incidents over several years involving observed or potential direct impact to drainage channel.

Current industry practices were found to be sufficient to prevent receiving water impacts from spills from portable toilets. The practices were recommended to be formalized to ensure consistent implementation by suppliers and users of the portables and disseminated through inspection, education and outreach efforts and through BMP fact sheets.

- Water Quality Management Plan (WQMP) requirements for new developments that have the potential to discharge bacteria/pathogens, or will discharge runoff into receiving waters 303(d) listed for bacteria/pathogens

  WQMP checklists for new projects/ developments require any downstream receiving waters be identified as well as any known water quality impairments. If the downstream receiving water is on the 303(d) list for bacteria, best management practices can be required as a prerequisite to project approval. These measures should be designed to help prevent bacteria loading to the downstream receiving water.

Of the MS4 elements, the following BMPs indirectly affect bacteria/ pathogens within stormwater runoff:

- Identification and elimination of illicit connections to the storm drain system

  Each MS4 program includes a program to detect, respond, and eliminate illegal discharges and illicit connections which are a significant source of pollutants to the storm drain system. Illegal discharge and illicit connection programs integrate municipal, industrial, commercial, residential, and construction inspection programs by training authorized inspectors to investigate, and detect incidences of violations. By identifying and eliminating illegal discharges and illicit connections, the potential for discharges which contain bacteria/ pathogens to enter the storm drain system is reduced.

- Spill response plans for certain types of spills and illegal discharges (sanitary sewer overflows)

  Each MS4 program has a program element to address spills and illegal discharges. These activities are related to the identification of illicit connections and illegal discharges as described above. Spill responders are designated by each County to coordinate with fire departments and other agencies in case of accidental spills, leaks, or prohibited discharges. Spill response procedures consist of record keeping, notifications of relevant authorities, on-scene assessments, containment, cleanup, investigations, reporting, and education and enforcement.

- Trash collection

  Each MS4 program contains trash collection BMPs as part of its municipal activities. Trash left uncollected or improperly contained can enter the storm drain systems. Trash is required to be collected on a regular basis and disposed of properly. Placement of trash receptacles, appropriate receptacle size, and frequency of trash collection is important so as to prevent unnecessary accumulation of the trash and discourage illegal dumping. These management practices prevent the decomposing trash that may be high in bacteria/ pathogen populations from entering the storm drain system.

- Street sweeping

  Each MS4 program contains municipal street sweeping as a program BMP. Sweeping activities occur throughout each city within the program, and target areas where historically elevated litter loads are observed. Regular sweeping not only prevents accumulation of trash, debris, and sediment but indirectly reduces the potential and medium for bacterial growth.

For the County of Orange, the "Unified Annual Progress Report; Program Effectiveness Assessment 2002-2003 Reporting Period" measured the effectiveness of BMP measures. The assessment measured effectiveness based on: (1) verification of program implementation, and (2) improved water quality or environmental conditions. However, the assessment "recognizes that scientifically robust evidence of improved water quality will follow confirmation on program implementation and should not be expected to be evident initially."

The assessment concluded that "while evidence of the connection between programmatic activities and changing environmental conditions remains elusive, the Permittees believe that there is strong evidence of increasing program effectiveness." Many specific achievements were identified in the assessment; however, bacteria-specific achievements were not mentioned.

In summary, information directly addressing reduction in bacteria/pathogen loading or concentration in receiving waters as a result of MS4 program implementation is not readily available.

Structural Treatment Controls

In addition to source control BMPs required by MS4 programs, structural treatment controls (treatment control BMPs) are now required for certain new development and significant redevelopment projects within the MS4's jurisdiction. Furthermore, there are a number of existing local or regional facilities such as detention or retention (recharge) basins, treatment wetlands, and diversions that have been constructed throughout the watershed that provide opportunities for reduction of pollutants in runoff including bacteria and pathogens.

Treatment control BMPs that are described within the WQMP requirements for the MS4 programs include:

- Biofilters, including:
    - Vegetated Buffer Strips
    - Vegetated Swales
    - Wetland Vegetated Swales
- Bioretention
- Detention Basins (extended dry basins, pervious and impervious lined)
- Infiltration Basins and Trenches
- Wet Ponds and Constructed Wetlands
- Filtration Systems, including
    - Media Filters / Sand Filtration

- Water Quality Inlets
  - Trapping Catch Basins
  - Oil Water Separators
- Hydrodynamic Separators
- Porous Pavement or Landscape Detention
- Manufactured Proprietary Control Measures

Development project proponents consider expected pollutants, receiving water pollutants of concern, site conditions, building restrictions, restriction on the use of infiltration, and economic feasibility when selecting treatment control BMPs. MS4 programs have researched treatment control BMP removal efficiencies and have provided some insight into selecting an appropriate BMP. Table 1 summarizes general removal effectiveness information provided in model WQMPs for MS4 programs.

Table 1
BMP Removal Effectiveness

Pollutant of Concern	Treatment Control BMP Categories					
	Biofilters	**Detention Basins**	**Infiltration Basins**	**Wet Ponds or Wetlands**	**Filtration**	**Hydrodynamic Separator Systems**
Sediment Turbidity	H/M	L/M	H/M	H/M	H/M	H/M (L for Turbidity)
Nutrients	L	L/M	H/M	H/M	L/M	L
Organic Compounds	U	U	U	U	H/M	L
Trash & Debris	L	H/M	U	U	H/M	H/M
Oxygen Demanding Substances	L	L/M	H/M	H/M	H/M	L
Bacteria & Viruses	U	U	H/M	U	H/M	L
Oil & Grease	H/M	L/M	U	U	H/M	L/M
Pesticides (non-soil bound)	U	U	U	U	U	L

L: Low removal efficiency
H/M: High or medium removal efficiency
U: Unknown removal efficiency

Sources: Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (1993), National Stormwater Best Management Practices Database (2001), and Guide for BMP Selection in Urban Developed Areas (2001).

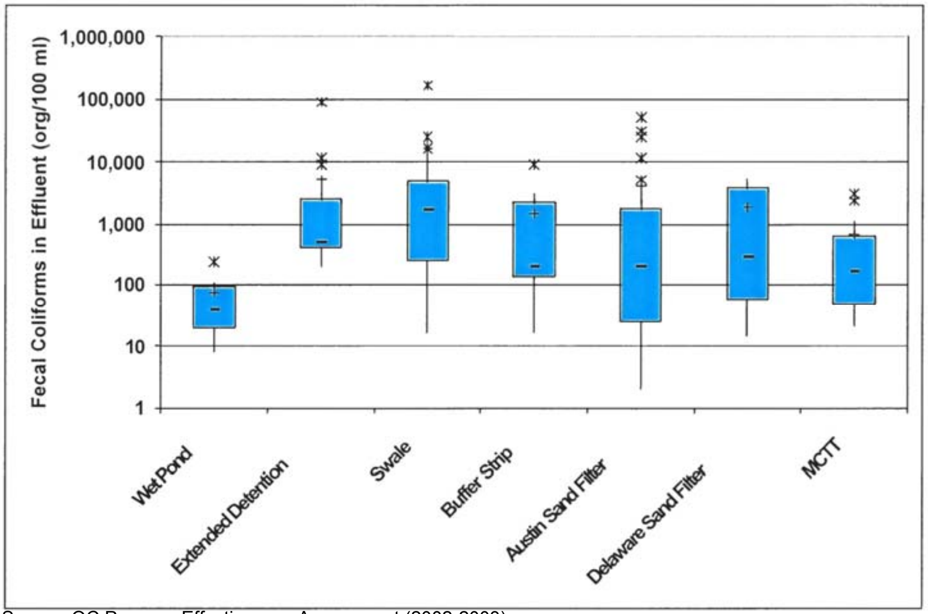
Specific to bacteria and pathogens, infiltration and filtration control BMPs are described as having a medium to high removal efficiency. Hydrodynamic separators are described as having low removal efficiency. Biofilters, detention basins, and wet ponds or wetlands are described as having unknown removal efficiency. Traditional design and operating practices for such systems have focused largely on trash and debris and suspended solids removal with some ability to reduce metals and nutrients. Only in the past several years has there been more emphasis on investigating methods to enhance bacteria removal from "typical" stormwater treatment methods. Examples include providing shallow zones to enhance natural UV penetration and looking at subsurface wetland systems.

Recent research indicates that wet ponds and constructed wetlands may have the potential for higher bacteria and pathogen removal efficiency; potentially the highest among treatment control BMPs currently described within MS4 programs. Larger wet pond and constructed wetland systems are typically integrated into regional treatment control programs to serve large drainage areas rather than from single project sites. Some larger, multi-acre projects could incorporate wet pond or wetland treatment.

Orange County's "Unified Annual Progress Report; Program Effectiveness Assessment 2002-2003 Reporting Period" contains performance reviews of structural BMPs. According to the Assessment, structural BMPs in Orange County have been constructed primarily to address nutrient loads and bacteria/pathogen concentrations. These structures have been designed to primarily treat dry-weather flows.

The Assessment describes wet ponds and constructed wetlands as suitable for treating dry-weather flows when sufficient flow is present to maintain a water pool and sustain necessary vegetation. The Assessment also describes wet ponds as capable of producing effluent that meets contact recreation standards for fecal coliform, although notes that reduction in bacteria concentrations can be achieved from other BMP measures.

The Assessment further compares the observed concentrations of fecal coliform in the effluent of the BMPs such as wet ponds, extended detention basins, swales, buffer strips, sand filters, and multi-chambered treatment trains as shown in Figure 2. Although substantial reduction is observed for many of the BMPs, contact recreation standards (REC1) are only observed to be met more consistently in the discharge from the wet pond.



Source: OC Program Effectiveness Assessment (2002-2003).

Figure 2
Comparison of Fecal Coliform Effluent Concentrations

Existing BMP Treatment Controls in Santa Ana Basin

Numerous structural BMPs exist within the watershed that were designed and installed for a variety of purposes but that have the potential to improve the quality of stormwater runoff on a regional (non-site specific) basis. Many of these directly or indirectly address bacteria/pathogens. These BMPs include:

- Low-flow diversion to sanitary sewer system
- Recharge (Infiltration) basins
- Detention basins, swales, and buffer strips
- Natural treatment wetlands/ wet ponds
- Ultraviolet disinfection
- Ozone

Low-Flow Diversion to Sanitary Sewer System

Dry-weather diversions consist of pumping or otherwise diverting low flows from storm drains to a sanitary sewer system for treatment at a waste water treatment plant, which would include disinfection as necessary to meet the discharge requirements for the plan. By eliminating dry weather flows from directly entering the receiving waters, the impact from bacteria levels in the dry weather runoff is eliminated.

In the County of Orange, the Dry Weather Diversion Plan, October 2003, evaluated the effectiveness of the dry weather diversions to the Orange County Sanitation District (OCSD). These diversions have been implemented in various coastal locations since 1997 (Table 2). The diversion program is not a requirement of the County's NPDES Permit but has been implemented as a result of continual closures and postings at coastal beaches due to unsafe bacteria levels. Existing diversion facilities are operating in 38 locations near the coastline or at a main drainage system facility of major watersheds. Figure 3 shows the locations of the existing diversion facilities in Orange County.

The report also describes an additional 38 proposed dry weather diversions. These diversions are proposed in the cities of Dana Point (5), Huntington Beach (13), Laguna Beach (11), San Juan Capistrano (6), Seal Beach (1), and San Clemente (2).

An example of one of the low flow diversions is the Greenville-Banning Channel diversion.

Greenville-Banning Channel

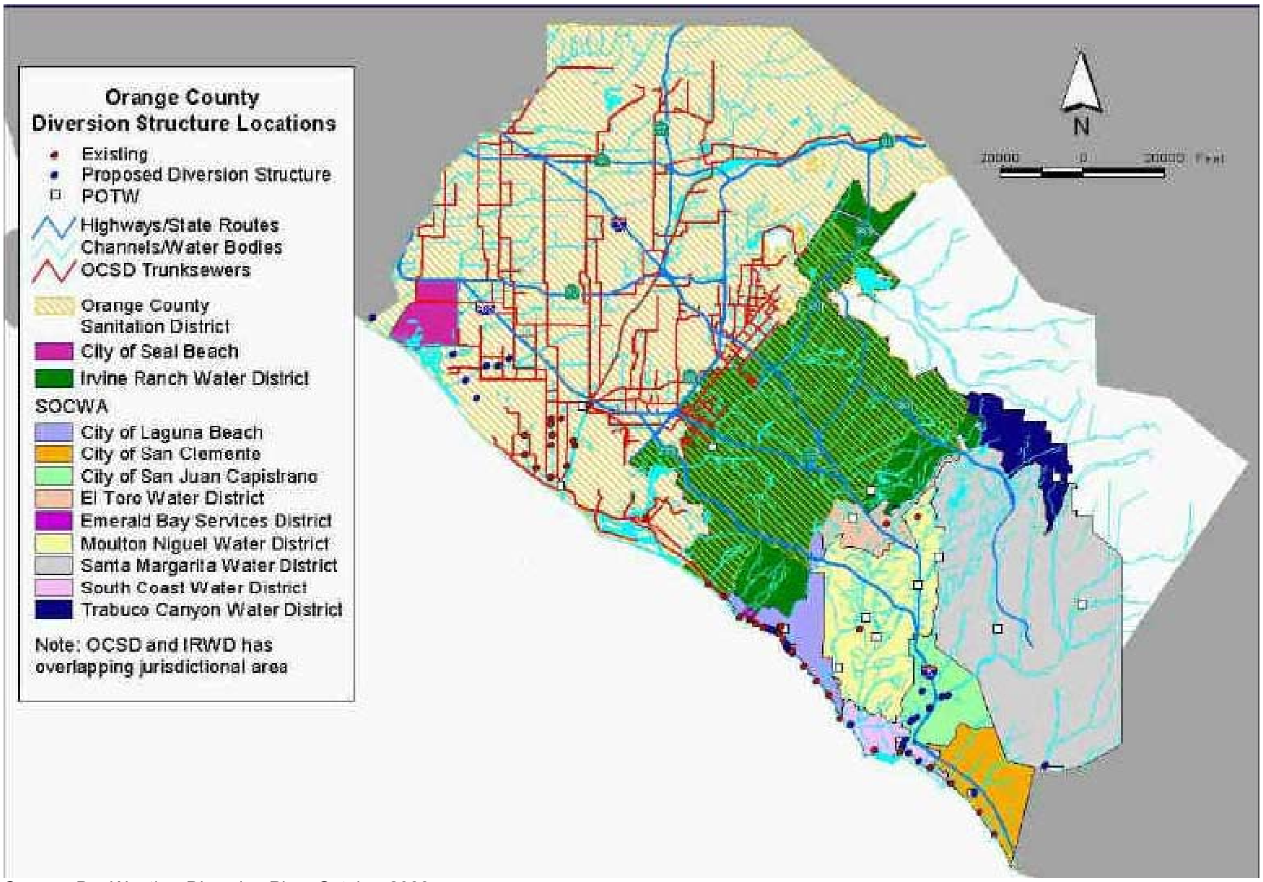
The Greenville-Banning Channel Urban Runoff Diversion (GBCURD) intercepts all dry weather urban runoff in the channel to prevent the runoff from reaching the Santa Ana River and then the ocean at Huntington State Beach. The physical diversion is an inflatable custom manufactured rubber dam (6.5 feet high by 60 feet long) placed in the Greenville Banning Channel upstream of the confluence with the Santa Ana River. Approximately 80 million gallons of urban runoff was diverted to OCSD for treatment during 2003 (Average flow 200,000 gpd). The County of Orange produced a report entitled, "Greenville Banning Channel Urban Runoff Diversion Project, Final Report" in April 2003, specifically to address findings from the Greenville Banning Channel Diversion

Table 2
List of Existing Low Flow Diversions

Location	Sanitary Sewer Treatment Agency	Permittee	Month/Year Built	Flow Diverted GPD
9731 Flounder Dr @ D02 (Flounder PS)	OCSD	Huntington Beach	Feb. 2000	72,000
9211 Yorktown Ave @ D02 (Yorktown PS)	OCSD	Huntington Beach	Feb. 2000	72,000
19661 Chesapeake Ln @ D02 (Adams PS)	OCSD	Huntington Beach	Feb. 2000	72,000
20192 Midland Ln @ E01 (Meredith PS)	OCSD	Huntington Beach	Feb. 2000	288,000
9221 Indianapolis Ave @ D02 (Indianapolis PS)	OCSD	Huntington Beach	Feb. 2000	144,000
8151 Atlanta Ave @ D01(Atlanta PS)	OCSD	Huntington Beach	July 1999	504,000
10101 Hamilton Ave @ E01 (Hamilton PS)	OCSD	Huntington Beach	Feb. 2000	144,000
2201 Malibu Ln @ D02 (Banning PS)	OCSD	Huntington Beach	July 1999	288,000
8612 Hamilton St @ D01(Newland PS)	OCSD	Huntington Beach	July 1999	288,000
1131 Back Bay Dr (Newport Dunes)	OCSD	Newport Beach	March 2001	8,640
Santa Ana Channel (E01)	OCSD	County of Orange	May 2001	295,000
Greenville-Banning Channel	OCSD	County of Orange	May 2001	215,000
Talbert Channel (D02)	OCSD	County of Orange	May 2001	120,000
Downstream of Adams Ave @ D01 (Huntington Beach)	OCSD	County of Orange	May 2001	-
Linda Ln @ Via Mecha	City of San Clemente	San Clemente	Aug. 2001	14,000
Camino del Estrella (est. location)	South Coast Water District (SCWD)	Dana Point	NA	1,000
Laguna Cyn @ Forest Ave	City of Laguna Beach	Laguna Beach	1987	140,000

Table 2 (continued) List of Existing Low Flow Diversions				
Location	Sanitary Sewer Treatment Agency	Permittee	Month/Year Built	Flow Diverted GPD
Bluebird Canyon	City of Laguna Beach	Laguna Beach	1997	30,000
Dumond Dr./Victoria Beach	City of Laguna Beach	Laguna Beach	1997	5,000
Fisherman's Cove	City of Laguna Beach	Laguna Beach	1998	2,000
El Paseo@Laguna Ave (Main Beach)	City of Laguna Beach	Laguna Beach	1998	10,000
5th Ave @ Coast Hwy	City of Laguna Beach	Laguna Beach	1999	2,000
Barranca St. @ Cliff Dr	City of Laguna Beach	Laguna Beach	2001	1,400
Cleo St. @ Gaviota	City of Laguna Beach	Laguna Beach	2001	35,000
Aliso Creek/ Sulphur Creek Confluence	Moulton Niguel Water District (MNWD)	Laguna Nigel	May 2000	175,000
Muddy Canyon	OCSD	Newport Beach/IRWD	April 2002	288,000
Los Trancos	OCSD	Newport Beach/IRWD	April 2002	288,000
Los Lobos (est. loc)	City of San Clement	San Clemente	Aug. 2001	29,000
Aliso Creek (J01) at mouth*	OCSD	County of Orange	May 2001	234,000
Riviera Beach (150 yards upstream of MO	City of San Clemente	San Clemente	-	29,000
Pump Station #1 (Emerald Point)	Emerald Bay Serice District (EBSD)	Laguna Beach	-	1,000
Three Arches Bay	SCWD	Laguna Beach	-	-
Dana Point Harbor-Baby Beach	SCWD	Dana Point	NA	1,300
Doheny State Beach	SCWD	Dana Point	NA	10,000
#118 Emerald Bay	EBSD	Laguna Beach	-	1,000
#206 Emerald Bay	EBSD	Laguna Beach	-	1,000
#101 Emerald Bay	EBSD	Laguna Beach	-	1,000
Crescent Bay Dr and Circle Way	City of Laguna Beach	Laguna Beach	2001	7,500

- Data not available
* Presently decommissioned



Source: Dry Weather Diversion Plan, October 2003
Orange County

Figure 3
Existing Low Flow Diversions Facilities in Orange County

Recharge (Infiltration) Basins

A number of basins that were designed for a variety of purposes exist throughout the Santa Ana Basin (Table 3). The design and intent of the some of these basins was not for bacteria removal, but rather to either recharge groundwater aquifers or reduce flood hazard potential downstream. Some basins were designed for both recharge of groundwater and for flood control purposes. SAWPA provided a GIS layer of basins throughout the Santa Ana Basin that includes recharge, flood control, and multifunction basins (Figure 4).

Table 3
Recharge Basins in Santa Ana River Watershed

Number	Agency	Name	Basin	County
1		Miller Basins	Santa Ana Forebay	Orange
2	Orange County Water District	Santa Ana River Forebay Rech.	Santa Ana Forebay	Orange County
3	Orange County Water District	Santiago Basin Rech. Ops.	Santa Ana Forebay	Orange County
4		Santiago Creek Basins	Santa Ana Forebay	Orange
5	San Bernardino Co. Flood Control	Montclair Basins	Chino I	San Bernardino
6		Cucamonga Basins North & South	Cucamonga	San Bernardino
7		Eighth Street Basins	Chino I	San Bernardino
8		Fifteenth Street Basin	Chino I	San Bernardino
9	Chino Basin Water Conservation District	Ely Basins	Chino II	San Bernardino
10		Red Hill Basin	Cucamonga	San Bernardino
11	Chino Basin Water Conservation District	Chris Basin	Chino II	San Bernardino
12	Chino Basin Water Conservation District	Lower Cucamonga Spr. Grounds	Chino II	San Bernardino
13		Turner Basins	Chino II	San Bernardino
14		Church Street Basin	Chino I	San Bernardino
15	Chino Basin Water Conservation District	Riverside Basins	Chino II	San Bernardino
16	Chino Basin Water Conservation District	Wineville Basin	Chino II	San Bernardino
17		Lower Day Creek Basin	Chino I	San Bernardino
18		Upper Day Creek Basins	Cucamonga	San Bernardino
19		Etiwanda Basin	Chino I	San Bernardino
20	San Bernardino Co. Flood Control District	Etiwanda Conservation Basins	Chino I	San Bernardino
21		East Ave. Spreading Grounds	Chino I	San Bernardino
22	San Bernardino Co. Flood Control District	Hickory Basin	Chino I	San Bernardino
23	San Bernardino Co. Flood Control District	Victoria Basin	Chino I	San Bernardino
24		East Etiwanda Creek Channel	Chino I	San Bernardino
25	San Bernardino Co. Flood Control District	Banana Basins	Chino I	San Bernardino
26	San Bernardino Co. Flood Control District	San Sevaine Spreading Area	Chino I	San Bernardino

Table 3 (continued)
Recharge Basins in Santa Ana River Watershed

Number	Agency	Name	Basin	County
27	Lytle Creek Water Conservation Assoc.	Lytle Creek Spreading Grounds	San Bern./Lytle Creek	San Bernardino
28		Merrill Basin	Chino I	San Bernardino
29		Linden	San Bernardino GW Basin	San Bernardino
30		Linden Basin	Chino I	San Bernardino
31		Mill Basin	Colton-Rialto	San Bernardino
32		Pepper Basin	Colton-Rialto	San Bernardino
33		Randall Basin	Colton-Rialto	San Bernardino
34	San Bernardino Co. Flood Control District	Devil Cyn/Swt. Spill. Spr. Gr.	San Bern./Bunker Hill	San Bernardino
35		Muscoy (North)	San Bernardino GW Basin	San Bernardino
36		Muscoy (South)	San Bernardino GW Basin	San Bernardino
37	Chino Basin Water Conservation District	Jurupa Basins	Chino II	San Bernardino
38		Mayfield	San Bernardino GW Basin	San Bernardino
39	San Bernardino Co. Flood Control District	Waterman Cyn. Spr. Grounds	San Bern./Bunker Hill	San Bernardino
40		Waterman (North)	San Bernardino GW Basin	San Bernardino
41		Waterman (South)	San Bernardino GW Basin	San Bernardino
42		Twin	San Bernardino GW Basin	San Bernardino
43		Marshall	San Bernardino GW Basin	San Bernardino
44		Patton	San Bernardino GW Basin	San Bernardino
45	San Bernardino Co. Flood Control District	City Creek Spreading Grounds	San Bern./Bunker Hill	San Bernardino
46	Eastern MWD	Skiland Ponds	Perris South II	Riverside
47	Eastern MWD	Winchester Ponds	Winchester	Riverside
48	San Bernardino Valley Water Conservation District	Santa Ana River Spr. Grounds	San Bern./Bunker Hill	San Bernardino
49	Eastern MWD	Salt Creek Water Harvesting	Winchester	Riverside
50	San Bernardino Valley Water Conservation District	Mill Creek Spreading Grounds	San Bern./Bunker Hill	San Bernardino
51	Eastern MWD	Fish & Game Wetlands	San Jacinto - Lower Pres.	Riverside

Table 3 (continued)
Recharge Basins in Santa Ana River Watershed

Number	Agency	Name	Basin	County
52	Eastern MWD	EMWD Trumble Ponds - Romoland	Perris South II	Riverside
53	San Bernardino Co. Flood Control District	Wilson Creek Spr. Grounds	San Bern./Bunker Hill	San Bernardino
54	Eastern MWD	San Jacinto Reservoir	San Jacinto - Upper Pres.	Riverside
55	Eastern MWD	Alessandro Ponds	San Jacinto - Upper Pres.	Riverside
56	Eastern MWD	SPW Recharge Ponds	San Jacinto Intake	Riverside
57	Eastern MWD	Fruitvale 20 Ac. Basins - (L)	San Jacinto Canyon	Riverside
58	Eastern MWD	Fruitvale 40 Ac. Basins - (U)	San Jacinto Canyon	Riverside
59	Chino Basin Water Conservation District	Brooks		
60	Chino Basin Water Conservation District	College Heights		
61	City of Upland	Upland		
62	San Bernardino County Flood Control District	Declez		
63	IEUA	RP3		
64		Thomson Creek SG		
65		San Antonio Dam		
66		Pomona SG		
67		Live Oak SG		
68	IEUA	Cucamonga SG1-2-3		
69	IEUA	Cucamonga 1		
70	IEUA	Cucamonga 2		
71	IEUA	Alta Loma 1-2		
72	IEUA	Turner 1		
73	IEUA	Turner 2-3-4		
74	IEUA	Turner 5-8-9		
75	IEUA	Grove Ave. Basin		
76	IEUA	Jurupa		
77	IEUA	San Sevaine 2		
78	IEUA	San Sevaine 1		
79	IEUA	Rich		

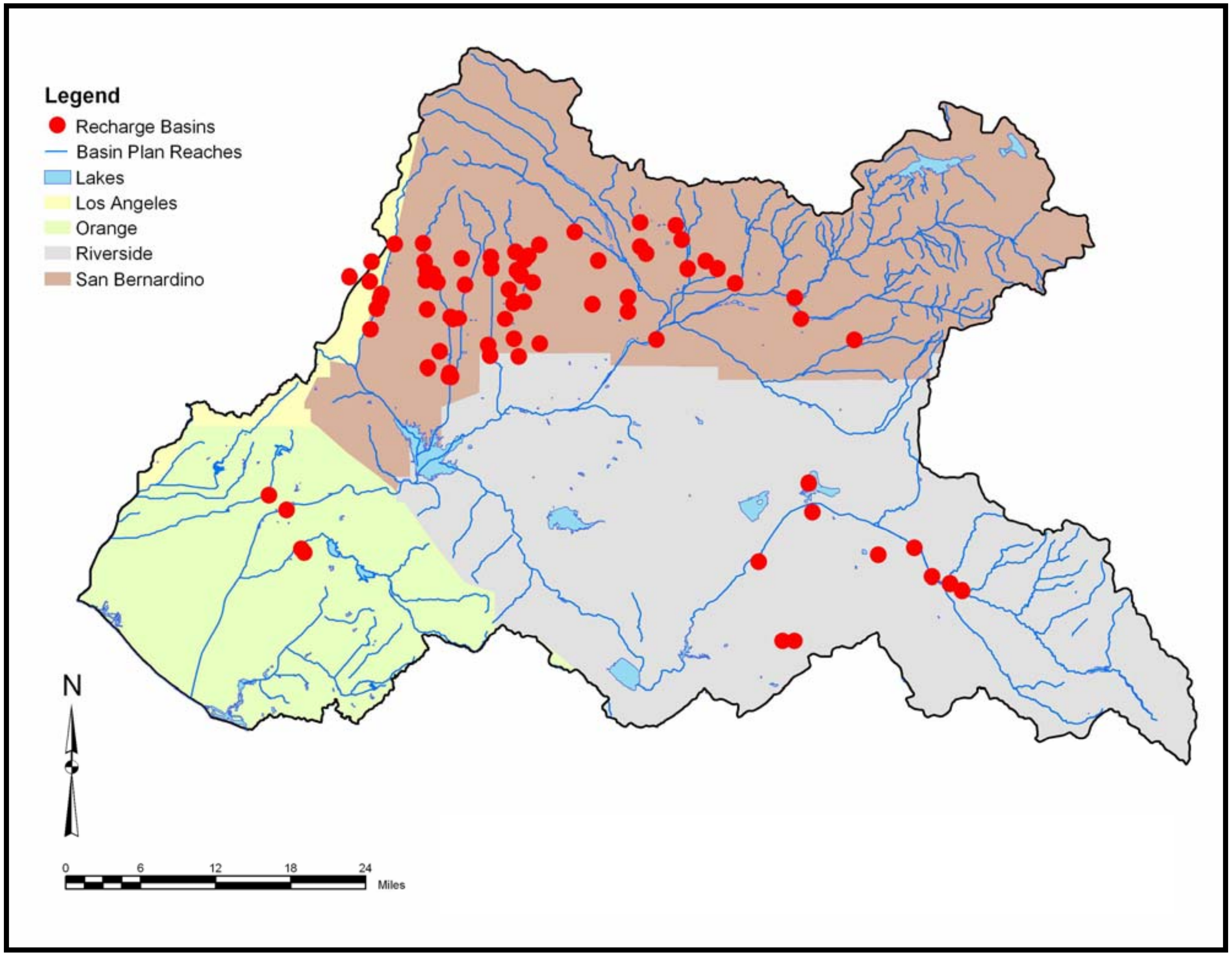


Figure 4
Surface Water Basins with Potential for Bacteria Reduction

Recharge, flood control, or multi-function surface water basins may also be reducing bacteria in downstream receiving waters. This water quality functionality is achieved by filtration and removal through adsorption and decay within the soil matrix and underlying formation. The Santa Ana Regional Water Quality Control Board encourages basin owners to look for opportunities to retrofit surface water basins for water quality improvement. This can be accomplished by facilitating infiltration or through construction of multi-stage outlets.

Orange County Water District (OCWD) operates and maintains a man-made series of T-levees within the Santa Ana River near Imperial Highway to increase groundwater recharge capacity. The levees are constructed along side the River and receive low flows from a diversion structure. The levees provide for spreading, slowing, and retention of River flows primarily to increase groundwater infiltration rates. During low flow periods, increased spreading decreases the amount of water flowing through the River, and provides for increased settling, both conditions that can decrease the amount of bacteria and pathogens within the River, potentially improving water quality.

Natural Treatment Wetlands / Wet Ponds

In its June 2003 study, Appendix E1 – BMP Effectiveness and Applicability for Orange County, wet ponds and wetlands are described as being particularly effective in reducing bacteria levels from dry weather flows diverted to the wet ponds. Examples of wet ponds/ wetlands in the Santa Ana basin are described below. Attachment A to this technical memorandum is an inventory of existing or planned wetland BMPs within the Santa Ana Basin.

Natural Treatment System (NTS) - Irvine Ranch Water District

The proposed Irvine Ranch Water District Natural Treatment System (NTS) is a network of 31 water quality wetlands designed to remove sediment, nutrients, pathogens, and other pollutants from urban runoff within the San Diego Creek Watershed to improve water quality in Upper Newport Bay. The 31 sites are located throughout the cities of Irvine, Tustin, Lake Forest, Newport Beach, Orange, and in unincorporated areas of Orange County.

The primary drainage channel in the treatment area is San Diego Creek and its main tributary, Peters Canyon Wash. San Diego Creek flows into Upper Newport Bay, which contains the 752 acre Upper Newport Bay Ecological Reserve. This coastal estuary is one of the largest remaining estuaries in Southern California.

Three basic facility types are proposed in the NTS. These include off-line, in-line, and combination treatment facilities. The off-line treatment type treats dry weather and wet weather low flows. Flows would divert to open water ponds. The ponds reduce flow velocities and trap sediment and aid in ultraviolet (UV) degradation of pathogens.

The in-line treatment facilities consist of a water quality treatment wetland located within existing stream channels. Wetland vegetation would be located in shallow ponds behind a series of constructed weirs within the channels.

The combination facilities would be built in existing flood control basins. While maintaining the flood control storage volume, the basin would be altered to accommodate constructed wetland areas. A separate outlet from the basin is required to remove flows from treatment wetland. Besides dry weather low flows and wet weather low flows, first flush from storms are designed to be removed from the combination type facility.

The NTS program is anticipated to result in reduced fecal coliform concentrations. The fecal coliform TMDL for Upper Newport Bay is expected to be met during the dry season. During wet weather, the fecal coliform TMDL may be met for low flow conditions but is not expected to be met during storm conditions.

San Joaquin Marsh
The San Joaquin Marsh is the largest coastal freshwater wetlands in Southern California. This 500 acre marsh is adjacent to the University of California, Irvine, and bounded by the San Diego Creek, Michelson Drive, and Carlson Drives. IRWD owns approximately 300 acres of the marsh, of which 150 acres were restored and enhanced in 1997. The University of California Natural Reserve System owns the remaining 200 acres. The restoration project re-established a water supply by diverting dry weather flows from San Diego Creek into a series of ponds for several days before most of the flow is returned to San Diego Creek, about a mile upstream of Newport Bay. The water released back to the creek has about a 50% reduction of nitrates prior to treatment. The primary goal of the marsh is to reduce nutrient concentrations in the San Diego Creek discharge to Newport Bay. Nutrient reduction of nitrogen and phosphorus reduces algae bloom and its effect of oxygen depletion. Approximately, 50,000 tons of sediment and 10,000 pounds of phosphorus are removed each year in desilting basins.

No specific studies were identified which have evaluated the specific effects on bacteria reduction by the San Joaquin Marsh.

Hidden Valley Wetlands Enhancement Project
The Hidden Valley Wetlands Enhancement Project (WEP) was developed in the Hidden Valley Wildlife Area (HVWA) in order to restore and improve existing wetlands within the HVWA by supplying tertiary treated effluent from the City of Riverside Regional Water Quality Control Plant (RWQCP). Within the WEP boundary, there is approximately 37 acres of constructed wetlands. HVWA is operated by the County of Riverside Parks and Open Space Department under a cooperative agreement with the California Department of Fish and Game.

WEP is a multi-purpose project aiming to provide the following:

- De-nitrification
- Enhancement of environment for riparian habitat for native and migratory wildlife species
- Groundwater recharge
- Basis of research for natural treatment processes design criteria

While reducing the nitrogen in the effluent, no specific studies have been conducted to determine the impact, if any, on reducing pathogens.

Prado Wetlands, Orange County Water District
Orange County Water District (OCWD) owns approximately 2,150 acres behind Prado Dam. Of this land, 465 acres are constructed wetlands. The wetland system consists of 50 shallow ponds used for reduction of nitrogen levels in the Santa Ana River since 1992. The Santa Ana River consists mainly of tertiary treated wastewater from upstream discharges. Since the Santa Ana River is the main source of water for groundwater recharge in Orange County, nitrogen levels in the water have been reduced prior to its use as recharge for the groundwater basins. This wetland system removes approximately 20 tons of nitrates per month.

Currently, the base flow of the river is approximately 120 cubic feet per second (cfs), with 60 cfs traveling through the wetland. The base flow of the river potentially may increase beyond 200 cfs due to population increases (and subsequent increases of recycled water discharge) in Riverside and San Bernardino Counties. In order to handle this potential increase in base flows, modifications have been made to increase the hydraulic capacity of the Prado Wetlands pond system.

Since 1999, OCWD has also conducted water quality monitoring of influent and effluent from the Prado Wetlands and analyzed for coliform, E.coli, and enterococci.

Optimal Basin Management Plan – Chino Basin
Chino Basin Watermaster is developing the Optimum Basin Management Program (OBMP). The Chino Basin consists of approximately 235 square miles of the upper Santa Ana River watershed. The Chino Basin is one of the largest groundwater basins in southern California.

The OBMP consists of nine key elements covering a wide range of water activity in the Basin. The OBMP elements as a whole are aimed to develop a groundwater management program that enhances the yield and quality of the Chino Basin. One of the missions of the plan is to increase the Basin water supplies by utilizing stormwater and reclaimed water recharge. The plan is composed of nine program elements which include:

- Comprehensive Monitoring
- Comprehensive Recharge
- Water Supply Plan for Impaired Areas
- Management Zone Strategies
- Regional Supplemental Water Program
- Cooperative Program
- Salt Management Program
- Groundwater Storage Management
- Storage and Recovery Program

The second element, Comprehensive Recharge, has a component that aims to capture wet weather storm flows for recharge to infiltration basins. The resulting reduction in urban runoff downstream could reduce bacteria levels. The Chino Basin Watermaster is looking at obtaining increased recharge capacity by expanding recharge capacity at Montclair Basins, Upland Basins, and Brooks Basins.

Other Emerging Technologies

There are several other emerging technologies that can be utilized to retrofit existing structural BMPS or for implementing in targeting reaches of impacted receiving waters. These alternative technologies include:

- Filtration

Several filtration technologies have been developed for treatment of urban runoff, some of which are specifically designed or indirectly effective at removing bacteria. Treatment devices range from highly specialized proprietary technologies to more conventional media filtration, such sand filters.

Sand filters function by filtering stormwater through sand media, and may be installed underground in trenches or pre-cast concrete boxes, or above ground. Large, above ground sand filters have been used with success for larger drainage areas. Pretreatment to remove large debris and other materials that can hinder sand filter performance is typically necessary. Sand filters have proven moderately effective at removing bacteria. Results have varied based upon site and climatic differences.

Sand filter designs include the surface sand filter basin (Austin sand filter), the underground vault sand filter (Washington, DC sand filter), the double trench sand filter (Delaware sand filter), the stone reservoir trench sand filter, and the peat sand filter system. Modifications are often made to these designs based on site-specific conditions.

A large amount of testing data is available for conventional media filtration for bacteria removal, with some studies showing high removal effectiveness. The ability of media filtration to meet bacterial water quality objectives would depend on source runoff conditions.

Media filtration is also the functional component of several proprietary devices advertised to remove bacteria. Several different configurations of proprietary devices are available through various vendors, though limited application and effectiveness data is available.

- Ozone

Ozone has been used in the water treatment industry since the late 1800s for disinfection, odor control, and other applications. Ozone is generated by an electrical discharge through either dry air or pure oxygen. As an oxidant, ozone is preferred to chlorine due to its extremely efficient disinfection properties and ability to dissipate very rapidly in water, leaving no residuals. Ozone is also considerably less hazardous to handle than chlorine. These properties have made ozone an effective chemical for water treatment for nearly a century. It is, however, a very expensive chemical to use for disinfection.

Ozone, like chlorine, is a strong oxidizing agent and is used in much the same manner. It is an excellent virucide, is effective against most amoebic cysts, and destroys bacteria and phenols. Ozone may not kill large cysts and some other large organisms, so these should be eliminated by filtration or other procedures prior to treatment.

- Ultraviolet Disinfection

Ultraviolet (UV) treatment is an emerging treatment technology for controlling bacteria and pathogens within urban runoff. The technology has been generally accepted in conventional water and wastewater treatment, but also has potential for treatment of urban runoff.

Conventional ultra-violet (UV) treatment technology involves passing water by a special UV light source. The light source is immersed in the water in a protective transparent sleeve, and emits UV waves that can inactivate microorganisms. The ultra-violet rays, similar to the sun's UV rays only stronger, alter the nucleic makeup of viruses, bacteria, molds, and parasites so that they cannot reproduce, and are thus inactivated. UV treatment does not alter the water chemically as nothing is added except light energy. UV treatment does not permanently divert stream flows, does not require chemical storage, and does not produce a chemical residual. Pretreatment of flows is necessary to remove sediments and other constituents prior to UV light exposure, to improve the clarity of water for increased UV light penetration.

Two Southern California examples of UV application for treating urban runoff include systems installed and operated at Moonlight Beach within Cottonwood Creek in Encinitas, and within a storm drain that discharges into Aliso Creek in Laguna Niguel, neither of which are in the Santa Ana Basin.

The Cottonwood Creek UV system installation became operational in December 2002. Cottonwood Creek flows year-round from Encinitas Ranch golf course to Moonlight Beach, draining a watershed of approximately three square miles. Most of the Creek is buried under strip malls, residential communities, and streets. The system has capacity to treat a rate of 200,000 gallons per day. The system is operated only during the dry season, and deactivated during the winter. The City is treating 85 percent of the Creek's flow, bypassing 15 percent of the flow to allow some nutrient contribution to the Creek and the beach. Water is collected directly from the Creek. The UV system was installed for $470,000, and monthly O&M costs are expected to be under $1,000.

The UV system installed within the storm drain tributary to Aliso Creek in Laguna Nigel can also process 200,000 gallons per day. Flow is collected at the storm drain, treated, and discharged to nearby pond. The system is contractually operated at $664 per million gallons treated—averaging $3,000 a month. The system is considered temporary. Plans are to replace it with a system that will carry dry season flow into a series of constructed wetlands for treatment.

To adapt to variable flow rates or organic loading, flow equalization or recirculation is often used. Had ozonation been selected for the Moonlight Beach project, a monitored side stream of minimal flow would have been continuously re-circulated and injected with ozone. In the event of high ozone levels, an automated ozone system would have shut down the re-circulating stream.

In addition to pretreatment filtration, ozone generators, and ozone destruct units, a complete disinfection system requires ozone injectors and injector pumps, a closed-loop chiller, an ozone concentrator, oil-free compressors, an air receiver, an ozone contactor, and an ozone separator. Most of the equipment would have had to fit in the required footprint inside an enclosure, with ozone contact and destruct basins located above or below ground. The investigated system could have met the city's acoustical requirements with some attenuation.

The major benefit of ozone treatment is that ozone is extremely active as a disinfectant. In contrast to chlorine, ozone is active over a wide pH and temperature range. The required contact time is so short that it is not a consideration in system design.

Attachment A

Attachment A
Planned or Operating Wetlands in the Santa Ana Basin

Project	Owner	Location	Status	BMP Type	Objectives	Description
Hidden Valley Wetlands Enhancement Project	City of Riverside	Hidden Valley Wildlife Area	Operational	Natural treatment wetlands Wastewater treatment	Total organic nitrogen TMDL (1991) 10 mg/l; protection of groundwater basins Purposes: de-nitrification of tertiary effluent; environmental enhancements for riparian habitat; groundwater recharge; improvements to public use; research and development	Influent structure, conveyance channel, wetlands ponds; Average TIN removal in 2003 – 43% in surface flow; 38% in sub-surface flow; No specific studies conducted on potential pathogen reduction.
San Joaquin Marsh	Irvine Ranch Water District	San Diego Creek, Orange County	Five wetlands are operational	Natural treatment wetlands Runoff treatment	Nitrate and sediment removal	Currently IRWD is operating water quality treatment wetlands with 45 acres of open water and 11 acres of marshland vegetation. Water is diverted from San Diego Creek to marsh and circulated through ponds. Nitrogen loads to Newport Bay are reduced by 50%; No specific studies conducted on potential pathogen reduction.
San Diego Creek Watershed Natural Treatment System	Irvine Ranch Water District	San Diego Creek, Orange County	31 new wetlands are being planned	Natural treatment Wetlands Runoff treatment	Achieving TMDL targets for total nitrogen for dry season low flow conditions of 2007 and wet season low flow conditions by 2012. Achieve total phosphorous TMDL targets for 2002 and 2012 during stormwater runoff. Reduction in fecal coliform concentrations; fecal coliform TMDL will be met during the dry season only. Some facilities will be designed to remove selenium to meet TMDLs.	Proposed off-stream, in-stream and combined wetlands will treat low and runoff from small events, and first-flush from large storm events. Some of the proposed facilities will treat only dry weather flows. Aims to reduce fecal coliform loads.

Attachment A (continued)
Planned or Operating Wetlands in the Santa Ana Basin

Project	Owner	Location	Status	BMP Type	Objectives	Description
Prado Wetland	Orange County Water District	At Prado Dam in Riverside County	Operational	Wetlands for treatment of Santa Ana River flows	Nitrogen removal	465 acres of constructed wetlands consisting of 50 shallow ponds that remove approximately 20 tons of nitrate per month; OCWD has tested for coliform, E.coli, and enterococci pathogens since 1999.
Crystal Cove	The Irvine Company	Crystal Cove, Orange County	Operational	Detention and filtration; low-flow diversion to sewer system; storm-drain filters; wetlands	Eliminate low-flow during dry weather; remove sediments, bacteria and trash from runoff	Runoff control for residential development. Detention and filtration; low-flow diversion to sewer system; storm-drain filters; wetlands
Urban Runoff Diversion Projects – Greenville Banning Channel, Talbert Channel, Lower Santa Ana River, and Huntington Beach Channel	County of Orange	Santa Ana River Watershed, Orange County	Operational	Inflatable dams to divert urban runoff low flow to the sewer system	To reduce the number of beach-mile-days postings at Huntington State Beach by diverting urban runoff water to OCSD for treatment. The projects reduce the loading of fecal and total coliform bacteria reaching the ocean during dry-weather that contribute to beach closures	The four inflatable dams divert low flow urban runoff during dry weather to the sewer system for treatment at OCSD facilities.
Lytle Creek North	???	???	Proposed???	Infiltration basins and vegetated wet basins	TSS, Total N, Total P, Lead, Zinc, total hydrocarbons, fecal coliform, BOD removal	Four infiltration basins; two of them with vegetated wet basins to treat nuisance flows, and two with dry forebays
Orange Coast River Park	Friends of Harbors, Beaches and Parks	Lower end of Santa Ana River	Concept	Recreational park and programs	Enhance/restore ecological functions, improve habitat, recreation	1000-1400 acre park by Santa Ana River – trails, shared support facilities, and wildlife habitat and park management program; Continue wetland restoration at Huntington-Talbert Marsh area.

Attachment A (continued)
Planned or Operating Structural BMPs in the Santa Ana Basin

Project	Owner	Location	Status	BMP Type	Objectives	Description
Constructed Wetlands – Bolsa Chica Channel	County of Orange Public Facilities and Resources Dept.	Bolsa Chica Channel	Feasibility Study	Wetland system for urban runoff	Enhance/restore ecological functions, improve habitat, improve water quality	Route urban runoff from the Bolsa Chica Channel through wetlands constructed on property by the Seal Beach Naval Weapons Station. Detention system, vegetation system, and upstream debris removal included.
Chino Creek Wetlands	Orange County Water District	Chino Creek just above Prado Dam	CEQA Complete	Constructed wetlands	Restore/improve ecological habitat	100 acres of constructed wetlands to reduce nitrates/TIN in drinking water
Natural Treatment System – East Garden Grove Channel	City of Huntington Beach	East Garden Grove	In process	Wetland system and groundwater/surface water improvements	Divert urban runoff, rehabilitate surface water, recharge aquifer	Divert up to 4 mgd urban runoff into 2-acre wetland; treated water would rehabilitate Talbert Lake and recharge Huntington Beach Central Park aquifer; public education/outreach
Prado River Road Wetlands Expansion	Orange County Water District	Orange County, River Road	CEQA Complete	Constructed wetlands	Restore/improve ecological habitat, water quality	200 acres of constructed wetlands above River Road bridge to treat Santa Ana River flows; reduce nitrates/TIN in drinking water
Regional Plant Coordinated Habitat and Stormwater Management Plan	Inland Empire Utilities Agency	Inland Empire, Prado Basin	N/A	BMPs	Improve water/habitat/ ecosystem quality	IEUA properties site -plan to use BMPs for stormwater management, organics processing, habitat/water conservation

Attachment A (continued)
Planned or Operating Structural BMPs in the Santa Ana Basin

Project	Owner	Location	Status	BMP Type	Objectives	Description
Temescal Creek Riparian Enhancement	Riverside/ Corona	Temescal Creek	Ongoing planning	Habitat restoration	Improve ecosystem/water quality	50 acres of riparian habitat restoration, small ponds for fresh water marsh/water use; reintroduce native vegetation
Lake Elsinore Nutrient Removal (Wetlands)	Lake Elsinore/ San Jacinto Watersheds Authority	Lake Elsinore	Planning	Constructed wetlands	Improve habitat/ water quality	Construct wetlands and implementing other nutrient control measures for Lake Elsinore
Nutrient Removal Eastern Municipal Water District Water Reclamation Plants	Lake Elsinore/ San Jacinto Watersheds Authority	Eastern Municipal Water District Reclamation Plants	Planning	Improvements to Water Reclamation Plants	Improve habitat/ water quality	Increase nitrogen/phosphorus removal capacities at EMWD Water Reclamation Plants, which discharge into Lake Elsinore
Installation of Aeration Systems and Oxygenation System	City of Canyon Lake, County of Riverside	Canyon Lake, Riverside County	Planning	Structural water quality improvements	Improve water quality/ recreational	Install oxygenation systems to improve drinking water of Canyon Lake and water quality for recreational users
San Timoteo Canyon State Park	Riverside Land Conservancy	San Timoteo Canyon State Park	Planning	Creation of new state park	Enhance ecology, improve habitat/ water quality	Create new state park centered around San Timoteo Creek Watershed; create, restore, and protect wetlands
San Timoteo Habitat Enhancement Project	East Valley Resource Conservation District	San Timoteo Creek	Ongoing	Restore tributary to natural state	Restore ecology, improve habitat/water quality	Restore tributary by removing trash/debris in creek bed
San Jacinto Wildlife Area Environmental Enhancement and Recycled Water Storage Initiative	Eastern Municipal Water District	San Jacinto Wildlife Area	Ongoing	Wetlands restoration, water conservation	Restore ecology, improve habitat/water quality	Use recycled water for restoring historic wetlands; recycled water conservation; groundwater management

Attachment A (continued)
Planned or Operating Structural BMPs in the Santa Ana Basin

Project	Owner	Location	Status	BMP Type	Objectives	Description
San Jacinto Flow through Wetlands	Lake Elsinore San Jacinto Watershed Authority	San Jacinto River area	Planning	Constructed wetlands	Improve habitat/ water quality	Create flow-through wetland to enhance habitat and remove nutrients from San Jacinto River from Canyon Lake to Lakeshore Drive
San Jacinto River Project	Riverside County Flood Control and Water Conservation District	San Jacinto River area	Planning	Increase river width	Enhance ecology; improve habitat; flood control	Increase San Jacinto River width from 500-1200 feet to help with flood control and habitat improvement
Wetlands and Habitat Conservation Area	City of Ontario	City of Ontario	CEQA Complete	Constructed wetlands	Enhance/improve ecology/water quality/ habitat; education; recreation	Conjunctive uses with wetlands construction; 85 acres of restoration and 145 acres of land acquisition
Cucamonga Creek Wetlands	Inland Empire Utilities Agency	Cucamonga Creek, Inland Empire Utilities Agency	Planning	Constructed wetlands	Enhance ecology; improve habitat	Construct wetlands for natural treatment of Cucamonga Creek
Santa Ana River Wetlands (Mission Zanja Creek Channel)	San Bernardino County Dept. of Public Works, Regional Trails Division	Mission Zanja Creek Channel	Planning	Constructed wetlands	Enhance ecology; improve habitat/water quality	Create wetlands via removal of nonnative vegetation, planting of native species; put in place signage, boardwalk, bike path for access and educational opportunities
San Timoteo Wetlands	NA	San Timoteo Canyon	NA	Create, restore, protect wetlands	Enhance and restore habitat; improve water quality	Increase water quantity and quality by protecting/enhancing floodplains in San Timoteo Canyon and major tributaries beginning at Loma Linda
Yucaipa Valley Water District Wetlands Enhancement	Yucaipa Valley Water District	Yucaipa Valley, San Timoteo Creek	Planning	Constructed wetlands	Recreation; education; improve water quality	Constructed 30-acre wetlands in YVWD region prior to discharge to San Timoteo Creek; includes pipelines, hydraulic control structures

Attachment A (continued)
Planned or Operating Structural BMPs in the Santa Ana Basin

Project	Owner	Location	Status	BMP Type	Objectives	Description
Wilson and Polato Creek Watershed Plan	City of Yucaipa	Wilson and Polato Creeks	Planning	Constructed spillover detention basins	Improve habitat/ water quality; water conservation	Basins for flood control, groundwater recharge, habitat preservation in Wilson/Polato Creeks
Noble Creek/ Marshall Creek Wetland Project	Beaumont-Cherry Valley Water District	City of Beaumont	Planning	Utilize recycled water for wetlands construction	Improve water quality	Based on Recycled Water Master Plan; use recycled water for constructing wetlands and recharging groundwater to Beaumont Storage Unit
Native and Treatment Wetlands	NA	Orange, Riverside, San Bernardino Counties	Program Adoption	Restore wetlands; create treatment wetlands	Improve habitat/ ecosystem/ water quality; flood control	5-year program to identify projects where water quality improvements are most critical, promote wetlands restoration/construction