APPENDIX A

Priority and Highest Priority Water Quality Condition Selection Methodology

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APPENDIX A – Methodology for Selecting Priority and Highest Priority Water Quality Conditions

The methodology to select the priority and highest priority water quality conditions follows four steps.

Step 1: Determine Receiving Water Conditions (Permit B.2.a). The goal of the receiving water assessment is to determine the receiving water conditions in the watershed. Some receiving water conditions may be selected as priority water quality conditions if there is sufficient data showing that the MS4 is causing and contributing to the receiving water condition or if it is suspected that the MS4 may be causing and contributing but there is a gap in the data.

a. Information and data to evaluate receiving waters conditions includes:
   i. TMDLs;
   ii. 303(d) listings to determine impaired beneficial uses;
   iii. Sources that are provided as part of the 303(d) listing. (This is important if the 303(d) listing has called out the MS4 as a source);
   iv. RW limits for appropriate segments;
   v. Historic and current data from the LTEA and WURMP. (Associate a NPDES monitoring location with each watershed when available. The priorities listed by these documents exceed water quality benchmarks.); and
   vi. 3rd party data submitted in response to public data call.
b. Determine a receiving water condition based on the following criteria:
   i. TMDLs in the watershed applied upstream where appropriate;
   ii. All 303(d) listings;
   iii. All additional receiving water conditions indentified by reviewing historic and current monitoring data; and
   iv. 3rd party data submitted in response to public data call.

Step 2: Determine Potential Receiving Water Impacts from MS4 Discharges (Permit B.2.b). Review MS4 Monitoring Data to determine potential receiving water impacts associated with MS4 discharges by assessing the following:

a. Outfall monitoring data provided in the WURMP and LTEA. (It is important to note that often only one MS4 wet weather outfall location is associated with each NPDES monitoring location, meaning that the analysis is done at the subwatershed level and not in the receiving water);
b. WQBELs where appropriate;
c. The 303(d) listing identifies the MS4 as a source; and
d. 3rd party data submitted in response to public data call.

Step 3: Determine Priority Water Quality Conditions (Permit B.2.c.(1)). The goal of this step is to select the priority water quality conditions by analyzing the receiving water conditions based on the potential for the MS4 to cause and contribute to the condition. Priority water quality conditions may be identified based on the following criteria:

a. MS4 subwatershed outfall data compared to the receiving water condition. If the subwatershed level outfall data shows that MS4 is causing and contributing to the receiving water condition then it may be considered a priority water quality condition;
b. If there is no outfall monitoring data associated with the receiving water condition, the 303(d) listing will be referenced to determine if the MS4 is included as a source. If the MS4 is listed as a source, this receiving water condition may be considered a priority water quality condition with a data gap; and
c. Consider 3rd party input submitted in response to public data call.

Step 4: Determine Highest Priority Water Quality Condition(s) (Permit B.2.c.(2)). The MS4 Permit requires the Copermittees to identify the highest priority water quality conditions to be addressed by the Water Quality Improvement Plan, and provide a rationale for selecting a subset of the priority water quality conditions identified in Step 3. Because the MS4 Permit requires the development and identification of numeric goals, strategies, and schedules for the highest priority water quality conditions, a scientifically-based screening analysis of priority water quality conditions was applied. Conditions already subject to an approved TMDL, ASBS or other water quality regulation will be elevated to highest priority water quality condition.

The Responsible Agencies will identify priority water quality conditions not subject to an approved water quality regulation as a highest priority based on the following factors:

a. The supporting data set is sufficient to adequately characterize the degree to which the priority water quality condition changes seasonally, and over geographic area, to support its consideration as a highest priority water quality condition.
b. Storm water/ non-storm water runoff is a predominant source for the priority water quality condition.
c. The priority water quality condition is controllable by the Responsible Agencies.
d. The priority water quality condition would not be addressed by strategies identified for other highest priority water quality conditions in this Water Quality Improvement Plan.

APPENDIX B

Mission Bay WMA Maps

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Table of Contents

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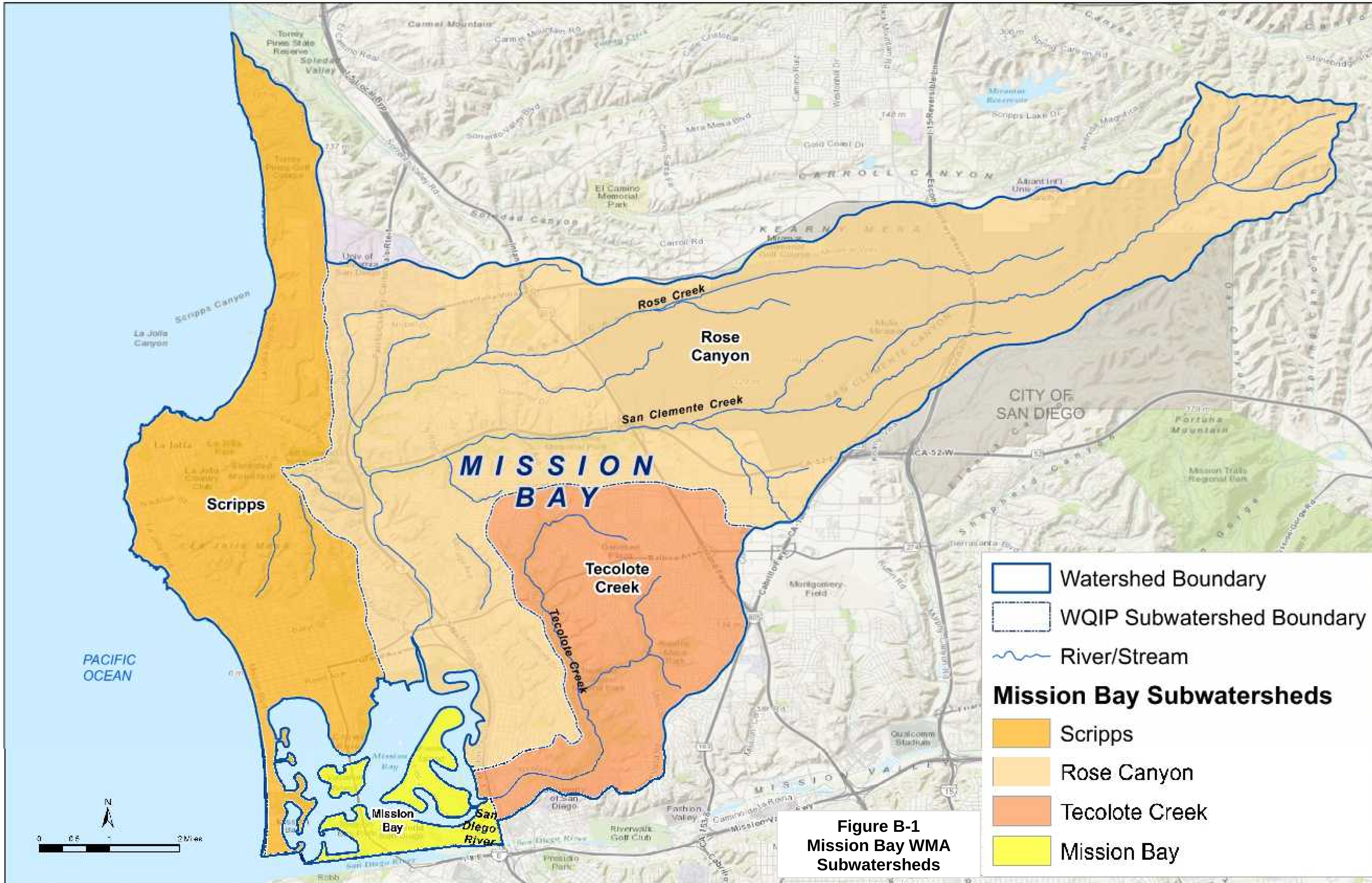

Figure B-1
Mission Bay WMA Subwatersheds

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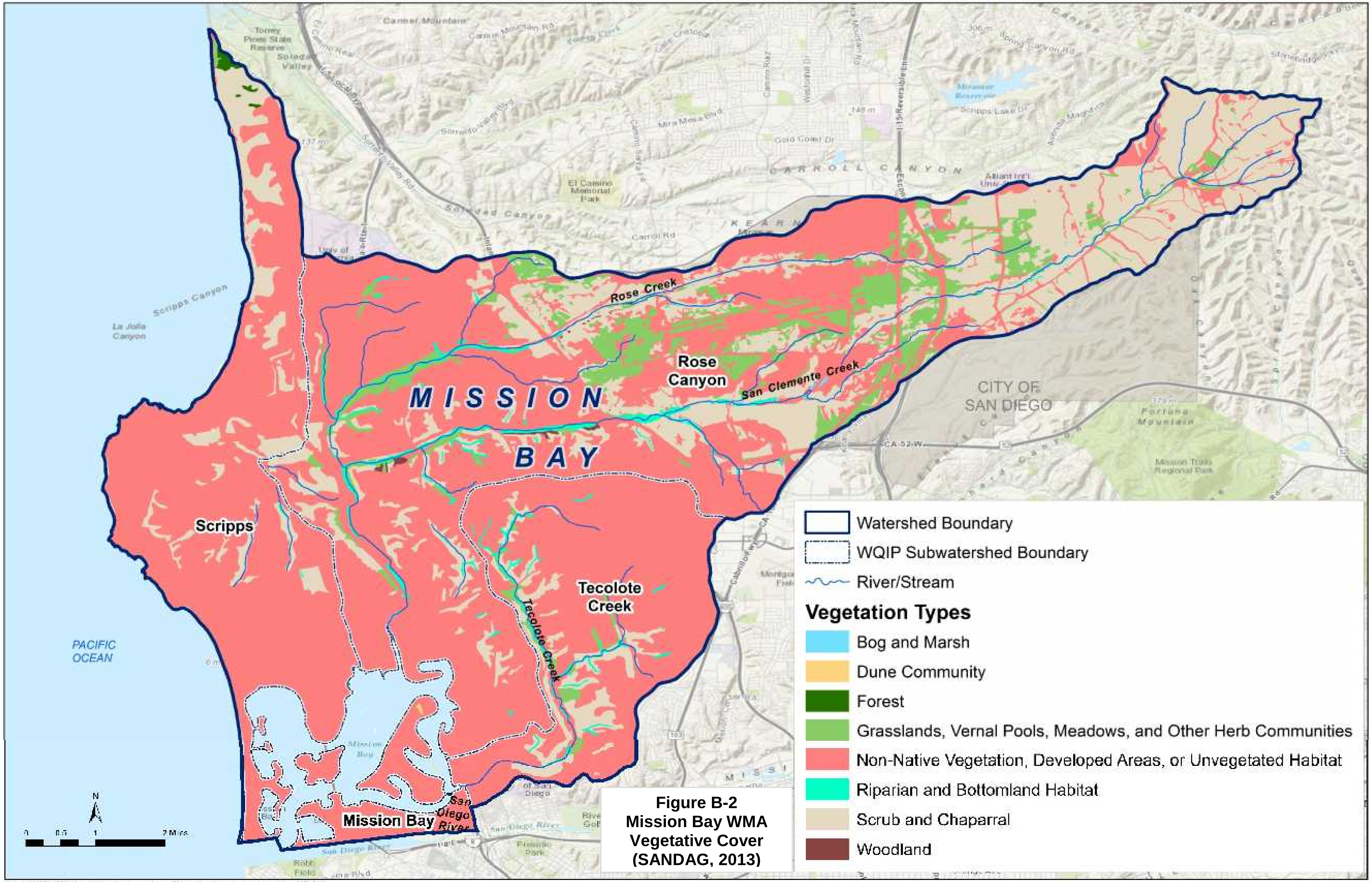

Figure B-2
Mission Bay WMA Vegetative Cover (SANDAG, 2013)

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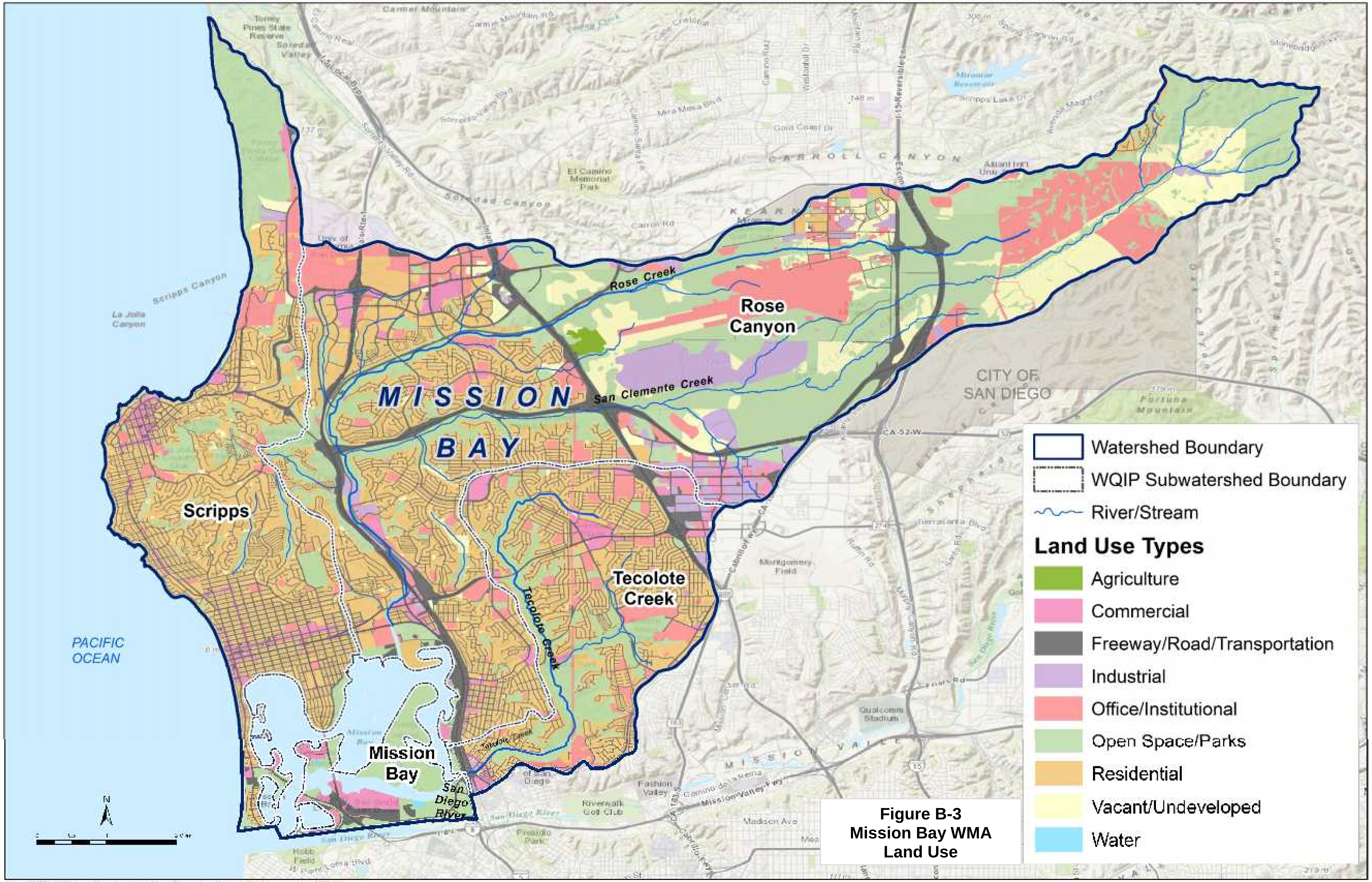

Figure B-3
Mission Bay WMA
Land Use

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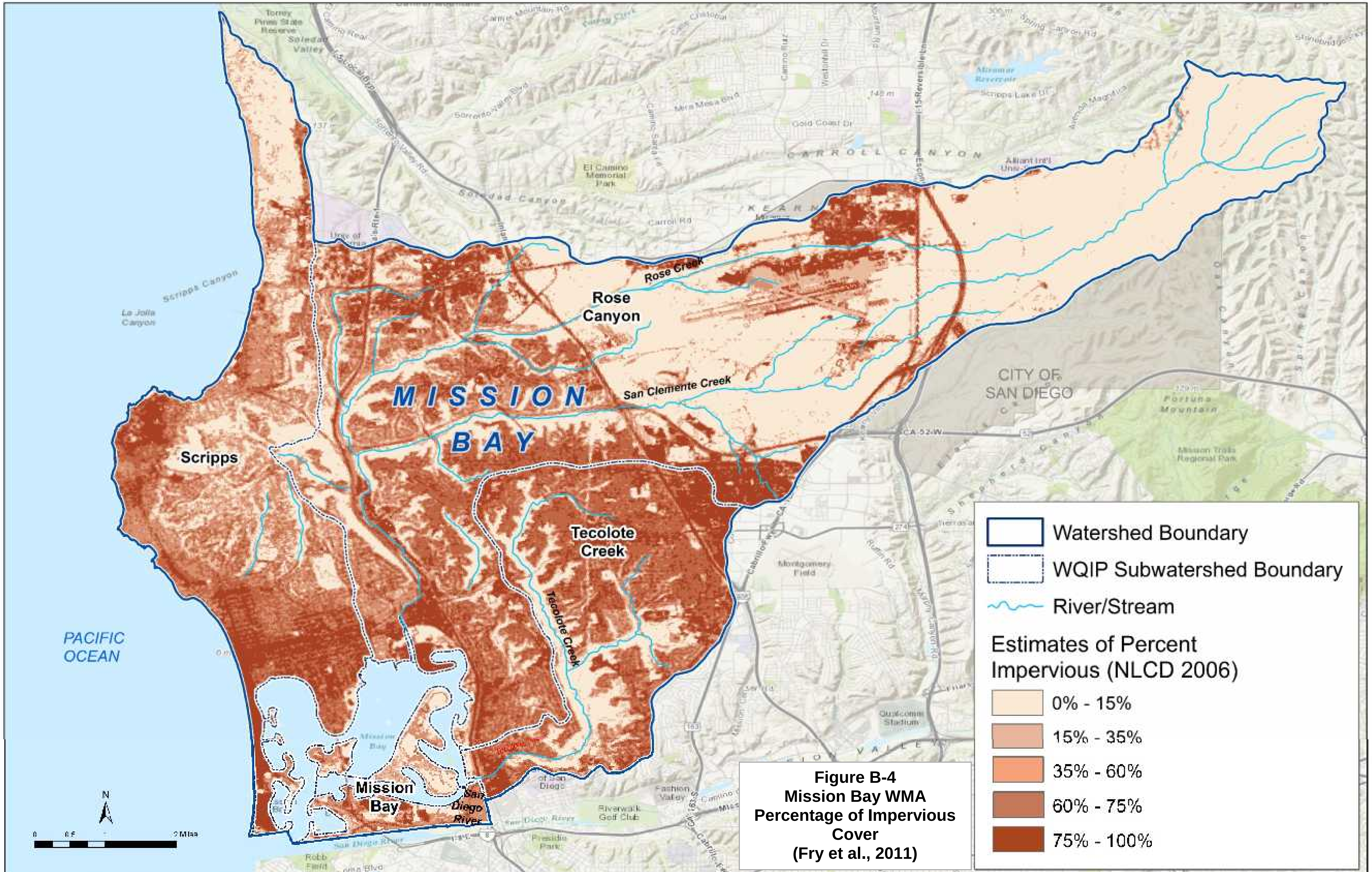

Figure B-4
Mission Bay WMA Percentage of Impervious Cover
(Fry et al., 2011)

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APPENDIX C

Beneficial Uses of 303(d) Listed Waterbodies in the Mission Bay WMA

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Table C-1 presents the beneficial use designations of the 303(d) listed waterbodies in the Mission Bay WMA. Beneficial uses specifically identified as impaired by the 2010 303(d) list are shaded blue. This table does not present waterbodies that were not identified as impaired on the 303(d) list. Approximately 72% of the beneficial uses in the Mission Bay WMA are not impaired or have not been assessed. Of those waterbodies that are listed as having impairments, most beneficial uses are attained.

Table C-1
Beneficial Uses of the 2010 303(d) Listed Waterbodies in the Mission Bay WMA

303(d) Listed Waterbody Name	Beneficial Use															
	MUN	IND	REC1	REC2	BIOL	WARM	WILD	RARE	SPWN	NAV	COMM	EST	MAR	AQUA	MIGR	SHELL
Rose Creek (906.40)	+	○	●	●		●	●									
Tecolote Creek (906.50)	+		○	●		●	●									
Mission Bay at Quivira Basin (906.7)		●	●	●			●	●	●		●	●	●[1]		●	●
Mission Bay Shoreline, at Leisure Lagoon (906.4)		●	●	●			●	●	●		●	●	●		●	●
Mission Bay Shoreline, at North Crown Point (906.3)		●	●	●			●	●	●		●	●	●		●	●
Mission Bay (mouth of Rose Creek only) (906.4)		●	●	●			●	●	●		●	●	●		●	●
Mission Bay Shoreline, at Visitors Center (906.4)		●	●	●			●	●	●		●	●	●		●	●
Mission Bay Shoreline, at Bahia Point (906.3)		●	●	●			●	●	●		●	●	●		●	●
Mission Bay Shoreline, at Bonita Cove (906.3)		●	●	●			●	●	●		●	●	●		●	●
Mission Bay Shoreline, at Campland (906.4)		●	●	●			●	●	●		●	●	●		●	●

continued on next page

303(d) Listed Waterbody Name	Beneficial Use															
	MUN	IND	REC1	REC2	BIOL	WARM	WILD	RARE	SPWN	NAV	COMM	EST	MAR	AQUA	MIGR	SHELL
Mission Bay Shoreline, at De Anza Cove (906.4)		●	●	●			●	●	●		●	●	●		●	●
Mission Bay Shoreline, at Fanuel Park (906.3)		●	●	●			●	●	●		●	●	●		●	●
Mission Bay (mouth of Tecolote Creek) (906.5)		●	●	●			●	●	●		●	●	●		●	●
Mission Bay Shoreline, at Tecolote Shores (906.5)		●	●	●			●	●	●		●	●	●		●	●
Pacific Ocean Shoreline, Casa Beach (Children's Pool) (906.3)		●	●	●	●		●	●	●	●	●		●	●	●	●
Pacific Ocean Shoreline, La Jolla Cove (906.3)		●	●	●	●		●	●	●	●	●		●	●	●	●
Pacific Ocean Shoreline, La Jolla Shores Beach at Avenida de La Playa (906.3)		●	●	●	●		●	●	●	●	●		●	●	●	●
Pacific Ocean Shoreline, Pacific Beach at Pacific Beach Point (906.3)		●	●	●	●		●	●	●	●	●		●	●	●	●
Pacific Ocean Shoreline, Vallecitos Court (906.3)		●	●	●	●		●	●	●	●	●		●	●	●	●
Pacific Ocean Shoreline, Whispering Sands Beach at Ravina Street (906.3)		●	●	●	●		●	●	●	●	●		●	●	●	●

Beneficial use is impaired based on the 2010 303(d) list
○ Potential beneficial use
● Existing beneficial use
+ Excepted from MUN
1. Marine Habitat in Mission Bay at Quivira Basin is designated as an “impaired aquatic life” use in the 303(d) list. It is designated a “beneficial use” in the Basin Plan, and is referred to herein for consistency.

The definitions of beneficial uses that are impaired based on the 303(d) list in the Mission WMA are defined in the Basin Plan as follows:

- **Estuarine Habitat (EST)** includes uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).
- **Industrial Service Supply (IND)** includes uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.
- **Marine Habitat (MAR)** includes uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).
- **Contact Water Recreation (REC-1)** includes uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and SCUBA diving, surfing, white water activities, fishing, or use of natural hot springs.
- **Non-Contact Water Recreation (REC-2)** includes the uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
- **Shellfish Harvesting (SHELL)** includes uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sport purposes.
- **Warm Freshwater Habitat (WARM)** includes uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates.

The beneficial uses in the Mission Bay WMA which are not listed as impaired are defined in the Basin Plan as follows:

- **Aquaculture (AQUA)** includes the uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and a nimals for human consumption or bait purposes.

- **Preservation of Biological Habitats of Special Significance (BIOL)** includes uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or ASBS, where the preservation or enhancement of natural resources requires special protection.
- **Commercial and Sport Fishing (COMM)** includes the uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.
- **Migration of Aquatic Organisms (MIGR)** includes uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish.
- **Municipal and Domestic Supply (MUN)** includes uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.
- **Navigation (NAV)** includes uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.
- **Rare, Threatened, or Endangered Species (RARE)** includes uses of water that support habitats necessary, at least in part, for the survival and s uccessful maintenance or plant or animal species established under state or federal law as rare, threatened, or endangered.
- **Spawning, Reproduction, and/or Early Development (SPWN)** includes uses of water that support high quality habitats suitable for reproduction, early development and sustenance of marine fish and/or cold freshwater fish.
- **Wildlife Habitat (WILD)** includes uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

APPENDIX D

Additional Data Sources

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Table of Contents

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APPENDIX D.1

Primary and Secondary Data Sources

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Primary and Secondary Data Sources

Primary References

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2011-2012 San Diego County Copermittee Receiving Waters and Urban Runoff Monitoring Report
2010-2011 San Diego County Copermittee Receiving Waters and Urban Runoff Monitoring Report
2008 City of San Diego JURMP (Including FY11 and FY12 Annual Report)
Mission Bay & La Jolla WURMP (Including FY11 and FY12 Annual Report)
Scripps CLRP Phase I & II
Tecolote CLRP Phase I & II

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Appendix D.2

Third Party Data Sources Summary

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Document:
City of San Diego JURMP 2012

Locations within watershed:
No data

Conditions:
Analytical screening analyte exceedances highest for *Enterococcus*, Total Coliform, then Fecal Coliform. Field screening analytes with exceedances highest for Turbidity

Sources:
No data

Strategies:
Outlined in detail in Mission Bay and La Jolla WURMP 2012. Includes monitoring, trash removal, retrofits/enhancements, low flow diversions, and outreach, among other things.

Document:
San Diego Coastkeeper Water Quality Monitoring and Data Summary 2011-2013

Locations within watershed:
Rose Creek, Tecolote Creek, San Clemente Canyon

Conditions:
Tecolote Creek has significant bacteria issues. Recommend that bacteria and over-irrigation be considered priority pollution conditions for the watershed.

Sources:
No data

Strategies:
No data

Document:
City of San Diego Storm Water Program Rose Creek Watershed Opportunities Project Report from San Diego Earth Works, 2005

Locations within watershed:
Rose Creek

Conditions:
Sporadic elevated constituent levels in storm drains during dry weather. Ammonia and pH exceeded trigger levels. One Enterococcus exceedance. No pesticides detected.

Sources:
No data

Strategies:
No data

Document:
Rose Creek Watershed Opportunities Assessment. Hydrologic Modifications Technical Memorandum from San Diego Earth Works

Locations within watershed:
Rose Creek

Conditions:
Hydrologic modification

Sources:
Slope failure due to rainfall, use of iceplant as erosion control measure

Strategies:
No data

Document:
Rose Creek Watershed Opportunities Assessment. Biological Resources Technical Memorandum from San Diego Earth Works

Locations within watershed:
Rose Creek

Conditions:
Erosion, wildlife killed by cars, habitat degradation

Sources:
High numbers of trails, urbanization, runoff

Strategies:
Habitat restoration through repair of erosion areas, reclamation of disturbed lands, trail consolidation.

Document:
Rose Creek Watershed Opportunities Assessment. Recreational Elements

Locations within watershed:
Rose Creek

Conditions:
No data

Sources:
No data

Strategies:
No data

Document:
Rose Creek Watershed Wetland, Riparian, and Water Quality Restoration Opportunities Analysis from San Diego Earth Works, 2012

Locations within watershed:
Rose Creek

Conditions:
No data ï general watershed assessment only

Sources:
No data

Strategies:
No data

Document:
Rose Creek Opportunities Assessment from Rose Creek Watershed Alliance

Locations within watershed:
Rose Creek

Conditions:
No data: general watershed assessment only

Sources:
No data

Strategies:
Provides recommendations to enhance the natural, cultural, public safety, and recreation attributes of the Rose Creek Watershed.

Document:
Email From Marian Bear Park Recreation Council, public input form all referencing Marian Bear Memorial Park Natural Resource Master Plan, 1994

Locations within watershed:
San Clemente Creek, Marian Bear Memorial Park

Conditions:
Erosion, Sediments in San Clemente Creek

Sources:
Canyon walls, slopes, banks

Strategies:
ÅWater quality monitoring slated to commence in near future at time of publication
ÅVegetation of eroding areas

Document:
Photos and video submitted by Debby Knight showing storm flow in 2010

Locations within watershed:
Rose Creek, exact location unknown

Conditions:
Hydromodification

Sources:
No data

Strategies:
No data

Document:
Regional Harbor Monitoring Plan 2008 Final Report and 3 Year Summary Report

Locations within watershed:
Mission Bay

Conditions:
During dry weather, concentration above water quality criteria for both water and sediment including total arsenic, total and dissolved copper, total zinc, total mercury, total DDT, and total chlordanes.

Sources:
No data

Strategies:
No data

Document:
City of San Diego Strategic Plan for Watershed Activity Implementation, input from Consultation Committee

Locations within watershed:
Tecolote Watershed and Miramar Watershed

Conditions:
In Tecolote Watershed, the priority conditions were identified as:
ÅBacteria

ÅHeavy Metals
ÅNutrients
ÅSediments
ÅBenthic Alterations
ÅToxicity

In Miramar Watershed, the priority conditions were identified as:
ÅBacteria
ÅHeavy Metals
ÅNutrients
ÅSediments
ÅToxicity

Sources:
Potential Sources in Tecolote Watershed include:
ÅEating and Drinking Establishments
ÅResidential Areas and Activities
ÅCommercial Landscaping
ÅAnimal Related Facilities
ÅGolf Courses, Parks, and Recreational Activities
ÅMunicipal Facilities and Activities
ÅAuto Related Facilities
ÅRoads, Streets, Highways, and Parking Facilities
ÅPest Control Facilities
ÅConstruction Activities

Potential Sources in Miramar Watershed include:
ÅEating and Drinking Establishments
ÅResidential Areas and Activities
ÅCommercial Landscaping
ÅAnimal Related Facilities
ÅGolf Courses, Parks, and Recreational Activities
ÅIndustrial Facilities
ÅMunicipal Facilities and Activities
ÅAuto Related Facilities
ÅRoads, Streets, Highways, and Parking Facilities
ÅPest Control Facilities
ÅConstruction Activities

Strategies:
No data (Strategies identified through 2011 only)

Document:
Mission Bay Water and Sediment Testing Project Final Report, input from Consultation Committee

Locations within watershed:
Six sites within Mission Bay:
ÅTecolote Creek Inlet
ÅCudahy Creek Inlet

ÅRose Creek Inlet
ÅFiesta Bay
ÅSail Bay
ÅVentura Point (near the mouth of the Bay)

Conditions:
ÅElevated levels of phosphate, particularly observed in the Back Bay in concert with rain events
ÅExceedances of ERL values for copper, lead, zinc, 4ã4ôDDE, and dieldrin

Sources:
ÅInput from creeks, street runoff, and historical nutrients in Bay

Strategies:
No data

Document:
Download SWAMP data from CEDEN website using the following search parameters ï San Diego County and SWAMP RWB 9 Monitoring

http://ceden.waterboards.ca.gov/AdvancedQueryTool

Locations within watershed:
See red highlighted waterbodies in the table on Page C-11.

Conditions:
SWAMP monitoring data available from CEDEN for Region 9 was reviewed to determine if the data provide additional priority water quality conditions. Many of the programs included 1 -4 sampling events and measured a range of parameters. A majority of the monitoring occurred before the 2005 and 2011 LTEAs that incorporated the most recent regional monitoring data for the region. No additional conditions were selected based on a review of the data.

Sources:
No Data

Strategies:
No Data

Project Name from CEDEN	Years	Station Name(s)	Temporal	No. of Sampling Events	Matrix	Summary of General Analyses
Statewide Project Urban Pyrethroid Status Monitoring		Pe¶asquitos Creek @ Springbrook	dry weather	1	sediment	TOC, % fines, moisture, and pyrethroids
RWB9 Status Sampling 2008	2008	Campo Creek 1, Ironside Creek, Los Pe¶asquitos Creek 6, Rose Canyon Creek 4	dry weather	1	water, benthic	field measurements, comments noted, velocity, algae, and conventional chemistry
RWB9 Rotational BA Monitoring 2005	2005	Santa Ysabel Creek ~2mi E Hwy 79	dry weather	1	physical	field measurements, velocity, and slope profile
RWB9 Rotational Monitoring 2002	2002	Los Pe¶asquitos Creek 6, Poway Creek 2, Rose Canyon Creek 4, Soledad Canyon Creek 2, and Soledad Canyon Creek 4	dry weather	1-4	water, sediment	field measurements, conventional chemistry, metals, herbicides, pesticides, and velocity. % fines
RWB9 Rotational Monitoring 2003	2003	Green Valley Creek 2, San Dieguito River 9, Santa Ysabel Creek 1	dry weather	2-4	water, sediment	Field measurements, conventional chemistry, metals, herbicides, pesticides, and velocity. % fines
San Diego Regional Board Fire Study	2005, 2007, 2008, 2009	Black Mountain Creek Upstream of Santa Ysabel Creek, Boden Canyon Creek (BOD), Boden Canyon Creek ~0.5 mile upstream of Santa Ysabel Creek , Chicarita Creek downstream of Evening Creek Road, Green Valley Creek 2, Kit Carson Creek Sunset Drive crossing	dry weather	1-3	water	field measurements and velocity
Statewide Perennial Streams Assessment 2008	2008	Encinitas Creek, Arroyo Trabuco 57, Santa Ysabel Creek	dry weather	1	water, benthic	field measurements, comments noted, velocity, algae, and conventional chemistry

continued on next page

Project Name from CEDEN	Years	Station Name(s)	Temporal	No. of Sampling Events	Matrix	Summary of General Analyses
MAP Wadeable Streams 2004	2004	Santa Ysabel Creek below Witch Creek	dry weather	2	water	field measurements and velocity
Statewide Ref Condition Management Plan 2009	2009	Noble Canyon Creek ~0.8mi above Pine Valley Cr.	dry weather	1	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Ref Condition Management Plan 2010	2010	Cedar Creek 2, Japacha Creek above Hwy 79, Spring Canyon Creek ~2.3mi above Hwy 74	dry weather	1	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Ref Condition Management Plan 2008	2008	Arroyo Trabuco	dry weather	1	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Ref Condition Management Plan 2011	2011	Cold Spring Canyon above Devil Cyn Creek, Devils Canyon Creek above San Mateo Cyn. Creek, Juaquapin Creek above Sweetwater River, Kitchen Creek at Kitchen Creek Road, Troy Canyon Creek (TCC2), Wilson Creek 3	dry weather	1	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Ref Condition Mgmt Plan Index Study 2009	2009	Noble Canyon Creek ~0.8mi above Pine Valley Cr.	dry weather	2	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Ref Condition Mgmt Plan Index Study 2010	2010	Cedar Creek 2	dry weather	4	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Stream Pollution Trends Study 2008	2008, 2009, 2010	Agua Hedionda Creek 6, Escondido Creek at Camino del Norte, Forrester Creek 2, Los Pe¶asquitos Creek 6, San Diego River at Ward Road, San Dieguito River 9, San Juan Creek 9, Santa Margarita at Basilone Rd, Soledad Canyon Creek 4, Tijuana River at Hollister Rd	dry weather	1	sediment	Organics, PCBs, Pyrethroids, Pesticides, Semi-volatile Organic Carbons, metals

APPENDIX D.3

Persistent Flow Outfall Summary

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Potential Persistent Flow Outfalls[1]

Jurisdiction[2]	Subwatershed	Site ID	Latitude	Longitude	Land Use
City of San Diego[3]	Mission Bay	DW0166	32.76707	-117.23218	Commercial/Roads
	Rose Canyon	DW0066	32.84057	-117.16789	Parks/Open Space
		DW0104	32.80919	-117.21887	Residential
		DW0273	32.81917	-117.22407	Residential
		DW0398	32.79662	-117.21088	Residential
		DW0400	32.784350	-117.209246	Roads
	Scripps	DW0053	32.83938	-117.28185	Residential/Parks
		DW0152	32.81183	-117.27011	Residential
		DW0156	32.79984	-117.25853	Residential
		DW0158	32.791417	-117.248014	Residential
		DW0159	32.791438	-117.244266	Residential
		DW0162	32.78333	-117.25066	Residential
		DW0580	32.81963	-117.25239	Residential
	Tecolote Creek	DW0107	32.80861	-117.17597	Residential
		DW0116	32.80332	-117.19156	Residential
		DW0176	32.77755	-117.18396	Residential/Commercial
		DW0275	32.82403	-117.17834	Residential
		DW0382	32.80500	-117.17497	Residential
		DW0392	32.83228	-117.17893	Residential/Commercial

1. This list of persistent flow outfalls is current based on 2014 dry weather monitoring data.
2. No outfalls with persistent dry weather flow have been identified in Caltrans jurisdiction.
3. Identified land uses for the City of San Diego include all land uses comprising more than 30% of upstream drainage area.

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APPENDIX D.4

Public Input from Water Quality Improvement Plan Workshop

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project clean water

Public Input Form

Conditions

- Landfill (source)
- Freshwater
- Purple pipes – runoff and intermittent stream discharges
- Nutrients
- Over-irrigation
- Trolley conditions (future impacts)
- Sediment in Rose Canyon
- Sediment in San Clemente Creek
- Velocity – Hydro Mod
- Trash, feces from homeless encampments
- Bacteria
- Plastic trash bags
- Beach trash visitors/tourists – Plastic bags, diapers
- Mission Bay/Ocean currents and tides carry trash from other areas to Mission beach.
- Non-native plants and wildlife
- Rose Canyon – Freeway and rail traffic
- Toxicity in all areas due to emergent pollutants such as hormones and caffeine
- Wild fires – Flame retardants, metals, ash, and sedimentation

Sources

- Airplane exhaust – aerial deposition into Mission Beach
- Tires
- Rail transit – Degreasers and dust
- Dumping dog waste in canyon – (Requested better education)
- Parking lots – Retrofits, new developments, reflective coating
- Soap from car washing
- Development in UTC – Wetlands filled in and exported mitigation to other areas

- Pave everything, put pipe at the top of the canyon, causes sedimentation and erosion of the canyon
- Schools, particularly high schools have a lot of waste, trash, etc. in the parking lots and fields
- Boats, particularly two-stroke engines, in Mission Bay – Trash and chemicals from boats
- Nesting of birds is affected by trash and plastics, nests are built with trash
- Wind is N/W and currents
- Boats dumping holding tanks (lifeguards and coast guard are supposed to monitor)
- Homeless encampments
- Trash from day use in scenic areas because there are no trash cans
- Illegal dumping in Rose Creek
- Seagulls distribute trash throughout Bay due to open trash receptacles

Strategies

- Trash cans where people use open spaces
- Comprehensive strategies for encampment issues
- Native plants/pervious surfaces
- Demonstration projects
- Low water usage gardens in the watershed such as rainwater harvesting/smart water/pervious surfaces
- Partner with colleges, check out innovation center
- Port-a-Potties along entire trail, not just one spot
- Development review boards should include strategies for managing water
- Construction/building permits (Phase II) should include water management
- Education to city/local planning boards
- Public signs, too small and not adequate, pack-in/pack-out signs
- Ban car washing in streets or driveways
- Make street sweeping schedule public, more parking restrictions
- Require wetland mitigation in the watershed
- No more outlet pipes at the tops of canyons
- Treat storm water the same way as sewage
- Prevent purple pipe from going into storm drain/creeks

- Dog parks – ticket people without bags or flashlights at night
- Support restoration of wetlands in NE corner of Mission Bay
- Reverse flow valves don't work/berm ponds for fresh water. Sewer interceptor system doesn't work
- Ban plastic bags and bottles
- Repair storm drains, one size does not fit all
- Chemical pollutant responses such as acid neutralizing
- Swales – Are they effective? Enforcement of effectiveness to developers and Caltrans
- Operation and maintenance issues of structural BMPs
- Caltrans – Swales in I-5 widening project
- Allow community groups to have access to dumpsters when they do clean ups so they bags are not left exposed until they are picked up. Better facilitation of these clean ups, such as through ILACSD
- Landscaping to prevent runoff, restoring natural contours of the land
- Private property right on the creek
- TJ Estuary has bought properties in the flood plain to prevent these issues
- Don't allow certain uses in sensitive areas
- Train planning groups (such as CEQA training)
- Don't favor some areas of the watershed over others when it comes to directing resources for water quality improvements

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APPENDIX E

Receiving Water Condition and Urban Runoff Assessment

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Table of Contents

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Appendix E –Receiving Water Condition and Urban Runoff Assessment

Appendices E.1 and E.2 present an assessment of receiving water conditions and the impact of urban discharges in Mission Bay WMA during wet and dry weather, respectively. The list of receiving water conditions was developed on the basis of the 2010 303(d) list, applicable TMDLs, waterbodies with special biological significance, public input, and the priority pollutants or stressors identified from current and historical receiving water monitoring data. MS4 monitoring data compiled from the LTEA and WURMP Annual Reports, as well as any applicable TMDL WQBELs, are also evaluated in relation to the receiving water conditions to determine if a priority water quality condition existed.

The tables in Appendices E.1 and E.2 are presented by WQIP Subwatershed and 303(d) listed waterbody. In order to mirror the process used by the Responsible Agencies to assess the potential receiving water conditions for each waterbody, the data are presented in the order they were evaluated. The following is an illustration of how the reader might follow the process used to assess receiving water conditions in an example waterbody (Example Waterbody A):

- **303(d) Listings (Page E-5, reading left to right)** identifies the WQIP subwatershed, applicable TMDLs, and 303(d) listed waterbody (Example Waterbody A), and then presents the associated pollutants, impaired beneficial uses, and potential sources of impairment for Example Waterbody A as identified under the 2010 303(d) list.
- **Receiving Water Assessment and Conditions (Page E-6, reading left to right)**
    - **Receiving Water Assessment** identifies the WQIP subwatershed, applicable TMDLs, and 303(d) listed waterbody (Example Waterbody A), and then presents public input submitted in response to the public data call and NPDES receiving water monitoring station data for Example Waterbody A. The receiving water priorities identified were noted as exceeding water quality benchmarks in the 2005-2010 LTEA, FY 11 & 12 WURMP, or 2008 RHMP (for dry weather assessment only).
    - **Receiving Water Conditions** summarizes the receiving water conditions identified through the 303(d) listings and receiving water assessment, and states the applicable lines of evidence.
- **Urban Runoff Monitoring Assessment (Page E-7, reading left to right)** identifies the WQIP subwatershed and 303(d) listed waterbody (Example Waterbody A), and then presents the priority pollutants at the MS4 outfall, based on the Urban Runoff Monitoring Program and identified in the 2005-2010 LTEA and FY 11&12 WURMP Annual Reports, for Example Waterbody A. as well as the applicable WQBELs where appropriate.

Page E-8 then restarts the assessment with an evaluation of 303(d) listings for the next waterbody.

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APPENDIX E.1

Wet Weather Receiving Water Condition Assessment

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WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	**Impaired Beneficial Use(s)**	**Potential Source(s)**
Mission Bay	NA	Mission Bay at Quivira Basin	Copper	Estuarine Habitat, Marine Habitat	Unknown
Rose Canyon	NA	Mission Bay Shoreline, at Campland	*Enterococcus*	Water Contact Recreation	Unknown
			Fecal Coliform	Water Contact Recreation	Unknown
			Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Conditions	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY11 & 12 WURMP		
Mission Bay	NA	Mission Bay at Quivira Basin	Freshwater Discharges, Nutrients, Sediment (Rose Canyon and San Clemente Creek, Velocity (Hydromodification)), Trash, Feces, Bacteria, Non-native Vegetation and Invasive Species, Toxicity, Flame Retardants, Metals, Ash, Sedimentation	NA	NA	NA	Impairment of MAR and EST due to copper in Quivira Basin during wet weather.	303(d)
Rose Canyon	NA	Mission Bay Shoreline, at Campland	Same as above	MB-TWAS 1	Turbidity, Bifenthrin, BOD, TSS, Permethrin, Fecal Coliform, TDS	Turbidity, Bifenthrin, TSS, Permethrin, Very Poor IBI, Fecal Coliform, TDS	Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Mission Bay Shoreline at Campland during wet weather.	303(d)
							Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Campland during wet weather.	303(d)

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Mission Bay	NA	Mission Bay at Quivira Basin	NA	NA	NA
Rose Canyon	NA	Mission Bay Shoreline, at Campland	TSS, Fecal Coliform	NA	NA

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Rose Canyon	NA	Mission Bay Shoreline, at De Anza Cove	*Enterococcus*	Water Contact Recreation	Unknown
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Source Unknown
		Mission Bay Shoreline, at Leisure Lagoon	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Unknown Non-Point Source
		Mission Bay Shoreline, at North Crown Point	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Conditions	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY11 & 12 WURMP		
Rose Canyon	NA	Mission Bay Shoreline, at De Anza Cove	Same as above	MB-TWAS 1	Turbidity, Bifenthrin, BOD, TSS, Permethrin, Fecal Coliform, TDS	Turbidity, Bifenthrin, TSS, Permethrin, Very Poor IBI, Fecal Coliform, TDS	Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Mission Bay Shoreline at De Anza Cove during wet weather.	303(d)
							Impairment of SHELL due to total coliform of the Mission Bay Shoreline at De Anza Cove during wet weather.	303(d)
		Mission Bay Shoreline, at Leisure Lagoon					Impairment of REC-1 due to *Enterococcus* of the Mission Bay Shoreline at Leisure Lagoon during wet weather.	303(d)
							Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Leisure Lagoon during wet weather.	303(d)
		Mission Bay Shoreline, at North Crown Point					Impairment of REC-1 due to *Enterococcus* of the Mission Bay Shoreline at North Crown Point during wet weather.	303(d)
							Impairment of SHELL due to total coliform of the Mission Bay Shoreline at North Crown Point during wet weather.	303(d)

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Rose Canyon	NA	Mission Bay Shoreline, at De Anza Cove	TSS, Fecal Coliform	NA	NA
		Mission Bay Shoreline, at Leisure Lagoon			
		Mission Bay Shoreline, at North Crown Point			

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Rose Canyon	NA	Mission Bay (Mouth of Rose Creek)	Eutrophic	Marine Habitat	Landfills, Nurseries, Point Source, Highway/Road/Bridge Runoff, Non-point Source, Urban Runoff/Storm Sewers
			Lead	Marine Habitat	Highway/Road/Bridge Runoff, Landfills, Urban Runoff/Storm Sewers, Non-point Source, Point Source
		Mission Bay Shoreline, at Visitors Center	*Enterococcus*	Water Contact Recreation	Unknown
			Fecal Coliform	Water Contact Recreation	Point Source/Non-point Source
			Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers
		Rose Creek	NA	NA	NA

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Conditions	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY11 & 12 WURMP		
Rose Canyon	NA	Mission Bay (Mouth of Rose Creek)	Same as above	MB-TWAS 1	Turbidity, Bifenthrin, BOD, TSS, Permethrin, Fecal Coliform, TDS	Turbidity, Bifenthrin, TSS, Permethrin, Very Poor IBI, Fecal Coliform, TDS	Potential eutrophic conditions not included because impacts to MAR during wet weather are unknown. Potential eutrophic conditions will be listed as contributing to impairment of MAR during dry weather.	
							Impairment of MAR due to lead in Mission Bay at the Mouth of Rose Creek during wet weather.	303(d)
		Mission Bay Shoreline, at Visitors Center					Impairment of REC-1 due to *Enterococcus* and total and fecal coliform of the Mission Bay Shoreline at the Visitors Center during wet weather.	303(d)
							Impairment of SHELL due to total coliform of the Mission Bay Shoreline at the Visitors Center during wet weather.	303(d)
		Rose Creek					Elevated TDS near NPDES monitoring locations in Rose Creek during wet weather.	RW monitoring data (historic & current)

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Rose Canyon	NA	Mission Bay (Mouth of Rose Creek)	TSS, Fecal Coliform	NA	NA
		Mission Bay Shoreline, at Visitors Center			
		Rose Creek			

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Rose Canyon	NA	Rose Creek	NA	NA	NA
			Selenium	Warm Freshwater Habitat	Natural Sources
			Toxicity	Warm Freshwater Habitat	Urban Runoff/Storm Sewers

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Conditions	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY11 & 12 WURMP		
Rose Canyon	NA	Rose Creek	Same as above	MB-TWAS 1	Turbidity, Bifenthrin, BOD, TSS, Permethrin, Fecal Coliform, TDS	Turbidity, Bifenthrin, TSS, Permethrin, Very Poor IBI, Fecal Coliform, TDS	Elevated turbidity near NPDES monitoring locations in Rose Creek during wet weather.	RW monitoring data (historic & current)
							Elevated TSS near NPDES monitoring locations in Rose Creek during wet weather.	RW monitoring data (historic & current)
							Elevated bifenthrin and permethrin near NPDES monitoring locations in Rose Creek during wet weather.	RW monitoring data (historic & current)
							Impairment of WARM due to selenium in Rose Creek during wet weather.	303(d)
							Impairment of WARM due to toxicity in Rose Creek during wet weather.	303(d)

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Rose Canyon	NA	Rose Creek	TSS, Fecal Coliform	NA	NA

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	**Impaired Beneficial Use(s)**	**Potential Source(s)**
Scripps	Bacteria TMDL & La Jolla Shores ASBS	ASBS 29 - La Jolla Shores ASBS	Fecal Coliform	ASBS	NA
			Total Coliform	ASBS	NA
			Copper	ASBS	NA
			Sediment	ASBS	NA
		Mission Bay Shoreline, at Bahia Point	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Unknown
		Mission Bay Shoreline, at Bonita Cove	*Enterococcus*	Water Contact Recreation	Unknown
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Unknown

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Conditions	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY11 & 12 WURMP		
Scripps	Bacteria TMDL & La Jolla Shores ASBS	ASBS 29 - La Jolla Shores ASBS	Same as above	Numerous years of monitoring conducted in the ASBS 29 drainage area and ASBS 29 starting in 2005. This data was used to develop the La Jolla Shores Coastal Watershed Management Plan, Scripps CLRP, and other compliance related documents. Priorities taken from the La Jolla Shores Coastal Watershed Management Plan. No direct NPDES monitoring locations.			Reduction of fecal coliform loads to those specified in the Scripps CLRP during wet weather.	Scripps Phase II CLRP Table 2-8
							Reduction of total coliform loads to those specified in the Scripps CLRP during wet weather.	Scripps Phase II CLRP Table 2-8
							Reduction of copper loads to those specified in the Scripps CLRP during wet weather.	Scripps Phase II CLRP Table 2-8
							Reduction of sediment loads to those specified in the Scripps CLRP during wet weather.	Scripps Phase II CLRP Table 2-8
		Mission Bay Shoreline, at Bahia Point		NA	NA	NA	Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Mission Bay Shoreline at Bonita Cove during wet weather.	303(d)
							Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Bahia Point during wet weather.	303(d)
		Mission Bay Shoreline, at Bonita Cove					Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Mission Bay Shoreline at the Bonita Cove during wet weather.	303(d)
							Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Bonita Cove during wet weather.	303(d)

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	ASBS 29 - La Jolla Shores ASBS	Indicator Bacteria, Copper, TSS (ASBS outfall monitoring data 2010-2013)	NA	*Enterococcus* , Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Mission Bay Shoreline, at Bahia Point	NA	NA	*Enterococcus* , Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Mission Bay Shoreline, at Bonita Cove			

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	**Impaired Beneficial Use(s)**	**Potential Source(s)**
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Mission Bay Shoreline, at Fanual Park	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Source Unknown
		Pacific Ocean Shoreline, Avenida de La Playa	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers
		Pacific Ocean Shoreline, Avenida de La Playa	Total Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers
				Shellfish Harvesting	Urban Runoff/Storm Sewers
		Pacific Ocean Shoreline, Children's Pool	*Enterococcus*	Water Contact Recreation	Natural Sources/Other Urban Runoff
			Fecal Coliform	Water Contact Recreation	Natural Sources/Unknown
			Total Coliform	Water Contact Recreation	Natural Sources/Other Urban Runoff/Unknown

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Conditions	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY11 & 12 WURMP		
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Mission Bay Shoreline, at Fanual Park	Same as above	NA	NA	NA	Impairment of REC-1 due to *Enterococcus* of the Mission Bay Shoreline at Fanual Park during wet weather.	303(d)
							Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Fanual Park during wet weather.	303(d)
		Pacific Ocean Shoreline, Avenida de La Playa					Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Pacific Ocean Shoreline at Avenida de la Playa during wet weather.	Bacteria TMDL
		Pacific Ocean Shoreline, Avenida de La Playa					Impairment of REC-1 due to total coliform of the Pacific Ocean Shoreline at Avenida de la Playa during wet weather.	Bacteria TMDL
							Impairment of SHELL due to total coliform of the Pacific Ocean Shoreline at Avenida de la Playa during wet weather.	303(d)
		Pacific Ocean Shoreline, Children's Pool					Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Pacific Ocean Shoreline at Children's Pool during wet weather.	303(d) and Bacteria TMDL
							Impairment of REC-1 due to total coliform of the Pacific Ocean Shoreline at Children's Pool during wet weather.	Bacteria TMDL

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Mission Bay Shoreline, at Fanual Park	NA	NA	*Enterococcus* , Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Pacific Ocean Shoreline, Avenida de La Playa			
		Pacific Ocean Shoreline, Avenida de La Playa			
		Pacific Ocean Shoreline, Children's Pool			

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Children's Pool	Total Coliform	Shellfish Harvesting	Natural Sources/Other Urban Runoff/Unknown
		Pacific Ocean Shoreline, La Jolla Cove	Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers and Other Unknown Source
		Pacific Ocean Shoreline, Pacific Beach Point	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
		Pacific Ocean Shoreline, Pacific Beach Point	Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers and Other Unknown Source
		Pacific Ocean Shoreline, Ravina	Total Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
		Pacific Ocean Shoreline, Vallecitos Court	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
			Total Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Conditions	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY11 & 12 WURMP		
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Children's Pool	Same as above	NA	NA	NA	Impairment of SHELL due to total coliform of the Pacific Ocean Shoreline at Children's Pool during wet weather.	303(d)
		Pacific Ocean Shoreline, La Jolla Cove					Impairment of SHELL due to total coliform of the Pacific Ocean Shoreline at La Jolla Cove during wet weather.	303(d)
		Pacific Ocean Shoreline, Pacific Beach Point					Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Pacific Ocean Shoreline at Pacific Beach Point during wet weather.	303(d)
		Pacific Ocean Shoreline, Pacific Beach Point					Impairment of SHELL due to total coliform of the Pacific Ocean Shoreline at Pacific Beach Point during wet weather.	303(d)
		Pacific Ocean Shoreline, Ravina					Impairment of REC-1 due to total coliform of the Pacific Ocean Shoreline at Ravina during wet weather.	303(d) and Bacteria TMDL
		Pacific Ocean Shoreline, Vallecitos Court					Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Pacific Ocean Shoreline at Vallecitos Court during wet weather.	Bacteria TMDL
							Impairment of REC-1 due to total coliform of the Pacific Ocean Shoreline at Vallecitos Court during wet weather.	Bacteria TMDL

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Children's Pool	NA	NA	*Enterococcus* , Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Pacific Ocean Shoreline, La Jolla Cove			
		Pacific Ocean Shoreline, Pacific Beach Point			
		Pacific Ocean Shoreline, Pacific Beach Point			
		Pacific Ocean Shoreline, Ravina			
		Pacific Ocean Shoreline, Vallecitos Court			

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Vallecitos Court	Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers and Other Unknown Source
		Pacific Ocean Shoreline, La Jolla Shores Beach at el Paseo Grande	NA	NA	NA
		Pacific Ocean Shoreline, La Jolla Shores Beach at Caminito del Oro			
		Pacific Ocean Shoreline, South Casa Beach at Coast Blvd.			
		Pacific Ocean Shoreline, Windansea Beach at Vista de la Playa			
		Pacific Ocean Shoreline, Windansea Beach at Bonair Street			

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Conditions	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY11 & 12 WURMP		
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Vallecitos Court	Same as above	NA	NA	NA	Impairment of SHELL due to total coliform of the Pacific Ocean Shoreline at Vallecitos Court during wet weather.	303(d)
		Pacific Ocean Shoreline, La Jolla Shores Beach at el Paseo Grande					Impairment of REC-1 due to total coliform, *Enterococcus* , and fecal coliform during wet weather	Bacteria TMDL
		Pacific Ocean Shoreline, La Jolla Shores Beach at Caminito del Oro					Impairment of REC-1 due to total coliform, *Enterococcus* , and fecal coliform during wet weather	Bacteria TMDL
		Pacific Ocean Shoreline, South Casa Beach at Coast Blvd.					Impairment of REC-1 due to total coliform, *Enterococcus* , and fecal coliform during wet weather	Bacteria TMDL
		Pacific Ocean Shoreline, Windansea Beach at Vista de la Playa					Impairment of REC-1 due to total coliform, *Enterococcus* , and fecal coliform during wet weather	Bacteria TMDL
		Pacific Ocean Shoreline, Windansea Beach at Bonair Street					Impairment of REC-1 due to total coliform, *Enterococcus* , and fecal coliform during wet weather	Bacteria TMDL

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Vallecitos Court	NA	NA	*Enterococcus* , Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Pacific Ocean Shoreline, La Jolla Shores Beach at el Paseo Grande			NA
		Pacific Ocean Shoreline, La Jolla Shores Beach at Caminito del Oro			
		Pacific Ocean Shoreline, South Casa Beach at Coast Blvd.			
		Pacific Ocean Shoreline, Windansea Beach at Vista de la Playa			
		Pacific Ocean Shoreline, Windansea Beach at Bonair Street			

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Windansea Beach at Playa del Norte	NA	NA	NA
		Pacific Ocean Shoreline, Windansea Beach at Palomar Ave.			
		Pacific Ocean Shoreleine, Pacific Beach at Grand Ave.			

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Conditions	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY11 & 12 WURMP		
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Windansea Beach at Playa del Norte	Same as above	NA	NA	NA	Impairment of REC-1 due to total coliform, *Enterococcus* , and fecal coliform during wet weather	Bacteria TMDL
		Pacific Ocean Shoreline, Windansea Beach at Palomar Ave.					Impairment of REC-1 due to total coliform, *Enterococcus* , and fecal coliform during wet weather	Bacteria TMDL
		Pacific Ocean Shoreleine, Pacific Beach at Grand Ave.					Impairment of REC-1 due to total coliform, *Enterococcus* , and fecal coliform during wet weather	Bacteria TMDL

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Windansea Beach at Playa del Norte	NA	NA	NA
		Pacific Ocean Shoreline, Windansea Beach at Palomar Ave.			
		Pacific Ocean Shoreleine, Pacific Beach at Grand Ave.			

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Tecolote Creek	Bacteria TMDL	Tecolote Creek	Indicator Bacteria	Water Contact Recreation	Point Source/Non-point Source
			Cadmium	Warm Freshwater Habitat	Point Source/Non-point Source
			Copper	Warm Freshwater Habitat	Point Source/Non-point Source
			Lead	Warm Freshwater Habitat	Point Source/Non-point Source
			Zinc	Warm Freshwater Habitat	Point Source/Non-point Source
			Phosphorus	Non-contact Recreation	Unknown
			Toxicity	Warm Freshwater Habitat	Point Source/Non-point Source

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Conditions	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY11 & 12 WURMP		
Tecolote Creek	Bacteria TMDL	Tecolote Creek	Same as above	TC-MLS, MB-TWAS-2	Turbidity, Bifenthrin, Fecal Coliform, TSS, BOD, Malathion, Permethrin, Toxicity (*C. dubia* acute survival, *C. dubia* chronic survival, *C. dubia* reproduction)	TSS, Turbidity, Bifenthrin, Permethrin, COD, Very Poor IBI, Fecal Coliform, Toxicity (*S. capricornutum* growth)	Impairment of REC-1 due to indicator bacteria in Tecolote Creek during wet weather.	303(d), Bacteria TMDL and RW monitoring data (historic & current)
							Impairment of WARM due to cadmium, copper, lead, and zinc in Tecolote Creek during wet weather.	303(d)
							Phosphorous not included because impacts to REC-2 during wet weather are unknown. Phosphorus will be listed as contributing to impairment of REC-2 during dry weather.	
							Impairment of WARM due to toxicity in Tecolote Creek during wet weather.	303(d) and RW monitoring data (historic & current)

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Tecolote Creek	Bacteria TMDL	Tecolote Creek	Fecal Coliform	NA	*Enterococcus* , Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Tecolote Creek	Bacteria TMDL	Tecolote Creek	Turbidity	Non-contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
			NA	NA	NA
		Mission Bay (Mouth of Tecolote Creek)	Eutrophic	Estuarine Habitat	Point Source/Non-point Source
			Lead	Industrial Service Supply	Point Source/Non-point Source
		Mission Bay Shoreline, at Tecolote Shores	*Enterococcus*	Water Contact Recreation	Urban Runoff and Other Unknown Source
			Total Coliform	Shellfish Harvesting	Unknown

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Conditions	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY11 & 12 WURMP		
Tecolote Creek	Bacteria TMDL	Tecolote Creek	Same as above	TC-MLS, MB-TWAS-2	Turbidity, Bifenthrin, Fecal Coliform, TSS, BOD, Malathion, Permethrin, Toxicity (*C. dubia* acute survival, *C. dubia* chronic survival, *C. dubia* reproduction)	TSS, Turbidity, Bifenthrin, Permethrin, COD, Very Poor IBI, Fecal Coliform, Toxicity (*S. capricornutum* growth)	Impairment of REC-2 due to turbidity in Tecolote Creek during wet weather.	303(d) and RW monitoring data (historic & current)
							Elevated bifenthrin and permethrin near NPDES monitoring locations in Tecolote Creek during wet weather.	RW monitoring data (historic & current)
		Mission Bay (Mouth of Tecolote Creek)					Eutrophic conditions not included because impacts to EST during wet weather are unknown. Eutrophic conditions will be listed as contributing to impairment of ESTduring dry weather.	
							Impairment of IND due to lead in Mission Bay at the Mouth of Tecolote Creek during wet weather.	303(d)
		Mission Bay Shoreline, at Tecolote Shores					Impairment of REC-1 due to *Enterococcus* of the Mission Bay Shoreline at Tecolote Shores during wet weather.	303(d)
							Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Tecolote Shores during wet weather.	303(d)

WQIP Subwatershed	TMDL/ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Tecolote Creek	Bacteria TMDL	Tecolote Creek	Fecal Coliform	NA	*Enterococcus* , Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)
		Mission Bay (Mouth of Tecolote Creek)			*Enterococcus* , Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Mission Bay Shoreline, at Tecolote Shores			

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APPENDIX E.2

Dry Weather Receiving Water Condition Assessment

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WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Mission Bay	NA	Mission Bay at Quivira Basin	Copper	Estuarine Habitat, Marine Habitat	Unknown
		NA	NA	NA	NA

<table>
<tr><th rowspan="3">WQIP Subwatershed</th><th rowspan="3">TMDL/ ASBS</th><th rowspan="3">303(d) Listed Waterbody</th><th colspan="7">Receiving Water Assessment</th><th colspan="2">Receiving Water Conditions</th></tr>
<tr><th rowspan="2">Public Input</th><th rowspan="2">Applicable Receiving Water Station(s)</th><th colspan="2">NPDES Receiving Water</th><th colspan="2">SMC Program</th><th rowspan="2">RHMP Monitoring Data</th><th rowspan="2">Receiving Water Conditions</th><th rowspan="2">Line(s) of Evidence</th></tr>
<tr><th>2005-2010 LTEA</th><th>FY 11 & 12 WURMP</th><th>2005-2010 LTEA</th><th>FY 11 & 12 WURMP</th></tr>
<tr><td rowspan="2">Mission Bay</td><td rowspan="2">NA</td><td>Mission Bay at Quivira Basin</td><td rowspan="2">Freshwater discharges, nutrients, sediment (Rose Canyon and San Clemente Creek, Velocity (Hydromodification)), Trash, Feces, Bacteria, non-native vegetation and invasive species, toxicity, flame retardants, metals, ash, sedimentation</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2"><u>Freshwater Influenced Areas</u>: Elevated total arsenic, total copper, total zinc, and total DDT in sediments; <u>Marinas</u>: Elevated dissolved copper and total copper in surface waters; Elevated total arsenic, total copper, total mercury, total zinc, and total DDT in sediments; <u>Shallow Areas:</u> Elevated total arsenic, total copper, total zinc, total DDT, and total chlordanes in sediments ; Elevated total copper in surface waters</td><td>Impairment of MAR and EST due to copper in Quivira Basin during dry weather.</td><td>303(d)</td></tr>
<tr><td>NA</td><td>Elevated total arsenic, total copper, total zinc, and total DDTs in sediments of freshwater influenced areas</td><td>Historical RHMP Monitoring Data</td></tr>
</table>

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Mission Bay	NA	Mission Bay at Quivira Basin	NA	NA	NA
		NA			

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Mission Bay	NA	NA	NA	NA	NA

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Mission Bay	NA	NA	Same as above	NA	NA	NA	NA	NA	Freshwater Influenced Areas: Elevated total arsenic, total copper, total zinc, and total DDT in sediments; Marinas: Elevated dissolved copper and total copper in surface waters; Elevated total arsenic, total copper, total mercury, total zinc, and total DDT in sediments; Shallow Areas: Elevated total arsenic, total copper, total zinc, total DDT, and total chlordanes in sediments ; Elevated total copper in surface waters	Elevated dissolved copper in surface waters of marina areas	Historical RHMP Monitoring Data
										Elevated total arsenic, total mercury, total zinc, and total DDTs in sediments of marina areas	Historical RHMP Monitoring Data
										Elevated total copper in surface waters and sediments of marina areas	Historical RHMP Monitoring Data
										Elevated total arsenic, total zinc, total DDTs, and total chlordanes in sediments of shallow areas	Historical RHMP Monitoring Data
										Elevated total copper in surface waters and sediments of shallow areas	Historical RHMP Monitoring Data

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Mission Bay	NA	NA	NA	NA	NA

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	**Impaired Beneficial Use(s)**	**Potential Source(s)**
Rose Canyon	NA	Mission Bay Shoreline, at Campland	*Enterococcus*	Water Contact Recreation	Unknown
			Fecal Coliform	Water Contact Recreation	Unknown
			Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers
		Mission Bay Shoreline, at De Anza Cove	*Enterococcus*	Water Contact Recreation	Unknown
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Source Unknown

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Rose Canyon	NA	Mission Bay Shoreline, at Campland	Same as above	MB-TWAS 1	Toxicity (*C. dubia* acute survival, *C. dubia* chronic survival, *C. dubia* reproduction, *S. capricornutum* acute), Poor IBI, O/E, CRAM, TDS	Toxicity (*C. dubia* reproduction, *S. capricornutum* growth, *C. dubia* chronic survival) , Very Poor IBI **Based on one sample**; TDS, DO and *Enterococcus* (Coastkeeper)	Chloride, Sulfate, Bifenthrin, Very Poor IBI, O/E, Total N, Total P, TDS **Based on two stations**	NA	NA	Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Mission Bay Shoreline at Campland during dry weather.	303(d)
											303(d)
										Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Campland during dry weather.	303(d)
		Mission Bay Shoreline, at De Anza Cove								Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Mission Bay Shoreline at De Anza Cove during dry weather.	303(d)
										Impairment of SHELL due to total coliform of the Mission Bay Shoreline at De Anza Cove during dry weather.	303(d)

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Rose Canyon	NA	Mission Bay Shoreline, at Campland	*Enterococcus,* Fecal Coliform, Total N, Total P, TDS	*Enterococcus,* Fecal Coliform, Total N, Total P, TDS	NA
		Mission Bay Shoreline, at De Anza Cove			

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Rose Canyon	NA	Mission Bay Shoreline, at Leisure Lagoon	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Unknown Non-point Source
		Mission Bay Shoreline, at North Crown Point	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Rose Canyon	NA	Mission Bay Shoreline, at Leisure Lagoon	Same as above	MB-TWAS 1	Toxicity (*C. dubia* acute survival, *C. dubia* chronic survival, *C. dubia* reproduction, *S. capricornutum* acute), Poor IBI, O/E, CRAM, TDS	Toxicity (*C. dubia* reproduction, *S. capricornutum* growth, *C. dubia* chronic survival), Very Poor IBI ***Based on one sample***; TDS, DO and *Enterococcus* (Coastkeeper)	Chloride, Sulfate, Bifenthrin, Very Poor IBI, O/E, Total N, Total P, TDS ***Based on two stations****	NA	NA	Impairment of REC-1 due to *Enterococcus* of the Mission Bay Shoreline at Leisure Lagoon during dry weather.	303(d)
										Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Leisure Lagoon during dry weather.	303(d)
		Mission Bay Shoreline, at North Crown Point								Impairment of REC-1 due to *Enterococcus* of the Mission Bay Shoreline at North Crown Point during dry weather.	303(d)
										Impairment of SHELL due to total coliform of the Mission Bay Shoreline at North Crown Point during dry weather.	303(d)

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Rose Canyon	NA	Mission Bay Shoreline, at Leisure Lagoon	*Enterococcus,* Fecal Coliform, Total N, Total P, TDS	*Enterococcus,* Fecal Coliform, Total N, Total P, TDS	NA
		Mission Bay Shoreline, at North Crown Point			

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Rose Canyon	NA	Mission Bay (Mouth of Rose Creek)	Eutrophic	Marine Habitat	Landfills, Nurseries, Point Source, Highway/Road/Bridge Runoff, Non-point Source, Urban Runoff/Storm Sewers
			Lead	Marine Habitat	Highway/Road/Bridge Runoff, Landfills, Urban Runoff/Storm Sewers, Non-point Source, Point Source
		Mission Bay Shoreline, at Visitors Center	*Enterococcus*	Water Contact Recreation	Unknown
			Fecal Coliform	Water Contact Recreation	Point Source/Non-point Source
			Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Rose Canyon	NA	Mission Bay (Mouth of Rose Creek)	Same as above	MB-TWAS 1	Toxicity (*C. dubia* acute survival, *C. dubia* chronic survival, *C. dubia* reproduction, *S. capricornutum* acute), Poor IBI, O/E, CRAM, TDS	Toxicity (*C. dubia* reproduction, *S. capricornutum* growth, *C. dubia* chronic survival), Very Poor IBI ***Based on one sample***; TDS, DO and *Enterococcus* (Coastkeeper)	Chloride, Sulfate, Bifenthrin, Very Poor IBI, O/E, Total N, Total P, TDS ***Based on two stations****	NA	NA	Impairment of MAR due to potential eutrophic conditions in Mission Bay at the Mouth of Rose Creek during dry weather.	303(d)
										Impairment of MAR due to lead in Mission Bay at the Mouth of Rose Creek during dry weather.	303(d)
		Mission Bay Shoreline, at Visitors Center								Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Mission Bay Shoreline at the Visitors Center during dry weather.	303(d)
										Impairment of SHELL due to total coliform of the Mission Bay Shoreline at the Visitors Center during dry weather.	303(d)

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Rose Canyon	NA	Mission Bay (Mouth of Rose Creek) Mission Bay Shoreline, at Visitors Center	*Enterococcus,* Fecal Coliform, Total N, Total P, TDS	*Enterococcus,* Fecal Coliform, Total N, Total P, TDS	NA

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Rose Canyon	NA	Rose Creek	NA	NA	NA
			Selenium	Warm Freshwater Habitat	Natural Sources
			Toxicity	Warm Freshwater Habitat	Urban Runoff/Storm Sewers
Scripps	Bacteria TMDL & La Jolla Shores ASBS	ASBS 29 - La Jolla Shores ASBS	Dry Weather Flows	ASBS	NA

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Rose Canyon	NA	Rose Creek	Same as above	MB-TWAS 1	Toxicity (*C. dubia* acute survival, *C. dubia* chronic survival, *C. dubia* reproduction, *S. capricornutum* acute), Poor IBI, O/E, CRAM, TDS	Toxicity (*C. dubia* reproduction, *S. capricornutum* growth, *C. dubia* chronic survival), Very Poor IBI ***Based on one sample***; TDS, DO and *Enterococcus* (Coastkeeper)	Chloride, Sulfate, Bifenthrin, Very Poor IBI, O/E, Total N, Total P, TDS ***Based on two stations****	NA	NA	Very Poor IBI scores near NPDES monitoring locations in Rose Creek during dry weather.	RW monitoring data (historic & current)
										Elevated TDS near NPDES monitoring locations in Rose Creek during dry weather.	RW monitoring data (historic & current)
										Impairment of WARM due to selenium in Rose Creek during dry weather.	303(d) and RW monitoring data (historic & current)
										Impairment of WARM due to toxicity in Rose Creek during dry weather.	303(d) and RW monitoring data (historic & current)
Scripps	Bacteria TMDL & La Jolla Shores ASBS	ASBS 29 - La Jolla Shores ASBS	Same as above	NA	NA	NA	NA	NA	NA	No dry weather runoff into ASBS 29.	2012 Ocean Plan Special Exceptions for ASBS

WQIP Subwatershed	**TMDL/ ASBS**	**303(d) Listed Waterbody**	**Urban Runoff Monitoring Assessment**		
			MS4 Outfall and Dry Weather Monitoring Program		**TMDL**
			2005-2010 LTEA	**FY 11 & 12 WURMP**	**WQBELs**
Rose Canyon	NA	Rose Creek	*Enterococcus,* Fecal Coliform, Total N, Total P, TDS	*Enterococcus,* Fecal Coliform, Total N, Total P, TDS	NA
Scripps	Bacteria TMDL & La Jolla Shores ASBS	ASBS 29 - La Jolla Shores ASBS	The City of San Diego has installed low flow diversions throughout the watershed draining to ASBS 29. No MS4 data is available since dry weather flow has been eliminated.		

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	**Impaired Beneficial Use(s)**	**Potential Source(s)**
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Mission Bay Shoreline, at Bahia Point	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Unknown
		Mission Bay Shoreline, at Bonita Cove	*Enterococcus*	Water Contact Recreation	Unknown
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Unknown

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Mission Bay Shoreline, at Bahia Point	Same as above	NA	NA	NA	NA	NA	NA	Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Mission Bay Shoreline at Bahia Point during dry weather.	303(d)
										Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Bahia Point during dry weather.	303(d)
		Mission Bay Shoreline, at Bonita Cove								Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Mission Bay Shoreline at Bonita Cove during dry weather.	303(d)
										Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Bonita Cove during dry weather.	303(d)

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Mission Bay Shoreline, at Bahia Point	NA	NA	*Enterococcus,* Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Mission Bay Shoreline, at Bonita Cove			

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	**Impaired Beneficial Use(s)**	**Potential Source(s)**
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Mission Bay Shoreline, at Fanuel Park	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Source Unknown
		Pacific Ocean Shoreline, Avenida de La Playa	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers
			Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Mission Bay Shoreline, at Fanuel Park	Same as above	NA	NA	NA	NA	NA	NA	Impairment of REC-1 due to *Enterococcus* of the Mission Bay Shoreline at Fanuel Park during dry weather.	303(d)
										Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Fanuel Park during dry weather.	303(d)
		Pacific Ocean Shoreline, Avenida de La Playa								Impairment of REC-1 due to *Enterococcus,* fecal and total coliform of the Pacific Ocean Shoreline at Avenida de La Playa during dry weather.	Bacteria TMDL
										Impairment of SHELL due to total coliform of the Pacific Ocean Shoreline at Avenida de La Playa during dry weather.	303(d)

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Mission Bay Shoreline, at Fanuel Park	NA	NA	*Enterococcus,* Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Pacific Ocean Shoreline, Avenida de La Playa			

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Children's Pool	*Enterococcus*	Water Contact Recreation	Natural Sources/Other Urban Runoff
			Fecal Coliform	Water Contact Recreation	Natural Sources/Unknown
			Total Coliform	Water Contact Recreation	Natural Sources/Other Urban Runoff/Unknown
			Total Coliform	Shellfish Harvesting	Natural Sources/Other Urban Runoff/Unknown
		Pacific Ocean Shoreline, La Jolla Cove	Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers and Other Unknown Source

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Children's Pool	Same as above	NA	NA	NA	NA	NA	NA	Impairment of REC-1 due to *Enterococcus* and total and fecal coliform of the Pacific Ocean Shoreline at Children's Pool during dry weather.	303(d) and Bacteria TMDL
											Bacteria TMDL
										Impairment of SHELL due to total coliform of the Pacific Ocean at Children's Pool during dry weather.	303(d)
		Pacific Ocean Shoreline, La Jolla Cove								Impairment of SHELL due to total coliform of the Pacific Ocean at La Jolla Cove during dry weather.	303(d)

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Children's Pool	NA	Total N, Total P, Fecal Coliform, *Enterococcus* (2012 Annual Monitoring Report Targeted Dry Weather Program)	*Enterococcus,* Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Pacific Ocean Shoreline, La Jolla Cove			

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	**Impaired Beneficial Use(s)**	**Potential Source(s)**
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Pacific Beach Point	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
			Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers and Other Unknown Source
		Pacific Ocean Shoreline, Ravina	Total Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
		Pacific Ocean Shoreline, Vallecitos Court	*Enterococcus*	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
			Fecal Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Pacific Beach Point	Same as above	NA	NA	NA	NA	NA	NA	Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Pacific Ocean Shoreline at Pacific Beach Point during dry weather.	303(d)
										Impairment of SHELL due to total coliform of the Pacific Ocean at Pacific Beach Point during dry weather.	303(d)
		Pacific Ocean Shoreline, Ravina								Impairment of REC-1 due to total coliform of the Pacific Ocean at Ravina during dry weather.	303(d) and Bacteria TMDL
		Pacific Ocean Shoreline, Vallecitos Court								Impairment of REC-1 due to *Enterococcus* and fecal coliform of the Pacific Ocean at Vallecitos Court during dry weather.	Bacteria TMDL

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Pacific Beach Point	NA	Total N, Total P, Fecal Coliform, *Enterococcus* (2012 Annual Monitoring Report Targeted Dry Weather Program)	*Enterococcus,* Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Pacific Ocean Shoreline, Ravina			
		Pacific Ocean Shoreline, Vallecitos Court			

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Vallecitos Court	Total Coliform	Water Contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
			Total Coliform	Shellfish Harvesting	Urban Runoff/Storm Sewers and Other Unknown Source
		Pacific Ocean Shoreline, La Jolla Shores Beach at el Paseo Grande	NA	NA	NA
		Pacific Ocean Shoreline, La Jolla Shores Beach at Caminito del Oro			

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Vallecitos Court	Same as above	NA	NA	NA	NA	NA	NA	Impairment of REC-1 due to total coliform of the Pacific Ocean at Vallecitos Court during dry weather.	Bacteria TMDL
										Impairment of SHELL due to total coliform of the Pacific Ocean at Vallecitos Court during dry weather.	303(d)
		Pacific Ocean Shoreline, La Jolla Shores Beach at el Paseo Grande								Impairment of REC-1 due to *Enterococcus,* and total and fecal coliform during dry weather	Bacteria TMDL
		Pacific Ocean Shoreline, La Jolla Shores Beach at Caminito del Oro								Impairment of REC-1 due to *Enterococcus,* and total and fecal coliform during dry weather	Bacteria TMDL

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, Vallecitos Court	NA	Total N, Total P, Fecal Coliform, *Enterococcus* (2012 Annual Monitoring Report Targeted Dry Weather Program)	*Enterococcus,* Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Pacific Ocean Shoreline, La Jolla Shores Beach at el Paseo Grande		NA	NA
		Pacific Ocean Shoreline, La Jolla Shores Beach at Caminito del Oro			

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, South Casa Beach at Coast Blvd.	NA	NA	NA
		Pacific Ocean Shoreline, Windansea Beach at Vista de la Playa			
		Pacific Ocean Shoreline, Windansea Beach at Bonair Street			
		Pacific Ocean Shoreline, Windansea Beach at Playa del Norte			
		Pacific Ocean Shoreline, Windansea Beach at Palomar Ave.			

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, South Casa Beach at Coast Blvd.	Same as above	NA	NA	NA	NA	NA	NA	Impairment of REC-1 due to *Enterococcus,* and total and fecal coliform during dry weather	Bacteria TMDL
		Pacific Ocean Shoreline, Windansea Beach at Vista de la Playa								Impairment of REC-1 due to *Enterococcus,* and total and fecal coliform during dry weather	Bacteria TMDL
		Pacific Ocean Shoreline, Windansea Beach at Bonair Street								Impairment of REC-1 due to *Enterococcus,* and total and fecal coliform during dry weather	Bacteria TMDL
		Pacific Ocean Shoreline, Windansea Beach at Playa del Norte								Impairment of REC-1 due to *Enterococcus,* and total and fecal coliform during dry weather	Bacteria TMDL
		Pacific Ocean Shoreline, Windansea Beach at Palomar Ave.								Impairment of REC-1 due to *Enterococcus,* and total and fecal coliform during dry weather	Bacteria TMDL

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreline, South Casa Beach at Coast Blvd.	NA	NA	NA
		Pacific Ocean Shoreline, Windansea Beach at Vista de la Playa			
		Pacific Ocean Shoreline, Windansea Beach at Bonair Street			
		Pacific Ocean Shoreline, Windansea Beach at Playa del Norte			
		Pacific Ocean Shoreline, Windansea Beach at Palomar Ave.			

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreleine, Pacific Beach at Grand Ave.	NA	NA	NA
Tecolote Creek	Bacteria TMDL	Tecolote Creek	*Enterococcus*	Water Contact Recreation	Point Source/Non-point Source
			Total Coliform		
			Fecal Coliform		
			Cadmium	Warm Freshwater Habitat	Point Source/Non-point Source
			Copper		
			Lead		
			Zinc		
			Phosphorus	Non-contact Recreation	Unknown

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreleine, Pacific Beach at Grand Ave.	Same as above	NA	NA	NA	NA	NA	NA	Impairment of REC-1 due to *Enterococcus,* and total and fecal coliform during dry weather	Bacteria TMDL
Tecolote Creek	Bacteria TMDL	Tecolote Creek	Same as above	TC-MLS, MB-TWAS-2	Selenium, Toxicity (*S. capricornutum* acute, *C. dubia* reproduction and chronic survival, *C. dubia* acute survival), Poor IBI, O/E, CRAM, Total P, Benthic Algae, *Enterococcus,* Fecal Coliform	Toxicity (*C. dubia* reproduction, *S. capricornutum* growth, *C. dubia* reproduction), Very Poor IBI, *Enterococcus*	Toxicity (*C. dubia* chronic survival and reproduction), Very Poor IBI, CRAM, Total N ***Based on one station at TWAS, and on one sample in TC-MLS****	Toxicity (*C. dubia* reproduction), Very Poor IBI, Total P	NA	Impairment of REC-1 due to *Enterococcus* , total coliform, and fecal coliform in Tecolote Creek during dry weather.	303(d), Bacteria TMDL, and RW monitoring data (historic & current)
										Impairment of WARM due to cadmium, copper, lead, and zinc in Tecolote Creek during dry weather.	303(d)
										Impairment of REC-2 due to potential eutrophic conditions (phosphorus) in Tecolote Creek during dry weather.	303(d) (Phosphorous) and RW monitoring data (current)

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Scripps	Bacteria TMDL & La Jolla Shores ASBS	Pacific Ocean Shoreleine, Pacific Beach at Grand Ave.	NA	NA	NA
Tecolote Creek	Bacteria TMDL	Tecolote Creek	pH, *Enterococcus,* Fecal Coliform, Total N, Total P	*Enterococcus,* Fecal Coliform, Total N, Total P	*Enterococcus,* Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Tecolote Creek	Bacteria TMDL	Tecolote Creek	Toxicity	Warm Freshwater Habitat	Point Source/Non-point Source
			Turbidity	Non-contact Recreation	Urban Runoff/Storm Sewers and Other Unknown Source
			NA	NA	NA
		Mission Bay (Mouth of Tecolote Creek)	Eutrophic	Estuarine Habitat	Point Source/Non-point Source

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment: Public Input	Receiving Water Assessment: Applicable Receiving Water Station(s)	NPDES Receiving Water: 2005-2010 LTEA	NPDES Receiving Water: FY 11 & 12 WURMP	SMC Program: 2005-2010 LTEA	SMC Program: FY 11 & 12 WURMP	RHMP Monitoring Data	Receiving Water Conditions: Receiving Water Conditions	Receiving Water Conditions: Line(s) of Evidence
Tecolote Creek	Bacteria TMDL	Tecolote Creek	Same as above	TC-MLS, MB-TWAS-2	Selenium, Toxicity (*S. capricornutum* acute, *C. dubia* reproduction and chronic survival, *C. dubia* acute survival), Poor IBI, O/E, CRAM, Total P, Benthic Algae, *Enterococcus,* Fecal Coliform	Toxicity (*C. dubia* reproduction, *S. capricornutum* growth, *C. dubia* reproduction), Very Poor IBI, *Enterococcus*	Toxicity (*C. dubia* chronic survival and reproduction), Very Poor IBI, CRAM, Total N ***Based on one station at TWAS, and on one sample in TC-MLS****	Toxicity (*C. dubia* reproduction), Very Poor IBI, Total P	NA	Impairment of WARM due to toxicity in Tecolote Creek during dry weather.	303(d) and RW monitoring data (historic & current)
										Impairment of REC-2 due to turbidity in Tecolote Creek during dry weather.	303(d) and RW monitoring data (historic & current)
										Very poor IBI scores near NPDES monitoring locations in Tecolote creek during dry weather.	RW monitoring data (historic & current)
		Mission Bay (Mouth of Tecolote Creek)								Impairment of EST due to eutrophic conditions in Mission Bay at the Mouth of Tecolote Creek during dry weather.	303(d)

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Tecolote Creek	Bacteria TMDL	Tecolote Creek	pH, *Enterococcus,* Fecal Coliform, Total N, Total P	*Enterococcus,* Fecal Coliform, Total N, Total P	*Enterococcus,* Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)
		Mission Bay (Mouth of Tecolote Creek)	pH, *Enterococcus,* Fecal Coliform, Total N, Total P	*Enterococcus,* Fecal Coliform, Total N, Total P	Enterococcus, Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Tecolote Creek	Bacteria TMDL	Mission Bay (Mouth of Tecolote Creek)	Lead	Industrial Service Supply	Point Source/Non-point Source
		Mission Bay Shoreline, at Tecolote Shores	*Enterococcus*	Water Contact Recreation	Urban Runoff and Other Unknown Source
			Total Coliform	Shellfish Harvesting	Unknown

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Receiving Water Assessment							Receiving Water Conditions	
			Public Input	Applicable Receiving Water Station(s)	NPDES Receiving Water		SMC Program		RHMP Monitoring Data	Receiving Water Conditions	Line(s) of Evidence
					2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP			
Tecolote Creek	Bacteria TMDL	Mission Bay (Mouth of Tecolote Creek)	Same as above	TC-MLS, MB-TWAS-2	Selenium, Toxicity (*S. capricornutum* acute, *C. dubia* reproduction and chronic survival, *C. dubia* acute survival), Poor IBI, O/E, CRAM, Total P, Benthic Algae, Enterococcus, Fecal Coliform	Toxicity (*C. dubia* reproduction, *S. capricornutum* growth, *C. dubia* reproduction), Very Poor IBI, *Enterococcus*	Toxicity (*C. dubia* chronic survival and reproduction), Very Poor IBI, CRAM, Total N ***Based on one station at TWAS, and on one sample in TC-MLS****	Toxicity(*C. dubia* reproduction), Very Poor IBI, Total P	NA	Impairment of IND due to lead in Mission Bay at the mouth Tecolote Creek during dry weather.	303(d)
		Mission Bay Shoreline, at Tecolote Shores								Impairment of REC-1 due to *Enterococcus* of the Mission Bay Shoreline at Tecolote Shores during dry weather.	303(d)
										Impairment of SHELL due to total coliform of the Mission Bay Shoreline at Tecolote Shores during dry weather.	303(d)

WQIP Subwatershed	TMDL/ ASBS	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Tecolote Creek	Bacteria TMDL	Mission Bay (Mouth of Tecolote Creek)	pH, *Enterococcus,* Fecal Coliform, Total N, Total P	*Enterococcus,* Fecal Coliform, Total N, Total P	*Enterococcus,* Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Mission Bay Shoreline, at Tecolote Shores			

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APPENDIX F

Receiving Water Conditions, Potential Impacts of MS4 Discharges, and Priority Water Quality Conditions in the Mission Bay WMA

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Table of Contents

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This appendix contains details of the analysis of receiving water conditions (Section 2.1), impacts from MS4 discharges (Section 2.2), and the factors that were evaluated to develop the final list of priority water quality conditions and high priority water quality conditions. The information is presented in three tables, which are described below.

It should be noted that the Mission Bay subwatershed does not have any priority water quality conditions because the receiving water conditions did not have evidence of MS4 impacts.

Table F-1: Receiving Water Conditions and Potential Impacts of MS4 Discharges in the Mission Bay WMA

Table F-1 presents all identified receiving water conditions in the Mission Bay WMA and the potential impacts of the MS4 discharges. These conditions were identified as described in Sections 2.1 and 2.2 based on the considerations detailed in the table. These include:

- Available receiving water data (current or historic) or regulatory drivers that support the condition. A check mark in the table indicates that samples have exceeded water quality objectives or the 2010 303(d) list or a TMDL identifies the waterbody as impaired. Where possible, the data were divided by temporal extent (wet- or dry-weather).
- Available current or historic MS4 monitoring data indicating that the MS4 potentially causes or contributes to the condition. A check mark indicates that samples collected from the MS4 during wet- or dry-weather have exceeded water quality objectives. MS4 data from the subwatershed was typically used for this consideration; data for MS4 discharges directly to the receiving water body in question are rarely available.
- Identification of the MS4 as a source of the condition in the 2010 303(d) list or a TMDL.
- The factors that led to the determination that the condition exists and was therefore included in the table.

Table F-2: Priority Water Quality Conditions in the Mission Bay WMA Subwatersheds

Table F-2 presents the following information for each priority water quality condition per the MS4 Permit (Provision B.2.b):

- The beneficial use impairment(s) associated with the priority water quality condition;
- The pollutant or stressor causing the beneficial use impairment, if known;
- The temporal extent of the priority water quality condition (dry and/or wet weather);

- The geographical extent of the priority water quality condition within the WMA, if known (based on the extent of the associated 303(d) listing or the location of the associated NPDES monitoring location);
- Lines of evidence leading to identification as a priority water quality condition, including evidence of MS4 discharges that may cause or contribute to the condition; and
- An assessment of the adequacy of the monitoring data to characterize the factors causing or contributing to the priority water quality condition, including consideration of spatial and temporal variation.

The table also lists the Responsible Agencies that potentially contribute to the condition. The contents of this table were determined by the assessment of the receiving water conditions and the MS4 impacts (presented in Table F-1).

Table F-3: Evaluation of Priority Water Quality Conditions in the Mission Bay WMA

As described in Section 2.3, priority water quality conditions that were identified based on the methodology presented in Appendix A. The remaining priority water quality conditions were evaluated based on several factors to determine if they warranted elevation to high priority water quality conditions for this iteration of the Water Quality Improvement Plan. Table F-3 summarizes this evaluation. The priority water quality condition must meet all of the following criteria to be considered a high priority water quality condition:

- Supporting data are sufficient to characterize the receiving water condition. To be sufficient, multiple samples collected under quality controlled monitoring must have exceeded water quality objectives.
- Storm water or non-stormwater runoff is a predominant source. Samples or observations collected under quality controlled monitoring programs must indicate that MS4 discharges are a predominant source of the receiving water condition.
- Controllable by Responsible Agencies. The pollutant or stressor must be within the authority of the Responsible Agency to control. To be considered controllable, there must be a clear link between the MS4 contribution and the receiving water condition, and the potential strategies to address the condition must be applicable to the geographic extent of the condition.
- Cannot be addressed by strategies identified for other high priority water quality conditions. The condition was not elevated to a high priority water quality condition if strategies identified for other high priority water quality conditions are expected to address the condition

Table F-1
Receiving Water Conditions and Potential Impacts of MS4 Discharges in the Mission Bay WMA

Subwatershed	Waterbody	Condition	Receiving Water Data or Regulatory Drivers Support Consideration as a Receiving Water Condition		Determining Factor(s) For Receiving Water Data	MS4 Monitoring Data Indicates Potential MS4 Impact[1]		MS4 Listed As Source on 303(d) or TMDL	Elevated to Priority Water Quality Condition?
			Wet	Dry		Wet	Dry		
Rose Canyon	Mission Bay Shoreline, at Campland	Impairment of REC-1 due to *Enterococcus* and fecal coliform	✓	✓	2010 303(d)	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	Wet, Dry	Yes
	Mission Bay Shoreline, at De Anza Cove	Impairment of REC-1 due to *Enterococcus*	✓	✓	2010 303(d)	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Impairment of REC-1 due fecal coliform	✓	✓	2010 303(d)	–	–	Wet, Dry	Yes
		Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
	Mission Bay Shoreline, at Leisure Lagoon	Impairment of REC-1 due to *Enterococcus*	✓	✓	2010 303(d) and public input	–	✓	Wet, Dry	Yes
		Impairment SHELL due to total coliform	✓	✓	2010 303(d) and public input	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
	Mission Bay Shoreline, at North Crown Point	Impairment of REC-1 due to *Enterococcus*	✓	✓	2010 303(d) and public input	✓	✓[2]	Wet, Dry	Yes
		Impairment SHELL due to total coliform	✓	✓	2010 303(d) and public input	–	–	Wet, Dry	Yes
	Mission Bay (Mouth of Rose Creek)	Impairment of MAR due to potential eutrophic[3] conditions (no pollutant specified)	–[3]	✓	2010 303(d) and public input	–	✓	Dry	Yes
		Impairment of MAR due to lead	✓	✓	2010 303(d) and public input	–	–	Wet, Dry	Yes
	Mission Bay Shoreline, at Visitor's Center	Impairment of REC-1 due to fecal coliform	✓	✓	2010 303(d) and public input	✓	✓[2]	–	Yes
		Impairment of REC-1 due to *Enterococcus*	✓	✓	2010 303(d) and public input	–	✓[2]	–	Yes
		Impairment of SHELL due to total coliform	✓	✓	2010 303(d) and public input	–	–	Wet, Dry	Yes
	Rose Creek	Impairment of WARM due to toxicity	✓	✓	2010 303(d) and public input	–	–	Wet, Dry	Yes
		Impairment of WARM due to selenium	✓	✓	2010 303(d) and public input	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Very poor IBI scores near NPDES monitoring locations in Rose Creek	–	✓	Current and historical receiving water monitoring data	–	–	–	No; Very poor IBI scores cannot be identified as a priority water quality condition because the full impact of all environmental contributions including the MS4 have not been characterized.
		Elevated TDS near NPDES monitoring locations in Rose Creek	✓	✓	Current and historical receiving water monitoring data	–	✓	–	Yes
		Elevated turbidity near NPDES monitoring locations in Rose Creek	✓	–	Current and historical receiving water monitoring data, public input	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Elevated TSS near NPDES monitoring locations in Rose Creek	✓	–	Current and historical receiving water monitoring data, public input	✓	–	–	Yes

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Subwatershed	Waterbody	Condition	Receiving Water Data or Regulatory Drivers Support Consideration as a Receiving Water Condition		Determining Factor(s) For Receiving Water Data	MS4 Monitoring Data Indicates Potential MS4 Impact[1]		MS4 Listed As Source on 303(d) or TMDL	Elevated to Priority Water Quality Condition?
			Wet	Dry		Wet	Dry		
Rose Canyon	Rose Creek	Elevated bifenthrin and permethrin levels near NPDES monitoring locations in Rose Creek	✓	–	Current and historical receiving water monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
Tecolote Creek	Tecolote Creek	Impairment of REC-1 due to indicator bacteria (total coliform, *Enterococcus*, and fecal coliform)	✓	✓	2010 303(d), Bacteria TMDL, current and historical receiving water monitoring data, and public input	✓	✓	Wet, Dry	Yes
Tecolote Creek	Tecolote Creek	Impairment of WARM due to cadmium, copper, lead, and zinc	✓	✓	2010 303(d) and public input	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Impairment of REC-2 due to potential eutrophic conditions[3] (phosphorus)	–[3]	✓	2010 303(d) and current and historical receiving water monitoring data, public input	–	✓	–	Yes
		Impairment of WARM due to toxicity	✓	✓	2010 303(d) current and historical receiving water monitoring data, public input	–	–	–	No; Toxicity cannot be identified as a priority water quality condition because the full impact of all environmental contributions including the MS4 have not been characterized.
		Impairment of REC-2 due to turbidity	✓	✓	2010 303(d) and current and historical receiving water monitoring data	–	–	Wet, Dry	Yes
		Very poor IBI scores near NPDES monitoring locations	–	✓	Current and historical receiving water monitoring data	–	–	–	No; Very poor IBI scores cannot be identified as a priority water quality condition because the full impact of all environmental contributions including the MS4 have not been characterized.
		Elevated bifenthrin and permethrin levels near NPDES monitoring locations in Tecolote Creek	✓	–	Current and historical receiving water monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
	Mission Bay (Mouth of Tecolote Creek)	Impairment of EST from eutrophic conditions[3] (no pollutant specified)	–[3]	✓	2010 303(d)	–	–	–	No; No MS4 data, and based on best professional judgment MS4 impacts on eutrophic conditions are not quantifiable.
		Impairment of IND from lead	✓	✓	2010 303(d)	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
	Mission Bay Shoreline, at Tecolote Shores	Impairment of REC-1 due to *Enterococcus*	✓	✓	2010 303(d)	✓	✓[3]	Wet, Dry	Yes
		Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
Mission Bay	Quivira Basin	Impairment of MAR and EST due to copper	✓	✓	2010 303(d)	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
	Mission Bay (Freshwater Influenced Areas)	Elevated total arsenic, total copper, total zinc, and total DDTs in sediments	–	✓	Historical RHMP monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.

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Subwatershed	Waterbody	Condition	Receiving Water Data or Regulatory Drivers Support Consideration as a Receiving Water Condition		Determining Factor(s) For Receiving Water Data	MS4 Monitoring Data Indicates Potential MS4 Impact[1]		MS4 Listed As Source on 303(d) or TMDL	Elevated to Priority Water Quality Condition?
			Wet	Dry		Wet	Dry		
Mission Bay	Mission Bay (Marinas)	Elevated dissolved copper in surface waters	–	✓	Historical RHMP monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Elevated total arsenic, total mercury, total zinc, and total DDTs in sediments	–	✓	Historical RHMP monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Elevated total copper in surface waters and sediments	–	✓	Historical RHMP monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
	Mission Bay (Shallow Areas)	Elevated total arsenic, total zinc, total DDTs, and total chlordanes in sediments	–	✓	Historical RHMP monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Elevated total copper in surface waters and sediments	–	✓	Historical RHMP monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
Scripps	La Jolla Shores/ ASBS 29	No dry weather runoff into La Jolla Shores ASBS 29	–	✓	Scripps Phase II CLRP Table 2-8	–	–[4]	–	No; no MS4 data to justify designation as priority water quality condition.
		Reduction of fecal coliform loads to those specified in the Scripps CLRP	✓	–	Scripps Phase II CLRP Table 2-8	✓	–	–	Yes
		Reduction of total coliform loads to those specified in the Scripps CLRP	✓	–	Scripps Phase II CLRP Table 2-8	✓	–	–	Yes
		Reduction of copper loads to those specified in the Scripps CLRP	✓	–	Scripps Phase II CLRP Table 2-8	✓	–	–	Yes
		Reduction of sediment loads to those specified in the Scripps CLRP	✓	–	Scripps Phase II CLRP Table 2-8	✓	–	–	Yes
	Mission Bay Shoreline, at Bahia Point	Impairment of REC-1 due to *Enterococcus* and fecal coliform	✓	✓	2010 303(d)	–	–	Wet, Dry[2]	Yes
		Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
	Mission Bay Shoreline, at Bonita Cove	Impairment of REC-1 due to *Enterococcus*	✓	✓	2010 303(d)	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Impairment of REC-1 due to fecal coliform	✓	✓	2010 303(d)	–	–	Wet, Dry	Yes
		Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
	Mission Bay Shoreline, at Fanuel Park	Impairment of REC-1 due to *Enterococcus*	✓	✓	2010 303(d)	–	–	Wet, Dry	Yes
		Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
	Pacific Ocean Shoreline, Casa Beach (Children's Pool)	Impairment of REC-1 due to *Enterococcus*	✓	✓	2010 303(d) and Bacteria TMDL[5]	–	✓[2]	Wet, Dry[2]	Yes
		Impairment of REC-1 due to fecal coliform	✓	✓	2010 303(d) and Bacteria TMDL[5]	–	✓[2]	–	Yes
		Impairment of REC-1 due to total coliform	✓	✓	Bacteria TMDL[5]	–	–	Wet, Dry[2]	Yes
		Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	Wet, Dry[2]	Yes

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Subwatershed	Waterbody	Condition	Receiving Water Data or Regulatory Drivers Support Consideration as a Receiving Water Condition		Determining Factor(s) For Receiving Water Data	MS4 Monitoring Data Indicates Potential MS4 Impact[1]		MS4 Listed As Source on 303(d) or TMDL	Elevated to Priority Water Quality Condition?
			Wet	Dry		Wet	Dry		
Scripps	Pacific Ocean Shoreline, La Jolla Cove	Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	Wet, Dry	Yes
	Pacific Ocean Shoreline, La Jolla Shores Beach at Avenida de la Playa[6]	Impairment of REC-1 due to *Enterococcus* and fecal coliform	✓	✓	Bacteria TMDL[5]	–	–	Wet, Dry	Yes
		Impairment of REC-1 due to total coliform	✓	✓	Bacteria TMDL[5]	–	–	Wet, Dry	Yes
	Pacific Ocean Shoreline, La Jolla Shores Beach at Avenida de la Playa[6]	Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	Wet, Dry	Yes
	Pacific Ocean Shoreline, La Jolla Shores Beach at Caminito del Oro	Impairment of REC-1 due to total coliform, *Enterococcus*, and fecal coliform	✓	✓	Bacteria TMDL[5,8]	–	–	–[7]	Yes
	Pacific Ocean Shoreline, La Jolla Shores Beach at El Paseo Grande	Impairment of REC-1 due to total coliform, *Enterococcus*, and fecal coliform	✓	✓	Bacteria TMDL[5,8]	–	–	–[7]	Yes
	Pacific Ocean Shoreline, Pacific Beach at Grand Ave	Impairment of REC-1 due to total coliform, *Enterococcus*, and fecal coliform	✓	✓	Bacteria TMDL[5,8]	–	–	–[7]	Yes
	Pacific Ocean Shoreline, Pacific Beach at Pacific Beach Point	Impairment of REC-1 due to *Enterococcus* and fecal coliform	✓	✓	2010 303(d)	–	✓	Wet, Dry	Yes
		Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	Wet, Dry	Yes
	Pacific Ocean Shoreline, South Casa Beach at Coast Boulevard	Impairment of REC-1 due to total coliform, *Enterococcus*, and fecal coliform	✓	✓	Bacteria TMDL[5,8]	–	–	–[7]	Yes
	Pacific Ocean Shoreline, Tourmaline Surf Park	Impairment of REC-1 due to total coliform, *Enterococcus*, and fecal coliform	✓	✓	Bacteria TMDL[5,8]	–	–	–[7]	Yes
	Pacific Ocean Shoreline, Vallecitos Court	Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	Wet, Dry[2,9]	Yes
		Impairment of REC-1 due to total coliform, *Enterococcus* and fecal coliform	✓	✓	Bacteria TMDL[5]	–	–	Wet, Dry	Yes
	Pacific Ocean Shoreline, Windansea Beach at Bonair Street	Impairment of REC-1 due to total coliform, *Enterococcus*, and fecal coliform	✓	✓	Bacteria TMDL[5,8]	–	–	–[7]	Yes

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Subwatershed	Waterbody	Condition	Receiving Water Data or Regulatory Drivers Support Consideration as a Receiving Water Condition		Determining Factor(s) For Receiving Water Data	MS4 Monitoring Data Indicates Potential MS4 Impact[1]		MS4 Listed As Source on 303(d) or TMDL	Elevated to Priority Water Quality Condition?
			Wet	Dry		Wet	Dry		
Scripps	Pacific Ocean Shoreline, Windansea Beach at Palomar Avenue	Impairment of REC-1 due to total coliform, *Enterococcus*, and fecal coliform	✓	✓	Bacteria TMDL[5,8]	–	–	–[7]	Yes
	Pacific Ocean Shoreline, Windansea Beach at Playa del Norte	Impairment of REC-1 due to total coliform, *Enterococcus*, and fecal coliform	✓	✓	Bacteria TMDL[5,8]	–	–	–[7]	Yes
	Pacific Ocean Shoreline, Windansea Beach at Vista de la Playa	Impairment of REC-1 due to total coliform, *Enterococcus*, and fecal coliform	✓	✓	Bacteria TMDL[5,8]	–	–	–[7]	Yes
	Pacific Ocean Shoreline at Whispering Sands Beach at Ravina Street[6]	Impairment of REC-1 due to total coliform	✓	✓	2010 303(d) and Bacteria TMDL[5]	–	–	Wet, Dry	Yes
		Impairment of REC-1 due to *Enterococcus* and fecal coliform	✓	✓	Bacteria TMDL[5]	–	–	Wet, Dry	Yes

1. Monitoring results show that the water quality standard exceedances were exceeded in the MS4 monitoring data
2. Dry weather diversions have been installed upstream.
3. Only listed as a dry weather condition based on best professional judgement that wet weather impacts are not quantifiable
4. The City of San Diego has installed low-flow diversions throughout the watershed draining to ASBS 29. No MS4 data are available since dry weather flow has been eliminated.
5. Although, these segments were originally 303(d) listed as impaired by total coliform, the TMDL applied numeric targets for three indicator bacteria (total coliform, Enterococcus, and fecal coliform).
6. These Bacteria TMDL shoreline segments are located within the ASBS 29 sub-drainage area.
7. These segments were delisted from the 2010 303(d) list because monitoring data showed that the segments did not exceed water quality standards.
8. Segment not currently listed on the 2010 CWA 303(d) List but is listed in the Bacteria TMDL.
9. Only the REC-1 beneficial use is impaired by the MS4 per the bacteria TMDL.

✓ = Criteria are met. – = Criteria are not met

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Table F-2
Priority Water Quality Conditions in the Mission Bay WMA Subwatersheds

Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies	
					RW[1]	MS4[2]	CT	SD
Rose Canyon Subwatershed								
Impairment of SHELL of Mission Bay Shoreline at Campland	Total coliform	Wet, Dry	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	–	✓
Impairment of REC-1 of Mission Bay Shoreline at De Anza	Fecal coliform	Wet[3]	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	–	✓
Impairment of REC-1 at Mission Bay Shoreline at Leisure Lagoon	*Enterococcus*	Wet, Dry	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources; current and historical dry weather receiving water monitoring data located upstream in Rose Creek; current and historical subwatershed level outfall monitoring data	Y	Y	–	✓
Impairment of REC-1 at Mission Bay Shoreline at North Crown Point	*Enterococcus*	Wet[3]	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources; current and historical dry weather receiving water monitoring data located upstream in Rose Creek; historical subwatershed level outfall data for wet weather	Y	Y	–	✓

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies	
					RW[1]	MS4[2]	CT	SD
Rose Canyon Subwatershed								
Impairment of SHELL at Mission Bay Shoreline at North Crown Point	Total coliform	Wet[3]	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources; current and historical dry weather receiving water monitoring data located upstream in Rose Creek; historical subwatershed level outfall data for wet weather	Y	Y	–	✓
Impairment of MAR of Mission Bay at Mouth of Rose Creek	Potential eutrophic conditions (no pollutant specified)	Dry	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources; current and historical dry weather subwatershed level outfall monitoring data	Y	Y	–	✓
Impairment of MAR of Mission Bay at Mouth of Rose Creek	Lead	Wet, Dry	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	✓	✓
Impairment of REC-1 of Mission Bay Shoreline at Visitor's Center	Enterococcus	Wet[3]	2010 303(d) listed segment	Historical wet weather subwatershed level outfall data	Y	Y	–	✓
	Fecal coliform			Historical wet weather subwatershed level outfall data; current and historical dry weather subwatershed level outfall monitoring				
Impairment of SHELL of Mission Bay Shoreline at Visitor's Center	Total coliform	Wet[3]	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	–	✓

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies	
					RW[1]	MS4[2]	CT	SD
Rose Canyon Subwatershed								
Impairment of WARM in Rose Creek	Toxicity	Wet, Dry	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	✓	✓
	TDS	Dry	Rose Creek near NPDES monitoring location	Current and historical receiving water monitoring data; current and historical subwatershed level outfall monitoring data	N	Y	–	✓
	TSS	Wet		Current and historical receiving water monitoring data; subwatershed level historical outfall monitoring data	N	Y	✓	✓
Tecolote Creek Subwatershed								
Impairment of REC-1 of Tecolote Creek	Indicator bacteria (total coliform, *Enterococcus*, and fecal coliform)	Wet, Dry	2010 303(d) listed segment	Bacteria TMDL; current and historical receiving water; subwatershed level current and historical outfall monitoring data	N	N	–	✓
Impairment of REC-2 of Tecolote Creek	Potential eutrophic conditions (Phosphorous)	Dry	2010 303(d) listed segment	Current and historical receiving water monitoring data; subwatershed level current and historical outfall monitoring data	N	Y	–	✓
	Turbidity	Wet, Dry		Current and historical receiving water monitoring data; Urban runoff/storm sewers 2010 303(d) listed as sources	N	Y	–	✓

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies	
					RW[1]	MS4[2]	CT	SD
Tecolote Creek Subwatershed								
Impairment of REC-1 of Mission Bay Shoreline at Tecolote Shores	*Enterococcus*	Wet[3]	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	–	✓
Scripps Subwatershed								
Impairment of Area of Special Biological Significance (ASBS)	Fecal coliform Total coliform Copper Sediment	Wet	La Jolla Shores ASBS, MS4–ASBS 29	Scripps Phase II CLRP Table 2-8	N	N	–	✓
Impairment of REC-1 of Mission Bay Shoreline at Bahia Point	*Enterococcus* Fecal coliform	Wet[3]	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources.	Y	Y	–	✓
Impairment of REC-1 of Mission Bay Shoreline at Bonita Cove	Fecal coliform	Wet, Dry	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources.	Y	Y	–	✓
Impairment of REC-1 of Mission Bay Shoreline at Fanuel Park	*Enterococcus*	Wet, Dry	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	–	✓

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies	
					RW[1]	MS4[2]	CT	SD
Scripps Subwatershed								
Impairment of REC-1 of Pacific Ocean Shoreline, Casa Beach (Children's Pool)	*Enterococcus* and fecal coliform	Wet[3]	2010 303(d) listed segment	Bacteria TMDL; Natural sources/other urban runoff 2010 303(d) listed as sources	N	N	–	✓
	Total coliform	Wet[3]		Bacteria TMDL	Y	Y	–	✓
Impairment of SHELL of Pacific Ocean Shoreline, Casa Beach (Children's Pool)	Total coliform	Wet[3]	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	–	✓
Impairment of SHELL of Pacific Ocean Shoreline, La Jolla Cove	Total coliform	Wet, Dry	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	–	✓
Impairment of REC-1 of Pacific Ocean Shoreline, La Jolla Shores Beach at Avenida de la Playa[4]	*Enterococcus*, fecal coliform, and total coliform	Wet, Dry	2010 303(d) listed segment	Bacteria TMDL	N	N	–	✓

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies	
					RW[1]	MS4[2]	CT	SD
Scripps Subwatershed								
Impairment of SHELL of Pacific Ocean Shoreline, La Jolla Shores Beach at Avenida de la Playa[4]	Total coliform	Wet, Dry	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	–	✓
Impairment of REC-1 of Pacific Ocean Shoreline, La Jolla Shores Beach at Caminito del Oro	Total coliform, *Enterococcus*, and fecal coliform	Wet, Dry	2002 303(d) listed segment	Bacteria TMDL[5]	Y[6]	Y[6]	–	✓
Impairment of REC-1 of Pacific Ocean Shoreline, La Jolla Shores Beach at El Paseo Grande	Total coliform, *Enterococcus*, and fecal coliform	Wet, Dry	2002 303(d) listed segment	Bacteria TMDL[5]	Y[6]	Y[6]	–	✓
Impairment of REC-1 of Pacific Ocean Shoreline, Pacific Beach at Grand Avenue	Total coliform, *Enterococcus*, and fecal coliform	Wet, Dry	2002 303(d) listed segment	Bacteria TMDL[5]	Y[6]	Y[6]	–	✓

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies	
					RW[1]	MS4[2]	CT	SD
Scripps Subwatershed								
Impairment of REC-1 of Pacific Ocean Shoreline, Pacific Beach at Pacific Beach Point	*Enterococcus*, fecal coliform	Wet, Dry	2010 303(d) listed segment	Current dry weather outfall monitoring; Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	–	✓
Impairment of SHELL of Pacific Ocean Shoreline, Pacific Beach at Pacific Beach Point	Total coliform	Wet, Dry	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources				
Impairment of REC-1 of Pacific Ocean Shoreline, South Casa Beach at Coast Boulevard	Total coliform, *Enterococcus*, and fecal coliform	Wet, Dry	2002 303(d) listed segment	Bacteria TMDL[5]	Y[6]	Y[6]	–	✓
Impairment of REC-1 of Pacific Ocean Shoreline, Tourmaline Surf Park	Total coliform, *Enterococcus*, and fecal coliform	Wet, Dry	2002 303(d) listed segment	Bacteria TMDL[5]	Y[6]	Y[6]	–	✓

Continued on next page

Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies	
					RW[1]	MS4[2]	CT	SD
Scripps Subwatershed								
Impairment of REC-1 of Pacific Ocean Shoreline, Vallecitos Court	*Enterococcus*, fecal coliform, and total coliform	Wet[3]	2010 303(d) listed segment	Bacteria TMDL	N	N	–	✓
Impairment of SHELL of Pacific Ocean Shoreline at La Jolla Shores Beach at Vallecitos	Total coliform	Wet[3]	2010 303(d) listed segment	Urban runoff/storm sewers 2010 303(d) listed as sources	Y	Y	–	✓
Impairment of REC-1 of Pacific Ocean Shoreline at Windansea Beach at Bonair Street	*Enterococcus*, fecal coliform, and total coliform	Wet, Dry	2002 303(d) listed segment	Bacteria TMDL[5]	Y[6]	Y[6]	–	✓
Impairment of REC-1 of Pacific Ocean Shoreline at Windansea Beach at Palomar Ave	*Enterococcus*, fecal coliform, and total coliform	Wet, Dry	2002 303(d) listed segment	Bacteria TMDL[5]	Y[6]	Y[6]	–	✓

Continued on next page

Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies	
					RW[1]	MS4[2]	CT	SD
Scripps Subwatershed								
Impairment of REC-1 of Pacific Ocean Shoreline at Windansea Beach at Playa del Norte	*Enterococcus*, fecal coliform, and total coliform	Wet, Dry	2002 303(d) listed segment	Bacteria TMDL[5]	Y[6]	Y[6]	–	✓
Impairment of REC-1 of Pacific Ocean Shoreline at Windansea Beach at Vista de la Playa	*Enterococcus*, fecal coliform, and total coliform	Wet, Dry	2002 303(d) listed segment	Bacteria TMDL[5]	Y[6]	Y[6]	–	✓
Impairment of REC-1 of Pacific Ocean Shoreline at Whispering Sands Beach at Ravina Street[4]	*Enterococcus*, fecal coliform, and total coliform	Wet, Dry	2010 303(d) listed segment	Bacteria TMDL	N	N	–	✓

1. Are there gaps in the RW data used to characterize the priority water quality condition? (Y = yes; N = no)
2. Are there gaps in the MS4 data used to characterize the geographical contribution of the MS4 to priority water quality condition? (Y = yes; N = no)
3. Dry weather diversions have been installed upstream.
4. These Bacteria TMDL shoreline segments are located within the ASBS 29 sub-drainage area
5. Segment currently not listed on the 2010 CWA 303(d) List but is listed in the Bacteria TMDL.
6. These segments are meeting water quality standards in the receiving waters and therefore, the MS4 is not contributing to a priority water quality condition. These segments are a priority because they are listed in the Bacteria TMDL.

CT = California Department of Transportation (Caltrans); SD = City of San Diego

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Table F-3
Evaluation of Priority Water Quality Conditions in the Mission Bay WMA

Sub-watershed	Priority Water Quality Condition	Potential Stressor(s)	(a) Supporting Data Is Sufficient to Characterize the Receiving Water Conditions	(b) Storm Water/Non-Storm Water Runoff Predominant Source	(c) Controllable by Responsible Agencies[1]	(d) Cannot Be Addressed by Identified Strategies
Rose Canyon	Impairment of SHELL of Mission Bay Shoreline at Campland	Total coliform	–	–	–	–
	Impairment of REC-1 of Mission Bay Shoreline at De Anza Cove	Fecal coliform	–	–	–	–
	Impairment of REC-1 at Mission Bay Shoreline at Leisure Lagoon	*Enterococcus*	–	–	–	–
	Impairment of REC-1 at Mission Bay Shoreline at North Crown Point	*Enterococcus*	–	–	–	–
	Impairment of SHELL at Mission Bay Shoreline at North Crown Point	Total coliform	–	–	–	–
	Impairment of MAR of Mission Bay at Mouth of Rose Creek	Potential eutrophic conditions (no pollutant specified)	–	–	–	–
		Lead	–	–	–	–

Continued on next page

Sub-watershed	Priority Water Quality Condition	Potential Stressor(s)	(a) Supporting Data Is Sufficient to Characterize the Receiving Water Conditions	(b) Storm Water/Non-Storm Water Runoff Predominant Source	(c) Controllable by Responsible Agencies[1]	(d) Cannot Be Addressed by Identified Strategies
Rose Canyon	Impairment of REC-1 of Mission Bay Shoreline at Visitor's Center	Enterococcus	–	–	–	–
		Fecal coliform	–	–	–	–
	Impairment of SHELL of Mission Bay Shoreline at Visitor's Center	Total coliform	–	–	–	–
	Impairment of WARM in Rose Creek	Toxicity	✓	–	–	✓
		TSS	✓	–	–	–
		TDS	✓	✓	–	✓
Tecolote Creek	Impairment of REC-2 of Tecolote Creek	Potential Eutrophic Conditions (Phosphorus)	✓	–	–	–
		Turbidity	–	–	–	–
	Impairment of REC-1 of Mission Bay Shoreline at Tecolote Shores	*Enterococcus*	–	–	–	–
Scripps	Impairment of Area of Special Biological Significance (ASBS)	Copper	✓	✓	✓	–
	Impairment of REC-1 of Mission Bay Shoreline at Bahia Point	*Enterococcus*	–	–	–	–
		Fecal coliform	–	–	–	–

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Sub-watershed	Priority Water Quality Condition	Potential Stressor(s)	(a) Supporting Data Is Sufficient to Characterize the Receiving Water Conditions	(b) Storm Water/Non-Storm Water Runoff Predominant Source	(c) Controllable by Responsible Agencies[1]	(d) Cannot Be Addressed by Identified Strategies
Scripps	Impairment of REC-1 of Mission Bay Shoreline at Bonita Cove	Fecal coliform	–	–	–	–
	Impairment of REC-1 of Mission Bay Shoreline at Fanuel Park	*Enterococcus*	–	–	–	–
	Impairment of SHELL of Pacific Ocean Shoreline, Casa Beach (Children's Pool)	Total coliform	–	–	–	–
	Impairment of SHELL of Pacific Ocean Shoreline, La Jolla Cove	Total coliform	–	–	–	–
	Impairment of SHELL of Pacific Ocean Shoreline, La Jolla Shores Beach at Avenida de la Playa	Total coliform	–	–	–	–
	Impairment of REC-1 of Pacific Ocean Shoreline, Pacific Beach at Pacific Beach Point	*Enterococcus*, fecal coliform	–	–	–	–

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Sub-watershed	Priority Water Quality Condition	Potential Stressor(s)	(a) Supporting Data Is Sufficient to Characterize the Receiving Water Conditions	(b) Storm Water/Non-Storm Water Runoff Predominant Source	(c) Controllable by Responsible Agencies[1]	(d) Cannot Be Addressed by Identified Strategies
Scripps	Impairment of SHELL of Pacific Ocean Shoreline, Pacific Beach at Pacific Beach Point	Total coliform	–	–	–	–
	Impairment of SHELL of Pacific Ocean Shoreline, Vallecitos Court	Total coliform	–	–	–	–

"✓" – The criterion is met for the priority water quality condition.

"—" – The criterion is not met for the priority water quality condition.

1. The priority water quality condition is considered controllable if two criteria are met: (1) There is a clear link between the MS4 contribution and the receiving water conditions, and (2) The potential strategies that apply to the potential stressor are applicable for the drainage area of the receiving water condition.

APPENDIX G

ASBS Compliance Plan

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FINAL COMPLIANCE PLAN
LA JOLLA AREA OF SPECIAL BIOLOGICAL SIGNIFICANCE

Submitted to:
San Diego Regional Water Quality Control Board

Submitted by:
City of San Diego

Prepared by:
AMEC Environment & Infrastructure, Inc.
San Diego, California

September 20, 2014

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

ASBS	area of special biological significance
ASBS 29	La Jolla ASBS
ASBS 31	San Diego—Scripps ASBS
Bacteria TMDL	*Revised Total Maximum Daily Loads for Indicator Bacteria* (SDRWQCB, 2010)
Bight ’08	*Southern California Bight 2008 Regional Monitoring Survey* (SCCWRP, 2003)
Bight ’13	*Southern California Bight 2013 Regional Monitoring Survey* (SCCWRP, 2013)
BMP	best management practice
City	City of San Diego
CLRP	comprehensive load reduction plan
CSDM	coastal storm drain monitoring
FY	(City) fiscal year
General Exception	Resolution Number 2012-0012 (SWRCB, 2012b), a general exception to the Ocean Plan
HA	hydrologic area
HOA	homeowners’ association
IC	illegal connection
ID	illicit discharge
JURMP	jurisdictional urban runoff management program
La Jolla ASBS Dilution Study	La Jolla ASBS Site-Specific Dilution and Dispersion Model (City, 2013c)
La Jolla Watershed	La Jolla Shores Coastal Watershed
LID	low-impact development
MLS	mass loading station
MS4	municipal separate storm sewer system
new NPDES MS4 Permit	Order Number R9-2013-0001 (SDRWQCB, 2013b)
NPDES	National Pollutant Discharge Elimination System
Ocean Plan	Water Quality Control Plan for Ocean Waters of California (SWRCB, 2012e)
PFEIR	Program Final Environmental Impact Report (SWRCB, 2012a)
PGA	pollutant-generating activities
previous NPDES MS4 Permit	Order Number R9-2007-0001 (SDRWQCB, 2007)

ACRONYMS AND ABBREVIATIONS (Continued)

Project SWELL	Project Stewardship: Water Education for Lifelong Leadership
RWQCB	(California) Regional Water Quality Control Board
SCCWRP	Southern California Coastal Water Research Project
Scripps Watershed	Scripps Hydrologic Area (HA 906.30)
SDRWQCB	California Regional Water Quality Control Board San Diego Region
SIO	Scripps Institution of Oceanography
SMC	Storm Water Monitoring Coalition
SUSMP	standard urban storm water mitigation plan
SWMP	storm water management plan
SWPPP	storm water pollution prevention plan
SWRCB	(California) State Water Resources Control Board
TCBMP	treatment control best management practice
TWAS	temporary watershed assessment station
UC IPM	University of California (Agriculture and Natural Resources Statewide) Integrated Pest Management Program
UCSD	University of California San Diego
USEPA	United States Environmental Protection Agency
WQIP	water quality improvement plan
WQO	water quality objective
WURMP	watershed urban runoff management program

1.0 INTRODUCTION AND BACKGROUND

This compliance plan applies to the La Jolla Area of Special Biological Significance (La Jolla ASBS; also ASBS 29) and how it is impacted by storm water discharges and associated potential contaminants. Specifically, the plan describes the approach of the City of San Diego (City) to comply with the requirements of Resolution Number 2012-0012[1] of the State Water Resources Control Board (SWRCB), *Approving Exceptions to the California Ocean Plan for Selected Discharges into Areas of Special Biological Significance, Including Special Protections for Beneficial Uses, and Certifying a Program Environmental Impact Report* (2012b) (General Exception).

Based on data collected in ASBS 29, the La Jolla ASBS Site-Specific Dilution and Dispersion Model (La Jolla ASBS Dilution Study) (City, 2013c) (discussed in Section 3.2) and analysis provided in the Scripps Watershed Comprehensive Load Reduction Plan (CLRP) (City, 2013d) (discussed in Section 4.0), the City's current implementation of non-structural and structural best management practices (BMPs) complies with the General Exception requirement to protect natural water quality during wet and dry weather conditions. Low-flow diversions currently installed at nine locations are intended to eliminate non-storm water discharges to the ASBS during dry weather. Furthermore, the City's implementation of BMPs is in accordance with the schedule required in the General Exception (discussed in Section 5.1). The City plans to continue to maintain and implement existing BMPs and to continue monitoring in the ASBS per the General Exception to protect and assess maintenance of natural water quality.

The following sections describe the regulatory framework for this La Jolla ASBS Compliance Plan.

1.1 Storm Water Regulation

The Clean Water Act (CWA) was adopted in 1972 and prohibits point sources of discharges, such as storm water, into waters of the United States (U.S.) unless the discharge complies with the National Pollutant Discharge Elimination System (NPDES) program. The U.S. Environmental Protection Agency (USEPA) authorizes the SWRCB to administer the NPDES program under CWA Section 402. Similarly, the SWRCB authorizes the Regional Water Quality Control Boards (RWQCBs) to issue NPDES permits for storm water discharges.

Storm water runoff is commonly transported through municipal separate storm sewer system (MS4s), which typically discharge water (and any potential pollutants) directly into streams, bays, and/or an ocean. The San Diego RWQCB (SDRWQCB) adopted a revised NPDES MS4 Permit (SDRWQCB, 2013b) that regulates MS4 discharges from municipalities such as the City. Therefore, based on Section I.A.2.d of the General Exception, this Compliance Plan is subject to approval from the Executive Officer of the SDRWQCB.

[1] Resolution 2012-0012 was subsequently revised by Resolution 2012-0031 (SWRCB, 2012d). The only change was a correction of the compliance timeframe from four years to six years.

The new NPDES MS4 Permit requires the City to conduct multiple activities, including:

- Identify major outfalls and pollutant loadings;
- Detect and eliminate all non-storm water discharges to the MS4, except as specifically and legally exempted;
- Prevent and reduce pollutants in runoff from industrial, commercial, and residential areas by implementing best management practices (BMPs);
- Control storm water discharges from new development and redevelopment;
- Inspect industrial, commercial, and construction activities;
- Provide pertinent education about and promote public reporting of pollution; and
- Monitor discharges and impacts on receiving waters.

In 1974, the SWRCB designated 34 regions along the coast of California as ASBS under Resolution Number 74-28 (SWRCB, 1974). These ASBS are “areas designated by the SWRCB as ocean areas requiring protection of species or biological communities to the extent that alteration of natural water quality is undesirable” (SWRCB, 2012b).

Section 13170.2 of the California Water Code requires the SWRCB to prepare and adopt a *Water Quality Control Plan for Ocean Waters of California* (last revised, 2012e) (Ocean Plan). The Ocean Plan establishes water quality objectives (WQOs) that are the basis of regulating point source and non-point source waste discharges into coastal waters. The Ocean Plan prohibits all discharges to an ASBS and requires discharge points to be located far enough away from an ASBS to maintain natural water quality conditions; however, the SWRCB can issue permits that exempt certain discharges to an ASBS.

In March 2012, the SWRCB adopted the General Exception (SWRCB, 2012b), which exempts certain listed dischargers. The conditions in the General Exception are designed to protect beneficial uses of the receiving water, yet allow continuation of essential public services, such as flood control, slope stabilization, erosion prevention, maintenance of the natural hydrologic relationship between terrestrial and marine ecosystems, public health and safety, public recreation and coastal access, commercial and recreational fishing, navigation, and essential military operations (national security) (SWRCB, 2012b).

The General Exception designates the City as the sole discharger to ASBS 29. The General Exception authorizes the City to discharge into ASBS 29, provided that it:

- Complies with the NPDES MS4 Permit; and
- Includes an ASBS Compliance Plan in the Mission Bay Watershed Management Area (WMA) Water Quality Improvement Plan (WQIP)[2]; the Mission Bay WMA includes the La Jolla ASBS.

[2] The new NPDES MS4 Permit (Order Number R9-2013-0001) (SDRWQCB, 2013b) requires the City to develop a WQIP, which is equivalent to a storm water management plan (SWMP) or storm water pollution prevention plan (SWPPP).

1.2 Document Organization

1.2.1 General Compliance

In general, the ASBS Compliance Plan:

- Addresses the prohibition of non-storm water runoff and the requirement to maintain natural water quality for storm water discharges to ASBS 29, according to Section I.A.2 of the General Exception;
- Serves as the ASBS Pollution Prevention Plan required for non-point source discharges, according to Section I.B.2 of the General Exception;
- Describes the City's strategy to comply with the General Exception; and
- Will be updated according to Sections I.A.2.h and I.B.2.c of the General Exception.

1.2.2 Specific Compliance

Specifically, this ASBS Compliance Plan:

- Describes the measures by which non-authorized, non-storm water runoff has been eliminated by the City, and how these measures will be maintained, monitored, and documented;
- Includes minimum frequencies for inspection of MS4s;
- Addresses storm water discharges and, in particular, describes how pollutant reductions in storm water runoff are achieved by implementing BMPs;
- Addresses erosion control and the reduction and/or prevention of anthropogenic sedimentation in the ASBS; and
- Describes the City's non-structural and structural BMPs currently employed and its plan to continue implementation in the future, including a schedule for the City's WQIP.

1.2.3 General Exception Requirements

The requirements for this ASBS Compliance Plan per the General Exception are addressed in sections of this report, as noted below:

Section 1—Introduction: Describes California discharge regulations, ASBS-specific requirements, compliance actions, and the organization of this ASBS Compliance Plan.

Section 2—Discharges to the La Jolla ASBS: Describes the ASBS 29 drainage area, identifies discharges to ASBS 29, and specifically addresses the prohibition of non-storm water runoff and the requirement to maintain natural water quality for storm water discharges to an ASBS; describes measures by which all non-authorized, non-storm water runoff has been eliminated, states how these measures will be maintained over time, and states how these measures are monitored and documented; and identifies storm water runoff and pollutant sources from the City's parks and recreation facilities and areas of erosion potential. (Addresses Sections I.A.2.a, Section I.A.2.e, I.B.2.b, and II of the General Exception.)

Section 3—Prioritization of Discharges: Identifies municipal and industrial storm water discharges, prioritizes them based on risk to water quality, and incorporates data from storm water runoff and ocean receiving water monitoring. (Addresses Section I.A.2.a of the General Exception.)

Section 4—Implemented BMPs: Describes existing nonstructural BMPs, including an education and outreach program; and describes existing structural BMPs and their role. Describes the planned continuation of currently implemented non-structural and structural BMPs, and the role of BMPs in maintaining natural water quality. (Addresses Sections I.A.2.b, I.A.2.c, I.A.2.d, I.A.2.e, I.A.2.f, I.A.2.g, I.B.2.b, and II of the General Exception.)

Section 5—Compliance and Implementation Schedule: Provides the compliance schedule and the BMP implementation schedule; mandates submitting a report if receiving water monitoring indicates that discharges are altering natural conditions; and describes the procedures for revising the ASBS Compliance Plan to maintain compliance with the General Exception. (Addresses Sections I.A.2.g, I.A.2.h, I.A.3, I.B.2.c, and I.B.3 of the General Exception.)

Section 6—References: Presents the documents referenced in the development of this ASBS Compliance Plan.

2.0 Discharges to the La Jolla Area of Special Biological Significance

2.1 La Jolla Watershed

ASBS 29 is located off the northern coast of the Scripps Hydrologic Area (HA) (HA 906.30; also Scripps Watershed) in the La Jolla Shores Coastal Watershed (La Jolla Watershed). The ASBS 29 drainage area is approximately 1,600 acres and extends from the Pacific Ocean shoreline to an elevation of approximately 243 meters (800 feet) at Mount Soledad. Drainage into the ASBS flows from MS4 storm water outfalls, overland sheet flow (directly from non-MS4 discharges), and natural drainage features (La Jolla Shores Watershed Management Group, 2008). The primary land use is residential with some commercial and institutional (i.e., the University of California San Diego Scripps Institute of Oceanography [UCSD-SIO] campus) areas.

The MS4 storm water outfalls are point sources of storm water runoff into receiving water bodies, regulated by the NPDES MS4 Permit. The location and density of these outfalls generally indicate the significance of storm-water-based sources in the drainage area. The degree of urbanization and the imperviousness of a drainage area dictate the amount of storm water that is conveyed directly to the MS4 and into receiving waters. Contributing land use activities include, but are not limited to, landscaping, car washing, pet waste, and vehicle wear (City, 2012c).

2.2 Dry Weather Flows

Non-storm water discharges are prohibited under the General Exception. The only discharges allowed are those that are essential for emergency response purposes, structural stability, slope stability, or those that occur naturally. Landscape irrigation in the La Jolla Watershed is a high-water-use activity. Over-irrigation often results in dry weather urban runoff that transports pollutants from impervious surfaces (such as roadways and parking lots) and discharges them into the ASBS. The primary pollutants from urban runoff are sediment, bacteria, nutrients, and metals.

The City's BMPs to reduce or eliminate non-storm water discharges include constructing low-flow diversions, education and outreach targeted on reducing irrigation runoff, incentivizing smart gardening and water conservation measures (such as rebates to incentivize grass removal), and promoting rain barrels and downspout disconnections. The City also investigates illegal connections and illicit discharges (IC/ID) in response to flows that exceed the water quality criteria during routine dry weather monitoring.

The City's programs to eliminate non-storm water discharges and reduce or control pollutant sources that drain into the ASBS are discussed further in Section 4.

2.3 Storm Water Discharges (Wet Weather Flows)

Under the General Exception, the only permitted point source discharges of storm water are those authorized by the General Exception or by an NPDES permit issued by the SWRCB or SDRWQCB. Per the General Exception, the only allowed discharges to the ASBS are those from existing storm water outfalls and those discharges must comply with all of the applicable terms, prohibitions, and special conditions in the General Exception.

Because of urbanization, steep slopes and a highly developed storm drain network in the upper reaches of its drainage system, the La Jolla Watershed responds quickly to rainfall events when fast-moving storm water surges downstream. Most of the runoff from the ASBS 29 drainage area is conveyed through a network of storm drains before it is discharged at several locations along the shoreline into the ASBS. Most of the runoff enters the City's NPDES-permitted MS4 through curb inlets in public streets or through catch basins at the lower (western) ends of open space and undeveloped areas. Runoff is then discharged into the ASBS via outfalls along the shoreline. The Avenida de la Playa and El Paseo Grande storm drains are the largest of these outfalls; together, they drain more than 50 percent of the ASBS 29 drainage area to the Pacific Ocean.

Sheet flow is minimal and is limited to the western end of Avenida de la Playa, the bluffs of the Devil's Slide area, and small portions of the boardwalk. Although no streams flow directly into the ASBS, natural drainage features discharge some urban runoff from cliffs or directly onto beaches (La Jolla Shores Watershed Management Group, 2008). Other discharges to the ASBS originate from private homes that discharge directly to the ocean via pipes, outfalls and weep holes embedded in the sea walls.

Figure 2-1 shows the locations of storm water outfalls to the ASBS and the City's MS4 in the La Jolla Watershed.

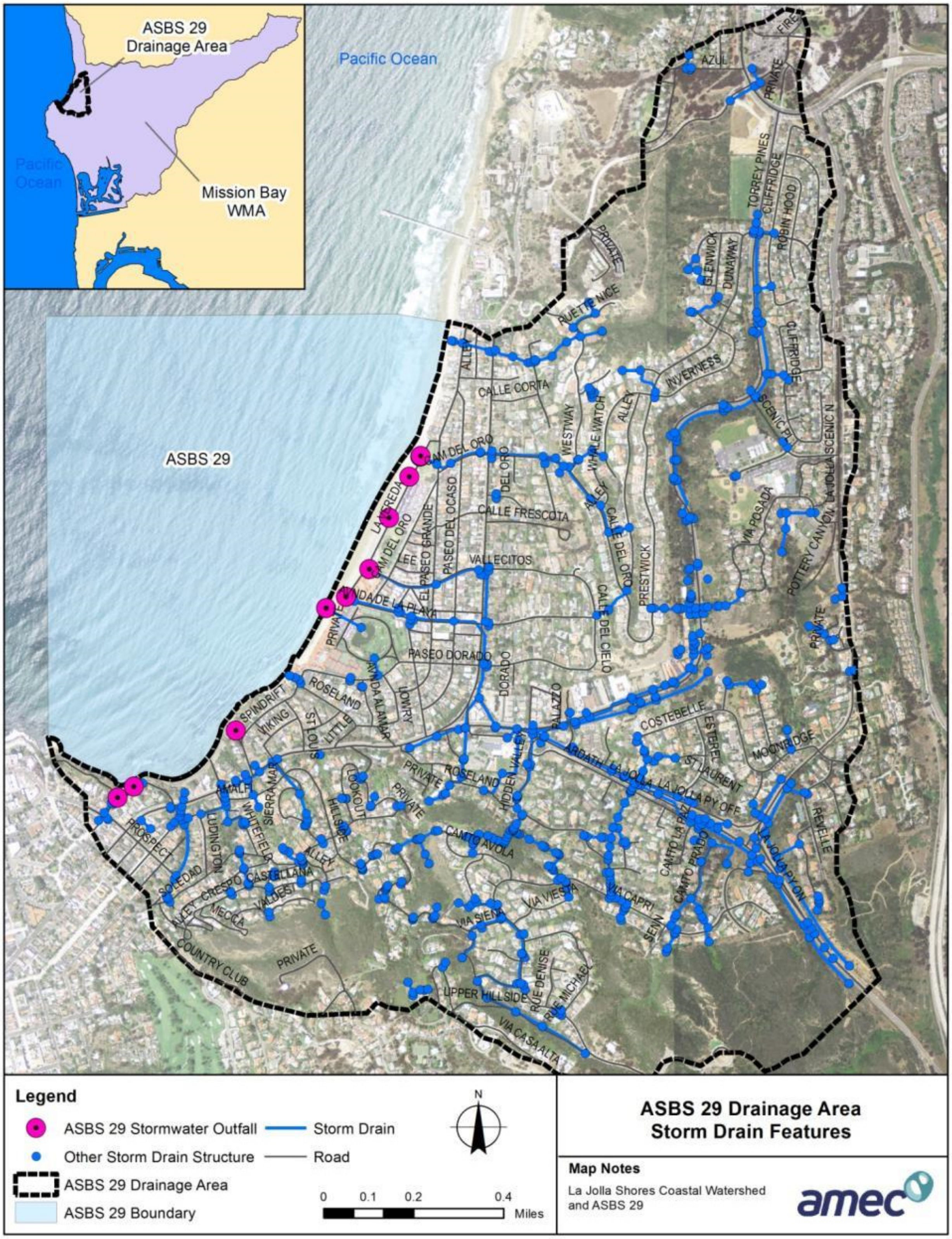


Figure 2-1: La Jolla Shores Coastal Watershed and ASBS 29 with MS4 Outfall Locations

2.4 Parks and Recreation Facilities Discharges

The General Exception requires the City to address storm water runoff from parks and recreation facilities and to identify all pollutant sources (including sediment sources) that may cause waste to enter storm water runoff. Over-watering landscaped areas increases the potential for fertilizer, herbicides and pesticides to be conveyed into the City's MS4. Parking lots in parks and recreation facilities are potential sources of heavy metals, oil and sediment. In addition, pet waste that is not properly disposed of in parks is a major source of pathogenic bacteria and other parasites. As a result, storm water pollutant mitigation measures must address parks and recreation facilities and their associated potential pollutant sources.

To meet the requirements of the General Exception, the City has implemented a number of non-structural and structural BMPs throughout the La Jolla Watershed, including BMPs at City Park and Recreation Department facilities (Section 4). The BMPs are effective at controlling soil erosion, preventing pesticide discharges, limiting trash, and reducing runoff from parking areas (discussed further in Section 4). The City plans to continue maintaining and implementing these BMPs to protect natural water quality.

The City's Park and Recreation Department oversees nearly 40,000 acres of developed and undeveloped open space and more than 340 parks (City, 2013c). Five of these parks are in the ASBS 29 drainage area (Figure 2-2) and are briefly described below.

- **Kellogg Park and La Jolla Shores Beach Park** (at 2112 Vallecitos and 8200 Camino del Oro, respectively, and totaling 13.42 acres) are, given their proximity and overlapping public use, discussed herein as one large park. Kellogg Park is a long, grassy area that parallels La Jolla Shores Beach Park; the two are separated by a palm-tree-lined, concrete boardwalk. Amenities include a children's playground, picnic tables, grills, restrooms, showers, and a free parking lot. La Jolla Shores is adjacent to the San Diego La Jolla Underwater Park Ecological Reserve.
- **Cliffridge Park** (10.90 acres at 8311 Cliffridge Avenue) is located amidst a residential neighborhood, the La Jolla YMCA and Torrey Pines Elementary School. To the west is a natural hillside that descends to Torrey Pines Road. The park features athletic fields, including four baseball diamonds, one tee-ball field, and two lined soccer fields within the baseball outfields. Other amenities are a food concession stand, picnic tables and restrooms.
- **Laureate Mini Park** is a small (0.81-acre) neighborhood park at the intersection of Avenida de la Playa and El Paseo del Ocaso. Mini parks generally are open spaces with 0.5 to 1.5 acres of play area and serve a neighborhood.
- **La Jolla Athletic Area (Allen Field)** (6.41 acres on Torrey Pines Road, south of Expedition Way) is a grass athletic field, primarily dedicated to soccer fields used by the La Jolla Youth Soccer League. This park is leased to La Jolla Youth, Inc., which is responsible for park maintenance. An office building in the park is the soccer league's offices and clubhouse; three portable toilets are located behind the building.

Potential sources of pollutants are identified and discussed in subsequent sections.

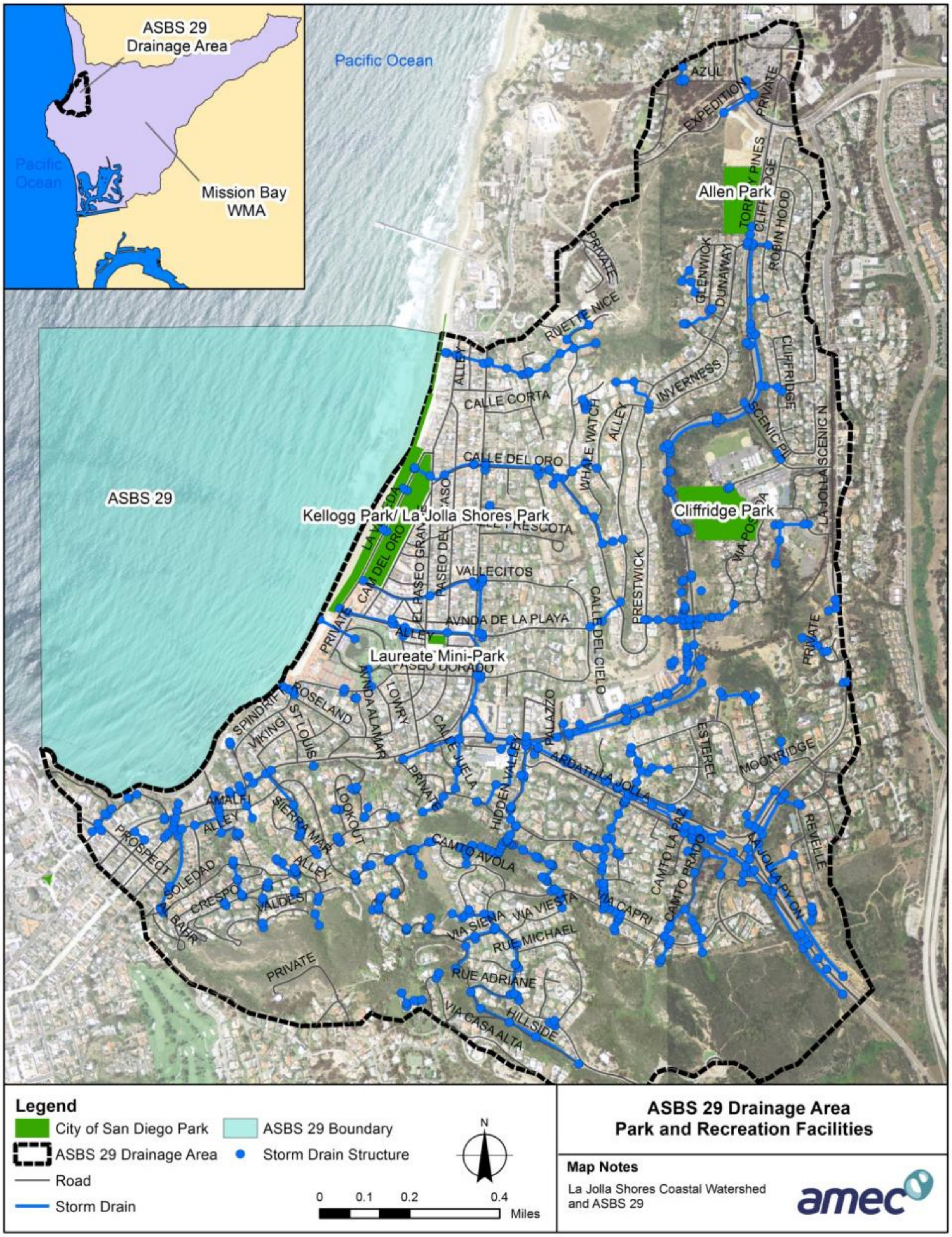


Figure 2-2: Park and Recreation Facilities Within ASBS Drainage Area

2.4.1 La Jolla Shores Small Vessel Boat Launch

La Jolla Shores has the only drive-on beach access to the ocean within City limits. It is located on the 2000 Block of Avenida de la Playa, four blocks west of La Jolla Shores Drive and approximately 300 yards south of the lifeguard station. Access consists of a break (of about 35 feet) in the seawall that permits vehicles to drive onto the beach to unload and load small vessels close to the surf. Discharges of storm water from impervious surfaces on the land side of the sea wall consist of sheet flow to the beach.

This is an unimproved boat launch (sand launch for small vessels and personal watercraft only); vehicles are allowed to drive on the sand only in a very limited area and no faster than 5 miles per hour. There is no ramp structure at this location and trailered boats cannot be launched by backing into water as at traditional boat launch ramps. Given these conditions this area was determined to not be considered as a waterfront and marine operations area as defined in Section III of the General Exception.

2.4.2 Trash Receptacles

The City provides numerous trash receptacles to properly manage trash and reduce the amount of trash that could enter the ASBS.

An overview of the trash receptacles at the parks in the ASBS drainage area is presented below

- Kellogg Park and La Jolla Shores Beach Park have 91 waste receptacles:
  - Eight solar-powered trash compactors (which are emptied as needed);
  - Thirty-six covered trash cans (in the park), 24 around the southern grassy area and 12 in the northern grassy area and picnic areas, all of which are emptied daily;
  - Forty-one uncovered trash cans (placed on the beach sand), which are emptied daily in the summer (Memorial Day through Labor Day) and three times a week during the rest of the year; and
  - Six covered dumpsters (at the northeastern end of the Kellogg Park parking lot).
- Cliffridge Park has 18 waste receptacles:
  - Nine covered trash cans (six around the picnic tables and three dispersed in other high-use areas, all of which are emptied daily);
  - Eight uncovered trash cans (two around the picnic tables and six dispersed in other high-use areas, all of which are emptied daily); and
  - One covered dumpster.
- Laureate Mini Park has two trash cans on the sidewalk adjacent to the park that are maintained by the City.

- Allen Field has 10 waste receptacles, maintained by La Jolla Youth, Inc.:
  - Nine covered trash cans (in its three soccer fields); and
  - One covered dumpster.

2.4.3 Roadways and Parking Lots

Impervious surfaces in urban landscapes increase runoff volume and contribute pollutants. Roadways and parking lots collect pollutants from tailpipe emissions and brake linings that are associated with a number of pollutants, including copper, lead, zinc, and polycyclic aromatic hydrocarbons (City, 2010b).

Parking lots and roadways associated with the parks in the ASBS watershed are:

- Kellogg Park and La Jolla Shores Beach Park—a parking lot that is available to the public from 4:00 a.m. to 10:00 p.m. (City, 2013c);
- Cliffridge Park— a small City-maintained parking area, with additional public parking on the neighboring City streets and no City-maintained roads;
- Laureate Mini Park—no parking lots, with City street parking available; and
- Allen Field—a small one-way parking lot accessible from Torrey Pines Road with parking on the adjacent grass and dirt areas.

At Kellogg Park the City has implemented the Kellogg Park Green Lot Retrofit Project (discussed in Section 4.2) to allow infiltration of urban runoff by replacing conventional asphalt in the parking lot with porous pavement. This pavement addresses potential water quality problems by reducing and treating runoff flows and discharges to the ASBS via infiltration and retention.

2.4.4 Picnic Areas

Picnic areas are often sources of litter. Waste generated from recreational picnic area use (such as carelessly discarded trash, paper wrappers and plastic bottles) has the potential to enter the storm drain system and ASBS.

Picnic facilities are available at City parks, as follows:

- At Kellogg Park and La Jolla Shores Beach Park there are 19 picnic tables and 7 barbecue grills in the north end of the park. The picnic areas are well maintained and have covered trash cans and hot coal receptacles. Other amenities include 37 benches along the boardwalk facing the beach, seven fire pits on the beach, two restroom facilities, four sinks, nine showers, and three water fountains.
- Cliffridge Park has five picnic tables and three benches. There is a food concession area on the north end of the park with four tables, along with covered trash cans. A fifth table is in the grassy area and has a covered trash can at each end of the table (see Figure 2-3).

Laureate Mini Park has no picnic facilities.

- Allen Field has no picnic facilities, but it has five benches and one three-tiered set of bleachers for spectators.

Figure 2-3: Picnic Area at Cliffridge Park

2.4.5 Soil Erosion

Park areas have the potential to deliver sediment into the storm drain system and/or ASBS. Unpaved areas, non-vegetated areas and parking lots are potential sources of non-point sediment.

Potential soil erosion and sediment delivery from park and recreation facilities in the ASBS drainage area are as follows:

- Kellogg Park has a low potential to contribute sediment to the ASBS because it consists of two well-established grassy areas, a concrete boardwalk and walkways, a developed parking lot, and a sand playground. In addition, the City's Kellogg Park Green Lot Retrofit Project allows infiltration of urban runoff and reduces sediment from being discharged to the ASBS from the parking lot.

- Cliffridge Park has a low potential to contribute sediment as most of the park is grass sports fields and its landscaped areas are generally within curbing or are vegetated and mulched.
- Laureate Mini Park has a contiguous grassy area without exposed soil; therefore, the potential for soil erosion is very low.
- Allen Field has a low potential to contribute sediment to the ASBS because most of it is well-established grass fields. However, the adjacent parking lot is a potential sediment source because street dirt accumulates on roads and parking lots and has the potential to run off in response to precipitation.

2.5 Erosion Potential and Control

The General Exception identifies sediment as a targeted pollutant. The most likely source of sediment in the ASBS 29 is erosion of canyon and open space areas within the drainage area. Development around open space areas has increased storm water flow volumes and velocities and has led to higher rates of erosion. Sediment in storm water runoff may result from land-disturbing activities at residences, such as landscaping, construction, and exposed non-vegetated soils. Other potential sources of sediment are urban and residential land uses, transportation uses (such as roads, highways, and parking lots), and coastal bluffs. Of these potential sources, construction activities would likely generate the largest sediment load. Road grit and finer particles not collected through street sweeping also contribute sediment to storm water runoff.

La Jolla is underlain primarily by sedimentary rock and has occasional outcrops of plutonic and metamorphic rocks. Small surficial landslides associated with expansible clay deposits of the Friars and Delmar Formations in the area are abundant. The shoreline along the ASBS is approximately 1.6 miles long. The northern 1.0 mile consists of fine sandy beaches; the southern 0.6 mile is composed of rocky boulders or ledges at the base of the cliffs, with one pebble beach in the Devil's Slide area. This area is bisected by a strand of the active Rose Canyon fault system. The northern three-fourths of the shoreline faces westward; the southernmost one-fourth faces northward (SWRCB, 1979).

The City's Development Services Department has conducted a seismic safety study (City, 2008) that contains a series of maps that identify likely geological hazards throughout the City. Based on these maps, Figure 2-4 shows unstable coastal bluffs, known landslide areas and areas with slide-prone geology in the La Jolla Watershed. BMPs currently implemented and planned to be continued to address the erosion control requirements of the General Exception are discussed in Section 4.

2.5.1 Construction Activities

Runoff from construction sites can transport pollutants including sediment, debris and chemicals to the storm drain system or directly to a river, lake or coastal water. Polluted storm water runoff can harm aquatic wildlife. Sedimentation can destroy aquatic habitat and high volumes of runoff can cause stream bank erosion. Debris can clog waterways and potentially reach the ocean where it can kill marine wildlife and impact habitat (USEPA, 2013).

2.5.2 Coastal Bluffs and Open Space Areas

Natural open spaces, ravines and canyons can generate sediment from erosion. As shown in Figure 2-4, unstable coastal bluffs, which have the potential to deliver sediment to the ASBS, form much of the shoreline. At the bluff tops are private homes, other structures and open space. Portions of undeveloped hillsides and bluffs further up in the La Jolla Watershed are exposed to wind and rain erosion, potentially contributing to sediment transported to the ASBS via roadways and the MS4.

Areas such as Pottery Canyon and La Jolla Heights Open Space have been designated as open space within La Jolla. Areas such as the slopes of Mount Soledad and Pottery Canyon are being preserved to protect the environmentally sensitive resources of La Jolla, including its coastal bluffs, steep hillside slopes, canyons, native plant life, and wildlife habitat linkages.

Because the beach is narrow and lacks a wide sand buffer, the bluffs along the shoreline are subjected to erosion from wave action, particularly during the winter.

Sediment, road grit and finer particles that accumulate on streets and parking lots from erosion, residential landscaping and atmospheric deposition are minimized through street sweeping. The City's Street Sweeping Program is discussed in more detail in Section 4.

Areas of open space designated as parks and recreation facilities under the management of the City, such as Cliffridge Park, are discussed in Section 2.4.

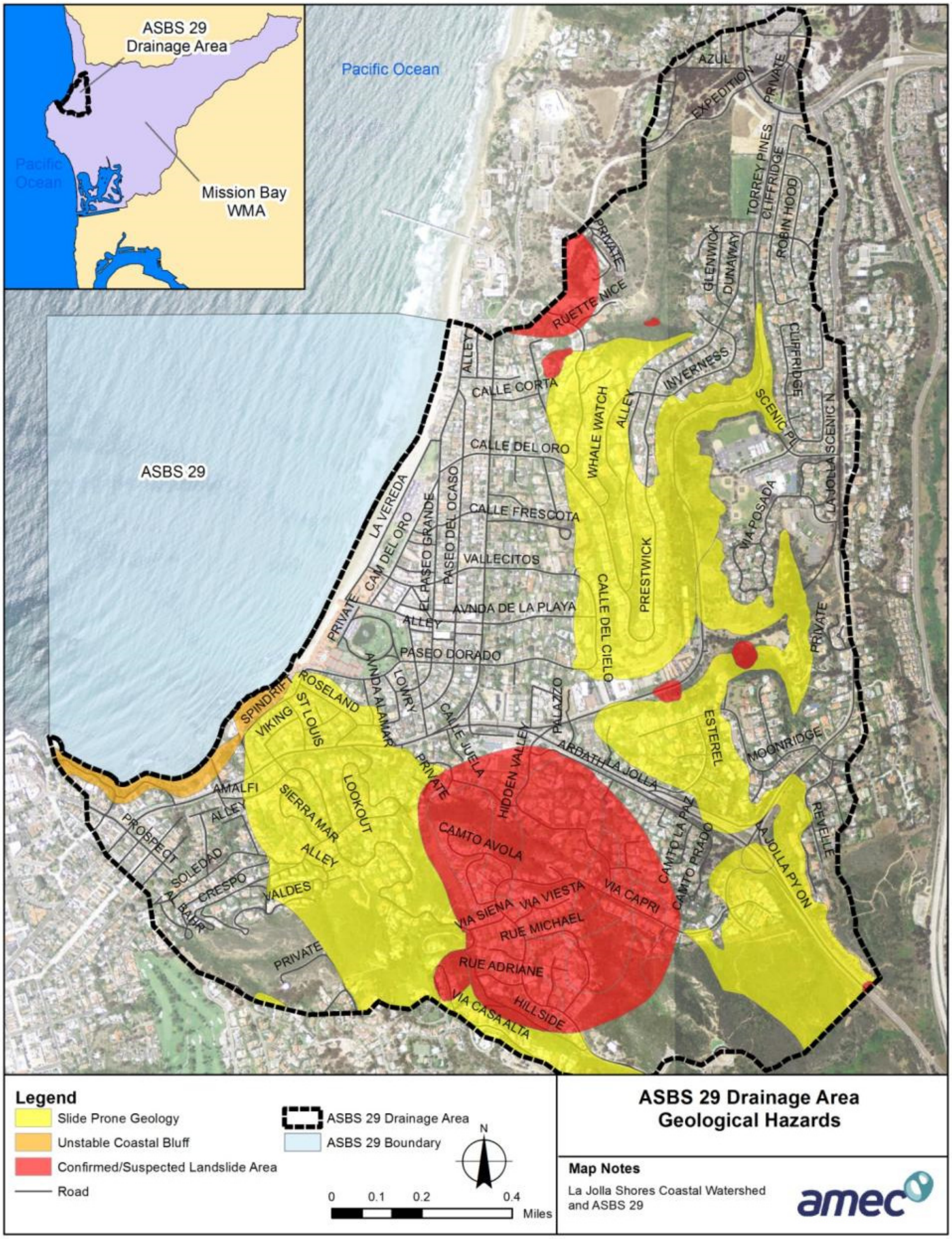


Figure 2-4: ASBS 29 Drainage Area Erosion Potential Map

3.0 Priority Discharges

The General Exception requires the ASBS Compliance Plan to include a map indicating the priority of discharges. High-priority discharges are those that pose the greatest threat to water quality and that have been identified as potentially requiring the installation of structural BMPs.

The City evaluated the discharges within ASBS 29 to determine the high-priority discharges based on the following factors:

- Available monitoring data;
- The La Jolla ASBS Dilution Study;
- Appendix 5 of the SWRCB Program Final Environmental Impact Report (PFEIR) (SWRCB, 2012a);
- Size of outfall or discharge;
- Drainage area size and land use; and
- Practicality and safety of structural BMP placement and monitoring (e.g., bluff access limitations).

Based on these factors, three high-priority discharges have been identified within ASBS 29 (see Table 3-1) and are detailed in the following subsections.

3.1 Historical and Current Monitoring

The City has participated extensively in monitoring storm water runoff and receiving waters in order to:

- Provide a means of evaluating the environmental risks of storm water discharges by identifying types and amounts of pollutants present;
- Determine the relative potential for storm water discharges to affect water quality;
- Identify potential sources of pollutants;
- Eliminate or control identified sources through management actions; and
- Assess the effectiveness of permit conditions and storm water management plans.

Monitoring through these programs, although not always regulation-driven, assesses the effectiveness of measures implemented to protect the water quality and ASBS beneficial uses.

3.1.1 Regulatory Monitoring Programs

Water quality monitoring conducted under several regulatory monitoring programs includes:

- Coastal Storm Drain Monitoring (CSDM) Program,
- Storm Water Monitoring Coalition (SMC) Regional Bioassessment,

- Dry Weather Monitoring Program under the Jurisdictional Urban Runoff Management Program (JURMP),
- Mass Loading Station (MLS) and Temporary Watershed Assessment Stations (TWAS) Ambient and Storm Monitoring Program ,
- AB 411 Beach Sanitation Posting, and
- Revised Total Maximum Daily Loads for Indicator Bacteria, Project 1–Twenty Beaches and Creeks in the San Diego Region (Bacteria TMDL) (SDRWQCB, 2010).

The results of these programs are presented in the *San Diego County Co-permittees Annual Urban Runoff Monitoring Report* and the *2005–2010 San Diego Storm Water Co-permittees Long-Term Effectiveness Assessment Report* (San Diego County Co-permittees, 2011).

No MLS or TWAS sites are in the Scripps Watershed, which limits water quality analysis to a review of the special studies in the La Jolla Watershed area (which are often associated with ASBS compliance and characterization).

3.1.2 La Jolla Shores Coastal Watershed Management Plan

The La Jolla Shores Coastal Watershed Management Plan was developed by the La Jolla Shores Watershed Management Group under Proposition 84 grant funding. Development of this plan included initial water quality monitoring of outfall discharges and receiving water conditions during storm events within the La Jolla Watershed and ASBS 29 (La Jolla Shores Watershed Management Group, 2008).

3.1.3 Core Discharge Monitoring Program

To comply with the Core Discharge Monitoring Program aspect of the General Exception, the City (because it discharges to the ASBS) is required to monitor storm water at its outfalls that are at least 18 inches in diameter and discharge to the ASBS. Five storm drains in the City's jurisdiction that drain to ASBS 29 have been voluntarily monitored by the City for multiple wet weather seasons prior to and in accordance with the monitoring requirements of the General Exception. The City’s voluntary and required monitoring in ASBS 29 has created a multi-year data set, particularly with respect to its largest outfall at Avenida de la Playa. Under the new NPDES MS4 Permit, the CSDM and Dry Weather Monitoring programs will be discontinued. However, the City will continue to monitor in accordance with Section IV of the General Exception.

3.1.4 Bight ’08 and ’13 ASBS Regional Monitoring Programs

The City has participated in two ASBS regional monitoring programs: The 2008 and 2013 Southern California Bight Regional Monitoring Programs (Bight ’08 and Bight ’13, respectively). These programs comprise a region-wide comprehensive assessment of receiving water conditions by assessing reference locations and locations influenced by urban runoff for water quality during storm events; bioaccumulation of potential pollutants, rocky intertidal habitat surveys, and a variety of focused special studies.

Preliminary draft results for receiving water monitoring under the Bight ’13 ASBS Regional Monitoring Program were released by SCCWRP on August 21, 2014 (SCCWRP, 2014). These program results include storm water monitoring results from reference site and receiving water sites, as well as the findings from the rocky intertidal habitat surveys, bioaccumulation sampling and plume studies. Water quality data collected from reference sites were used to determine the 85th percentile benchmark. By definition of the 85th percentile, the reference sites have an exceedance rate of 15 percent; the exceedance rate in the La Jolla ASBS (12 percent) was less than that. Results from the Bight ’08 ASBS Regional Monitoring Program also showed an exceedance rate less than 15 percent (5 percent). These analytical results indicate that the condition of water quality in the La Jolla ASBS is consistent with that of reference conditions, which represent natural water quality, and demonstrates consistency across program years. These findings also support those of the La Jolla ASBS Dilution Study, which indicated a high level of dilution in the receiving water. The collective results of water chemistry data, toxicity data, and biological assessments during this study showed consistency with natural water quality conditions in reference sites. This suggests that the City’s current management measures (i.e., BMPs) are achieving the targeted receiving water quality conditions.

Although a few constituents showed inconsistent and minor exceedances of the 85th percentile, these exceedances did not persist across monitored storms. Toxicity was not observed in the receiving water mixing zone, except for a sub-lethal response observed for kelp growth in a single sample.

The biological surveys that were part of the Bight ’13 program indicate that reference and receiving water quality conditions were similar. The rocky intertidal habitat survey concluded that there was no discernible difference in species richness and community composition for mobile and sessile species among selected discharge and reference ASBS in southern California, including the Devil’s Slide area in the southern portion of the La Jolla ASBS. Bioaccumulation monitoring results as a part of the Bight 13 Program also found median concentrations of a suite of trace metals and organic compounds to be similar among selected discharge and reference ASBS in southern California, including Scripps Reef (the site representing the La Jolla ASBS for this particular assessment).

The goal of the General Exception (and of the ASBS program as a whole) is to protect natural water quality to support the sensitive and valued native biological communities in these special areas. The results from the overall Bight ’13 program and, in particular, the biological components of the latest rocky intertidal habitat survey show that natural water quality conditions are being maintained in the La Jolla ASBS. The few exceedances in the analytical samples are anticipated to be managed by the City’s existing BMPs in the watershed, which it plans to continue. Despite any observed minor and transient exceedances of individual constituents in the receiving water during storm events, multiple supporting lines of evidence indicate that the overall health of the biota in the La Jolla ASBS is in good condition and that its natural water quality is being maintained. These conclusions are based on information collected not only during the Bight 13 Program but also through the past several years of compliance monitoring and a variety of other recent ecosystem assessment special studies in the La Jolla ASBS. A more thorough summary of these efforts and the resulting supporting conclusions is currently in preparation and will be available soon for review under a separate report to be submitted to the City.

3.2 La Jolla ASBS Dilution Study

In 2012, the City conducted the La Jolla ASBS Dilution Study to provide a quantitative, site-specific dilution and dispersion model to help determine appropriate dilution factors per guidance provided in the Ocean Plan (2012a) (City, 2013c). The effluents from three permitted outfalls (SDL-186, SDL-062, and SDL-157) within ASBS 29 were studied using the SEDXPORT hydrodynamic modeling system. The model is designed to numerically simulate dry weather and wet weather scenarios. The dilution study incorporated historical site-specific outfall data on water mass boundary properties (bathymetry, salinity, temperature, ocean levels and tides) and ocean forcing functions (waves, currents and winds). This modeling approach has been conducted for UCSD SIO's discharges, reviewed by the Natural Water Quality Committee (SCCWRP, 2010), and accepted by the SDRWQCB in 2008 when it was incorporated into a revision of UCSD SIO's NPDES Permit (SIO, 2008).

Results of the La Jolla ASBS Dilution Study (City, 2013c) indicated that storm water discharges from monitored outfalls into ASBS 29 generated dilution factors ranging from 10^2 in the near shore to 10^7 in the seaward boundary during wet weather. Further resolution of the model at the zone of initial dilution produced a worst-case dilution factor of 15 to 1 for 90 percent of the possible outcomes for the greatest-discharge outfall, SDL-062. The extreme worst case (0.13 percent probability in conditions of high discharge and a calm sea state) generated a 12.6:1 dilution factor for this outfall.

The dilution factor of 12.6:1 has been accepted by the SDRWQCB for the City to incorporate into its Mission Bay WMA WQIP. This factor has been included in pollutant-reduction analyses of outfall discharges to ASBS 29 and the results indicate that currently implemented non-structural BMPs provide the pollutant reductions necessary to protect natural water quality.

3.3 SWRCB Program Final Environmental Impact Report

SWRCB staff issued a PFEIR (SWRCB, 2012a) that evaluated the potential environmental effects of the adoption and implementation of the proposed statewide General Exception to the Ocean Plan waste discharge prohibition. Appendix 5 of the PFEIR includes the results of an assessment of discharges to ASBS conducted by the Southern California Coastal Water Research Project (SCCWRP, 2003) between March 2001 and February 2003. Discharges were documented within 100 meters (328 feet) of the high tide lines. The PFEIR Appendix 5 also includes the water quality threat levels designated for the surveyed discharges.

3.4 Evaluation of Discharges

Three outfalls are designated as high threats to water quality and are potentially subject to additional management measures: SDL062, SDL063 and SDL157 (see Figure 3-1).

Table 3-1: High-Priority Discharges in ASBS 29

Outfall	Latitude	Longitude	Upstream Source	Shape	Diameter/ Width (meters)	Discharges Onto
SDL062	32.8546	-117.2589	Urban watershed	Rectangular	5.00	Beach
SDL063	32.8556	-117.2582	Urban watershed	Rectangular	1.00	Beach
SDL157	32.8628	-117.25485	Urban watershed	Round	1.00	Beach

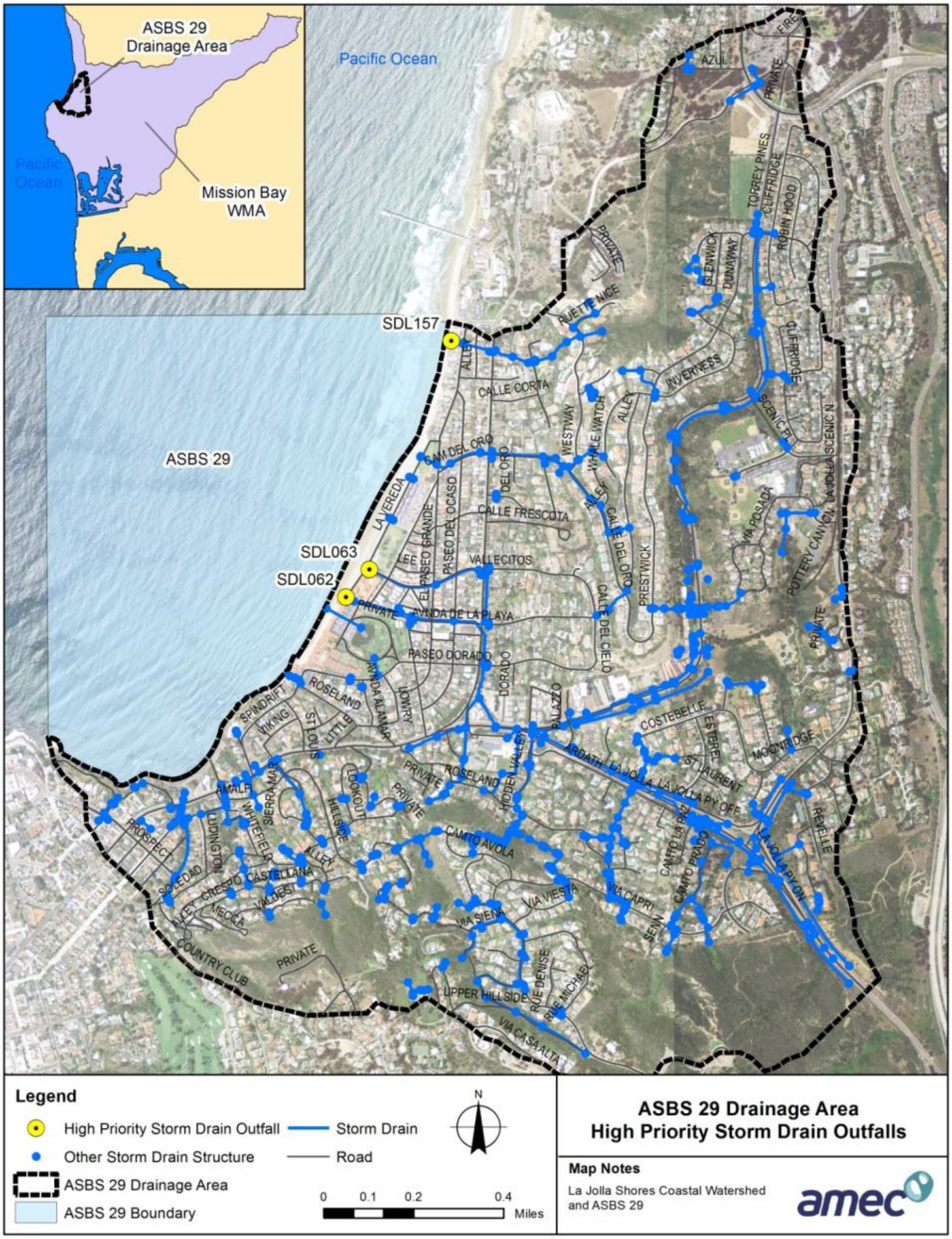


Figure 3-1: ASBS 29 Storm Drain Prioritization Map

4.0 Implemented Best Management Measures and Practices

To meet the requirements of the General Exception, the City conducted receiving water and outfall discharge monitoring as a participant in the Bight ’08 and Bight ’13 Regional Monitoring Programs and implemented a number of non-structural and structural BMPs throughout the La Jolla Watershed. The City plans to continue implementation of these BMPs, which control soil erosion, prevent pesticide discharges, enhance public education and outreach, limit trash, and reduce storm water runoff from parking areas.

The combined use of non-structural and structural BMPs makes pollutant reduction more practical and effective. Non-structural BMPs are designed to reduce pollutant loads before they enter the storm drain system. Source reduction strategies, such as addressing the discharge of trash and the disposal of animal waste, often reduce multiple pollutants including nutrients, sediment and bacteria. Structural BMPs, including storm water infiltration systems and low-flow diversions, are designed to reduce pollutant loading by treatment and by reducing runoff volume via capture, retention and infiltration.

City services include activities to maintain and improve City infrastructure and to reduce the amount of pollution that enters the storm drain system. The City has several special projects and pilot studies to assess the most efficient way to prevent pollution at local beaches, bays and creeks. These projects include both non-structural and structural BMPs, such as outreach programs designed to educate and change existing behaviors and attitudes of residents and business operators. Design and construction of low-impact development (LID) and capital improvement projects, such as detention basins and porous (pervious) pavement, provide long-term benefits to the storm drain system. The City also offers inspection services for businesses to determine how best to reduce their impact on the storm drain system.

Table 4-1 summarizes the City’s BMPs that are currently implemented in the ASBS 29 drainage area and the benefits of each type of BMP.

4.1 Implemented Non-Structural BMPs

Consistent with the Scripps Watershed CLRP, non-structural BMP reduction strategies are actions and activities to reduce storm water pollution that do not involve construction of a physical component or structure to filter and treat storm water (City, 2012c). Non-structural BMPs also include landscape-based measures, but whose functions are not exclusively limited to storm water filtration or treatment.

This section describes currently implemented non-structural BMPs and/or management activities in the La Jolla Watershed[3]. Some of these non-structural BMPs have been implemented citywide and are not exclusive to the ASBS 29 drainage area.

The new NPDES MS4 Permit (Order Number R9-2013-0001) (SDRWQCB, 2013) requires the development of WQIPs. The WQIPs are intended to guide responsible parties towards improving water quality in receiving waters by controlling pollutants from MS4 discharges. Future water quality improvement goals, strategies and monitoring and assessment programs will be included in the WQIP for the Mission Bay WMA, which includes ASBS 29.

Table 4-1: Summary of City-Implemented BMPs in ASBS 29 and Potential Benefits

Best Management Practice	Pollutant Reduction & Prevention	Runoff Reduction & Elimination	Runoff Treatment	Erosion Control
Non-Structural BMPs				
Inspections	✓	✓	—	✓
Trash Management	✓	—	—	—
Animal Waste Management	✓	—	—	—
MS4 Cleaning	✓	—	—	—
Street Sweeping	✓	—	—	—
Channel and Slope Stabilization	✓	—	—	✓
Sanitary Sewer Management	✓	✓	—	—
Smart Gardening and Water Conservation	✓	✓	—	✓
Education and Outreach	✓	✓	—	✓
Pesticides and Other Chemical Management	✓	—	—	—
Land Development Code Amendments	✓	✓	✓	✓
Updated Minimum BMPs	✓	✓	✓	✓
Structural BMPs				
Low-Flow Diversions	✓	✓	✓	—
Low-Impact Development (LID)	✓	✓	✓	✓

BMP = best management practice; MS4 = municipal separate storm sewer system

4.1.1 Facility and Construction Site Inspections

Storm water inspections occur under multiple types of permits, including the General Exception, NPDES permits, a statewide Construction General Permit, Phase I and Phase II MS4 Permits, and a statewide Industrial Activities Storm Water Permit.

Inspections of operations or activities within the ASBS 29 drainage area are an effective way to quickly assess potential impacts on water quality and to correct deficiencies and/or change

[3] The City described and summarized water quality improvement activities annually in its Watershed Urban Runoff Management Program (WURMP) reports required under the previous NPDES MS4 Permit (Order Number R9-2007-0001) (SDRWQCB, 2007). Details specific to the La Jolla Watershed are in the Mission Bay and La Jolla WURMP (City, 2012a). Water quality improvement activities were also identified in the CLRP for the Scripps HA, which was developed in response to the Bacteria TMDL and submitted to the RWQCB in 2012.

behaviors. These evaluations increase efficiencies in addressing discharges, correcting behaviors and abating sources of targeted pollutants at a variety of residential, commercial, and industrial areas.

In accordance with the General Exception, the City inspects facilities and/or sites in the ASBS 29 drainage area at the following frequencies:

- Municipal facilities: Once prior to and once during the rainy season;
- Construction sites: Weekly during the rainy season;
- Industrial facilities: Monthly during the rainy season;
- Commercial Facilities: Twice during the rainy season; and
- Outfalls greater than or equal to 18 inches in diameter: Once prior to the beginning of rainy season (October 1) and once during the rainy season; outfalls are routinely maintained to remove trash and other anthropogenic debris.

The City has multiple inspection programs that are described in the following subsections.

4.1.1.1 Treatment Control BMP Inspection and Maintenance Verification Program

Treatment control BMPs (TCBMPs) are permanent storm water treatment features that are incorporated into the design of newly developed or redeveloped properties to meet the requirements of the City's Model Standard Urban Storm Water Mitigation Plan (SUSMP) (San Diego Co-permittees, 2002). The City is required by the JURMP to annually verify via inspection that TCBMPs on properties within its jurisdiction are being effectively operated and maintained. Owners and operators of these properties are required to conduct regular maintenance activities per agreements signed with the City and filed with the County of San Diego.

The City's TCBMP program (City, 2013e) has three main components:

- Inventory maintenance
- An annual maintenance verification form
- Periodic TCBMP maintenance site inspections

There are currently 10 private TCBMP projects in the ASBS 29 drainage area that the City inspects to verify proper maintenance; these are described in Section 4.2 (Implemented Structural BMPs).

4.1.1.2 Industrial and Commercial Facilities Inspection Program

The NPDES MS4 Permit (SDRWQCB, 2013) requires the City to inventory and inspect industrial and commercial businesses to prevent illegal discharges to the storm drain system. The City implemented an inspection program to evaluate these sites and sources, inspect businesses, and answer the following management questions:

- What areas and activities should be targeted?

- Does the City's industrial and commercial inventory need to be re-evaluated?
- Can specific pollutant source types within the inventory be feasibly prioritized, based on site-specific characteristics?

The City continuously re-evaluates the inventory to include all businesses required to be on the inventory. Businesses are inspected to verify that the City's minimum BMPs are being implemented and are effective at preventing non-storm water discharges. Inspections assess the staff's knowledge of storm water and BMPs, and evaluate pollutant-generating activities of the businesses. A "pollutant potential" is calculated to help gauge the likelihood of an illegal discharge from every business. Enforcement actions are taken against businesses that have not implemented effective BMPs.

During fiscal year 2014 (FY14), 24 commercial facilities within the ASBS 29 drainage area were inspected (SWRCB, 2012c). (No industrial facilities were in the ASBS 29 drainage area.) Based on assigned codes, five new commercial and two new industrial businesses were added to the ASBS 29 drainage area business inventory during the FY15 update to be confirmed and inspected.

4.1.1.3 Construction Inspections

The City issues construction permits with inherent inspection requirements for private construction in the ASBS 29 drainage area. The City Engineer oversees construction inspection for public capital improvement projects. Repair and replacement of existing public infrastructures is occasionally performed as an operational activity rather than a capital improvement project, and in those cases the operational department performing the work has standard procedures addressing inspection. All construction sites inspected by the City are inspected for construction BMP compliance in accordance with the JURMP, which identifies the frequency and scope of inspections. Additionally, if the construction site exceeds thresholds that make it subject to the Construction General Permit, the City verifies that projects are enrolled.

Per the Construction General Permit, dischargers are required to conduct weekly BMP visual inspection and quarterly non-storm water visual inspections at each drainage area for the presence of unauthorized and authorized non-storm water discharges and their sources. Storm-related inspections for qualifying storm events (½ inch or more of rainfall) must include visual inspections of BMPs and observations of storm water discharges at all discharge locations prior to the storm, during the storm (every 24 hours), and after the storm. Inspection and potential sampling requirements could increase, based on site risk level, as determined by the site SWPPP.

4.1.1.4 Municipal Facility Inspection Program

The City requires two self-inspections of municipal facilities in the ASBS 29 drainage area each year (once prior to and once during the rainy season). The purpose of these inspections is to determine whether proper BMPs and good housekeeping measures are being implemented to eliminate non-storm water discharges and reduce pollutants in storm water runoff. If deficiencies or ineffective procedures are identified, City staff develops and implements plans for corrective action(s) to address the deficiency. If City staff determine that no corrective action(s) can be implemented immediately (such as construction of a structural control), the City establishes a schedule for implementing the corrective action(s).

4.1.1.5 Inspections Based on Property and Pollutant-Generating Activities (PGA)

The City has evaluated and recommended changes to its inspection program to focus on land uses, pollutant-generating activities (PGAs) and high-priority areas that are most likely to be contributing to pollutant loading, and areas where the greatest pollutant load reductions are likely to be achieved by inspection and enforcement.

For example, the City has transitioned to property-based inspections, as opposed to tenant-based, as part of its business (industrial and commercial) inspection program in the ASBS 29 drainage area. Property-based inspections are an important inspection strategy because dumpsters, landscaping and parking areas are typically managed by a general property management company or contractor rather than by a specific business. Under the previous inspection program, these common areas were often not covered during an inspection. Adding property-based inspections provides significant opportunities to increase the effectiveness and reach of the City's ongoing conservation strategies related to outreach and education, enforcement and inspection.

The City has incorporated the new property-based inspection protocols into its industrial and commercial inspection program and is currently conducting property-based inspections citywide, including in the ASBS 29 drainage area.

4.1.2 Trash Management

The General Exception prohibits discharging trash to ASBS 29. To comply with this prohibition, the City has multiple measures to address trash discharges. The City promotes recycling of solid waste to reduce the amount entering landfills, which helps the City comply with the California Integrated Waste Management Act of 1989 (Assembly Bill 939), and helps meet the recycling goals established by the City and mandated by the State of California. Routine trash collection services within the ASBS 29 drainage area minimize trash and debris discharges to ASBS 29.

The City maintains the following trash management measures:

- Residential Collection of Refuse—Weekly trash service, including collection, transportation and disposal of residential refuse;
- Recycling—Curbside collection of recyclable materials every-other-week, required as part of the City's Recycling Ordinance (City, 2007);
- Green Material and Yard Waste—Curbside collection of green material and yard waste every other week, which is used to generate compost, wood chips and mulch that are made available to residents;
- Composting—Access by residents to composting resources and education with a voucher program that discounts compost bins for residents;

- Household Hazardous Wastes—Recycling of residential household hazardous wastes at the City's household hazardous waste transfer facility;
- Environmentally Preferable Purchasing—Use by City departments of products with a lesser effect on human health and the environment, as much as practical;
- The City's Storm Water Division "Think Blue" Hotline, on which residents may report illegal dumping; and
- Trash clean-up sponsorships, including through community-based organizations (which are detailed in the WURMP activity sheets).

At park and recreation facilities, the City provides numerous trash receptacles to properly manage trash and reduce the amount of trash that could enter ASBS 29. In addition to regularly scheduled trash service (as described in Section 2.4.2), during major holidays or planned events, the City places temporary trash and recycle receptacles on beaches to facilitate proper disposal of the increased volume of trash (San Diego Clean Beach Coalition, 2012).

Additionally, maintained picnic areas reduce the "spillover" caused by visitors taking food, trash and party decorations into more sensitive beach areas. Picnic areas provide designated areas for cooking and are near receptacles for trash and hot coals. Signs encouraging users to keep the picnic areas clean are posted.

4.1.3 Animal Waste Management

Dogs are allowed at City beaches and bay locations within the ASBS 29 drainage area while on a leash. There are two off-leash dog beaches within the City that are not located in the ASBS 29 drainage area. Some general guidelines for dog owners are (City, 2013c):

- Leashed dogs are allowed on beaches from 6:00 p.m. to 9:00 a.m. from April 1 to October 31, and from at 4:00 p.m. to 9:00 a.m. from November 1 to March 31.
- Pet owners must be prepared to pick up pet waste in all areas, whether the pet is leashed or unleashed. It is unlawful to allow a dog (or other pet) to defecate on public property without immediately removing the waste and disposing of it properly.

The City also dispenses pet waste bags in some areas frequented by pet owners. During the City's two-year Pet Waste Bag Dispenser pilot study, the number of pet waste bags dispensed was recorded and the effectiveness of the overall program at reducing pollutants was assessed (City, 2012a). Animal waste management is also a large part of the City's "Think Blue" campaign, which is discussed in greater detail in Section 4.1.8.

4.1.4 MS4 Cleaning

The City Storm Water Division inspects, maintains and repairs the City's MS4 including the unblocking of drains, the removal of debris from storm drain structures and channels, the cleaning and repairing of damaged drainpipes, and the sweeping of City streets throughout the City including within the ASBS 29 drainage area (City, 2013e).

The San Diego region's weather pattern is typified by a long dry season from roughly May through October. During this time, materials are expected to accumulate in catch basins without discharging. This dry season is typically followed by a wet weather season, with sporadic but occasionally significant rain events that can transport these materials to the receiving waters.

Catch basin cleaning programs provide direct, additional reduction of pollutants. The City conducted a Catch Basin Cleaning pilot study that characterized the physical dimensions, conditions and functions of catch basins in the City's drainage network (City, 2013d). The City assessed the effectiveness of both manual and Vactor™ (vacuum eductor trucks) cleaning methods in different land use settings, and characterized the sediments removed, accumulation rates and pollutants. Catch basins in four pilot area networks were cleaned four times between December 2011 and March 2012 and one time in September 2012. The study also included the development and implementation of record-keeping protocols for the City and its contracted crews, and thus enabled the City to identify catch basins that consistently accumulate the greatest amount of debris. Using these data, the City identified areas where more frequent catch basin cleanings would reduce clogging and other maintenance issues. This study provided considerations to optimize the City's catch basin cleaning methods to remove the most debris and pollutants for the level of effort (i.e., cost) expended. These optimization techniques may be applied to catch basins in the ASBS 29 if funding becomes available.

4.1.5 Street Sweeping

The City's Street Sweeping Program uses mechanical and enhanced pavement cleaning practices to minimize transport of pollutants, primarily those associated with sediment (e.g., metals) within the ASBS 29 drainage area. Street sweeping also helps prevent pipes and outlet structures in storm water detention facilities from becoming clogged with debris and trash. The City sweeps streets and parks and recreation facilities regularly for general road maintenance.

Results from effectiveness monitoring and operational assessments of the City's sweeping program are documented in several City street sweeping pilot studies: *Targeted Aggressive Street Sweeping Pilot Study Effectiveness Assessment* (City, 2010a), *City of San Diego Street Sweeper Literature Review Final Technical Memorandum* (URS, 2010a), *City of San Diego Targeted Aggressive Street Sweeping Pilot Program Phase III Median Sweeping Study* (URS, 2010b), and *City of San Diego Targeted Aggressive Street Sweeping Pilot Program Phase IV Speed Efficiency Study* (URS, 2011).

Based on City street sweeping pilot studies, improved street and median sweeping technology has been shown to reduce wet weather pollutant loads for bacteria, metals, non-metal toxics, and nutrients (City, 2012c). Increasing the sweeping frequency, increasing the area of impervious cover swept, and upgrading sweeping equipment were found to potentially remove more pollutants.

The City has replaced some of its mechanical broom street sweepers with high-efficiency, regenerative air- and vacuum-assisted sweepers that are expected to improve pollutant load removal. The City has converted some of its routes in the ASBS 29 drainage area from mechanical to vacuum sweeping and begun sweeping selected median areas within the ASBS drainage area.

4.1.6 Sanitary Sewer Management

In 2001, the City initiated a sewer spill reduction program within the ASBS 29 drainage area, which included cleaning all 3,000 miles of the municipal sewerage system by 2004; developing a system-wide cleaning schedule; televising and assessing the condition of more than 1,200 miles of the oldest and most problematic sewer lines in the system; and increasing the number of miles of sewer lines that are replaced or rehabilitated from 15 to 45 miles per year. Between 2000 and 2007, the program reduced the number of spills by 79 percent (City, 2013g). The program's success has also reduced beach closures from sewer spills (City, 2013g) and associated bacteria entering ASBS 29. The City has a sewer overflow tracking and response plan to ensure that all sanitary sewer overflows are identified, responded to, investigated, and reported promptly and effectively.

The City has developed two residential and commercial programs targeted at reducing the introduction of materials that may impede or damage the sewer system:

- Residential Grease Disposal Program—The City provides residents with a cooking oil and grease recycling program at the Miramar Landfill Recycling Center and with educational materials on how to keep grease out of the drain; and
- Food Establishment Wastewater Discharge Program—This program controls the discharge of grease from food establishments into the wastewater collection system and requires a permit to do so; the permitting process requires that the facilities install the appropriate grease-removal equipment to trap cooking grease before it enters the wastewater system.

4.1.7 Smart Gardening and Water Conservation

To reduce runoff entering the MS4, the City provides various resources to promote smart gardening and to educate and inspire residents through exhibits and programs featuring water conservation and the sustainable use of related natural resources. The resources are available to residents and businesses in the ASBS 29 drainage area.

Specifically, these smart gardening and water conservation methods include:

- Vegetated Swales—Biofiltration BMPs reduce runoff velocities, which allows sediment and other pollutants to settle out (SDRWQCB, 2013a); biofiltration also absorbs nutrients and reduces peak runoff velocities;
- Bioretention Systems (Rain Gardens)—These landscaping features are adapted to treat storm water runoff on-site, and are typically applied to small sites; they function as soil- and plant-based filters that remove pollutants through a variety of physical, biological, and chemical treatment processes;
- Revegetation—Ornamental vegetation is replaced with native, drought-resistant vegetation, providing soil cover to reduce erosion, water use, and runoff; and

- Water Conservation—Expanded conservation programs aim to conserve water and prevent pollution by reducing the runoff entering the storm drain system; these include residential rainwater harvesting rebates, greywater information, resources for California-friendly landscape plants, residential water survey, and water conservation rebates and incentives, such as turf conversion and rebates for smart-irrigation controllers.

4.1.8 Education and Outreach

The City has multiple approaches to educating its residents, visitors and industry on ways to prevent pollution and protect local waterways within the ASBS 29 drainage area. Following are some elements and examples of how these programs are implemented.

Think Blue—The "Think Blue" outreach program works to educate residents, business owners, and industry leaders about the effects of storm water pollution and steps everyone can take to protect the environment. Think Blue works with community-based organizations and other government agencies to promote storm water pollution prevention. Information on general practices and impacts on water quality are available through guidebooks on the following topics:

- Wash water and irrigation runoff
- Construction activities
- Trash storage and disposal
- Vehicle maintenance
- Pet waste disposal
- Integrated pest management
- Landscaping (green waste, pesticide use, and erosion prevention)

Project SWELL (Stewardship: Water Education for Lifelong Leadership)—This program is a school-based science curriculum that teaches children (through classroom presentations) about the importance of the region's waterways and how to understand and improve their condition (City, 2013f). It is administered through a partnership of the City, the San Diego Unified School District, and San Diego Coastkeeper (Coastkeeper).

Partnership with Coastkeeper—The City, in a partnership with Coastkeeper and SIO, developed full-color trifold brochures about the La Jolla ASBS with general information on ASBS issues, marine protected areas information, and pollution prevention practices for local businesses and residents. Approximately 2,000 brochures were distributed in 2006 to the community, and the brochure continues to be available to the public. (La Jolla Shores Watershed Management Group, 2008). At the City's Kellogg Park, Coastkeeper worked with The Friends of Kellogg Park to develop ASBS content for a permanent lithocrete (crushed glass in concrete) map installed in the concrete boardwalk. The map is an educational tool for the visitors of La Jolla Shores; provides information on the area's ecological, cultural, and conservation aspects; and easily and accessibly raises ASBS awareness.

Publically Available Data—Historical and current data are available to the public through the Southern California Coastal Ocean Observing System, which maintains a website with user-friendly interfaces and products (such as Google maps) to display coastal data interactively.

Enhance Education and Outreach—Based on results of an effectiveness survey and changing regulatory requirements, the City distributed information about minimum BMPs (including LID descriptions) through the public information processes of the City's Development Services Department, including BMP and LID descriptions. This information is available to anyone seeking development permits or information about development opportunities in the City. The Storm Water Division actively distributes fact sheets about BMP requirements as part of its code compliance and inspection functions, and makes this information available on the Division's Website and, as communication needs are refined, via other outlets.

4.1.8.1 Posted Requirements, Public Signage and Notifications

Signs or other appropriate measures are placed throughout the parks, beaches and visitor centers that inform and educate the public of any applicable requirements of the General Exception and identify the ASBS boundaries.

City of San Diego regulation signs that prohibit alcohol use, glass containers, smoking, littering, disturbing noises, and overnight sleeping, camping, or parking are placed at beaches, cliffs, walkways, park areas, and adjacent parking lots within the ASBS 29 drainage area. These regulation signs also explain restrictions on beach fires and pets.

At Kellogg Park, 22 regulations are posted at the corners of the park that have access to the grassy areas, at picnic areas, at all but one beach entrance (behind Lifeguard Tower 32), and at the small vessel boat launch at the end of Avenida de La Playa. Additionally, "No Littering" and "Clean up After Your Pet" signs are posted at Cliffridge Park. At Allen Field, all organized activities must be coordinated through La Jolla Youth, Inc., which conveys to users, along with signage at the park, the prohibition of litter. Dogs are also prohibited at Allen Field.

4.1.8.2 Posted ASBS Boundaries

A large lithocrete map depicting the coastal waters of the ASBS is featured at Kellogg Park/La Jolla Shores Beach Park, between the playground and the bathrooms, at the southern end. It depicts the intertidal, nearshore, and offshore species of the ASBS, as well as ASBS boundaries, coastal geologic features, and geographic coordinates of the area, all designed for pedestrian access.

Species found in the ASBS are represented on the lithocrete map by their physical features, as shown in Figure 4-1, and are numbered to correspond with photographs on a board near the water fountains at the restroom facilities. This numbering system is also used in the children's play structure to promote further ASBS education.

Figure 4-1: Portion of the Lithocrete Map at La Jolla Shores Beach

Preservation of the marine environment is encouraged through placards within and around the lithocrete map that inform visitors of the locations of the preserves and of the regulation that “nothing may be disturbed or taken without a permit; plant and invertebrate, water quality, archeological and cultural resources protected by law.”

The southern end of Kellogg Park has a children's playground with swings and a play structure on the sand. The structure incorporates aspects of environmental education and stewardship of the ASBS, and also teaches ocean safety through interactive informational displays of the ASBS and local marine life.

At the La Jolla Shores small vessel boat launch (see Section 2), signs provide notice of the La Jolla Underwater Park and Ecological Preserve and the La Jolla State Marine Conservation Area, and specify the state restrictions for the area. The lifeguard station at La Jolla Shores Beach has a large sign on its eastern wall that describes in detail the La Jolla Underwater Park and a map of that shows the ASBS boundaries (Figure 4-2).

Figure 4-2: Sign Posted at La Jolla Shores Beach Lifeguard Station

4.1.9 Management of Pesticides and Other Chemicals

The City's integrated pest management program provides resources and educational information on pest control and proper lawn care to reduce the use of pesticides throughout the City. The City encourages using native plants in landscaping to reduce pesticide, fertilizer and water usage within the ASBS 29 drainage area. The City promotes the following tips to maintain a healthy yard with minimal fertilizers, herbicides, insecticides, or other chemicals:

- When fertilizing, use no more than 3–6 pounds of nitrogen per 1,000 square feet per year;
- Routinely inspect and repair sprinkler heads;
- Aerate lawns annually and remove thatch if it exceeds ½ inch;
- Plant grass species that do well in the area;
- Irrigate deeply and infrequently; and
- Cut only one-third to one-half of grass height at each mowing and keep lawnmower blades sharp.

The City collaborates with the University of California's Agriculture and Natural Resources Statewide Integrated Pest Management Program (UC IPM). This program provides extensive online resources about home and landscape pests, weeds and pesticides. The program also provides online training, events and workshops on pesticide safety. UC IPM offers interactive tools (such as weather models) to help plan and to base pest management decisions on site conditions.

The City also works with the County of San Diego to promote the safe use of pesticides at their parks and recreation facilities and to promote the use of effective biocontrol measures. If pesticides must be used, the City offers these tips to reduce their effects on local waterways (City, 2013a):

- Choose an insecticide based on the targeted pest, preferably the least toxic option;
- Don't apply pesticides indoors to areas that will be washed with water or where food is prepared or stored;
- Determine the right amount of pesticide to purchase and use;
- Don't over-water after applying outdoor pesticides;
- Never let pesticide runoff flow into storm drains;
- Don't apply indoor pesticide into or near floor drains or sinks;
- Use spot treatments whenever possible;
- Don't apply pesticides outdoors when rain is forecast or when it is windy; and
- Don't apply pesticides on paved areas.

4.1.10 Enhanced Implementation of Low-Impact Development Through Land Development Code Amendments

SUSMP and Land Development Code ordinances outline low-impact development (LID) requirements that minimize impervious surfaces and promote infiltration and evaporation of runoff using natural filters, which mimic the natural hydrologic functions. Retained water can also be used for reuse. In some cases, existing City Land Development Codes and policies create barriers to LID. Updating City development codes, in this instance, has been a multiple-year process that began with a pilot study that assessed opportunities to implement LID measures.

The City's Storm Water Division undertook a review of the City's Municipal Code, ordinances and policies to identify opportunities to facilitate using LID storm water management measures. The review identified and prioritized opportunities for storm water LID site planning and design implementation within the ASBS 29 drainage area, and recommended amendments to the City's current policies and codes. Amending these policies and the Land Development Code will enhance LID implementation for both new development and redevelopment by amending zoning, which is expected to better control pollutant sources. The next step is to proceed with the City's discretionary review process to codify the accepted recommended changes.

In FY 14–15, the City gathered input from the following City and stakeholder groups:

- Code Monitoring Team.
- Technical Advisory Committee.
- Community Planners Committee.
- Planning Commission. and
- City Council (final City approval).

Once the City process has been completed, the California Coastal Commission will review the proposed code changes for approval and application within the Coastal Zone, which is anticipated to take 15–18 months.

4.1.11 Land Development Code and Enforcement

This BMP is a catch-all category for updating required minimum BMPs as standards based on the requirements of the new MS4 Permit. The City is currently updating its minimum BMPs and prohibitions for residential, commercial and industrial uses.

4.1.11.1 Construction Activities

The Construction General Permit applies to any construction project in the ASBS 29 drainage area that disturbs one or more acres of soil, or disturbs less than one acre but is part of a larger common plan of development that in total disturbs one or more acres. Such projects are required to obtain coverage under the General Permit for Discharges of Storm Water Associated with Construction and Land Disturbance Activities, Order 2009-0009-DWQ (SWRCB, 2009) (Construction General Permit).. This permit requires developing and implementing a SWPPP that contains a plan to prevent erosion and control sediment delivery to the MS4. The SWPPP must list BMPs that the discharger will use to treat or minimize storm water runoff and specify the placement of those BMPs. These regulations help control sediment discharge from construction activities.

The City's *Storm Water Standards Manual* (City, 2012b) specifies permanent and construction-phase storm water quality requirements for the following project types and phases:

- Private projects processed through the City's Development Services Department, and
- Capital improvement projects processed through the City's Engineering and Capital Projects Department.

The *Storm Water Standards Manual* further guides developers in selecting, designing and incorporating BMPs that help address construction erosion and sediment control.

The JURMP specifies construction-related BMPs that are required for activities associated with operations and maintenance.

4.1.11.2 Coastal Bluffs and Open Space Areas

Development on coastal bluffs is subject to the environmentally sensitive land regulations in the City Municipal Code, which are intended to "assure that development occurs in a manner that protects the overall quality of the resources and the natural and topographic character of the area, encourages a sensitive form of development, retains biodiversity and interconnected habitats, maximizes physical and visual public access to and along the shoreline, and reduces hazards due to flooding in specific areas while minimizing the need for construction of flood control facilities" (City, 2012d). Private property owners in the ASBS 29 drainage area are responsible for assessing their property's erosion problems and taking appropriate protection.

4.2 Implemented Structural BMPs

This section describes the structural BMPs, including LID measures that are currently in use by the City. To control storm water discharge to the MS4 during a design storm[4], dischargers must first consider using on-site LID practices to infiltrate, use or evapotranspire storm water runoff.

LID emphasizes conservation and use of on-site natural features to protect water quality. LID can significantly increase the protection of water quality by using engineered, small-scale controls that replicate the pre-development hydrologic regime of watersheds by infiltrating, storing, evaporating, and detaining runoff close to its source. The City developed the *LID Design Manual* (City, 2011) to provide guidance for planning, designing and implementing LID BMPs for street improvement, new public streets and development and redevelopment of city parks and recreation facilities. The Design Manual provides clear guidance to planners, design engineers, plan reviewers, inspectors, and maintenance staff for designing and implementing LID practices and for tailoring design standards and recommendations to the unique climate and geography of the San Diego area, including the ASBS 29 drainage area.

Structural BMPs are built into the development at the site scale, and large-scale structural BMPs receive flows from neighborhoods or regions and often serve the dual purpose of both flood control and groundwater recharge. These BMPs are often in public spaces and can be co-located in parks or green spaces.

Figure 4-3 provides an overview of all implemented structural BMPs in the ASBS 29 drainage area. Structural BMPs are described in Sections 4.2.1 through 4.2.3.

4.2.1 Low-Flow Diversions

In 1997, storm drain outfalls along the coastline were inventoried and prioritized by their potential for human contact with flow from the drain (i.e., flow crossing the beach). Outfalls were labeled by street name location, and those with high or medium contact potential were studied to determine the feasibility and cost of diverting low flows to the wastewater collection system.

[4] A design storm is a storm event of a specified size that is used to determine the required treatment capability of a BMP based on calculated runoff volumes and peak discharge rates.

Low-flow diversions are structures that redirect dry weather urban runoff into the sanitary sewer system, where the runoff then receives the same treatment as sewer water. The City has installed low-flow storm drain diversion systems in phases to serve the coastlines of the La Jolla, Pacific Beach and Ocean Beach areas. Installation of dry weather flow diversions is a BMP implementation strategy to meet the General Exception's prohibition of dry weather flows and reduces loading of pollutants by capturing and treating runoff.

The City has nine low-flow diversions installed within the ASBS 29 drainage area, as shown in Figure 4-3. The locations of installed low-flow diversions are:

- Corner of Spindrift Avenue and Roseland,
- Avenida de la Playa and Paseo del Ocaso,
- Vallecitos and Camino del Oro,
- Along Camino del Oro near La Jolla Shores Drive,
- 8555½ El Paseo Grande,
- 7920 Princess Street,
- 1624 Torrey Pines Road,
- Corner of Torrey Pines Road and Charlotte, and
- Corner of Camino del Oro and El Paseo.

The City will monitor low-flow diversion measures on the downstream side of the diversion to verify zero flow beyond the diversion and into ASBS 29.

4.2.2 Low Impact Development "Green Lot" Project at Kellogg Park

At Kellogg Park, the City has implemented the Green Lot Retrofit Project to allow infiltration of urban runoff by replacing a portion of the conventional asphalt in the parking lot with porous pavement and other infiltration areas. The northern and southern ends of the parking lot were replaced with porous pavement, and the western perimeter was upgraded with a decomposed granite planter area that runoff can flow into and infiltrate. The parking lot is also planter-bed-landscaped with native, drought-tolerant vegetation. This retrofit project addresses potential water quality problems by reducing and treating runoff flows and discharges to ASBS 29 via infiltration and retention.

4.2.3 Treatment Control Best Management Practices

TCBMPs are permanent storm water treatment features that are incorporated into the design of newly developed or redeveloped properties, and are installed to meet the City's SUSMP requirements. Currently, there are 10 private TCBMP projects in the ASBS 29 drainage area, each with varying numbers and types of BMPs (see Figure 4-3 and Table 4-2). The types of TCBMPs within the ASBS 29 drainage area include vegetated swales, drainage inserts, filtration systems, and infiltrations basins/trenches.

A vegetated swale is a broad, shallow channel with a dense stand of vegetation covering the side slopes and bottom (USEPA, 1999). They are designed to trap particulate pollutants (suspended solids and trace metals), promote infiltration and reduce the flow velocity of storm water runoff (USEPA, 1999). Drainage inserts are manufactured filters or fabric placed in a drop inlet to remove sediment and debris (CASQA, 2003). Filtration systems treat storm water runoff by using various types of filtration media including sand, vegetation, and/or some other absorptive filtering media. An infiltration trench is a long, narrow, rock-filled trench with no outlet that receives storm water runoff. Runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix (CASQA, 2003). An infiltration basin is a shallow impoundment that is designed to infiltrate storm water. Infiltration basins use the natural filtering ability of the soil to remove pollutants in storm water runoff (CASQA, 2003).

Table 4-2: Treatment Control Best Management Practices in ASBS 29 Drainage Area

Project Name	Number of BMPs by Type			
	Drainage Insert	Filtration Systems	Grass/Vegetated Swale	Infiltration Basin or Trench
Arellano Grading/Paul Residence	—	1	—	—
Bondy Residence	3	—	—	—
Chenango Residence	1	—	—	—
Hawley Residence	7	—	—	—
Hazard Residence	—	—	—	1
Liu Residence	1	—	—	—
Mashayekan Residence	1	—	—	—
Rosen Residence	1	—	—	—
Schroeder Residence	1	—	—	—
Spindrift Drive Residence (04)	—	—	1	—

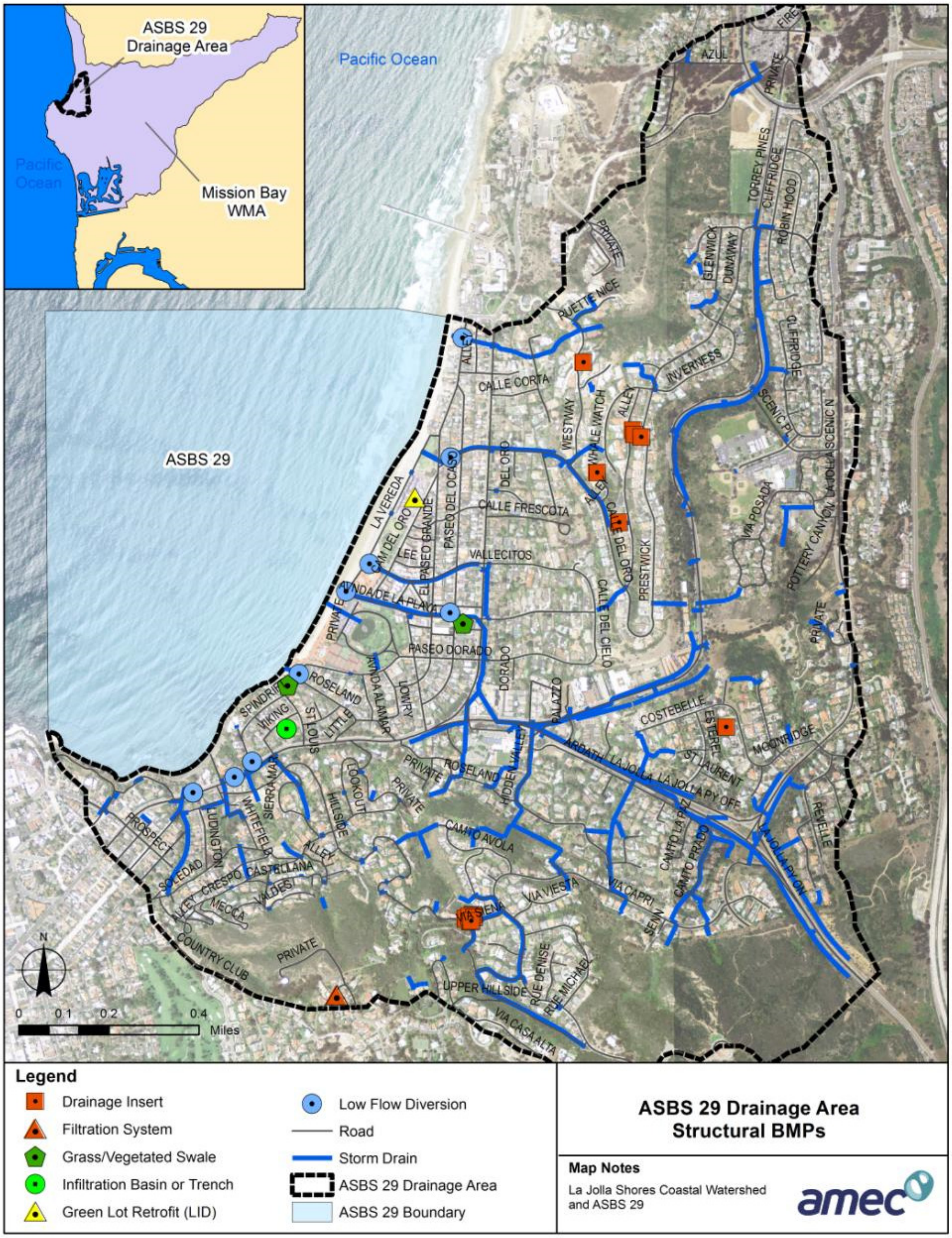


Figure 4-3: Structural Best Management Practices Implemented in ASBS 29

4.3 Planned Continuation of Existing Best Management Practices

The Scripps Watershed CLRP was prepared and submitted to the SDRWQCB in 2012 and updated in 2013 (City, 2013d). The CLRP was developed as an integrated water quality plan that combines multiple permit-based and voluntary strategies and BMPs into a comprehensive approach to compliance with the Bacteria TMDL (SDRWQCB, 2010). The CLRP also integrates considerations for addressing General Exception regulations for the Scripps Watershed (a portion of the Mission Bay WMA) and the adjacent ASBS 29.

The City, as the sole responsible party in the Scripps Watershed (except for UCSD), will use the CLRP to develop watershed implementation programs, evaluate their effectiveness, and make adjustments over the anticipated 20-year implementation period of the Bacteria TMDL. The prioritization process for implementing BMPs carefully considers many factors, including feasibility, cost-effectiveness, social and other impacts, and the potential to reduce pollutant loads. These factors have been considered and analyzed as part of the CLRP development process for each individual management practice. Prioritization allows earlier implementation of the BMPs that have the highest feasibility, highest cost-effectiveness and greatest potential to reduce loads. The forthcoming Mission Bay Watershed WQIP (due in June 2015) will incorporate the CLRP, and will supersede and serve as the CLRP upon its adoption by the SDRWQCB.

Water quality target levels for BMP design in the General Exception are (a) Table B, Instantaneous Maximum Water Quality Objectives in Chapter II of the Ocean Plan, or (b) a 90 percent reduction in pollutant loading during storm events for the City's total discharges.

The Scripps Watershed CLRP made recommendations regarding non-structural and structural BMPs for load reductions in the watershed, a subset of which are applicable to BMP recommendations for the La Jolla Watershed required by the General Exception. However, when the dilution factor of 12.6:1 (see Section 3.2) is incorporated into the CLRP analysis, the results indicate that the necessary pollutant load reductions required by the General Exception are being achieved by the non-structural and structural BMPs currently implemented by the City. Based on these results, no further non-structural or structural BMPs are necessary. However, currently implemented BMPs are planned to continue at their current level. Furthermore, based on the requirement of the General Exception to cease all dry weather discharges, the currently installed low-flow diversions and non-structural BMPs were implemented by the compliance date of September 20, 2013.

5.0 Compliance and BMP Implementation Schedule

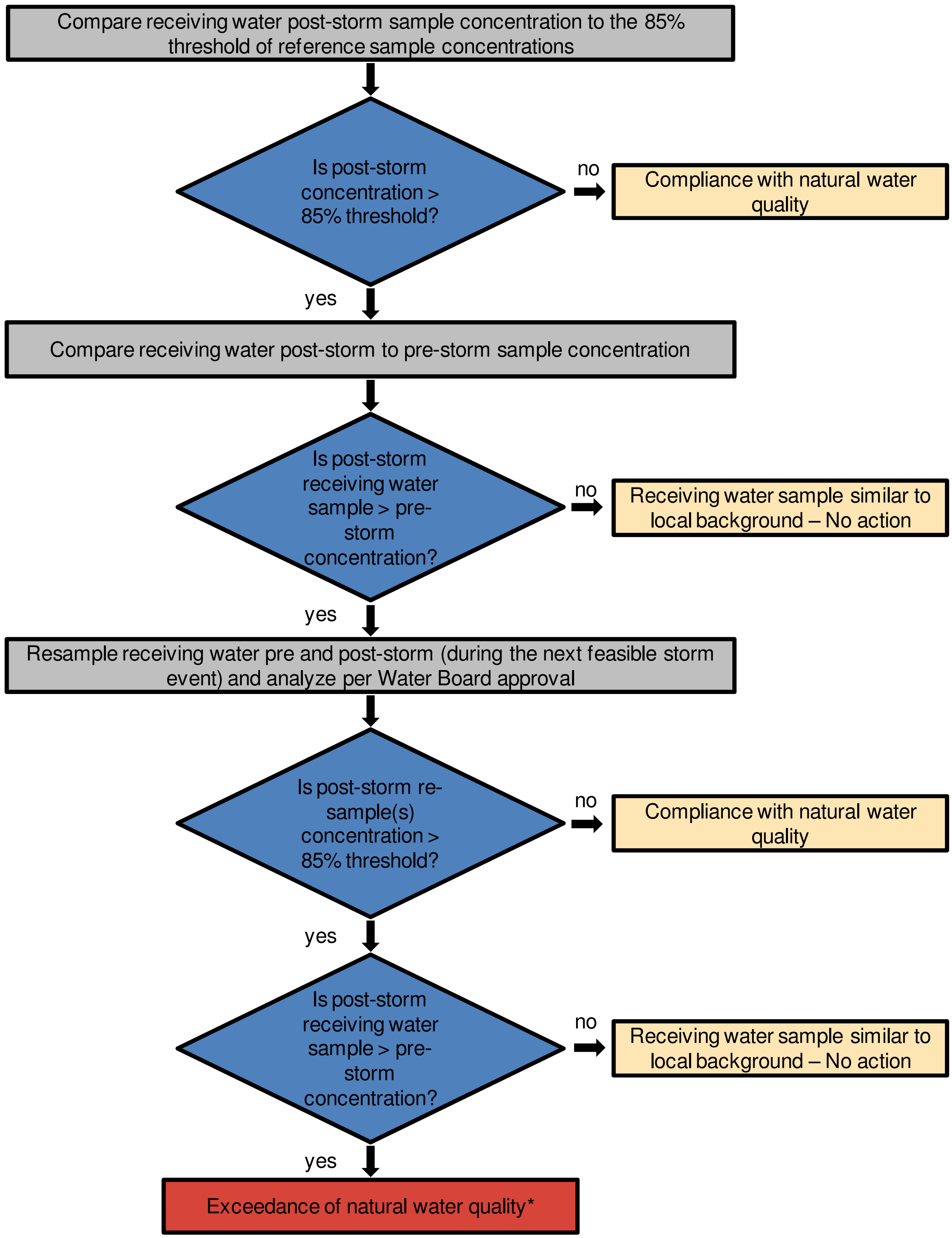
5.1 Compliance and Implementation Schedule

Based on data collected under the Bight ’08 and Bight ’13 Regional Monitoring Surveys, the *La Jolla ASBS Dilution Study* (discussed in Section 3.2), and analysis provided in the Scripps Watershed CLRP (discussed in Section 4.0), the City’s current level of non-structural and structural BMP implementation complies with the General Exception requirement to protect natural water quality. Low-flow diversions currently installed at nine locations are intended to eliminate non-storm water discharges to ASBS 29. The implementation schedule deadlines for the City, in accordance with the General Exception, are as follows:

- **March 20, 2012:**
  - Non-authorized discharges to ASBS 29 were effectively prohibited. **(complete)**
- **September 20, 2013:**
  - The City submitted a Draft ASBS Compliance Plan for ASBS 29 to the SWRCB Executive Director and the SDRWQCB Executive Officer. **(complete)**
  - Non-structural controls were implemented. **(complete)**
- **September 20, 2014:**
  - The City shall submit the Final ASBS Compliance Plan for ASBS 29 with a schedule for structural controls based on the results of monitoring runoff and receiving water. **(on schedule)**
- **March 20, 2018:**
  - Dischargers must comply with the requirement that their discharges into the affected ASBS maintain natural ocean water quality (within the 85^{th} percentile threshold of reference water quality data and pre-storm levels). If results exceed this threshold, see the flowchart in Figure 5-1 for appropriate actions. **(on schedule)**

The City has met the compliance dates for prohibiting non-authorized discharges to ASBS 29 and implementing non-structural controls. To continue compliance with the General Exception, the City plans to maintain and implement existing BMPs as described in Section 4, and to continue monitoring in the ASBS per the General Exception.

According to Section I.A.2 of the General Exception, the Compliance Plan is to be included in the discharger’s WQIP (equivalent to a SWMP or SWPPP). The City shall submit the Final WQIP for the Mission Bay WMA on June 27, 2015, which will include this Compliance Plan.



*Note: When an exceedance of natural water quality occurs, the discharger must comply with Section I.A.2.h (for permitted storm water) or Section I.B.2.C (for non-point sources). Note, when sampling data are available, end-of-pipe effluent concentrations will be considered by the Water Boards in making this determination.

Source: General Exception, Attachment 1

Figure 5-1: Flowchart to Determine Compliance with Natural Water Quality

5.2 Required Reporting of Water Quality Exceedances

If the results of receiving water monitoring (described in Section IV.B of the General Exception) indicate that wet weather discharges that include storm water are causing or contributing to an alteration of natural water quality in the ASBS, the City must submit a report to the SDRWQCB within 30 days of receiving the analytical results. (See Figure 5-1 for determining compliance.)

The report must:

- Identify the constituents in storm water that alter natural water quality and the potential sources of those constituents;
- Describe BMPs that are currently being implemented, BMPs that are identified in the ASBS Compliance Plan for future implementation, and any additional BMPs that may be added to the ASBS Compliance Plan to address the alteration of natural water quality; and
- Include a new or modified implementation schedule.

Within 30 days of approval of the report by the SDRWQCB, the City must revise its ASBS Compliance Plan to incorporate any new or modified BMPs that have been or will be implemented, the implementation schedule, and any additional monitoring required. Non-structural BMPs must be implemented within one year of the approval (by the SWRCB or SDRWQCB) of the revised ASBS Compliance Plan. Structural BMPs must be implemented as soon as practicable.

As long as the City has complied with the procedures described above and is implementing the revised ASBS Compliance Plan, the City is not required to repeat the same reporting procedure for continuing or recurring exceedances of natural ocean water quality conditions that are due to the same constituent.

5.3 Modifications of This Compliance Plan

The ASBS Compliance Plan is a dynamic document that may be edited or updated as needed. Any updates, alterations, modifications, or amendments to the document must be submitted to the SDRWQCB for its approval. The plan will be modified when changes occur that directly affect the purpose (Section 1.2), receiving water quality conditions (Section 5.2), or activities of this ASBS Compliance Plan.

This section provides the procedure for notifying the SDRWQCB of any technical changes that the City seeks to make and for seeking a formal modification. This section is not intended to be an exhaustive review of all aspects of modification, but is meant to provide a basis for updating or modifying this plan in a manner that recognizes the plan's objective of protecting natural water quality in ASBS 29. A modification to this document is intended to be an efficient mechanism for notifying the SDRWQCB of a proposed change to the plan set forth in this document and for providing data to support the change.

A proposed modification shall include:

- A narrative justification that describes in detail all changes and the reasons they are necessary; and
- A form that includes, at a minimum, a summary of or an excerpt from the modified (new) text and information, and the previous text and information, with their location(s) in the document.

With the narrative justification, the City shall:

- Submit a cover letter on the agency's letterhead, signed by a City representative;
- Describe the changes;
- Discuss and justify the necessity for the change(s); and
- Identify and explain how the implications of the modification will affect components of the ASBS Compliance Plan.

The City must submit one signed original copy of the modification documents to the SDRWQCB Executive Officer to maintain its compliance status.

5.3.1 Non-Substantive Revisions

Non-substantive revisions are changes that do not affect the purpose of the ASBS Compliance Plan but relate to matters addressed in the requirements of Section 1.A.2 of the General Exception. Examples of such non-substantive changes include, but are not limited to:

- Typographical errors in the ASBS Compliance Plan or underlying documentation; and
- Change in department name, where there is no change in ownership or responsibility.

The City shall give the SDRWQCB notice of such non-substantive changes promptly in writing whenever the need for a non-substantive revision is recognized. An addendum sheet to the document shall summarize all updates to the ASBS Compliance Plan and shall be provided to the SDRWQCB. Although non-substantive revisions do not require approval of the SDRWQCB, it may reply, indicating agreement or disagreement that the change is non-substantive. All non-substantive modifications will be included as part of the modification summary for the next following formal modification.

5.3.2 Alteration of Natural Water Quality and Non-Storm Water Flows

As discussed in Section 5.2, monitoring results that indicate that wet weather MS4 discharges cause or contribute to an alteration of natural water quality shall be reported to the SDRWQCB within 30 days. Within 30 days of approval of the report by the SDRWQCB, the City shall revise its ASBS Compliance Plan, as described in Section 5.3.

If applicable, the revised ASBS Compliance Plan shall describe the measures by which non-storm water discharges will be eliminated and any interim measures that will be employed to reduce non-storm water flows until the final measures have been implemented.

6.0 REFERENCES

California Regional Water Quality Control Board, San Diego Region: See "San Diego Regional…"

California State Water Resources Control Board (SWRCB): See "State…"

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APPENDIX H

Bacterial Conceptual Models and Literature Review

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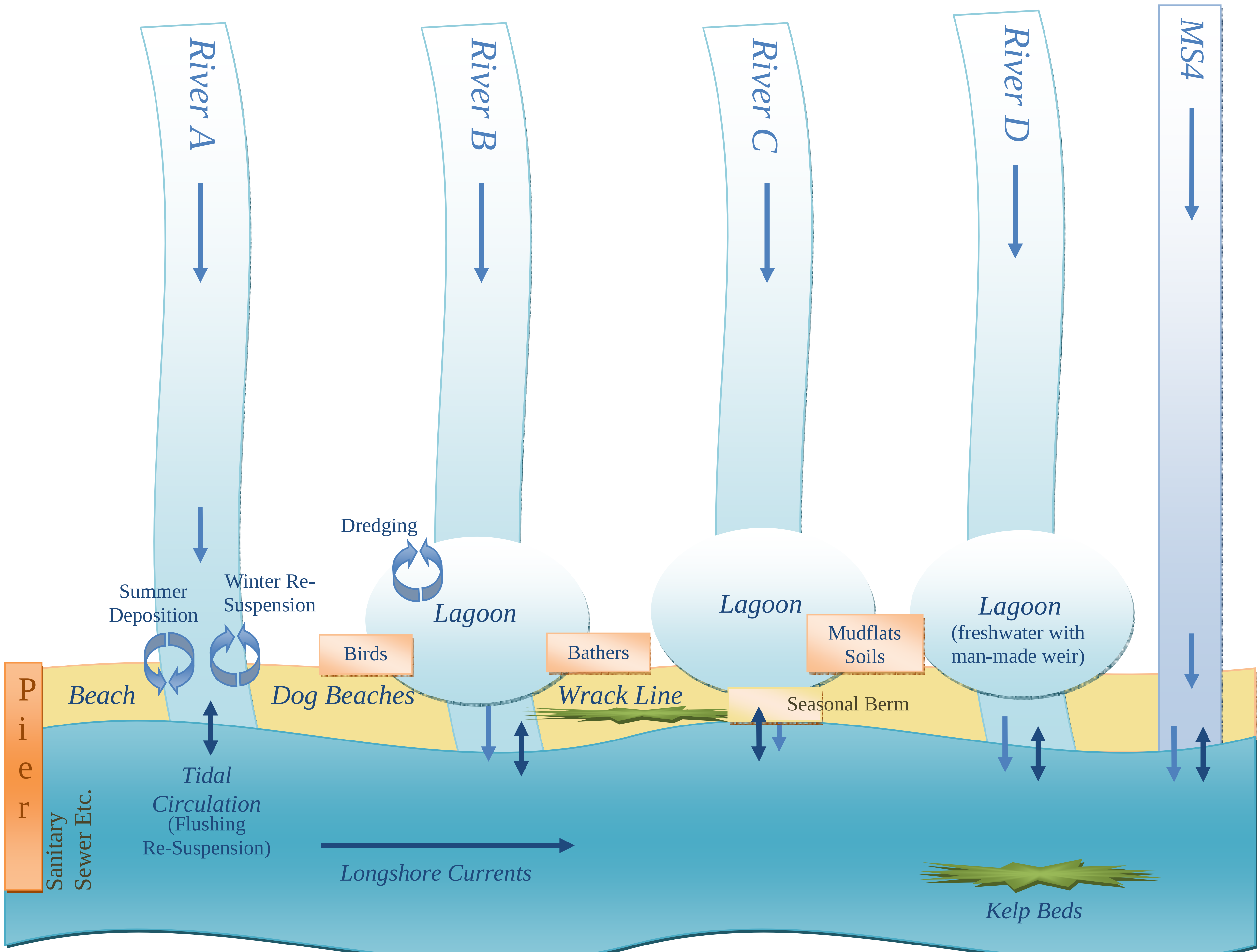
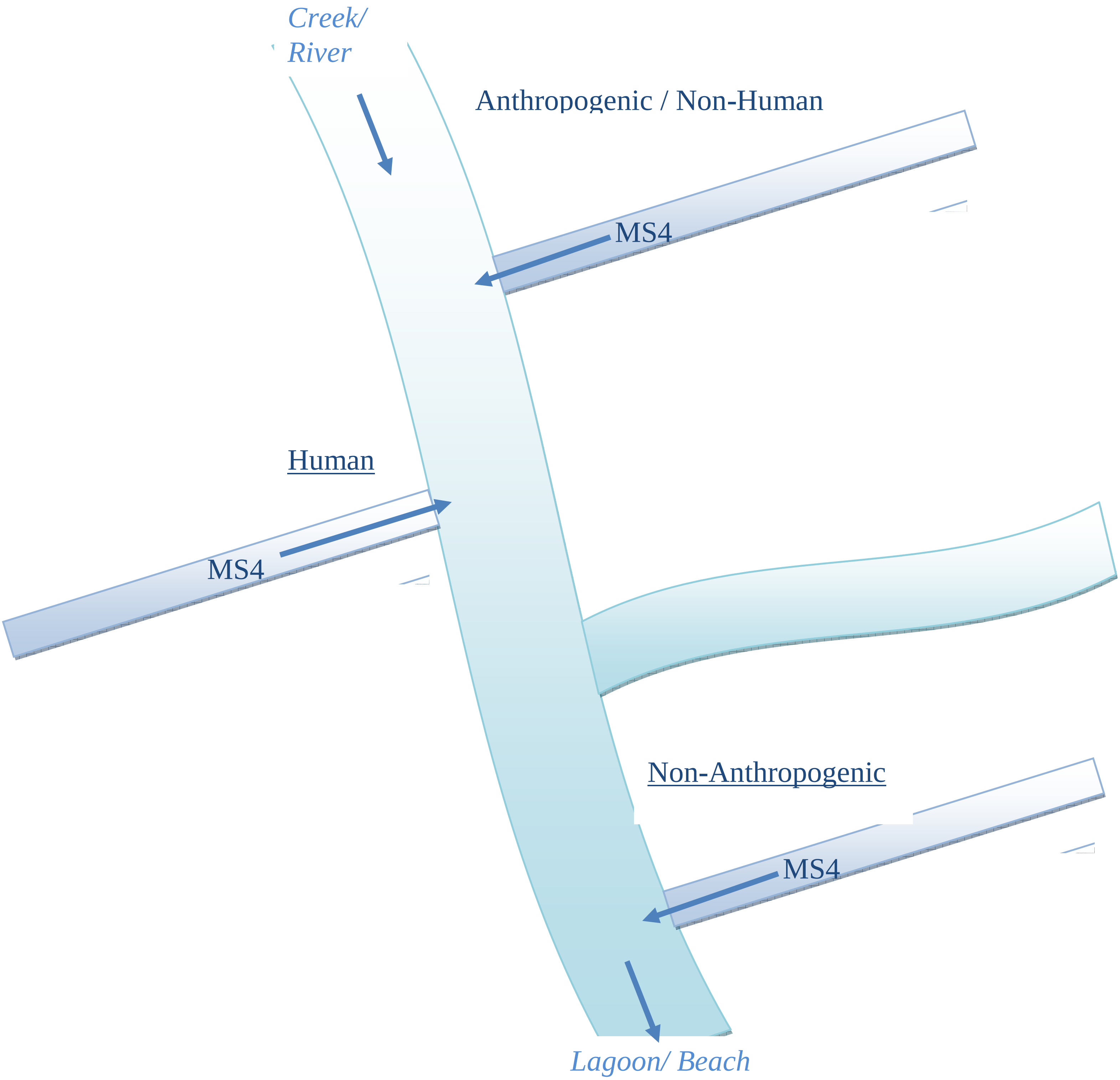
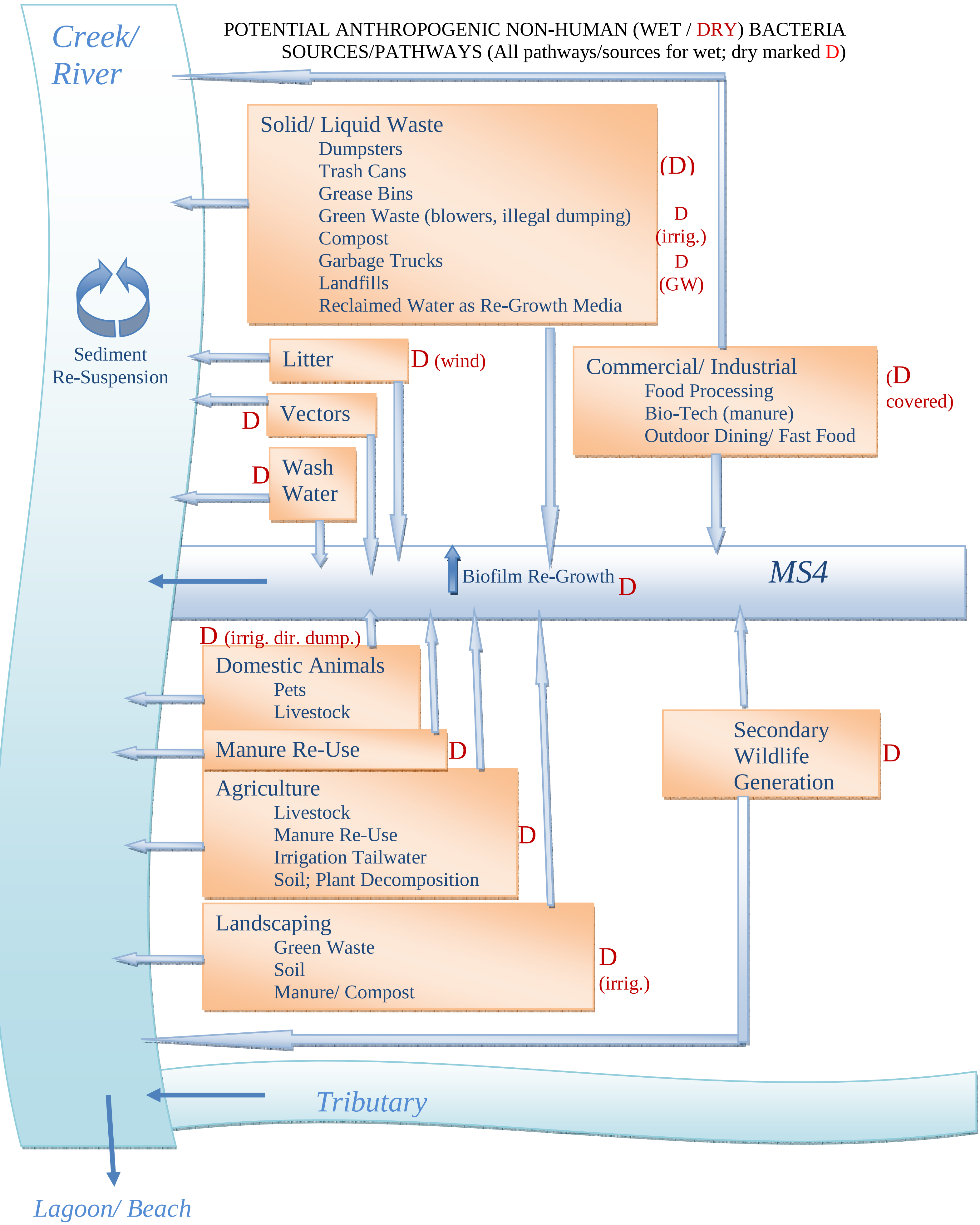


River A
River B
River C
River D
MS4
Dredging
Summer Deposition
Winter Re-Suspension
Lagoon
Lagoon
Lagoon
(freshwater with man-made weir)
Birds
Bathers
Mudflats Soils
Seasonal Berm
Pier
Beach
Dog Beaches
Wrack Line
Tidal Circulation
(Flushing Re-Suspension)
Sanitary Sewer Etc.
Longshore Currents
Kelp Beds

Conceptual Overview of Bacteria Sources

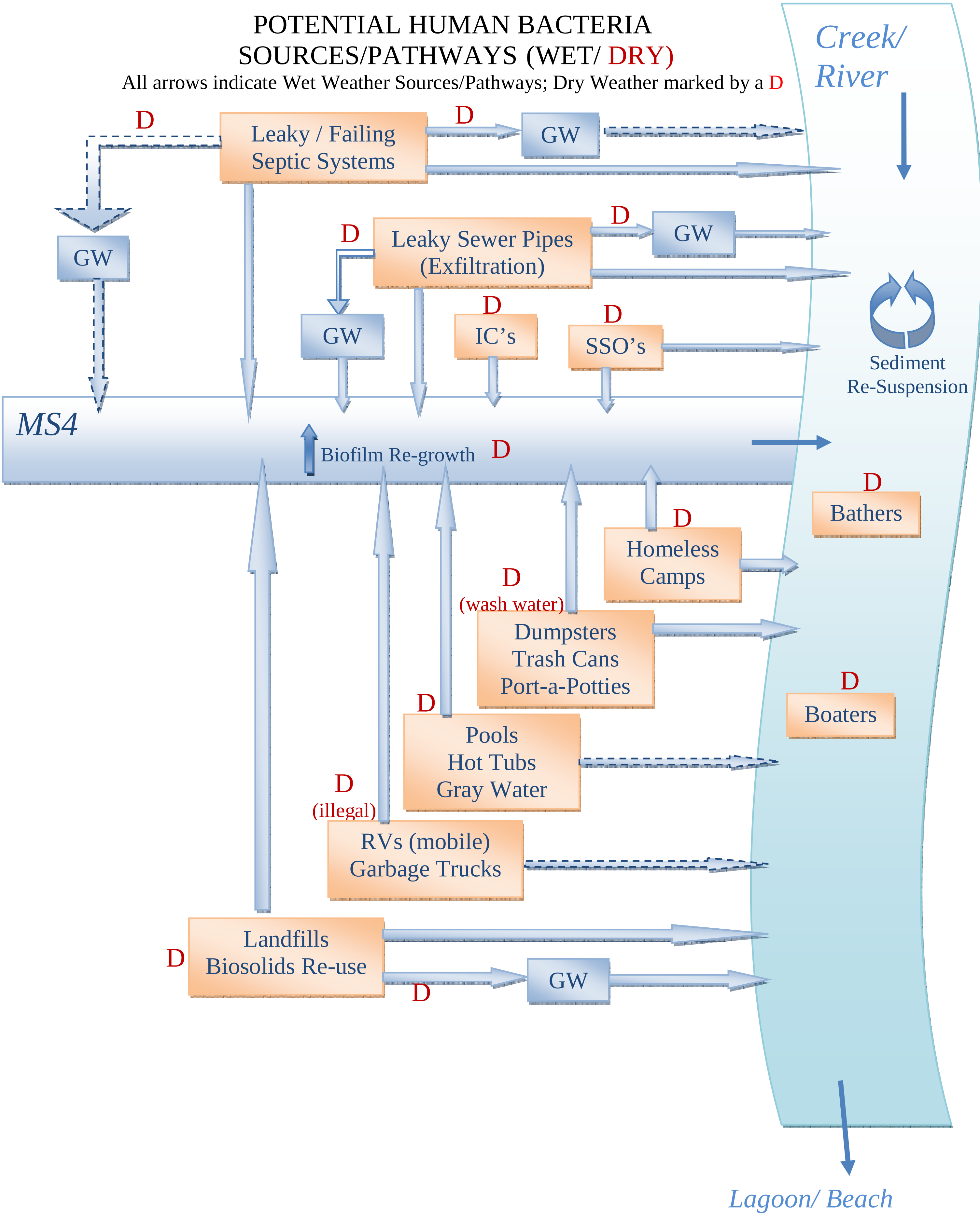




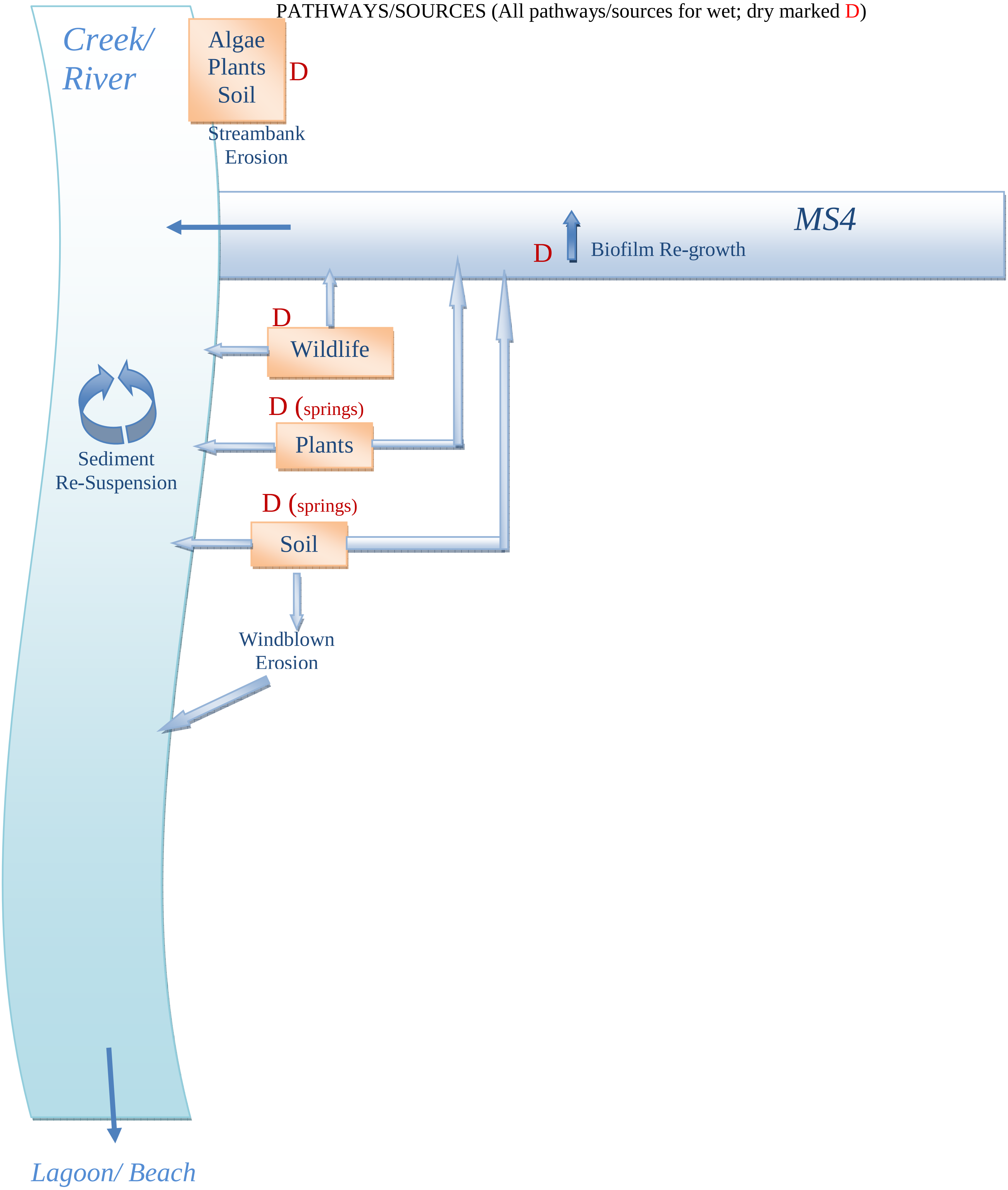
POTENTIAL ANTHROPOGENIC NON-HUMAN (WET / DRY) BACTERIA SOURCES/PATHWAYS (All pathways/sources for wet; dry marked D)
Creek/ River
Solid/ Liquid Waste
Dumpsters
Trash Cans
Grease Bins
Green Waste (blowers, illegal dumping)
Compost
Garbage Trucks
Landfills
Reclaimed Water as Re-Growth Media
(D)
D (irrig.)
D (GW)
Sediment Re-Suspension
Litter
D (wind)
Vectors
D
Wash Water
D
Commercial/ Industrial
Food Processing
Bio-Tech (manure)
Outdoor Dining/ Fast Food
(D covered)
Biofilm Re-Growth
D
MS4
D (irrig. dir. dump.)
Domestic Animals
Pets
Livestock
Manure Re-Use
D
Agriculture
Livestock
Manure Re-Use
Irrigation Tailwater
Soil; Plant Decomposition
D
Secondary Wildlife Generation
D
Landscaping
Green Waste
Soil
Manure/ Compost
D (irrig.)
Tributary
Lagoon/ Beach

POTENTIAL HUMAN BACTERIA SOURCES/PATHWAYS (WET/ DRY)

All arrows indicate Wet Weather Sources/Pathways; Dry Weather marked by a D



POTENTIAL NON-ANTHROPOGENIC WET/ DRY BACTERIA PATHWAYS/SOURCES (All pathways/sources for wet; dry marked D)



DRAFT TECHNICAL MEMORANDUM
Summary of Literature Review, Bacteria Source Identification
March 12, 2012

Prepared by: Armand Ruby Consulting in Association with AMEC

This Technical Memorandum summarizes work performed under Task 2, Literature Search and Data Review, for the County of San Diego Bacterial Indicators Source Identification Services Project. The work was overseen by a workgroup of San Diego County Stormwater Copermittee representatives, and included communication with scientists who have expertise in bacteria source tracking and identification. The literature review focused on identifying and summarizing studies that quantify sources and sinks for bacterial constituents in urban watersheds, and was international in scope.

The work products delivered for this task include this technical memorandum, a separate spreadsheet summary of each study/report reviewed, and a compilation of reviewed studies/reports on the AMEC ftp site:
ftp://ftp.mactec.com/Incoming/Copermittee%20Bact%20Lit%20Review/

The entries in this memorandum are ordered alphabetically by last name of primary author. Each entry begins with the study number (for cross-referencing back to the spreadsheet matrix), followed by the study title. Web links are provided when available.

A number of studies were found that contained information on indicator bacteria but did not include specific information related to source identification within urban watersheds. These studies are summarized as NSC (Not Source Characterization) studies, beginning on p. 53.

The "Bacteria Source ID Lit Review Matrix" Excel workbook contains the following worksheets:

- The "Source ID Studies Summary Table" worksheet contains summaries of all studies reviewed and found to have useful information on bacteria sources; for each of these studies, any identified sources are indicated as Probably, Potential, Low or Suspected (see "Legend" worksheet for definitions)
- The "# Citations by Source" worksheet contains a tally of the numbers of studies with identified information on each source type
- The "Sources Summary Table" worksheet contains condensed summaries of the studies that have information on each particular source type
- The "Data Summary Table" worksheet contains brief summaries of study data (this is a work in progress)
- The "NSC Studies" worksheet provides summaries of the NSC (Not Source Characterization) studies

56 - Human and bovine adenoviruses for the detection of source-specific fecal pollution in coastal waters in Australia
Warish Ahmed, A. Goonetilleke, and T. Gardner
http://eprints.qut.edu.au/37690/1/Human_and_bovine_adenoviruses_for_the_detection_of_source-specific_fecal_pollution_in_coastal_waters_in_Australia.pdf
Purpose - To enhance the scientific foundation for preemptive public health warnings, examine the relationship between rainfall and beach indicator bacteria concentrations using five years of fecal coliform data taken daily at 20 sites in southern California.

Results - There was a clear relationship between the incidence of rainfall and reduction in beach bacterial water quality in Los Angeles County. Bacterial concentrations remained elevated for five days following a storm, although they generally returned to levels below state water quality standards within three days. The length of the antecedent dry period had a minimal effect on this relationship, probably reflecting a quickly developing equilibrium between the decay of older fecal material and the introduction of new fecal material to the landscape.

Sources:
Probable –Septic (human waste), bovine (domestic animals), animal farms (agriculture),
Potential -
Possible -

31 - Evaluation of Multiple Sewage-Associated Bacteroides PCR Markers for Sewage Pollution Tracking
Warish Ahmed, A. Goonetilleke, D. Powell, and T. Gardner
http://eprints.qut.edu.au/29217/1/c29217.pdf
Purpose - The host specificity of the five published sewage-associated Bacteroides markers (i.e., HF183, BacHum, HuBac, BacH and Human-Bac) was evaluated in Southeast Queensland, Australia by testing fecal DNA samples (n = 186) from 11 animal species including human fecal samples collected via influent to a sewage treatment plant (STP).

Results - For the 5 sewage-associated markers tested in this study, the HF183 marker performed better than others. This marker showed 99% specificity to distinguish between the sources of human and animal fecal pollution. The performance of the five markers in terms of specificity was HF183 > BacHum > BacH > Human-Bac > HuBac.

78 - Detection and source identification of faecal pollution in non-sewered catchment by means of molecular markers host-specific
Warish Ahmed, D. Powell, A. Goonetilleke, and T. Gardner
http://s3.amazonaws.com/publicationslist.org/data/w.ahmed/ref-23/WST%20Article.pdf
Purpose - To validate the previously published host-specific PCR markers (i.e. HF183, HF134, CF128, BacCan and esp) for the detection of sources of faecal pollution by testing a large number of faecal samples from 13 host groups in Southeast Queensland, Australia.

Results - All 197 faecal samples (100%) from the 13 host groups were positive for general Bacteroides. Of the 42 (i.e. 30 sewage and 12 septic samples) sewage/septic samples tested, all were positive for the human-specific HF183 and HF134 Bacteroides markers. The HF183 marker could not be detected in any faecal samples from animal host groups suggesting that the suitability of this marker to detect human faecal pollution. In contrast, the HF134 marker was detected in 7 (35%) samples from dogs. The presence of this marker in dogs could be due to the transfer of faecal bacteria between human and their companion pets (Dick et al. 2005).

79 - Evaluation of Bacteroides markers for the detection of human faecal pollution
Warish Ahmed, J. Stewart, D. Powell, and T. Gardner
http://onlinelibrary.wiley.com/doi/10.1111/j.1472-765X.2007.02287.x/pdf
Purpose - Evaluating the specificity and sensitivity of human-specific HF183 and HF134 Bacteroides markers in various host groups and their utility to detect human faecal pollution in storm water samples collected from non-sewered catchments in Southeast Queensland, Australia.

Results - The specificity and sensitivity of the HF183 and HF134 Bacteroides markers was evaluated by testing 207 faecal samples from 13 host groups, including 52 samples from human sources (via sewage and septic tanks). Polymerase chain reaction analysis of these samples revealed the presence ⁄ absence of HF183 and HF134 across these host groups, demonstrating their suitability for distinguishing between human and animal faecal pollution. The HF183 marker was found to be more reliable than that of HF134, which was also found in dogs.

35 - Quantitative PCR assay of sewage-associated Bacteroides markers to assess sewage pollution in an urban lake in Dhaka, Bangladesh
Warish Ahmed, R. Yusuf, I. Hasan, A. Goonetilleke, and T. Gardner
http://eprints.qut.edu.au/37689/1/Quantitative_PCR_assay_of_sewage-associated_Bacteroides_markers_to_assess_sewage_pollution_in_an_urban_lake_in_Dhaka,_Bangladesh.pdf
Purpose - To assess the magnitude of sewage pollution in an urban lake in Dhaka, Bangladesh 34 by using Quantitative PCR (qPCR) of sewage-associated Bacteroides HF183 markers.

Results – From the 20 water samples tested, 14 (70%) and 7 (35%) were PCR positive for the HF183 and CF128 markers, respectively. The high numbers of enterococci and the HF183 markers indicate sewage pollution.

Sources:
Probable - Slum-like establishments (human waste), MS4 Infrastructure (human waste),
Potential -
Possible – Dogs and cows

139 - Coastal water quality impact of storm water runoff from an urban watershed in Southern California
Jong Ho Ahn, S.B. Grant, C.Q. Surbeck, P.M. DiGiacomo, N.P. Nezlin, and S. Jiang
ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/528_B03_WQ_Appendix_I.pdf
Purpose - Assess the coastal water quality impact of storm water runoff from the Santa Ana River, which drains a large urban watershed located in southern California. This is the first wet weather study to examine the linkage between water quality in the surf zone -- where routine monitoring samples are collected and most human exposure occurs -- and water quality offshore of the surf zone.

Results - Storm water runoff from the Santa Ana River negatively impacts coastal water quality, both in the surf zone and offshore. However, the extent of this impact, and its human health significance, is influenced by numerous factors, including prevailing ocean currents, within-plume processing of particles and pathogens, and the timing, magnitude and nature of runoff discharged from river outlets over the course of a storm.

Sources:
Probable - Slum-like establishments (human waste), MS4 Infrastructure (human waste),
Potential -
Possible – Dogs and cows

17 - Lower San Luis Rey River Bacteria Source Identification Study
AMEC, UNC, City of Oceanside, SCCWRP, and USC
Purpose - The goal of the Project was to identify hot spots of fecal indicator bacteria; identify potential sources and prioritize those sources and locations for future bacteria reductions through management measures.

Results - There is evidence of the human-related bacterial sources throughout the river system. Sediment in the river mouth is a contributing source of fecal bacteria to the water column when the river mouth is closed to tidal exchange. The resident gull population was a probable source of fecal bacteria in the river mouth. Additional, monitoring is needed to identify human sources.

Sources:
Probable - Non-specific source (human waste),
Potential–Gulls (secondary wildlife), soil, sediment and sand (seasonal),
Possible - Sewage infrastructure, mobile sources (human waste), domestic animals

43 - Monitoring and Mitigation to Address Fecal Pathogen Pollution along California Coast
Applied Marine Sciences, Inc., University of California Davis, California Department of Fish and Game, and Marine Wildlife Veterinary Care and Research Center
Purpose - The goals of this research program were to use both laboratory and field approaches to investigate issues related to water quality monitoring and mitigation of fecal pathogen pollution along the central California coast.

Results - The universal Bacteroidales marker was detected in all water samples (100%). The human Bacteroidales marker was detected in 37% of samples, while the cow (8%) and dog (6%) bacteroidales markers were detected in less than 10% of samples. Overall, Bacteroidales concentrations ranged from 87-1.3 million gc/mL for universal markers, 45-17,268 gc/mL for human markers, 3-92 gc/mL for cow markers, and 12-575 gc/mL for dog markers.

Sources:
Probable – Non-specific source (human waste),
Potential - Dogs and livestock,
Possible –

68 - Little Sac River Watershed Bacterial Source Tracking Analysis
Dr. Claire Baffaut, Dr. C.A. Carson, and W. Rogers
https://mospace.umsystem.edu/xmlui/bitstream/handle/10355/3029/LittleSacBacterial.pdf?sequence=1
Purpose - To identify the sources of bacteria found in the Little Sac River using rep-PCR analyses of fecal material.

Results - The data show that the highest fecal coliform loads come from unknown sources, geese, and human. Data show that sources differ by season but the magnitude of the contamination is not significantly affected by season.

Sources:
Probable – Wastewater treatment plant, Geese (non-specific source)
Potential – Cattle and horses
Possible – Septic (sewage infrastructure)

117 - SOURCES OF POLLUTANTS IN WISCONSIN STORMWATER
R.T. Bannerman, D.W. Owens, R.B. Dodds, and N.J. Hornewer
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.176.2404&rep=rep1&type=pdf
Purpose - Identification of critical source areas (streets, roads, parking lots, etc.) could reduce the amount of area needing best-management practices in two areas of Madison, WI. Targeting best-management practices to 14% of the residential area and 40% of the industrial area could significantly reduce contaminant loads by up to 75%.

Results - Streets will probably be a critical source area in every land use. The majority of the runoff loads for many contaminants may be from streets in residential and commercial land uses. Parking lots are probably another critical source for commercial and industrial land uses. About 77% of the area in the commercial land use would have to be managed to control at least 75% of the loads for all contaminants except fecal coliform bacteria.

Sources:
Probable – Sewer outfall, Street runoff (residential, commercial and industrial)

Potential – Cattle and horses
Possible – Septic (sewage infrastructure)

82 - Tiered Approach for Identification of a Human Fecal Pollution Source at a Recreational Beach: Case Study at Avalon Bay, Catalina Island, California
Alexandria B. Boehm, J.A. Fuhrman, R.D. Morse, and S.B. Grant
http://dornsife.usc.edu/labs/fuhrman/Documents/Publications/Tiered%20Approach.pdf
Purpose - In this study, a three-tiered approach is used to identify human and nonhuman sources of FIB in Avalon Bay, a popular resort community on Catalina Island in southern California.

Results - Most of the FIB contamination along the shoreline of the City of Avalon is due to sources inside the bay and, in particular, from the land side of the beach. During the 24-h survey, the most contaminated shoreline sites exhibited a semi-diurnal FIB pattern in which the concentrations increased during ebbing tides. The multiple instances of positive HF and HV assay results at shoreline stations indicate that human fecal contamination exists in Avalon Bay. The nuisance runoff and bird feces had the highest levels of FIB with TC, EC, and ENT consistently near or above the upper limit of detection for water samples 24 192 MPN/100 mL. With the exception of sample R101, pipe discharges from underneath the pier and wharf and the cooling water boat discharge had relatively low levels of FIB. Sample R101 was take from a broken pipe carrying gray water underneath the wharf and had TC and EC levels above our detection limit of 24 192 MPN/100 mL and ENT levels of 10 462 MPN/100 mL, which is 100 times higher than the CDHS single-sample standard. City officials repaired this pipe in early October. Subsurface water collected from within the five trenches had sporadically high levels of FIB.

Sources:
Probable – Non-specific source (urban land use; human waste), MS4 Infrastructure (dry weather runoff; human waste), birds (secondary wildlife), reclaimed water (leaking graywater pipe)
Potential –
Possible – Commercial/Industrial (boat cooling water, pier, and wharf discharges from pipes)

153 - Cross-Shelf Transport at Huntington Beach Implications for the Fate of Sewage Discharged through an Offshore Ocean Outfall
Alexandria B. Boehm, B.F. Sanders, and C.D. Winant
http://www-ccs.ucsd.edu/~cdw/mypubs/109.pdf
Purpose - Evaluate the potential for internal tides to transport wastewater effluent from the Orange County Sanitation District (OCSD) ocean outfall toward Huntington Beach.

Results - On the basis of these analyses, it remains unclear whether OCSD effluent impairs surf-zone water quality. However, OCSD plume cannot be ruled out as a contributor to poor bathing-water quality at Huntington Beach.

131 - Source Tracking in Lake Darling Watershed
Janice Boekhoff
http://www.igsb.uiowa.edu/wqm/Publications/Reports/LakeDarlingFinalReport.pdf
Purpose - Determine the source of fecal contamination in Lake Darling and the surrounding watershed.

Results - E. coli bacteria from most of the water samples at Lake Darling have been identified by DNA ribotyping as coming from unknown sources of fecal contamination (75% of the water samples had bacteria from unknown sources using the WHU library). More unknown source classifications than known sources suggested the E. coli isolate library was either not large enough or was not representative of all of the sources in the watershed.

Sources:
Probable – Secondary wildlife (cattle and swine), Wildlife (unknown)
Potential –
Possible – Commercial/Industrial (boat cooling water, pier, and wharf discharges from pipes)

83 - Detection of Genetic Markers of Fecal Indicator Bacteria in Lake Michigan and Determination of Their Relationship to Escherichia coli Densities Using Standard Microbiological Methods
Patricia A. Bower, C.O. Scopel, E.T. Jensen, M.M. Depas, and S.L. McLellan
http://aem.asm.org/content/71/12/8305.full.pdf+html
Purpose - Lake Michigan surface waters impacted by fecal pollution were assessed to determine the occurrence of genetic markers for Bacteroides and Escherichia coli.

Results - Human-specific Bacteroides spp. were found at three of the nine beach sites tested. Human-specific Bacteroides genetic marker is a sensitive measure of sewage contamination. Sanitary sewage overflow samples taken in the suburban part of the watershed showed the presence of cow-specific genetic marker, since the cow-specific primers do not differentiate between types of ruminants, i.e., elk, deer, and cows.

Sources:
Probable – CSO and SSO (Sewage infrastructure; human waste)
Potential – Sanitary sewer infiltration into the storm drain (Sewage infrastructure; human waste), Ruminant (wildlife; non-anthropogenic)
Possible – Sanitary sewer infiltration into the storm drain (Sewage infrastructure; human waste)

27 – Antibiotic Resistance Analysis of Fecal Coliforms to Determine Fecal Pollution Sources in a Mixed-Use Watershed
Brian S. Burnes
http://www.springerlink.com/content/q3213338g1578x88/fulltext.pdf

Purpose - Antibiotic resistance analysis was performed on fecal coliform (FC) bacteria from a mixed-use watershed to determine the source, human or nonhuman, of fecal coliform contamination.

Results - Human sources contribute a majority (>50%) of the baseflow FC isolates found in the watershed in urbanized areas. Chicken and livestock sources are responsible for the majority of the baseflow FC isolates found in the rural reaches of the watershed. Stormwater introduces FC isolates from domestic (~16%) and wild (~21%) sources throughout the watershed and varying amounts (up to 60%) from chicken and livestock sources. These results suggest that antibiotic resistance patterns of FC may be used to determine sources of fecal contamination and aid in the direction of water quality improvement.

Sources:
Probable – Urbanized watershed (human waste), cows and chickens (rural watershed)
Potential –Stormwater runoff,
Possible –

13 - Results from a Microbial Source-Tracking Study at Villa Angela Beach, Cleveland, Ohio 2007

Rebecca N. Bushon, E.A. Stelzer, and D.M. Stoeckel

Purpose - The overall goal of the study was to provide NEORSD with source-tracking information to aid in their understanding of elevated bacterial concentrations at Villa Angela Beach in Cleveland Ohio. To understand these elevation concentrations, 13 source samples (influent/effluent to sewage treatment plant, waterfowl feces from beach area, combined sewer overflow, stormwater outfall) and 33 beach-area water and sand samples were analyzed for E coli and 3 Bacteroides DNA markers

Results - Therefore, Btheta does not appear to be a useful human-associated marker for this beach area. In the Lake, human source is not a likely contributor of fecal bacteria, however, the gulls are a probable source. In Euclid Creek, there were strong signals of human sources on two occasions and gulls were not present. The sand did not have human sources present and gull sources were present in low concentrations.

Sources:
Probable -
Potential - Combined sewer overflow, influent/effluent to sewage treatment plant, waterfowl feces from beach area,
Possible -

85 - Population structure, persistence, and seasonality of autochthonous Escherichia coli in temperate, coastal forest soil from a Great Lakes watershed

Muruleedhara N. Byappanahalli, R.L. Whitman, D.A. Shively, M.J. Sadowsky, and S. Ishii

http://www.glsc.usgs.gov/_files/publications/population.pdf

Purpose - In this study, undisturbed, forest soils within six randomly selected 0.5 m exclosure plots (covered by netting of 2.3 mm mesh size) were monitored from March to October 2003 for E. coli in order to describe its numerical and population characteristics.

Results - In this study, soil was found as a potential habitat for the persistent, perhaps resident, E. coli populations in temperate conditions. While our studies showed that E. coli can occur in temperate forest soils, albeit at low densities, it also had the ability to persist for extended periods in these habitats, suggesting that it is not a transient organism in soil but perhaps part of the natural microflora. Even if this is not the case, its population resiliency suggests that soil-borne E. coli should be treated as background concentration in source and impact evaluation investigations.

Sources:
Probable – Soil/Sediment/Sand (non-anthropogenic)
Potential –
Possible – Gull, deer, geese, terns (wrackline; non-anthropogenic)

84 - Ubiquity and Persistence of Escherichia coli in a Midwestern Coastal Stream
Muruleedhara Byappanahalli, M. Fowler, D. Shively, and R. Whitman.
http://aem.asm.org/content/69/8/4549.full.pdf+html
Purpose - Dunes Creek, a small Lake Michigan coastal stream that drains sandy aquifers and wetlands of Indiana Dunes, has chronically elevated Escherichia coli levels along the bathing beach near its outfall. This study sought to understand the sources of chronically elevated Escherichia coli levels along the bathing beach near its outfall in Dunes Creek's central branch.

Results - Water samples analyzed during the 1999 and 2000 monitoring seasons clearly demonstrated that E. coli concentrations in Dunes Creek were significantly correlated with the park's beach water. Dunes Creek empties directly onto the state park's only swimming beach, indicating that the creek directly impacts bathing water quality. E. coli is common within the stream basin, especially in submerged, margin, and wetted bank sediments, with numbers rapidly decreasing landward beyond the banks. The relationship between E. coli concentration and stream order suggests that excessive ditching and, consequently, non-point source input via sediment transport are responsible for elevated E. coli density in the watershed.

Sources:
Probable – Soil/Sediment/Sand (non-anthropogenic)
Potential –
Possible – Non-specific source (groundwater; non-anthropogenic)

3 - Pismo Beach Fecal Contamination Source Identification Study; Final Report. Aug. 12, 2010
CAL POLY and City of Pismo Beach
http://www.coastalrcd.org/images/cms/files/PismoFinalReport-v1_4%5B1%5D.pdf

Purpose - To identify biological sources of fecal contamination. Primary sources found were bird fecal contamination.

Results - The data collected in this study clearly shows the main source of fecal contamination on the beach is bird droppings near the pier. Nearly 40% of the E. coli strains collected in this study matched bird fecal sources, and E coli strains with a pigeon-specific fingerprint were collected. In addition, measuring the time since a tide last washed the part of the beach being sampled was an excellent predictor of FIB count, indicating that deposition of fecal matter on the beach itself was a predominate contamination mode.

Sources:
Probable - Bathers, dogs, pigeons (secondary wildlife)
Potential - Cows
Possible -

86 - Sourcing faecal pollution from onsite wastewater treatment systems in surface waters using antibiotic resistance analysis
S. Carroll, M. Hargreaves, and A. Goonetilleke
http://eprints.qut.edu.au/4018/1/4018.pdf
Purpose - To identify the sources of faecal contamination in investigated surface waters and to determine the significance of onsite wastewater treatment systems (OWTS) as a major contributor to faecal contamination.

Results - Antibiotic resistance patterns (ARP) were established for a library of 717 known Escherichia coli source isolates obtained from human, domesticated animals, livestock and wild sources. The resulting ARP DA indicated that a majority of the faecal contamination in more rural areas was nonhuman; however, the percentage of human isolates increased significantly in urbanized areas using OWTS for wastewater treatment.

Sources:
Probable – Sewage infrastructure (onsite wastewater treatment systems; human waste)
Potential –
Possible –

28 - Faecal pollution source identification in an urbanising catchment using antibiotic resistance profiling, discriminant analysis and partial least squares regression
Steven P. Carroll, L. Dawes, L., M. Hargreaves, and A. Goonetilleke
http://eprints.qut.edu.au/19108/1/c19108.pdf
Purpose - Antibiotic Resistance Patterns (ARP) were established for a library of 1005 known E. coli source isolates obtained from human and non-human (domesticated animals, livestock and wild) sources in an urbanising catchment in Queensland State, Australia. Discriminant Analysis (DA) was used to differentiate between the ARP of source isolates and to identify the sources of faecal contamination.

Results - The resulting ARP (Antibiotic Resistance Patterns) DA (Discriminant Analysis) indicated that a majority of the faecal contamination in the rural areas was non-human. However, the percentage of human isolates increased significantly in urbanised areas using onsite systems for wastewater treatment. The PLS regression was able to develop predictive models which indicated a high correlation of human source isolates from the urban area.

Sources:
Probable - Urbanized watershed (human waste), agriculture, other (land use)
Potential –
Possible -

47 - Middle Santa Ana River Bacterial Indicator TMDL Data Analysis Report
CDM and Risk Sciences
Purpose - The primary goal of this study was "to develop an investigative strategy at the highest priority sites, including site-specific or subwatershed-specific activities."

Results – Analysis showed significant differences in the frequency with which molecular markers for humans, dogs, and cattle were detected at the various source evaluation sites. The sites with highest frequency of detection of host-specific markers included the Human marker at Box Springs Channel and Chris Basin; Bovine marker at Anza Drain, Cypress Channel and San Antonio Channel; and Domestic canine marker at Chris Basin, County Line Channel and Day Creek. Where the universal marker was measured, it was a quantified at levels much higher than the other measured markers, indicating the presence of many other sources of bacteria, e.g. birds, rodents, small mammals and reptiles. Preliminary review of land use data indicates that bacterial concentrations are positively correlated with degree of urban development and negatively correlated with the proportion of agricultural acreage and open space in the area.

Sources:
Probable – Non-specific source (human waste; 1 of 13 sites), dogs(1 of 13 sites) and cows(3 of 13 sites), commercial/industrial (anthropogenic non-human source), residential, commercial, and industrial (land use)
Potential -
Possible – Agriculture (anthropogenic non-human source),natural land use (non-anthropogenic) natural and agricultural (land use)

127 - Densities of fecal indicator bacteria in tidal waters of the Ballona Wetlands, Los Angeles County, California
John. H. Dorsey
http://www.freepatentsonline.com/article/Bulletin-Southern-California-Academy-Sciences/151712972.html
Purpose - Densities of fecal indicator bacteria (FIB) represented by total coliforms, E. coil and enterococci were measured within tidal channels of the Ballona Wetlands (Los Angeles County) to see of the wetlands act as a sink or source for these bacteria and to measure increases in FIB densities during wet weather.

Results - Results suggest that the wetlands may act as a sink in that FIB densities tended to be greater during flood flows into the wetlands, but less in water draining out of the system during ebb flows. However, this condition was not consistently met, especially at stations farthest from the tide gates. These sites could be reflecting increased FIB densities through regrowth within sediments and other unidentified sources.

Sources:
Probable –Storm drains
Potential –
Possible -

181 - Reduction of fecal indicator bacteria (FIB) in the Ballona Wetlands saltwater marsh (Los Angeles County, California, USA) with implications for restoration actions
John H. Dorsey, P.M. Carter, S. Bergquist and R. Sagarin
http://www.sciencedirect.com/science/article/pii/S004313541000388X/
Purpose - Determine FIB tidal dynamics within the wetland

Results - The wetlands act as both a source and sink for FIB depending on tidal conditions and exposure to sunlight. Future restoration actions would result in a tradeoff – increased tidal channels offer a greater surface area for FIB inactivation, but also would result in a greater volume of FIB-contaminated re-suspended sediments carried out of the wetlands on stronger ebb flows. As levels of FIB in Ballona Creek and Estuary diminish through recently established regulatory actions, the wetlands could shift into a greater sink for FIB.

119 - FECAL COLIFORM AND STREPTOCOCCUS CONCENTRATIONS IN RUNOFF FROM GRAZED PASTURES IN NORTHWEST ARKANSAS
D. R. Edwards, M.S. Coyne, P.F. Vendrell, T.C. Daniel, P.A. Moore, Jr., and J.F. Murdoch
http://www.pcwp.tamu.edu/docs/lshs/end-notes/Fecal%20Coliform%20and%20Streptococcus%20Concen-0982758667/Fecal%20Coliform%20and%20Streptococcus%20Concentrations%20in%20Runoff%20from%20Grazed%20Pastures%20and%20Northwest%20Arkansas.pdf
Purpose - Assess the effects of grazing, time of year, and runoff amounts on FC and FS concentrations and to evaluate whether FCIFS concentration ratios are consistent with earlier values reported as characteristic of animal sources.

Results - In general, FC and FS concentrations were not directly related to either treatment with animal manure or presence of grazing cattle. Ratios of FC to FS concentrations varied widely ranging from almost zero to more than 100. These data confirm earlier findings that FC/FS ratios are not a reliable indicator of the source of FC and FS in the runoff.

147 - FECAL-INDICATOR BACTERIA IN STREAMS ALONG A GRADIENT OF RESIDENTIAL DEVELOPMENT
Steven A. Frenzel and C.S. Couvillion
http://lshs.tamu.edu/docs/lshs/end-notes/fecal%20indicator%20bacteria%20in%20streams%20along%20a%20gradient%20of%20resid-3692103194/fecal%20indicator%20bacteria%20in%20streams%20along%20a%20gradient%20of%20residential%20development.pdf
Purpose - In order to adopt EPA water-quality standards for concentrations of Escherichia coli (E. coli) or enterococci, and study to determine the effects of urbanization on water quality.

Results - Areas served by sewer systems had significantly higher fecal-indicator bacteria concentrations than did areas served by septic systems. The areas served by sewer systems also had storm drains that discharged directly to the streams, whereas storm sewers were not present in the areas served by septic systems. Fecal-indicator bacteria concentrations were highly variable over a two-day period of stable streamflow, which may have implications for testing of compliance to water-quality standards.

120 - Soil: the environmental source of Escherichia coli and Enterococci in Guam's streams
R. Fujioka, C. Sian-Denton, M. Borja, J. Castro, and K. Morphew
http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2672.1998.tb05286.x/pdf
Purpose - Test the hypothesis that faecal bacteria are able to establish themselves in the soil environments of tropical islands by conducting a study in Guam, a tropical pacific island with warmer temperatures and higher humidity than Hawaii (covered in a previous study).

Results - Results obtained in Guam were similar to the results obtained in Hawaii and provided convincing evidence that the faecal bacterial indicators selected by USEPA to establish recreational water quality standards are able to colonize the soil environments of warm, humid tropical islands, current hygienic water quality standards which are based on concentrations of faecal indicator bacteria may not be applicable in tropical islands and perhaps other subtropical and tropical countries in the world. In these countries, stream waters can be expected to contain elevated levels of faecal bacteria.

Sources:
Probable - Rainfall
Potential –
Possible -

91 - Use of composite data sets for source-tracking enterococci in the water column and shoreline interstitial waters on Pensacola Beach, Florida
Fred J. Genthner, J.B. James, D.F. Yates, and S.D. Friedman
http://64.9.200.77/lists/beachnet/2005-07/pdf00002.pdf

Purpose - Source identification was performed to better understand risk associated with higher densities of enterococci found in swash zone interstitial water (SZIW) as compared to adjacent bathing water on Pensacola Beach, FL.

Results - This study documents higher densities of enterococci in SZIW than in adjacent bathing waters on Pensacola Beach. Entrapment may partially account for increased bacteria densities, however, biological factors (nutrients, protection from predation) and physical factors (particulate matter, periodic wetting and drying, protection from solar irradiation) may not only allow the enhanced survival of bacteria but may actually provide a growth- promoting environmental niche on the beach.

Sources:
Probable – Seagull (secondary wildlife)
Potential –
Possible **– Non-specific source (human waste)**

46 - Laguna Watershed Study and Water Quality Improvement Feasibility Analysis
Geosyntec and UCSB
Purpose - To evaluate dry weather hydrology, microbiological indicators, bacterial sources and loads, and feasible water quality improvements for the Laguna Channel in Santa Barbara, CA.

Results – Based on the analysis of human-specific Bacteroides DNA, it appears that there is significant input of human fecal waste into some Laguna storm drains and into Laguna Channel. An obvious spatial correlation between measured FIB and Human specific Bacteroides Marker (HBM) concentrations could not be identified; similar trends between indicator species and HBM concentrations were also not observed.

Sources:
Probable – Non-specific source (human waste),
Potential -
Possible -

148 - Quantitative Detection of Hepatitis A Virus and Enteroviruses Near the United States-Mexico Border and Correlation with Levels of Fecal Indicator Bacteria
Richard M. Gersberg, M.A. Rose, R. Robles-Sikisaka, and A.K. Dhar
http://publichealth.sdsu.edu/publications/gersberg684.pdf
Purpose - To measure the levels of Hepatitis A virus (HAV) and enteroviruses in coastal waters, and compare to E. coli and enterococci.

Results - HAV and enterovirus were found in 93% of wet weather samples. Inadequate sewage infrastructure in Tijuana, Mexico, also contributes to the high levels found at some sites.

60 - Evaluation of Two Library-Independent Microbial Source Tracking Methods to Identify Sources of Fecal Contamination in French Estuaries

Michele Gourmelon, M.P. Caprais, R. Segura, C. Le Mennec, S. Lozach, J.Y. Piriou, and A. Rince

http://aem.asm.org/content/73/15/4857.full.pdf+html

Purpose - The aim of this study was to optimize and validate the two MST techniques (host-specific 16S rRNA gene markers from Bacteroidales and genotyping of F-specific RNA bacteriophages) on human and animal feces, sewage treatment plant (STP) sludge, wastewater samples, and pig liquid manure (PLM; pig slurry) collected in France. Both techniques were then applied to water samples collected at different times from three estuaries

Results - Humans and animals sources are detected as sources of E. coli and Enterococci contamination in the estuaries based on host-specific Bacteroidales and F-specific bacteriophages

Sources:
Probable – Septic (human waste), livestock (domestic animals), livestock (agriculture), birds (wildlife), birds (secondary wildlife)
Potential -
Possible -

23 - Generation of Enterococci Bacteria in Saltwater Marsh and its impact on the surf zone water quality

Steven B. Grant, B.F. Sanders, A.B. Boehm, A.J. Redman, J.H. Kim, R.D. Mrše, A.K. Chu, M. Gouldin, C.D. McGee, N.A. Gardiner, B.H. Jones, J. Svejkovsky, G.V. Leipzig, and A. Brown

https://www.crops.org/publications/jeq/pdfs/31/4/1300

Purpose - To characterize the sources and transport of Enterococcus in tidally influenced flood control channels and a saltwater marsh.

Results - We find that enterococci bacteria are present at high concentrations in urban runoff, bird feces, marsh sediments, and on marine vegetation. Surprisingly, urban runoff appears to have relatively little impact on surf zone water quality because of the long time required for this water to travel from its source to the ocean. On the other hand, enterococci bacteria generated in a tidal saltwater marsh located near the beach significantly impacts surf zone water quality.

Sources:
Probable – Marsh (non-anthropogenic; non-specific source), wildlife (marsh avian), marsh sediment, soil/sediment/sand
Potential –
Possible –

92 - Antibiotic Resistance Profiles to Determine Sources of Fecal Contamination in a Rural Virginia Watershed

Alexandria K. Graves, C. Hagedorn, A. Teetor, M. Mahal, A.M. Booth, and R.B. Reneau

https://www.crops.org/publications/jeq/pdfs/31/4/1300

Purpose - Antibiotic resistance analysis (ARA) was used to determine if enterococci of human origin were present in a stream (Spout Run) that passes through a rural non-sewered community (Millwood, VA)

Results - A human signature was found in Spout Run as it passed through upper and middle Millwood. No evidence of a human signature was found in Page Brook in an earlier report (Hagedorn et al., 1999), and no evidence of a human signature was found in any of the tributaries that form Spout Run in this study. There are 32 homes in upper Millwood, 21 homes in middle Millwood, and 13 homes in lower Millwood, all on individual septic systems. Repair or replacement of unsatisfactory systems (or installation of a community system) should result in removal of the human signature from Spout Run.

Sources:
Probable – Septic system (sewage infrastructure; human waste), Livestock (domestic animals; anthropogenic non-human sources), wildlife (non-anthropogenic)
Potential –
Possible –

2 - San Diego County Enterococcus Regrowth Study; Draft Final Report, June 11, 2011
John Griffith and D. Ferguson
Purpose - To investigate storm drains as a potential source of Enterococcus bacteria to San Diego's coastal waters during dry weather.

Results –The results of this study suggest that enterococci in these storm drain systems came from predominantly natural sources and include strains that are capable of growing on drain pipe surfaces. The results of the concrete coupon/growth study showed that enterococci were capable of attaching to and growing on concrete coupons. Testing of enterococci extracted from coupons in Cottonwood Creek revealed species and biotypes most closely related to freshwater plants and decomposed algae/vegetation. The majority (77%) of enterococci from the surfaces of coupons, pipe and cobble rock at a La Jolla storm drain were identified as an enterococcal species associated with plants.
A number of natural sources of enterococci were identified at Moonlight State Beach. In this study, up to 70% of creek water isolates were identified as a species commonly found on plants. Multivariate analysis of species and biotypes showed that enterococci in Cottonwood Creek were most similar enterococci found in decomposed algae and vegetation, freshwater plants and seawrack. At least 52% of enterococci in beach water were of a species found in plants, however 34% of isolates were either non-Enterococcus species or unidentifiable, suggesting the possibility of additional sources of enterococci that were not evaluated in this study. Some of the enterococci biotypes in beach water were the same ones found in decomposed algae and vegetation, freshwater plants and seawrack.
The low numbers of birds and predominance of E. faecalis in bird stools indicate that birds may not have been a major source of enterococci to creek and beach water, however the dissimilarity in enterococcal populations could also be related to different selection pressures.

All beach and storm drain/creek water samples tested for Bacteroidales indicated very low or non-detectable levels of the human marker, indicating that these samples had little or no evidence of human fecal material.

Sources:
Probable – MS4 Infrastructure (Human waste), avian (secondary wildlife), avian (non-anthropogenic)
Potential – Landscaping (irrigation and lawn clippings),
Possible – Wrackline, Plants (non-anthropogenic), seawrack, beach sand

121 - Escherichia coli and Enterococci at Beaches in the Grand Traverse Bay, Lake Michigan: Sources, Characteristics, and Environmental Pathways
Sheridan K. Haack, L.R. Fogarty, and C. Wright
http://www.glin.net/lists/beachnet/2007-07/pdf00000.pdf
Purpose - Overall objectives were to (i) quantify EC and ENT in dominant source materials and recreational waters; (ii) characterize selected source isolates using genomic (EC) or biochemical (ENT) profiling; (iii) identify associations between numbers of these two indicator bacteria groups and ambient conditions; (iv) identify processes that influence spatiotemporal variability of indicator bacteria at these beaches; and (v) evaluate standardized monitoring approaches in light of site-specific knowledge about sources and environmental processes

Results - Bird feces are likely one significant source of bacterial contamination to these beaches. Storm drains and the Boardman River contributed large numbers of EC and ENT to the bay, even during non-runoff conditions.
Sources:
Probable – Seawrack (vegetation and other detritus)
Potential –
Possible –

94 - Determining Sources of Fecal Pollution in a Rural Virginia Watershed with Antibiotic Resistance Patterns in Fecal Streptococci
C. Hagedorn, S.L. Robinson, J.R. Filtz, S.M. Grubbs, T.A. Angier, and R.B. Reneau Jr.
http://aem.asm.org/content/65/12/5522.full.pdf+html
Purpose - The objectives of this project were (i) to validate the method of using antibiotic resistance patterns in fecal streptococci and discriminant analysis (DA) to differentiate between human and animal sources and between certain types of animal sources with a larger database of known source isolates from a wider geographical region and (ii) to use this method in a watershed project to identify fecal pollution sources.

Results - The results presented affirm that antibiotic resistance patterns can be used with fecal streptococci to determine sources of fecal pollution in water. Results (detection of no human isolates) had a direct impact on water quality improvement in Page Brook, as local officials were able to focus restoration efforts on the actual sources (e.g., beef cattle) rather than on those that made no contribution to the water pollution.

Sources:
Probable – Cattle (domestic animals; anthropogenic non-human sources)
Potential – Waterfowl, deer unidentified (wildlife; non-anthropogenic)
Possible – Non-specific source (human waste)

69 - Influence of Freshwater Sediment Characteristics on Persistence of Fecal Indicator Bacteria

Laurence Haller, E. Amedegnato, J. Pote, and W. Wildi
http://www.springerlink.com/content/ju524662v67v4967/fulltext.pdf
Purpose - To investigate the effect of sediment characteristics such as particle grain size and nutrient and organic matter contents on the survival of fecal indicator bacteria including total coliforms, E. Coli, and Enterococcus.

Results - FIB survival in sediments and possible re-suspension are considerable significance for understanding permanent microbial pollution. Results revealed (1) FIB survived in sediments up to 50 days, (2) higher growth and lower decay rates of FIB in sediments with high levels of organic matter and nutrients and small grain size, (3) longer survival of Enterococcus compared to E. coli and total coliforms.

Sources:
Probable – Wastewater treatment plant (based on other studies), Soil/Sediment/Sand
Potential – Cattle and horses, storm runoff (MS4 Infrastructure; human waste), Agriculture
Possible – Septic (sewage infrastructure),Wastewater treatment plant, storm runoff (MS4 Infrastructure; human waste), Agriculture, Land use

193 - Soil: the environmental source of Escherichia coli and Enterococci in Hawaii's streams

C. M. Hardina, and R. Fukuda
http://md1.csa.com/partners/viewrecord.php?requester=gs&collection=ENV&recid=9200969&q=&uid=791338866&setcookie=yes
Purpose - To determine the concentrations and sources of Escherichia coli and enterococci in a typical stream (Manoa) in Hawaii.

Results - Soil is considered the most likely source for the high concentrations of indicator bacteria naturally present in the freshwater streams of Hawaii.

Sources:
Probable – Wastewater treatment plant (based on other studies), Soil/Sediment/Sand
Potential – Cattle and horses, storm runoff (MS4 Infrastructure; human waste), Agriculture, Land use
Possible – Septic (sewage infrastructure),Wastewater treatment plant, storm runoff (MS4 Infrastructure; human waste), Agriculture, Land use

61 - Combining targeted sampling and fluorometry to identify human fecal contamination in a freshwater creek
Peter G. Hartel, K. Rodgers, G.L. Moody, S.N.J. Hemmings, J.A. Fisher, and J.L. McDonald
http://www.iwaponline.com/jwh/006/0105/0060105.pdf
Purpose - The aim of this study was to conduct sampling at 2 reaches at Potato Creek, a freshwater creek in Georgia, and 1 tributary during baseflow and stormflow conditions and detect human sources of fecal contamination by using targeted sampling (finding hot spots of fecal contamination within the Creek and/or tributaries and re-sampling these spots) and fluorometry (detection of fluorescing compounds, optical brighteners, & laundry detergents)

Results - Humans, dogs, and cattle are the major suspected sources (not sampled) for fecal contamination in the Potato Creek reaches

Sources:
Probable -
Potential -
Possible – Broken home sewer line, dogs, cows, wildlife (non-anthropogenic),

63 - Drayton Harbor Watershed Microbial Source Tracking Pilot Study Phase 2: California Creek, Dakota Creek and Cain Creek Sub-watersheds
Hirsch Consulting Services
http://whatcomshellfish.whatcomcounty.org/Drayton/documents/DraytonHarborSanitarySurvey2010.pdf
Purpose - The objective of this study was to determine whether human or ruminant sources contribute to fecal contamination at selected sampling stations to inform follow-up investigations and corrective actions by Whatcom County and other agencies and to inform the Drayton Harbor Fecal Coliform TMDL Evaluation.

Results - Ruminant and human fecal sources threaten the shellfish harvest.

Sources:
Probable - Non-specific source (human waste), domestic animals,
Potential -
Possible -

67 - Sources and Mechanisms of Delivery of E. coli (bacteria) Pollution to the Lake Huron
Todd Howell
Purpose - To identify the potential sources of fecal pollution to the shoreline.

Results – The long-term fate of the potentially high E. coli loads delivered to the lake at these times is poorly understood. The association of E. coli with particulate material is thought to be a key mechanism by which survival and transport in the lake environment is enhanced.

Sources:
Probable – Agriculture,
Potential – Soil/Sediment/Sand
Possible - **Non-specific source (human waste), agriculture (listed under other with no degree of designation (probable, low, etc.)**

10 - Wrack promotes the persistence of fecal indicator bacteria in marine sands and seawater
Gregory J. Imamura, R.S. Thompson, A.B. Boehm, and J.A. Jay
http://onlinelibrary.wiley.com/doi/10.1111/j.1574-6941.2011.01082.x/full
Purpose - Study examined the relationship between beach wrack, FIB, and surrounding water and sediment at marine beaches along the California coast.

Results – FIB concentrations normalized to dry weight were the highest in stranded dry wrack, followed by stranded wet and suspended 'surf 'wrack. Laboratory microcosms were conducted to examine the effect of wrack on FIB persistence in seawater and sediment. Indigenous enterococci and Escherichia coli incubated in a seawater microcosm containing wrack showed increased persistence relative to those incubated in a microcosm without wrack. FIB concentrations in microcosms containing wrack-covered sand were significantly higher than those in uncovered sand after several days. These findings implicate beach wrack as an important FIB reservoir.

Sources:
Probable – Seawrack [1-Dry wrack (highest FIB), 2-wet wrack, 3-surf wrack]
Potential -
Possible -

57 - Presence and Growth of Naturalized Escherichia Coli in Temperate Soils from Lake Superior Watersheds
Satoshi Ishii, W.B. Ksoll, R.E. Hicks, and M.J. Sadowsky
http://aem.asm.org/content/72/1/612.full.pdf+html
Purpose - The goal of the study to was (i) examine the survival and persistence of E. coli populations in three soils in several coastal Lake Superior watersheds (extreme environmental conditions) and to determine if these E. coli strains have become naturalized to these soils, (ii) examine the genetic relatedness of soilborne E. coli strains from different locations, and (iii) determine if soilborne E. coli could actively multiply in the soils examined.

Results - E. Coli is able to survive and grow in soil, with growth occurring when temperature and nutrients are higher and able to survive in extreme environments (low temps). Animal feces of surrounding wildlife not shown to be likely source.
Sources:
Probable – Soil/Sediment/Sand
Potential -
Possible - Wildlife

156 - Sources and Persistence of Fecal Coliform Bacteria in a Rural Watershed
Rob C. Jamieson, R. J. Gordon, S. C. Tattrie, and G. W. Stratton
http://www.cawq.ca/journal/temp/journal/7.pdf#page=32
Purpose - Quantify the presence of fecal coliform bacteria in the surface waters of a rural watershed and to attempt to determine the primary sources of fecal pollution within rural watersheds.

Results - Fecal coliform levels frequently exceeded recreational water quality guidelines. At the watershed outlet, 94% of the collected samples exceeded the recreational water quality guideline during low flow conditions. Substantial bacterial loading was observed along stream reaches impacted by livestock operations. Bacterial loading was also observed along a stream reach that was not impacted by agricultural activities.

Sources:
Probable – Livestock
Potential -
Possible -

200 - The effect of cattle grazing on indicator bacteria in runoff from a Pacific Northwest watershed
M.D. Jawson, L.F. Elliott, K.E. Saxton, and D.H. Fortier
http://lshs.tamu.edu/docs/lshs/end-notes/the%20effect%20of%20cattle%20grazing%20on%20indica-1987218764/the%20effect%20of%20cattle%20grazing%20on%20indicator%20bacteria%20in%20runoff%20from%20a%20pacific%20northwest%20watershed.pdf
Purpose - Total coliform (TC), fecal coliform (FC), and fecal streptococcal (FS) numbers were monitored for 3 years to determine the effect of grazing on the presence of these organisms in runoff from a cattle grazed and a non-grazed watershed in the Pacific Northwest

Results - Sampling at several locations within the grazed watershed showed that sources of indicator bacteria were well distributed, and as a result were nonpoint after the initial runoff events. Thus, present FC recommendations developed for point-sources would not apply adequately to grazed land in the Pacific Northwest. Indicator bacteria as presently analyzed would not provide a basis for developing best management practices.

Sources:
Probable – Secondary Wildlife (Cows)
Potential -
Possible –

12 - 2009 Investigation of Spatial and Temporal Distribution of Human-specific Bacteroidales marker in Malibu Creek, Lagoon and Surfrider Beach

Jennifer Jay, R.F. Ambrose, V. Thulsiraj, and S. Estes
Purpose - The goal of the study is to understand the relationship between Fecal indicator bacteria (FIB) and human-specific Bacteroidales (HSB) in coastal wetland. The study examines the spatial & temporal relationship of human-specific Bacteroidales marker (HBM) & FIB in lower Malibu Creek, Lagoon, and Surfrider Beach during wet and dry weather to determine the presence of detectable concentrations of HBM in the lagoon and if concentrations of HBM correlate with FIB

Results - Of the 80 water samples analyzed within the Malibu watershed, five samples were positive for the human-specific HF183 Bacteroidales marker (HBM).The highest percent exceedance of FIB and HBM concentrations were measured during wet weather. During the study, 93.8% of the samples did not have detectable concentrations of HBM. These data do not rule out any particular potential sources of human fecal contamination.

Sources:
Probable -
Potential - storm drains
Possible - Septic systems, Tapia Wastewater Reclamation Facility disinfected discharge, wildlife and birds

98 - Microbial source tracking in a small southern California urban watershed indicates wild animals and growth as the source of fecal bacteria
Sunny C. Jiang, W. Chu B.H. Olson, J. He, S. Choi, J. Zhang, J.Y. Le, and P.B. Gedalanga
http://www.eng.uci.edu/files/07-1MST.pdf
Purpose - Apply three MST tools, namely, ARA, human viruses, and E. coli toxin biomarkers to aid in the cleanup of unknown pollution sources in Laguna Niguel. Laguna Niguel is a small urban watershed in southern California that experienced chronic fecal coliform and enterococci contamination, with concentrations on average of 2–4 orders of magnitude greater than State of California established type 2 recreational standards.

Results - Using three independent microbial source tracking methods, the results of this study indicate that human sewage was not a major contributor of fecal bacterial impairment in this small urban watershed. This study showed that rabbit feces contain one of the highest concentrations of Enterococcus spp. per unit weight.

Sources:
Probable – Urban land use (non-specific source), dogs (urban land use), cows and horses (rural open land use),
Potential –
Possible –

76 - Freshwater Beach Total Maximum Daily Load Microbial Source Tracking Study
Dr. Stephen H. Jones
http://des.state.nh.us/organization/divisions/water/wmb/tmdl/documents/sand_dam_appendix_b_beach.pdf
Purpose - The goal of this project was to investigate actual and potential bacterial sources at (3) public beaches. The approach reflects the latest concepts for efficient use of bacterial ribotyping for pollution source identification in New Hampshire, i.e., ribotyping of high priority samples and development of small local source species databases. This targeted approach was designed to optimize identification of the most significant contamination sources at the 3 beaches.

Results - Overall, birds were the most prevalent (37%) source species type, followed by livestock (24%), humans (5%), wild animals (4%) and pets (3%). The most commonly identified source species was geese (17 isolates), followed by cows and mixed avian (7) sheep (6), horses and ducks (3), septage, goat, wastewater effluent and dog (2), with single isolates identified as coming from deer, red foxes, wild turkeys and mixed wildlife.

Sources:
Probable – Livestock, birds (secondary wildlife)
Potential –
Possible – Non-specific source (human waste), pets, wildlife

99 - Tracking Bacterial Pollution Sources in Stormwater Pipes
Dr. Stephen H. Jones
http://www.unh.edu/users/unh/acad/colsa/marine-program/nhep/resources/pdf/trackingbacterialpollution-unh-03.pdf
Purpose - Determine the bacteria source species from two of the highest priority storm drain pipes that discharge to Hampton Harbor

Results - Many storm water/runoff studies have attributed fecal contamination to pet wastes. Of the four types of sources identified, pets were the least common, behind birds, humans and wildlife.

Sources:
Probable – Non-specific source (human waste), geese (secondary wildlife), cormorants (wildlife; non-anthropogenic)
Potential –
Possible – Cats and dogs (domestic animals; anthropogenic non-human sources), seagulls and pigeons (secondary wildlife), foxes, raccoons and coyotes (wildlife; non-anthropogenic)

32 - USING MULTIPLE ANTIBIOTIC RESISTANCE AND LAND USE CHARACTERISTICS TO DETERMINE SOURCES OF FECAL COLIFORM BACTERIAL POLLUTION
R. Heath Kelsey, G.I. Scott, D.E. Porter, B. Thompson, and L. Webster

http://www.springerlink.com/content/p5p4413ku0082707/fulltext.pdf
Purpose - Multiple Antibiotic Resistance (MAR) analysis and regression modeling techniques were used to identify surface water areas impacted by fecal pollution from human sources, and to determine the effects of land use on fecal pollution in Murrells Inlet, a small, urbanized, high-salinity estuary located between Myrtle Beach and Georgetown, South Carolina.

Results - MAR results suggest that the majority of the fecal pollution detected in the Murrells Inlet estuary may be from non-human sources, including fecal coliforms isolated from areas in close proximity to high densities of active septic tanks.

Sources:
Probable -
Potential -
Possible -

144 - Bacteria Attenuation Modeling and Source Identification in Kranji Catchment and Reservoir
Kathleen B. Kerigan, and J.M. Yeager
http://censam.mit.edu/publications/yeager.pdf
Purpose - Determine the bacterial loading of Kranji Catchment and Reservoir and how this will affect planned recreational use of the reservoir.

Results - Farm run-off near the reservoir was the bacterial source of greatest concern. The relatively high concentrations coupled with the short travel time, which diminishes opportunity for attenuation, resulted in high concentrations reaching the reservoir downstream levels.

73 - Draft Calleguas Creek Watershed Quantitative Microbial Source Tracking Study
Beverly Kildare, V. Rajal, S. Tiwari, D. Thompson, B. McSwain, S. Wuertz, D. Bambic, and G. Reide (Report Prepared by UC Davis in Collaboration with Larry Walker Associates)
Wuertz, S., Bambic, D., and Reide, G. (Report Prepared by UC Davis in Collaboration with Larry Walker Associates)
http://www.calleguas.com/ccwmp/DRAFT_CCW_MST_061406.pdf
Purpose - The goal of this microbial source tracking (MST) study was to provide quantitative, host-specific fecal source data and assist in the development of a bacteria TMDL for the Calleguas Creek Watershed(CCW).

Results - Urban areas were found to be sources of human and canine bacteria to Arroyo Simi and Conejo Creek. The Tapo Canyon site, which is upstream of urban influences, exhibited the lowest concentrations and ratios of the mixed-human marker, but the highest concentrations and ratios of the cow/horse marker. Analysis of tertiary-treated wastewater samples indicates that mixed-human Bacteroidales concentrations may be relatively high in discharged effluent. However, such cells are most likely non-viable and thus not associated with water quality objective exceedances.

Sources:
Probable – Non-specific source (human waste), dogs (canine urban land use), cows and horses (rural and open space)
Potential –
Possible –

100 - Non-point source pollution: Determination of replication versus persistence of Escherichia coli in surface water and sediments with correlation of levels to readily measurable environmental parameters
Julie Kinzelman, S.L. McLellan, A.D. Daniels, S. Cashin, A. Singh, S. Gradus, and R. Bagley
http://www.iwaponline.com/jwh/002/0103/0020103.pdf
Purpose - Racine, Wisconsin, located on Lake Michigan, experiences frequent recreational water quality advisories in the absence of any identifiable point source of pollution. This research examines the environmental distribution of Escherichia coli in conjunction with the assessment of additional parameters (rainfall, turbidity, wave height, wind direction, wind speed and algal presence) in order to determine the most probable factors that influence E. coli levels in surface waters.

Results - This study indicates that persistence, rather than environmental replication of E. coli, is responsible for the majority of microorganisms recovered from foreshore sands, submerged sands and surface waters at Racine, Wisconsin, beaches along Lake Michigan.

Sources:
Probable – Non-specific source (persistence in surface water; non-anthropogenic), Soil/Sediment/Sand (persistence)
Potential –
Possible –

135 - Source tracking faecal contamination in an urbanised and a rural waterway in the Nelson-Tasman region, New Zealand
M. Kirs, V.J. Harwood, A.E. Fidler, P.A. Gillespie, W.R. Fyfe, A.D. Blackwood, and C.D. Cornelisen
http://www.tandfonline.com/doi/pdf/10.1080/00288330.2010.535494
Purpose - Eight MST markers, including general, ruminant and human-associated Bacteroidales markers, a duck-associated E2 marker, a gull-associated Catellicoccus marimammalium marker and three additional human markers [Enterococcus faecium esp gene, Methanobrevibacter smithii nifH gene, and human polyoma viruses (HPyVs)] were tested for host specificity and sensitivity using an array of animal faecal samples of known origin and wastewater samples.

Results - The validation and application of a suite of end-point PCR assays for MST markers enabled us to identify the presence of faecal contamination from multiple sources, including humans, in a New Zealand urbanised waterway. Outcomes demonstrate that MST markers developed overseas can be utilised in New Zealand context.

150 - PISMO BEACH FECAL CONTAMINATION SOURCE IDENTIFICATION STUDY

Christopher L. Kitts, M.W. Black, M.Y. Moline, A.K. Hamrick, I.C. Robbins, A.A. Schaffner, and N.I. Boutet

http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1325&context=bio_fac

Purpose - Identify the biological sources of fecal contamination as well as the physical and environmental factors that influence the levels of bacteria in the ocean waters at Pismo Beach, California.

Results - The main source of fecal contamination on the beach is bird droppings near the pier. Both wave direction and current direction worked to push high concentrations of FIB away from the pier as the main source of fecal contamination.

Sources:
Probable – Sewage Infrastructure, Domestic animals (dogs, cats and horses), Secondary wildlife (cows, pigeons and gulls)
Potential –
Possible –

101 - Presence and Sources of Fecal Coliform Bacteria in Epilithic Periphyton Communities of Lake Superior

Winfried B. Ksoll, S. Ishii, M.J. Sadowsky, and R.E. Hicks

http://aem.asm.org/content/73/12/3771.full.pdf+html

Purpose - (i) determine if fecal coliforms and E. coli populations are present and persist in periphyton communities from a harbor and Lake Superior, (ii) identify the most probable sources of E. coli found in periphyton, (iii) use laboratory microcosms to examine colonization and survival of E. coli in natural periphyton communities, and (iv) estimate the contribution of periphyton borne E. coli to overlying waters.

Results - Although many E. coli strains isolated from periphyton may have originated from waterfowl and sewage effluent, other strains appeared to be unique to the periphyton studied and may have developed self-sustaining naturalized populations in these communities. E. coli cells attached to periphyton, whether they are unique to these periphyton communities or not, can detach and contribute to fecal coliform numbers measured in coastal waters. This confounds the use of fecal coliforms as a reliable indicator of recent fecal contamination of recreational waters.

Sources:
Probable –
Potential – Sewage effluent (wastewater treatment plant; human waste), waterfowl (wildlife; non-anthropogenic), algae (non-anthropogenic)
Possible –

65 - Microbial Source Tracking Study for South Cypress Creek
Thomas B. Lawrence, P.E. (City of Memphis, Division of Public Works)
Purpose - The objective of this project was to be able to determine possible sources of fecal coliform levels found in South Cypress Creek, as well as to be able to try to quantify the impacts. By identifying the sources of the impacts, the City will work to achieve the goal of the Clean Water Act by addressing the specific sources where possible.

Results – Data indicated that there may be both diffuse sources of Avian fecal coliform (such as deposited areas that are washed into the creek at a slow rate), as well as direct discharges into the creek, providing the high numbers. The total human impact was fairly low. Thus, pet contributions may be more related to storm water runoff, rather than would be seen with the other major source types which may be related to direct contact with the creek water. For sources attributed to Wild Animals, the number of isolates was higher than all of the other sources in all fecal result groups, except for the "TNTC" group, where it was second to Avian.

Sources:
Probable – avian (secondary wildlife), wildlife (including birds),
Potential -
Possible - Non-specific source (human waste), domestic animals,

39 - LINKING ON-FARM DAIRY MANAGEMENT PRACTICES TOSTORM-FLOWFECAL COLIFORM LOADING FOR CALIFORNIA COASTALWATERSHEDS
David J. Lewis, E.R. Atwill, M.S. Lennox, L. Hou, B. Karle, and K.W. Tate
http://waterquality.ucanr.org/documents/Dairy_Management_Resources7451.pdf
Purpose - We have conducted a systems approach study of 10 coastal dairies and ranches to document fecal coliform concentration and loading to surface waters at the management decision unit scale. Water quality samples were collected on a storm event basis from loading units that included: manure management systems; gutters; storm drains; pastures; and corrals and lots.

Results – Fecal coliform load from units of concentrated animals and manure are significantly more than units such as pastures while storm flow amounts were significantly less. Fecal coliform concentrations demonstrate high variability both within and between loading units. Fecal coliform concentrations for pastures range from 206 to 2,288,888 cfu/100 ml and for lots from 1,933 to 166,105,000 cfu/100 ml.

Sources:
Probable - Manure Management Systems, Stockpiles, and lots (agriculture),
Potential – MS4 Infrastructure (human waste), pasture (land use)
Possible -

15 - Evaluation of Chemical, Molecular, and Traditional Markers of Fecal Contamination in an Effluent Dominated Urban Stream
R.M. Litton, J.H. Ahn, B. Sercu, P.A. Holden, D.L. Sedlak, and S.B. Grant
http://pubs.acs.org/doi/abs/10.1021/es101092g

Purpose - To perform a quantitative sanitary survey of the Middle Santa Ana River, in southern California, utilizing a variety of source tracking tools, including traditional culture-dependent fecal markers, speciation of enterococci isolates, culture-independent fecal markers, and chemical markers of sewage and wastewater

Results - The results support the notion that regrowth of fecal indicator bacteria (FIB) in river sediments may lead to a decoupling between FIB and pathogen concentrations in the water column and thus limit the utility of FIB as an indicator of recreational waterborne illness in inland waters.

Sources:
Probable - in-situ growth in streambed sediments
Potential - effluent stream tributary to Santa Ana River, tributary to RW (Riverside WWTP plant stream tributary to Santa Ana River
Possible - Riverside WWTP & discharge pipe

128 - Snapshot investigation of likely contaminant sources in the Tilligerry Estuary catchment (Zones 5A and 5B)
S.A. Lucas, P.M. Geary, P.J. Coombes, and R.H. Dunstan
http://scholar.googleusercontent.com/scholar?q=cache:F75WyRF5YdUJ:scholar.google.com/&hl=en&num=100&as_sdt=0,5&as_vis=1
Purpose - a) To provide a “snapshot” of water quality in major surface waters draining to the estuary and within the estuary after a particularly wet period. The samples were analysed for nutrients (orthophosphate and nitrate), total coliforms, faecal coliforms, E.Coli, faecal streptococci and faecal sterols and; b) To interpret the most likely sources of faecal contamination from the data obtained as elevated faecal coliform concentrations had been recorded after significant rainfall in the past.

Results - However, the high microbial concentrations observed in major surface drains on the western and eastern side of the estuary also warrant further investigation, however it is clear that the majority of faecal contamination in the estuary is from agricultural land uses. A management program to control and mitigate runoff sources from agricultural lands in the catchment is therefore seen as an integral part of any plan to reduce faecal contamination in Tilligerry estuary.

Sources:
Probable –Human Waste (Non-specific source), Herbivores (Secondary Wildlife)
Potential -
Possible -

62 - Bacteriological methods for distinguishing between human and animal faecal pollution of water: results of fieldwork in Nigeria and Zimbabwe
D. Duncan Mara and J. Oragui
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2536379/pdf/bullwho00087-0144.pdf

Purpose - Recently, methods have been developed to distinguish between human and animal faecal pollution in temperate climates. The present study assessed the applicability and practicality of these methods in tropical countries.

Results - Ruminant and human fecal sources threaten the shellfish harvest.

Sources:
Probable –domestic animals,
Potential - Non-specific source (human waste), Non-specific source (anthropogenic non-human source),
Possible -

207 - Identifying sources of fecal contamination inexpensively with targeted sampling and bacterial source tracking
J.L. McDonald, P.G. Hartel, L.C. Gentit, C.N. Belcher, K.W. Gates, K. Rodgers, J.A. Fisher, K.A. Smith, and K.A. Payne
http://www.water.rutgers.edu/Source_Tracking/Enterococcus/IdentifyingSourcesofFecalContaminationInexpensivelywithTargetedSamplingandBacterialSource.pdf
Purpose - Our objective was to identify the sources of fecal contamination inexpensively at St. Andrews Park and Sea Island during calm and stormy weather conditions using targeted sampling and two or more BST methods: Enterococcus speciation, the detection of the esp gene, and fluorometry.

Results - Targeted sampling, when combined with two or more of three BST methods-enterococcal speciation, detection of the esp gene, and fluorometry--was able to identify sources of fecal contamination quickly, easily, and inexpensively.

Sources:
Probable – Wildlife (Birds)
Potential -
Possible –Human Waste (Non-specific source), Sewage infrastructure (leaking sewer lines), Unspecified wildlife

26 - Application of Bacteroides fragilis Phage as an Alternative Indicator of Sewage Pollution in Tampa Bay, Florida
Molly R. McLaughlin, and J.B. Rose
http://www.springerlink.com/content/922l116k3286u5p3/fulltext.pdf
Purpose - The use of bacteriophages were evaluated in the drainage basins of Tampa Bay

Results – In this study, the phages that infect B. fragilis host RYC2056 (RYC), including phage B56-3, and host ATCC 51477-HSP40 (HSP), including the human specific phage B40-8, were evaluated in the drainage basins of Tampa Bay, 7 samples (n=62), or 11%,
tested positive for the presence of phages infecting the host HSP, whereas 28 samples, or 45%, tested positive using the host RYC.

Sources:
Probable – Septic (sewage infrastructure),
Potential -
Possible -

4 - PB Point Bacterial Source Investigation Final Data Report
MEC- Weston and City of San Diego
Purpose - The goal of this study was to use molecular and standard bacterial indicator techniques to assess the host origin of the bacteria found in the receiving waters at PB point.

Results - The results of the PCR analysis are also presented in Table 2. Of the ten receiving water samples collected (not including duplicates), four (75-R on 8/15, 75R on 8/18, 75-L on 8/18 and 75-R on 8/20) were positive for the general PCR marker (GB), suggesting the presence of fecal material. Among the four samples that tested positive for the general marker, two were positive for at least one of the human-specific markers (75-L on 8/18 and 75-R on 8/20), which suggests the presence of bacteria from human origin.

Although the values for the bacterial indicators from all of the storm drain samples were high, only one (not including duplicates) of the five storm drain samples was positive for the general PCR marker (SD-0 on 8/15). None of the storm drain samples were positive for either of the two human markers.

Sources:
Probable –
Potential – Non-specific source (human waste)
Possible -

55 - MISSION BAY - Clean Beaches Initiative Bacterial Source Identification Study
MEC- Weston and City of San Diego
Purpose - The overall goal of this study was to identify the sources of bacterial contamination to Mission Bay.

Results -Results from both MST methods utilized in Phase II confirmed that the large majority of the enteric bacteria in Mission Bay originates from birds and contributions from human sources are insignificant

Sources:
Probable – Avian (secondary wildlife),
Potential –Dogs, over-irrigation, MS4 Infrastructure (delta sediment at storm drain outlet)
Possible - park restrooms and RV pump stations (human waste), boats and homeless(mobile sources), groundwater (non-anthropogenic), marine mammals, bay sediment

105 - Temporal and Spatial Variability of Fecal Indicator Bacteria: Implications for the Application of MST Methodologies to Differentiate Sources of Fecal Contamination
Marirosa Molina
http://www.environmental-center.com/Files%5C7698%5Carticles%5C5788%5CMolina20600.pdf
Purpose - Identify and compare the temporal and spatial variability of fecal indicator bacteria from a specific host in manure and water samples and evaluate the implications of such variability on microbial source tracking approaches and applications.

Results - Building an enterococci library is a time-consuming, expensive approach that has the potential to provide a great deal of information when the proper statistical analytical approach (in this case it was cluster analysis) is used to interpret the results. Application of a library-independent approach, such as the Bacteroides markers allows for a much faster and possibly less expensive results, but there remains a lack of thorough temporal, spatial and specificity analyses of the few genetic markers available so far.

Sources:
Probable – Cattle (domestic animals; anthropogenic non-human sources)
Potential –
Possible –

38 - Bacteria Monitoring and Source Tracking in Corpus Christi Bay at Cole and Ropes Parks
Joanna Mott, M. Lindsey, R. Sealy, and A. Smith
http://www.cbbep.org/publications/virtuallibrary/1010.pdf
Purpose - In this study water samples from the six Texas Beach Watch stations at Ropes and Cole Parks were analyzed to detect the esp marker as an indicator of human contamination at these locations. Additionally, data on three other human-specific markers--Bacteroidales, Human 2 Polyoma Viruses (HPyVs), and ethanobrevibacter.smithii—from another study, are included in this report for comparison with the esp analysis results.

Results - Human source contamination was detected at Ropes and Cole Park stations under ambient weather conditions as measured by several human-specific markers. The esp gene was detected when levels of enterococci at Ropes Park were higher following rainfall and suggest a human contribution at this location presumably either from storm drain outflow or non-point source run-off. For Ropes and Cole Parks, a broader bacteria source tracking project is recommended to examine not only human, but other sources of contamination.

Sources:
Probable – Non-specific source (human waste),
Potential -
Possible – MS4 Infrastructure (human waste),

72 - Bacteria Source Tracking on the Mission and Aransas Rivers
Joanna Mott, R. Lehman, Ph.D. and A. Smith
Purpose - In this study, bacteria source tracking (BST) was used to evaluate the sources of fecal contamination in the Mission and Aransas River segments and to provide additional data for assessment of sources of contamination into Copano Bay, the water body into which both segments empty.

Results - The majority of unknown source isolates collected from water samples at the five sampling stations along the Mission and Aransas tidal segments were classified as human source. Overall, 63.7-66.9% of unknown source isolate profiles from the composite (ARA+CSU) dataset were classified as treated human sources (originating from treated wastewater effluent). The remaining unknown source isolates were classified as livestock animals and wildlife, with cow, horse and duck contributions accounting for the majority of the animal sources in both the composite dataset and PFGE profiles.

Sources:
Probable – Wastewater treatment plant, cows, horses, ducks
Potential –
Possible – Gulls (secondary wildlife), hogs

41 - Multi-scale landscape factors influencing stream water quality in the state of Oregon
Maliha S. Nash, D.T. Heggem, D. Ebert, T.G. Wade, and R.K. Hall
http://www.springerlink.com/content/y17u3uh60155w313/fulltext.pdf
Purpose - This study used the State of Oregon surface water data to determine the likelihood of animal pathogen presence using enterococci and analyzed the spatial distribution and relationship of biotic (enterococci) and biotic (nitrogen and phosphorous) surface water constituents to landscape metrics and others (e.g. human use, percent riparian cover, natural covers, grazing, etc.).

Results – Landscape metrics related to amount of agriculture, wetlands and urban all contributed to increasing nutrients in surface water but at different scales. The probability of having sites with concentrations of enterococci above the threshold was much lower in areas of natural land cover and much higher in areas with higher urban land use within 60 m of stream. A 1% increase in natural land cover was associated with a 12% decrease in the predicted odds of having a site exceeding the threshold. Opposite to natural land cover, a one unit change in each of manmade barren and urban land use led to an increase of the likelihood of exceeding the threshold by 73%, and 11%, respectively. Change in urban land use had a higher influence on the likelihood of a site exceeding the threshold than that of natural land cover.

Sources:
Probable - Urbanized land use
Potential -
Possible – Agriculture

66 - Coastal Nonpoint Source Pollution Monitoring Program
New Jersey Department of Environmental Protection
Purpose - To identify the causes of the degrading water quality in the upper Navesink River. Perform stormwater monitoring to delineate major sources of fecal contamination. Utilize specialize tests, including coliphage and Multiple Antibiotic Resistance (MAR) analyses, to identify the sources of contamination (i.e., human, domestic animal, and wildlife). Once identified, actions can be recommended and taken to eliminate or reduce the impact.

Results – Results for Microbial Source Tracking indicators (F+RNA coliphage and Multiple Antibiotic Resistance) suggest a human source of fecal contamination at sites. Sites were identified as 'hot spots' for further source investigations.

Sources:
Probable - Non-specific source (human waste),wildlife
Potential – Domestic animals,
Possible -

1 - Multi-tiered Approach Using Quantitative Polymerase Chain Reaction for Tracking Source of Fecal Pollution to Santa Monica Bay, Ca, February 2005
Rachel T. Noble, J.F. Griffith, A.D. Blackwood, J.A. Fuhrman, J.B. Gregory, X. Hernandez, X. Liang, A.A. Bera, and K. Schiff
ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/AnnualReports/2005_06AnnualReport/AR0506_181-194.pdf
Purpose - The objective of this study was to identify the contribution and quantify the loading of fecal contamination to the SMB using a multi-tiered approach. No discussion on what fecal source types (agriculture, birds, dogs) are impacting Santa Monica Bay

Results - Measurements of Bacteroides sp. and enterovirus indicated the presence of human fecal contamination throughout the system. Bacteroides sp. was present in 33% of mainstem samples. Enterovirus was present in 44% of mainstem samples. The concordance among these measurements was nearly complete; almost every location that detected Bacteroides sp. was also positive for enterovirus.

Sources:
Probable - Non-specific Source (human waste)
Potential -
Possible-

108 - Use of Fecal Steroids to Infer the Sources of Fecal Indicator Bacteria in the Lower Santa Ana River Watershed, California: Sewage Is Unlikely a Significant Source
James A. Noblet, D.L. Young, E.Y. Zeng and S. Ensari
ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/444_fecal_steroids.pdf
Purpose - Utilize a suite of fecal steroids, as chemical markers to examine whether sewage was a significant source of FIB within the lower Santa Ana River watershed.

Results - The results implied that sewage was not a significant source of fecal steroids, and therefore perhaps FIB to the study area. Instead, birds may be one possible source of the intermittently high levels of FIB observed in the lower Santa Ana River watershed and the nearby surf zone.

Sources:
Probable –
Potential – Gulls (secondary wildlife; anthropogenic non-human sources)
Possible – Sewage infrastructure (human waste), dogs (domestic animals; anthropogenic non-human sources)

109 - Fecal source tracking by antibiotic resistance analysis on a watershed exhibiting low resistance
Yolanda Olivas, and B.R. Faulkner
http://www.springerlink.com/content/k02q5v6748702773/fulltext.pdf
Purpose - To test the efficiency of the antibiotic resistance analysis (ARA) method under low resistance by tracking the fecal sources at Turkey Creek, Oklahoma exhibiting this condition.

Results - The original seasonal and annual DA of the stream sources showed no significant difference between human and livestock input rates in winter, spring and summer ($0.56 \le P \le 0.76$). Deer was consistently lower than the other two sources ($0.00 \le P \le 0.30$). In fall, the human source predominated over livestock and deer ($P<0.0001$). Revision of the original DA using the rates of misclassification, decreased classification into the human and deer sources by 6–7% ($0.22 \le P \le 0.33$), and increased classification into livestock by 13–14% ($0.04 \le P \le 0.06$), showing the significance of the original DA misclassification. In conclusion, the major effect of low antibiotic resistance to this ARA work was a significant level of negative misclassification into the livestock source.

Sources:
Probable – Non-specific source (human waste), livestock (domestic animals; anthropogenic non-human sources)
Potential – Deer (wildlife; non-anthropogenic)
Possible –

143 - Investigation of Faecal Pollution and Occurrence of Antibiotic Resistant Bacteria in the Mooi River System as a Function of a Changed Environment
M.J. Pantshwa, A.M. van der Walt, S.S. Cilliers, and C.C. Bezuidenhout
http://www.ewisa.co.za/literature/files/2008_137.pdf
Purpose - Water quality monitoring and assessments are of paramount importance to identify the river confluence vulnerable to the pollution impacts of urbanization. Investigate some physico-chemical parameters, levels of faecal pollution and occurrence of antibiotic resistant bacteria in the Mooi River system as a function of a changed environment.

Results - Non-human sources contributed greater towards faecal pollution. Urban gradient was recognized in terms of faecal indicator species distribution. Higher levels of antibiotic resistant bacteria were detected in urban sites when compared to lower upstream and elevated downstream levels.

75 - Middle Rio Grande Microbial Source Tracking Assessment Report
Parsons Water & Infrastructure Inc.
Purpose - The objective of this project was to identify specific sources of fecal coliform causing high levels of bacteria in the Middle Rio Grande.

Results - Overall, ribotyping results show, the largest fraction of E. coli matched those found in avian sources, followed by canine, human/sewage, rodents, bovine, and equine. The source of approximately 9 percent of the E. coli could not be identified. With the exception of rodents, only a few species of wild mammals were identified as sources of fecal coliform found in water: deer or elk, raccoon, coyote, bear, and opossum. It should be noted that an unknown fraction of the canine isolates may be from coyotes and foxes, as many E. coli strains are resident both in domestic dogs and wild canines.

Sources:
Probable – Cats, dogs, birds (wildlife)
Potential – Non-specific source (human waste), livestock, rodents (secondary wildlife), Wildlife (deer or elk, raccoon, coyote, bear, and opossum)
Possible –

125 - Bacterial Contamination and Antibiotic Resistance in Fecal Coliforms from Glacial Water Runoff
S.P. Pathak, and K. Gopal
http://www.springerlink.com/content/fup31h3742514123/fulltext.pdf
Purpose - Assess the bacteriological contamination in glacial water runoff from the Gangotri glacier and Gangetic river system (Gaumukh to Rishikesh) by enumerating aerobic heterotrophs, coliforms, fecal coliforms and fecal streptococci. Antibiotic resistance among the fecal coliforms, identified as E. coli, was also studied.

Results - Contamination of coliform was observed in all samples, while fecal coliform and fecal streptococci were detected in 17 and 18 samples, respectively (Fig. 2). Thus, bacteriological analysis exhibited maximum contamination in most of the water samples from post-Gangotri and Gangetic stations. The observed increase in the proportion of coliforms and fecal coliforms was statistically significant ($p < 0.001$). The counts of fecal streptococci in all study stretches were too low for statistical comparison.

129 - Fecal BMAP Implementation: Identification of Probable Sources in the Butcher Pen Creek Watershed
PBS&J
http://publicfiles.dep.state.fl.us/dear/BMAP/LowerStJohns/Tributaries%20Fecal%20Coliform%20BMAPs/Technical_Reports/ButcherPen/Final%20Draft%20Butcher%20Pen%20WBID%202322%20Tech%20Report%20041008.pdf
Purpose - FDEP has verified 54 tributaries of the Lower St. Johns River—located throughout Duval County and in small portions of Clay and St. Johns Counties—as impaired for fecal coliform, and TMDLs must be developed for these waterbodies. Local stakeholders in the Lower St. Johns Basin, in conjunction with FDEP, are currently working to develop a Basin Management Action Plan (BMAP) to implement the TMDLs for fecal coliform.

Results - Elevated levels of fecal coliforms following rainfall may be an indication that unidentified pollution sources (e.g., leaking wastewater conveyance systems) are being transported by stormwater into Butcher Pen Creek. This evaluation indicates that the probable sources of fecal contamination in the Butcher Pen Creek WBID are human-related. Although Butcher Pen Creek does not have a designated septic tank phase-out area, some areas of the basin have likely had OSTDS failures, as indicated by the existence of septic tank repair permit applications, especially in the northeast corners of the watershed. Therefore, it is likely that there still remain isolated and problematic septic systems that are contaminating the neighboring surface waters.

Sources:
Probable – Sewage infrastructure (SSO events),
Potential – Wastewater discharge
Possible –

34 - Origin and spatial–temporal distribution of faecal bacteria in a bay of Lake Geneva, Switzerland
John Poté, N. Goldscheider, L. Haller, J. Zopfi, F. Khajehnouri, and W. Wildi
http://doc.rero.ch/lm.php?url=1000,43,4,20100511154847-XI/Pot_John_-_Origin_and_spatial-temporal_distribution_of_faecal_bacteria_20100511.pdf
Purpose - To quantify the input flux rates of faecal bacteria from the main contamination sources and to assess their spatial and temporal distribution in the bay, in order to estimate the human health risk related to recreational activities and drinking water use.

Results - The highest FIB concentrations in the near-surface water of the bay consequently occur during floods and mixed lake conditions. Although the thermocline protects the epilimnion from contamination in summer, effluent water may spread in the hypolimnion and reach the drinking-water pumping station 3.8 km further to the west.

Sources:
Probable – Wastewater Treatment Plant
Potential –
Possible –

110 - Classification Tree Method for Bacterial Source Tracking with Antibiotic Resistance Analysis Data
Bertram Price, E.A. Venso, M.F. Frana, J. Greenberg, A. Ware, and L. Currey
http://aem.asm.org/content/72/5/3468.full.pdf+html
Purpose - Apply the statistical method known as classification trees to build a model for BST for the Anacostia Watershed in Maryland.

Results - Applying the tree classification model to the 1,565 Anacostia River water isolates yielded the following distribution of sources: 468 (29.9%) pet, 222 (14.2%) human, 437 (27.9%) livestock, and 438 (28.0%) wildlife. These results were determined from analysis of all the water isolates, which represent six monitoring stations with samples collected monthly for 1 year. Therefore, the source distribution presented here does not account for the distribution of high-flow and low-flow periods, which may contribute different sources to the streams. Also, note that bacterial sources can be site specific in a watershed, given the non-conservative nature of bacterial transport. For the purpose of this analysis, all the water isolates from the six monitoring stations were used to estimate the overall watershed relative source contributions. The results based on this averaging method indicate that humans contribute the least bacterial contamination to the Anacostia River. The other sources of bacterial contamination are evenly distributed among pet animals, livestock, and wildlife.

Sources:
Probable – Pets and livestock (domestic animals; anthropogenic non-human sources), wildlife (non-anthropogenic)
Potential – Non-specific sources (human waste)
Possible –

113 - Quantitative microbial faecal source tracking with sampling guided by hydrological catchment dynamics
G. H. Reischer, J.M. Haider, R. Sommer, H. Stadler, K.M. Keiblinger, R. Hornek, W. Zerobin, R.L. Mach, and A.H. Farnleitner
http://onlinelibrary.wiley.com/doi/10.1111/j.1462-2920.2008.01682.x/pdf
Purpose - Apply modern quantitative microbial source tracking methods on a large and complex karstic spring catchment in context with hydrology and other water quality parameters over a prolonged period of time in order to comprehensively, qualitatively and quantitatively characterize the pollution sources.

Results - 1) Established and evaluated a new sampling concept with consideration for the whole seasonal hydrological catchment variability and special emphasis on strong pollution events.
2) Demonstrated the ability of quantitative microbial source tracking studies to quantitatively link source-specific marker levels to general faecal pollution indicators in order to estimate the contribution of one source group to total faecal pollution as measured in conventional faecal monitoring.

3) Showed that the thorough investigation of catchment hydrology and pollution dynamics is a prerequisite for successful quantitative microbial source tracking study design.

Sources:
Probable – Ruminant (wildlife; non-anthropogenic)
Potential – Non-specific sources (human waste)
Possible – Soil/Sediment/Sand

133 - Assessment of Sources of Bacterial Contamination At Santa Cruz County Beaches
John Ricker and S. Peters
ftp://ftpdpla.water.ca.gov/users/prop50/10045_SantaCruz/Work%20Plan%20CD%2004/reference%20plans%20and%20background%20information/Sources%20of%20Contamination%20at%20SCC%20Beaches%202005.pdf
Purpose - Determine the source and health threat of elevated bacteria levels at Santa Cruz County beaches

Results - The most significant source of beach contamination in Santa Cruz County is discharge from the creeks, with a high urban runoff component during both wet and dry weather. 22 point plan to be implemented to improve water quality

Sources:
Probable – Non-specific sources (human waste), Sewage infrastructure (storm drains), Domestic animals (dogs), Secondary wildlife (birds), Wildlife (rats)
Potential –
Possible –

42 - Bacterial Source Tracking Pilot Study DNA Fingerprinting, Human Bacteroidetes ID and Human Enterococci ID
Rogue Valley Council of Governments
Natural Resources Department
Purpose - The purpose of the pilot study was 1) to determine whether bacteria found in local streams is from human or animal sources and 2) to evaluate different BST methodology for future use within the Rogue Valley.

Results - DNA Fingerprinting results show that animal fecal matter is present, but were inconclusive in identifying whether human contamination was present. Many of the analyzed colonies could not be matched to animal or human sources. However, based on the isolates identified, animals are the primary contributor of bacteria to Ashland Creek, Baby Bear, and Griffin Creek (31 of 50).

Sources:
Probable - Domestic animals, wildlife,
Potential -
Possible – Non-specific source (human waste)

7 - Microbiological Water Quality at Reference Beaches in Southern California During Wet Weather

Kenneth Schiff, J. Griffith, and G. Lyon

http://www.sccwrp.org:8060/pub/download/DOCUMENTS/TechnicalReports/448_reference_beach.pdf

Purpose - The contribution of non-human sources of bacteria was quantified at coastal reference beaches in southern California. Provides an overview of sampling methods and analytical results for reference beaches are discussed. Bacteria sources were not identified

Results – Based on the results from this study, natural contributions of nonhuman fecal indicator bacteria were sufficient to generate exceedances of the State of California water quality thresholds during wet weather. Total coliform, E. coli, and enterococcus samples collected during wet weather exceeded water quality thresholds greater than 10 times more frequently during wet weather than during recent dry weather in summer or winter, although the frequency differed by beach. San Onofre State Beach had the greatest concentrations of bacteria and the greatest frequency of water quality threshold exceedances. This may have been the result of several factors that we cannot disentangle. First, San Onofre Creek was the largest watershed we sampled, which may have led to a greater number of nonhuman sources of fecal indicator bacteria upstream. Second, San Onofre Creek had the largest and most mature lagoon of any site sampled, which was located at the beach interface and may have attracted nonhuman fecal sources(i.e. birds). Third, San Onofre Creek was the only discharge where we found human enteric virus. The San Onofre Creek watershed had the greatest fraction of developed land use (3%) of any of the other watershed systems and human activities are known to occur in the lower part of this watershed.

Sources:
Probable – Non-specific source (anthropogenic)
Potential – Non-specific source (human waste)
Possible –

221 - Presence of Bacteroidales as a Predictor of Pathogens in Surface Waters of the Central California Coast

A. Schriewer, W.A. Miller, B.A. Byrne, M.A. Miller, S. Oates, P.A. Conrad,, D. Hardin, H.H. Yang, N. Chouicha, A. Melli, D. Jessup, C. Dominik, and S. Wuertz

http://ukpmc.ac.uk/articles/PMC2935056

Purpose - Evaluate the value of Bacteroidales genetic markers and fecal indicator bacteria (FIB) to predict the occurrence of waterborne pathogens in ambient waters along the central California coast.

Results - The ability to predict pathogen occurrence in relation to indicator threshold cutoff levels was evaluated using a weighted measure that showed the universal Bacteroidales genetic marker to have a comparable or higher mean predictive potential than standard FIB. This predictive ability, in addition to the Bacteroidales assays providing information on contributing host fecal sources, supports using Bacteroidales assays in water quality monitoring programs.

77 - Tracking Sources of Fecal Pollution in a South Carolina Watershed by Ribotyping Escherichia coli: A Case Study

Troy M. Scott, J. Caren, G.R. Nelson, T.M. Jenkins, and J. Lukasik

http://sourcemolecular.com/pdfs/scott3.pdf

Purpose - To describe the effective use of the ribotyping microbial source tracking procedure to determine the source(s) of Escherichia coli within a South Carolina watershed.

Results - Prior to investigating potential fecal inputs into this watershed, a significant human source was suspected as the primary input; however, of the 515 E. coli isolated from water samples collected during the course of this study, 88% were typed as being of animal fecal origin. Thus, this study was integral in the realization that animals may be a significant source of contamination and that remediation efforts should be redirected to accommodate these findings. Of the 454 animal isolates analyzed, 51 RT profiles were directly matched from a specific animal source. Of these, 22 (43%) were classified as coming from deer feces and 9 (18%) directly matched those generated from dog feces.

Sources:
Probable – Wildlife (deer, raccoons, birds and pelicans),
Potential – Non-specific source (human waste), cats and dogs, gulls (secondary wildlife)
Possible –

19 - Sewage Exfiltration As a Source of Storm Drain Contamination during Dry Weather in Urban Watersheds

Bram Sercu

http://pubs.acs.org/doi/abs/10.1021/es200981k

Purpose - To determine whether transmission of sewage is occurring from leaking sanitary sewers directly to leaking separated storm drains, field experiments were performed in three watersheds in Santa Barbara, CA.

Results – Above-background RWT peaks were detected in storm drains in high-risk areas, and multiple locations of sewage contamination were found. Sewage contamination during the field studies was confirmed using the human-specific Bacteroidales HF183 and Methanobrevibacter smithii nifH DNA markers. This study is the first to provide direct evidence that leaking sanitary sewers can directly contaminate nearby leaking storm drains with untreated sewage during dry weather and suggests that chronic sanitary sewer leakage contributes to downstream fecal contamination of coastal beaches.

Sources:
Probable -
Potential -
Possible -

6 - Storm Drains are Sources of Human Fecal Pollution during Dry Weather in Three Urban Southern California Watersheds
Bram Sercu, L.C. Van de Werehorst, J. Murray, and P.A. Holden
http://www.santabarbaraca.gov/NR/rdonlyres/C3B1ADAE-37E8-4F89-8F2D-1A24FBAB8D6A/0/Sercuetal_ESnT_2009_v43p2938SI.pdf
Purpose - Dry weather bacteria monitoring in urbanized Santa Barbara, CA watersheds

Results - Of the 80 water samples analyzed within the Malibu watershed, five samples were positive for the human-specific HF183 Bacteroidales marker (HBM).The highest percent exceedance of FIB and HBM concentrations were measured during wet weather. During the study, 93.8% of the samples did not have detectable concentrations of HBM. These data do not rule out any particular potential sources of human fecal contamination.

Sources:
Probable -
Potential - Sewage infrastructure, non-stormwater discharges, MS4 infrastructure (less likely – human waste), MS4 infrastructure (anthropogenic non-human sources)
Possible -

116 - Identification of human fecal pollution sources in a coastal area: a case study at Oostende (Belgium)
Sylvie Seurinck, M. Verdievel, W. Verstraete, and S.D. Siciliano
http://www.iwaponline.com/jwh/004/0167/0040167.pdf
Purpose - Identify fecal pollution sources in the North Sea and produce a model required to predict fecal pollution

Results - The canal Gent-Oostende, the Dode Kreek and Gauwelozekreek, the Voorhaven, and the Montgommerydok contained high levels of the indicator bacteria. The European E. coli standard (5 £ 102/ 100 ml) suggested in the revised draft Bathing Water Directive (Council of the European Communities 2000) was exceeded most of the time at these sites. The human specific Bacteroides marker was detected in almost all water samples from these sites, which indicates that they are regularly contaminated with human fecal pollution. The river Noordede, the Visserijdok and the beach water at 2 sites were only lightly contaminated based on the European E. coli standard. At these sampling sites the human-specific Bacteroides marker was less frequently detected and in lower amounts, except at one locations where high concentrations of 107 human-specific Bacteroides marker per l were recorded at the beginning of the sampling survey and at the end. The detection of indicator organisms and the human specific Bacteroides marker was strongly related to rainfall for this coastal area.

Sources:
Probable – Non-specific sources (human waste)
Potential –Wildlife (non-anthropogenic)
Possible –

11 - Regrowth of Enterococci & Fecal Coliform in Biofilm. Printed in The Journal for Surface Water

John F. Skinner, J. Guzman, and J. Kappeler

Purpose - The goal of the study was to determine the sources of high numbers of enterococci and fecal coliform found in street gutter runoff flowing from residential areas to the Dover Drive storm drain in Newport Beach, Orange County

Results – Bacteria counts in runoff from washing the sidewalk using bacteria-free hose water were 220 enterococci/100 ml and 180 fecal coliform/100 ml. Washoff water from the driveway by manually flooding a residential front lawn was 160 enterococci/100 ml and 9 fecal coliform/100 ml. Runoff from flooding the grass contained 1,250 enterococci/100 ml and 2,000 fecal coliform/100 ml. Water draining directly into the gutter through a hole cut through the curb grew out 70 enterococci/100 ml and 100 fecal coliform/100 ml.

Bacteria-free hose water was introduced into a dry street gutter and tested for enterococci and fecal coliform at 10 meters, 45 meters, and 100 meters downstream when the flow from the hose water reached those locations. There was a progressive rise of both enterococci and fecal coliform bacteria with the increased distance of flow. The levels of fecal indicator bacteria were 26,000 enterococci/100 ml and 14,000 fecal coliform/100 ml when the water reached the 100-meter test site, the last testing station. The source of these high numbers of bacteria is suspected to be coming from regrowth in the street gutters.

The findings of these studies provide evidence that regrowth of both enterococci and fecal coliform bacteria are occurring in biofilm located in residential street gutters and storm drains in Newport Beach.

Sources:
Probable - Street gutter biofilm regrowth (MS4 infrastructure)
Potential – Dog excrement (not tested), lawn irrigation runoff, sidewalk and driveway runoff (Solid/liquid waste), residential washwater, residential lawn runoff
Possible - Residential backyard and side yard patios, roof gutter drains but not tested

49 - F+ RNA Coliphages as Source Tracking Viral Indicators of Fecal Contamination

Dr. Mark D. Sobsey, D.C. Love, and G.L. Lovelace

http://webmail.ciceet.unh.edu/news/releases/springReports07/pdf/sobsey.pdf

Purpose - To evaluate and apply novel, cost-effective technologies and methods for the detection, quantification and identification of sources of microbial contaminants and the characterization of those sources as human or nonhuman.

Results - Microbial indicator concentrations in water and shellfish were higher at sites with greater wastewater treatment plant discharges. Of the 9 estuaries in the study, 4 were impacted by point source discharges of waste water treatment plant (WWTP) effluent. Human point source pollution in this study was primarily from waste water treatment plant (WWTP) treated effluent and possibly raw sewage leaks, while likely human non-point sources included urban runoff, seepage from septic tanks, and boat dumping. Sites with non-human non-point fecal waste contained populations of wildfowl (goose, duck, gull), wild horses, other feral animals, agricultural animals, a dog park and urban pet waste. At 4 estuaries the impacted sites included human point and non-point sources, while the non-impacted sites were pristine sites with wildlife refuges or were geographically separated from human populations. In the Tijuana River Reserve in Southern CA human impacts were documented at all study sites, so in the absence of a truly pristine or non-impacted site, a site with only non-point source runoff from human development was compared to a more contaminated site at the mouth of the Tijuana River containing untreated sewage from Mexico.

Sources:
Probable -
Potential – Sewage infrastructure, Urban runoff (MS4 infrastructure - human waste; suspected to potential)
Possible -

45 - Faecal sterols analysis for the identification of human faecal pollution in a non-sewered catchment.
D. Sullivan, P. Brooks, N. Tindale, S. Chapman, and Ahmed, W.
http://publicationslist.org/data/w.ahmed/ref-14/Daryle_s%20article_%20WST_revised%20version.pdf
Purpose - To identify human faecal pollution in a non-sewered catchment using faecal sterols.

Results - In this study, faecal sterol analysis was used to identify the presence of human sourced faecal pollution or others (non-point sources) in two adjacent creeks of North Maroochy Catchment. It appears that stanols concentrations generally increased with increased catchment runoff. After moderate rainfall, high coprostanols levels found in water samples indicated human faecal pollution and defective septic systems are the most likely sources of pollution. The human signal was traced on one occasion to a defective septic system. In contrast, it appears that during dry weather human faecal pollution is not occurring in the study catchment.

Sources:
Probable – Septic (sewage infrastructure),
Potential –
Possible -

124 - Ecological Control of Fecal Indicator Bacteria in an Urban Stream
Cristiane Q. Surbeck, S.C. Jiang, and S.B. Grant
http://lshs.tamu.edu/docs/lshs/end-notes/ecological%20control%20of%20fecal%20indicator%20bacteria%20in%20an%20urban%20stream-1429959691/ecological%20control%20of%20fecal%20indicator%20bacteria%20in%20an%20urban%20stream.pdf

Purpose - Determine the source(s) of elevated FIB concentrations in Cucamonga Creek, a concrete-lined urban stream in southern California. Flow in the creek consists primarily of treated and disinfected wastewater effluent, mixed with relatively smaller but variable flow of runoff from the surrounding urban landscape.

Results - Mass and volume balance calculations indicate that treated wastewater is not a significant source of FIB to Cucamonga Creek. Runoff from the urban landscape appears to be the primary source of FIB loading to Cucamonga Creek during both dry weather and wet weather periods. Observations from the study imply that DOC and FIB concentrations in runoff should co-vary, which is indeed the case both at Cucamonga Creek and in many agricultural and urban streams along the California coast. These results are not consistent with the hypothesis that FIB are static contaminants (like sediments or nutrients) with well-defined and land-use-specific export coefficients, as has been suggested for catchments in the United Kingdom. Rather, our data suggest that nonpoint source FIB impairments in southern California are best viewed as an ecological phenomenon, in which a dynamic balance between FIB sources, nutrient availability, competition with other heterotrophic bacteria, and predator prevalence determines the magnitude and extent of FIB pollution and its human health implications.

Sources:
Probable – Non-specific Source (Human Waste), Domestic animals (dogs), Secondary Wildlife (birds)
Potential –
Possible -

50 - B Street/Broadway Piers, Downtown Anchorage, and Switzer Creek Storm Drain Characterization Study
Tetra Tech, City of San Diego
Purpose - To further characterize the City's storm drain system discharges during both wet and dry weather. This monitoring program evaluated the potential sources of the pollutants-of-concern (POCs) throughout the MS4 system and collected data to calibrate and validate preliminary wet weather runoff modeling efforts for the San Diego Bay TMDLs.

Results - Bacteria concentrations from residential land use site DBR01 are higher than commercial land use site DBC02. The differences in bacteria concentrations across land use sampling sites were compared using t-test or Mann- Whitney Rank Sum test if data do not meet normality test. The results suggested significant difference in concentrations between the two sampling sites for both events and for all three microbiological parameters. Higher concentrations were found at the residential site (DBR01) than the commercial land use site (DBC02).

Sources:
Probable – Residential (Land use)
Potential – Commercial (Land use)
Possible -

53 - Chollas Storm Drain Characterization Study
Tetra Tech, City of San Diego
Purpose - To further characterize the City's storm drain system discharges during both wet and dry weather. This monitoring program evaluated the potential sources of the pollutants-of-concern (POCs) throughout the MS4 system and collected data to calibrate and validate preliminary wet weather runoff modeling efforts for the San Diego Bay TMDLs.

Results - The measured enterococcus and coliform concentrations generally showed large variations. The enterococcus concentrations showed a number of exceedances of the basin action level at a number of sites including several commercial and industrial sites and two residential sites. Fecal coliform concentrations were generally below action levels, with a few industrial and residential sites showing some exceedances. Total coliform concentrations showed a large number of exceedances at seven out of the ten sampling sites. The difference in bacteria concentrations across land use sampling sites was compared based on median concentrations and using the Mann-Whitney Rank Sum test (Table 7-4). The results suggested significant difference in concentrations among the sampling sites for both events and for all three microbiological parameters. Higher concentrations were found at two commercial (CHC07 and CHC12), industrial (CHI08) and two residential sites (CHR03 and CHR04).

Sources:
Probable – Commercial/Industrial (anthropogenic non-human sources; potential to probable), Commercial and industrial (land use)
Potential – Residential (land use)
Possible -

9 - Using Microbial Source Tracking to Support TMDL Development and Implementation
Tetra Tech, Inc. and Herrera Environmental Consultants
Purpose - Provides an overview of Microbial Source Tracking (MST) and how it can be used to support TMDL development and implementation. The document covers potential uses of MST, descriptions of common MST methods, factors for selecting an MST method and designing an MST study, and examples of MST studies used to support TMDL development or implementation.

Results – ID Study: The Bacteroides PCR results generally supported the PFGE results that wildlife was the predominant source of fecal bacteria in the sampled streams. The genetic fingerprinting showed that greater than 10 percent of the total E. coli colonies isolated were from dogs, and cats were almost 20 percent. In addition, there were two days on lower Hauser Creek when Idaho's primary contact water quality criterion for E. coli was exceeded, during which dogs were the source of over 40 percent of the isolates. Horses and cattle each did not exceed 10 percent of the total E. coli isolates; however, horses were greater than 15 percent of the E. coli isolates. Although humans made up 11 percent of the total E. coli colonies isolated on Right Fork Hauser Creek, only one E. coli colony was isolated from water samples collected on days when the water quality criterion was exceeded.

OR: Results indicated widespread contamination from ruminants (non-elk) and, in certain river segments of the Trask, Miami, and Tillamook Rivers and Holden Creek, significant contamination from humans.

NM: Overall, ribotyping results show the largest fraction of E. coli matched those found in avian sources, followed by canine, human/sewage, rodents, bovine, and equine. The source of approximately 9 percent of the E. coli could not be identified.

VA: MST Results indicate majority of sources derive from wildlife and livestock, followed by humans, and then pets.

NH: Ribotyping identified source species for 76% (19/25) of the E. coli isolates in the water samples. The remaining isolates (24%) could not be matched with certainty to patterns in the ribopattern database. Of the identified isolates, geese constituted the largest portion (52%) followed by livestock [sheep (12%) and cows (4%) for a total of 16%] and dogs (8%).

MI: During dry conditions, the human biomarker was present at all sites, except one site. The results were always negative for the human biomarker, giving a strong indication that E. coli from human sources was not impacting this site during dry conditions. Positive results for the other sites suggest that there are dry-weather sources of E. coli of human origin. These human sources of E. coli could include cross-connections between the sanitary and storm sewer systems, illicit discharges to storm sewers, failed on-site sewage disposal systems, and leaking sanitary sewers.

SD: Among the isolates for which the source could be identified, 26% were equine (horse) and 30% were ovine (sheep). Other identified animal sources include porcine (pig), bovine (cow), canine (dog), feline (cat) and human. Based on review of available information and communication with state and local authorities, the primary nonpoint sources of fecal coliform within the Beaver Creek watershed include agricultural runoff, as well as wildlife and human sources. Septic systems are assumed to be the primary human source of bacteria loads to Beaver Creek. The HSPF model was used to determine the contribution of fecal coliform bacteria from identified sources in the Beaver Creek watershed and evaluate the implementation of BMPs to control these sources.

Sources:
Probable – Geese (NH), avian (NM)
Potential – Non-specific source (human waste – NM, OR), sewage infrastructure (MI), illegal connections, domestic animals (NH, ID, NM), agriculture (OR), secondary wildlife (ID)
Possible -

37 - Monitoring Report for Bacterial Source Tracking Segments 0806, 0841, and 0805 of the Trinity River Bacteria TMDL
Texas Institute for Applied Environmental Research (TIAER)
http://repositories1.lib.utexas.edu/bitstream/handle/2152/7038/crwr_onlinereport08-08.pdf?sequence=2

Purpose - This report includes information on study area, characteristics, materials and methods of bacterial source tracking, and results and findings of the source tracking study.

Results – Overall, each of the source contributors showed a definite trend, whether positive or negative, as one moves downstream from Segment 0806, through Segment 0841, and into Segment 0805. The categories did show consistencies in source species. The avian category was consistently dominated by non waterfowl species, while the livestock category's contribution was shared by bovine and horses. Mammalian wildlife was found to be high in rodent species and raccoons, while the pet category was found to be consistently led by dogs.

Sources:
Probable – Non-specific source (human waste – potential to probable)
Potential - Pets and livestock, avian and mammals (wildlife)
Possible -

149 - Assessment of the Origins of Microbiological Contamination of Groundwater at a Rural Watershed in Chile
Mariela Valenzuela, M.A. Mondaca, M. Claret, C. Perez, B. Lagos, and O. Parra
http://www.scielo.org.mx/pdf/agro/v43n4/v43n4a10.pdf
Purpose - To improve the state of knowledge on the microbiological quality of groundwater at a rural watershed. Characterize the microbiological quality of the groundwater and to identify sources of contamination.

Results - The main source of fecal contamination is of animal origin, a diffuse one. Concentrations of bacterial indicators have a temporal basis showing variable levels among seasons, with a higher concentration in the rainy one. All 42 wells analyzed contained opportunistic pathogens.

167 - Bacterial pathogens in Hawaiian coastal streams-Associations with fecal indicators, land cover, and water quality
E.J. Viau, K.D. Goodwin, K.M. Yamahara, B.A. Layton, L.M. Sassoubre, S.L. Burns, H.I. Tong, S.H. Wong, and A.B. Boehm
http://www.sciencedirect.com/science/article/pii/S0043135411001448
Purpose - To understand the distribution of five bacterial pathogens in O'ahu coastal streams and relate their presence to microbial indicator concentrations, land cover of the surrounding watersheds, and physical-chemical measures of stream water quality.

Results - Results implicate streams as a source of pathogens to coastal waters. Future work is recommended to determine infectious risks of recreational waterborne illness related to O'ahu stream exposures and to mitigate these risks through control of land-based runoff sources.

146 - EFFECTS OF RUNOFF CONTROLS ON THE QUANTITY AND QUALITY OF URBAN RUNOFF AT TWO LOCATIONS IN AUSTIN, TEXAS

Clarence T. Welborn, and J.E. Veenhuis
http://pubs.usgs.gov/wri/1987/4004/report.pdf
Purpose - Determine if the rapid urban development in the Austin metropolitan area is causing an increase in the peak discharges from storm runoff and the degradation of the quality in receiving waters.

Results - Loads of most constituents and total densities of bacteria at the mall site were substantially larger in the inflow than in the outflow. The total densities of bacteria at the outflow were less by about 80 percent. Discharge weighted concentration data for Alta Vista indicate that the grass-covered swales and the grass-covered detention area had little or no effects on reducing concentrations or densities of most water-quality constituents.

Sources:
Probable – Residential, Industrial and Commercial Land Use(street, lawn and parking lot runoff)
Potential -
Possible -

14 - Tecolote Creek Microbial Source Tracking Summary Phases I, II, and III
Weston Solutions
Purpose - To investigate the bacterial sources, origins, and loads in the Tecolote Creek watershed and to assess and characterize specific priority activity contributions.

Results – Wet weather bacteria loads from individual land uses indicated that there were no significant differences between different land uses with flows merging and combining throughout drainage areas. There was some indication that higher loads were attributable to transportation corridors, commercial areas, and industrial land uses. Dry weather loads were higher in residential and commercial areas with specific activities identified as including poorly maintained dumpsters leaking high concentrations of indicator bacteria. A key transport mechanism found especially in commercial and industrial areas was over-irrigation. Residential areas were found to be abiding by water conservation recommendations, but this was not seen in commercial and industrial areas.

During dry weather, five positive Bacteroides samples were obtained. Each follow-up investigation failed to locate a point source; however, in every instance there was evidence of transient human activity. During wet weather, only 1 sample from a total of 37 samples collected over 9 storms was found to be positive for Bacteroides. This sample was collected during the early phase of the storm flows in an area known to be a transient area.

Biofilms on the walls of the MS4 system in particular were found to grow rapidly and contain high numbers of enterococci. Speciation of these enterococci determined that the origins were most likely environmental rather than fecal. Further investigation determined that the storm water, with high numbers of enterococci of fecal origin, was the primary inoculation mechanism but that biofilms matured rapidly into complex communities with a variety of species present. The high flows generated during wet weather were found to cause significant biofilm sloughing. The impact of biofilms on wet weather loads of indicator bacteria into receiving waters would appear to be significant. Sediments and biofilms within the creek and MS4 system were found to be significant reservoirs.

Sources:
Probable - Biofilm (MS4 Infrastructure), Sediment and biofilms in Tecolote Creek, Sediment and biofilms in MS4 Infrastructure
Potential - MS4 Infrastructure (anthropogenic non-human sources) Land use (residential, commercial, schools, restaurants, nurseries, golf course, livestock & domestic animal, industrial, Open space/Parks/Recreation, transportation corridors)
Possible -

52 - Dry Weather Bacterial Source Identification Study in the Mouth of Chollas Creek
Weston Solutions and the City of San Diego
Purpose - 1. What are the sources and magnitudes of dry weather urban runoff and associated indicator bacteria that influence water quality at the mouth of Chollas Creek?
2. What BMPs may be put in place to reduce or eliminate the influence of dry weather urban runoff at the mouth of Chollas Creek?

Results - During dry weather, there is no hydrologic connection between the mouth of Chollas Creek (the area influenced by tidal action) and the upstream drainage. Thus, bacteria found in the receiving waters of the creek mouth originate from sources that discharge directly to the mouth (i.e., storm drains). The highest bacterial concentrations were associated with the two storm drains near the National Avenue Bridge. Concentrations of indicator bacteria associated with the other identified storm drains were lower, but still contributed to elevated concentrations in the receiving water in the south fork and main stem, respectively. Two sources of flow that contributed to the high bacterial concentrations were identified as (1) over-irrigation of landscaping at the strip mall located at National Avenue and 35th Street and (2) a freshwater slough adjacent to a freeway off ramp that periodically discharges to a storm drain in the south fork of the creek.

Sources:
Probable - Storm drains and scour ponds at storm drain outlet; MS4 infrastructure; human waste), over-irrigation (landscaping)
Potential – Non-specific source (Freshwater slough; non-anthropogenic)
Possible -

54 - Regional Harbor Monitoring Program Pilot Project 2005-08 Summary Final Report
Weston Solutions and the City of San Diego
Purpose - The core monitoring program assesses the conditions found in the harbors based on comparisons to historical reference values for the four harbors and comparisons of contaminant concentrations to known surface water and sediment thresholds using chemistry, bacterial, toxicology, and benthic infaunal community indicators.
Results - Based on the results of the Pilot Project, the following statements can be made: 1) All bacterial concentrations were well below AB 411 levels, 2) The majorities of the marina and

freshwater-influenced strata contained sediments that were not toxic, 3) Benthic infaunal communities in both strata occurred at intermediate levels of disturbance, 4) Toxicity levels in the marina sediments generally were better than harbor-wide historical conditions, 5) Toxicity levels and benthic infaunal communities did not differ between the two strata, and 6) From 2005-2007, no negative short-term trends were evident for any indicator that would be indicative of a degrading condition.

70 - 2009-2010 Coastal Storm Drain Monitoring Annual Report
Weston Solutions, Inc. and County of San Diego Copermittees
Purpose - To determine the impacts that storm drains have on coastal receiving waters.

Results - There were a total of 28 exceedances of the total coliform storm drain action level. Twelve sites had at least one exceedance for total coliform, of which 3 had a total coliform exceedance on multiple dates.

Sources:
Probable – Cats
Potential –Cows, horses, fox, cormorants,
Possible – Non-specific source (human waste), gulls (secondary wildlife), Wildlife (muskrats, raccoons, coyotes, rabbits, turkeys and geese)

74 - MICROBIAL SOURCE TRACKING IN TWO SOUTHERN MAINE WATERSHEDS Report Number: MSG-TR-04-03March 2004Merriland River, Branch Brook and Little River (MBLR) Watershed Report
Kristen Whiting-Grant, F. Dillon, C. Dalton, Dr. M. Dionne, and Dr. S. Jones
Purpose - This study focuses on the Merriland River, Branch Brook and Little River (MBLR) watershed in Wells, Kennebunk and Sanford Maine, where chronic and persistent bacterial contamination from unidentified sources has restricted shellfish harvesting.

Results - Cats were the most frequently identified single source of bacterial contamination (21%); followed by cow (11%); fox (7%); cormorant (5%); human, rabbit, muskrat, horse and gull (all at3%); turkey (2%); and goose, raccoon, coyote and dog (all at 1%). Also note that ribotypes for 35% of the bacteria samples analyzed by JEL could not be identified, which is to say that no clear matches could be established between ribotypes of known source species and ribotypes from unknown water samples.

Sources:
Probable – Cats
Potential –Cows, horses, fox, cormorants,
Possible – Non-specific source (human waste), gulls (secondary wildlife), Wildlife (muskrats, raccoons, coyotes, rabbits, turkeys and geese)

64 - Microbial Source Tracking in the Dungeness Watershed, Washington
D.L. Woodruff, N.K. Sather, V.I. Cullinan, and S.L. Sargeant
Purpose - To determine the sources of fecal coliform pollution that have been impacting the water quality and shellfish harvesting activities for more than a decade.

Results – The predominant sources of fecal coliform contamination in the Dungeness from all matrix types (e.g. water, sediment, wrack) in the freshwater and marine environments were, in rank order, avian (19.6%), gull (12.5%), waterfowl (9.7%), raccoon (9.2%), unknown (7.3%), human-derived (7.1%), rodent (6.3%) and dog (4.3%). When bird groups were combined, they represented in total about 42% of samples collected and analyzed throughout the study.

Sources:
Probable – Wildlife,
Potential - Non-specific source (human waste), domestic animals,
Possible -

44 - Quantitative Pathogen Detection and MST Combined with modeling of fate and transport of Bacteroidales in San Pablo Bay.
Stefan Wuertz, F. Bombardelli, K. Sirikanchana, A. Schriewer, and Z. Kaveh
Purpose - To develop a decision-making took in the form of a 3-D model to benefit coastal managers both in terms of pinpointing major sources of fecal pollution and maximizing the usefulness of any monitoring activity.

Results – Monitoring results indicated low-level general and human-derived fecal contamination in the bay, while cow- and dog-derived contamination was not detected, except for one sample which contained dog-specific genetic marker. Human viruses were also below the sample detection limit. The pollution was more likely to come from surrounding urban areas or wastewater treatment facilities than from agricultural farm land or wildlife areas.

Sources:
Probable – Non-specific source (human waste),
Potential -
Possible – Dogs and cows

232 - Indicator organism sources and coastal water quality: a catchment study on the island of Jersey
M.D. Wyer, D. Kay, G.F. Jackson, H.M. Dawson, J. Yeo, and L. Tanguy
http://www.ncbi.nlm.nih.gov/pubmed/7730205
Purpose - Compliance monitoring of bathing waters at La Grève de Lecq on the North coast of Jersey revealed a significant deterioration in water quality between 1992 and 1993, as indexed by presumptive coliform, presumptive Escherichia coli and streptococci concentrations. During the 1993 bathing season the beach failed to attain the compliance with the EC Guideline criteria for presumptive E. coli and streptococci.

Results - A bacteriological survey of the stream catchment draining to the beach revealed that: (i) concentrations of faecal indicator organisms were enhanced at high discharge after rainfall; and (ii) a captive water fowl population, which expanded between 1990 and 1993, was a potential source of faecal pollution.

233 - Beach sands along the California coast are diffuse sources of fecal bacteria to coastal waters

K.M. Yamahara, B.A. Layton, A.E. Santoro, and A.B. Boehm

http://pubs.acs.org/doi/abs/10.1021/es062822n

Purpose - The potential for FIB to be transported from the sand to sea was investigated at a single wave-sheltered beach with high densities of ENT in beach sand

Results - We collected samples of exposed and submerged sands as well as water over a 24 h period in order to compare the disappearance or appearance of ENT in sand and the water column. Exposed sands had significantly higher densities of ENT than submerged sands with the highest densities located near the high tide line. Water column ENT densities began low, increased sharply during the first flood tide and slowly decreased over the remainder of the study. During the first flood tide, the number of ENT that entered the water column was nearly equivalent to the number of ENT lost from exposed sands when they were submerged by seawater. The decrease in nearshore ENT concentrations after the initial influx can be explained by ENT die-off and dilution with clean ocean water. While some ENT in the water and sand at LP might be of human origin because they were positive for the esp gene, others lacked the esp gene and were therefore equivocal with respect to their origin.

58 - High-Throughput and Quantitative Procedure for Determining Sources of Escherichia coli in Waterways by Using Host-Specific DNA Marker Genes

Tao Yan, M.J. Hamilton, and M.J. Sadowsky

http://aem.asm.org/content/73/3/890.full.pdf+html

Purpose - The objective of the study was to evaluate a high-throughput, semi-automated, quantitative procedure for determining sources of *E. coli* in waterways by using host-specific DNA marker genes of geese and ducks and robot-assisted high-throughput technology. Although the objective was to evaluate the method, the seasonal goose/duck population as a bacteria source was evaluated at 2 lakes frequented with migratory goose/duck populations and an additional lake that is not frequented by migratory goose

Results - The relative contributions of fecal *E.coli* from the geese/ducks were estimated to be 34% and 51% in Lake Superior and Lake Calhoun, respectively and 0.28% at Lake Hartwell (which has no migratory goose population)

Sources:
Probable – Wildlife (Lake Calhoun, Lake Superior),
Potential -
Possible–Wildlife (Lake Hartwell which has no migratory goose populations)

NSC (Not Source Characterization) Studies

137 - Relationship between rainfall and beach bacterial concentrations on Santa Monica Bay beaches
Drew Ackerman and S. B. Weisberg
http://www.sccwrp.org:8060/pub/download/DOCUMENTS/AnnualReports/2001_02AnnualReport/18_ar37-drew.pdf
Purpose - To enhance the scientific foundation for preemptive public health warnings, examine the relationship between rainfall and beach indicator bacteria concentrations using five years of fecal coliform data taken daily at 20 sites in southern California.

Results - There was a clear relationship between the incidence of rainfall and reduction in beach bacterial water quality in Los Angeles County. Bacterial concentrations remained elevated for five days following a storm, although they generally returned to levels below state water quality standards within three days. The length of the antecedent dry period had a minimal effect on this relationship, probably reflecting a quickly developing equilibrium between the decay of older fecal material and the introduction of new fecal material to the landscape.

175 - Persistence and potential growth of the fecal indicator bacteria, Escherichia coli in shoreline sand at Lake Huron
E.W. Alm, J. Burke, and E. Hagan
http://www.bioone.org/doi/abs/10.3394/0380-1330%282006%2932%5B401:PAPGOT%5D2.0.CO;2
Purpose - This study was initiated to test the hypothesis that high abundances of the fecal indicator Escherichia coli in shoreline sand at freshwater beaches can be explained, at least in part, by the ability of E. coli to persist and grow in beach sand.

Results - In controlled laboratory microcosm studies using autoclaved beach sand inoculated with E. coli strains previously isolated from ambient beach sand, E. coli densities increased from 2 CFU/g to more than 2 × 105 CFU/g sand after 2 days of incubation at 19°C, and remained above 2 × 105 CFU/g for at least 35 days. In field studies utilizing similarly inoculated beach sand in diffusion chambers incubated at a Lake Huron beach, E. coli also grew rapidly, reaching high densities (approximately 7.5 × 105 CFU/g), and persisting in a cultivable state at high density for at least 48 days. In comparison, E. coli levels in ambient beach sand adjacent to the chambers always had densities <100 CFU/g. Lake Huron beach sand clearly provides nutrients, temperatures, and other conditions needed to support growth of E. coli. The growth of E. coli in sterile sand diffusion chambers to higher levels than occurs in ambient beach sand may indicate the presence in ambient sand of biological controls on bacterial growth, such as predation or competition.

59 - Host Species-Specific Metabolic Fingerprint Database for Enterococci and Escherichia coli and Its Application to Identify Sources of Fecal Contamination in Surface Waters
Warish Ahmed, R. Neller, and M. Katoulli
http://aem.asm.org/content/71/8/4461.full.pdf+html

Purpose - To characterize two fecal indicator bacteria, enterococci and E. coli, from different host groups (i.e., animal species) to develop a metabolic fingerprint database to identify the source(s) of fecal contamination in a creek in Australia.

Results - Out of 27 water samples:10% of the biochemical phenotypes (BPT) found for enterococci belonged to human origin, 61% belonged to animals tested. 13% of the BPTs found for E. coli belonged to human origin and 54% belonged to animals tested. The remaining BPT found for Enterococci and E. coli belonged to BPTs shared between humans and animals or did not match database

Sources:
Probable –Septic (human waste), animal farms (domestic animals), animal farms (agriculture),
Potential -
Possible -

80 - Persistence and Differential Survival of Fecal Indicator Bacteria in Subtropical Waters and Sediments
K.L. Anderson, J.E. Whitlock, and V.J. Harwood
http://aem.asm.org/content/71/6/3041.full.pdf+html
Purpose - Fecal coliforms and enterococci are indicator organisms used worldwide to monitor water quality. These bacteria are used in microbial source tracking (MST) studies, which attempt to assess the contribution of various host species to fecal pollution in water. Ideally, all strains of a given indicator organism (IO) would experience equal persistence (maintenance of culturable populations) in water; however, some strains may have comparatively extended persistence outside the host, while others may persist very poorly in environmental waters. Assessment of the relative contribution of host species to fecal pollution would be confounded by differential persistence of strains.

Results - IO persistence according to mesocosm treatment followed the trend: contaminated soil > wastewater > dog feces. E. coli ribotyping demonstrated that certain strains were more persistent than others in freshwater mesocosms, and the distribution of ribotypes sampled from mesocosm waters was dissimilar from the distribution in fecal material. These results have implications for the accuracy of MST methods, modeling of microbial populations in water, and efficacy of regulatory standards for protection of water quality. Saltwater had a negative effect on FC persistence, as the decay rates of FC (all inoculum sources combined) in saltwater sediments and water column were greater than those in freshwater. Saltwater also significantly increased enterococcal decay rates compared to freshwater. IO persistence tended to be greater in sediments than in the water column. The average decay rate of FC in sediments of freshwater mesocosms was significantly less than those in the water column, and the difference was nearly significantly at the $\alpha = 0.05$ level in saltwater ($P = 0.083$). Although decay rates of enterococci tended to be greater in the water column than in sediments, the difference was not significant in freshwater or saltwater mesocosms.

176 - Persistence and differential survival of fecal indicator bacteria in subtropical waters and sediments
K.L. Anderson, J.E. Whitlock, and V.J. Harwood
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1151827/
Purpose - This study utilized mesocosms designed to simulate natural conditions, which were inoculated with fecal material, to test the hypothesis that certain *E. coli* phylotypes exhibit greater persistence than others in aquatic environments.

Results - This study demonstrated a high degree of variability in the response of fecal indicator organisms to stresses in aquatic environments on all levels investigated. Responses to water type (saline versus fresh), location (sediment versus water column), and inoculum type all varied within and between indicator bacterial groups (FC and ENT). The discrepant results emphasize the difficulties encountered in attempting to regulate diverse types of water bodies by one regulatory standard. Also cautionary is the persistence of indicator organisms in sediments, which leads to elevation of their densities and a false indication of recent pollution in the water column after events such as rain storms, construction, or recreational use.

130 - LEVELS OF FECAL INDICATOR BACTERIA AT DOG BEACH AND NEARBY COASTAL BEACHES OF THE CITY OF SAN DIEGO, CA
Amir Baum
http://www.sandiegoriver.org/documents/baum_final_thesis.pdf
Purpose - An analysis of historical County of San Diego microbial marine water quality was conducted to quantitatively compare the levels of fecal indicator bacteria (FIB) levels at Dog Beach, located at the San Diego River Outlet, and nearby coastal beaches. Additionally, this study aimed to determine if relationships existed between daily average river flow/daily precipitation and FIB densities at Dog Beach and nearby coastal beach stations and if significant associations existed between daily precipitation and FIB single sample exceedances.

Results - The study found the strongest association between river flow, precipitation, and TC levels to be at river discharge points during wet months, but no significant association was found during dry weather. The study demonstrated that using a stratified-random sampling design, urban runoff outlets are a primary source of contaminated runoff with 90% of sites near urban runoff outlets failing water quality standards.

81 - Integrated Analysis of Established and Novel Microbial and Chemical Methods for Microbial Source Tracking
Anicet R. Blanch, L. Belanche-Muñoz, X. Bonjoch, J. Ebdon, C. Gantzer, F. Lucena, J. Ottoson, C. Kourtis, A. Iversen, I. Kühn, L. Mocé, M. Muniesa, J. Schwartzbrod, S. Skraber, G.T. Papageorgiou, H. Taylor, J. Wallis, and J. Jofre
http://aem.asm.org/content/72/9/5915.full.pdf+html
Purpose - The objectives of the present study were (i) to determine the most discriminant tracers showing wide and consistent geographical stability between all locations, (ii) to identify subsets of variables derived from tracers with the highest discriminant capacity, and (iii) to evaluate and

compare statistical or machine learning methods to develop predictive models for source tracking using the minimum number of these variables. In this multilaboratory study, different microbial and chemical indicators were analyzed in order to distinguish human fecal sources from nonhuman fecal sources using wastewaters and slurries from diverse geographical areas within Europe.

Results - Fecal coliforms, enterococci, clostridia, somatic coliphages, and total bifidobacteria were detected in almost all samples (other than a single sample in the case of total bifidobacteria) of both human and animal origin. They were more abundant in the animal samples than in the human samples, but this seems to be due to the higher fecal load of these samples, since relative densities were similar in both groups of samples.

21 - Enterococci Concentrations in Diverse Coastal Environments Exhibit Extreme Variability
A.R. Boehm
http://pubs.acs.org/doi/abs/10.1021/es071807v
Purpose - The study examines extreme temporal variations (periods between 1 min andZ4 h) in FIB concentrations in diverse marine coastal environments ranging from wave-sheltered to wave-exposed open ocean beaches.

Results - The high frequency variability indicates that regardless of sampling time, a single sample of water tells one little about the true water quality, so multiple samples need to be collected. If it is not feasible to collect multiple samples, then a spatially or temporally composited sample will improve the estimate of the true water quality.

157 - Methicillin-resistant Staphylococcus aureus (MRSA) in municipal wastewater: an uncharted threat?
S. Börjesson, A. Matussek, S. Melin, S. Löfgren, and P.E. Lindgren
http://www.mendeley.com/research/methicillinresistant-staphylococcus-aureus-mrsa-in-municipal-wastewater-an-uncharted-threat/#page-1
Purpose - (i) To cultivate methicillin-resistant Staphylococcus aureus (MRSA) from a full-scale wastewater treatment plant (WWTP), (ii) To characterize the indigenous MRSA-flora, (iii) To investigate how the treatment process affects clonal distribution and (iv) to examine the genetic relation between MRSA from wastewater and clinical MRSA.

Results - MRSA could be isolated on all sampling occasions, but only from inlet and activated sludge. The number of isolates and diversity of MRSA were reduced by the treatment process, but there are indications that the process was selected for strains with more extensive antibiotic resistance and PVL+ strains. The wastewater MRSA-flora had a close genetic relationship to clinical isolates, most likely reflecting carriage in the community.

158 - A seasonal study of the mecA gene and Staphylococcus aureus including methicillin-resistant S. aureus in a municipal wastewater treatment plant
S. Börjesson, S. Melin, A. Matussek, and P.E. Lindgren
http://www.loudounnats.org/pdf/09WRAseasonalstudyofmecASaureusandMRSAinafull-scaleWWTP.pdf
Purpose - Determine the effect of wastewater treatment processes on mecA gene concentrations, and the prevalence of S. aureus and MRSA over time. To achieve this a municipal wastewater treatment plant was investigated for the mecA gene, S. aureus and MRSA, using real-time PCR assays

Results - Using molecular methods and cultivation, MRSA was for the first time detected in a municipal activated sludge and trickling filter WWTP, but mainly in the early treatment steps, IN, PS and AS. The mecA gene and S. aureus could be detected throughout the year at all sampling sites. The wastewater treatment process reduces mecA gene concentrations, which can partly be explained by removal of biomass.

140 - Particle Associated Microorganisms in Stormwater Runoff
Michael Borst, and A. Selvakumar
http://www.epa.gov/ORD/NRMRL/pubs/600j03262/600j03262.pdf
Purpose - Investigate the effects of blending and chemical addition before analysis of the concentration of microorganisms in stormwater runoff play a significant role.

Results - Particle-associated microorganisms play an important, if often unmeasured, portion of the total organism count in stormwater. All organisms, except for E. coli, showed an increase in the measured concentration after blending samples at 22,000 rpm with or without the chemical mixture. Other than fecal streptococci, the organism concentrations decreased with the addition of the Camper's solution in both blended and unblended samples before analyses. There was a statistically significant interaction between the effects of Camper's solution and the effects of blending for all the organisms tested, except for total coliform. Blending did not alter the mean particle size significantly. The results show no correlation between increased total coliform, fecal coliform, and fecal streptococcus concentrations and the mean particle size.

87 - Direct comparison of four bacterial source tracking methods and use of composite data sets
E.A. Casarez, S.D. Pillai, J.B. Mott, M. Vargas, K.E. Dean and G.D. Di Giovanni
http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2672.2006.03246.x/pdf
Purpose - (i) To compare the identification ability of the four BST methods individually and in combination through the use of composite data sets and (ii) to evaluate the use of the developed data sets for the identification of faecal contamination sources in two Central Texas lakes suspected of being impacted by agricultural operations and dairy cattle.

Results - Best matching identification using the composite data set correctly identified 100% of the replicate QC cultures (precision), and had 100% accuracy for E. coli strain and source class identification of the isolates. Therefore, the four-method composite performed better than any single method.

154 - Removal of bacterial indicators of fecal contamination in urban stormwater using a natural riparian buffer
M.J. Casteel, G. Bartow, S.R. Taylor, and P. Sweetland
http://www.lmtf.org/FoLM/Plans/Water/VistaGrande/Casteeletal_10icud_paper.PDF
Purpose - Determine if riparian buffers are able to remove bacterial indicators of fecal contamination and other microbial contaminants from intermittent, high-volume flows such as those encountered during storm events in heavily urbanized areas.

Results - Analysis of lake water showed that levels of Escherichia coli and total coliforms increased significantly during storm events, indicating the presence of nonpoint sources of fecal contamination in the area surrounding the lake.

134 - Population structure and persistence of Escherichia coli in ditch sediments and water in the Seven Mile Creek Watershed
Ramyavardhanee Chandrasekaran
http://conservancy.umn.edu/bitstream/108879/1/Chandrasekaran_Ramyavardhanee_May2011.pdf
Purpose - Examined the population structure of E. coli and determined whether ditch sediments can serve as reservoirs of environmental E. coli in the Seven Mile Creek (SMC) watershed, a minor watershed located in south central Minnesota

Results - Further analysis of the count data revealed a strong correlation between E. coli concentrations and temperature profile at the SMC. E. coli densities in SMC water samples exceeded the permissible Minnesota standard (126 CFU/100 ml) predominantly during summer and fall seasons. In addition to temperature, rainfall also drastically influenced the dynamics and distribution of E. coli populations at the SMC. Results suggest that the seasonal variation in E. coli counts observed in water and sediments are most likely related to temperature, rainfall, and the patchy distribution of E. coli within sampling locations

88 - Relative Decay of Bacteroidales Microbial Source Tracking Markers and Cultivated Escherichia coli in Freshwater Microcosms
Linda K. Dick, Erin A. Stelzer, Erin E. Bertke, Denise L. Fong, and Donald M. Stoeckel
http://aem.asm.org/content/76/10/3255.full.pdf+html
Purpose - Fecal indicator bacteria (FIB), commonly used to regulate sanitary water quality, cannot discriminate among sources of contamination. The use of alternative quantitative PCR (qPCR) methods for monitoring fecal contamination or microbial source tracking requires an understanding of relationships with cultivate FIB, as contamination ages under various conditions in the environment. In this study, the decay rates of three Bacteroidales 16S rRNA gene markers (AllBac for general contamination and qHF183 and BacHum for human-associated contamination) were compared with the decay rate of cultivated Escherichia coli in river water microcosms spiked with human wastewater.

Results - A major finding of this study was that HF marker decay was consistent with, or significantly faster than, that of E. coli under all treatments. This indicates that the HF markers might be useful as conservative estimators of human origin E. coli even as fecal contamination ages in the environment.

118 - Bacteriological Quality of Runoff Water from Pastureland
J.W. Doran, and D.M. Linn
http://aem.asm.org/content/37/5/985.abstract
Purpose - Determine the bacteriological characteristics of pasture runoff and to compare them with runoff from an ungrazed area.

Results - We found no relationship between FC and FS counts in rainfall runoff and either rainfall or total runoff for most events. Bacteriological quality of snowmelt runoff. During the 3-year study, there were 10 snowmelt runoff events-two in 1976 and 8 in 1978. The levels of TC in snowmelt runoff from both grazed and ungrazed pasture areas exceeded recommended water quality standards . FC counts, often considered a better index of fecal contamination, were within recommended standards.

89 - Microbial source tracking using host specific FAME profiles of fecal coliforms
Metin Duran, Berat Z. Haznedaroglu, and Daniel H. Zitomer
http://www.prairieswine.com/pdf/3397.pdf
Purpose - The objective of this study was to investigate the host-specific differences in fatty acid methyl ester (FAME) profiles of fecal coliforms (FC).

Results - The results presented here provide further evidence that FAME profiles of indicator organisms have statistically significant host specificity and suggest that these differences may be useful in predicting sources of microbial pollution in water environments. However, more research is needed to determine the mechanisms causing the host specificity and to assess the possible temporal and spatial variations in FAME profiles before FAME can be applied in the field.

183 - Quantitative evaluation of enterococci and Bacteroidales released by adults and toddlers in marine water
S.M. Elmir, T. Shibata, H.M. Solo-Gabriele, C.D. Sinigalliano, M.L. Gidley, G. Miller, L.R.W. Plano, J. Kish, K. Withum, and L.E. Fleming
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2761526/
Purpose - The main objectives of the this study were to measure shedding of enterococci and Bacteroidales using traditional and emerging laboratory methods, and to evaluate shedding from toddlers and adults. The added value of the current study was the evaluation of shedding from toddlers (all prior studies used adult volunteers), and the use of additional methods of fecal indicator bacteria analyses (i.e. enterococci by CS and qPCR, and Bacteroidales by qPCR) as no data are available which directly measure fecal indicator bacteria shedding using these alternate methods.

Results - Human bathers have the potential to release significant amounts of fecal indicator bacteria into the water column via direct shedding off their body and via sand transported by their skin. Direct shedding from the body can include releases from fecally contaminated body areas and skin, and releases from fecally contaminated diapers. In this study, the quantity of enterococci released was a function of bathing cycle, sand exposure, beach sand contamination levels, and microbial flora variations between swimmers.

182 - Quantitative evaluation of bacteria released by bathers in a marine water
S.M Elmir, M.E. Wright, A. Abdelzaher, H.M. Solo-Gabriele, L.E. Fleming, G. Miller, M. Rybolowik, M.T. Peter Shih, S.P. Pillai, J.A. Cooper and E.A. Quaye
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2633726/
Purpose - This study focused on estimating the amounts of enterococci and S. aureus shed by bathers directly off their skin and indirectly via sand adhered to skin.

Results - This study demonstrated that bathers shed significant concentrations of enterococci and S. aureus into the water column and that S. aureus was shed at concentrations at least one order of magnitude greater than enterococci. This study also showed that total enterococci and S. aureus released by bathers decreased significantly between bathing episodes, in particular after the first wash cycle. This conclusion agrees with the long standing universal requirement that bathers should shower before entering recreational waters to reduce the microbial load in particular at swimming pools since the water volume is limited. It is concluded from this study that the enterococci contribution from sand adhered to skin, was small relative to the amount shed directly from the skin and represented less than 5% of the total enterococci shed by bathers.

159 - Staphylococcus aureus and fecal indicators in Egyptian coastal waters of Aqaba Gulf, Suez Gulf, and Red Sea
M.A. El-Shenawy
http://www.nodc-egypt.org/contacts_files/vol-31-2/Volume%2031%20%282%29%202005.PDF/9/Text.pdf
Purpose - Study the hygienic status of Egyptian coastal waters of Aqaba Gulf, Suez Gulf and Red Sea. The possibility of using *S.aureus* as supplementary indicator to the conventional bacterial indicators was another goal.

Results - 107 samples (53.5 %) of the 200 total examined samples were found to harbour S aureus exceeding the aforementioned guide standards. The present results concluded that addition of S. aureus as supplementary indicator to the conventional fecal indications may be useful for judging the marine water quality in Red Sea region.

138 - Sediment Bacterial Indicators in an Urban Shellfishing Subestuary of the Lower Chesapeake Bay
Carl W. Erkenbrecher Jr.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC244041/pdf/aem00190-0106.pdf

Purpose - Historically, the Lynnhaven, an urban shellfishing estuary of the lower Chesapeake Bay region, has been opened and closed periodically to shellfishing during the past 40 years due to high fecal coliform counts. Document the spatial and temporal distributions and compositions of bacteria in the sediments and overlying waters of an important urban shellfishing area in the lower Chesapeake Bay region, the Lynnhaven Estuary.

Results - Densities of all indicator bacteria were always significantly higher in the sediments than in the overlying subsurface waters. The major problems inherent in this system are nonpoint in their origin. The primary sources of the Lynnhaven's bacterial pollution appeared to be typical of urban and agricultural runoff, although failure of septic tank systems was suspected as a problem in the Lynnhaven's western branch. These results illustrated that sediments in shellfishing areas could serve as a reservoir for high densities of indicator bacteria and that, potentially, pathogens could pose a health hazard.

184 - Enumeration and speciation of enterococci found in marine and intertidal sediments and coastal water in southern California

D.M. Ferguson, D.F. Moore, M.A. Getrich, and M.H. Zhowandai

http://www.ochealthinfo.com/docs/public/h2o/Enumeration-speciation.pdf

Purpose - To determine the levels and species distribution of enterococci in intertidal and marine sediments and coastal waters at two beaches frequently in violation of bacterial water standards.

Results - High levels of Enterococcus in intertidal sediments indicate retention and possible regrowth in this environment. Significance and Impact of the Study: Re-suspension of enterococci that are persistent in sediments may cause beach water quality failures and calls into question the specificity of this indicator for determining recent faecal contamination.

90 - Comparison of Bacteroides-Prevotella 16S rRNA Genetic Markers for Fecal Samples from Different Animal Species

Lisa R. Fogarty and Mary A. Voytek

http://aem.asm.org/content/71/10/5999.full.pdf+html

Purpose - The goals of this study were to compare Bacteroides-Prevotella populations from nine host species collected at multiple geographical locations and to determine if unique populations could be identified for each host species that could be used to develop markers for fecal source tracking.

Results - Results support the use of molecular techniques to characterize Bacteroides-Prevotella populations as a means to improve the ability to track sources of fecal contamination, but also show the need for more development of these methods.

186 - Abundance and characteristics of the recreational water quality indicator bacteria Escherichia coli and enterococci in gull faeces

L.R. Fogarty, S.K. Haack, M.J. Wolcott, and R.L. Whitman

http://cws.msu.edu/documents/FogartyetalJAM2003.pdf

Purpose - To evaluate the numbers and selected phenotypic and genotypic characteristics of the faecal indicator bacteria Escherichia coli and enterococci in gull faeces at representative Great Lakes swimming beaches in the United States.

Results - Gull faeces could be a major contributor of E. coli (105–109 CFU g)1) and enterococci (104– 108 CFU g)1) to Great Lakes recreational waters. E. coli and enterococci in gull faeces are highly variable with respect to their genotypic and phenotypic characteristics and may exhibit temporal or geographic trends in these features.

162 - A preliminary investigation of fecal indicator bacteria, human pathogens, and source tracking markers in beach water and sand
K.D. Goodwin, L. Matragrano, D. Wanless, C. Sinigalliano, and M.J. LaGier
http://yyy.rsmas.miami.edu/groups/ohh/projects/microbesresearch/GoodwinERK2_4.pdf
Purpose - Data suggesting that fecal indicating bacteria may persist and/or regrow in sand has raised concerns that fecal indicators may become uncoupled from sources of human fecal pollution. To investigate this possibility, wet and dry beach sand, beach water, riverine water, canal water, and raw sewage samples were screened by PCR for certain pathogenic microbes and molecular markers of human fecal pollution.

Results - Overall, this analysis pointed to the need to find better methods of extracting nucleic acids from environmental samples in order to reduce the possibility of false negative results. High quality nucleic acids need to be consistently and efficiently delivered to the detector system if the relationship between fecal indicators and human pathogens and human source tracking markers is to be elucidated.

93 - Comparing Wastewater Chemicals, Indicator Bacteria Concentrations, and Bacterial Pathogen Genes as Fecal Pollution Indicators
Sheridan K. Haack, Joseph W. Duris, Lisa R. Fogarty, Dana W. Kolpin, Michael J. Focazio, Edward T. Furlong, and Michael T. Meyer
https://www.crops.org/publications/jeq/pdfs/38/1/248
Purpose - Compare fecal indicator bacteria (FIB) (fecal coliforms, Escherichia coli [EC], and enterococci [ENT]) concentrations with a wide array of typical organic wastewater chemicals and selected bacterial genes as indicators of fecal pollution in water samples collected at or near 18 surface water drinking water intakes.

Results - In our study, which examined ambient waters in various land use environments with a wide range of FIB concentrations, fecal pollution was indicated by gene-based and/or chemical-based markers for 14 of the 18 tested samples, with little relation to FIB standards.

95 - Development of Goose- and Duck-Specific DNA Markers To Determine Sources of Escherichia coli in Waterways
Matthew J. Hamilton, Tao Yan, and Michael J. Sadowsky
http://aem.asm.org/content/72/6/4012.full.pdf+html

Purpose - The development and validation of host source-specific genetic markers for E. coli strains originating from Canada geese (*Branta canadensis*).

Results - SSH was successfully used to identify seven DNA markers with high levels of hybridization specificity for E. coli strains originating from geese. Combined, the marker DNAs were capable of identifying about 76% of the goose E. coli strains examined and 73% of the duck E. coli strains examined.

192 - Waterfowl Abundance Does Not Predict the Dominant Avian Source of Beach Escherichia coli
D.L. Hansen, S. Ishii, M.J. Sadowsky, and R.E. Hicks
https://www.soils.org/publications/jeq/abstracts/40/6/1924?access=0&view=pdf
Purpose - The horizontal, fluorophore enhanced, rep-PCR (HFERP) DNA fingerprinting technique was used to identify potential sources of Escherichia coli in water, nearshore sand, and sediment at two beaches in the Duluth-Superior Harbor, near Duluth, MN, and Superior, WI, during May, July, and September 2006.

Results - Waterfowl, including Canada geese, ring-billed gulls, and mallard ducks, were the largest source of E. coli that could be identified in water (55–100%), sand (59–100%), and sediment (92–100%) at both beaches. Although ring-billed gulls were more abundant in this harbor, Canada geese were usually the dominant source of waterfowl E. coli found at these beaches.

96 - Validation and field testing of library-independent microbial source tracking methods in the Gulf of Mexico
Valerie J. Harwood, Miriam Brownell, Shiao Wang, Joe Lepo, R.D. Ellender, Abidemi Ajidahun, Kristen N. Hellein, Elizabeth Kennedy, Xunyan Ye, and Christopher Flood
http://www.usm.edu/bst/pdf/Water%20Res%202009.pdf
Purpose - Standardize and validate MST methods across laboratories in coastal Gulf of Mexico states.

Results - An SOP was developed that allowed simultaneous purification of DNA for viral and bacterial markers, and gave comparable results among three laboratories. The method performance was generally similar whether it was conducted in buffer, fresh water or salt water; however, the human Bacteroidales method had a lower limit of detection in buffer and in salt water compared to fresh water.

97 - Fidelity of bacterial source tracking: Escherichia coli vs. Enterococcus spp. and minimizing assignment of isolates from non-library sources
W.M. Hassan, R.D. Ellender and S.Y. Wang
http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2672.2006.03077.x/pdf
Purpose - Improve the fidelity of library-dependent bacterial source tracking efforts in determining sources of faecal pollution.

Results - The use of enterococci provides higher rates of correct source assignment compared with E. coli. The use of similarity thresholds to decide whether to accept source assignments made by computer programmes reduces the rate of mis-assignment of non-library isolates.

197 - Contact with beach sand among beachgoers and risk of illness
C. D. Heaney, E. Sams, S. Wing, S. Marshall, K. Brenner, A.P. Dufour, and T.J. Wade
http://aje.oxfordjournals.org/content/170/2/164.full.pdf
Purpose - The purpose of this study is to better understand the illness risk associated with beach sand that can harbor high concentrations of fecal indicator organisms, as well as fecal pathogens.

Results - The results of our study suggest that, among beachgoers participating in a large prospective cohort study at beaches nearby sewage treatment discharges, reported contact with beach sand (defined as either digging in the sand or having one's body buried in the sand) was associated with an elevated risk of enteric illnesses (gastrointestinal illness and diarrhea). Being buried in the sand was more strongly associated with enteric illness than was digging in the sand. We also observed a higher proportion of people who got sand in their mouth among those buried in the sand (40%) compared with those who dug in the sand (20%).

155 - The Impact of Rainfall on Fecal Coliform Bacteria in Bayou Dorcheat (North Louisiana)
Dagne D. Hill, W.E. Owens, and P.B. Tchounwou
www.mdpi.com/1660-4601/3/1/114/pdf
Purpose - Assess the effect of surface runoff amounts and rainfall amount parameters on fecal coliform bacterial densities in Bayou Dorcheat in Louisiana.

Results - Nonpoint source pollution that is carried by surface runoff has a significant effect on bacterial levels in water resources.

199 - Beach sand and sediments are temporal sinks and sources of Escherichia coli in Lake Superior
Satoshi Ishii, D.L. Hansen, R.E. Hicks, and M.J. Sadowsky
http://pubs.acs.org/doi/pdf/10.1021/es0623156
Purpose - Report on a 2-year investigation of the seasonal variation of E. coli concentrations in water, sand, and sediment at the DBC Beach in the Duluth-Superior Harbor of Lake Superior.

Results - Waterfowl in addition to humans can be a significant source of fecal indicator bacteria like E. coli at Great Lakes beaches. Although waterfowl have been reported to carry a limited number of pathogenic E. coli (36), which was also found our study, they may harbor other potential pathogens such as Salmonella and Campylobacter (37). The potential health risks associated with waterfowl-borne bacteria found at beaches needs to be investigated in the future.

122 - Fecal bacteria and sex hormones in soil and runoff from cropped watersheds amended with poultry litter
Michael B. Jenkins, D.M. Endale, H.H. Schomberg, and R.R. Sharpe
http://phoenix.nal.usda.gov/bitstream/10113/15527/1/IND44044786.pdf
Purpose - Determine if applications of poultry litter to small watersheds would contribute to the load of fecal bacteria and sex hormones to soil and runoff

Results - Under the conditions of drought and conservation tillage, the rates at which we applied poultry litter to the four cropped watersheds appeared to have little or no significant effect on (a) soil community of fecal indicator bacteria, (b) concentrations of estradiol and testosterone in surface soil, and (c) quantities of estradiol and testosterone coming off the watersheds with runoff.

202 - Bacteroidales Diversity in Ring-Billed Gulls (*Laurus delawarensis*) Residing at Lake Michigan Beaches
S.N. Jeter, C.M. McDermott, P.A. Bower, J.L. Kinzelman, M. J. Bootsma, G.W. Goetz, and S.L. McLellan
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2655448/pdf/2261-08.pdf
Purpose - This study investigated the occurrence and diversity of Bacteroidales fecal bacteria in gulls residing in the Great Lakes region.

Results - A total of 467 gull fecal samples from five coastal beaches spanning Lake Michigan's western shore and one inland beach on Lake Winnebago were screened for the presence of Bacteroidales by PCR. There was a low but consistent occurrence of Bacteroidales in the gull populations at these beaches.

151 - The Impact of Annual Average Daily Traffic on Highway Runoff Pollutant Concentrations
Masoud Kayhanian, A. Singh, C. Suverkropp, and S. Borroum
http://escholarship.org/uc/item/86f8c8n8
Purpose - Evaluate correlations between annual average daily traffic and storm water runoff pollutant concentrations generated from California Department of Transportation highway sites.

Results - No direct linear correlation was found between highway runoff pollutant mean concentrations and AADT. However, through multiple regression analyses, it was shown that AADT has an influence on most highway runoff constituent concentrations, in conjunction with factors associated with watershed characteristics and pollutant build-up and wash off.

102 - Development of Bacteroides 16S rRNA Gene TaqMan-Based Real-Time PCR Assays for Estimation of Total, Human, and Bovine Fecal Pollution in Water
Alice Layton, Larry McKay, Dan Williams, Victoria Garrett, Randall Gentry, and Gary Sayler
http://aem.asm.org/content/72/6/4214.full.pdf+html

Purpose - Design real-time PC assay to target Bacteroides species (AllBac) present in human, cattle, and equine feces.

Results - This assay was shown empirically to be proportional to the concentration of human, bovine, and equine feces in water and thus can be used to estimate fecal concentrations without calculating the number of Bacteroides cells in the sample. The simplicity of performing these assays by direct PCR of water samples suggests that these assays may be field deployable and thus would aid data collection in watersheds with inherently high spatial and temporal variabilities.

203 - Persistence of fecal indicator bacteria in Santa Monica Bay beach sediments
C.M. Lee, T.Y. Lin, C.C. Lin, G.A. Kohbodi, A. Bhatt, R. Lee, and J.A. Jay
http://www.sciencedirect.com/science/article/pii/S004313540600220X
Purpose - This study involved monitoring the fecal indicator bacteria (FIB) levels in water and sediment at three ocean beaches (two exposed and one enclosed) during a storm event, conducting laboratory microcosm experiments with sediment from these beaches, and surveying sediment FIB levels at 13 beaches (some exposed and some enclosed).

Results - Results from microcosm experiments showing similar, dramatic growth of FIB in both overlying water and sediment from all beaches, as well as results from the beach survey, support the hypothesis that the quiescent environment rather than sediment characteristics can explain the elevated sediment FIB levels observed at enclosed beaches. This work has implications for the predictive value of FIB measurements, and points to the importance of the sediment reservoir.

205 - Phylogenetic Diversity and Molecular Detection of Bacteria in Gull Feces
J. Lu, J.W. Santo Domingo, R. Lamendella, T. Edge, and S. Hill
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2446513/
Purpose - To determine the occurrence of *C. marimammalium* in waterfowl, species-specific 16S rRNA gene PCR and real-time assays were developed and used to test fecal DNA extracts from different bird (n = 13) and mammal (n = 26) species.

Results - To determine the occurrence of *C. marimammalium* in waterfowl, species-specific 16S rRNA gene PCR and real-time assays were developed and used to test fecal DNA extracts from different bird (n = 13) and mammal (n = 26) species.

103 - Genetic Diversity of Escherichia coli Isolated from Urban Rivers and Beach Water
Sandra L. McLellan
http://aem.asm.org/content/70/8/4658.full.pdf+html
Purpose - Evaluate the genetic profiles of E. coli strains found in stormwater, where fecal pollution is derived from multiple uncharacterized host sources, and compare these profiles to known host sources of pollution.

Results - There does not appear to be a proportional relationship between fecal indicator bacteria from a host and what is actually detected in the environment, which will be an important consideration when developing methods for fecal pollution source tracking. Matching of isolates to the entire data set demonstrated that strains from a type of sample (e.g., gull, sewage, stormwater, river water, beach water) were most similar to other strains from the same host or environmental source. These findings may be a function of geographic distribution rather than host source specificity.

126 - Identification and Quantification of Bacterial Pollution At Milwaukee County Beaches

Sandra L. McLellan, and E.T. Jensen

http://www.glwi.freshwater.uwm.edu/research/genomics/ecoli/media/Technical%20document%209-12-05.pdf

Purpose - Assess the bacterial contaminant load in the waters and sand at beaches within Milwaukee County.

Results - Bacterial water data collected during the summer 2005 beach surveys suggests a positive relationship between rainfall and increased E. coli levels at these particular beach sites. Sewage contamination could potentially reach the beach during combined sewage overflows, or from nearby sewer infrastructure failures.

104 - Evaluation of Repetitive Extragenic Palindromic-PCR for Discrimination of Fecal Escherichia coli from Humans, and Different Domestic and Wild Animals

Bidyut Mohapatra, Klaas Broersma, Rick Nordin and Asit Mazumder

http://web.uvic.ca/~h2o/publications/Mohapatra%20et%20al.%20MI07pdf.pdf

Purpose - Investigate the potential of rep-PCR in differentiating e. coli isolates of human, domestic and wild animal origin that might be used as a molecular tool to identify the possible source(s) of fecal pollution of source water.

Results - Rep-PCR DNA fingerprinting results provide evidence about the robustness of this method, and it's simple and cost-effective screening tool to isolate and track non-point sources of fecal contamination.

106 - Evaluation of antibiotic resistance analysis and ribotyping for identification of faecal pollution sources in an urban watershed

D.F. Moore, V.J. Harwood, D.M. Ferguson, J. Lukasik, P. Hannah1, M. Getrich and M. Brownell

http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2672.2005.02612.x/pdf

Purpose **-** The accuracy of ribotyping and antibiotic resistance analysis (ARA) for prediction of sources of faecal bacterial pollution in an urban Southern California watershed was determined using blinded proficiency samples. Low rates of correct classification for E. coli proficiency isolates compared with the ARCCs of the libraries indicate that testing of bacteria from samples that are not represented in the library, such as blinded proficiency samples, is necessary to accurately measure predictive ability. The library-based MST methods used in this study may not be suited for determination of the source(s) of faecal pollution in large, urban watersheds.

Results - None of the methods performed well enough on the proficiency panel to be judged ready for application to environmental samples.

210 - Species distribution and antimicrobial resistance of enterococci isolated from surface and ocean water
D.F. Moore, J.A. Guzman, and C. McGee
http://www.glin.net/lists/beachnet/2008-05/pdf00000.pdf
Purpose - The species identification and antimicrobial resistance profiles were determined for enterococci isolated from Southern California surface and ocean waters.

Results - *Enterococcus faecalis, E. faecium, E. casseliflavus and E. mundti* are the most commonly isolated Enterococcus species from urban runoff and receiving waters in Southern California.

107 - A review of technologies for rapid detection of bacteria in recreational waters
Rachel T. Noble and Stephen B. Weisberg
http://www.environmental-expert.com/Files%5C19961%5Carticles%5C6674%5C479_rapid_detection_recreational_waters.pdf
Purpose - Review new methods that have the potential to reduce measurement period for fecal indicator bacteria from more than a day to less than an hour to reduce risk of swimmers to fecal bacteria.

Results - Enzyme substrate methods are most likely to be the first rapid methods adopted for recreational water quality. Enzymatic substrate methods are based on the same capture technology as currently-approved EPA methods, with greater speed attained through enhanced detection technology. As such, the relationship to health risk can be established by demonstrating that the new detection capability produces equivalent results to existing procedures.

214 - Comparison of total coliform, fecal coliform, and enterococcus bacterial indicator response for ocean recreational water quality testing
Rachel T. Noble, D.F. Moore M.K. Leecaster, C.D. McGee, and S.B. Weisberg
http://www.ochealthinfo.com/docs/public/epi/h2o/Water-Research-Publication-2003.pdf
Purpose - To compare the relationship between the bacterial indicators, and the effect that changing the standards would have on recreational water regulatory actions, three regional studies were conducted along the southern California shoreline from Santa Barbara to San Diego, California.

Results - Cumulatively, our results suggest that replacement of a TC standard with an EC standard will lead to a five-fold increase in failures during dry weather and a doubling of failures during wet weather. Replacing a TC standard with one based on all three indicators will lead to an eight-fold increase in failures. Changes in the requirements for water quality testing have strong implications for increases in beach closures and restrictions.

217 - Relationships between sand and water quality at recreational beaches
M.C. Phillips, H.M. Solo-Gabriele, A.M. Piggot, J.S. Klaus and Y. Zhang
http://www.sciencedirect.com/science/article/pii/S0043135411006269
Purpose - Enterococci are used to assess the risk of negative human health impacts from recreational waters. Studies have shown sustained populations of enterococci within sediments of beaches but comprehensive surveys of multiple tidal zones on beaches in a regional area and their relationship to beach management decisions are limited.

Results - We sampled three tidal zones on eight South Florida beaches in Miami-Dade and Broward counties and found that enterococci were ubiquitous within South Florida beach sands although their levels varied greatly both among the beaches and between the supratidal, intertidal and subtidal zones.

218 - Shedding of Staphylococcus aureus and methicillin-resistant Staphylococcus aureus from adult and pediatric bathers in marine waters
L.R.W. Plano, A.C. Garza, T. Shibata, S.M. Elmier, J. Kish, C.D. Sinigalliano,M.L. Gidley, G. Miller, K. Withum, L.E. Fleming, and H.M. Solo-Gabriele
http://www.biomedsearch.com/attachments/00/21/21/10/21211014/1471-2180-11-5.pdf
Purpose - The primary aim of this study was to evaluate the amount and characteristics of the shedding of methicillin sensitive S. aureus, MSSA and MRSA by human bathers in marine waters.

Results - Twelve of 15 MRSA isolates collected from the water had identical genetic characteristics as the organisms isolated from the participants exposed to that water while the remaining 3 MRSA were without matching nasal isolates from participants. The amount of S. aureus shed per person corresponded to 105 to 106 CFU per person per 15-minute bathing period, with 15 to 20% of this quantity testing positive for MRSA. These findings clearly demonstrate that adults and toddlers shed their colonizing organisms into marine waters and therefore can be sources of potentially pathogenic S. aureus and MRSA in recreational marine waters. Additional research is needed to evaluate recreational beaches and marine waters as potential exposure and transmission pathways for MRSA.

111 - A comparison of ARA and DNA data for microbial source tracking based on source-classification models developed using classification trees
Bertram Price, Elichia Venso, Mark Frana, Joshua Greenberg, and Adam Ware
http://faculty.salisbury.edu/~mffrana/Cell%20Biol%20Spring%2008/Frana%20paper,%20after.pdf

Purpose - Determine whether increased reliability, if any, of library-based MST developed with DNA data is sufficient to justify its higher cost, where source predictions are used in TMDL surface water management programs.

Results - While the overall rates of correct classification are higher for the DNA data than for the ARA data, the resulting source predictions for both data indicate similar TMDL surface water bacterial contamination reduction strategies. Questioning the value of DNA data relative to ARA data for MST intended for application in a TMDL program is justified, and the answer may favor ARA data for this application.

112 - Quantitative PCR Method for Sensitive Detection of Ruminant Fecal Pollution in Freshwater and Evaluation of This Method in Alpine Karstic Regions

Georg H. Reischer, David C. Kasper, Ralf Steinborn, Robert L. Mach, and Andreas H. Farnleitner

http://aem.asm.org/content/72/8/5610.full.pdf+html

Purpose - Establish a method for the sensitive quantification of ruminant fecal pollution in spring water and groundwater from alpine karstic regions important for public water supplies. Identify a ruminant-specific genetic marker in fecal members of the phylum Bacteroidetes.

Results - The marker could be found at concentrations ranging from not detectable in 4.5 liters (KPAS) to 106 marker equivalents per liter (LKAS2 flood). Strong differences in occurrence were obvious and in accordance with the expected different levels of ruminant fecal.

Preliminary experiments testing the stability of the marker in highly diluted fecal suspensions in spring water at ambient temperatures (4°C) found no strong reduction of detectable marker levels during an incubation period of 2 months.

After additional evaluation, the assay might allow the specific allocation of fecal pollution in alpine water sources, enabling target oriented measures in the catchment area and thus facilitating watershed management. Furthermore, it could also provide additional information for quantitative microbial risk assessment studies as part of water safety plans recommended by the WHO (35), allowing the relative estimation of ruminant fecal input compared to other sources.

164 - Pathogenic fungi: an unacknowledged risk at coastal resorts? New insights on microbiological sand quality in Portugal

R. Sabino, C. Verissimo, M.A. Cunha, B. Wergikoski, F.C. Ferreira, R. Rodrigues, H. Parada, L. Falcão, L. Rosado, C. Pinheiro, E. Paixão, and J. Brandão

http://www.sciencedirect.com/science/article/pii/S0025326X11001962

Purpose - Determine the presence of yeasts, pathogenic fungi, dermatophytes, total coliforms, Escherichia coli and intestinal enterococci in sand at thirty-three beaches across Portugal.

Results - Results showed that 60.4% of the samples were positive for fungi and that 25.2% were positive for the bacterial parameters. The most frequent fungal species found were Candida sp. and Aspergillus sp., whereas intestinal enterococci were the most frequently isolated bacteria.

Positive associations were detected among analyzed parameters and country-regions but none among those parameters and sampling period. Regarding threshold values, we propose 15 cfu/g for yeasts, 17 cfu/g for potential pathogenic fungi, 8 cfu/g for dermatophytes. Eighty four cfu/g for coliforms, 250 cfu/g for E. coli, and 100 cfu/g for intestinal enterococci.

114 - The use of ribotyping and antibiotic resistance patterns for identification of host sources of Escherichia coli strains

M. Samadpour, M.C. Roberts, C. Kitts, W. Mulugeta and D. Alfi

http://onlinelibrary.wiley.com/doi/10.1111/j.1472-765X.2004.01630.x/pdf

Purpose - To compare antibiotic resistance and ribotyping patterns ability to identify triplicate isolates sent from a group of 40 Escherichia coli taken from seven host sources.

Results - Of the 120 isolates, 22 isolates were resistant to ampicillin, streptomycin, tetracycline and trimethoprim and 98 isolates were susceptible. Antibiotic patterns identified 33 of the triplicates and three of the six groups had isolates from multiple hosts. Ribotyping divided the isolates into 27 ribotype groups with all triplicates grouped into the same ribotype group with one host per group.

219 - The effects of rainfall on Escherichia coli and total coliform levels at 15 Lake Superior recreational beaches

R. Sampson, S. Swiatnicki, C. McDermott, and G. Kleinheinz

http://www.environmental-expert.com/Files%5C6063%5Carticles%5C9235%5C11-12-6.pdf

Purpose - Fifteen beaches along Lake Superior were monitored over the course of the 2003 and 2004 summer swimming seasons from mid-May through mid-September. Water samples were collected at these 15 beaches less than 24-h after a rainfall event of at least 6 mm. The effect of rainfall on bacterial concentrations along the Wisconsin shores of Lake Superior was investigated.

Results - No relationship between rainfall amount and bacterial concentrations at any of the 15 beaches tested was found. Although other researchers have observed a direct positive relationship between rainfall and E. coli levels in beach water, we found no significant relationship for Lake Superior beaches. This is an important finding given the fact that beach closures are often based upon rainfall alone rather than on actual E. coli concentration measurements. This study reinforces the fact that the data obtained at one location should not necessarily be extrapolated to beach closure decisions at other locations.

141 - Modeling the dry-weather tidal cycling of fecal indicator bacteria in surface waters of an intertidal wetland

Brett F. Sanders, F. Arega, and M. Sutula

ftp://www.sccwrp.org/pub/download/DOCUMENTS/AnnualReports/2005_06AnnualReport/AR0506_051-66.pdf

Purpose - Utilize a developed model and apply it to predict the dry-weather tidal cycling of FIB in Talbert Marsh, in response to loads from urban runoff, bird feces and resuspended sediments.

Results - Model predictions show that surface water concentrations of TC, EC, and ENT in the wetland are driven by loads from urban runoff and resuspended wetland sediments. The model more accurately predicts TC than EC or ENT. The crucial role that sediments play in the cycling of FIB is highlighted by this study. Sediments function as a reservoir of FIB that may accumulate FIB due to regrowth or settling, or shed FIB when tidal currents or storm flows scour away or even just disturb surficial particles.

115 - Patterns of Antimicrobial Resistance Observed in Escherichia coli Isolates Obtained from Domestic- and Wild-Animal Fecal Samples, Human Septage, and Surface Water
Raida S. Sayah, J.B. Kaneene, Y. Johnson, and R. Miller
http://aem.asm.org/content/71/3/1394.full.pdf+html
Purpose - (i) To identify patterns of antimicrobial agent resistance of E. coli strains obtained from human septage, domestic animals, and wildlife living in the Red Cedar watershed in Michigan, and (ii) to compare these antimicrobial agent resistance patterns with those of E. coli strains obtained from surface water in the same watershed.

Results - Antimicrobial agent resistance was detected in all types of samples collected (Table 4). The most frequently encountered form of resistance in all samples was resistance to tetracycline (27.3%), followed by resistance to cephalothin (22.7%), resistance to sulfisoxazole (13.3%), and resistance to streptomycin (13.1%). Animal fecal samples exhibited resistance to all agents tested, while human septage and river water samples showed resistance to three agents and one agent, respectively.
Resistance to cephalothin was present in all types of samples, while tetracycline resistance and streptomycin resistance were found in all types of samples except river water. Resistance to tetracycline was present in both fecal and farm environment samples from all livestock species, while resistance to trimethoprim-sulfamethoxazole was present in both types of samples from only dairy cattle and equids.

142 - Tracking sources of bacterial contamination in stormwater discharges from Mission Bay, California
Kenneth C. Schiff, and P. Kinney
ftp://www.sccwrp.org/pub/download/DOCUMENTS/AnnualReports/1999AnnualReport/07_ar06.pdf
Purpose - Identify whether wet-weather discharges were the predominant source of bacterial contamination to receiving waters.

Results - Seasonal cycles were evident, with the highest levels of total coliform, fecal coliform and enterococcus occurring during the wettest months.

220 - Microbiological Water Quality at Reference Beaches in Southern California During Wet Weather. Technical Report #448
Kenneth C. Schiff, J. Griffith, and G. Lyon

http://www.sccwrp.org:8060/pub/download/DOCUMENTS/TechnicalReports/448_reference_beach.pdf
Purpose - Assess the microbial water quality at reference beaches following wet weather events in southern California.

Results - Based on the results from this study, natural contributions of nonhuman fecal indicator bacteria were sufficient to generate exceedances of the State of California water quality thresholds during wet weather.

145 - Water Quality Indicators and the Risk of Illness in Non-Point Source Impacted Recreational Waters
Kenneth C. Schiff, S.B. Weisberg and J.M. Colford Jr.
ftp://swrcb2a.waterboards.ca.gov/pub/rwqcb2/TMDL-WEF/5d.pdf
Purpose - Determine if: 1) water contact increased the risk of illness in the two weeks following exposure to water in Mission Bay? and 2) did the risk of illness increase with increasing levels of microbial indicators of water quality?

Results - Outside of skin rash and diarrhea, there was no statistically increased risk of 12 other symptoms, including highly credible gastrointestinal illness (HCGI). These results contrast with most other recreational bathing studies, most likely because of the lack of human sources of fecal pollution.

165 - Variation of microorganism concentrations in urban stormwater runoff with land use and seasons
A. Selvakumar, and M. Borst
http://www.iwaponline.com/jwh/004/0109/0040109.pdf
Purpose - This study investigates if variations in concentrations of microorganisms by at least 1/3-log at the 95% level of confidence are potentially attributable to land use and seasons. Differences less than 1/3-log have little practical importance even if there is statistical significance as the sensitivity of the analyses procedure is less than these.

Results - Statistically significant differences were found between land uses for all microorganisms studied except for E. coli. Other than E. coli, the microbial concentrations in stormwater runoff consistently vary within and between land uses. Generally, the concentrations in runoff from high-density residential areas are higher than the concentrations in other tested land uses.

222 - Indicator microbes correlate with pathogenic bacteria, yeasts and helminthes in sand at a subtropical recreational beach site
A.H. Shah, A.M. Abdelzaher, M. Phillips, R. Hernandez, H.M. Solo-Gabriele, J. Kish, G. Scorzetti, J.W. Fell, M.R. Diaz, T.M. Scott, J. Lukasik, V.J. Harwood,, S. McQuaig, C.D. Sinigalliano, M.L. Gidley, D. Wanless, A. Ager, J. Lui, J.R. Stewart, L.R. Plano, and L.E. Fleming
http://www.ncbi.nlm.nih.gov/pubmed/21447014

Purpose - The objectives of this study were to evaluate the presence and distribution of pathogens in various zones of beach sand (subtidal, intertidal and supratidal) and to assess their relationship with environmental parameters and indicator microbes at a non-point source subtropical marine beach.

Results - Results indicate that indicator microbes may predict the presence of some of the pathogens, in particular helminthes, yeasts and the bacterial pathogen Staphylococcus aureus including methicillin-resistant forms. Indicator microbes may thus be useful for monitoring beach sand and water quality at non-point source beaches.

132 - Evaluation of conventional and alternative monitoring methods for a recreational marine beach with non-point source of fecal contamination

Tomoyuki Shibata, H.M. Solo-Gabriele, C.D. Sinigalliano, M.L. Gidley, L.R.W. Plano, J.M. Fleisher, J.D. Wang, S.M. Elmir, G. He, M.E. Wright, A.M. Abdelzaher, C. Ortega, D. Wanless, A.C. Garza, J. Kish, T. Scott, J. Hollenbeck, L.C. Backer, and L.E. Fleming

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2966524/

Purpose - Compare enterococci (ENT) measurements based on the membrane filter, ENT(MF) with alternatives that can provide faster results including alternative enterococci methods (e.g. chromogenic substrate (CS), and quantitative polymerase chain reaction (qPCR)), and results from regression models based upon environmental parameters that can be measured in real-time.

Results - In addition to physico-chemical and hydrometeorological parameters, results also suggested that bacterial indicator levels were affected by the numbers of animals on the beach which may also have seasonal patterns associated with their numbers and fecal inputs. Thus, levels of enterococci at non-point source beaches are affected by a myriad of environmental factors and input loadings which are very difficult to capture within simple regression models.

223 - Adhesion of Enterococcus faecalis in the nonculturable state to plankton is the main mechanisms responsible for persistence of this bacterium in both lake and seawater

C. Signoretto, G. Burlacchini, M. del Mar Lleò, C. Pruzzo, M. Zampini, L. Pane, G. Franzini, and P. Canepari

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC525140/

Purpose - In this study we describe the results of the monitoring of the microbiological quality of both freshwater and marine water by applying an approach consisting of detecting both culturable and nonculturable enterococci which are present in water and adherent to the plankton in order to evaluate to what extent the adhesion to plankton and the VBNC state may represent survival strategies and contribute to the formation of environmental reservoirs of these microorganisms.

Results - We show that molecular methods for the detection of enterococci resulted in a higher number of positive samples than the culture method. The most interesting result of this study was the observation that in Lake Garda E. faecalis is almost exclusively found either adhering to plankton or in water, and not both. This result was also confirmed by the results in seawater, although not to such an evident extent.

123 - TRANSPORT OF FECAL BACTERIA FROM POULTRY LITTER AND CATTLE MANURES APPLIED TO PASTURELAND

M.L. Soupir, S. Mostaghimi, E.R. Yagow, C. Hagedorn, and D.H. Vaughan
http://www.environmental-center.com/Files%5C0%5Carticles%5C9338%5CTransportOfFecalBacteria.pdf
Purpose - An understanding of the overland transport mechanisms from land applied waste is needed to improve design of best management practices (BMPs) and modeling of nonpoint source (NPS) pollution.

Results - Results of this comparative study clearly indicate that cowpies have a greater potential to contribute high fecal bacteria concentrations into streams than the land application of liquid dairy manure or turkey litter, although bacteria concentrations in runoff from all treatments exceeded Federal standards for primary contact in the United States. The relationship between runoff rates and concentrations of the indicator species was dependent upon the animal waste application, the indicator species and antecedent soil moisture conditions.

152 - Variability of Indicator Bacteria at Different Time Scales in the Upper Hoosic River Watershed

Elena Traister, and S.C. Anisfeld
http://www.forestry.yale.edu/uploads/publications/Anisfeld-pub03.pdf
Purpose - Evaluate whether the Upper Hoosic River Basin is meeting water quality criteria for indicator bacteria.

Results - Bacterial levels were higher in more developed watersheds; in summer rather than winter; in storms rather than baseflow; and in the early morning rather than afternoon.

227- Prevalence of yeasts in beach sand at three bathing beaches in South Florida

C. Vogel, A. Rogerson, S. Schatz, H. Laubach, A. Tallman, and J. Fell
http://www.sciencedirect.com/science/article/pii/S004313540700108X
Purpose - Determine the abundance and types of yeasts in the wet and dry sand of three recreational beaches in South Florida.

Results - While definitive statements cannot be made, high levels of yeasts may have a deleterious bearing on human health and the presence of such a diverse aggregation of species suggests that yeasts could have a role as indicators of beach health.

224 - Effect of waterfowl (Anas platyrhynchos) on indicator bacteria populations in a recreational lake in Madison, Wisconsin

J.H. Standridge, J.J. Delfino, L.B. Kleppe, and R. Butler
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC243530/pdf/aem00202-0205.pdf

Purpose - Determine the level of effect that waterfowl has on the water quality of a Madison, WI lake.

Results - The most common human health hazard associated with ducks is swimmer's itch, or echinostoma revolutum (12). The duck tapeworm can also occasionally infect humans (4). Ducks have often been implicated as carriers and disseminators of Salmonella (1, 3, 11, 12, 16, 17). The occurrence of these zoonoses indicates that fecal contamination from ducks is a human health hazard and that beach closings based on the presence of high counts of fecal coliform indicator bacteria are warranted. Future surveys aimed at detecting the possible presence of Salmonella in the Vilas Park beach area are indicated.

228 - Estimation of enterococci input from bathers and animals on a recreational beach using camera images
J.D. Wang, H.M. Solo-Gabriele, Am. M. Abdelzher, and L.E. Fleming
http://www.sciencedirect.com/science/article/pii/S0025326X10001062
Purpose - Develop a counting methodology to better understand non-point source load impacts. Enterococci inputs to the study beach site (located in Miami, FL) are dominated by non-point sources (including humans and animals).

Results - Enterococci source functions were computed from the observed number of unique individuals for average days of each month of the year, and from average load contributions for humans and for animals. Results indicate that dogs represent the larger source of enterococci relative to humans and birds.

229 - Hand-mouth transfer and potential for exposure to E. coli and F+ coliphage in beach sand, Chicago, Illinois
R.L. Whitman, K. Przybyla-Kelly, D.A. Shively, M.B. Nevers, and M.N. Byappanahalli
http://www.ncbi.nlm.nih.gov/pubmed/19590129
Purpose - Examine the transferability of Escherichia coli and F+ coliphage (MS2) from beach sand to hands in order to estimate the potential subsequent health risk.

Results - Using dose-response estimates developed for swimming water, it was determined that the number of individuals per thousand that would develop gastrointestinal symptoms would be 11 if all E. coli on the fingertip were ingested or 33 if all E. coli on the hand were ingested. These results suggest that beach sand may be an important medium for microbial exposure; bacteria transfer is related to initial concentration in the sand; and rinsing may be effective in limiting oral exposure to sand-borne microbes of human concern.

169 - Microbial load from animal feces at a recreational beach
M.E. Wright, H.M. Solo-Gabriele, S. Elmir, and L.E. Fleming
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2771205/pdf/nihms138348.pdf
Purpose - The goal of this study was to quantify the microbial load (enterococci) contributed by the different animals that frequent a beach site.

Results - The highest enterococci concentrations were observed in dog feces with average levels of 3.9 x 10(7) CFU/g; the next highest enterococci levels were observed in birds averaging 3.3 x 10(5)CFU/g. The lowest measured levels of enterococci were observed in material collected from shrimp fecal mounds (2.0 CFU/g). A comparison of the microbial loads showed that 1 dog fecal event was equivalent to 6940 bird fecal events or 3.2 x 10(8) shrimp fecal mounds. Comparing animal contributions to previously published numbers for human bather shedding indicates that one adult human swimmer contributes approximately the same microbial load as one bird fecal event. Given the abundance of animals observed on the beach, this study suggests that dogs are the largest contributing animal source of enterococci to the beach site.

231 - Microbial load from animal feces at a recreational beach
M.E. Wright, H.M. Solo-Gabriele, S. Elmir, and L.E. Fleming
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2771205/
Purpose - Quantify the microbial load (enterococci) contributed by the different animals that frequent a beach site.

Results - Results from this study provide evidence that dog feces represent the largest animal source to the study site. Improved management of dog feces at the beach could potentially reduce enterococci inputs to the beach, thereby decreasing the number of advisories for beach sites which are frequented by significant numbers of dogs.

8 - Are microbial indicators and pathogens correlated? A statistical analysis of 40 years of research
J. Wu, S. C. Long, D. Das and S. M. Dorner
http://www.iwaponline.com/jwh/up/wh2011117.htm
Purpose - The data were analyzed to assess factors affecting correlations using a logistic regression model considering indicator classes, pathogen classes, water types, pathogen sources, sample size, the number of samples with pathogens, the detection method, year of publication and statistical methods.

136 - Monitoring and Modeling Non-Point Source Contributions of Host-Specific Fecal Contamination in San Pablo Bay
Stefan Wuertz, F.A. Bombardelli, K. Sirikanchana, and D. Wang
http://escholarship.org/uc/item/8tk0z6p0.pdf
Purpose - This study employed mathematical and numerical transport models in concert with new molecular techniques to (i) characterize the sources of fecal contamination of water bodies and (ii) quantify the loads and distributions of *Bacteroidales* marker DNA sequences originating from different animal hosts in San Pablo Bay.

Results - Microbial source tracking using fecal *Bacteroidales* is an effective way to monitor fecal pollution of coastal waters. Low levels of the universal genetic marker are ubiquitous throughout

San Pablo Bay. The human marker BacHum-UCD was found in 75% of all samples but no cow- and almost no dog-specific marker was detected.

234 - Growth of enterococci in unaltered, unseeded beach sands subjected to tidal wetting
K.M. Yamahara, S.P. Walters, and A.B. Boehm
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2655449/
Purpose - To establish if naturally occurring enterococci can replicate in beach sands under environmentally relevant conditions.

Results - The results provide evidence that enterococci may not be an appropriate indicator of enteric disease risk at recreational beaches subject to nonpoint sources of pollution.

170 - A water quality modeling study of non-point sources at recreational marine beaches
X. Zhu, J.D. Wang, H.M. Solo-Gabriele, L.E. Fleming
http://www.sciencedirect.com/science/article/pii/S0043135411001266
Purpose - A model study was conducted to understand the influence of non-point sources including bather shedding, animal fecal sources, and near shore sand, as well as the impact of the environmental conditions, on the fate and transport of the indicator microbe, enterococci, at a subtropical recreational marine beach in South Florida.

Results - Enterococci released from beach sand during high tide caused mildly elevated concentration for a short period of time (ten to twenty of CFU/100 ml initially, reduced to 2 CFU/100 ml within 4 h during sunny weather) similar to the average baseline numbers observed at the beach. Bather shedding resulted in minimal impacts (less than 1 CFU/100 ml), even during crowded holiday weekends. In addition, weak current velocity near the beach shoreline was found to cause longer dwelling times for the elevated concentrations of enterococci, while solar deactivation was found to be a strong factor in reducing these microbial concentrations.

APPENDIX I

Identification of Goals

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Table of Contents

List of Tables

APPENDIX I. IDENTIFICATION OF GOALS

Numeric goals have been developed to support Water Quality Improvement Plan implementation and are used to measure progress toward addressing the highest priority water quality conditions. Numeric goals may take a variety of forms, but must be quantifiable so that progress toward and achievement of the goals are measurable. Applicable Total Maximum Daily Load (TMDL) targets are required to be incorporated as Water Quality Improvement Plan goals. Also in accordance with the MS4 Permit and applicable regulatory drivers, final goals and reasonable interim goals for each five-year period from Water Quality Improvement Plan approval to the anticipated final goal compliance date (including an interim goal for this permit term) have been developed.

Within the Mission Bay WMA, the Bacteria TMDL dictates the bacteria goals for each weather condition in Tecolote Creek and Scripps subwatersheds to address and attain REC-I beneficial uses. A TMDL represents the maximum amount of a pollutant of concern that a water body can receive and still attain water quality standards. TMDLs can take a variety of forms, including concentration-based TMDLs, which focus on reducing pollutant sources to achieve a maximum pollutant concentration consistent with existing water quality objectives (WQOs), and load-based TMDLs, which focus on reducing sources to achieve a watershed-specific maximum load that is protective of beneficial uses. The Bacteria TMDL incorporates load-based reductions that were calculated on the basis of watershed modeling results and applicable bacteria WQOs.

In addition to the Bacteria TMDL-listed segments of beach in the Scripps subwatershed, a portion of the subwatershed drains into the La Jolla Area of Special Biological Significance (ASBS 29) and is subject to regulation under the Ocean Plan and the ASBS General Exception and Special Protections. The City's Phase II Comprehensive Load Reduction Plan (CLRP) for Scripps (City, 2013a) determined copper to be the critical pollutant (stressor) requiring the largest load reduction (i.e., requires the greatest implementation of BMPs to meet the water quality target). However, the Phase II CLRP also noted that when the City's ASBS Site-Specific Dilution and Dispersion Model (dilutor factor) (City, 2013e) is applied to the ASBS water quality objectives, the critical stressor in the ASBS changes from copper to sediment. For the purposes of Water Quality Improvement Plan development, the dilution factor was applied and, therefore, sediment during wet weather is the highest priority water quality condition within the ASBS drainage areas (refer to Section 2.4 of this Water Quality Improvement Plan for additional detail).

Compliance with the Special Protections is measured by comparing monitoring results with the 85th percentile threshold of reference water quality, which is currently being investigated. The primary regulatory driver, identified by the largest required load reduction, determines the interim and final goals for each of the small coastal drainages that make up the Scripps subwatershed. The majority of the area is regulated by the Bacteria TMDL. Only one drainage area is solely regulated by the ASBS Special Protections and not the Bacteria TMDL. The remaining areas are not identified in the

Bacteria TMDL and are outside of the ASBS and are therefore not considered in the highest priority water quality condition.

This appendix presents Bacteria TMDL and ASBS Special Protections numeric targets, how the targets were derived, and how the targets were translated into Water Quality Improvement Plan numeric goals. Section I.1 presents the interim and final Water Quality Improvement Plan bacteria numeric goals for Scripps and Tecolote subwatersheds. Section H.2 presents the interim and final Water Quality Improvement Plan sediment numeric goals for the ASBS.

I.1 Identification of Bacteria Numeric Goals

The final numeric goals for both Tecolote Creek and Scripps subwatersheds were derived from water quality-based effluent limitations (WQBELs) identified in the Bacteria TMDL and incorporated into the MS4 Permit for freshwater creeks (Tecolote Creek) and beaches (Scripps). Bacteria TMDL WQBELs include receiving water limitations and effluent limitations, presented in multiple formats. The receiving water limitations and effluent limitations are discussed in detail in Section I.1.1 and Section I.1.2, respectively. Attachment E.4 of the Municipal Permit provides the following options to meet numeric goals and to demonstrate final compliance with the Bacteria TMDL:

(1) There is no direct or indirect discharge from the Responsible Agency's municipal separate storm sewer systems (MS4s) to the receiving water; OR

(2) There are no exceedances of the final receiving water limitations in the receiving water at, or downstream of, the Responsible Agency's MS4 outfalls; OR

(3) There are no exceedances of the final effluent limitations at the Responsible Agency's MS4 outfalls; OR

(4) The pollutant load reductions for discharges from the Responsible Agencies' MS4 outfalls are greater than or equal to the final effluent limitations; OR

(5) The Responsible Agencies can demonstrate that exceedances of the final receiving water limitations in the receiving water are due to loads from natural sources, AND pollutant loads from the Responsible Agencies'' MS4 are not causing or contributing to the exceedances; OR

(6) The Responsible Agencies develop and implement the Water Quality Improvement Plan as follows:

    (a) The Responsible Agencies incorporate best management practices (BMPs) to achieve the receiving water limitations and/or the effluent limitations,

    (b) The Responsible Agencies include an analysis in the Water Quality Improvement Plan, utilizing a watershed model or other watershed analytical tools, to demonstrate that the implementation of the BMPs achieves compliance with the final receiving water and/or effluent limitations,

(c) The results of the analysis must be accepted by the San Diego Water Board as part of the Water Quality Improvement Plan,

(d) The Responsible Agencies continue to implement the BMPs, and

(e) The Responsible Agencies continue to perform the specific monitoring and assessment specified to demonstrate compliance with the receiving water and effluent limitations (RWQCB, 2013a).

I.1.1 Receiving Water Limitations

Bacteria TMDL receiving water limitations are expressed as concentrations and as an allowable exceedance frequency. The limitations vary depending on the weather condition. The Bacteria TMDL identified WQBELs based on precipitation: wet weather (day of 0.2 inches of rainfall or more plus three days) and dry weather (all other days, including those in the winter season). For each condition, receiving water targets were identified based on water quality objectives (WQOs) (WQOs are concentrations of bacteria indicators identified as acceptable levels for recreational contact (REC-1). Total coliform WQOs are identified for saltwater segments only and are not applicable to freshwater streams, therefore receiving Water Quality Improvement Plan goals for Tecolote Creek are only identified for fecal coliform and *Enterococcus*. Table I-1.). The WQOs also vary depending on the type of receiving water; freshwater or saltwater. Tecolote Creek must comply with the freshwater WQOs. The Scripps shoreline must comply with the saltwater WQOs. The TMDL targets are directly incorporated as Water Quality Improvement Plan numeric goals. Table I-1 presents the TMDL receiving water limitations, and thus the Water Quality Improvement Plan numeric goals for Tecolote Creek and the Scripps shoreline, and the final compliance date.

WQOs are concentrations of bacteria indicators identified as acceptable levels for recreational contact (REC-1). Total coliform WQOs are identified for saltwater segments only and are not applicable to freshwater streams, therefore receiving Water Quality Improvement Plan goals for Tecolote Creek are only identified for fecal coliform and *Enterococcus.*

Table I-1
Final Receiving Water Numeric Goals for Mission Bay WMA

Bacteria Indicator	Tecolote Creek WQO (MPN/100mL)	Scripps Shoreline WQO (MPN/100mL)	Allowable Exceedance Frequency[1] (% Days Exceeding WQOs)	Final Compliance
Wet Weather (Single Sample Maximum)[2]				
Fecal coliform	400	400	22%	April 4, 2031
Enterococcus	61	104	22%	
Total coliform	N/A	10,000	22%	
Dry Weather (30-Day Geometric Mean)[3]				
Fecal coliform	200	200	0%	April 4, 2021
Enterococcus	33	35	0%	
Total coliform	N/A	1,000	0%	

Note:
1. The 22% allowable exceedance frequency only applies to wet weather days. For dry weather days, the dry weather bacteria densities must be consistent with the single sample maximum REC-1 water quality objects in the Ocean Plan.
2. During wet weather days, only the single sample maximum receiving water limitations are required to be achieved.
3. During dry weather days, the single sample maximum and 30-day geometric mean receiving water limitations are required to be achieved.

% = percent; mL = milliliters; MPN = most probable number; WQO = water quality objective

Wet weather conditions are episodic and short in duration; therefore, single-sample maximum WQOs apply. Geometric mean WQOs apply during dry weather when monitoring results over a longer duration are averaged and assessed. The WQOs do not account for a natural increase in bacteria loads during storm events. To account for background bacteria concentrations during wet weather, the Bacteria TMDL incorporated an allowable exceedance frequency of the WQO based on a reference (mostly undeveloped) watershed.

The Bacteria TMDL specifies a final receiving water limitation allowable exceedance frequency of 22 percent during wet weather periods based on reference conditions, but allows no exceedances during dry weather. Although the number of wet and dry weather days may change from year to year because of variable weather conditions, the percentage of allowable wet weather exceedance days will remain fixed. For example, the number of wet weather days in Water Year 2003 was 42. Therefore, the number of allowable wet weather exceedance days was 9 (22 percent of 42 days, rounded). Final compliance with the dry weather WQOs and TMDL loads is required by Fiscal Year (FY) 2021. Final compliance with the wet weather WQOs and TMDL loads is required by FY 2031.

I.1.2 Effluent Limitations

The Bacteria TMDL provides two expressions of effluent limitations. The first expression is equivalent to the receiving water limitations, but is assessed at MS4 outfalls (Table I-2). The second expression is a mass-based load reduction from the subwatersheds discussed below. Per the Municipal Permit, total coliform WQOs and corresponding exceedance frequencies are applicable to MS4 outfalls that drain to the Tecolote Creek mouth and are therefore included in both expressions of effluent limitations.

Table I-2
Final Effluent Numeric Goals Expressed as an Exceedance Frequency for Mission Bay WMA

Bacteria Indicator	Tecolote Creek (MPN/100mL)	Scripps Shoreline (MPN/100mL)	Allowable Exceedance Frequency[1] (% Days Exceeding WQOs)	Final Compliance
Wet Weather (Single Sample Maximum)[2,3]				
Fecal coliform	400	400	22%	April 4, 2031
Enterococcus	61	104	22%	
Total coliform[4]	10,000	10,000	22%	
Dry Weather (30-Day Geometric Mean)				
Fecal coliform	200	200	0%	April 4, 2021
Enterococcus	33	35	0%	
Total coliform[4]	1,000	1,000	0%	

Note:
1. The 22% allowable exceedance frequency only applies to wet weather days. For dry weather days, the dry weather bacteria densities must be consistent with the single sample maximum REC-1 water quality objects in the Ocean Plan for discharges to beaches, and the Basin Plan for discharges to creeks and creek mouths.
2. During wet weather days, only the single sample maximum receiving water limitations are required to be achieved.
3. During dry weather days, the single sample maximum and 30-day geometric mean receiving water limitations are required to be achieved.
4. Total coliform effluent limitations only apply to MS4 outfalls that discharge to the Pacific Ocean Shorelines and creek mouths.

% = percent; mL = milliliters; MPN = most probable number; WQO = water quality objective

The Bacteria TMDL calculated the watershed load reductions that were required to achieve the Bacteria TMDL receiving water limitations. The MS4 Permit incorporated these load reductions for wet and dry weather as effluent limitations. Watershed load reductions were recently recalculated using the watershed models used to develop the Bacteria TMDL for Tecolote Creek and Scripps subwatersheds to better reflect current conditions and improve the accuracy of bacteria load estimates for Water Quality Improvement Plan development. A representative time period was used to calculate the number of allowable exceedance days, since the Water Quality Improvement Plan focuses on implementation planning through an adaptive management framework. Water Year 2003 represents typical wet and dry weather conditions within the subwatershed, based on an analysis of rainfall data over a 20-year time period. There were 42 wet weather days in Water Year 2003. This representative period provides an appropriate benchmark to use in defining numeric goals and the resulting BMP implementation needs.

As in the Bacteria TMDL, the subwatersheds' loading capacity was calculated by multiplying the WQOs by the average daily modeled flow. Modeled daily loads greater than this threshold were flagged as an exceedance. The allowable exceedance load for wet weather was calculated by summing the top 9 days (22 percent of the 42 wet weather days in the representative year) with the highest modeled daily loads. This load was then subtracted from the modeled wet weather total for the year. The difference between the remaining modeled load and the updated TMDL load represents the load reduction required for wet weather. The percent load reduction is calculated by dividing the exceedance load by the total annual load for the representative year. In Scripps subwatershed, the percent load reduction was quantified for each sub-basin draining to the shoreline and then averaged across the TMDL subbasins. The final load reductions estimated to meet receiving water goals are presented in Table I-3 for Tecolote Creek and Scripps subwatersheds.

Table I-3
Final Numeric Goals Expressed as Percent Load Reduction within the Mission Bay WMA

Bacteria Indicator	Tecolote Creek Subwatershed Percent Load Reduction	Scripps Subwatershed Percent Load Reduction	Final Compliance
Wet Weather (Single Sample Maximum)			
Fecal coliform	17.9%	9.6%[1]	April 4, 2031
Enterococcus	11.7%	6.4%[1]	
Total coliform	9.9%	4.9%[1]	
Dry Weather (30-day Geometric Mean)			
Fecal coliform	98.7%	99.2%[1]	April 4, 2021
Enterococcus	100%	100%[1]	
Total coliform	99.7%	99.8%[1]	

Note:
1. Calculated based on the average load reduction required from sub-basins draining to TMDL Pacific Ocean Shoreline segments within the Scripps subwatershed.

% = percent; N/A = not applicable

Although total coliform WQOs are not applicable to freshwater creeks, Attachment E to the MS4 Permit incorporated total coliform effluent limitations to MS4 outfalls that discharge to Pacific Ocean shoreline *and* creek mouths listed in the Bacteria TMDL. Therefore, load reductions were assigned to the Tecolote Creek watershed.

Dry weather WQBELs, expressed as percent subwatershed load reduction, were calculated using the same formula, but without an allowable load using the reference watershed approach applied for dry weather, per the Bacteria TMDL. The TMDL load was calculated in the same manner as for wet weather, and the difference between the remaining modeled load and the TMDL load is the load reduction required for dry weather. The percent load reduction was calculated by dividing the exceedance load by the total annual load for the representative year. Note that dry weather modeling results are typically less reliable because of the episodic nature of irrigation runoff and other water sources during dry periods.

I.1.3 Interim Goals and Existing Conditions

The first five TMDL interim compliance pathways are the same as the final compliance pathways. In addition, two compliance pathways (6 and 7 below) provide interim compliance calculated using a midpoint between existing conditions and final targets. Finally, compliance pathway 8 provides interim compliance with the TMDL if the Responsible Agencies are implementing strategies selected and included in a watershed model or other analytical tool to demonstrate that the interim TMDL compliance requirements will be met. Attachment E.4 of the Municipal Permit provides the following options to meet interim numeric goals and to demonstrate interim compliance with the Bacteria TMDL:

(1) There is no direct or indirect discharge from the Responsible Agency's municipal separate storm sewer systems (MS4s) to the receiving water; OR

(2) There are no exceedances of the final receiving water limitations in the receiving water at, or downstream of, the Responsible Agency's MS4 outfalls; OR

(3) There are no exceedances of the final effluent limitations at the Responsible Agency's MS4 outfalls; OR

(4) The pollutant load reductions for discharges from the Responsible Agencies' MS4 outfalls are greater than or equal to the final effluent limitations; OR

(5) The Responsible Agencies can demonstrate that exceedances of the final receiving water limitations in the receiving water are due to loads from natural sources, AND pollutant loads from the Responsible Agencies'' MS4 are not causing or contributing to the exceedances; OR

(6) There are no exceedances of the interim receiving water limitations in the receiving water at, or downstream of, the Responsible Agency's MS4 outfalls; OR

(7) The pollutant load reductions for discharges from the Responsible Agencies' MS4 outfalls are greater than or equal to the interim effluent limitations; OR

(8) The Responsible Agencies submit and are fully implementing a Water Quality Improvement Plan, accepted by the San Diego Water Board, which provides reasonable assurance that the interim TMDL compliance requirements will be achieved by the interim compliance dates.

Interim goals are identified for each expression of WQBELs and each weather condition. TMDL interim compliance is calculated as the halfway point between the existing, 2002 conditions and the final TMDL target. The MS4 Permit allows an alternative interim compliance date from the original Bacteria TMDL compliance date (MS4 Permit, Attachment E). Interim compliance of receiving water or effluent limitations is most reasonably attained in FY24 for wet weather and FY19 for dry weather. Updates to existing programs, changes in municipal ordinances, and collaboration within jurisdictions, WMAs, and the region have been occurring since the Bacteria TMDL and the 2013 MS4 Permit were adopted and are ongoing. Through CLRP and Water Quality Improvement Plan development, planning efforts are underway, including measures to secure funding and increase general momentum to implement and expand storm water and water conservation measures. The alternative compliance dates allow for the success of the monitoring, assessment, and goal and strategy adaptation process detailed within this Water Quality Improvement Plan.

The TMDL model used data through 2002, which is why 2002 is considered the existing condition. The existing condition does not necessarily reflect current conditions, nor is it the Water Quality Improvement Plan baseline for all goals. The existing condition for load reductions is assumed to be 0% in 2002, as that was the beginning of implementation planning. The Bacteria TMDL estimated the 2002 existing exceedance frequency for wet weather since wet weather data was not available. The MS4 permit requires the dry weather exceedance frequency to be calculated and presented in the Water Quality Improvement Plans. For each indicator bacteria, available monitoring data collected between January 1, 1996 and December 31, 2002 was assessed and compared to 30-day geometric mean WQOs. Table I-4 presents the existing condition for the receiving water and effluent limitations and the interim TMDL compliance target for Tecolote Creek.

The Bacteria TMDL estimates that the 2002 wet weather exceedance frequency for fecal coliform at the mouth of Tecolote Creek was 75 percent and 81% for *Enterococcus* based on modeling results. To calculate dry weather exceedance frequencies in Tecolote Creek, 104 results were available for *Enterococcus* and 20 results for fecal coliform between 1996 and 2002. The exceedance frequency using geomeans (percent of dry weather days with a geomean exceeding the geomean WQO in Tecolote Creek) was 100% for both indicators, requiring an interim exceedance of 50%.

Table I-4
Existing Conditions and Interim TMDL Targets within the Tecolote Creek Subwatershed

Bacteria Indicator	Receiving Water Exceedance Frequency		Effluent Load Reduction		Interim Compliance Date
	Existing 2002 Condition	Interim Compliance[1]	Existing 2002 Condition	Interim Compliance[1]	
Wet Weather					
Fecal coliform	75%[2]	49%	0%	8.9%[3]	April 4, 2024
Enterococcus	81%[2]	51%	0%	5.8%[3]	
Total coliform	NA	NA	0%	5.0%[3]	
Dry Weather					
Fecal coliform	100%[4]	50%	0%	49.3%[3]	April 4, 2019
Enterococcus	100%[4]	50%	0%	50.0%[3]	
Total coliform	NA	NA	0%	49.9%[3]	

Note:
1. Interim compliance is calculated as 50% between the existing condition and the final TMDL target.
2. Source: Bacteria TMDL
3. Source: Updated modeling results
4. Source: Monitoring data

% = percent; N/A = not applicable

Table I-5 presents the existing condition for the receiving water and effluent limitations and the interim TMDL compliance target for the Scripps subwatershed. In Scripps, four shoreline monitoring stations have historical data: 1) La Jolla Shores at Vallecitos, 2) La Jolla Shores at Avenida de la Playa, 3) Children's Pool at Casa Beach, and 4) Whispering Sands Beach at Ravina Street. Table I-6 presents the existing exceedance frequencies calculated at each monitoring site and the overall exceedance frequency. The overall existing dry weather exceedance frequency was selected to calculate the Scripps interim goals, 50% of the reduction required between existing and final exceedance frequencies. In the interim compliance year, the interim goal will be met if the exceedance frequency is equal to or less than 6% for *Enterococcus*, 7% for fecal coliform, and 3% for total coliform.

Table I-5
Existing Conditions and Interim TMDL Targets within the Scripps Subwatershed

Bacteria Indicator	Receiving Water Exceedance Frequency		Effluent Load Reduction		Interim Compliance Date
	Existing 2002 Condition	Interim Compliance[1]	Existing 2002 Condition	Interim Compliance[1]	
Wet Weather					
Fecal coliform	52%[2]	37%	0%	4.8%[3]	April 4, 2024
Enterococcus	52%[2]	37%	0%	3.2%[3]	
Total coliform	52%[2]	37%	0%	2.5%[3]	
Dry Weather					
Fecal coliform	15%[4]	7%	0%	49.6%[3]	April 4, 2019
Enterococcus	13%[4]	6%	0%	50.0%[3]	
Total coliform	6%[4]	3%	0%	49.9%[3]	

Note:
1. Interim compliance is calculated as 50% between the existing condition and the final TMDL target.
2. Source: Bacteria TMDL
3. Source: Updated modeling results
4. Source: Monitoring data

% = percent; N/A = not applicable

Table I-6 Scripps Shoreline Dry Weather Existing Exceedance Frequencies

Site ID	Constituent	RWL	Historic Number of Geomeans	Historic Number of Exceedances	Existing Exceedance Frequency
Whispering Sands Beach at Ravina Street	Total Coliforms	1000	99	1	1.0%
	Fecal Coliforms	200	99	0	0.0%
	Enterococcus	35	99	4	4.0%
Children's Pool	Total Coliforms	1000	59	9	15.3%
	Fecal Coliforms	200	59	56	94.9%
	Enterococcus	35	59	0	0.0%
La Jolla Shores at Vallecitos	Total Coliforms	1000	2	0	0.0%
	Fecal Coliforms	200	2	0	0.0%
	Enterococcus	35	2	2	100%
La Jolla Shores at Avenida de la Playa	Total Coliforms	1000	230	12	5.2%
	Fecal Coliforms	200	230	1	0.4%

Site ID	Constituent	RWL	Historic Number of Geomeans	Historic Number of Exceedances	Existing Exceedance Frequency
	Enterococcus	35	230	44	19.1%
TOTAL	Total Coliforms		390	22	5.6%
	Fecal Coliforms		390	57	14.6%
	Enterococcus		390	50	12.8%

I.1.4 Compliance Pathways

Interim and final compliance with the Bacteria TMDL, as incorporated into the MS4 Permit, may be demonstrated by the Responsible Agencies using any one of the methods presented in the previous sections. Section 5 of the Water Quality Improvement Plan provides additional information on the monitoring that will be completed for assessment. The compliance analysis, modeling conducted to provide assurance that interim and final goals will be met, is discussed in more detail in Appendix K and Section 4.3 of the Water Quality Improvement Plan.

I.2 Identification of Goals from ASBS Special Protections

The California Ocean Plan prohibits waste discharges to ASBS with exceptions granted for select discharges (SWRCB, 2005). Storm water runoff from the City is permitted into the La Jolla State Marine Conservation Area (ASBS No. 29) per Resolution 2012-0012 (SWRCB, 2012). The Resolution includes narrative effluent limitations that require an iterative approach for evaluating and implementing BMPs that will prevent storm water from altering natural ocean water quality. BMPs to control storm water discharges to the ASBS shall be designed to achieve the Ocean Plan Table B instantaneous maximum WQOs or a 90% reduction in pollutant loading.

For the Comprehensive Load Reduction Plan (CLRP) Phase II and Water Quality Improvement Plan modeling analysis, concentration-based Ocean Plan effluent limitations, rather than the narrative requirements, form the basis for determining ASBS load reduction targets (SWRCB, 2005; City of San Diego, 2013). The Ocean Plan effluent limitations were also used in favor of the more generic 90% pollutant load reduction target. To focus the list of Table B constituents, the greatest threats to the ASBS were selected. The La Jolla Shores Coastal Watershed Management Plan identified metals (copper, chromium, nickel and arsenic), bacteria, and sediment as high priority pollutants of concern within the ASBS (SIO et al., 2008). The 2012 ASBS Special Protections provide protection for marine aquatic life and natural water quality, as opposed to the Bacteria TMDL, which focuses protection of human health. Bacteria are not required constituents for discharge, ocean, or reference monitoring because ASBS No. 29 is outside of the range of the southern sea otter. Therefore, the greatest threats to ASBS No. 29 are metals and sediment, for the purpose of this Water Quality Improvement Plan.

The WQOs listed in Table B of the Ocean Plan are equal to the instantaneous maximum concentration acceptable after initial dilution within the receiving water. To calculate concentration limits that would apply to storm water effluent, the Ocean Plan provides an equation based on background seawater concentrations and the minimum probable initial dilution of the effluent. To obtain an appropriate minimum initial dilution value, the City conducted a dilution and dispersion study for ASBS No. 29 similar to the study conducted and used in the University of California – San Diego, Scripps Institute of Oceanography (UCSD/SIO) discharge effluent limitations to the San Diego-Scripps State Marine Conservation Area (ASBS No. 31) (Jenkins et al., 2013; Jenkins et al., 2007). The goal was to produce a site-specific minimum probable initial dilution for the ASBS. The most conservative dilution factor was estimated to be 12.6:1 (based on storm drain SDL-062). CLRP (ASBS) load reduction targets were calculated based on the instantaneous maximum concentrations specified in Table B of the Ocean Plan for the ASBS priority pollutants. Dilution-adjusted discharge effluent limitations were calculated using the conservative initial dilution estimate (12.6:1). The Table B concentrations (with dilution) were used to calculate the Water Quality Improvement Plan load reduction targets for the ASBS drainage area and demonstrate compliance with the ASBS requirements.

Copper was used to represent metals for the Water Quality Improvement Plan load reduction calculations considering copper has one of the lowest effluent limit concentrations and extensive literature and monitoring data were available to develop modeling parameters (Table I-7). The models simulate total metals rather than total recoverable (dissolved) metals due to the availability of extensive literature and monitoring data relating model parameters to total metals. As a result, the total-to-dissolved metals conversion factor specified in the Chollas dissolved metals TMDL was used to convert the Table B total recoverable value to total copper (Regional Board, 2007). This value was then multiplied by the daily modeled flows to calculate the total copper wet weather load target for the ASBS drainage area. The required wet weather load reduction represents the difference between the modeled (existing) load and the target load for the ASBS drainage area.

Table I-7 Ocean Plan Table B: Priority Metals Water Quality Objectives

	Instantaneous Maximum Concentration at Completion of Initial Dilution	Discharge Effluent Limitations ASBS No. 29 (Dm = 12.6:1)
Total Recoverable Arsenic (µg/L)	80	1050.2
Total Recoverable/ Hexavalent Chromium (µg/L)	20	272
Total Recoverable Copper (µg/L)	30	382.8
Total Recoverable Nickel (µg/L)	50	680

Sedimentation measures were not included in Table B of the Ocean Plan. The Ocean Plan does list effluent limitations (after initial dilution is completed) specifically for

POTWs and industrial discharges for suspended solids, settleable solids, and turbidity. Although these effluent limits do not apply to municipal stormwater discharges, they were used to gauge the amount of sediment load reduction that may be needed. The Water Quality Improvement Plan models include TSS; therefore TSS was used to represent sediment loading for the ASBS. While Table A does not include a TSS maximum limit, the narrative objective states that the limit shall not be lower than 60 mg/l. This value was used to calculate the sediment load reduction target for the ASBS drainage area (multiplied by modeled daily flows) for TSS (Table I-8). Since the Ocean Plan values are effluent limits, separate calculations were not needed to adjust for initial dilution.

Table I-8 Ocean Plan Table A: Effluent Limitations

	Maximum at Any Time
Suspended Solids (mg/l)	+ (calculated using default value of 60)
Settleable Solids (ml/l)	3.0
Turbidity (NTU)	225

+ Dischargers shall remove 75% of suspended solids from the influent stream before discharging wastewater to the ocean, except that the effluent limitation to be met shall not be lower than 60 mg/l unless a lower effluent concentration is approved by the Regional Board and EPA.

I.2.1 ASBS Pollutant Load Reductions

The wet weather load reductions required for the two pollutants of concern were calculated for the ASBS drainage area and are presented in Table I-9. Total copper does not require a watershed load reduction and therefore sediment in the ASBS drainage area was determined to be the highest priority water quality condition. It is anticipated that by targeting sediment and bacteria throughout Scripps subwatershed, other pollutants will also be addressed.

Table I-9 ASBS Pollutant Load Reductions

Pollutant	Subwatershed Percent Load Reduction
Total Suspended Sediment (TSS)	0.25%[1]
Total Copper	<0.01%[1]

Note:
1. Calculated based on the cumulative total of the sub-basins draining to the ASBS.

I.2.2 Compliance with ASBS Special Protections

Within 30 months of the effective date of the ASBS Exception, a final ASBS Compliance Plan must be submitted to the Regional Board. The ASBS Compliance Plan is included as an appendix to the Mission Bay Water Quality Improvement Plan as Appendix G. Within six years of the effective date, any structural controls that are necessary to comply with the special conditions must be implemented and discharges into the affected ASBS maintain natural ocean water quality. Compliance with the Special Protections is measured by comparing monitoring results with the 85^{th} percentile threshold of reference water quality, which is currently being investigated. Additional information on compliance with ASBS Special Protections is provided in Appendix G.

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APPENDIX I

Jurisdictional Strategies and Schedules

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Table of Contents

List of Tables

APPENDIX J. JURISDICTIONAL STRATEGIES

Strategy selection within the Mission Bay WMA is discussed in Section 4.2.1 and Appendix K. This appendix provides the selected strategies for each Responsible Agency including the implementation approach and level of effort required. The corresponding implementation year and duration provide context for when the strategy will be implemented. Strategies not being implemented upon approval of the Water Quality Improvement Plan provide a future date for implementation or a trigger for implementation in the future. Responsible Agencies are continually collaborating with internal jurisdictional departments, other Responsible Agencies, stakeholders, and watershed groups, and these collaborating entities are presented in the jurisdictional strategies tables as well. The strategies are subject to change and will be modified through the adaptive management process, as needed.

J.1 City of San Diego Strategies

The City has identified water quality improvement strategies that are expected to provide the greatest benefits to the watershed and its residents, businesses, communities within the City's jurisdictional boundaries.

Strategies were selected by evaluating the following considerations, in descending priority:

- Potential to reduce pollutant loads for the highest priority condition condition(s)
- Potential to reduce loads for other pollutants (including priority water quality conditions)
- Cost effectiveness
- Feasibility and ease of implementation
- Social impacts and benefits
- Other[1] impacts and benefits

The strategies that provide the best value, most return on investment, and greatest range of benefits will be recommended, as needed, as the City moves forward in its water quality improvement efforts. The recommended strategies identified are consistent with those already identified in the Comprehensive Load Reduction Plans (CLRPs) for various TMDLs in the San Diego Region.

The City is currently developing a framework to evaluate potential other benefits the recommended strategies may provide beyond improved water quality. These benefits may be financial, environmental, or societal. The recommended strategies will be scored based on the number of other benefits they provide, and may guide future updates to the Water Quality Improvement Plan (Appendix N).

[1] Other benefits refer to outcomes of a strategy beyond water quality improvements. Other benefits can include reduced air pollution, increased water conservation, watershed protection, public open space, aesthetics-induced property value increases, and increased business investments.

The cumulative storm water quality benefits of the Recommended Strategies identified in this Plan are needed to achieve the level of effort needed to demonstrate progress toward achieving the Water Quality Improvement Plan's interim and final numeric goals. It is important to note that these strategies are subject to change through the iterative, adaptive management process set forth in this Water Quality Improvement Plan. Through the adaptive management process the Responsible Agencies will be able to implement strategies and assess their impact to water quality and use new available information to refine, modify, remove, replace, or add strategies which will ensure the most effective suite of strategies are being implemented. Therefore, actual implementation of strategies is dependent upon both approval of funding in future annual budgets and adjustments that may occur as part of the iterative process.

The recommended strategies selected are presented in Table J-1. These strategies will be implemented by the City; they are not intended to be implemented by private entities (e.g., development, business, industry, etc.). Some of the City's strategies, such as development planning, may have implications for private entities. The City has also developed a schedule as a best estimate of the shortest amount of time required to plan and implement the strategies. The City's schedule table is found in Table J-2. A compliance analysis using a watershed model was conducted to identify the strategies required to be implemented to meet interim and final goals. The adaptive management process provides the framework to evaluate progress toward meeting the goals and allows for modification of strategies. As strategies are modified, the compliance analysis will be updated as needed to provide assurance that numeric goals will be met.

Optional strategies are activities that may be implemented by the Responsible Agencies at their discretion through the iterative approach. Unlike the recommended strategies, optional strategies have not been determined to be necessary in order to achieve the Plan's interim and final numeric goals. However, the Responsible Agencies may select from the optional strategies if the current suite of recommended strategies is not demonstrating sufficient progress toward achieving interim or final numeric goals, and if other identified triggers are met. The City acknowledges watershed stakeholder concerns that opportunities for optional strategies may occur prior to achieving or not achieving interim goals. The City will implement optional strategies, such as land conservation, at any time during the compliance period if opportunities become available and identified triggers are met.

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Table J-1 City of San Diego Jurisdictional Strategies

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
Jurisdictional Strategies						
Development Planning						
All Development Projects						
CSD-1	Establish guidelines and standards for all development projects; provide technical support related to implementation of source control BMPs to minimize pollutant generation at each project and implement LID BMPs to maintain or restore hydrology of the area or implement easements to protect water quality, where applicable and feasible. Includes internal coordination and collaboration between City departments (DSD, PWD, and Engineering) to improve success and long-term benefits of BMPs.	Refer to JRMP (currently under development).	City-wide	Prior to FY16	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-1.1	Investigation and research of emerging technology.	Annually the Construction & Development Standards Group identifies new tasks to conduct literature review, communication with researchers outside of the City, physical testing and experimentation of new or emerging technologies, and other research with the goal of updating tools available for reducing pollutant loads from development and redevelopment sites.	City-wide	Prior to FY16	As needed	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-1.2	Approve and implement a green infrastructure policy.	The City will begin developing a policy in FY16 that will increase the green infrastructure requirements for City CIP projects. This policy will be coordinated with ongoing efforts to update City design manuals and LID design standards for public LID BMPs.	City-wide on public parcels	FY16 (Begin)	As needed	T&SW with DSD and PWD
CSD-1.3	Develop Design Standards for Public LID BMPs.	Improve quality of design to ensure efficiency and reliability in public designs.	City-wide	FY14-FY15	As needed	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-1.4	Outreach to impacted industry regarding minimum BMP requirement updates.	Affects commercial, industrial, and residential development.	City-wide	FY15	As needed	TBD
CSD-2	Train staff on LID regulatory changes and LID practices.	Formal training is required for all staff involved in development plan review to increase knowledge of LID BMPs. Goal of training associated with LID practices and regulations is to promote LID implementation and to avoid adverse conditions such as trees planted within swales, or planned drainage patterns which obstruct or inhibit LID performance.	City-wide	FY16	As needed	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-3	Amend municipal code and ordinances, including zoning ordinances, to facilitate and encourage LID opportunities to support compliance with the MS4 Permit and TMDLs in a reasonable manner. Ensure consistency with the City of San Diego's BMP Design Manual. Update the Storm Water Standards Manual accordingly.	Municipal codes and ordinances will be brought to City Council for consideration to encourage LID implementation (e.g., runoff detention and filtration using natural filters and stormwater retention for reuse). LID stormwater management will be encouraged in proposed codes and ordinances associated with development and redevelopment projects, which are brought to City Council for consideration.	City-wide	FY15	As needed	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-4	Create a manual that outlines right-of-way design standards.	Create a manual that includes flood control performance standards, permanent BMP elements design standards, design standards for green streets and other BMPs, and maintenance access. Provides drainage and streets design standards. Opportunity to merge various existing manuals and provide consistency.	City-wide	FY15	One time	T&SW with DSD and PWD
CSD-5	Provide technical education and outreach to the development community on the design and implementation requirements of the MS4 Permit and Water Quality Improvement Plan requirements.	Technical education and outreach to the development community includes outreach on design standards, City design manuals, and the WMAA.	City-wide	Prior to FY16	Ongoing	T&SW with DSD
Priority Development Projects (PDPs)						
CSD-6	For PDPs, provide technical support to other City departments to ensure implementation of on-site structural BMPs to control pollutants and manage hydromodification by developing City wide storm water development standards and design guidelines.	Coordinate with other City departments to promote and confirm a thorough understanding of requirements for implementing structural BMPs that control pollutants and manage hydromodification. Included in that understanding are requirements to confirm proper design and construction through processes controlled by other City departments.	City-wide	FY16	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-6.1	Institute a program to verify and enforce maintenance and performance of treatment control BMPs.	Refer to JRMP (currently under development).	City-wide	FY16	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-7	Update BMP Design Manual procedures to determine nature and extent of storm water requirements applicable to development projects and to identify conditions of concern for selecting, designing, and maintaining appropriate structural BMPs.	Refer to JRMP (currently under development).	City-wide	FY15	Every 5 years/ permit cycle	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-7.1	Amend BMP Design Manual for trash areas. Require full four-sided enclosure, siting away from storm drains and cover. Consider the retrofit requirement.	Amend BMP Design Manual and zoning standards/requirements which address reduction of pollutants for common areas of trash build-up (e.g. restaurants, supermarkets, "big box" retail stores with food, pet stores). Most effective method for source control of bacteria and trash is to employ four-sized trash enclosures with a cover over trash areas.	City-wide	FY15	One time	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-7.2	Amend BMP Design Manual for animal-related facilities, such as such as animal shelters, "doggie day care" facilities, veterinary clinics, breeding, boarding and training facilities, groomers, and pet care stores.	Amend BMP Design Manual and zoning requirements (including retrofits) to provide supplemental standards for animal facilities (including animal shelters, dog daycares, veterinary clinics, groomers, pet car stores, and breeding, boarding, and training facilities). Supplemental standards may include requiring covered trash enclosures, identification of landscaped relief areas on site plans, ensuring drainage connections and treatment swales for areas that will not drain to the sanitary sewer, as well as inspection of grading, drainage, and landscaping for outdoor exercise areas.	City-wide	FY15	One time	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-7.3	Amend BMP Design Manual for nurseries and garden centers.	Amend BMP Design Manual to provide supplemental standards for plant nurseries and garden centers. Standards will focus on reducing irrigation runoff, and loading of sediment, pesticides, and nutrients. Measures may include: covered outdoor storage, green waste management BMPs, improved irrigation efficiency to reduce dry-weather runoff, and containment of runoff from impervious areas where plants and materials are stored.	City-wide	FY15	One time	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-7.4	Amend BMP Design Manual for auto-related uses.	Amend BMP Design Manual to provide supplemental standards for automotive-related uses to reduce loading of metals, oils, grease, and trash. Measures may include: four-sized covered trash enclosures, and careful review of auto-related usage areas (e.g. garage bays at repair shops) for grading, drainage, and drain connections to sanitary sewer systems.	City-wide	FY15	One time	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-8	Develop and administer an alternative compliance program for on-site structural BMP implementation (includes identifying Watershed Management Area Analysis [WMAA] candidate projects). Refer to Section 4.2.5.	Refer to JRMP (currently under development).	City-wide	FY15	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-8.1	Create a fund that allows habitat acquisition, protection enhancement, and restoration in conjunction with other cooperating entities including community groups, academic institutions, state county, and federal agencies, etc.	This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, 4) partners have been identified and formal MOUs have been developed, and 5) consensus and community support has been achieved.	City-wide	Optional	TBD	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
Construction Management						
CSD-9	Coordinate with other City departments to promote and confirm a thorough understanding of requirements for implementing temporary BMPs that control sediment and other pollutants during the construction phase of projects. Included in that understanding are requirements to inspect at appropriate frequencies and effectively enforce requirements through process controlled by other City departments.	Refer to JRMP (currently under development).	City-wide	FY16	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
Existing Development						
Commercial, Industrial, Municipal, and Residential Facilities and Areas						
CSD-10	Administer a program to require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types, and PGAs, as appropriate. Includes inspection of existing development at appropriate frequencies and using appropriate methods.	Refer to JRMP (currently under development).	City-wide	FY16	Ongoing	T&SW with DSD, PUD, & PWD
CSD-10.1	Update minimum BMPs for existing residential, commercial, and industrial development. Specific updates to BMPs include required street sweeping, catch basin cleaning, and maintenance of private roads and parking lots in targeted areas.	Refer to JRMP (currently under development).	City-wide	FY15	Every 5 years	T&SW

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-10.2	Outreach to property managers and trash haulers to elevate the emphasis of power washing as a pollutant source.	Emphasis will be placed on non-compliant washing as an enforceable violation.	City-wide Residential, commercial and industrial areas	FY15	Ongoing	T&SW
CSD-10.3	Implement property based inspections.	Property-based inspections increase awareness and responsibility for individual properties to tackle issues associated with trash, landscapes, and parking areas. Expanding beyond the business-level inspections will achieve different and more effective opportunities for education, outreach, inspection, and enforcement to encourage water conservation strategies.	City-wide	Prior to FY16	Ongoing	T&SW
CSD-10.4	Review policies and procedures to ensure discharges from swimming pools meet permit requirements.	Verify and bring to City Council for consideration an update (as needed) for the City's Municipal Code (43.0301) to meet new permit requirements for swimming pool discharges.	City-wide	FY15	As needed	T&SW, City Attorney (Civil & Criminal)
CSD-11	Promote and encourage implementation of designated BMPs for residential and non-residential areas.	Landscape-based rebates are a "gateway" for adoption of other beneficial practices and are one of the nonstructural methods which address impacts from single-family residential areas (City of San Diego 2011 program development background study). Residential incentives can include: education and training (neighborhood watershed field days), and aggressive subsidies or rebates for grass replacement and rainwater harvesting. Existing programs will be expanded overall, and also have targeted expansion within specific subwatershed, particularly with highest water quality priority conditions.	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing	T&SW with DSD, PUD, PWD, MWD, CWA & local water agencies
CSD-11.1	Residential and Commercial BMP: Rain Barrel	The existing PUD rebate program will continue for residential properties and expand for commercial properties for water collection, conservation, and reuse with rain barrels.	City-wide Residential Areas	Prior to FY16	Ongoing	T&SW with DSD, PUD, PWD, & local water agencies
CSD-11.2	Residential and Commercial BMP: Grass Replacement	The existing PUD grass replacement cash rebate program will continue and expand for residential and commercial properties. Program encourages a reduction in water use through the conversion of non-artificial grass to water wise plant material, while maintaining a high level of living landscape to benefit the environment.	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing	T&SW with DSD, PUD, PWD, & local water agencies
CSD-11.3	Residential and Commercial BMP: Downspout Disconnect	Disconnecting downspouts provide alternate runoff pathways from rooftops, sidewalks, driveways, and roads. Disconnecting downspouts from residential areas to pervious land can allow for depression storage and infiltration.	City-wide Residential and Commercial Areas	FY16	Ongoing	T&SW with DSD, PUD, PWD, & local water agencies
CSD-11.4	Residential and Commercial BMP: Microirrigation	The existing PUD micro-irrigation rebate program will continue and increase for residential and commercial properties. Application of microirrigation aims to improve the efficiency of landscape irrigation through the precise application of water.	City-wide Residential Areas	Prior to FY16	Ongoing	T&SW with DSD, PUD, PWD, & local water agencies

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-11.5	Provide Onsite Water Conservation Surveys.	Provide free onsite water conservation surveys to commercial and residential customers to reduce overirrigation and to encourage water conservation.	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing	T&SW with DSD, PUD, PWD, & local water agencies
MS4 Infrastructure						
CSD-12	Implementation of operation and maintenance activities (inspection and cleaning) for MS4 and related structures (catch basins, storm drain inlets, channels as allowed by resource agencies, detention basins, etc.) for water quality improvement and for flood control risk management.	Refer to JRMP (currently under development).	City-wide	FY16	Ongoing	T&SW
CSD-12.1	Proactively repair and replace MS4 components to provide source control from MS4 infrastructure.	In order to limit inflow of pollutants and reduce pollutant loads, proactive measures will be taken to improve, repair, and replace MS4 components. The City of San Diego will start a multi-year program of repairing and replacing storm drain pipes to reduce sediment loading to the MS4. Development of an assessment management program and bond issues will be addressed. Exploration of daylighting pipes will take place where feasible and appropriate.	City-wide	FY16	Ongoing	T&SW
CSD-13	Coordinate with other City departments (PUD) to implement controls to prevent infiltration of sewage into the MS4 from leaking sanitary sewers.	Refer to JRMP (currently under development).	City-wide	FY16	Ongoing	T&SW with PUD
CSD-13.1	Identify sewer leaks and areas for sewer pipe replacement prioritization.	Risk assessment to include identifying targeted areas (age, location, proximity to MS4), coming up with methodology, pilot, desktop exercise/analysis.	City-wide	FY16	As needed	T&SW with PUD
Roads, Street, and Parking Lots						
CSD-14	Implement operation and maintenance activities for public streets, unpaved roads, paved roads, and paved highways.	Refer to JRMP (currently under development).	City-wide	FY16	Ongoing	T&SW
CSD-14.1	Initiate sweeping of medians on high-volume arterial roadways.	Medians of roadways are also a potential source of pollutants. Consider implementing or increasing sweeping of medians. Consider mechanical and hand sweeping techniques.	City-wide	FY17	Ongoing	T&SW
Pesticide, Herbicides, and Fertilizer BMP Program						
CSD-15	Require implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers on commercial, industrial, and municipal properties. Includes education, permits, and certifications.	Refer to JRMP (currently under development).	City-wide	FY16	Ongoing	T&SW with Parks and Rec
Retrofit and Rehabilitation in Areas of Existing Development						
CSD-16	Develop and implement a strategy to identify candidate areas of existing development appropriate for retrofitting projects and facilitate the implementation of such projects.	Refer to JRMP (currently under development). The Offsite Alternative Compliance Program will include methods for identifying and assessing potential retrofit projects in existing development areas. Retrofit project selection will be based upon a variety of factors including proximity to high priority water quality conditions, potential pollutant load removal effectiveness, and feasibility of implementation. The program will include protocols related to funding mechanisms for project construction and long-term maintenance, payment and credit structures, and water quality equivalency standards.	City-wide	TBD	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-17	Develop and implement a strategy to identify candidate areas of existing development for stream, channel, or habitat rehabilitation projects and facilitate implementation of such projects.	Refer to JRMP (currently under development). The Offsite Alternative Compliance Program (Section 4.2.5.2 and Appendix N) will include methods for identifying and assessing potential stream, channel, or habitat rehabilitation projects in existing development areas. Rehabilitation project selection will be based upon a variety of factors including existing stream or habitat degradation, potential future cumulative stream or habitat impacts, and feasibility of implementation. The program will include protocols related to funding mechanisms for project construction and long-term maintenance, payment and credit structures, and water quality equivalency standards.	City-wide	TBD	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
Illicit Discharge, Detection, and Elimination (IDDE) Program						
CSD-18	Implement Illicit Discharge, Detection, and Elimination (IDDE) Program per the JRMP. Requirements include: maintaining an MS4 map, using municipal personnel and contractors to identify and report illicit discharges, maintaining a hotline for public reporting of illicit discharges, monitoring MS4 outfalls, and investigating and addressing any illicit discharges.	Refer to JRMP (currently under development).	City-wide	Prior to FY16	Ongoing	T&SW
Public Education and Participation						
CSD-19	Implement a public education and participation program to promote and encourage development of programs, management practices, and behaviors that reduce the discharge of pollutants in storm water prioritized by high-risk behaviors, pollutants of concern, and target audiences.	Refer to JRMP (currently under development).	City-wide	Prior to FY16	Ongoing	T&SW
CSD-19.1	Continue implementation of a Pet Waste Program.	Pet Waste Program includes outreach on "Scoop the poop", installation of posts for dispensers, distribution of lawn signs, and attendance at dog-related community activities.	City-wide	Prior to FY16	Ongoing	T&SW with Parks and Rec
CSD-19.2	Consider installing trash bins, pet waste bag dispensers and pickup services along the Rose Creek Bicycle Path and Rose Canyon Bicycle Path.	The City will consider expansion to current service levels for refuse collection and disposal in conjunction with enhanced education and outreach efforts regarding personal responsibility for trash and litter control. The City will also explore opportunities for the addition of refuse containers that can be served with collection by local community groups including the Friends of Rose Creek or through services contracted by a community initiated Maintenance Assessment District. This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, 4) partners have been identified and formal MOUs have been developed, and 5) consensus and community support has been achieved.	Mission Bay WMA (Rose Canyon)	Optional	TBD	Friends of Rose Creek
CSD-19.3	Promote and encourage implementation of designated BMPs in commercial and industrial areas.	Provide education and outreach on BMPs for commercial businesses and industrial facilities.	City-wide Non-residential Areas	Prior to FY16	Ongoing	T&SW with PUD; Funding: Prop 84 and water districts (MWD)

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-19.4	Expand outreach to homeowners' association (HOA) common lands and HOA incentives.	Approaches to consider include: offering incentives to HOAs and maintenance districts to adopt water-conserving/efficiency and stormwater-reduction changes to their landscapes, irrigation, and maintenance; conducting workshops with property managers; providing supplemental standards, inspection, or enforcement for HOA-managed properties.	City-wide	FY16	Ongoing	T&SW
CSD-19.5	Develop an outreach and training program for property managers responsible for HOAs and maintenance districts.	Approaches to engage HOAs and property managers include: conducting workshops with property managers, providing supplemental standards, inspections or enforcement around HOA properties, and offering incentives to HOAs and maintenance districts to adopt changes to landscapes, irrigation, or maintenance which promote water conservation or stormwater reduction. Property managers are also a target for enhanced outreach.	City-wide	FY16	Ongoing	T&SW
CSD-19.6	Enhance and expand trash cleanups through community-based organizations involving target audiences.	Increase effectiveness and reach of trash/beach cleanups and community based efforts by engaging community groups to self-define and carry-out trash clean-ups. Longstanding partnerships and sponsorships with I Love A Clean San Diego and others are recommended to be continued and enhanced. To effectively target stream clean-up efforts, focus on partnerships with community organizations which provide strong engagement with target audiences and communities.	City-wide	FY16	Ongoing	T&SW and Parks and Rec
CSD-19.7	Improve consistency and content of websites to highlight enforceable conditions and reporting methods.	Websites will be updated to provide a user-friendly format and clarity for stormwater violations, conditions which citizens can and should report, and how to make such reports. Examples of reports for common incidents will be developed and posted which may vary locally and regionally. Photographs of allowable practices as well as illegal practices should be shown for utmost clarity. Displaying hotline numbers prominently on the website and near the photographs of illegal practices will ensure that those seeking to report will be able to do so easily. Also ensure hotline number and website are searchable and can be retrieved by simple internet searches.	City-wide	Prior to FY16	Ongoing	T&SW
CSD-19.8	Enhance school and recreation-based education and outreach.	Develop curriculum and establish distribution in public schools. Includes education on water conservation.	City-wide	FY15	Ongoing	T&SW, PUD with community-based organization
CSD-19.9	Develop education and outreach to reduce irrigation runoff.	Example approaches to reduce or eliminate irrigation runoff may include: education and outreach, prohibition, enhanced enforcement of existing prohibitions, and pilot projects such as the City of Del Mar's pilot door hanger project.	City-wide	Prior to FY16	Ongoing	T&SW with PUD
CSD-19.10	Develop regional training for water-using mobile businesses.	Consider development of supplemental standards for mobile businesses including: covered trash enclosures, careful review of washing areas (grading, drainage, landscaping, sanitary sewer system connectivity), and appropriate signage (either through zoning for retrofits or "best fix" approaches, or through BMP Design Manual standards). Businesses may include carpet cleaners, tile installers, plumbers, etc.	City-wide	FY16	Ongoing	T&SW

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-19.11	Enhance education and outreach based on results of effectiveness survey and changing regulatory requirements.	Use effectiveness surveys to enhance existing education and outreach programs while proactively keeping up with and incorporating changing regulatory requirements.	City-wide	FY16	Ongoing	T&SW
CSD-19.12	Continue to promote and encourage implementation of Integrated Pest Management (IPM) for residents and businesses.	The City will continue to provide education on IPM techniques during presentations and on the City's Think Blue website.	City-wide	Prior to FY16	Ongoing	T&SW
Enforcement Response Plan						
CSD-20	Continue to implement escalating enforcement responses to compel compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development in the Storm Water Code Enforcement Unit's Standard Operating Procedures (SOPs) - Enforcement Response Plan.	Refer to JRMP (currently under development).	City-wide	Prior to FY16	Ongoing	T&SW with PUD, other City enforcement compliance programs
CSD-20.1	Increase enforcement of irrigation runoff.	Increased enforcement policies against irrigation runoff will be established in tandem with the education and outreach programs on how these actions lead to pollutant loading. By shifting to property-based inspections irrigation runoff can be handled as enforceable violations once the public is well-informed.	City-wide	FY16	Ongoing	T&SW
CSD-20.2	Increase enforcement of water-using mobile businesses.	In addition to education, pollution associated with mobile business sources can be handled through policy, code development, inspections of business practices, and enforcement.	City-wide	FY16	Ongoing	T&SW
CSD-21	Increase enforcement of all minimum BMPs for existing residential, commercial, and industrial development.	Increased enforcement of existing development minimum BMPs.	City-wide	FY16	As needed	T&SW
CSD-22	Increase enforcement associated with property-based inspections.	Shifting inspections from businesses-specific to property-based will increase effectiveness and sense of responsibility and ownership. Education and outreach must be followed up with inspection and enforcement of regulations to encourage proper landscape and water conservation strategies.	City-wide	FY16	Ongoing	T&SW
CSD-23	Increase enforcement of sweeping and maintenance of private roads and parking lots in targeted areas.	Refer to Minimum BMPs in JRMP.	City-wide	FY16	Ongoing	T&SW
CSD-24	Increase identification and enforcement of actionable erosion and slope stabilization issues on private property and require stabilization and repair.	Eroding and unstable slope areas on private property (excluding construction sites) will be identified as potential sediment loading sources and subject to enforcement. In the short term, this will target enhanced inspection and enforcement programs to ensure inspectors address erosion and slope instability for the purpose of education.	City-wide	FY16	Ongoing	T&SW
CSD-24.1	Coordinate and work with Parks and Recreation, where appropriate, to effectively implement the City's brush management program to ensure that the City is not creating erosion issues.	The Storm Water Department Division will work coordinate with the Parks and Recreation Open Space Division, where appropriate, to develop and implement continue effective implementation of City brush management activities.	Mission Bay WMA	FY16	Ongoing	T&SW with Parks and Rec

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
Additional Nonstructural Strategies						
CSD-25	Conduct a Comprehensive Benefits Analysis to identify benefits other than water quality that are applicable to each of the specific WQIP strategies.	The analysis identifies which other benefits apply to each strategy, and documents the assumptions making those linkages. The delineation of other benefits to strategies includes a general description of each benefit, and a listing of the assumptions that were made to link those benefits to strategies. In addition, the other benefits are characterized with respect to who is directly affected: the city, local residents, local businesses, or visitors. This analysis may be used as part of the adaptive management process to modify future strategies.	City-wide	FY15	One time	T&SW
CSD-26	Address and clean up trash from transient encampments with collaboration from the Homeless Outreach Team.	Coordinate with the Homeless Outreach Team to respond to transient encampment trash complaints.	City-wide	FY16	Ongoing	T&SW with Police, ESD, Urban Corps, Alpha Project
CSD-27	Continue participating in source reduction initiatives.	Source reduction initiatives are ultimately the most effective measure to remove pollutants from surface waters, where feasible. Bans or progressive phase-outs that may be considered include: leaf blowers, plastic bags, architectural copper (generally a legacy issue), as well as prohibiting or more aggressively regulating vehicle washing. Additional source reduction initiatives to consider include pesticide sales at hardware stores and irrigation supply stores.	City-wide	Prior to FY16	Ongoing	T&SW
CSD-27.1	Coordinate with Fleet Services to replace City-owned vehicle brake pads with copper-free brake pads as they become commercially available.	Consider legislative mandate and cooperative implementation of copper-free brake pads on city-owned vehicle to reduce pollutant deposition.	City-wide	FY18	Ongoing	T&SW, ESD with PWD (Fleet Services)
CSD-28	Proactively monitor for erosion, and complete minor repair and slope stabilization on municipal property.	Actively identify and repair eroding slopes that may be contributing to sediment loading. Prepare an inventory and assessment of eroding areas and their risk to surface waters. Follow assessment with a schedule for ongoing inspection and stabilization (potentially based on a number or percentage of sites annually). Consider Caltrans program as a template.	City-wide	FY16	Ongoing	T&SW
CSD-29	Conduct special studies.	Special studies will be conducted to gather data to identify pollutant sources, appropriate targets, or other information. Includes collaboration with universities.	City-wide	FY16	Ongoing	T&SW
CSD-29.1	Participate in Reference Watershed Study.	The San Diego Regional Reference Stream Study (currently being conducted by the Southern California Coastal Water Research Project). The study will develop numeric targets that account for “natural sources” to establish the concentrations or loads from streams in a minimally disturbed or “reference” condition. Refer to Section 5.1 for further details.	Region-wide	Prior to FY16	One time	T&SW, SCCWRP, Regional copermittees
CSD-29.2	Participate in Reference Beach Study.	The San Diego Regional Reference Beach Study will develop numeric targets that account for “natural sources” to establish the concentrations or loads from the beach in a minimally disturbed or “reference” condition. The purpose of this monitoring program is to advise the public of potential health risks that could occur with water contact recreation at local beaches. DEH will post a health advisory notice or close a beach when FIB results are above REC-1 water quality standards.	Region-wide (Mission Bay)	Prior to FY16	One time	T&SW, SCCWRP, Regional copermittees

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-29.3	Tecolote Creek Quantitative Microbial Risk Assessment (QMRA).	The Tecolote Creek Quantitative Microbial Risk Assessment (QMRA) is currently being conducted in response to the Bacteria TMDL. The study is designed to characterize the predominance of non-human sources in the watershed, quantify the potential risks associated with water contact recreation (e.g., swimming), and, if appropriate, calculate WQOs to reflect the watershed's site-specific conditions. Refer to Section 5.1 for further details.	Mission Bay WMA (Tecolote Creek)	FY16	One time	T&SW
CSD-29.4	Using adaptive management, delist the beach segment from the TMDL and Attachment E of the MS4 Permit.	Using the adaptive management process outlined in Section 6, remove 303(d) delisted beach segments from the Bacteria TMDL and Attachment E of the MS4 Permit.	Mission Bay WMA	FY16	Ongoing	T&SW, Potential Stakeholders, Coastkeeper
CSD-29.5	Conduct a Cost of Service Study.	Conduct a Cost of Service Study that will examine the full cost of flood control and storm water strategies needed to comply with storm water regulations for the City of San Diego. The City of San Diego's Watershed Asset Management Plan will be used as the basis for the study.	City-wide	FY16	One time	TBD
CSD-30	Conduct Sustainable Return on Investment (SROI) analysis to estimate strategies' co-benefits and impacts to the public and the private sector on a common scale.	SROI is an economics-based framework for evaluating quantitative and qualitative performance metrics and monetizing them, if possible, along a triple bottom line (i.e. financial, societal, and environmental). This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, 4) partners have been identified and formal MOUs have been developed, and 5) consensus and community support has been achieved.	City-wide	Optional	TBD	T&SW and public participation
CSD-31	Collaborate with the County, if a County-led regional social services effort is established, to provide sanitation and trash management for individuals experiencing homelessness and determine if the program is suitable and appropriate for jurisdictional needs to meet goals.	Support a non-profit or consortium to provide sanitation services associated with hygiene as well as trash management for persons experiencing homelessness. Rented or purchased shower/sanitary trailers providing mobile showers may be organized at specifically scheduled locations and times. This provision has been proposed as a method for preventing surface water usage for sanitation and bathing, as well as opportunity for outreach and referral by social service agencies. The trash management services will include providing trash bags, trash collection areas, and shower/sanitary facilities at centers which provide daytime shelter to their clients, or on a mobile-basis for known transit camps. This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, 4) partners have been identified and formal MOUs have been developed, and 5) consensus and community support has been achieved.	City-wide	Optional	TBD	T&SW

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-32	Participate in an assessment to determine if implementation of an urban tree canopy (UTC) program would benefit water quality and other City goals, where feasible.	Perform a feasibility study to determine if implementing an UTC program would be beneficial to the City's goals. UTC intercepts rainfall through increased coverage of leaves, branches, and stems and reduces runoff from the storm drainage system. Benefits associated with enhancing an UTC include reducing heat island effects and air pollution in addition to aesthetics and community benefits. Where feasible, native trees will be utilized to prevent invasive trees from migrating to open spaces and to conserve water. This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, and 3) staff resources are identified and secured.	City-wide	Optional	TBD	Planning Dept. with T&SW, SANDAG, and Nature Conservancy
CSD-33	Conduct a feasibility study to test Permeable Friction Course (PFC), a porous asphalt that overlays impermeable asphalt.	Perform an assessment to determine the feasibility of implementing PFC on City streets. PFC, an overlay of porous asphalt, is an innovative roadway material that improves driving conditions in wet weather and water quality. Placed in a layer 25-50mm thick on top of regular impermeable pavement, PFC allows rainfall to drain within the porous layer rather than on top of the pavement. PFC has also been shown to reduce concentrations of pollutants commonly observed in highway runoff. PFC incorporates stormwater treatment into the roadway surface and does not require additional right-of-way. This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, and 3) staff resources are identified and secured.	City-wide	Optional	One time	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-34	As opportunities arise and funding sources are identified, protect areas that are functioning naturally by avoiding impervious development and degradation on unpaved open space areas, creating permanent open space protections on undeveloped city-owned land, and accepting privately-owned undeveloped open areas.	This strategy may be implemented if there is interest in participation by the public or private entity with current control of the land. Conditions to be met also include 1) identification of partners, if needed (public, private, non-profit), 2) identification of costs and potential sources of funding, 3) final agreement by public or private entity with current control of the land, 4) final agreement by all other participating partners including acceptance by intended land- or asset-owning City department, 5) funding in place, and 6) if it can be determined that the benefit of preventing increased pollutant loads and minimizing impacts of future growth through land conservation is a more cost effective strategy to meet interim and final numeric goals than other recommended strategies included in this plan (Chesapeake Bay Commission, 2013).	City-wide	Optional	TBD	TBD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-34.1	Add permanent open spaces protections to underdeveloped city-owned land in and on the rim of all canyons, including but not limited to Rose Canyon, San Clemente Canyon, Gilman Canyon, and Carroll Canyon.	This strategy may be implemented if there is interest in participation by the public or private entity with current control of the land. Conditions to be met also include 1) identification of partners, if needed (public, private, non-profit), 2) identification of costs and potential sources of funding, 3) final agreement by public or private entity with current control of the land, 4) final agreement by all other participating partners including acceptance by intended land- or asset-owning City department, 5) funding in place, and 6) if it can be determined that the benefit of preventing increased pollutant loads and minimizing impacts of future growth through land conservation is a more cost effective strategy to meet interim and final numeric goals than other recommended strategies included in this plan (Chesapeake Bay Commission, 2013).	Mission Bay WMA	Optional	TBD	TBD
CSD-34.2	Add permanent open space protection to undeveloped land in the Mission Bay watershed.	This strategy may be implemented if there is interest in participation by the public or private entity with current control of the land. Conditions to be met also include 1) identification of partners, if needed (public, private, non-profit), 2) identification of costs and potential sources of funding, 3) final agreement by public or private entity with current control of the land, 4) final agreement by all other participating partners including acceptance by intended land- or asset-owning City department, 5) funding in place, and 6) if it can be determined that the benefit of preventing increased pollutant loads and minimizing impacts of future growth through land conservation is a more cost effective strategy to meet interim and final numeric goals than other recommended strategies included in this plan (Chesapeake Bay Commission, 2013).	Mission Bay WMA	Optional	TBD	TBD
CSD-34.3	Forming a linear “park” from the southern end of Marian Bear Natural Park to the mouth of Rose Creek.	This strategy may be implemented if there is interest in participation by the public or private entity with current control of the land. Conditions to be met also include 1) identification of partners, if needed (public, private, non-profit), 2) identification of costs and potential sources of funding, 3) final agreement by public or private entity with current control of the land, 4) final agreement by all other participating partners including acceptance by intended land- or asset-owning City department, 5) funding in place, and 6) if it can be determined that the benefit of preventing increased pollutant loads and minimizing impacts of future growth through land conservation is a more cost effective strategy to meet interim and final numeric goals than other recommended strategies included in this plan (Chesapeake Bay Commission, 2013).	Mission Bay WMA (Rose Canyon)	Optional	TBD	TBD
CSD-35	Participate in a watershed council or group if one is established.	This strategy may be triggered as 1) partners have been identified and formal MOUs have been developed and 2) consensus and community support has been achieved.	City-wide	Optional	TBD	TBD
CSD-35.1	City coordination with the Mission Bay Wetland Initiative.	This strategy may be triggered as 1) partners have been identified and formal MOUs have been developed and 2) consensus and community support has been achieved.	Mission Bay WMA	Optional	TBD	TBD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-35.2	Collaborate with stakeholders to identify funding opportunities including the preparation and competition for grants or involvement with existing groups, such as the Integrated Regional Water Management (IRWM) group.	This strategy may be triggered as 1) partners have been identified and formal MOUs have been developed and 2) consensus and community support has been achieved.	Mission Bay WMA	Optional	TBD	TBD
CSD-36	Prohibit introduction of invasive plants in new development and redevelopment projects.	Coordinate with the City's Development Services Department to continue to prohibit introduction of invasive species such as Arundo donax and Cortaderia selloana for new development or redevelopment projects as specified in the City's municipal code for landscape.	City-wide	Prior to FY16	Ongoing	T&SW with DSD
Green Infrastructure						
CSD-37	Green Lot in Kellogg Park.	Green lot of 0.6 acres include infiltrative treatment systems (porous pavement and bioretention areas) to treat a 8.9-acre drainage area. This project has been constructed.	Mission Bay WMA (Scripps)	Prior to FY16	Ongoing	T&SW with PWD
CSD-38	Green infrastructure treatment on public parcels with approximately 2.09 acres of bioretention and 0.55 acres of permeable pavement to treat a 65-acre drainage area.	By FY27, implement at least 2.09 acres of bioretention and 0.55 acres of permeable pavement or equivalent treatment capacity to treat a 65-acre drainage area. Ramp up construction over time, constructing most efficient BMPs first and increasing BMP quantity over time.	Mission Bay WMA (Tecolote Creek)	FY29	Ongoing	T&SW with PWD; Potential to collaborate with transit agencies, public school districts, and state and federal agencies
Green Streets						
CSD-39	Mt. Abernathy Avenue	Construction, operation and maintenance of 0.06 acres of a green street project at Mt. Abernathy and Camber Drive to treat a 19.6-acre drainage area.	Mission Bay WMA (Tecolote Creek)	Prior to FY16	Ongoing	T&SW with PWD
CSD-40	Bannock Avenue	Construction, operation and maintenance of 0.47 acres of a green street project at Bannock Avenue and Genesee Avenue to treat a 65-acre drainage area.	Mission Bay WMA (Tecolote Creek)	2014	Ongoing	T&SW with PWD
Multiuse Treatment Areas						
Infiltration and Detention Basins						
CSD-41	Torrey Pines Golf Course Phase 1 (Project ID 1019)	This project consists of four 185' lengths of perforated 48" HDPE in crushed rock envelope for detention and infiltration. This infiltration system will span 0.11 acres and is designed to treat 3.7 acres of land.	Mission Bay WMA (Scripps)	Prior to FY16	Ongoing	T&SW with PWD
CSD-42	Wetland system at Sam Snead All American Golf Course.	Construction, operation and maintenance of a wetland system that would treat about 5,642 acres of drainage area on 11.4 acres of available space (APN 4310700600).	Mission Bay WMA (Tecolote Creek)	FY27	Ongoing	T&SW with PWD
CSD-43	Subsurface detention/infiltration system at Tecolote Canyon Park.	Construction, operation and maintenance of a subsurface detention/infiltration system that would treat about 6,032 acres of drainage area on 6 acres of available space (APN 4362612100). Subsurface detention basins would be designed and constructed per all applicable City safety codes and standards.	Mission Bay WMA (Tecolote Creek)	FY27	Ongoing	T&SW with PWD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-44	Extended Dry Detention system at James Madison High School.	Construction, operation and maintenance of an extended dry detention system that would treat about 97 acres of drainage area on 1.36 acres of available space (APN 3620106900).	Mission Bay WMA (Tecolote Creek)	FY27	Ongoing	T&SW with PWD
CSD-45	Extended Dry Detention system at John Muir School/Anderson School.	Construction, operation and maintenance of an extended dry detention system that would treat about 72 acres of drainage area on 0.98 acres of available space (APN 3612900400).	Mission Bay WMA (Tecolote Creek)	FY27	Ongoing	T&SW with PWD
CSD-46	Subsurface detention/infiltration system at Mt. Everest Academy Elementary School.	Construction, operation and maintenance of a subsurface detention/infiltration system that would treat about 21 acres of drainage area on 0.22 acres of available space (APN 4190200100). Subsurface detention basins would be designed and constructed per all applicable City safety codes and standards.	Mission Bay WMA (Tecolote Creek)	FY27	Ongoing	T&SW with PWD
CSD-47	If interim load reduction goals are not met and additional multiuse treatment areas are required, a subsurface detention/infiltration system can be implemented at Pacific Beach Elementary School upon detailed site assessment.	Construction, operation and maintenance of a subsurface detention/infiltration system that would treat about 213 acres of drainage area on 1.3 acres of available space (APN 4152711900). This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, and 3) staff resources are identified and secured. Subsurface detention basins would be designed and constructed per all applicable City safety codes and standards.	Mission Bay WMA (Scripps)	Optional	TBD	T&SW with PWD
CSD-48	If interim load reduction goals are not met and additional multiuse treatment areas are required, a subsurface detention/infiltration system at La Jolla Community Park upon detailed site assessment.	Construction, operation and maintenance of a subsurface detention/infiltration system that would treat about 19.3 acres of drainage area on 0.21 acres of available space (APN 3503110200). This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, and 3) staff resources are identified and secured. Subsurface detention basins would be designed and constructed per all applicable City safety codes and standards.	Mission Bay WMA (Scripps)	Optional	TBD	T&SW with PWD
CSD-49	If jurisdictional nonstructural and structural strategies do not meet interim targets by interim load reduction goals, a subsurface detention/infiltration system at Bird Rock Elementary School and Bird Rock Park upon detailed site assessment.	Construction, operation and maintenance of a subsurface detention/infiltration system that would treat about 81 acres of drainage area on 0.51 acres of available space (APN 4150700500). This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, and 3) staff resources are identified and secured. Subsurface detention basins would be designed and constructed per all applicable City safety codes and standards.	Mission Bay WMA (Scripps)	Optional	TBD	T&SW with PWD
CSD-50	If interim load reduction goals are not met and additional multiuse treatment areas are required, an infiltration basin(s) may be considered on publicly owned open spaces in canyon areas on a case-by-case basis when no other opportunities for load reductions exist.	Construction, operation, and maintenance of infiltration basin(s) in canyon areas. Twenty potential canyon sites, owned by City of San Diego, have been identified in Mission Bay WMA (Scripps and Tecolote Creek) that provide up to 143 acres of available space (773 total parcel acreage). This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, 4) partners have been identified and formal MOUs have been developed, and 5) permits required by regulatory agencies are secured.	Mission Bay WMA	Optional	TBD	T&SW with PWD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
Stream, Channel and Habitat Rehabilitation Projects						
CSD-51	Day lighting Cudahy Creek.	This strategy may be triggered as 1) funding to address MS4 discharges is identified and secured, 2) staff resources are identified and secured, 3) partners have been identified and formal MOUs have been developed, 4) permits required by regulatory agencies are secured, 5) consensus and community support has been achieved, and 6) it can be determined that the benefit of preventing increased pollutant loads and minimizing impacts of future growth through land conservation is a more cost effective strategy to meet interim and final numeric goals than other recommended strategies included in this plan (Chesapeake Bay Commission, 2013).	Mission Bay WMA (East side of Mission Bay Park between the Park and Claremont)	Optional	TBD	TBD
CSD-52	Restoration of the riparian corridor under Genesee Avenue Bridge.	Restore more natural flow regimes, wetlands, and riparian corridors. This strategy may be triggered as 1) funding to address MS4 discharges is identified and secured, 2) staff resources are identified and secured, 3) partners have been identified and formal MOUs have been developed, 4) permits required by regulatory agencies are secured, 5) consensus and community support has been achieved, and 6) it can be determined that the benefit of preventing increased pollutant loads and minimizing impacts of future growth through land conservation is a more cost effective strategy to meet interim and final numeric goals than other recommended strategies included in this plan (Chesapeake Bay Commission, 2013).	Mission Bay WMA (Rose Canyon)	Optional	TBD	TBD
CSD-53	If interim load reduction goals are not met and additional stream, channel, and habitat rehabilitation projects are required, implement as needed.	This strategy may be triggered as 1) funding to address MS4 discharges is identified and secured, 2) staff resources are identified and secured, 3) partners have been identified and formal MOUs have been developed, 4) permits required by regulatory agencies are secured, 5) recommendations from the community are identified and consensus and community support has been achieved, and 6) it can be determined that the benefit of preventing increased pollutant loads and minimizing impacts of future growth through land conservation is a more cost effective strategy to meet interim and final numeric goals than other recommended strategies included in this plan (Chesapeake Bay Commission, 2013).	Areas identified during feasibility studies	Optional	TBD	T&SW
Water Quality Improvement BMPs						
Proprietary BMPs						
CSD-54	Torrey Pines Golf Course Phase 1 (Project ID 1019)	9 Kristar FloGards plus drainage inserts have been installed at this site.	Mission Bay WMA (Scripps)	Prior to FY16	Ongoing	T&SW with PWD
CSD-55	Mt. Ashmun Drive (Project ID 1327)	A bioclean baffle box has been installed at this site.	Mission Bay WMA (Tecolote Creek)	Prior to FY16	Ongoing	T&SW with PWD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
Dry Weather Flow Separation and Treatment Projects						
CSD-56	Dry-weather flow diversion	A dry-weather flow diversion is constructed near 7920 Princess St.	Mission Bay WMA (Scripps)	2014	Ongoing	T&SW with PWD
CSD-57	Dry-weather flow diversion	A dry-weather flow diversion is constructed near 1624 Torrey Pines Rd.	Mission Bay WMA (Scripps)	2014	Ongoing	T&SW with PWD
CSD-58	Dry-weather flow diversion	A dry-weather flow diversion is constructed near Torrey Pines Rd & Charlot.	Mission Bay WMA (Scripps)	2014	Ongoing	T&SW with PWD
CSD-59	Dry-weather flow diversion	A dry-weather flow diversion is constructed near Camino del Oro & El Paseo.	Mission Bay WMA (Scripps)	2014	Ongoing	T&SW with PWD
CSD-60	Dry-weather flow diversion	A dry-weather flow diversion is replaced near Avenida De La Playa.	Mission Bay WMA (Scripps)	2015	Ongoing	T&SW with PWD
CSD-61	Dry-weather flow diversion	Limited low-flow storm drain inlets in Lindberg Park. Project is on-hold, according to Sumer Hasenin (interview).	Mission Bay WMA (Tecolote Creek)	2021-2022	2023 - on-going	T&SW with PWD
CSD-62	If interim load reduction goals are not met and additional dry weather flow separation and treatment projects are required, implement as needed.	Construction of dry weather flow separation and treatment projects, where identified. This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, and 4) permits required by regulatory agencies are secured.	Downstream reaches where persistent dry weather flows have been observed	Optional	TBD	T&SW with PWD
Trash Segregation						
CSD-63	If interim load reduction goals are not met and additional trash segregation projects are required, implement as needed.	Construction of trash segregation (Trash Guards, etc.) projects, where identified. This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, and 4) permits required by regulatory agencies are secured.	High-loading areas city-wide	Optional	TBD	T&SW with PWD

DSD= Development Services Department; PUD = Public Utilities Department; PWD = Public Works Department; T&SW = Transportation and Storm Water Division; WAMP = Watershed Asset Management Plan; TBD = will be determined during the next fiscal year.

Reference: Chesapeake Bay Commission. 2013. *Crediting Conservation: Accounting for the Water Quality Value of Conserved Lands Under the Chesapeake Bay TMDL*. Available online at http://www.chesbay.us/Publications/CreditingConservationReport.pdf. June.

Table J-2 City of San Diego Annual Schedule

Construction
Ongoing Implementation/ O&M
As needed/Design

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
Jurisdictional Strategies																								
Development Planning																								
All Development Projects																								
CSD-1	Establish guidelines and standards for all development projects; provide technical support related to implementation of source control BMPs to minimize pollutant generation at each project and implement LID BMPs to maintain or restore hydrology of the area or implement easements to protect water quality, where applicable and feasible. Includes internal coordination and collaboration between City departments (DSD, PWD, and Engineering) to improve success and long-term benefits of BMPs.	City-wide	Prior to FY16	Ongoing																				
CSD-1.1	Investigation and research of emerging technology.	City-wide	Prior to FY16	As Needed																				
CSD-1.2	Approve and implement a green infrastructure policy.	City-wide on public parcels	FY16 (Begin)	As Needed																				
CSD-1.3	Develop Design Standards for Public LID BMPs.	City-wide	FY14-FY15	As Needed																				
CSD-1.4	Outreach to impacted industry regarding minimum BMP requirement updates.	City-wide	FY15	As Needed																				
CSD-2	Train staff on LID regulatory changes and LID practices.	City-wide	FY16		As Needed																			
CSD-3	Amend municipal code and ordinances, including zoning ordinances, to facilitate and encourage LID opportunities to support compliance with the MS4 Permit and TMDLs in a reasonable manner. Ensure consistency with the City of San Diego's BMP Design Manual. Update the Storm Water Standards Manual accordingly.	City-wide	FY15	As Needed																				
CSD-4	Create a manual that outlines right-of-way design standards.	City-wide	FY15	One time																				
CSD-5	Provide technical education and outreach to the development community on the design and implementation requirements of the MS4 Permit and Water Quality Improvement Plan requirements.	City-wide	Prior to FY16	Ongoing																				
Priority Development Projects (PDPs)																								
CSD-6	For PDPs, provide technical support to other City departments to ensure implementation of on-site structural BMPs to control pollutants and manage hydromodification by developing City wide storm water development standards and design guidelines.	City-wide	FY16		Ongoing																			
CSD-6.1	Institute a program to verify and enforce maintenance and performance of treatment control BMPs.	City-wide	FY16		Ongoing																			
CSD-7	Update BMP Design Manual procedures to determine nature and extent of storm water requirements applicable to development projects and to identify conditions of concern for selecting, designing, and maintaining appropriate structural BMPs.	City-wide	FY15	Cycle																				

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
CSD-7.1	Amend BMP Design Manual for trash areas. Require full four-sided enclosure, siting away from storm drains and cover. Consider the retrofit requirement.	City-wide	FY15	One time																				
CSD-7.2	Amend BMP Design Manual for animal-related facilities, such as such as animal shelters, "doggie day care" facilities, veterinary clinics, breeding, boarding and training facilities, groomers, and pet care stores.	City-wide	FY15	One time																				
CSD-7.3	Amend BMP Design Manual for nurseries and garden centers.	City-wide	FY15	One time																				
CSD-7.4	Amend BMP Design Manual for auto-related uses.	City-wide	FY15	One time																				
CSD-8	Develop and administer an alternative compliance program for on-site structural BMP implementation (includes identifying Watershed Management Area Analysis [WMAA] candidate projects). Refer to Section 4.2.5.	City-wide	FY15	Ongoing																				
CSD-8.1	Create a fund that allows habitat acquisition, protection enhancement, and restoration in conjunction with other cooperating entities including community groups, academic institutions, state county, and federal agencies, etc.	City-wide	Optional												If triggered, begin planning, acquiring funding and resources									
Construction Management																								
CSD-9	Coordinate with other City departments to promote and confirm a thorough understanding of requirements for implementing temporary BMPs that control sediment and other pollutants during the construction phase of projects. Included in that understanding are requirements to inspect at appropriate frequencies and effectively enforce requirements through process controlled by other City departments.	City-wide	FY16		Ongoing																			
Existing Development																								
Commercial, Industrial, Municipal, and Residential Facilities and Areas																								
CSD-10	Administer a program to require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types, and PGAs, as appropriate. Includes inspection of existing development at appropriate frequencies and using appropriate methods.	City-wide	FY16		Ongoing																			
CSD-10.1	Update minimum BMPs for existing residential, commercial, and industrial development. Specific updates to BMPs include required street sweeping, catch basin cleaning, and maintenance of private roads and parking lots in targeted areas.	City-wide	FY15	Cycle																				
CSD-10.2	Outreach to property managers and trash haulers to elevate the emphasis of power washing as a pollutant source.	City-wide Residential, commercial and industrial areas	FY15	Ongoing																				
CSD-10.3	Implement property based inspections.	City-wide	Prior to FY16	Ongoing																				
CSD-10.4	Review policies and procedures to ensure discharges from swimming pools meet permit requirements.	City-wide	FY15	As Needed																				
CSD-11	Promote and encourage implementation of designated BMPs for residential and non-residential areas.	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing																				
CSD-11.1	Residential and Commercial BMP: Rain Barrel	City-wide Residential Areas	Prior to FY16	Ongoing																				

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
CSD-11.2	Residential and Commercial BMP: Grass Replacement	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing																				
CSD-11.3	Residential and Commercial BMP: Downspout Disconnect	City-wide Residential and Commercial Areas	FY16		Ongoing																			
CSD-11.4	Residential and Commercial BMP: Microirrigation	City-wide Residential Areas	Prior to FY16	Ongoing																				
CSD-11.5	Provide Onsite Water Conservation Surveys.	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing																				
MS4 Infrastructure																								
CSD-12	Implementation of operation and maintenance activities (inspection and cleaning) for MS4 and related structures (catch basins, storm drain inlets, channels as allowed by resource agencies, detention basins, etc.) for water quality improvement and for flood control risk management.	City-wide	FY16		Ongoing																			
CSD-12.1	Proactively repair and replace MS4 components to provide source control from MS4 infrastructure.	City-wide	FY16		Ongoing																			
CSD-13	Coordinate with other City departments (PUD) to implement controls to prevent infiltration of sewage into the MS4 from leaking sanitary sewers.	City-wide	FY16		Ongoing																			
CSD-13.1	Identify sewer leaks and areas for sewer pipe replacement prioritization.	City-wide	FY16		As Needed																			
Roads, Street, and Parking Lots																								
CSD-14	Implement operation and maintenance activities for public streets, unpaved roads, paved roads, and paved highways.	City-wide	FY16		Ongoing																			
CSD-14.1	Initiate sweeping of medians on high-volume arterial roadways.	City-wide	FY17			Ongo ing																		
Pesticide, Herbicides, and Fertilizer BMP Program																								
CSD-15	Require implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers on commercial, industrial, and municipal properties. Includes education, permits, and certifications.	City-wide	FY16		Ongoing																			
Retrofit and Rehabilitation in Areas of Existing Development																								
CSD-16	Develop and implement a strategy to identify candidate areas of existing development appropriate for retrofitting projects and facilitate the implementation of such projects.	City-wide	TBD																					
CSD-17	Develop and implement a strategy to identify candidate areas of existing development for stream, channel, or habitat rehabilitation projects and facilitate implementation of such projects.	City-wide	TBD																					

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
Illicit Discharge, Detection, and Elimination (IDDE) Program																								
CSD-18	Implement Illicit Discharge, Detection, and Elimination (IDDE) Program per the JRMP. Requirements include: maintaining an MS4 map, using municipal personnel and contractors to identify and report illicit discharges, maintaining a hotline for public reporting of illicit discharges, monitoring MS4 outfalls, and investigating and addressing any illicit discharges.	City-wide	Prior to FY16	Ongoing																				
Public Education and Participation																								
CSD-19	Implement a public education and participation program to promote and encourage development of programs, management practices, and behaviors that reduce the discharge of pollutants in storm water prioritized by high-risk behaviors, pollutants of concern, and target audiences.	City-wide	Prior to FY16	Ongoing																				
CSD-19.1	Continue implementation of a Pet Waste Program.	City-wide	Prior to FY16	Ongoing																				
CSD-19.2	Consider installing trash bins, pet waste bag dispensers and pickup services along the Rose Creek Bicycle Path and Rose Canyon Bicycle Path.	Mission Bay WMA (Rose Canyon)	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-19.3	Promote and encourage implementation of designated BMPs in commercial and industrial areas.	City-wide Non-residential Areas	Prior to FY16	Ongoing																				
CSD-19.4	Expand outreach to homeowners' association (HOA) common lands and HOA incentives.	City-wide	FY16		Ongoing																			
CSD-19.5	Develop an outreach and training program for property managers responsible for HOAs and maintenance districts.	City-wide	FY16		Ongoing																			
CSD-19.6	Enhance and expand trash cleanups through community-based organizations involving target audiences.	City-wide	FY16		Ongoing																			
CSD-19.7	Improve consistency and content of websites to highlight enforceable conditions and reporting methods.	City-wide	Prior to FY16	Ongoing																				
CSD-19.8	Enhance school and recreation-based education and outreach.	City-wide	FY15	Ongoing																				
CSD-19.9	Develop education and outreach to reduce irrigation runoff.	City-wide	Prior to FY16	Ongoing																				
CSD-19.10	Develop regional training for water-using mobile businesses.	City-wide	FY16		Ongoing																			
CSD-19.11	Enhance education and outreach based on results of effectiveness survey and changing regulatory requirements.	City-wide	FY16		Ongoing																			
CSD-19.12	Continue to promote and encourage implementation of Integrated Pest Management (IPM) for residents and businesses.	City-wide	Prior to FY16	Ongoing																				
Enforcement Response Plan																								
CSD-20	Continue to implement escalating enforcement responses to compel compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development in the Storm Water Code Enforcement Unit's Standard Operating Procedures (SOPs) - Enforcement Response Plan.	City-wide	Prior to FY16	Ongoing																				
CSD-20.1	Increase enforcement of irrigation runoff.	City-wide	FY16		Ongoing																			
CSD-20.2	Increase enforcement of water-using mobile businesses.	City-wide	FY16		Ongoing																			
CSD-21	Increase enforcement of all minimum BMPs for existing residential, commercial, and industrial development.	City-wide	FY16		As needed																			
CSD-22	Increase enforcement associated with property-based inspections.	City-wide	FY16		Ongoing																			

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
CSD-23	Increase enforcement of sweeping and maintenance of private roads and parking lots in targeted areas.	City-wide	FY16		Ongoing																			
CSD-24	Increase identification and enforcement of actionable erosion and slope stabilization issues on private property and require stabilization and repair.	City-wide	FY16		Ongoing																			
CSD-24.1	Coordinate and work with Parks and Recreation, where appropriate, to effectively implement the City's brush management program to ensure that the City is not creating erosion issues.	Mission Bay WMA	FY16		Ongoing																			
Additional Nonstructural Strategies																								
CSD-25	Conduct a Comprehensive Benefits Analysis to identify benefits other than water quality that are applicable to each of the specific WQIP strategies.	City-wide	FY15	One time																				
CSD-26	Address and clean up trash from transient encampments with collaboration from the Homeless Outreach Team.	City-wide	FY16		Ongoing																			
CSD-27	Continue participating in source reduction initiatives.	City-wide	Prior to FY16	Ongoing																				
CSD-27.1	Coordinate with Fleet Services to replace City-owned vehicle brake pads with copper-free brake pads as they become commercially available.	City-wide	FY18				Ongo ing																	
CSD-28	Proactively monitor for erosion, and complete minor repair and slope stabilization on municipal property.	City-wide	FY16		Ongoing																			
CSD-29	Conduct special studies.	City-wide	FY16		Ongoing																			
CSD-29.1	Participate in Reference Watershed Study.	Region-wide	Prior to FY16	One time																				
CSD-29.2	Participate in Reference Beach Study.	Region-wide (Mission Bay)	Prior to FY16	One time																				
CSD-29.3	Tecolote Creek Quantitative Microbial Risk Assessment (QMRA).	Mission Bay WMA (Tecolote Creek)	FY16		One time																			
CSD-29.4	Using adaptive management, delist the beach segment from the TMDL and Attachment E of the MS4 Permit.	Mission Bay WMA	FY16		Ongoing																			
CSD-29.5	Conduct a Cost of Service Study.	City-wide	FY16		One time																			
CSD-30	Conduct Sustainable Return on Investment (SROI) analysis to estimate strategies' co-benefits and impacts to the public and the private sector on a common scale.	City-wide	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-31	Collaborate with the County, if a County-led regional social services effort is established, to provide sanitation and trash management for individuals experiencing homelessness and determine if the program is suitable and appropriate for jurisdictional needs to meet goals.	City-wide	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-32	Participate in an assessment to determine if implementation of an urban tree canopy (UTC) program would benefit water quality and other City goals, where feasible.	City-wide	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-33	Conduct a feasibility study to test Permeable Friction Course (PFC), a porous asphalt that overlays impermeable asphalt.	City-wide	Optional												If triggered, begin planning, acquiring funding and resources									

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
CSD-34	As opportunities arise and funding sources are identified, protect areas that are functioning naturally by avoiding impervious development and degradation on unpaved open space areas, creating permanent open space protections on undeveloped city-owned land, and accepting privately-owned undeveloped open areas.	City-wide	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-34.1	Add permanent open spaces protections to underdeveloped city-owned land in and on the rim of all canyons, including but not limited to Rose Canyon, San Clemente Canyon, Gilman Canyon, and Carroll Canyon.	Mission Bay WMA	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-34.2	Add permanent open space protection to undeveloped land in the Mission Bay watershed.	Mission Bay WMA	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-34.3	Forming a linear "park" from the southern end of Marian Bear Natural Park to the mouth of Rose Creek.	Mission Bay WMA (Rose Canyon)	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-35	Participate in a watershed council or group if one is established.	City-wide	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-35.1	City coordination with the Mission Bay Wetland Initiative.	Mission Bay WMA	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-35.2	Collaborate with stakeholders to identify funding opportunities including the preparation and competition for grants or involvement with existing groups, such as the Integrated Regional Water Management (IRWM) group.	Mission Bay WMA	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-36	Prohibit introduction of invasive plants in new development and redevelopment projects.	City-wide	Prior to FY16	Ongoing																				
Green Infrastructure																								
CSD-37	Green Lot in Kellogg Park.	Mission Bay WMA (Scripps)	Prior to FY16																					
CSD-38	Green infrastructure treatment on public parcels with approximately 2.09 acres of bioretention and 0.55 acres of permeable pavement to treat a 65-acre drainage area.	Mission Bay WMA (Tecolote Creek)	FY29																					
Green Streets																								
CSD-39	Mt. Abernathy Avenue	Mission Bay WMA (Tecolote Creek)	Prior to FY16																					
CSD-40	Bannock Avenue	Mission Bay WMA (Tecolote Creek)	2014																					
Multiuse Treatment Areas																								
Infiltration and Detention Basins																								
CSD-41	Torrey Pines Golf Course Phase 1 (Project ID 1019)	Mission Bay WMA (Scripps)	Prior to FY16																					
CSD-42	Wetland system at Sam Snead All American Golf Course.	Mission Bay WMA (Tecolote Creek)	FY27																					
CSD-43	Subsurface detention/infiltration system at Tecolote Canyon Park.	Mission Bay WMA (Tecolote Creek)	FY27																					
CSD-44	Extended Dry Detention system at James Madison High School.	Mission Bay WMA (Tecolote Creek)	FY27																					

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
CSD-45	Extended Dry Detention system at John Muir School/Anderson School.	Mission Bay WMA (Tecolote Creek)	FY27																					
CSD-46	Subsurface detention/infiltration system at Mt. Everest Academy Elementary School.	Mission Bay WMA (Tecolote Creek)	FY27																					
CSD-47	If interim load reduction goals are not met and additional multiuse treatment areas are required, a subsurface detention/infiltration system can be implemented at Pacific Beach Elementary School upon detailed site assessment.	Mission Bay WMA (Scripps)	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-48	If interim load reduction goals are not met and additional multiuse treatment areas are required, a subsurface detention/infiltration system at La Jolla Community Park upon detailed site assessment.	Mission Bay WMA (Scripps)	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-49	If jurisdictional nonstructural and structural strategies do not meet interim targets by interim load reduction goals, a subsurface detention/infiltration system at Bird Rock Elementary School and Bird Rock Park upon detailed site assessment.	Mission Bay WMA (Scripps)	Optional												If triggered, begin planning, acquiring funding and resources									
CSD-50	If interim load reduction goals are not met and additional multiuse treatment areas are required, an infiltration basin(s) may be considered on publicly owned open spaces in canyon areas on a case-by-case basis when no other opportunities for load reductions exist.	Mission Bay WMA	Optional												If triggered, begin planning (acquire funding and resources, conduct site feasibility analysis and site selection) to implement multiuse treatment area projects.									
Stream, Channel and Habitat Rehabilitation Projects																								
CSD-51	Day lighting Cudahy Creek.	Mission Bay WMA (East side of Mission Bay Park between the Park and Claremont)	Optional												If triggered, begin planning (acquire funding and resources, conduct site feasibility analysis and site selection) to implement rehabilitation projects.									
CSD-52	Restoration of the riparian corridor under Genesee Avenue Bridge.	Mission Bay WMA (Rose Canyon)	Optional												If triggered, begin planning (acquire funding and resources, conduct site feasibility analysis and site selection) to implement rehabilitation projects.									
CSD-53	If interim load reduction goals are not met and additional stream, channel, and habitat rehabilitation projects are required, implement as needed.	Areas identified during feasibility studies	Optional												If triggered, begin planning (acquire funding and resources, conduct site feasibility analysis and site selection) to implement rehabilitation projects.									
Water Quality Improvement BMPs																								
Proprietary BMPs																								
CSD-54	Torrey Pines Golf Course Phase 1 (Project ID 1019)	Mission Bay WMA (Scripps)	Prior to FY16																					
CSD-55	Mt. Ashmun Drive (Project ID 1327)	Mission Bay WMA (Tecolote Creek)	Prior to FY16																					
Dry Weather Flow Separation and Treatment Projects																								
CSD-56	Dry-weather flow diversion	Mission Bay WMA (Scripps)	2014																					

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
CSD-57	Dry-weather flow diversion	Mission Bay WMA (Scripps)	2014																					
CSD-58	Dry-weather flow diversion	Mission Bay WMA (Scripps)	2014																					
CSD-59	Dry-weather flow diversion	Mission Bay WMA (Scripps)	2014																					
CSD-60	Dry-weather flow diversion	Mission Bay WMA (Scripps)	2015																					
CSD-61	Dry-weather flow diversion	Mission Bay WMA (Tecolote Creek)	2021-2022																					
CSD-62	If interim load reduction goals are not met and additional dry weather flow separation and treatment projects are required, implement as needed.	Downstream reaches where persistent dry weather flows have been observed	Optional												If triggered, begin planning (acquire funding and resources, conduct site feasibility analysis and site selection) to implement dry weather flow separation projects.									
Trash Segregation																								
CSD-63	If interim load reduction goals are not met and additional trash segregation projects are required, implement as needed.	High-loading areas city-wide	Optional												If triggered, begin planning (acquire funding and resources, conduct site feasibility analysis and site selection) to implement trash segregation projects.									

J.2 Caltrans Strategies

Caltrans' jurisdiction areas include roadways, land adjacent to roadways, and facilities; Caltrans' jurisdictional strategies specifically focus on BMP implementation to reduce known pollutants within these areas. Caltrans is not permitted within the MS4 Permit; however, Caltrans is subject to similar requirements through its MS4 Permit (SWRCB, 2013). Though not permitted within the MS4 permit, Caltrans has voluntarily contributed to the Water Quality Improvement Plan effort to provide a consistent and subwatershed-wide approach to meeting applicable TMDL requirements. Caltrans voluntary contributions include a detailed list of strategies developed and provided in the tableTable J-3 below. The strategies and schedules presented in Table J-3 are subject to change and are contingent upon annual budget approvals and funding availability. They will be modified through the adaptive management process as needed.

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Table J-3 Caltrans Jurisdictional Strategies

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
Jurisdictional Strategies						
Design Stormwater Program						
CT-1	Update and implement design BMPs.	Office of Stormwater Management Design (OSWMD) develops, evaluates, and enhances guidance documents and tools. Refer to Landscape Architecture Program (LAP).	Jurisdiction-wide	FY16	Ongoing	HQ (OSWMD)
CT-1.1	Update and implement Landscape Architecture Program (LAP).	LAP provides technical assistance on new and ongoing research related to permanent erosion control and permanent BMPs. In addition, the LAP develops methods to enhance roadside vegetation, which protects slopes from erosion and sediment loss, and may remove pollutants from stormwater runoff.	Jurisdiction-wide	FY16	As needed	HQ (OSWMD)
CT-1.2	Implement native landscape/LID Design Guide Strategy.	Require native landscaping/LID in stormwater data report and project plan design guide. Done as part of erosion control. The Project Planning and Design Guide (PPDG) include an online training program. Projects go through the same review process for native landscape reviews. If project is greater than an acre, subject to a stormwater data report. Minor projects are not subject to as extensive reviews. Try to treat 100% of roadway.	Jurisdiction-wide	FY16	Ongoing	District 11 with HQ (OSWMD)
CT-2	Train staff on Design Stormwater Program.	Train staff on Design Stormwater Program. Curriculum updated to reflect the latest strategies.	Jurisdiction-wide	FY16	Ongoing	District 11
CT-3	Plan and implement treatment BMPs as appropriate.	Treatment BMPs are planned and implemented to comply with Caltrans NPDES Permit project development requirements, TMDL waste load allocations, location specific requirements, and the requirements in the Project Planning and Design Guide (PPDG) according to the Targeted Design Constituent (TDC) approach. The treatment BMP consideration process favors infiltration of stormwater and directs staff to evaluate LID strategies first.	Jurisdiction-wide	FY16	Ongoing	District 11 NPDES and Design with HQ (OSWMD)
CT-4	Develop procedures to encourage mitigation for projects within the same watershed.	Caltrans will investigate procedures to mitigate within the same watershed as new projects.	Jurisdiction-wide	FY16	Ongoing and As needed	District 11 NPDES and Stewardship
CT-5	Implement a self-audit program to ensure BMPs are designed, implemented, and maintained.	Design Compliance Monitoring Program is a self-audit program that uses the SWDR (Stormwater Data Report) as a tool for documenting compliance with the design pollution prevention and treatment BMP requirements of the 1999 NPDES Permit, 2012 NPDES Permit, and the Caltrans' 2003 Statewide SWMP. The SWDR and its checklists are reviewed by District staff to ensure that BMPs are being considered and appropriately incorporated into Caltrans' projects. This review also ensures stormwater compliance throughout the project planning and design phases.	Jurisdiction-wide	FY16	Ongoing	District 11 NPDES
Construction Management						
CT-6	Administer a program to oversee implementation of BMPs during the construction phase of Caltrans projects. Includes inspections at an appropriate frequency and enforcement of requirements.	Caltrans complies with the statewide Construction General Permit. The district holds pre-construction meetings for all projects that require a SWPPP. For larger projects, there are year-round, weekly inspections.	Jurisdiction-wide	FY16	Ongoing	District 11 with the Division of Construction

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CT-7	Construction stormwater training for District staff.	Continue implementation of the construction stormwater classes offered throughout the Caltrans districts by the Division of Construction. Classes updated to reflect latest permit requirements.	Jurisdiction-wide	FY16	Ongoing	District 11 with the Division of Construction
CT-8	Implement a self-audit program to ensure compliance with water quality requirements.	Continue implementation of the Construction Compliance Evaluation Plan. Evaluates contractor's SWPPP or WPCP implementation and assesses compliance with water quality requirements, evaluates stormwater contract administration, and incorporates quality control, quality assurance, and independent assurance elements.	Jurisdiction-wide	FY16	Ongoing	District 11 NPDES
CT-9	Maintenance training for employees.	The Division of Maintenance has formal stormwater management training sessions for new employees and refresher training for existing staff. Both types of courses are scheduled from one to 15 hours in length. In addition to formal training, Division of Maintenance policy is that Supervisors conduct stormwater BMP tailgate meetings a minimum of every 10 working days or when there is a change in the type of work activity. These meetings are to review BMPs prior to conducting roadside maintenance activities.	Jurisdiction-wide	FY16	Ongoing	District 11 with Division of Maintenance
CT-10	Administer a program to require implementation of minimum BMPs for facilities and leased space (air space leases).	Refer to SWMP. Leased space is required to meet current stormwater regulations.	Jurisdiction-wide	FY16	Ongoing	District 11 with ROW Dept.
CT-11	Inspection of facilities and leased areas.	The Department will continue to reduce the potential for storm water pollution by the development and implementation of Facility Pollution Prevention Plans (FPPPs), which specify controls to minimize contact between storm water and the various substances at highway maintenance facilities. Per Maintenance Manual Vol.2 under F Family, periodic inspections are conducted to evaluate whether the BMPs are adequate and properly implemented. The SWMP states this provision regarding FPPP. *Maintenance Facility Pollution Prevention Plans. Facility Pollution Prevention Plans (FPPP) has been developed for each maintenance facility owned or operated by the Department. The FPPPs describe the activities conducted at the facility and the BMPs to be implemented to reduce the discharge of pollutants in storm water runoff from these facilities. Supervisors inspect their maintenance facilities monthly to monitor the implementation and adequacy of the BMPs. A report that includes the date of the inspection, the name of the inspector, observations, and recommended corrective actions is prepared by the Supervisor. All inspection records will be maintained for a period of 3 years. Any observed instances of non-compliance will be reported to the District Maintenance.*	Jurisdiction-wide	FY16	Ongoing	District 11 with ROW Dept.
CT-12	Implement BMPs targeting reduction of over-irrigation.	Reduce over irrigation by requiring native, drought tolerant plants and irrigation system improvements.	Jurisdiction-wide	FY16	Ongoing	District 11 Landscape and Stewardship
CT-13	Proactively monitor for erosion, and complete repair and slope stabilization.	Division of Maintenance conducts inspections on a five-year cycle. Program includes self-imposed goal to annually inspect approximately 20% of slopes in each District and includes investigating public complaints and widely understood problem areas (WUPAs).	Jurisdiction-wide	FY16	Ongoing	District 11 with Division of Maintenance

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
MS4 Infrastructure						
CT-14	Inspect and clean catch basins and conduct source investigations to identify upstream source of materials.	Inspect catch basins once every three years with 1/3 inspected per year. If needed, catch basins are cleaned. If a catch basin is cleaned, a source inspection is conducted to identify source of sediment or other material.	Jurisdiction-wide	FY16	Ongoing	District 11 with Division of Maintenance
CT-15	Proactively repair and replace MS4 components to provide source control from MS4 infrastructure.	Prioritize MS4 repairs. Funding for repairs based on size of project. Districts are able to conduct small repairs immediately, while larger projects are prioritized for repair out of annual budget.	Jurisdiction-wide	FY16	Ongoing	District 11 with Division of Maintenance
Roads and Streets						
CT-16	Implement operation and maintenance activities on streets and roadways.	Refer to Work Plan.	Jurisdiction-wide	FY16	Ongoing	District 11 with Division of Maintenance
CT-16.1	Implement street sweeping.	Every road swept once a month. To meet performance schedule, street sweepers are replaced on a four-year cycle.	Jurisdiction-wide	FY16	Ongoing	District 11 with Division of Maintenance
CT-16.2	Perform sweeping of medians on high-volume arterial roadways.	Medians with shoulders are swept approximately once per month.	Jurisdiction-wide	FY16	Ongoing	District 11 with Division of Maintenance
Pesticide, Herbicides, and Fertilizer BMP Program						
CT-17	Implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers.	Refer to Vegetation Control Plan. Caltrans is actively reducing fertilizer/pesticide application and only applies to targeted areas. All pesticide use is reported to the California Department of Pesticide Regulation.	Jurisdiction-wide	FY16	Ongoing	District 11 with Roadside Maintenance Office and California DPR
Illicit Connections/Illegal Discharges						
CT-18	Identify and resolve potential illicit connections/illegal discharges (IC/IDs).	Continue maintaining a hotline for reporting of illicit discharges. Majority of calls come from contractors and construction and maintenance staff. Continue coordination with other jurisdictions to address IC/IDs and provide written notification of potential IC/IDs associated with a municipality's jurisdiction.	Jurisdiction-wide	FY16	Ongoing	District 11 with other jurisdictions
CT-19	Identify erosion and slope stabilization issues on private or municipal property and inform the source for repair.	When Caltrans staff or contractors identify erosion or slopes in need of repair, it is treated as an IC/ID and the property owner is notified.	Jurisdiction-wide	FY16	Ongoing	District 11 with Division of Maintenance
Public Education and Participation						
CT-20	Implement a public education and participation program to raise awareness of stormwater pollution and prevention on California's freeways and highways.	Continue to implement the "Don't Trash California" Campaign, Adopt-A-Highway program, and partner with local organizations.	Jurisdiction-wide	FY16	Ongoing	District 11 with HQ (OSWMD)
CT-20.1	Conduct trash cleanups.	Conduct trash cleanups through local probation and adopt-a-highway programs. Encourage prevention through "Don't Trash California" campaign.	Jurisdiction-wide	FY16	Ongoing	District 11 Division of Maintenance
CT-20.2	Target school-based education and outreach.	Provide outreach to schools raising awareness of stormwater pollution through watershed model demonstrations. Hold bring-your-child-to-work days with watershed model.	Jurisdiction-wide	FY16	Ongoing	District 11 with HQ (OSWMD)
Other Nonstructural Strategies						
CT-21	To provide sanitation and trash management, implement access control in targeted areas.	As necessary, implement methods such as rip-rap, chain link fences, and remove low-lying brush to discourage use of right-of-way areas.	Jurisdiction-wide	FY16	Ongoing	District 11 NPDES, Design and Maintenance

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CT-22	Continue participating in source reduction initiatives.	Continue participation in Brake Pad Partnership through work with California Stormwater Quality Association.	Jurisdiction-wide	FY16	Ongoing	HQ with CASQA
CT-23	Removal of invasive plants.	Removal of invasive plants through maintenance and construction programs.	Jurisdiction-wide	FY16	Ongoing	District 11 with Division of Maintenance
CT-24	Protect areas that are functioning naturally.	Required as part of the stormwater data report (SWDR), the Project Planning and Design Guide (PPDG), and the Natural Environment as Treatment (NEAT) programs, Caltrans minimizes disturbance of exiting vegetation and avoids hardscapes.	Jurisdiction-wide	TBD	As available	District 11 with HQ (OSWMD)
CT-25	Collaborate with Responsible Agencies on Water Quality Improvement Plans.	Voluntarily participate in the development of the Water Quality Improvement Plan and continue to collaborate with RAs on water quality planning and implementation projects.	Jurisdiction-wide	FY16	Ongoing	District 11

APPENDIX K

Strategy Selection and Compliance Analysis

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX K. STRATEGY SELECTION AND COMPLIANCE ANALYSIS

This appendix details the basis for strategy selection and prioritization, implementation assumptions used to estimate strategy effectiveness within the simulation models, and the results of the modeling efforts including anticipated load reductions by strategy, subwatershed, jurisdiction, and pollutant. Figure K-1 provides a conceptual model of the quantification of benefits from the strategies represented in the model and discussed within this appendix. Section 4 of the Water Quality Improvement Plan provides a summary by jurisdiction of selected strategies, and Appendix J provides the schedule for implementation by jurisdiction.

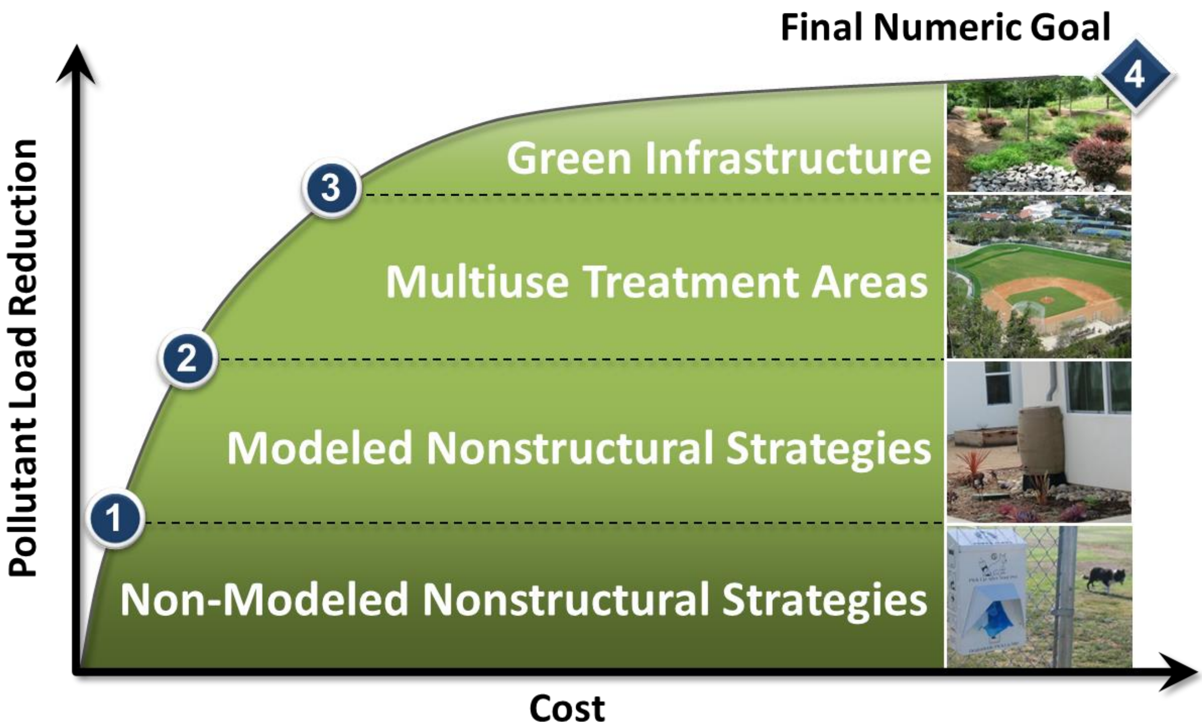


Figure K-1
Conceptual Diagram Illustrating BMP Implementation
(Not to Scale)

Strategies were selected based on their ability to effectively and efficiently eliminate non-storm water discharges to the MS4, reduce pollutants in storm water discharges in the MS4 to the maximum extent practicable (MEP), and achieve the interim and final numeric goals. Efficiency in pollutant reduction is based on identifying the known and suspected areas or sources likely contributing to the highest priority water quality condition and targeting those sources. To assist in the geographical identification of sources, watershed modeling and GIS tools were used to estimate the relative bacteria loading within the Tecolote Creek and Scripps subwatersheds, land ownership and availability of public land for implementation, and physical watershed characters such as slope and soil types for BMP selection.

Section K.1 presents the relative, estimated bacteria loading by drainage area in Tecolote Creek and Scripps subwatersheds. The relative loading results can assist Responsible Agencies in selecting locations to focus nonstructural and structural strategies within subwatersheds. Section K.2 provides additional detail on nonstructural strategy selection and implementation. Many of the nonstructural strategies overlap with administrative programs. Responsible Agencies may utilize the relative loading results to target application of administrative programs, such as street sweeping, rebate programs or education and outreach programs, in high priority areas. Specific load reductions for select nonstructural programs or activities that had a sufficient amount of data collected to estimate load reductions were modeled. Modeling assumptions for those activities are also presented in Section K.2. Section K.3 provides additional detail on structural strategy selection and implementation. Additional factors to the relative loading analysis were considered in the selection of structural BMPs, such as parcel ownership, slope, and soil type. These additional factors generally have a greater influence on site selection for structural BMPs than just the relative loading by area. They also play an important role in determining the costs for implementation of structural BMPs and affect the cost-efficiency results. The structural BMP modeling assumptions are also provided in this section. Finally, Section K.4 provides a summary of the expected, cumulative load reductions estimated from the suite of strategies selected. A summary of the modeling assumptions used in the projection and the cost-effectiveness assessments are provided.

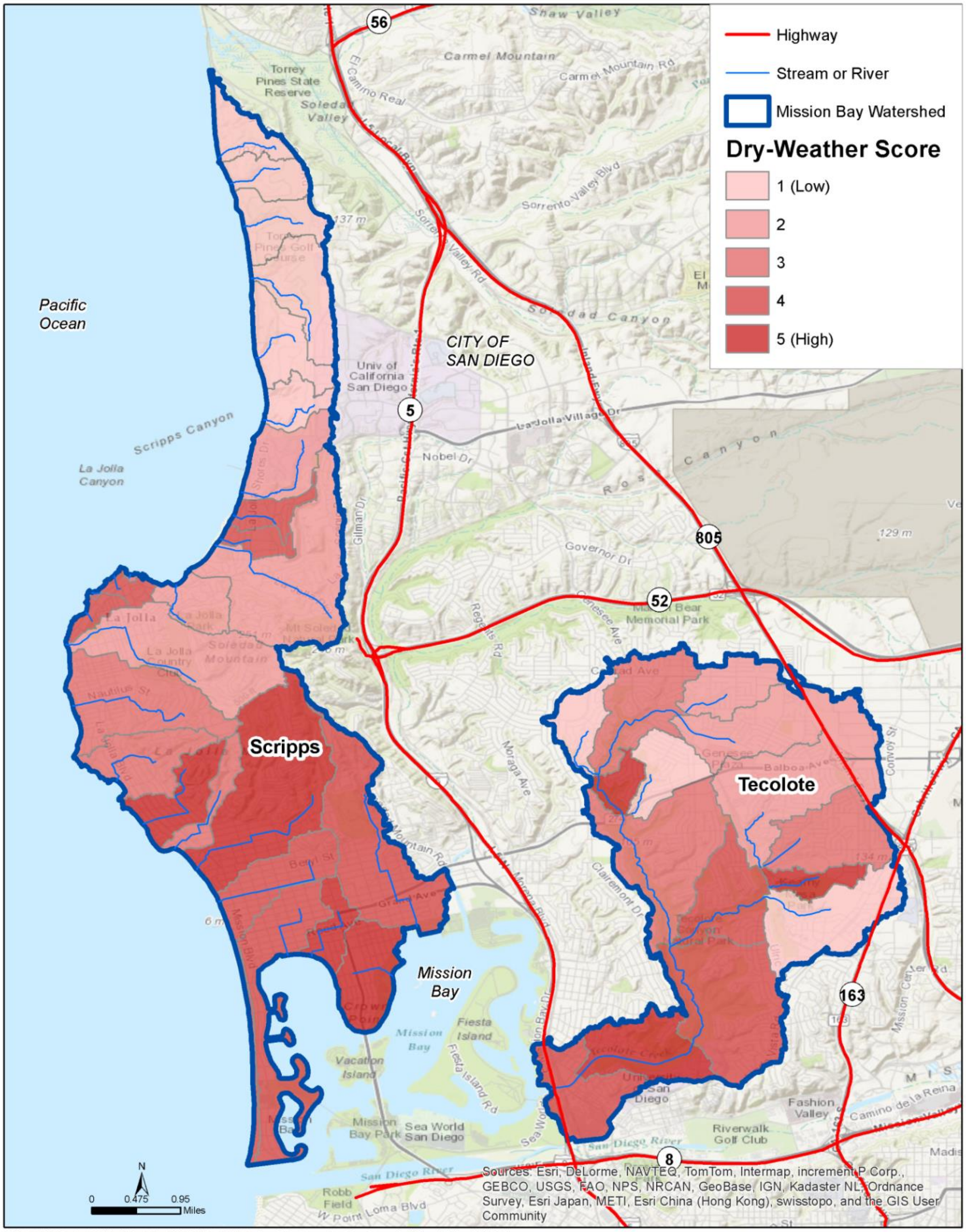
K.1 Prioritization of Bacteria-Loading Areas

The MS4 Permit requires the identification of known and suspected areas or sources causing or contributing to the highest priority water quality condition within the following Responsible Agency inventories: MS4 outfall, priority development project, construction site, and existing development. The bacteria-generating activities within the WMA were identified in Section 3. To identify potential geographic areas where bacteria-generating activities are contributing to watershed load, subwatersheds delineated in a recent modeling effort were prioritized based on modeled bacteria loading results (City of San Diego, 2012a, 2013a, and City of San Diego and Caltrans 2012b, 2013b).

Modeling was conducted using the Loading Simulation Program in C++ (LSPC) watershed model (Shen et al. 2004; Tetra Tech and USEPA 2002), which estimated bacteria loading based on physical watershed characteristics (e.g., slope, soil types, precipitation zones) and land use-based runoff parameters. LSPC was calibrated to available flow and water quality data measurements in the receiving waters, which incorporate the effects of existing pollutant sources and current management actions upstream of the calibration points. The final calibrated model represents a simulation of baseline existing conditions for Water Year 2003 (which represents typical wet and dry weather conditions, based on an analysis of rainfall data over a 20-year time period) and recent land use data (using the San Diego Association of Governments 2009 data) in the Mission Bay WMA; any pollutant load reductions resulting from jurisdictional strategies will be subsequently subtracted from the baseline conditions in the following sections to demonstrate progress towards meeting watershed load reduction goals.

The calibrated watershed models were used to prioritize subwatersheds within the Mission Bay WMA using a relative estimate of bacteria loading. All modeled bacteria results were averaged for both wet weather and dry weather and quintiles were established for each subwatershed and assigned to each pollutant. The individual quintiles scores (1–5) for *Enterococcus*, fecal coliform, and total coliform were averaged to create a dry composite bacteria pollutant loading score and a wet composite bacteria pollutant loading score. A score of 5 indicates that the subwatershed pollutant loading was in the top 20th percentile (high pollutant loading), whereas a score of 1 represents a subwatershed loading in the bottom 20th percentile (low pollutant loading). The overall composite water quality score (2–10) is the summation of the dry composite score (Figure K-2) and wet composite score (Figure K-3), which is shown in Figure K-4.

Areas that are expected to contribute the highest loading, and therefore suspected to have more sources, are darker, and areas that are less likely to contribute are lightly shaded. Subwatersheds with more development (western part of the WMA) are expected to contribute more bacteria than less developed, open space. The model simulates bacteria loading based on land use. Sources identified in Section 3 of the Water Quality Improvement Plan are generally associated with land use types, but are not explicitly represented in this prioritization. For example, sources such as episodic sanitary sewer overflows are not explicitly included in the model, however residential areas or areas with general development do have a higher bacteria load associated than undeveloped areas. This prioritization is meant as a guideline for identification of geographic areas within which to investigate sources. Each responsible agency may have additional information to inform jurisdictional strategy implementation. Further analysis to determine the site suitability for structural strategies is discussed in Section K.3.



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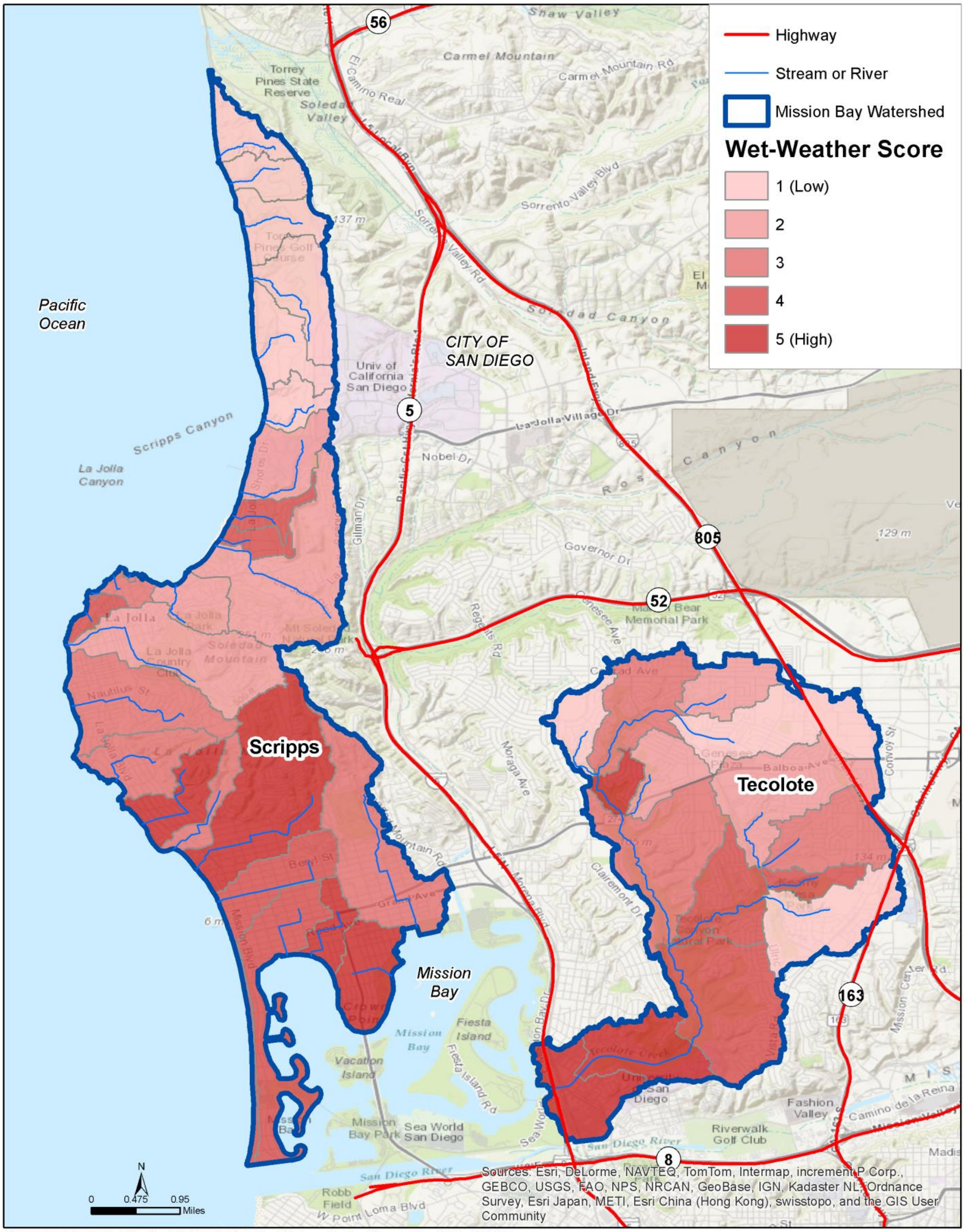
Aerial Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

Figure K-2
Dry-Weather Water Quality Composite Score for Bacteria



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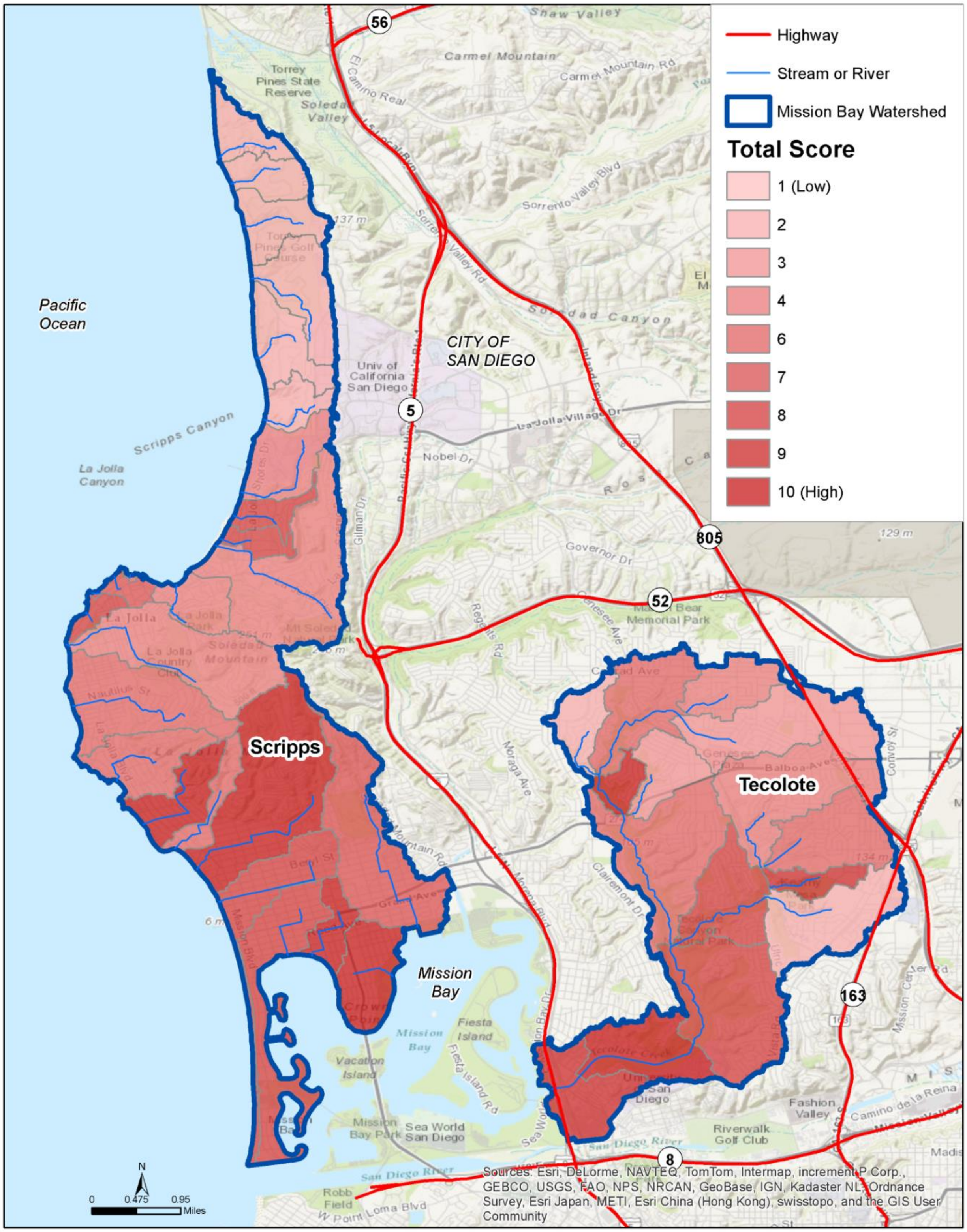
Aerial Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

Figure K-3
Wet-Weather Water Quality Composite Score for Bacteria



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Aerial Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

Figure K-4
Total Water Quality Composite Score for Bacteria

K.2 Nonstructural Strategies

To assist in the phased reduction of pollutant loads, various nonstructural strategies have been identified for implementation. Nonstructural reduction strategies are defined as those actions and activities that are intended to reduce storm water pollution and that do not involve construction or implementation of a physical structure to filter and treat storm water. These strategies are improvements of existing nonstructural programs, as well as implementation of new nonstructural best management practices (BMPs). Administrative policies, creation and enforcement of municipal ordinances, education and outreach programs, rebate and other incentive programs, and cooperation and collaboration with other WMA or regional partners are several examples of nonstructural strategies.

It is challenging to accurately quantify most nonstructural BMP benefits in terms of pollutant load reductions because it generally requires extensive survey and monitoring information. In addition, nonstructural BMPs may target pollutants, land uses, or populations, resulting in different load reductions depending on the implementation technique. The nonstructural strategies with sufficient data were modeled using LSPC to determine the pollutant load reductions from implementing these strategies. Pollutant load reductions from all strategies in this appendix are subtracted from loads simulated in the baseline model (discussed in the previous subsection) to quantify progress towards meeting the watershed numeric goals.

Estimated pollutant and flow reduction benefits from the non-modeled and modeled nonstructural BMPs provide the baseline from which additional reductions from structural BMPs will be achieved. Nonstructural BMPs are effective at reducing pollutant loads before they enter the storm drain and are generally cost-effective and require a shorter planning period; therefore, most nonstructural strategies are planned for implementation before or upon approval of the Water Quality Improvement Plan.

A summary of modeling assumptions used to quantify the load reduction potential from nonstructural strategies is provided in this section.

K.2.1 Non-Modeled, Nonstructural Strategy Assumptions

As previously stated, not all nonstructural strategies can be effectively modeled for load reductions due to their variable implementation, so these strategies are referred to as non-modeled nonstructural strategies. Since their benefits are not individually quantifiable, these strategies were assigned a conservative cumulative pollutant load reduction value of 10%, as shown in Figure K-5. Each of these non-modeled nonstructural strategies is described in further detail in the jurisdictional strategy tables in Section 4.

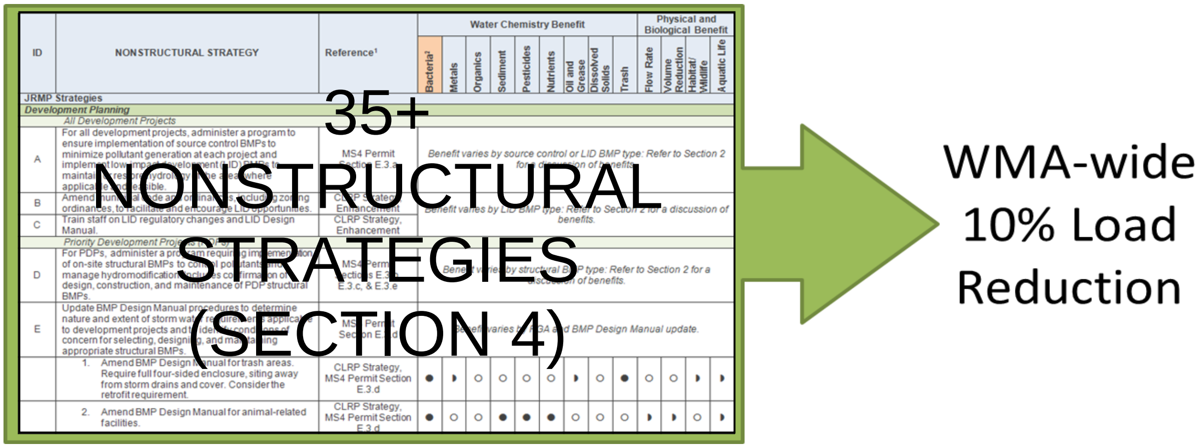


Figure K-5
Non-Modeled Nonstructural Strategies Load Reduction

As described in section 4.2.2.1 of the report, the 10 percent load reduction for non-modeled, nonstructural activities was estimated by averaging the range of measured and anticipated pollutant removal from the list of City of San Diego nonstructural strategies. Strategies were categorized as "high" percent removal, those with greater City control (operation and maintenance of MS4 infrastructure) or "low" percent removal, those requiring public behavior changes. The range of pollutant load reduction was as low as approximately 2 percent and as high as 72%. The overall average percent removal for all constituents and all activities is 10.1% (HDR, 2014).

K.2.2 Modeled Nonstructural Strategy Assumptions

Three of the nonstructural strategies selected for implementation in the Mission Bay WMA were modeled: Rain Barrels Incentive Program, Downspout Disconnection Incentive Program, and Irrigation Runoff Reduction Program. The following sections outline the nonstructural strategies that were modeled for the City of San Diego.

K.2.2.1 Rain Barrels Incentive Program

The City of San Diego Public Utilities Department currently operates a rebate program for customers who harvest rainwater, including with rain barrels and cistern-type devices. The goal of this program is to minimize pollutant loads to receiving waters by reducing the runoff volume and peak flow originating from rooftops. Rooftop runoff can be collected in rain barrels and retained for irrigation reuse or slowly released after a period of storage. Pollutant load is reduced by releasing captured runoff onto landscaped areas, where pollutants are removed by the natural processes of infiltration and evapotranspiration.

The City's rain barrel rebate program is part of a larger landscape-based rebate program to promote and encourage implementation of specific BMPs for residential and commercial areas. The rain barrel rebate aspect of the program currently focuses on single-family residential landscapes, but it is intended to expand the program to multifamily and commercial areas. The landscape-based rebate program has a budget of $250,000 of annual funding to support rebate costs for all aspects of the program including rain barrels, downspout disconnects, micro-irrigation, and grass replacement. Of this rebate budget, it is anticipated that 10% of funds will support rain barrel rebates. In addition to staffing, the City anticipates an annual 4% increase to the annual rebate budget for this program to accommodate program expansion.

Treatment Process Model Overview

Figure K-6 illustrates rain barrel use to reduce runoff volume. As implementation of the rain barrel program grows, more rooftop runoff will be intercepted and temporarily stored in rain barrels. As a result, runoff volume and associated pollutant loads to receiving waters will also decrease. The effectiveness of a rain barrel program in reducing runoff volume is a function of the number of rain barrels installed. As the program encourages more rain barrel installations, reducing runoff volume further can be expected.

Simulating long-term rainfall and runoff processes in the LSPC will help determine the average rain barrel capture performance (runoff reduction) per rooftop drainage acre. Rain barrel modeling parameters are summarized in Table K-1.

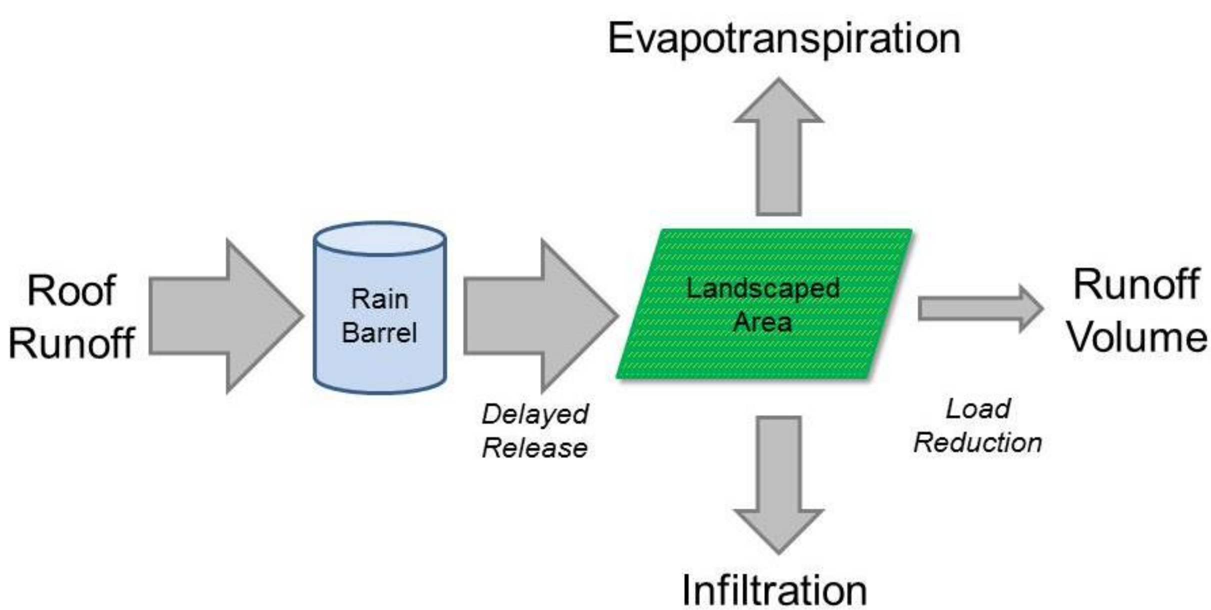


Figure K-6
Rain Barrel Treatment Process

Table K-1
Model Parameters for Rain Barrel Program Enhancements

Parameter	Value	Source
Contributing rooftop area to rain barrel in residential areas	500 square feet	City of San Diego
Rain barrel size (average)	65 gallons	City of San Diego
Primary outlet diameter (minimum)	0.5 inches	City of San Diego
Outlet pipe invert location	< 6 inches above bottom of barrel	City of San Diego
Overflow pipe diameter (minimum)	2 inches	City of San Diego
Maximum rain barrel outflow via 0.5-inch primary outlet	0.010 cubic feet per second	Orifice equation with depth = 2.5 feet
Rain barrel dewatering time	18 minutes	Typical value
Assumed soil infiltration rate at rain barrel discharge	0.03 inches per hour	Type D soil infiltration parameter range
Assumed potential evapotranspiration rate	1.43 inches per month	Minimum monthly value in San Diego region in 2012
Assumed potential evapotranspiration rate	0.002 inches per hour	Typical regional value
Assumed allowable ponding depth in landscaping area	0.75 inches	Typical regional value
Required landscaped area downstream of rain barrel discharge location to prevent rain barrel runoff	144 square feet	Typical regional value
Landscaped area dewatering time	23 hours	Typical regional value

Program Enhancements

To maximize the benefit of implementation and to improve the effectiveness of the current program, program enhancements are recommended. As presented in the CLRP Phase I and II reports (City of San Diego, 2012a and City of San Diego and Caltrans, 2012b), the recommended enhancements were determined based on rain barrel capture volumes and costs, potentially available single-family zoned parcels, available program budget, and discussions with City staff. Based on this information, it was estimated that 26 households and 20 households will take advantage of rain barrel rebates in the Scripps and Tecolote Creek watersheds, respectively. These figures are based on the single-family zoned parcels potentially available for implementation as well as input from City staff; see Table K-2.

Table K-2
Rain Barrel Program Enhancements

Annual Rain Barrel Implementation Metric	City of San Diego	
	Scripps Subwatershed	Tecolote Creek Subwatershed
Single-family zoned parcels (SFZPs)	20,448	15,850
SFZP percentage in City of San Diego	6.78%	5.26%
Rain barrel installations per year (based on number of rebates per year)	26	20

K.2.2.2 Downspout Disconnection Incentive Program

Downspout disconnections are a BMP alternative to reduce runoff volumes in highly impervious watersheds. The purpose of this cost-effective BMP is to disconnect downspouts from rooftop surfaces and reroute downspout runoff to pervious areas where natural processes such as storage, infiltration, and evapotranspiration can remove pollutants.

The City of San Diego has recently initiated a pilot downspout disconnection program in the Newport Avenue area of the Ocean Beach community. The pilot program has demonstrated the effectiveness of downspout disconnections in reducing pollutant loads in highly impervious areas.

As part of the City's larger landscape-based rebate program, implementation of downspout disconnections are encouraged in residential and commercial areas. The landscape-based rebate program has an annual budget of $250,000 to support rebate costs for all aspects of the program. Of this rebate budget, it is anticipated that 10% of funds will support downspout disconnections in residential areas and 10% of funds will support downspout disconnections in commercial areas. In addition to staffing, the City anticipates an annual 4% increase to the annual rebate budget for this program to accommodate program expansion.

Treatment Process Model Overview

Downspout disconnection is modeled by routing roof runoff to pervious land surfaces where overland flow over a typical lawn can be simulated. As roof runoff flows over a pervious surface, such as a lawn, natural infiltrative and evapotranspiration processes occur, reducing runoff volume and removing pollutants.

An overview of downspout disconnection represented in LSPC is shown in Figure K-7.

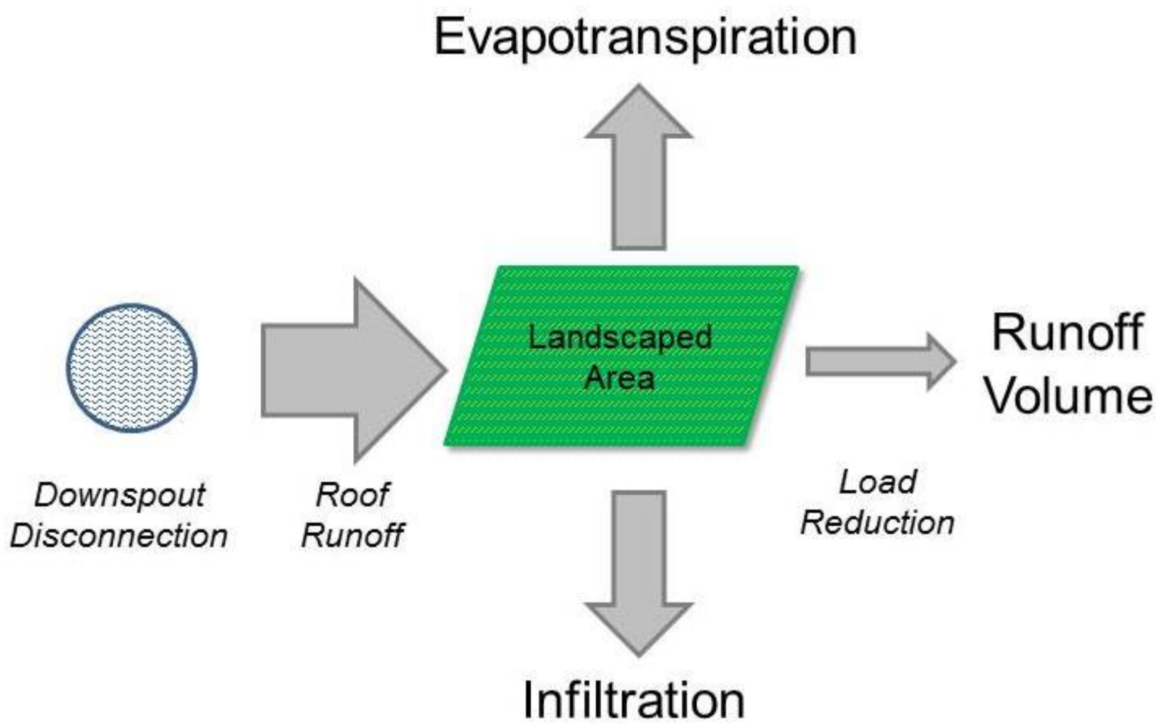


Figure K-7
Downspout Disconnection Treatment Process

Since the downspout disconnection program has recently been initiated, methods for improving runoff volume reduction through downspout disconnections are primarily additional facility installations. Because this program focuses on single-family residential areas, implementation is a function of available single-family zoned parcels in the subwatersheds. To estimate the number of anticipated downspout disconnection rebates in Mission Bay WMA and throughout the City of San Diego, single-family zoned parcels was used as a metric to determine the relative distribution of rebates. Assumptions regarding modeling parameters for downspout disconnections are summarized in Table K-3.

Table K-3
Model Parameters for Downspout Disconnection Program Enhancements

Parameter	Value	Source
Contributing rooftop area to rain barrel (residential areas/commercial areas)	500 square feet 3,600 square feet	Typical area
85th percentile flow to disconnection	0.001 cubic feet per second	Rainfall intensity = 0.2 inches/hour
85th percentile runoff volume to disconnections	10 cubic feet	P = 0.6 inches
Assumed soil infiltration rate at rain barrel discharge	0.03 inches per hour	Type D soil infiltration parameter range
Assumed potential evapotranspiration rate	1.43 inches per month	Minimum monthly value in San Diego region in 2012
Assumed potential evapotranspiration rate	0.002 inches per hour	Typical regional value
Assumed allowable ponding depth in landscaping area	0.75 inches	Typical regional value
Landscaped area dewatering time	23 hours	Typical regional value

Program Enhancements

Based on the available City budget for the program, the cost of installation, relative distribution of single-family zone parcels, and discussion with City staff, it is estimated that 42 and 33 single-family households will take advantage of downspout disconnection rebates in the Scripps subwatershed and Tecolote Creek subwatershed, respectively. Estimated program enhancements and potential single-family parcels for implementation are summarized in Table K-4.

Table K-4
Downspout Disconnection Program Enhancements

Annual Downspout Disconnection Implementation Metric	Scripps Subwatershed	Tecolote Creek Subwatershed
Single-family zoned parcels (SFZP)	20,147	15,759
SFZP percentage in City of San Diego	6.57%	5.14%
Downspout disconnection installations per year (based on number of rebates/year)	42	33

K.2.2.3 Irrigation Runoff Reduction Program

Reductions of irrigation runoff help meet reduction goals for runoff volume and associated pollutant loads. This nonstructural BMP, which doubles as a water conservation initiative, incorporates good landscaping practices to limit irrigation runoff. Measures to reduce irrigation runoff can be implemented wherever landscapes are irrigated. Residential, commercial, recreational, and industrial land uses can be targeted by incentive policies and programs.

The City of San Diego Public Utilities Department currently operates a rebate program for various landscape-based practices. As part of this program, implementation of irrigation reduction runoff measures, such as micro-irrigation and grass replacement, are encouraged in residential and commercial areas. The landscape-based rebate program has an annual budget of $250,000 to support rebate costs for all aspects of the program. Of this rebate budget, it is anticipated that 15% of funds will support micro-irrigation rebates in residential areas, 15% will support micro-irrigation rebates in commercial areas, 20% will support grass replacement rebates in residential, and 20% will support grass replacement rebates in commercial areas. In addition to staffing, the City anticipates an annual 4% increase to the annual rebate budget for this program to accommodate program expansion.

Treatment Process Model Overview

The irrigation runoff reduction program encourages three types of practices—grass replacement projects, micro-irrigation system conversions, and weather-based irrigation controllers—to reduce irrigation runoff. These practices reduce runoff by increasing the capacity of runoff infiltration, conserving water, and/or irrigating only as needed, based on weather and soil inputs. These practices, collectively, are modeled by adjusting (reducing) the extent of irrigated areas and adjusting how irrigation overspray is allocated between impervious and pervious land uses. To reduce irrigated runoff, the model simulates a combination of 25% less irrigated area and the elimination of overspray to impervious areas. As implementation of irrigation runoff reduction measures increase, runoff volume and associated pollutant loads to receiving waters decrease. Figure K-8 illustrates the irrigation reduction treatment process as represented in the LSPC model.

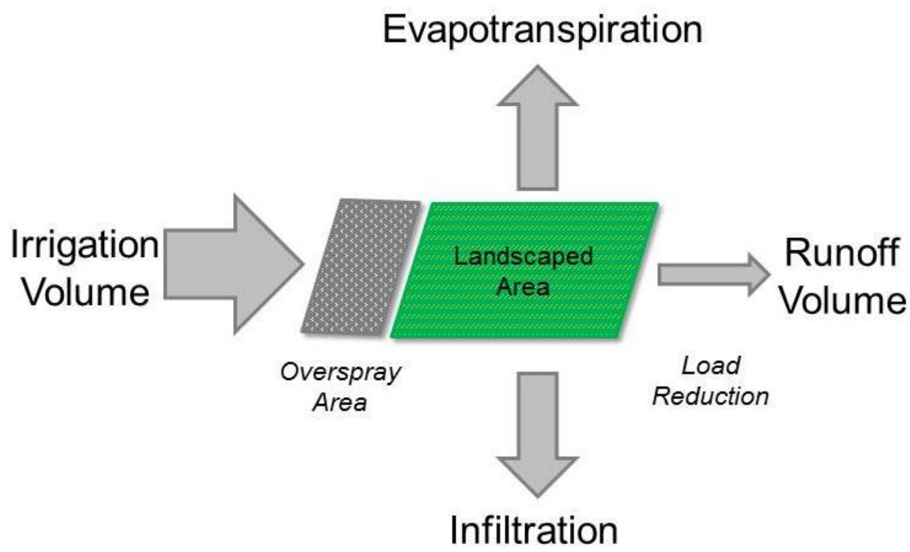


Figure K-8
Irrigation Reduction Treatment Process

Program Enhancements

Based on interviews with City staff and the diverse options and means of implementation in the irrigation runoff reduction program, the recommendation to enhance this program is not a specific action or strategy, but a targeted outcome of 25% irrigation runoff reduction. Regardless of the reduction method, it is recommended that the City reduce runoff from irrigation practices by 25%.

K.2.3 Nonstructural Modeling Results

In compliance with the Settlement Agreement and Release (Settlement) made with San Diegans for Open Government (SDOG) and Coastal Environmental Rights Foundation (CERF), City of San Diego will conduct either increased street sweeping or additional catch basin inspection and cleaning efforts near channel facilities as they are cleared. According to the Settlement, the City of San Diego with either a) increase street sweeping of high traffic commercial routes adjacent to maintained channels to monthly, weekly, or twice weekly (beyond the recommended frequency of bi-weekly) or b) conduct an inspection and cleaning (as necessary) of every catch basin within 100 feet of the maintained segment every three months for one year after cleaning. There are 3 channel facilities located in the Scripps watershed and 12 channel facilities located in Tecolote watershed. Another 13 channel facilities are located outside these watersheds in the Rose Canyon watershed of Mission Bay WMA. The effects of these settlement agreement related activities are not quantified through modeling efforts as these efforts primarily address the impacts of channel clearing and not baseline pollutant loading.

Results of nonstructural strategy modeling of the Scripps subwatershed are summarized in Table K-5. Results of nonstructural strategy modeling of the Tecolote Creek subwatershed are summarized in Table K-6 for the City of San Diego.

Table K-5
Nonstructural BMP Modeling Results for Scripps Subwatershed

Strategy and Level of Implementation[1]	City of San Diego Reduction – Scripps Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero	Total Coliform
Wet Weather										
Nonstructural, non-modeled[3] See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Rain barrel installations Assume 26 households take advantage of rebates/year	0.01%	<0.01%	0.01%	0.01%	0.01%	0.01%	<0.01%	<0.01%	0.01%	0.01%
Downspout Disconnect Assume 42 installations per year	0.13%	0.04%	0.03%	0.05%	0.05%	0.08%	0.04%	0.04%	0.02%	0.02%
Irrigation reduction[4] Eliminate irrigation overspray and reduce irrigation by 25%	<0.1%	2.4%	1.4%	0.4%	0.6%	0.1%	1.0%	2.5%	<0.1%	<0.1%
Total	**10.1%** ***Goal= 10.0%***	**12.4%**	**11.5%**	**10.5%**	**10.6%**	**10.2%**	**11.0%**	**12.5 %**	**10.0%** ***Goal = 6.6%***	**10.0%** ***Goal = 5.1%***
Dry Weather										
Nonstructural, non-modeled[3] See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Irrigation reduction[4] Eliminate irrigation overspray and reduce irrigation by 25%	99%	34%	25%	25%	25%	25%	24%	24%	99%	99%

Strategy and Level of Implementation[1]	City of San Diego Reduction – Scripps Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero	Total Coliform
Total	100%[5] *Goal= 99.0%*	44%	35%	35%	35%	35%	34%	34%	100%[5] *Goal = 99.9%*	100%[5] *Goal = 99.8%*

Note: Orange-shaded cells indicate highest priority water quality conditions for the WMA.

1. Note that these numbers are planning-level and calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site.
2. Limiting impairment for highest priority water quality condition.
3. Nonstructural load reductions include both the modeled and non-modeled load reductions. Non-modeled load reductions are assumed to be 10% for all pollutants (HDR, 2014) and modeled load reductions vary by strategy and pollutant.
4. Irrigation reduction strategies include the implementation of turf conversion projects, micro-irrigation system conversions, weather-based irrigation controllers, downspout disconnections, education and outreach, and enforcement of regulations that prohibit runoff. This strategy was only modeled to include surface contributions of bacteria on overspray areas. Non-highest priority water quality pollutants were not modeled.
5. Mechanistic, process-based assumptions were not applied to non-modeled nonstructural BMPs, resulting in the cumulative dry weather load reductions exceeding 100% (this implies that the combination of strategies will be more than sufficient to achieve dry weather load reduction goals).

Cu = copper; N = nitrogen; P = phosphorus; Pb = lead; Zn = zinc

Table K-6
Nonstructural BMP Modeling Results for Tecolote Creek Subwatershed

Strategy and Level of Implementation[1]	City of San Diego Reduction – Tecolote Creek Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero	Total Coliform
Wet Weather										
Nonstructural, non-modeled[3] See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Rain barrel installations Assume 33 households take advantage of rebates/year	0.01%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%	0.01%	0.01%
Downspout Disconnect Assume 90 installations per year	0.12%	0.04%	0.02%	0.04%	0.04%	0.07%	0.04%	0.04%	0.02%	0.02%
Irrigation reduction[4] Eliminate irrigation overspray and reduce irrigation by 25%	<0.1%	1.6%	1.5%	0.3%	0.6%	0.1%	0.6%	1.6%	<0.1%	<0.1%
Total	**10.1%** ***Goal= 17.9%***	**11.6%**	**11.5%**	**10.4%**	**10.6%**	**10.2%**	**10.6%**	**11.7%**	**10.0%** ***Goal= 11.8%[3]***	**10.0%** ***Goal= 10.0%***
Dry Weather										
Nonstructural, non-modeled[3] See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Irrigation reduction[4] Eliminate irrigation overspray and reduce irrigation by 25%	99%	32%	25%	25%	25%	25%	25%	25%	99%	99%

Strategy and Level of Implementation[1]	City of San Diego Reduction – Tecolote Creek Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero	Total Coliform
Total[4]	100%[5] *Goal= 98.4%*	42%	35%	35%	35%	35%	35%	35%	100%[5] *Goal= 99.9%*	100%[5] *Goal= 99.6%*

Note: Orange-shaded cells indicate highest priority water quality conditions for the WMA.

1. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Limiting impairment for highest priority water quality condition.
3. Nonstructural load reductions include both the modeled and non-modeled load reductions. Non-modeled load reductions are assumed to be 10% for all pollutants (HDR, 2014) and modeled load reductions vary by strategy and pollutant.
4. Irrigation reduction strategies include the implementation of turf conversion projects, micro-irrigation system conversions, weather-based irrigation controllers, downspout disconnections, education and outreach, and enforcement of regulations that prohibit runoff. This strategy was only modeled to include surface contributions of bacteria on overspray areas. Non-highest priority water quality pollutants were not modeled.
5. Mechanistic, process-based assumptions were not applied to non-modeled nonstructural BMPs, resulting in the cumulative dry weather load reductions exceeding 100% (this implies that the combination of strategies will be more than sufficient to achieve dry weather load reduction goals).

Cu = copper; N = nitrogen; P = phosphorus; Pb = lead; Zn = zinc

K.3 Structural Strategies

Structural strategies provide the opportunity to intercept runoff and filter, infiltrate, and treat stormwater. These structures tend to be more expensive than nonstructural strategies, but they also tend to have predictable and reliable effectiveness in removing pollutant loads. Additionally, structural strategies provide other multiuse benefits to the community, such as habitat, aesthetics, and recreational opportunities.

Three major categories of potential structural strategies were modeled in the Mission Bay WMA, using the LSPC and the System for Urban Stormwater Treatment and Analysis Integration model (SUSTAIN):

- Multiuse treatment areas
- Green infrastructure
- Water quality improvement BMPs

Section 4 describes these structural strategies in detail. This appendix summarizes representative BMP information for the three types of structural BMPs evaluated as part of this analysis.

K.3.1 Structural Strategy Modeling Assumptions

Structural strategies will be an important element of the overall Water Quality Improvement Plan compliance strategy. The following subsections describe the assumptions that were applied to model the structural BMPs.

K.3.1.1 Multiuse Treatment Areas

Large treatment structural BMPs (referred to as multiuse treatment areas) are regional facilities that receive flows from neighborhoods or larger areas, which often serve dual purposes—flood control and groundwater recharge. These BMPs are often located in public spaces and can be collocated within parks or green spaces; these strategies can provide excellent ecosystem services and aesthetic value to stakeholders. The first steps in evaluating potential multiuse treatment areas were primary site-selection screening and prioritization analysis, as shown in Figure K-9.

Figure K-9
Screening and Prioritization Methodology Concept

This analysis began by assessing parcels to screen out unsuitable site parameters for structural BMPs, such as steep slopes. These screened sites were then assessed for landscape characteristics, jurisdictional attributes, water quality needs, and general site sustainability to systematically evaluate and prioritize potential sites in each municipality throughout the WMA. Field investigations determined BMP feasibility and potential configuration; then the water quality and hydrology of the multiuse treatment areas were dynamically modeled. This subsection provides the process details and assumptions.

Screening and Prioritization Methodology

In 2009, the City of San Diego performed the *Parcel Evaluation for BMP Implementation Study* that provided a geographical information system (GIS) analysis and decision criteria for selecting parcels for BMP implementation in the City's jurisdiction. The study methodology was a starting point in developing the prioritization and screening process.

The process was further refined based on the experience of the Responsible Agencies and Tetra Tech, and based on CLRP Task 2 Pollutant Source Characterization data (City of San Diego, 2012a and City of San Diego and Caltrans, 2012b). The site-selection process identified parcels potentially suitable for BMP implementation using GIS-based analyses and the best available landscape and water quality data, as shown conceptually in Figure K-10.

Figure K-10
Parcel Screening Results

Site selection consisted of two major steps, including:

1. A primary screening to eliminate unsuitable parcels on the basis of physical and zoning characteristics; and

2. A separate site prioritization process for green infrastructure and multiuse treatment areas, to rank the suitability of the remaining parcels.

The primary screening for potential BMP opportunities was based on two parameters:

- **Parcel Zoning:** Parcels classified as single-family residential, based on the Nucleus Use Code attribute (a description of the use of the property provided by the county assessor), were not considered because of their average small size and the typically low cost-benefit ratio of implementing BMPs on single-family residential parcels. Research and experience nationally indicate that the runoff impacts of single-family parcels can be addressed more cost-effectively through outreach and education, or incentives for practices such as harvesting rainwater, improving irrigation, and converting turf and landscape.

- **Slope:** Parcels with a slope greater than 15 percent were not considered for BMP opportunities, other than parcels located in canyons. The screening was expanded to include areas in and around canyons for multiuse treatment areas. For this analysis, slope was determined on the basis of digital elevation maps or other available topographic data sets. In areas where the overall slope of the parcel was in question, slope was verified through review of aerial imagery.

The results of the primary screening provided a base list of parcels potentially suitable for BMP implementation. A GIS analysis was performed on the remaining parcels to identify the potential sites for optional multiuse treatment area placement and to rank their potential suitability.

Potential sites were then prioritized on the basis of the parcel characteristics, plus additional considerations and different numerical criteria for multiuse treatment areas that were developed and reviewed in discussions with the Responsible Agencies. The additional considerations for identifying potential sites for multiuse treatment areas mainly regarded the use of open space and contributing watershed characteristics; see the following list.

- **Hydrologic Soil Group:** The mapped hydrologic soils groups are used as an initial estimate for the infiltration rate and storage capacity of the soils. Sites where mapped hydrologic soils groups have infiltration rates suitable for infiltration BMPs receive higher priority.
- **Proximity to Wells and Contaminated Soils:** Areas near contaminated sites received lower priority because of their potential for increased costs and complications during implementation.
- **Proximity to Environmentally Sensitive Areas (ESAs):** Areas where runoff can be treated before draining to an ESA were given a higher priority.
- **Parcel Percent Impervious:** Parcels with a large extent of existing open space tend to be more cost effective for BMP retrofits. Additionally, multiuse treatment areas can commonly be incorporated into existing recreational facilities to provide enhanced community benefits. Sites with a lower impervious coverage therefore received higher priority.
- **Parcel Size:** The size of the parcel was used to prioritize sites for multiuse treatment areas, with larger parcels receiving higher priority.
- **Proximity to Existing BMPs:** To distribute treatment opportunities effectively throughout the watershed, areas close to existing or planned future BMPs were given a lower priority.
- **Proximity to Parks and Schools:** Parks typically have the largest available open area and the lowest percentage of impervious area, and are well suited for multiuse treatment area implementation. Schools also tend to have large open areas, providing opportunities for BMP implementation. Areas classified as parks were given the highest priority, followed by schools. Other areas were given higher priority because of their opportunity for public outreach and education.
- **Proximity to the Storm Drainage Network:** Because multiuse treatment areas are especially effective where runoff can be diverted from the existing drainage

network for treatment and control, areas close to the storm drainage network received higher priority.

- **Contributing Area:** The size of the drainage area that could be diverted and treated at each potential site was evaluated, and areas that capture and effectively treat runoff from the largest drainage areas were given higher priority.
- **Impervious Coverage of Contributing Area:** During storms, contributing drainage areas with a higher percentage of imperviousness produce increased runoff relative to the watershed size. Drainage areas with higher imperviousness were targeted for greater potential volume reduction and water quality improvements
- **Proximity to Corrugated Metal Pipe Systems:** To incorporate future upgrades to the storm drainage network in the City of San Diego, the proximity to a corrugated metal pipe system is to be considered and ranked on the basis of the necessity for rehabilitation.

The advantage of this prioritization process is the ability to select BMP locations that are best suited for maximum cost-effectiveness, resulting in the greatest pollutant load reductions per dollar. Because structural BMPs at any scale involve identifying and setting aside land for stormwater treatment, assessing opportunities on existing publicly owned lands is especially important. Structural treatment often can be integrated into parks, playing fields, street rights-of-way, and medians without compromising function, so opportunities for incorporating BMPs in recreation areas, streets, and other public open spaces are typically prioritized and used as a first step in evaluating sites.

The agreed-upon weightings for each factor are listed in Table K-7.

As part of CLRP Phase I efforts, multiple desktop and field-screening exercises were completed to develop a full understanding of the opportunities that exist for multiuse treatment area implementation in this WMA (City of San Diego, 2012a and City of San Diego and Caltrans, 2012b). The sites were pared down and prioritized, based on feasibility, potential for pollutant load reduction, and other physical characteristics. The top-ranked sites in each hydrologic area for each Responsible Agency jurisdiction were identified then each was reviewed using aerial photography to assess the validity of the site. Sites that were potentially feasible per the aerial photography review were used to target parcels where field investigations would be conducted. On the basis of the field evaluations, the sites were ranked by implementation feasibility. Fact sheets were then composed to convey the design intent and potential configuration of each site.

Table K-7
Prioritization Criteria for Multiuse Treatment Area BMP Implementation (Excluding Canyon Areas)

Factor	Score (1 = Worst; 5 = Best)				
	1	2	3	4	5
Parcel Type	All Others	All Private Commercial or Industrial Parcels	—	Other-Owned Public Parcels (Assigned a Priority Score of 8)	City or County Public Parcels (Assigned a Priority score of 10)
Hydrologic Soil Group	D	—	C	—	A, B
Proximity to Wells and Water Supplies, and Contaminated Soils (Feet)	< 100	—	> 100	—	—
Proximity to Environmental Sensitive Areas (ESAs)	—	—	—	Drains to	Adjacent
Parcel Percent Impervious	> 40	—	—	30–40	≤ 30
Parcel Size (Acres)	< 1	1–100	100–150	150–200	≥ 200
Proximity to Existing and Proposed BMP Site (Miles)	< 2	2–3	3–4	4–5	> 5
Proximity to Parks and Schools (Feet)	—	—	< 1,000	School	Park
Proximity to Storm Drainage Network (Feet)	> 300	< 300	< 100	—	—
Contributing Area (Acres)	< 50	> 50	> 100	> 150	> 250
Impervious Coverage of Contributing Area (%)	< 40	> 40	> 50	> 60	> 70
Proximity to Corrugated Metal Pipe (CMP) Systems	CMP requiring no action	—	CMP needing rehabilitation	—	CMP needing replacement

Note:
1. Schools and universities, state and federal facilities, and utilities

Model Representation

Each of the multiuse treatment area BMPs was represented directly in the LSPC using a storage-discharge relationship to simulate outflow and a background infiltration rate reflective of the underlying soils (as shown in Figure K-11). By incorporating these features directly into the LSPC, the dynamic effect on volume and water quality incorporates all of the spatial variability (land use distribution and precipitation time series) within the model.

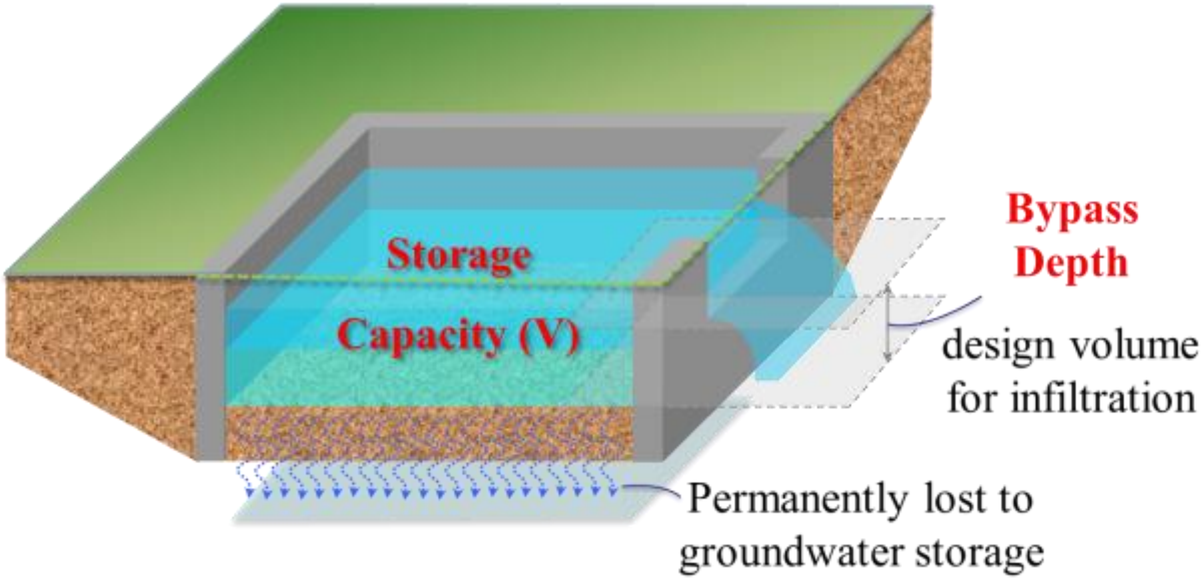


Figure K-11
Multiuse Treatment Area BMP Representation

The static storage volume of each optional multiuse treatment area was initially calculated as the required volume corresponding to the 85th percentile runoff depth, based on the average percent imperviousness in the upstream contributing drainage area (City of San Diego, 2008). The 85th percentile runoff depth was calculated uniquely for each multiuse treatment area, using the weather station assigned to the model subwatershed that includes each BMP. The storage volume and BMP dimensions were then verified and refined based on field reconnaissance to reflect realistic dimensions of the BMPs implemented at each unique location. Additionally, one already-implemented multiuse treatment area (Torrey Pines infiltration gallery) with known dimensions and drainage areas was also modeled.

Modeling Results

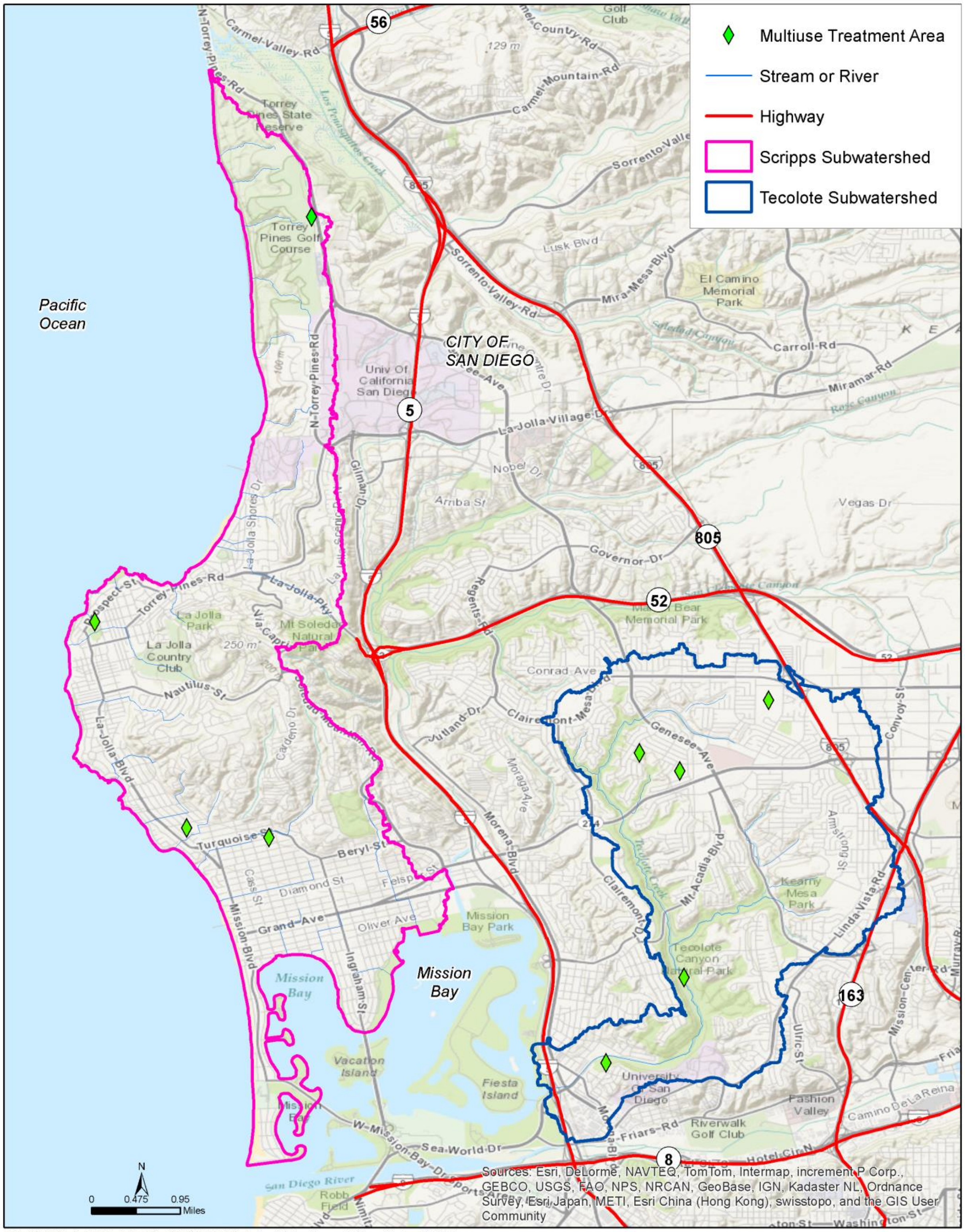
From previous site selection optimization analyses, approximately 3,200 parcels were screened for BMP opportunities in the Mission Bay WMA (2,690 parcels in the Scripps subwatershed and 502 parcels in the Tecolote Creek subwatershed). Nine multiuse treatment areas were identified during the screening and prioritization process, as listed in Table K-8 and displayed in Figure K-12.

Table K-8
Tabulation of Identified Potential Multiuse Treatment Areas in the Mission Bay WMA

Name of Multiuse Treatment Area[1]	Subwatershed	Type of Best Management Practice (BMP)	Modeled Drainage Area (acres)	Modeled Storage Volume (acre-feet)
Torrey Pines Golf Course	Scripps	Infiltration Basin	3.7	0.43
Pacific Beach Elementary School	Scripps	Detention/ Infiltration Basin	213	3.9
La Jolla Community Park	Scripps	Detention/ Infiltration Basin	19	0.6
Bird Rock Elementary School and Bird Rock Park	Scripps	Detention/ Infiltration Basin	81	1.5
Mt. Everest Academy Elementary School	Tecolote Creek	Detention/ Infiltration Basin	21	0.7
John Muir School and Anderson School	Tecolote Creek	Detention/ Infiltration Basin	72	2.0
Tecolote Canyon Park	Tecolote Creek	Detention/ Infiltration Basin	6,032	18.0
James Madison High School	Tecolote Creek	Detention/ Infiltration Basin	97	2.7
Sam Snead All American Golf Course	Tecolote Creek	Wetland	5,642	34.2

Note:
1. Kellogg Park, an optional multiuse treatment area identified during the CLRP I efforts (City of San Diego, 2012a), was omitted from the Water Quality Improvement Plan as a multiuse treatment area BMP because green infrastructure BMPs have since been constructed at this location.

Source: City of San Diego, 2012a and City of San Diego



Path: O:\GIS\Project\California\SanDiegoWQIP\MXDs\MissionBay_MUAs_Map.mxd, hillary.nicholas 5/21/2014
Aerial Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

Figure K-12
Locations of Multiuse Treatment Area BMPs in the Mission Bay WMA

Tecolote Creek Subwatershed Modeling Results. The multiuse treatment area BMPs on public parcels incorporated in the Tecolote Creek model are mostly detention and infiltration facilities (see Table K-8). These features were largely located on soils with low infiltration capacities. Table K-9 summarizes the planning-level pollutant and flow reductions predicted for these facilities. All sites should be analyzed in detail to optimize their design and to maximize the subwatershed-wide load reductions.

Scripps Subwatershed Modeling Results. No optional multiuse treatment areas were incorporated into the Scripps model because the wet weather fecal coliform load reduction goal is attained by nonstructural strategies. However, as it has already been constructed, the multiuse treatment area at Torrey Pines golf course was modeled to demonstrate the City of San Diego's progress towards exceeding the load reduction goal. Table K-10 presents the modeled flow and load reductions attributed to the jurisdictional multiuse treatment area in the Scripps subwatershed.

Table K-9
Flow and Pollutant Load Reduction Attributed to Multiuse Treatment Areas on Public Parcels in Tecolote Creek Subwatershed

Strategy and Level of Implementation[1]	City of San Diego Reduction—Tecolote Creek Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Wet Weather										
Multiuse Treatment Areas: 20 acre BMP to treat 11,864 acres of drainage area with a total storage volume of 58 acre-feet	**4.2%**	1.1%	0.4%	0.5%	0.5%	0.5%	2.1%	1.1%	**5.0%**	**4.1%**
Dry Weather										
Multiuse Treatment Areas: 20 acre BMP to treat 11,864 acres of drainage area with a total storage volume of 58 acre-feet	**96%**	95%	96%	96%	96%	96%	96%	96%	**96%**	**96%**

Note:

1. Note that these numbers are planning-level values and calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the above numeric goals at each respective project site.
2. Orange-shaded cells indicate highest priority water quality conditions for the Mission Bay WMA.

Cu = copper; N = nitrogen; P = phosphorus; Pb = lead; Zn = zinc

Table K-10
Flow and Pollutant Load Reduction Attributed to Already-Constructed Multiuse Treatment Areas on Public Parcels in Scripps Subwatershed

Strategy and Level of Implementation[1]	City of San Diego Reduction—Scripps Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment[2]	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Wet Weather										
Torrey Pines Golf Course: 0.1 acre BMP to treat 3.7 acres of drainage area with a total storage volume of 0.4 acre-feet	**0.02%**	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	**0.03%**	**0.02%**
Dry Weather										
Torrey Pines Golf Course: 0.1 acre BMP to treat 3.7 acres of drainage area with a total storage volume of 0.4 acre-feet	**0.2%**	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.1%	**0.2%**	**0.2%**

Note:
1. Note that these numbers are planning-level values and calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the above numeric goals at each respective project site.
2. Orange-shaded cells indicate highest priority water quality conditions for the Mission Bay WMA.

Cu = copper; N = nitrogen; P = phosphorus; Pb = lead; Zn = zinc

K.3.1.2 Green Infrastructure

As with multiuse treatment areas, the first step in selecting the best potential new locations for green infrastructure BMPs (outside of the right-of-way) was a site-selection and prioritization analysis. This analysis follows the concept presented in Section K.3.1.1, with some modifications specific to green infrastructure practices. The following analyses evaluated opportunities for green infrastructure only outside of the right-of-way because modeling results predicted that green street implementation would not be required to meet water quality goals in the Mission Bay WMA. Green infrastructure on public parcels tends to be more cost-effective than green streets and provides many multiuse benefits.

Screening and Prioritization Methodology

The same primary screening criteria presented in Section K.3.1.1 for multiuse treatment areas were used to initially screen out potentially unsuitable parcels for green infrastructure, based on slopes and land ownership. The results of the primary screening provided a base list of parcels potentially suitable for BMP implementation. Then a GIS analysis was performed on the remaining parcels to identify the potential sites for green infrastructure BMP placement and to rank their potential suitability. The following characteristics were used in this ranking:

- **Pollutant Loading:** Parcels where estimated pollutant loadings are greatest were given a higher priority. Land-based pollutant loadings were obtained from the CLRP Task 2 Pollutant Source Characterization modeling results. Pollutant loading percentiles were determined on a watershed basis, and represent the average pollutant loading scores. A composite wet- and dry-weather areal loading score was developed for each applicable TMDL pollutant in each watershed.
- **Parcel Zoning and Ownership:** Land costs generally are minimized by using existing public lands; therefore, a higher priority was placed on publicly owned parcels.
- **Hydrologic Soil Groups:** The mapped hydrologic soils groups were used as an initial estimate of the infiltration rate and storage capacity of the soils. Sites where mapped hydrologic soils groups have infiltration rates suitable for infiltration BMPs received higher priority.
- **Wells, Water Supplies, and Contaminated Sites:** Areas near contaminated sites received lower priority because of their potential for increased costs and complications during implementation.
- **Environmentally Sensitive Areas:** Areas where runoff can be treated before draining to an ESA were given a higher priority.
- **Total Impervious Area:** Parcels with a larger total impervious area typically generate more runoff and greater pollutant loads, and so were given a higher priority. Where impervious data were not available, the impervious area was estimated using aerial imagery.

- **Percent Impervious:** Parcels with a higher percentage of impervious area also typically produce more runoff, and so were targeted on the basis of their greater potential to reduce volume and improve water quality.
- **Proximity to Existing BMPs:** To distribute treatment opportunities effectively throughout the watershed, areas close to existing or planned future BMPs were given a lower priority.
- **Proximity to Parks and Schools**: Areas closest to parks and schools were given a higher priority, in part to provide a greater opportunity for public outreach and education.
- **Proximity to the Storm Drainage Network:** Areas close to the storm drain network were given a higher priority. Green infrastructure BMPs on poorly draining soils require underdrain systems that tap into existing infrastructure, and siting these near the storm drain network can minimize cost.

Potential sites were prioritized using a scoring methodology developed in conjunction with the City and presented in Table K-11. This scoring methodology puts an equally high emphasis on municipal or public ownership and areas most affected by land-based pollutant loadings (combined wet and dry weather loading). Ownership and pollutant loading can achieve a maximum score of 10; the remaining scoring criteria can achieve a maximum score of 5. Therefore, this methodology not only prioritizes locations where green infrastructure BMPs are practicably feasible but allows for selecting BMPs in public parcels where the load reduction would be potentially most effective.

The top-ranked sites in each hydrologic or subwatershed area were also identified.

Table K-11
Prioritization Criteria for Potential Green Infrastructure BMP Locations

Factor	Score (1 = Worst; 5 = Best)				
	1	2	3	4	5
Wet Weather Areal Pollutant Loading	<20th percentile	40-20th percentile	60-40th percentile	80-60th percentile	>80th percentile
Dry Weather Areal Pollutant Loading	<20th percentile	40-20th percentile	60-40th percentile	80-60th percentile	>80th percentile
Parcel Zoning and Ownership	All Other Parcels	All Private Commercial or Industrial Parcels	—	Other-Owned Public Parcels: Priority Score of 8	City- or County-Owned Public Parcels and Rights-of-Way: Priority Score of 10
Hydrologic Soil Group	D	—	C	—	A, B
Proximity to Wells, Water Supplies, and Contaminated Soils (Feet)	< 100	—	> 100	—	—
Proximity to ESA (Optional)	—	—	—	Drains to	Adjacent to
Impervious Area (Acres)	—	> 0.1	> 0.25	> 0.5	> 1
Percentage Impervious	< 50	—	—	80–90	60–80
Proximity to Existing or Proposed BMP Site (Miles)	< 2	2–3	3–4	4–5	> 5
Proximity to Parks and Schools (Feet)	> 1,000	—	< 1,000	—	—
Proximity to Storm Drainage Network (Feet)	> 300	< 300	< 100	—	—

Note:
1. Schools and universities, state and federal facilities, utilities, etc.

Model Representation

Green infrastructure BMPs were simulated in the LSPC, using bioretention or permeable pavement features. These BMPs' runoff and pollutant loading boundary conditions were generated for the modeling framework and were selected for evaluation in consideration of their suitability in various site configurations and their multiuse benefits. The model represented green infrastructure BMPs using a set of (a) physical characteristics that describe the feature geometry and (b) process-based parameters that describe the mechanisms related to flow and pollutant transport, such as evapotranspiration, infiltration, and pollutant loss. Physically, both bioretention and pervious pavement were conceptualized as having three compartments: (a) surface storage, which provides volume for ponding, (b) soil media or aggregate substrate, and (c) an optional underdrain reservoir when required by background soil conditions. Both bioretention and permeable pavement options were configured with and without underdrains, depending on the underlying soils. For instance, HSG B areas were modeled without underdrains and HSG C and D areas were modeled with underdrains.

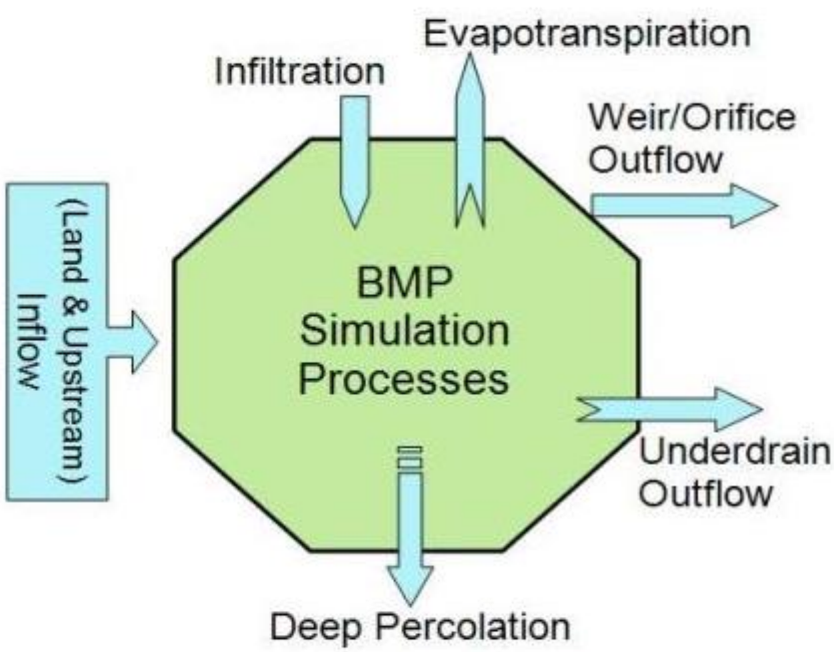
These modeling parameters are outlined in Table K-12.

Table K-12
Detailed Model Representation for Green Infrastructure BMPs

Parameter	Bioretention	Permeable Pavement
Surface Parameters		
Unit size (square feet) *(Varies with 85th percentile rainfall depth)*	808–1,520	1,388–2,610
Design drainage area (acres)*	1	1
Substrate depth (feet)	3	2
Underdrain depth (feet)	None for B Soil; 1.5 for C, D Soil	None for B Soil; 1.5 for C, D Soil
Ponding depth (feet)	0.75	0.01
Subsurface Parameters		
Substrate layer porosity	0.4	0.4
Substrate layer field capacity	0.25	0.1
Substrate layer wilting point	0.1	0.05
Underdrain gravel layer porosity	0.4	0.4
Vegetative parameter, A	1	0
Monthly growth index	1	0
Background soil infiltration rate (in./hr.), f_c	B–0.8; C–0.2; D–0.01	B–0.8; C–0.2; D–0.01
Media final constant infiltration rate (inches per hour), f_c	2	2

The modeled BMPs incorporated a variety of pathways through which water and pollutants travel through the BMP (i.e., infiltration, evapotranspiration, weir overflow, and underdrain outflow). Figure K-13 is a schematic diagram of the soil media and underdrain components illustrating the related physical and process-based parameters. As discussed above, inflow from the land was represented using the time series from the LSPC.

While the model representation of permeable pavement is similar to that of bioretention, the two features are distinguished by a different set of physical and process-based parameters that describe the function of infiltration, both through the aggregate media and into background soils. For example, the ponding depth of pervious pavement is physically much shallower than that of bioretention, because, in practice, stormwater would not be allowed to accumulate on the paved surface. Also, because permeable pavement is not vegetated, its potential for evapotranspiration is also greatly diminished as compared to that of bioretention.



Source: Lee et al., 2012

Figure K-13
Conceptual Diagram of Selected Processes Associated with Structural BMPs

Green infrastructure BMPs were modeled in CLRP Phase II by assuming that BMPs were sized to capture the 85th percentile runoff volume from each suitable public parcel in each subwatershed (City of San Diego 2013a, and City of San Diego. Additionally, the City of San Diego is demonstrating progress towards reducing fecal coliform loads through a number of green infrastructure BMP projects that have already been implemented. Those green infrastructure projects (identified in Table K-13) were modeled with project-specific details to consider the water quality benefits provided by these practices.

Table K-13
Tabulation of Identified Mission Bay
Green Infrastructure Projects Already Implemented

Green Infrastructure	Subwatershed	Best Management Practice Type	Drainage Area (acres)	BMP Footprint (acres)
Kellogg Park Green Lot	Scripps	Permeable Pavement and Bioretention	8.9	1.75
Mt. Abernathy and Camber Green Infiltration BMP	Tecolote Creek	Green Street	19.6	0.06
Bannock Avenue Green Street	Tecolote Creek	Green Street	65	0.47

For the Scripps subwatershed, only those green infrastructure projects that were already implemented were considered because water quality goals are achieved by nonstructural strategies.

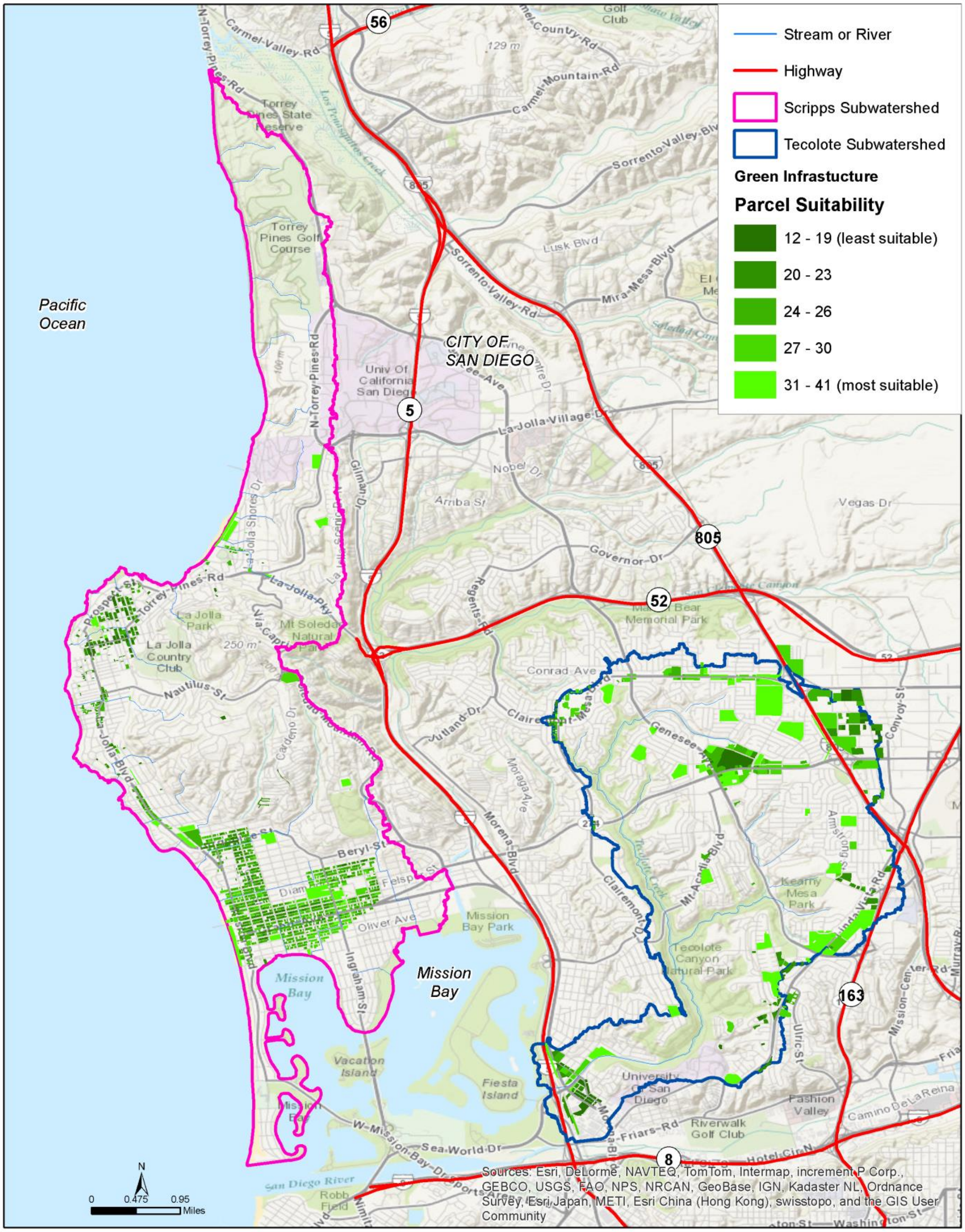
Modeling Results

The screening and prioritization process identified the potentially suitable parcels for optional green infrastructure implementation in the Mission Bay WMA, as shown in Figure K-14. Although not all optional opportunities are needed to meet water quality goals, these prioritized parcels provide opportunities for future green infrastructure projects if future adaptive management exercises reveal that the strategies identified in the Water Quality Improvement Plan require augmentation.

Tecolote Creek Subwatershed. The modeled quantities of green infrastructure that were predicted (in addition to nonstructural strategies and multiuse treatment areas) to meet the fecal coliform wet weather load reductions are listed in Table K-14. These BMPs should be applied throughout each modeled subwatershed, based on the list of prioritized parcels identified during CLRP I efforts (City of San Diego and Caltrans, 2012b) and shown in Figure K-14.

Table K-15 presents the modeled flow and pollutant load reduction attributed to implementation of green infrastructure BMPs by the City of San Diego in the Tecolote Creek subwatershed.

Table K-16 presents the additional modeled flow and pollutant load reduction (above and beyond reductions predicted for nonstructural and multiuse treatment area strategies) attributed to the implementation of green infrastructure BMPs in the Scripps subwatershed.



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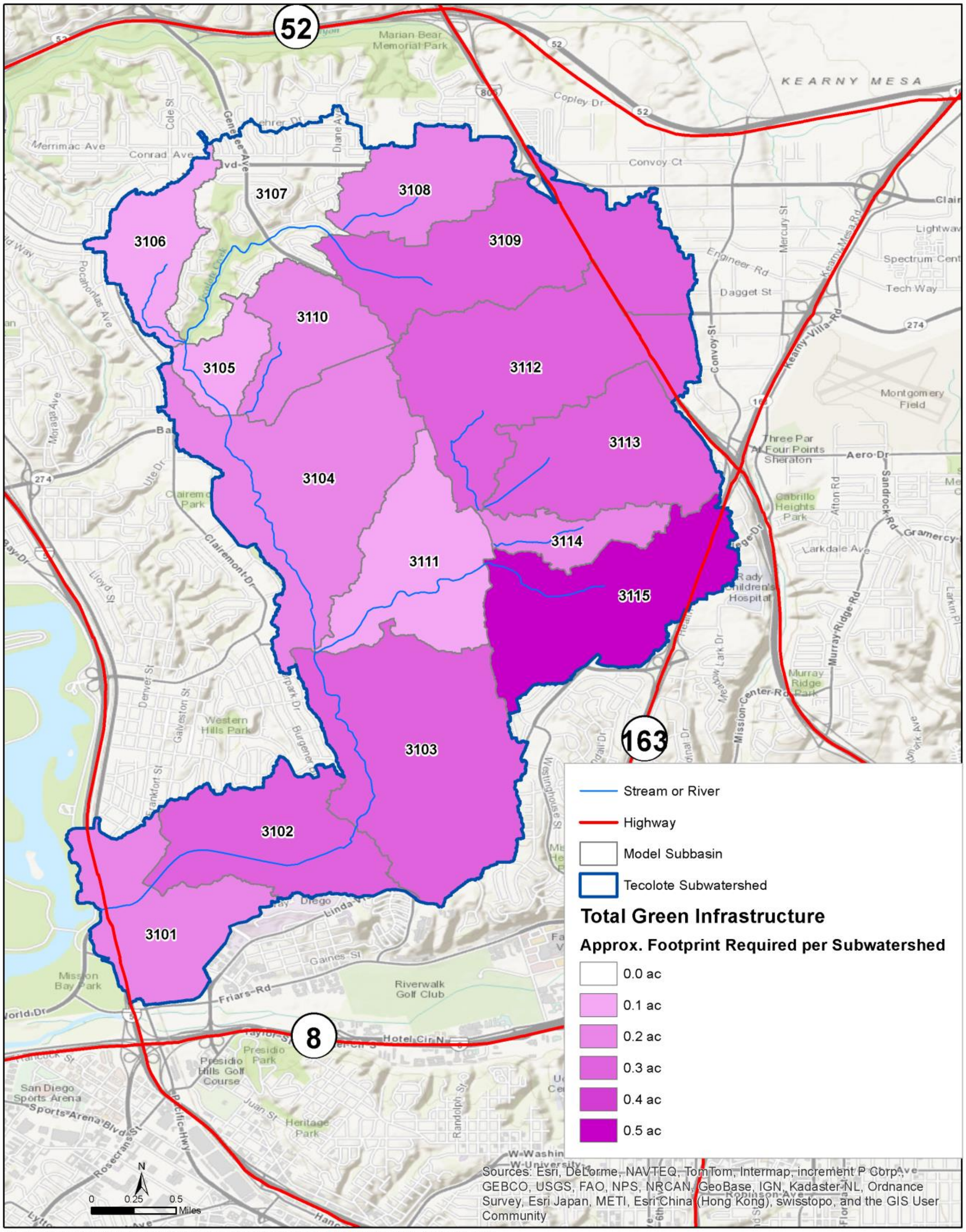
Aerial Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

Figure K-14
High-Ranked Locations
of Optional Green Infrastructure Best Management Practices



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Aerial Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

Figure K-15
Required Extent of Green Infrastructure in Tecolote Creek Subwatershed in Addition to Projects Already Implemented

Table K-14
Required Extent of Green Infrastructure (Sized and Sited To Capture the 85th Percentile Runoff Volume from Public Parcels) in Addition to Existing Projects in Tecolote Creek Subwatershed[1]

Subwatershed (See Figure K-15)	Bioretention Footprint Modeled (acres)	Permeable Pavement Footprint Modeled (acres)	Total Optional Green Infrastructure Footprint (acres)
3101	0.11	0.03	0.13
3102	0.17	0.04	0.21
3103	0.23	0.06	0.29
3104	0.12	0.03	0.14
3105	0.00	0.00	0.00
3106	0.02	0.00	0.02
3107	0.00	0.00	0.00
3108	0.10	0.02	0.12
3109	0.18	0.09	0.27
3110	0.12	0.03	0.15
3111	0.04	0.01	0.05
3112	0.22	0.05	0.27
3113	0.22	0.05	0.28
3114	0.15	0.04	0.18
3115	0.40	0.10	0.50
Totals	**2.09**	**0.55**	**2.63**

Note:
1. Note that these numbers are planning-level recommendations and are calculated at a subwatershed scale; structural BMPs should be sited and designed to meet both jurisdictional standards and the numeric goals for the subwatershed.

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Table K-15
Flow and Pollutant Load Reduction Attributed to Green Infrastructure BMPs on Public Parcels in Tecolote Creek Subwatershed

Strategy and Level of Implementation[1]	City of San Diego Reduction—Tecolote Creek Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Wet Weather										
Green infrastructure: 2.09 acres of bioretention and 0.55 acre of permeable pavement	**3.5%**	2.0%	1.8%	1.1%	1.6%	1.7%	2.0%	2.6%	**2.7%**	**0.8%**
Dry Weather										
Green infrastructure: 2.09 acres of bioretention and 0.55 acre of permeable pavement	**<0.1%**	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	**<0.1%**	**<0.1%**

Note:
1. Note that these numbers are planning-level values and are calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the above numeric goals at each respective project site. Reported quantities include the extent of projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality conditions for the Mission Bay WMA.

Cu = copper; N = nitrogen; P = phosphorus; Pb = lead; Zn = zinc

Table K-16
Flow and Pollutant Load Reduction Attributed to Green Infrastructure BMPs on Public Parcels in Scripps Subwatershed

Strategy and Level of Implementation[1]	City of San Diego Reduction – Scripps Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment[2]	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Wet Weather										
Kellogg Park: 0.6 acre of permeable pavement to treat 8.9 acres of drainage area	**0.4%**	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	**0.3%**	**0.1%**
Dry Weather										
Kellogg Park: 0.6 acre of permeable pavement to treat 8.9 acres of drainage area	**<0.1%**	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	**<0.1%**	**<0.1%**

Note:
1. Note that these numbers are planning-level values and are calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the above numeric goals at each respective project site.
2. Orange-shaded cells indicate highest priority water quality conditions for the Mission Bay WMA.

Cu = copper; N = nitrogen; P = phosphorus; Pb = lead; Zn = zinc

K.3.1.3 Water Quality Improvement BMPs

Water quality improvement BMPs include strategies such as low-flow diversions and proprietary BMPs. These BMPs can be useful where green infrastructure is not suitable because of design constraints. Identified water quality improvement BMPs within the Mission Bay WMA are displayed in Figure K-16.

K.3.1.4 Tecolote Creek Subwatershed

The City of San Diego currently operates one low-flow diversion facility within the Tecolote Creek main channel Figure K-17. This was included in the baseline model of existing conditions and was therefore not included in the flow and pollutant load estimates for dry weather presented herein. Based on review of information on this diversion and communications with City staff, a diverted flow rate of 1.4 cubic feet per second (cfs) was assumed in the model for this facility.

K.3.1.5 Scripps Subwatershed

The City currently operates 31 low-flow diversion facilities within the Scripps subwatershed (Figure K-18). These were included in the baseline model of existing conditions and are therefore not included in the flow and pollutant load estimates for dry weather presented herein. Based on review of information on these diversions and communications with City staff, a cumulative diverted flow rate of 12.9 cfs was assumed in the model for these facilities, with individual facility locations and diversion rates represented appropriately.

Path: O:\GIS\Project\California\SanDiegoWQIP\MXDs\MissionBay_WQImpBMPs_Map.mxd, hillary.nicholas 5/21/2014
Aerial Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

Figure K-16
Water Quality Improvement BMPs

Figure K-17
Low-Flow Diversion in Tecolote Creek Subwatershed

Figure K-18
Low-Flow Diversion in Scripps Subwatershed

K.3.2 Structural Modeling Results

The results of all structural strategy modeling for the Mission Bay WMA are summarized below, Note that these results do not include the reductions associated with nonstructural strategies presented in Section K.2.3.

Table K-17 summarizes the predicted reductions from structural BMPs in the Scripps subwatershed. BMPs were first optimized for wet weather, and then the models were used to simulate pollutant reductions for dry weather.

Table K-18 tabulates the predicted reductions from structural strategies in the Tecolote Creek subwatershed.

Table K-17
Scripps Subwatershed Structural BMP Model Results

Strategy and Level of Implementation[1]	City of San Diego Reduction—Scripps Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Wet Weather										
Multiuse Treatment Areas: 0.1 acre BMP to treat 3.7 acres of drainage area with a total storage volume of 0.4 acre-feet	**0.02%**	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	**0.03%**	**0.02%**
Green Infrastructure: 0.6 acre of permeable pavement to treat 8.9 acres of drainage area	**0.4%**	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	**0.3%**	**0.1%**
Totals	**0.5%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.3%**	**0.1%**
Dry Weather										
Multiuse Treatment Areas: 0.1 acre BMP to treat 3.7 acres of drainage area with a total storage volume of 0.4 acre-feet	**0.2%**	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.1%	**0.2%**	**0.2%**
Green Infrastructure: 0.6 acre of permeable pavement to treat 8.9 acres of drainage area	**<0.1%**	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	**<0.1%**	**<0.1%**
Totals	**0.2%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.2%**	**0.1%**	**0.2%**	**0.2%**

Note:
1. Note that these numbers are planning-level values and are calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the above numeric goals at each respective project site. Reported quantities include the extent of projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality conditions for the Mission Bay WMA.

Cu = copper; N = nitrogen; P = phosphorus; Pb = lead; Zn = zinc

Table K-18
Tecolote Creek Subwatershed Structural BMP Model Results

Strategy and Level of Implementation[1]	City of San Diego Reduction – Tecolote Creek Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Wet Weather										
Multiuse Treatment Areas: 20 acre BMP to treat 11,864 acres of drainage area with a total storage volume of 58 acre-feet	**4.2%**	1.1%	0.4%	0.5%	0.5%	0.5%	2.1%	1.1%	**5.0%**	**4.1%**
Green Infrastructure: 2.09 acres of bioretention and 0.55 acre of permeable pavement	**3.5%**	2.0%	1.8%	1.1%	1.6%	1.7%	2.0%	2.6%	**2.7%**	**0.8%**
Totals	**7.7%**	3.1%	2.2%	1.6%	2.1%	2.2%	4.1%	3.7%	**7.7%**	**4.9%**
Dry Weather										
Multiuse Treatment Areas: 20 acre BMP to treat 11,864 acres of drainage area with a total storage volume of 58 acre-feet	**96%**	95%	96%	96%	96%	96%	96%	96%	**96%**	**96%**
Green Infrastructure: 2.09 acres of bioretention and 0.55 acre of permeable pavement	**<0.1%**	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	**<0.1%**	**<0.1%**
Totals	**96%**	95%	96%	96%	96%	96%	96%	96%	**96%**	**96%**

Note:
1. Note that these numbers are planning-level values and are calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the above numeric goals at each respective project site. Reported quantities include the extent of projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality conditions for the Mission Bay WMA.

Cu = copper; N = nitrogen; P = phosphorus; Pb = lead; Zn = zinc

K.4 Comprehensive Strategy Results

Nonstructural and structural strategies were modeled to demonstrate progress toward attaining the numeric goals outlined in the main body of this document. The focus of the optimization analysis is to consider the cost-effectiveness of subwatershed-wide implementation of BMPs. Optimization incrementally considers costs of BMP implementation and accounts for progress toward achieving the load reduction goals. The targets for optimization are the jurisdictional goals, the percent load reduction goal equitably distributed among jurisdictions, presented in Section 4.1. An equitable percent load reduction goal ensures an overall net load reduction for the entire subwatershed with the ability for each Responsible Agency to achieve the load reduction appropriately and effectively for each jurisdiction. A relative percent load reduction goal also ensures equitable distribution of the pollutant mass to be reduced.

Strategies were prioritized by order of those that are most cost-effective, following the order shown in Figure K-1. For instance, nonstructural strategies are effective in reducing pollutant loads before they enter the storm drain and are generally cost-effective and require a shorter planning period. Therefore, most nonstructural strategies are planned for implementation before or upon approval of the Water Quality Improvement Plan. Structural BMPs can be cost-effective when greater load reductions are needed and treatment must occur after the pollutants enter the storm drain system, particularly when benefits other than water quality improvements are considered. However, planning for structural BMPs requires more time to secure resources, design BMPs, and obtain permits. Most of the structural BMPs are planned for later in the compliance period to allow more time to ensure that the implementation is necessary to meet numeric goals and is designed to achieve the load reductions required, and that alternatives to construction have been evaluated.

The following sections summarize the combined load reductions predicted for all modeled strategies.

K.4.1 Tecolote Creek Subwatershed

The final wet weather subwatershed percent load reduction goal for the City of San Diego is 17.9% for the critical pollutant, fecal coliform. BMPs were first optimized to meet wet weather goals, and then the models were used to simulate pollutant reductions for dry weather. This technique was used because wet weather load reduction goals tend to be more conservative (i.e., they require larger BMPs for compliance) than are dry weather load reduction goals. In other words, BMPs optimized to capture and treat dry weather flows (generally minimal discharges over short periods of time) would not likely be adequate to capture and treat wet weather (storm) flows. Table K-19 summarizes pollutant load reductions for wet and dry weather conditions for the critical pollutant, fecal coliform. No process-based assumptions were applied to non-modeled, nonstructural BMPs, which implies that the combination of strategies will be more than sufficient to achieve dry weather load reduction goals. These tables present the load reductions predicted for all modeled strategies within the Tecolote Creek subwatershed and demonstrate that the strategies presented in the Water Quality Improvement Plan will reach the dry and wet weather subwatershed percent load reduction goals.

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Table K-19
Water Quality Improvement Plan Wet and Dry Weather Reductions in the Tecolote Creek Subwatershed

Strategy and Level of Implementation[1]	City of San Diego Reduction – Tecolote Creek Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Wet Weather										
Nonstructural, non-modeled See Section 4.2.4	**10%**	10%	10%	10%	10%	10%	10%	10%	**10%**	**10%**
Nonstructural, modeled Rain Barrels, Downspout Disconnections, and Irrigation Reductions[3]	**0.2%**	1.6%	1.5%	0.4%	0.6%	0.2%	0.6%	1.7%	**<0.1%**	**<0.1%**
Multiuse Treatment Areas 20 acre BMP to treat 11,864 acres of drainage area with a total storage volume of 58 acre-feet	**4.2%**	1.1%	0.4%	0.5%	0.5%	0.5%	2.1%	1.1%	**5.0%**	**4.1%**
Green Infrastructure 2.09 acres of bioretention and 0.55 acre of permeable pavement	**3.5%**	2.0%	1.8%	1.1%	1.6%	1.7%	2.0%	2.6%	**2.7%**	**0.8%**
Total[4]	**17.9%** **Goal = 17.9%**	**14.7%**	**13.7%**	**12.0%**	**12.7%**	**12.4%**	**14.7%**	**15.4%**	**17.7%** **Goal = 11.8%**	**14.9%** **Goal = 10.0%**

Strategy and Level of Implementation[1]	City of San Diego Reduction – Tecolote Creek Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Dry Weather										
Nonstructural, non-modeled See Section 4.2.4	**10%**	10%	10%	10%	10%	10%	10%	10%	**10%**	**10%**
Nonstructural, modeled **Irrigation Reduction[3]**	**99%**	32%	25%	25%	25%	25%	25%	25%	**99%**	**99%**
Total	**100%[5]** **Goal = 98.4%**	**42%**	**35%**	**35%**	**35%**	**35%**	**35%**	**35%**	**100%[5]** **Goal = 99.9%**	**100%[5]** **Goal = 99.6%**

Note:

1. Note that these numbers are planning-level values and are calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the above numeric goals at each respective project site. Reported BMP sizes are in addition to projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality conditions for the Mission Bay WMA.
3. Irrigation reduction strategies include the implementation of turf conversion projects, micro-irrigation system conversions, weather-based irrigation controllers, downspout disconnections, education and outreach and enforcement of regulations that prohibit runoff. This strategy was only modeled to include surface contributions of bacteria on overspray areas. Non-highest priority water quality pollutants were not modeled.
4. Load reduction totals that exceed the goals reflect coarseness in the model that can be improved with finer physical data at the parcel and/or street scale.
5. Mechanistic, process-based assumptions were not applied to non-modeled nonstructural BMPs, resulting in the cumulative dry weather load reductions exceeding 100% (this implies that the combination of strategies will be more than sufficient to achieve dry weather load reduction goals).

Cu = copper; N = nitrogen; P = phosphorus; Pb = lead; Zn = zinc

For the City of San Diego, the implementation of nonstructural (both non-modeled and modeled), multiuse treatment areas and green infrastructure strategies is required to meet the fecal coliform load reduction goal of 17.9% for wet weather. The City of San Diego has more cost-efficient, nonstructural BMPs that result in a lower cost of nonstructural strategy implementation. Nonstructural strategies achieve a greater load reduction for a lower cost, because costs are often primarily administrative or programmatic. Multiuse treatment areas are large, structural strategies and can treat a greater load compared to the storage capability of green infrastructure strategies. The larger storage volume per area is more cost-effective per-unit; therefore, multiuse treatment area costs tend to be lower than green infrastructure costs and should be implemented after nonstructural strategies.

It should be noted that although BMPs sized for wet weather tend to provide adequate capacity to treat contributing dry weather flows, they must be sited such that dry weather flows are intercepted before reaching the storm drain or waterway. In the modeled scenario, dry weather flows are generated by various land uses across the entire subwatershed, whereas wet weather BMPs were modeled at specific locations (allowing a portion of dry weather flows to bypass wet weather BMPs). During the implementation phase, higher-precision analysis can be used to target sources of dry weather flows and to place BMPs where they will be most effective. Additionally, nonstructural strategies to eliminate dry weather loads will be further investigated through a sensitivity analysis. Progress towards achieving the dry weather goal will be addressed through the iterative process and additional strategies will be identified, if interim goals are not being met.

While cost and efficiency are primary concerns for selecting BMPs, additional factors based on public input were considered (such as specific BMP strategies, sites, and levels of implementation that were preferred by stakeholders and Responsible Agencies). Therefore, the implementation schedules for strategies do not necessarily follow the cost-effectiveness, but do assist in planning and management decisions.

Caltrans will voluntarily implement the strategies outlined in Section 4.2 of the Water Quality Improvement Plan, as resources are available, per the schedule provided in Appendix I. Attachment IV to the Caltrans MS4 permit, outlines a methodology for prioritizing stream segments included in TMDLs in which Caltrans is subject to. The permit establishes BMP implementation requirements evaluated in terms of compliance units, as opposed to load reduction targets. Caltrans is expected to achieve 1650 compliance units per year through the implementation of retrofit BMPs, cooperative implementation, and post construction treatment beyond permit requirements.

For Bacteria TMDLs, Caltrans is expected to eliminate dry weather flows by implementing control measures to ensure effective prohibition (Provision B.2 of the Permit). For wet weather flows, Caltrans is expected to implement control measures/BMPs to prevent discharge of bacteria from the ROW; this can be source control and preemptive activities such as street sweeping, clean-up of illegal dumping and public education on littering. Implementation of these controls is per the TMDL prioritization list currently under development.

K.4.2 Scripps Subwatershed

The modeling results demonstrate that implementation of the nonstructural and structural strategies in the entire Scripps subwatershed (excluding the Mission Bay drainage area) will meet and exceed both the wet and dry weather load reduction required for fecal coliform (Table K-20). As discussed in Section K.2.1, the non-modeled, nonstructural strategies were assumed to achieve an overall load reduction of 10% (HDR, 2014). In addition, the City of San Diego is implementing multiuse treatment area and green infrastructure BMPs on public land, which provide additional reductions.

Table K-20
Water Quality Improvement Plan Wet and Dry Weather Reductions for Scripps Subwatershed

Strategy and Level of Implementation[1]	City of San Diego Reduction – Scripps Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Wet Weather										
Nonstructural, non-modeled See Section 4.2.4	**10%**	10%	10%	10%	10%	10%	10%	10%	**10%**	**10%**
Nonstructural, modeled Rain Barrels, Downspout Disconnections, and Irrigation Reductions[3]	**0.1%**	2.4%	1.5%	0.5%	0.6%	0.2%	1.0%	2.5%	**<0.1%**	**<0.1%**
Multiuse Treatment Areas 0.1 acre BMP to treat 3.7 acres of drainage area with a total storage volume of 0.4 acre-feet	**0.02%**	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%	**0.03%**	**0.02%**
Green Infrastructure 0.6 acre of permeable pavement to treat 8.9 acres of drainage area	**0.4%**	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	**0.3%**	**0.1%**
Total[4]	**10.6%** ***Goal= 10.0%***	**12.5%**	**11.6%** ***Goal = 0.6%***	**10.6%**	**10.7%**	**10.3%**	**11.1%**	**12.6%**	**10.4%** ***Goal = 6.6%***	**10.1%** ***Goal= 5.1%***
Dry Weather										
Nonstructural, non-modeled See Section 4.2.4	**10%**	10%	10%	10%	10%	10%	10%	10%	**10%**	**10%**
Nonstructural, modeled	**99%**	34%	25%	25%	25%	25%	24%	24%	**99%**	**99%**

Strategy and Level of Implementation[1]	City of San Diego Reduction – Scripps Subwatershed									
	Fecal Coliform[2]	Flow	Total Sediment	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Irrigation Reduction[3]										
Total	**100%[5]** **_Goal= 99.0%_**	**44%**	**35%**	**35%**	**35%**	**35%**	**35%**	**35%**	**100%[5]** **_Goal = 99.9%_**	**100%[5]** **_Goal = 99.8%_**

Note:
1. Note that these numbers are planning-level values and are calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the above numeric goals at each respective project site.
2. Orange-shaded cells indicate highest priority water quality conditions for the Mission Bay WMA.
3. Irrigation reduction strategies include the implementation of turf conversion projects, micro-irrigation system conversions, weather-based irrigation controllers, downspout disconnections, education and outreach and enforcement of regulations that prohibit runoff.
4. Load reduction totals that exceed the goals reflect coarseness in the model that can be improved with finer physical data at the parcel and/or street scale.
5. Mechanistic, process-based assumptions were not applied to non-modeled nonstructural BMPs, resulting in the cumulative dry weather load reductions exceeding 100% (this implies that the combination of strategies will be more than sufficient to achieve dry weather load reduction goals).

Cu = copper; N = nitrogen; P = phosphorus; Pb = lead; Zn = zinc

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APPENDIX L

Strategy Benefits and References

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APPENDIX L. STRATEGY BENEFITS AND REFERENCES

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APPENDIX M

Comprehensive Benefits Analysis of Water Quality Improvement Plan Strategies

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Appendix M
Comprehensive Benefits Analysis of Water Quality Improvement Plan Strategies

Final Technical Memorandum

November 2014

Prepared for:

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Summary

The City of San Diego Storm Water Division ("Division") is developing Water Quality Improvement Plans (WQIPs) that consist of a range of structural and nonstructural strategies for meeting TMDL regulatory requirements in each watershed. However, the Division recognizes that these strategies differ with respect to their contribution to "additional" or "other" benefits to the local community, environment, and economy that are beyond specific water quality improvements in streams. This assessment has been implemented to provide the Division with supplemental information on these potential benefits. The Division aims to consider these other benefits in selecting strategies only in cases when strategies yield the same level of water quality improvements but which may produce markedly different levels of other benefits.

This document outlines a framework for assessing other benefits from these strategies. The framework assesses how each type of strategy could impact one or more types of other benefits. These additional benefits consist of various types of changes beyond water quality improvements in terms of environmental resources, quality of life, property values, business development, and others.

In the WQIPs, individual strategies are grouped into a series of categories that are defined as either 'Nonstructural' or 'Structural.' Over 20 categories of strategies have been defined based on their similarity in how they can improve water quality and include *Development Planning*, *Construction Management*, *Existing Development*, *Illicit Discharge*, *Detection, and Elimination (IDDE) Program*, *Public Education and Participation*, and *Enforcement Response Plan*.

The framework for assessing the potential for additional benefits from strategies has several dimensions including::

- *Strategy Categories* are defined by how they influence water quality improvements (see Section 2). There are three Structural and four Nonstructural types of strategy categories including.
  - *Structural Strategies*, as defined in the WQIP include: (a) Green infrastructure, (b) multi-use treatment areas, or (c) water quality improvement BMPs
  - *Nonstructural Strategies,* as defined in this assessment based on how these strategies aim to: (a) Improve Structural Systems Performance, (b) Increase the Number of Structural Systems, (c) Change Behavior; or (d) Reduce Pollutants Directly.
- *Benefit Categories* include a range of economic, social and environmental outcomes. This assessment determines the relevance and impact of each strategy category on a benefit category (see Section 3).

- *Impact Levels* of a strategy category in a benefit category is classified as either (a) monetizable, (b) measurable, (c) potential, or (d) not applicable. (See Section 3). These impact levels are indented to provide *order of magnitude* information about the potential impact of a strategy on each type of benefit.

- A scoring system is established for the magnitude of benefits evaluation to compare different strategies (see Section 3). In addition, the total number of applicable benefits is provided for additional information about the relative advantage of different strategies.

A discussion and rationale for assessing the level of impact for a given strategy on a benefit category is provided in Section 4. This assessment is intended to be an initial, order of magnitude of benefits of different strategies. It can only be an illustrative assessment since details on the design and location of any individual strategy is not available at this stage. The framework however is intended to indicate how and to what degree benefits could be estimated once a strategy is in place. As an order of magnitude assessment, strategies with measurable and monetizable would be expected to exhibit successively higher levels of estimable benefits compared to strategies that are classified as only having a potential connection to benefits.

The results, as presented in Section 5, indicate that structural strategies (especially, Green Infrastructure and Multiuse Treatment Areas) have the highest potential to generate sizable benefits. However, a number of nonstructural strategies (e.g. Initiatives to Change Behavior for Existing Development, Priority Development Projects, Construction Management, Public Education and Enforcement, among others) could also provide additional benefits. Many other non-structural strategies have the potential to generate a wide range of different benefits for the community.

A cross-cutting theme in this assessment is the impact of strategies on property values and business development. Some strategies, such as ones that foster on-site water retention and reduction of street debris, have the potential to provide tangible and intangible benefit to communities and local businesses by reducing water and clean-up costs and providing an overall improved aesthetic environment. Depending on where and how a strategy is implemented, benefits can be higher or lower. The literature review in Appendix 1 discusses cases where these benefits have measured.

A next step for this assessment would entail site-specific evaluations of strategies and potential additional benefits of WQIP at a planning level. As strategies become more defined and specific data becomes available on project conditions, this framework could be adapted further to create more detailed results for prioritizing strategies. This step would include applying current research to site specific projects to more direct monetize and quantify the outcomes of strategies in terms of cost savings and property value enhancements. Better still would be a pre- and post-monitoring program to assess the singular and combined effects of strategies to different stakeholders.

Table of Contents

Table of Contents (continued)

Page

Table of Contents (continued)

Page

List of Tables

Acronyms and Abbreviations

Acronym or Abbreviation	Definition
ac	Acres
BCA	Benefit Cost Analysis
BES	Bureau Of Environmental Services
BMP	Best Management Practice
Btu	British Thermal Unit
CAMX	California-Mexico Power Area
CEA	Cost-Effectiveness Analysis
CLRP	Comprehensive Load Reduction Plan
CNT	Center For Neighborhood Technology
CO2	Carbon Dioxide
CSO	Combined Sewer Overflow
DOT	Department Of Transportation
EIA	Economic Impact Analysis
EPA	Environmental Protection Agency
GHG	Greenhouse Gas
GI	Green Infrastructure
HOA	Home Owner's Association
IDDE	Illicit Discharge, Detection, And Elimination
kWh	Kilowatt Hour
LACDPW	Los Angeles County Department Of Public Works
LID	Low Impact Development
M Wh	Mega Watt Hour
MMSD	Milwaukee Metropolitan Sewage District
MODA	Multi-Objective Decision Analysis
MS4	Municipal Separate Storm Sewer System
NOx	Nitric Oxide And Nitrogen Dioxide
NPV	Net Present Value
NRDC	Natural Resources Defense Council
O&M	Operations And Maintenance
O3	Oxide
PDP	Priority Development Projects
PFC	Permeable Friction Course
PGA	Pollutant Generating Activities

Acronyms and Abbreviations (continued)

Acronym or Abbreviation	Definition
PM	Particulate Matter
PWD	Philadelphia Water District
QMRA	Quantitative Microbial Risk Assessment
SO2	Sulfur Dioxide
SPU	Seattle Public Utilities
SROI	Sustainable Return On Investment
TBL	Triple Bottom Line
TIGER	Transportation Investment Generating Economic Recovery
TMDL	Total Maximum Daily Load
UTC	Urban Tree Canopy
WAMP	Watershed Asset Management Plan
WERF	Water Environment Research Foundation
WQIP	Water Quality Improvement Plan

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1 Introduction

The City of San Diego Storm Water Division (Division) has prepared many potential strategies as part of its Water Quality Improvement Plan (WQIP). These strategies have identified a range of structural best management practices (BMPs) (e.g., a constructed runoff reduction system, such as a bio-swale), and nonstructural BMP activities (e.g., programs that promote installation of constructed systems, or reduce pollutants directly through education and outreach). This memo seeks to assess the potential for strategies to generate “additional” or “other” benefits beyond water quality improvements. The Division seeks such information to contribute to prioritization of strategies that meets regulatory requirements and generates the best value for the community and local businesses.

The concept for evaluating the other benefits of proposed strategies has been under discussion since April 2014. A technical memo was developed as an initial task to classify additional benefits from the Division’s stormwater management strategies. That memo is contained in Appendix 1 and includes a literature review of potential benefit categories and case studies of green infrastructure program benefits. The economic framework was presented to stakeholders at a meeting on May 20, 2014. Feedback was elicited during and after that meeting, and has been incorporated into this document and to the Division’s current approach to evaluating strategies (see presentation, handout, and comments from workshop in Appendix 2).

The next several sections in this document present the approach and draft evaluation of additional benefits. The evaluation has been applied to a comprehensive list of strategies from the City’s three draft WQIPs (Mission Bay, Los Peñasquitos, and San Dieguito). The framework entails the characterization of strategy categories by type of impact (Section 2), definition of potential types of benefit categories (Section 3) and a classification of benefits for each strategy category (Section 4). Results of this evaluation are contained in Section 5.

This assessment of additional benefits of WQIP strategies is conducted for initial planning purposes only. As strategies become more defined and specific data becomes available on project conditions, this framework could be adapted further to create more detailed results for prioritizing strategies. This step would include applying current research to site specific projects to more directly monetize and quantify the outcomes of strategies areas such as recreational, property value and business development benefits.

2 Strategy Classifications

The WQIP identifies a number of strategy categories as either “Nonstructural” or “Structural”, and in terms of whether they are Jurisdictional Strategies or Optional Jurisdictional Strategies. Optional strategies are those strategies that may be triggered in the future to achieve the interim and final numeric goals." In the analysis of benefits, the main distinction is between Nonstructural or Structural types which are defined in the following ways.

Nonstructural Strategies include “those actions and activities intended to reduce storm water pollution, which do not involve construction of a physical component or structure to filter and treat storm water.” Individual strategies are grouped into over 25 different categories including: *Development Planning*, *Construction Management*, *Existing Development*, *Illicit Discharge, Detection, and Elimination (IDDE) Program*, *Public Education and Participation*, *Enforcement Response Plan*, and *Non-JRMP Strategies*. For each watershed, a list of potential nonstructural strategies has been developed that reflect the needs, opportunities and constraints in different locations. In general, many of these initiatives have been implemented by the Division for many years and are integral to regulatory compliance on a watershed-specific basis.

Nonstructural strategy categories are further defined in this assessment by *how* they improve water quality, which in turn indicates how they may generate other benefits. For example, four types of mechanisms include the ways in which strategies:

- ***Improve Structural Systems Performance:*** These include strategies that relate to new design standards and performance monitoring would be measured by the improvement in the performance of installed structural systems. The benefits of these nonstructural strategies would ultimately draw from the benefits of structural systems that are implemented.
- ***Increase the Number of Structural Systems*****:** These strategies aim to increase the rate of BMP adoption is due to training in the community or general promotion of BMPs, lead to benefits whenever they are installed. The outcome of these strategies then depends on the number of *additional* systems that are installed.
- ***Change Behavior*****:** These strategies target efforts to encourage improved environmental stewardship and storm water protection by residents and businesses throughout the community. Various types of actions that people may take who become more aware of environmental impacts through these strategies include adoption of rain barrels, reducing litter, and reducing unnecessary levels of pesticides, herbicides and fertilizers.

- ***Reduce Pollutants Directly:*** These strategies include those that aim to directly control pollution through actions that the Division and other public agencies can take independently, such as internal training, enforcement and administrative changes. These strategies can lead to behavior change by individuals but initially through a focus on public entities.

Structural Strategies, in contrast to Nonstructural strategies, are physical infrastructure that are designed for site-specific conditions and placed strategically across a watershed to improve water quality. The effectiveness and feasibility of implementing any of these BMPs varies depending on their design and site conditions. For example, the effectiveness of a BMP for enhanced infiltration capacity of a watershed depends on amenable soil types. Other site-specific considerations include the physical land area available for effective implementation and maintenance. Also, the capital and maintenance costs of a BMP influence its feasibility for the Division, especially in comparison to other BMPs which can be implemented more cost-effectively. The structural strategies that have been identified as potentially suitable for San Diego watersheds and have been classified as one of three types: (1) green infrastructure, (2) multiuse treatment areas, and (3) water quality improvement BMPs.

- ***Green Infrastructure*** covers a range of BMPs that are designed to be integrated in a broader site plan to maintain healthy waters, provide multiple environmental benefits, and support sustainable communities. Green infrastructure is distinguished from other methods by making deliberate and effective use of vegetation and soil to manage storm water.

- ***Multiuse Treatment Areas*** in the Water Quality Improvement Plan are identified as large-scale treatment areas such as multiuse basins and stream, channel, and habitat rehabilitation projects. These systems are designed as regional facilities that can receive flows from neighborhoods or larger areas and become cost-effective solutions that provide multiple benefits. For example, such systems can be integrated in public spaces, such as soccer fields and parks, which provide recreational areas and flood control, ground water recharge, restoration, habitat enhancement, and recreation. In addition stream bank projects that reduce erosion can improve water quality and simultaneously improve habitat.

- ***Water Quality Improvement BMPS*** include systems that supplement the design performance of existing infrastructure. For example, systems that segregate trash includes inlet devices, such as trash guards or racks that capture debris before they enter surface waters. Another example are proprietary commercial products that often aim to use settling, filtration, absorptive/adsorptive materials, vortex separation, and sometimes vegetative components to remove pollutants from runoff. Finally, dry weather flow separation and treatment projects target non-storm water dry season flows and divert these flows for treatment either on-site or to sanitary sewer systems and ultimately wastewater treatment plants.

Overall, 30 different groups of strategies have been classified as either “Jurisdictional” (strategy types numbered 1-23, in Table 2 and Table 6 or “Optional Jurisdictional” (strategies types numbered 24-30, in Table 3 and Table 7). Optional strategies are those strategies that may be triggered in the future to achieve the interim and final numeric goals." The number ordering for these strategies follows from documents provided by the Division and reflects the most comprehensive list of current strategies under consideration. Specific strategies have also been identified by the Division within each strategy group.

3 Benefit Categories and Levels of Impact

Stormwater management strategies can generate various types of benefits and have different levels of impact. Economic research has shown that stormwater management strategies can generate a range of benefit categories with economic, environmental and social impacts for the local residents, businesses, and public agencies. The level of impact of a strategy can differ across benefit categories and depends on the design of the strategy, site conditions where the strategy is implemented, and characteristics in the community. Estimation of economic benefits from a strategy depends on the degree to which linkages can be quantified between strategy and a benefit category and then available economic literature to value this change. In some cases, only a part of the link between a strategy and a benefit category can be quantified (e.g. the volume of water retained by a green infrastructure system can be measured, but not its impact on stream bank stabilization).

3.1 Description of Benefit Categories

This section below discusses a number of benefit categories that are found in economic literature. They are grouped by financial, environmental and social dimensions. A broader discussion from the literature is contained in the Appendix 1.

Financial Benefits

- ***Water Cost Savings:*** This type of benefit could occur when potable water needed for landscaping, washing or other property maintenance is reduced. Green infrastructure strategies could enable such savings if water retention reduces water demand, or some part of the system improves irrigation efficiency. The reduction in demand lowers water costs. These savings could be quantified and monetized if the volumes of water retained at a site can be measured.

- ***Energy Cost Savings:*** Green infrastructure can generate energy cost savings in several ways. For example, buildings which are adjacent to trees or which install green roofs can benefit from lower the heating and cooling energy costs because of shading and insulation, respectively. Some research suggests that if such green infrastructure system were installed throughout a city, the overall ambient temperature would decline and which would in turn reduce cooling loads for other buildings. Finally, in cases when green infrastructure provides water storage that lowers pumping costs, there would be a corresponding reduction in energy costs.

Environmental Benefits

- ***Flood Risk Reduction:*** Reduced runoff in an urban watershed can reduce the frequency and severity of flooding in downstream neighborhoods in some cases. The magnitude of these benefits though depends on if such a neighborhood is downstream and on the design and scale of a strategy that reduces flooding. Other factors include rainfall conditions, soil characteristics, slope, elevation and watershed characteristics. A first step in quantifying the potential for flood risk reduction benefits requires an understanding how much water is retained.

- ***Air Particulate Entrapment:*** Some green infrastructure systems can trap airborne pollutants, such as particulate matter (e.g. PM10), directly from the environment on their leaves and in turn reduce adverse human health impacts.[1] The total amount of particulate trapping depends on the type of vegetation, and local climate conditions. For trees, the US Forest Service published a report that provides benchmark values for use in calculations.[2] This type of benefit can be quantified and potentially monetized based on the amount and type of plants.

- ***Climate Impacts:*** Carbon sequestration is a natural process in which plants store carbon in biomass and soils as they grow. When atmospheric carbon dioxide is taken up by trees, grasses, and other plants, it can reduce greenhouse gas effects on the planet. The amount of carbon that can be sequestered by a green infrastructure system depends on the above ground quantity of biomass of the tree, green roof or bio-swale. Economic valuation of climate change effects can be used to monetize carbon sequestration.

- ***Habitat Related Benefits:*** Green infrastructure that can provide habitat benefits include strategies that create new habitat areas, or improve existing ones. For example, vegetated infiltration systems can improve the habitat for flora and fauna, birds, and insect species. These different types of habitats are usually small in size and have limited impacts. Greater benefits may arise from large-scale strategies that enhance habitat connectivity in existing corridors. This type of benefit is readily quantified based on the acreage and plantings at a green infrastructure site, or stream bank stabilization effects, but more difficult to monetize because of limitations in economic research.

- ***Air Quality Emission Reduction:*** The total amount of reduction in criteria air contaminant emissions, such as particulate matter, from a power plant is directly tied to the reduction in energy use as discussed above. Energy savings are readily converted to its emission rate reductions by utilizing data from EPA and other public sources. Reduction in air pollution would generate health-related benefits for people. This benefit can be quantified and monetized if information is available on the amount of water and energy reduced at a treatment facility.

- ***GHG Emission Reduction:*** Similar to air quality emission reductions, energy demand reduction also reduces greenhouse gas emissions. The tons of greenhouse gas emissions are computed from the same data sources as criteria air contaminants. The economic damage caused by greenhouse gas emissions are broadly related to changes in productivity and damage costs.

[1] Center for Neighborhood Technology, The Value of Green Infrastructure. 2010

[2] http://www.fs.fed.us/psw/programs/uesd/uep/products.shtml

Social / Community Benefits

- ***Property Value Enhancement:*** Green infrastructure and other strategies can lead to enhanced property values under a variety of circumstances. For example, strategies that improve the overall visual appearance of a community simply by having planted material, street trees and bioswales among impervious surfaces have been shown to enhance value of nearby properties. In addition, some BMPs strategies aim to directly reduce litter or debris from public spaces to make it more visually appealing. These effects improve the overall quality of life in those neighborhoods. Benefits can be quantified by measuring the number of properties that are adjacent to the green infrastructure. Monetization of the effect would depend on the applicability of economic research on a site specific basis.
- ***Recreational Benefits:*** Certain green infrastructure strategies provide recreational benefits if they facilitate pedestrian, bicycle use, or connect to an existing recreational corridor or trails. Benefits would be monetized by the number of participants in a recreational activity at a site and their value per use. Other quantitative measures include the number and type of design features that offer recreational options.
- ***Business Development & Jobs:*** Green infrastructure, such as comprehensive green street designs, and initiatives to reduce street debris can lead to an enhanced sense of place, and increase in foot traffic that can support retail activity. Additionally, spending on capital investments and operations and maintenance (O&M) leads to job creation. This benefit can be measured by assessing the number of jobs created in an area where a green infrastructure strategy is implemented. In addition, these jobs can be associated with wider economic development benefits.
- ***Crime Reduction:*** Research suggests that fewer crimes occur near buildings with trees and non-invasive vegetation. Maintained areas of vegetation encourage informal social gatherings outdoors. Incidence of crime declines when with the presence of people and possibly by psychological precursors to crime.
- ***Public Education/ Environmental Stewardship:*** Promoting strategies that seek to change people's behaviors and make them more aware of their environmental impacts helps to cultivate a *stewardship perspective* in the community about its local natural resources. Quantification of this type of benefit may be measured in terms of how many people are reached with messages of programs aimed to enhance knowledge and ultimately actions towards to improve stormwater management.
- ***Heat Island Effect:*** Trees and other vegetation can reduce ambient temperatures in cities that have higher air temperatures. Lower temperatures can reduce health effects especially in populations that are at risk of heat stroke. Additionally, the overall lowering of temperatures can reduce cooling needs at properties located within the area. This type of benefit is only quantifiable in cases where the strategy is applied over a large scale.

- ***Noise Reduction:*** Some green infrastructure systems, such as wetlands or trees, are effective in reducing ambient noise because they can absorb it. This is also true for porous concrete and green roofs, but there is limited research in quantifying these benefits.

3.2 Characterization of the Benefit Level from a Strategy

The potential magnitude of benefits differs across strategy types. To account for these differences, four 'levels' are defined that represent a decreasing association between the impact of a strategy and a benefit category. These levels include:

Monetizable – The level of benefits indicates impacts that can be quantified and where economic research has been produced to determine a monetary value.

Measurable – There exists a connection for some measure of non-monetary impact can be identified and measured, even if economic research is not available to monetize the impacts.

Potential - A conceivable connection exists between a strategy and benefit category but it is not likely to be measurable.

Not Applicable - There is no discernible connection between a strategy and benefit category.

At this stage in program implementation and project design, the impact of each strategy on a benefit category can only be considered to be an order of magnitude assessment. An estimation of the actual impact would be highly uncertain since most strategies currently lack site-specific data about the design and implementation. Instead, these levels of impact are intended to provide separable categories that indicate the order of magnitude of benefits that a strategy may be able to generate. That is, it is only possible to assess the likelihood that a project can generate monetizable benefits, not the actual size of monetizable benefits.

At the same time, these four categories are intended to provide a broad degree of separation between strategies in terms of their measurable connection with each benefit category. For instance, if a strategy can be classified as having monetizable benefits, then its overall level of measurable benefits can be reasonably assumed to be higher than another strategy that is classified as being quantifiable, even if only in part. By the same rationale, these classifications would likely have more direct impact for a benefit category than a strategy whose impact can only be presumed

This assessment aims to achieve consistency in evaluations within a specific strategy outcome group, as well as across strategy outcome groups. While some strategies have design or location specifications (e.g., total acres of bioretention), or target certain groups (developers vs. residential), others entail broad descriptions. Due to this uncertainty, the evaluation has taken a conservative approach to drawing conclusions about the magnitude of benefits that could arise from a strategy.

3.3 Scoring System

A scoring system is established to support comparisons of strategies with respect to the potential benefits they can generate (see Table 1). Each benefit level is assigned a point value that has been established through discussions with the Division. The values are intended to provide an indication of the strategy's impact across all benefit categories. In this case, potentially monetizable benefits are assigned a higher score than one that is only quantifiable (and not monetizable). This approach is intended to separate the types of benefits that are likely to be larger in magnitude from others that cannot be monetized nor quantified.

Table 1. Overview of Benefit Scoring

Level	Description	Point Value
Monetizable	Strategy can realize quantifiable impacts, and sufficient economic evidence supports placing a dollar value on these impacts.	1
Measurable	Strategy can realize quantifiable impacts, but lacks sufficient economic evidence to support placing a dollar value on these impacts.	0.667
Potential	Strategy most likely provides a positive impact, but the magnitude of the impact is uncertain.	0.333
Not Applicable	Strategy will not impact the benefit category in any meaningful way.	0

This scoring system places higher weight on strategies which may generate benefits that can be monetized (3 times the weight of a potential benefit level). Accordingly, in some cases a strategy that influences many additional benefit categories at a "*Potential"* level could score lower than one with fewer categories but with "*Monetizable"* impacts. This scoring system is designed for that type of result to give greater emphasis on strategy impacts that can be measured and are thus more tangible. Potential impacts are circumstantial and small, as compared to more significant impacts that can be measured and monetized. Furthermore, the implications of this scoring system have been taken into account in a consistent approach in determining which impacts of strategy are classified as monetizable, measureable or potential.

This scoring system is applied to the strategies in Table 2 through Table 7. This scoring system is only relevant for comparing strategies with respect to additional benefits, not in ways that influence a ranking towards meeting permit requirements and/or encourages other program objectives such as habitat restoration.

In addition, the total number of applicable benefit categories is also shown in Table 2 through Table 7 for additional reference on the impact of these strategies.

4 Framework for Assessment of Strategies

Determination of the applicability of benefits for each strategy depends primarily on the assignment of a strategy to one of the structural or nonstructural categories (defined in Section 2). Consistency in the applicability of a benefit category (defined in Section 3) for a strategy is maintained by jointly evaluating all strategies of a specific type. This section discusses the framework for assessing potential additional benefits that can arise from the implementation of each strategy. The aim of this exercise is to apply a consistent and transparent rationale for each strategy. Since available evidence is limited with respect to each strategy, the application of a consistent set of assumptions to each strategy underlies the basis for determining (a) which benefit categories are applicable, and (b) the potential magnitude of benefits, if a category is applicable.

The approach to assigning a magnitude level began with an assessment of the strategy for which the most information is available about its potential impact: Green Infrastructure (Ref 19). This type of strategy is used as a benchmark for assigning benefit categories and potential magnitudes of benefits due to the availability of evidence from projects implemented elsewhere in the U.S. To illustrate this approach for Green Infrastructure (Ref 19), consider the rationale below:

- In some cases, sufficient information available about the specific strategies specifies the area of bioretention and permeable pavement to be installed and the location of the project. Due to the size of these initiatives, and knowing that the vegetation can improve air quality through the uptake of criteria pollutants and improve the climate through carbon sequestration, it is assumed that the total pollutant and CO2 removal from the atmosphere can be quantified. These quantified amounts of pollutant and CO2 can then be monetized using standard practices that are currently being used to value these impacts.
- Additionally, it is assumed that these projects will provide aesthetic improvements to the existing site, which can be quantified with information regarding the number of properties within a certain radius and the property value changes.
- These sites will also need to be maintained, which will require spending on jobs, and depending on the specific site location, the improved aesthetics can also improve businesses located near the site.
- The total land area of the bioretention and permeable pavement will allow for quantifying the amount of rain water which gets absorbed onsite, and does not cause localized flooding, where applicable.
- The remaining other benefit categories are assumed to see positive impacts. For example, GHG emission reductions may occur from the lifecycle CO2 emissions for permeable pavement being lower than the lifecycle CO2 emissions of asphalt or pavement. However, there is not enough information at this time to accurately quantify that impact.

- ❖ Similarly, permeable pavement absorbs less heat than conventional pavement, which is a benefit for Urban Heat Island reduction. The amount of heat, and how that will affect public health cannot be quantified.

The potential impacts of all other strategies have been evaluated relative to the benchmark as established by the above assumptions for green infrastructure. As an example, the first group of strategies evaluated below, All Development Projects (Ref 1). focuses on improving existing systems performance. It is assumed that specific actions, such as administrative training or increased monitoring, will have positive impacts for the same benefit categories as a green infrastructure project. But since there is no way to quantify any of those impacts, the magnitude of benefits is assumed to be lower.

The remainder of this section discusses the assessment of Jurisdictional and Optional Jurisdictional Strategies. Note that these strategies represent the latest consideration in an evolving process of identification, specification and assessment. Not all strategies have been implemented or have plans for immediate implementation. At the same time, the specification of the design standards also varies from strategy to strategy. This assessment takes into account the *potential* benefits that may occur, given the information available, and assumptions that are listed in each strategy.

4.1 Jurisdictional Strategies

This section discusses the rationale and methodology for assigning scoring categories to the Jurisdictional Strategies, based on the most recent description of the strategy. This list of individual strategies has been grouped according to the same categories that are proposed for the draft WQIPs and are presented in the same chronological order. The information found in the parenthesis next to the strategy group name (*Ref X*), refers to the number in the far left columns of Table 2 and Table 6. Note that in some cases (e.g., Commercial, Industrial, Municipal, and Residential Facilities and Areas) the strategies are separated into two types (i.e., Improve Structural Systems Performance and Initiatives to Change Behavior) based on the specific ways in which a strategy creates benefits.

4.1.1 All Development Projects (Ref 1)

Strategies in this group consist of administrative and other tasks that center on improving the structural system's performance. Many of these types of strategies focus on broad initiatives such as training or source control. The list of strategies includes the following:

- ❖ Administer a program to ensure implementation of source control BMPs to minimize pollutant generation at each project and implement LID BMPs to maintain or restore hydrology of the area, where applicable and feasible.
- ❖ Investigation and research of emerging technology.
- ❖ Train staff on LID regulatory changes and LID practices.

- ❖ Amend municipal code and ordinances, including zoning ordinances, to facilitate and encourage LID opportunities. Ensure consistency with the City of San Diego's BMP Design Manual.
- ❖ Develop and implement Green Infrastructure Program and Guidelines.
- ❖ Develop Design Standards for Public LID BMPs.
- ❖ Create Right-of-Way Design Manual.

In scoring these strategies, it is assumed that the programs that target the administration or enforcement of BMPs would mostly affect the same benefit categories as a Green Infrastructure (GI) project which increases the acres of bioretention, but on a smaller scale. It is assumed that these projects would generate a positive impact but due to the uncertainty of the implementation and magnitude of the effect of these strategies, it cannot be measured.

Some of the broad initiatives are deemed to have too much uncertainty to reasonably assign a specific benefit level. It is however reasonable to assume that overall public awareness and knowledge of the issue will increase.

4.1.2 Priority Development Projects (PDPs) (Ref 2)

Similar to the strategies in the All Development Projects section, PDP initiatives are assumed to increase the number of structural systems and improve existing structural systems. These strategies include the following:

- ❖ For PDPs, administer a program requiring implementation of on-site structural BMPs to control pollutants and manage hydromodification. Includes confirmation of design, construction, and maintenance of PDP structural BMPs.
- ❖ Update BMP Design Manual procedures to determine nature and extent of storm water requirements applicable to development projects and to identify conditions of concern for selecting, designing, and maintaining appropriate structural BMPs.
  - ➢ Amend BMP Design Manual for trash areas. Require full four-sided enclosure, siting away from storm drains and cover. Consider the retrofit requirement.
  - ➢ Amend BMP Design Manual for animal-related facilities, such as such as animal shelters, "doggie day care" facilities, veterinary clinics, breeding, boarding and training facilities, groomers, and pet care stores.
  - ➢ Amend BMP Design Manual for nurseries and garden centers.
  - ➢ Amend BMP Design Manual for auto-related uses.
- ❖ Administer a program to inspect and enforce updated BMPs in BMP Design Manual

- Develop and administer an alternative compliance program to on-site structural BMP implementation (includes identifying Watershed Management Area Analysis [WMAA] candidate projects).

Scoring the impact of programs that target the administration or enforcement of BMPs would mostly affect the same benefit categories as a green infrastructure project which increases the acres of bioretention, but on a smaller scale. Initiatives that focus on updating various components of the design manual are assumed to increase the efficiency of the already existing systems. However, the total magnitude of this improvement cannot be estimated without additional information, and thus other benefits for this group cannot be measured.

4.1.3 Construction Management (Ref 3)

There is one specific strategy under this group, and it is assumed it will improve structural system performance. Construction Management strategy is:

- Administer a program to oversee implementation of BMPs during the construction phase of land development. Includes inspections at an appropriate frequency and enforcement of requirements.

The scoring for this strategy is assumed to be the same as previously discussed strategies that improve the performance of existing systems.

4.1.4 Commercial, Industrial, Municipal, and Residential Facilities and Areas – Improve Structural Systems Performance (Ref 4)

The specific initiatives under this strategy group focus on improving structural systems performance. These strategies differ from the strategies in the next group, which also are included under Commercial, Industrial, Municipal, and Residential Facilities and Areas in the Water Quality Improvement Plan, but target a different outcome. Administering programs which require minimum BMPs are assumed to affect the same benefit categories as a GI project which increases the acres of bioretention, but a smaller scale. These strategies include:

- Administer a program to require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types, and PGAs, as appropriate. Includes inspection of existing development at appropriate frequencies and using appropriate methods.
  - Update minimum BMPs for existing residential, commercial, and industrial development. Specific updates to BMPs include require sweeping, catch basin cleaning and maintenance of private roads and parking lots in targeted areas.
  - Power-washing minimum BMPs: Outreach to property managers and trash haulers to elevate the emphasis of washing as a pollutant source. Emphasize non-compliant washing as an enforceable violation.

- Implement property based inspections.
- Review policies and procedures to ensure discharges from swimming pools meet permit requirements.

Strategies that target pollutants directly, such as the power-washing minimum BMPs, can be assumed to reduce the amount of pollutants entering the environment. However, while these strategies protect habitats and improving aesthetics, the total amount of pollutants reduced cannot be measured until more information is known regarding the current level of pollutant discharges, and how many people are targeted as part of this initiative. These initiatives are assumed to require some level of public outreach or promotion, and public awareness of these issues will be raised.

4.1.5 Commercial, Industrial, Municipal, and Residential Facilities and Areas – Initiatives to Change Behavior (Ref 5)

While also focusing on Commercial, Industrial, Municipal, and Residential Areas, these strategies seek to initiate changes in behavior. This list includes:

- Implement pet waste program
- Consider installing trash bins, pet waste bag dispensers and pickup services on Rose Creek Bicycle Path and Rose Canyon Bicycle Path.
- Promote and encourage implementation of designated BMPs for residential and non-residential areas.
- Residential BMP: Rain Barrel.
- Residential and Commercial BMP: Grass Replacement.
- Residential and Commercial BMP: Downspout Disconnect.
- Residential and Commercial BMP: Microirrigation.
- Onsite Water Conservation Survey.

These types of initiatives can also lead to measurable impacts. Specifically, initiatives which encourage water conservation allow for quantification if a simple number of variables are known, such as the number of Rain Barrels, and average annual rainfall.

4.1.6 MS4 Infrastructure (Ref 6)

The specific strategy initiatives for MS4 Infrastructure focus on improving the structural systems performance. The list of MS4 Infrastructure Strategies includes:

- Implementation of operation and maintenance activities (inspection and cleaning) for MS4 and related structures (catch basins, storm drain inlets, detention basins, etc.) for water quality improvement and for flood control risk management.
  - Optimize catch basin cleaning to maximize pollutant removal (4 times per year for metals and sediment TMDLs, elsewhere 1 per year).

  - Increased frequency of catch basin inspection and as-needed cleaning (Settlement Agreement).
  - Proactively repair and replace MS4 components to provide source control from MS4 infrastructure.
- Implement controls to prevent infiltration of sewage into the MS4 from leaking sanitary sewers.
- Identify sewer leaks and areas for sewer pipe replacement prioritization.

Since these projects specifically focus on sub-surface activities, it is assumed that other benefits associated with changes above ground are not affected. Due to the specificity of these initiatives, it is reasonable to assume they will have a positive impact on local flood risk reduction, which in turn could potentially affect habitat related benefits, and possibly aesthetics.

4.1.7 Roads, Street, and Parking Lots (Ref 7)

These strategies specifically target street litter or debris will create aesthetic improvements. These strategies include:

- Implement operation and maintenance activities for public streets, unpaved roads, paved roads, and paved highways.
- Outreach to street sweeping enhancement-targeted areas.
- Enhance street sweeping through equipment replacement (replace every 4 years) and route optimization (sweep all areas twice a month).
- Initiate sweeping of medians on high-volume arterial roadways.
- Implement additional street sweeping near commercial routes adjacent to maintained MS4 channels..

The impact of these strategies can be quantified by estimating the volume of litter and street pollutants removed. Also, depending on the local land-use for the streets targeted, it is conceivable that a cleaner environment can lead to business development and investment. Jobs then would be supported by the money spent on operation and maintenance activities.

4.1.8 Pesticide, Herbicides, and Fertilizer BMP Program (Ref 8)

This category includes a broad initiative to reduce pollutant loads. The strategy entails:

- Require implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers on commercial, industrial, and municipal properties. Includes education, permits, and certifications.

While there is too much uncertainty at this time to be able to assign specific measurable benefits, this reduction in pollutants entering the environment will benefit habitats, and aesthetics. It is assumed that overall public awareness and knowledge of the issue will increase.

4.1.9 Retrofit and Rehabilitation in Areas of Existing Development – Improve Structural Systems Performance (Ref 9)

The goal of this strategy is to improve existing systems, specifically:

- ❖ Develop and implement a strategy to identify candidate areas of existing development appropriate for retrofitting projects and facilitate the implementation of such projects.

As this strategy focuses on retrofitting, is assumed to follow the same methodology for scoring other projects which increase the number of structural systems.

4.1.10 Retrofit and Rehabilitation in Areas of Existing Development – Increase the Number of Structural Systems (Ref 10)

This strategy was separated from the previous as it focuses on rehabbing existing ecological areas.

- ❖ Develop and implement a strategy to identify candidate areas of existing development for stream, channel, or habitat rehabilitation projects and facilitate implementation of such projects.

Specific improvements in streams and other systems will improve habitats and aesthetics and can be measured using the area of each project.

4.1.11 Illicit Discharge, Detection, and Elimination (IDDE) Program (Ref 11)

This program is assumed to change behavior, specifically, reduce pollutants entering the environment through illegal discharges and disposal. The strategy is defined as:

- ❖ Implement Illicit Discharge, Detection, and Elimination (IDDE) Program per the JRMP. Requirements include: maintaining an MS4 map, using municipal personnel and contractors to identify and report illicit discharges, maintaining a hotline for public reporting of illicit discharges, monitoring MS4 outfalls, and investigating and addressing any illicit discharges.

While broad strategies cannot be measured, it is assumed that the targeting of pollutants will improve the environment and benefit habitats and aesthetics. It is also assumed that overall public awareness and knowledge of the issue will increase.

4.1.12 Public Education and Participation: Initiatives to Change Behavior (Ref 12)

Strategies under Public Education and Participation are grouped under two categories, those which seek to change behavior, and are targeted at the community at large, and those which seek to reduce pollutants directly, by targeting business and industries. The strategies in this grouping target changing behavior, and are listed below:

- Implement a public education and participation program to promote and encourage development of programs, management practices, and behaviors that reduce the discharge of pollutants in storm water prioritized by high-risk behaviors, pollutants of concern, and target audiences.
- Expand outreach to homeowners' association (HOA) common lands and HOA incentives.
- Develop an outreach and training program for property managers responsible for HOAs and maintenance districts.
- Enhance and expand trash cleanups through community-based organizations involving target audiences.
- Improve consistency and content of websites to highlight enforceable conditions and reporting methods.
- Develop a targeted education and outreach program for homeowners with orchards or other agricultural land uses on their property.
- Enhance school and recreation-based education and outreach.
- Develop education and outreach to reduce over-irrigation.
- Enhance education and outreach based on results of effectiveness survey and changing regulatory requirements.

4.1.13 Public Education and Participation: Initiatives to Reduce Pollutants Directly (Ref 13)

These strategies differ from the previous group, it that they aim to reduce pollutants directly by targeting business and industries. This list includes:

- Provide technical education and outreach to the development community on the design and implementation requirements of the MS4 Permit and Water Quality Improvement Plan requirements.
- Develop regional training for water-using mobile businesses.
- Promote and encourage implementation of designated BMPs in commercial and industrial areas.
- Outreach to impacted industry regarding minimum BMP requirement updates. Affects commercial, industrial, residential development.

While the total effect of the strategies cannot be determined at this time, it is assumed that the targeting of pollutants will improve the environment and benefit habitats and aesthetics.

The strategies which target commercial areas are assumed to effect more benefit categories, consistent benefit category scoring for other strategies which require minimum BMPs.

4.1.14 Enforcement Response Plan: Initiatives to Change Behavior (Ref 14)

The Enforcement Response Plan strategies can be categorized by 3 separate desired outcomes, and have been grouped separately. These strategies are focused at changing behavior.

It can be assumed that irrigation cost savings will occur as one strategy specifically targets over-irrigation. Where irrigation cost savings occur, there can potentially be emission savings. This is due to the reduced energy needed to provide the water, which in turn reduces the emissions generated from energy production. More information would be needed about these projects to determine the extent to which irrigation cost savings are realized.

List of Enforcement Response Plan Strategies to Change Behavior:

- ❖ Continue to implement escalating enforcement responses to compel compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development in the Enforcement Response Plan.
- ❖ Increase enforcement of over-irrigation.

4.1.15 Enforcement Response Plan: Initiatives to Reduce Pollutants Directly (Ref 15)

This strategy differs from the previous, in that its outcome creates initiatives to reduce pollutants directly.

List of Enforcement Response Plan Strategies to Reduce Pollutants Directly:

- ❖ Increase enforcement associated with property-based inspections.
- ❖ Increase enforcement of sweeping and maintenance of private roads and parking lots in targeted areas.
- ❖ Increase identification and enforcement of actionable erosion and slope stabilization issues on private property and require stabilization and repair.
- ❖ Increase enforcement of water-using mobile businesses.

4.1.16 Enforcement Response Plan - Improve Structural Systems Performance (Ref 16)

This strategy in the Enforcement Response Plan is assumed to improve structural systems performance through minimum BMP enforcement, which is different from the targeted outcome of the other strategies:

- Increase enforcement of minimum BMPs for existing residential, commercial, and industrial development, including power washing.

As this strategy targets commercial and industrial areas, consistent benefit category scoring for other strategies which require minimum BMPs is used.

4.1.17 Additional Nonstructural Strategies- Reduce Pollutants Directly (Ref 17)

The remaining Nonstructural strategies related to pollutant reduction are grouped together, and separated from the additional strategies which improve structural systems performance. They are assumed to see habitat related benefits, but due to the broad nature and lack of specific details, that is the only benefit category affected. Additional outreach is assumed to provide Public Education benefits.

List of Additional Nonstructural Strategies which Reduce Pollutants Directly:

- Address and clean up pollutants from homeless encampments through Homeless Outreach Team
- Continue participating in source reduction initiatives
- Coordinate with other City of San Diego Departments to replace City-owned vehicle brake pads with copper-free brake pads as they become commercially available
- Pesticide Use Reduction
- Zinc Reduction Program
- San Dieguito Source Identification and Prioritization Process

4.1.18 Additional Nonstructural Strategies - Improve Structural Systems Performance (Ref 18)

These strategies differ from those which seek to reduce pollutants directly, as these target outcomes to improve structural systems and have specific tasks such as ‘actively monitor erosion’ are expected to positively impact habitat and flooding benefits. All the strategies which are research studies are assumed to provide public education benefits.

List of Additional Nonstructural Strategies which Improve Structural Systems Performance:

- ❖ Proactively monitor for erosion, and complete minor repair and slope stabilization on municipal property
- ❖ Using adaptive management, delist the beach segment from the TMDL and Attachment E of the MS4 Permit
- ❖ Los Peñasquitos Watershed Special Study
- ❖ Reference watershed study
- ❖ Reference beach study
- ❖ Tecolote Creek Quantitative Microbial Risk Assessment (QMRA)
- ❖ Implement ASBS Compliance Plan
- ❖ Collaborate with City of San Diego PUD and other watershed stakeholders in the Lake Hodges Water Quality Concentration Study. Study will characterize conditions and identify sources.
- ❖ Develop and implement targeted roof replacement incentive program for Chollas

4.1.19 Green Infrastructure (Ref 19)

These strategies produce a large amount of quantifiable benefits due to the research that exists demonstrating the effectiveness of green infrastructure. This means that in most cases, at a minimum, the benefits can be measured. In certain cases, they can be monetized when enough information is available. As the specific strategies vary by watershed, a high level summary is provided.

Several BMPs involve increasing the total area (acres) of bioretention and permeable pavement on public parcels. Other strategies focus on specific target sites such as parks on green lots.

Strategies with specific design features (such as size of bioretention, etc.) allow for the ability to calculate the amount of storm water runoff retained, which can be used in to quantify Flood Risk Reduction, where applicable.

Less information is known about how these systems will fully operate, so it is possible that there could be irrigation cost savings, but such benefits cannot be accurately quantified without additional information. Where instances of irrigation cost savings could occur, some level of emission savings could also occur because of reduced energy use for delivering water.

Changes in biomass at a site (due to green streets plantings, or bioretention) can have quantifiable impacts on air quality and climate. The quantified amount depends on the specific properties of the new vegetation. Assuming that changes in biomass can be quantified, it is possible to suggest that noise reduction is a potential benefit, and local aesthetics would be improved. Local aesthetics would be quantified by the area of improved land.

An increase in biomass could reduce ambient temperatures, but the scale would be localized and small overall. Thus, we scored this other benefit category as ‘potential.’’

In instances where aesthetics are realized, business development can be quantified if enough information is available about the local characteristics of a green Infrastructure site (i.e., the proximity of the site to existing retail businesses).

Projects which provide pedestrian or bike access such as a green street or open space are assumed to provide quantifiable recreational benefits, such as additional miles of walkable or livable streets. The amount of these benefits will depend on data on size of the local population, the area of the site, and site usage.

4.1.20 Green Infrastructure: Green Streets (Ref 20)

Due to the information available regarding bioretention and the size of implementation, it can be assumed green streets will have the same scoring as the green infrastructure projects. As the specific strategies vary by watershed, a high level summary is provided. Several BMPs involve increasing the total area (acres) of green streets on specific avenues or subwatersheds.

4.1.21 Multiuse Treatment Areas: Infiltration and Detention Basins (Ref 21)

This section describes the process for scoring the structural strategies consisting of infiltration and detention basins.

It is assumed that the strategies for both golf courses involve similar wetland system projects, which are assumed to increase total biomass and provide entrainment and sequestration. If the total biomass change can be quantified, air and climate benefits can be measured and monetized.

While underground systems will be able to provide flood risk reduction, which in turn protects local habitats and ecological systems, any benefit categories that depend on changes in the above ground environment (such as habitat benefits) will not be affected, and are indicated as ‘Not Applicable.’ Projects that occur on public land, such as schools, provide the opportunity for educating the public or students about the strategy, and can be quantified by the number of people who learn about the strategy. These benefits depend on the number of students enrolled at the school, or the population of a neighboring community where public outreach about the project occurs.

Where instances of irrigation cost savings are thought to occur, emission savings could occur, but more information would be needed about these projects to determine the extent to which irrigation cost savings are realized.

As the specific strategies vary by watershed, a high level summary is provided. Several BMPs involve the installation of a subsurface detention galley on public parcels. Other options include dry detention systems, sediment basins, infiltration basins, and hyrdomodification BMPs.

4.1.22 Multiuse Treatment Areas: Stream, Channel and Habitat Rehabilitation Projects (Ref 22)

As these strategies target streams and other ecological areas, it is assumed habitats and aesthetics will improve, and can be measured using the area of the project. This strategy is assumed to be similar to the MS4 and Retrofit and Rehabilitation in Areas of Existing Development strategies.

As the specific strategies vary by watershed, a high level summary is provided. Several BMPs involve either wetlands or the Chollas Creek.

4.1.23 Water Quality Improvement BMPs: Proprietary BMPs (Ref 23)

Due to the nature of these projects, a basic assumption is the projects will improve water flow, and flood control and habitat benefits can occur. However, no other benefit categories can reasonably be expected to be impacted until more specific details about the sites and projects are known.

As the specific strategies vary by watershed, a high level summary is provided. Several BMPs involve drainage inserts on public parcels. Others involve hydrodynamic separation systems, dry-weather, or low flow diversions. Some are broader in nature, and provide direction on implementing a certain amount of acres of multiuse treatment area projects on private parcels and/or through public-private partnerships with various total storage sizes.

4.2 Optional Jurisdictional Strategies

This section provides a discussion of the methodology for assigning scoring categories to the Optional Jurisdictional Strategies, as well as sub-categories. Optional strategies are those strategies that may be triggered in the future to achieve the interim and final numeric goals." Many of these strategies are assumed to have a similar outcome and thus a similar other benefit category scoring as their Jurisdictional counterpart. The scores take into account the *potential* benefits that may occur, given the information available, and assumptions that are listed in each strategy. The scoring for these strategies is presented in Section 5, in Table 3 and Table 7. These strategies represent the latest consideration in an evolving process of identification, specification and assessment. Not all strategies have been implemented or have plans for immediate implementation. At the same time, the specification of the design standards also varies from strategy to strategy.

This list of individual strategies has been grouped according to the same categories that are contained in the Water Quality Improvement Plan and are presented in the same chronological order. The information found in the parenthesis next to the strategy group name (*Ref X*), refers to the number in the far left columns of Table 3 and Table 7.

4.2.1 Additional Nonstructural Strategies (Ref 24)

Many of these strategies are studies, which until they are completed, and the recommendations are implemented, cannot produce any benefits other than public education at the moment. Additionally, initiatives that involve participating or collaborating with other agencies or organizations are not applicable to other benefit categories at this time. The removal of invasive plants should protect existing habitats.

Additonal Nonstructural Strategies include:

Project	Location
Conduct Sustainable Return on Investment (SROI) analysis to estimate strategies' co-benefits and impacts to the public and the private sector on a common scale.	City-wide
Collaborate with the County, if a County-led regional social services effort is established, to provide sanitation and trash management for person experiencing homelessness and determine if the program is suitable and appropriate for jurisdictional needs to meet goals.	City-wide
Identify strategy resources and funding to support mapping and assessment of agricultural operations.	SDG above Lake Hodges
Coordinate with County of San Diego and identify resources and funding to implement a program to target on-site wastewater treatment (septic) systems. May include mapping and risk assessment, inspection, or maintenance practices.	SDG
Participate in an assessment to determine if implementation of an urban tree canopy (UTC) program would benefit water quality and other City goals.	City-wide
Conduct a feasibility study to test Permeable Friction Course (PFC), porous asphalt that overlays impermeable asphalt.	City-wide
As opportunities arise and funding sources are identified, protect areas that are functioning naturally by avoiding impervious development and degradation on unpaved open space areas, creating permanent open space protections on undeveloped city-owned land, and accepting privately-owned undeveloped open areas.	City-wide MB-Rose Canyon
Add permanent open spaces protections to underdeveloped city-owned land in and on the rim of Rose canyon and San Clemente Canyon.	MB, Rose Canyon
Forming a linear "park" from the southern end of Marian Bear Natural Park to the mouth of Rose Creek.	MB, Rose Canyon
Lake Hodges Natural Treatment System Project	SDG: Lake Hodges

Project	Location
If a regional collaboration is established for the Los Peñasquitos Lagoon, participate in restorative efforts in collaboration with TMDL Responsible Parties and TMDL responsible parties and other stakeholders.	Los Peñasquitos Lagoon Subwatershed
Participate in a watershed council or group and support the establishment of a watershed coordinator if one is established.	City-wide
Participate in a watershed council or group and support the establishment of a watershed coordinator if one is established. Includes participation in Rose Creek Watershed Team.	MB, Rose Canyon
Removal of invasive plants.	MB, Rose Canyon

4.2.2 Green Infrastructure – Optional Jurisdictional Strategies (Ref 25)

These strategies follow the same scoring as Jurisdictional Green Infrastructure projects. Under certain circumstances, these Green Infrastructure Strategies could be implemented.

4.2.3 Green Infrastructure: Green Streets – Optional Jurisdictional Strategies (Ref 26)

This strategy follows the same scoring as Jurisdictional Green Streets projects. Green Streets Strategies could be implemented if:

- If interim load reduction goals are not met and additional green infrastructure is required, the additional acreage of bioretention and permeable pavement can be implemented through green streets if potential opportunities for green infrastructure implementation on public parcels are not available.

4.2.4 Multiuse Treatment Areas: Infiltration and Detention Basins – Optional Jurisdictional Strategies (Ref 27)

These strategies follow the same scoring as Jurisdictional Multiuse Treatment Areas: Infiltration and Detention Basins projects.

4.2.5 Multiuse Treatment Areas: Stream, Channel, and Habitat Rehabilitation Projects – Optional Jurisdictional Strategies (Ref 28)

These strategies follow the same scoring as Jurisdictional Multiuse Treatment Areas: Stream, Channel, and Habitat Rehabilitation projects. List of Stream, Channel, and Habitat Rehabilitation Project includes:

- If interim load reduction goals are not met and additional stream, channel, and habitat rehabilitation projects are required, implement as needed.

- Day lighting Cudahy Creek implementation.
- An example of this would be to lengthen the Genesee Avenue Bridge in Rose Canyon in order to eliminate the berm that bisects the riparian corridor. This would restore the natural riparian corridor and promote wildlife and recreational passage under Genesee.

4.2.6 Multiuse Treatment Areas: Other Opportunities – Optional Jurisdictional Strategies (Ref 29)

This strategy follows the same scoring as Jurisdictional Multiuse Treatment Areas: Other Opportunities projects. Other Opportunity Strategy is defined as:

- If interim load reduction goals are not met and additional multiuse treatment area projects are required, implement, as needed, on private parcels and/or through public-private partnerships.

4.2.7 Water Quality Improvement BMPs: Trash Segregation – Optional Jurisdictional Strategies (Ref 30)

These projects specifically target street litter or debris, and are assumed to create an aesthetic improvement, and can be quantified with estimates on the volume of litter removed. Depending on the local land-use for the streets targeted, business development could potentially increase. Jobs can also be supported by the money spent on operation and maintenance activities. Trash Segregation Strategies would be implemented under conditions defined as:

- If interim load reduction goals are not met and additional trash segregation projects are required, implement as needed.
- If interim load reduction goals are not met and additional proprietary projects are required, implement as needed.
- If interim load reduction goals are not met and additional dry weather flow separation and treatment projects are required, implement as needed.

5 Results of Assessment

An overview of all the strategies, with the number of benefits, by benefit level, shown in descending order is presented in Table 2 and Table 3. Additionally, the total point value across the other benefit categories is presented in the far right column, with the header 'Total Point Value.' For example, green infrastructure has the greatest benefit score for both the jurisdictional and optional jurisdictional strategies. It is located at the top of Table 2, with a 'Total Point Value' of 7.3. This is calculated by:

- Multiplying the number of monetizable benefits (2), by their benefit scoring value (1);
- Multiplying the number of measurable benefits (3), by their benefit scoring value (0.667),
- Multiplying the number of potential benefits (10), by their benefit scoring value (0.333),
- Multiplying the number of not applicable benefits (0), by their benefit scoring value (0),
- Adding the subtotals together results in a total score of (2 + 2 + 3.3 + 0 = 7.3).

A detailed summary of the potential level of impact for each strategy and benefit category is presented in Table 6 and Table 7. For convenience, the number in the far left column, with the header 'Ref,' corresponds to the number next to the strategy group descriptions in the previous sections, and is consistent across all tables. Using Green Infrastructure as an example, the number in the first column of Table 2, (19) can be found in Table 6, and corresponds to the discussion of green infrastructure in the previous section, *Green Infrastructure (Ref 19)*

Table 2: Overview of Jurisdictional Strategies in Descending Order

Ref.[1]	Description of Strategy Group	Category	Strategy Outcome	Monetizable	Measurable	Potential	Not Applicable	Total Point Value	Number of Applicable Benefits
19	Green Infrastructure	Structural	Green Infrastructure	2	3	10	0	7.33	15
20	Green Streets	Structural	Green Infrastructure	2	3	10	0	7.33	15
5	Commercial, Industrial, Municipal, and Residential Facilities and Areas[2]	Non-Structural	Initiatives to Change Behavior	0	5	6	4	5.33	11
21	Multiuse Treatment Areas - Infiltration and Detention Basins	Structural	Multiuse Treatment Areas	2	1	6	6	4.67	9
1	All Development Projects	Non-Structural	Initiatives to Reduce Pollutants Directly	0	0	14	1	4.67	14
2	Priority Development Projects (PDPs)	Non-Structural	Increase # Of Structural Systems	0	0	14	1	4.67	14
3	Construction Management	Non-Structural	Improve Structural Systems Performance	0	0	14	1	4.67	14
4	Commercial, Industrial, Municipal, and Residential Facilities and Areas[1]	Non-Structural	Improve Structural Systems Performance	0	0	14	1	4.67	14
9	Retrofit and Rehabilitation in Areas of Existing Development - Structures	Non-Structural	Increase # Of Structural Systems	0	0	14	1	4.67	14

Table 2: Overview of Jurisdictional Strategies in Descending Order (continued)

Ref.[1]	Description of Strategy Group	Category	Strategy Outcome	Monetizable	Measurable	Potential	Not Applicable	Total Point Value	Number of Applicable Benefits
13	Public Education and Participation: Reduce Pollutants Directly	Non-Structural	Initiatives to Reduce Pollutants Directly	0	0	14	1	4.67	14
15	Enforcement Response Plan: Improve Structural Systems Performance	Non-Structural	Improve Structural Systems Performance	0	0	14	1	4.67	14
22	Multiuse Treatment Areas - Stream, Channel and Habitat Rehabilitation Projects	Structural	Multiuse Treatment Areas	0	2	8	5	4.00	10
14	Enforcement Response Plan: Initiatives to Change Behavior	Non-Structural	Initiatives to Change Behavior	0	1	6	8	2.67	7
10	Retrofit and Rehabilitation in Areas of Existing Development	Non-Structural	Improve Structural Systems Performance	0	2	3	10	2.33	5
16	Enforcement Response Plan: Initiatives to Reduce Pollutants Directly	Non-Structural	Initiatives to Reduce Pollutants Directly	0	2	3	10	2.33	4
12	Public Education and Participation: Initiatives to Change Behavior	Non-Structural	Initiatives to Change Behavior	0	1	4	10	2.00	4
11	Illicit Discharge, Detection, and Elimination (IDDE) Program	Non-Structural	Initiatives to Change Behavior	0	1	3	11	1.67	4
7	Roads, Street, and Parking Lots - Cleaning Maintaining, etc	Non-Structural	Improve Structural Systems Performance	0	1	2	12	1.33	3

Table 2: Overview of Jurisdictional Strategies in Descending Order (continued)

Ref.[1]	Description of Strategy Group	Category	Strategy Outcome	Monetizable	Measurable	Potential	Not Applicable	Total Point Value	Number of Applicable Benefits
8	Pesticide, Herbicides, and Fertilizer BMP Program	Non-Structural	Initiatives to Reduce Pollutants Directly	0	1	2	12	1.33	3
6	MS4 Infrastructure	Non-Structural	Improve Structural Systems Performance	0	0	3	12	1.00	3
18	Additional Nonstructural Strategies: Improve Structural Systems Performance	Non-Structural	Improve Structural Systems Performance	0	0	3	12	1.00	3
17	Additional Nonstructural Strategies: Initiatives to Reduce Pollutants Directly	Non-Structural	Initiatives to Reduce Pollutants Directly	0	0	2	13	0.67	2
23	Water Quality Improvement BMPs - Proprietary BMPs	Structural	Water Quality Improvement	0	0	2	13	0.67	2

1. The reference number refers to strategy groups presented in pages 9-28.

Table 3: Overview of Optional Jurisdictional Strategies by Descending Order

Ref.[1]	Description of Strategy Group	Category	Strategy Outcome	Monetizable	Measurable	Potential	Not Applicable	Total Point Value	Number of Applicable Benefits
25	Green Infrastructure – Optional Strategies	Structural	Green Infrastructure	2	3	10	0	7.33	15
26	Green Streets – Optional Strategies	Structural	Green Infrastructure	2	3	10	0	7.33	15
27	Multiuse Treatment Areas-Infiltration and Detention Basins – Optional Strategies	Structural	Multiuse Treatment Areas	2	1	6	6	4.67	9
28	Multiuse Treatment Areas-Stream, Channel and Habitat Rehabilitation Projects – Optional Jurisdictional Strategies	Structural	Multiuse Treatment Areas	0	2	8	5	4.00	9
29	Multiuse Treatment Areas- Other Opportunities – Optional Strategies	Structural	Multiuse Treatment Areas	0	1	8	6	3.33	9
30	Water Quality Improvement BMPs-Trash Segregation – Optional Strategies	Structural	Water Quality Improvement	0	0	3	12	1.00	2
24	Additional Nonstructural Strategies – Optional Jurisdictional Strategies	Non-Structural	Initiatives to Reduce Pollutants Directly	0	0	2	13	0.67	2

1. The reference number refers to strategy groups presented in pages 9-29.

In Table 6 and Table 7, a detailed summary of the potential level of impact for each strategy and benefit category is presented. For these tables, a key to symbols and point value is presented for each level of impact in Table 4. In some cases, the strategy group includes individual strategies that are classified by different types of strategy outcomes. Table 5 shows the numerical key used in Table 6 and Table 7. To make the evaluation process more transparent, a discussion about the assumptions and rationale for the assignment of a benefit category level to a specific strategy is briefly discussed for each type of Water Quality Improvement Plan strategy following the summary tables. The reference for the discussion below for each strategy is listed in column 1 of Table 6 and Table 7. In addition to presenting point values, the total number of potentially applicable benefits is also shown.

Table 4: Key to Symbols

Symbol	Level of Impact	Point Value
●	Monetizable	1
⦿	Measurable	0.67
○	Potential	0.33
⊗	Not Applicable	0

Table 5 provides a key to the number in the column with the header ‘Strategy Outcome.’ For example, the first strategy group listed, All Development Projects, has the number 6 in the ‘Strategy Outcome’ column. The number 6 in Table 5 indicates that All Development Projects are Nonstructural Strategies comprised of Initiatives to Reduce Pollutants Directly.

Table 5: Key to Strategy Outcome

ID	Category of Strategy	Type of Strategy Outcome
1	Structural	Green Infrastructure
2	Structural	Multi Use Treatment
3	Structural	Water Quality Improvement
4	Nonstructural	Improve Structural Systems Performance
5	Nonstructural	Increase the Number of Structural Systems
6	Nonstructural	Initiatives to Reduce Pollutants Directly
7	Nonstructural	Initiatives to Change Behavior

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies

			Financial		Environmental						Social								
Ref[1]	**Strategy Group**	**Strategy Outcome[2]**	**Water Cost Savings**	**Energy Cost Savings**	**Flood Risk Reduction**	**Air Particulate Entrainment**	**Climate Impacts**	**Habitat Related Benefits**	**Air Quality Emission Reduction**	**GHG Emission Reduction**	**Property Value Enhancement**	**Recreational Benefits**	**Business Development & Jobs**	**Crime Reduction**	**Public Education/ Environmental Stewardship**	**Noise Reduction**	**Heat Island Effect**	**Total Point Value**	**Number of Applicable Benefits**
1	**All Development Projects**	4	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**4.7**	**14**
2	**Priority Development Projects (PDPs)**	5	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**4.7**	**14**
3	**Construction Management**	4	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**4.7**	**14**
4	**Commercial, Industrial, Municipal, and Residential Facilities and Areas**	4	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**4.7**	**14**

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
5	**Commercial, Industrial, Municipal, and Residential Facilities and Areas**	7	● [0.67]	● [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	● [0.67]	● [0.67]	○ [0.33]	⊗ [0]	○ [0.33]	⊗ [0]	● [0.67]	⊗ [0]	○ [0.33]	**5.3**	**11**
6	**MS4 Infrastructure**	4	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	**1.0**	**3**
7	**Roads, Street, and Parking Lots**	4	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	● [0.67]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	**1.3**	**3**
8	**Pesticide, Herbicides, and Fertilizer BMP Program**	6	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	● [0.67]	⊗ [0]	⊗ [0]	**1.3**	**3**

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	**Strategy Group**	**Strategy Outcome[2]**	**Water Cost Savings**	**Energy Cost Savings**	**Flood Risk Reduction**	**Air Particulate Entrainment**	**Climate Impacts**	**Habitat Related Benefits**	**Air Quality Emission Reduction**	**GHG Emission Reduction**	**Property Value Enhancement**	**Recreational Benefits**	**Business Development & Jobs**	**Crime Reduction**	**Public Education/ Environmental Stewardship**	**Noise Reduction**	**Heat Island Effect**	**Total Point Value**	**Number of Applicable Benefits**
9	**Retrofit and Rehabilitation in Areas of Existing Development - Improve Structural Systems Performance**	5	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**4.7**	**14**
10	**Retrofit and Rehabilitation in Areas of Existing Development - Increase the Number of Structural Systems**	4	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	◉ [0.67]	⊗ [0]	⊗ [0]	◉ [0.67]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**2.3**	**5**

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
11	**Illicit Discharge, Detection, and Elimination (IDDE) Program**	7	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	○ [0.33]	⊗ [0]	◉ [0.67]	⊗ [0]	⊗ [0]	**1.7**	**4**
12	**Public Education and Participation: Initiatives to Change Behavior**	7	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	○ [0.33]	⊗ [0]	◉ [0.67]	⊗ [0]	⊗ [0]	**2.0**	**4**

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	**Strategy Group**	**Strategy Outcome[2]**	**Water Cost Savings**	**Energy Cost Savings**	**Flood Risk Reduction**	**Air Particulate Entrainment**	**Climate Impacts**	**Habitat Related Benefits**	**Air Quality Emission Reduction**	**GHG Emission Reduction**	**Property Value Enhancement**	**Recreational Benefits**	**Business Development & Jobs**	**Crime Reduction**	**Public Education/ Environmental Stewardship**	**Noise Reduction**	**Heat Island Effect**	**Total Point Value**	**Number of Applicable Benefits**
13	**Public Education and Participation: Initiatives to Reduce Pollutants Directly**	6	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**4.7**	**14**
14	**Enforcement Response Plan: Initiatives to Change Behavior**	7	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	⊗ [0]	◉ [0.67]	⊗ [0]	⊗ [0]	**2.7**	**9**
15	**Enforcement Response Plan: Improve Structural Systems Performance**	4	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**4.7**	**14**

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
16	**Enforcement Response Plan**: **Initiatives to Reduce Pollutants Directly**	6	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	◉ [0.67]	⊗ [0]	○ [0.33]	⊗ [0]	◉ [0.67]	⊗ [0]	⊗ [0]	**2.3**	**4**
17	**Additional Nonstructural Strategies**: **Initiatives to Reduce Pollutants Directly**	6	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**0.7**	**2**

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
18	**Additional Nonstructural Strategies: Improve Structural Systems Performance**	4	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**1.0**	**3**
19	**Green Infrastructure**	1	○ [0.33]	○ [0.33]	◉ [0.67]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	◉ [0.67]	○ [0.33]	◉ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**7.3**	**15**
20	**Green Streets**	1	○ [0.33]	○ [0.33]	◉ [0.67]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	◉ [0.67]	○ [0.33]	◉ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**7.3**	**15**
21	**Multiuse Treatment Areas - Infiltration and Detention Basins**	2	○ [0.33]	○ [0.33]	○ [0.33]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	◉ [0.67]	⊗ [0]	⊗ [0]	**4.7**	**9**

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
22	**Multiuse Treatment Areas - Stream, Channel and Habitat Rehabilitation Projects**	2	○ [0.33]	○ [0.33]	◉ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	◉ [0.67]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**4.0**	**10**
23	**Water Quality Improvement BMPs**	3	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	**0.7**	**2**

1. The reference number refers to strategy groups presented in pages 9-29.
2. Strategy Outcome as described in Table 5.

Table 7: Overview of Potential Other Benefits of Water Quality Improvement Plan - Optional Jurisdictional Strategies

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
24	**Additional Nonstructural Strategies**	6	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**0.7**	**2**
25	**Green Infrastructure**	1	○ [0.33]	○ [0.33]	◉ [0.67]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	◉ [0.67]	○ [0.33]	◉ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**7.3**	**15**
26	**Green Streets**	1	○ [0.33]	○ [0.33]	◉ [0.67]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	◉ [0.67]	○ [0.33]	◉ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**7.3**	**15**
27	**Multiuse Treatment Areas - Infiltration and Detention Basins**	2	○ [0.33]	○ [0.33]	○ [0.33]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	◉ [0.67]	⊗ [0]	⊗ [0]	**4.7**	**9**

Table 7: Overview of Potential Other Benefits of Water Quality Improvement Plan - Optional Jurisdictional Strategies (continued)

			Financial		Environmental						Social							
Ref[1]	**Strategy Group**	**Strategy Outcome[2]**	**Water Cost Savings**	**Energy Cost Savings**	**Flood Risk Reduction**	**Air Particulate Entrainment**	**Climate Impacts**	**Habitat Related Benefits**	**Air Quality Emission Reduction**	**GHG Emission Reduction**	**Property Value Enhancement**	**Recreational Benefits**	**Business Development & Jobs**	**Crime Reduction**	**Public Education/ Environmental Stewardship**	**Noise Reduction**	**Heat Island Effect**	**Total Point Value**	**Number of Applicable Benefits**
28	**Multiuse Treatment Areas - Stream, Channel and Habitat Rehabilitation Projects**	2	○ [0.33]	○ [0.33]	◉ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	◉ [0.67]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**4.0**	**9**
29	**Multiuse Treatment Areas - Other Opportunities**	2	○ [0.33]	○ [0.33]	◉ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**3.3**	**9**
30	**Water Quality Improvement BMPs - Trash Segregation**	3	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	**1.0**	**2**

1. The reference number refers to strategy groups presented in pages 9-29.
2. Strategy Outcome as described in Table 5.

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Appendix 1: Sustainable Return on Investment Assessment of Water Quality Improvement Strategies. Draft Report. June 2014

Note to reader: This appendix is a re-print of the Phase 1 Draft Report from this project. Some aspects of the strategies and framework differ from what is included in the main report. The literature review in the following Phase 1 report provides a foundation for all subsequent analysis.

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Sustainable Return on Investment Assessment of Water Quality Improvement Strategies

Draft Report

June 2014

Prepared for:

City of San Diego, Storm Water Division

Prepared by:

HDR Engineering, Inc.

100 Oceangate, Ste. 1120
Long Beach, CA 90802

Executive Summary

The aim of this project is to help the City of San Diego Storm Water Division account for the costs and benefits of storm water management strategies. Benefits (sometimes called "co-benefits") include a variety of outcomes beyond improved water quality that some storm water strategies may achieve. The Division has identified a range of structural best management practices (BMPs (e.g., a constructed runoff reduction system such as a bio-swale), and nonstructural BMP activities (i.e. programs that promote installations of constructed systems, or reduce pollutants directly through education and outreach, for example). The Division now seeks to incorporate information on benefits of strategies into a prioritization approach so that as the Division selects strategies to meet its regulatory requirements, it is generating the best value for the community and local businesses.

This report summarizes the findings of a literature review on storm water management benefits and costs and a programmatic assessment of the Division's strategies and associated benefits. The purpose of the assessment is to determine which types of benefits, beyond water quality improvements, might arise from the Division's different storm water management strategies and to determine if and how these benefits can be quantified, and included in a decision making framework.

Our findings in this report indicate that many types of benefits can accrue to local residents, businesses, and the general public. Common types of benefits that have been evaluated in a number of cities around the U.S. include flood risk reduction, reduced energy consumption (and associated air quality emissions), and improved aesthetics. Computing benefits of BMPs has been standardized to some extent in the Center for Neighborhood Technology (CNT) report which outlines the data and calculations for a number of benefits (CNT, 2010). For the Division, a similar calculation process could be implemented and it would be consistent with efforts implemented in other cities. However, a significant level of uncertainty would arise in preparing such estimates without specific data on BMP designs and activities for each strategy as well as site specific information about where they would be implemented.

The City developed several dozen storm water management strategies ranging from types of structural BMPs to projects designed to affect public or municipal employee polluting behavior. Some of the strategies listed are assessment projects that provide information necessary to make decisions or to implement a subsequent non-structural strategy. To initiate this study, we grouped the strategies into specific categories:

- Structural
    - Green Infrastructure
    - Multiuse Treatment Areas
    - Water Quality Improvements

- Non Structural
    - Results in increases in the number of structural systems
    - Results in improved performance of existing structural systems
    - Results in changes in behavior that reduced pollutant loads
    - Results in direct removal of pollutants from watersheds

The next best evaluation strategy for the Division at present would entail a simplified assessment of the likely *existence* of quantifiable net benefits for each strategy. In this report, we have evaluated the degree to which benefits can be quantified (and potentially monetized) for each type of strategy. A net result of benefits exceeding negative attributes has been qualitatively assessed based on findings in the literature. This is not to say that the benefit would be greater than implementation costs, but that co-benefits would likely exceed negative impacts to the community of implementing the strategy.

The results of this assessment are shown in Table 1. A "Yes" in one of the table cells indicates that there would be sufficient evidence to quantifiably determine the value of a strategy, provided that information about the strategy and implementation location is better understood. In this high-level summary, it may be assumed that if a quantifiable benefit exists, they would be large enough to generate observable public value and influence decisions accordingly.

These initial findings however must be developed in more detail to provide practical use in prioritizing strategies for the Division. In particular, the feasibility of estimating benefits must assessed for each individually identified strategy (see Appendix 2), not its strategy group as shown in Table 1. With this information, the Division can establish an initial indication of specific strategies that provide the best value. This effort is planned for phase two of this project.

Table 1: Summary of Evidence for Estimating Benefits for Structural and Nonstructural Strategies

Strategy	Structural			Nonstructural			
	Green Infrastructure	Multiuse Treatment Areas	Water Quality Improvement	Increase # Of Structural Systems	Improve Structural Systems Performance	Initiatives To Change Behavior	Initiatives To Reduce Pollutants Directly
Flood Control	YES	YES	YES	YES	YES	YES	
Irrigation Cost Savings	YES			YES	YES	YES	
Energy Cost Savings	YES			YES		YES	YES
Air Particulate Entrainment	YES			YES		YES	YES
Climate Impacts	YES			YES		YES	YES
Habitat Related Benefits							
Air Quality Emission Reduction	YES			YES		YES	YES
GHG Emission Reduction	YES			YES		YES	YES
Heat Island Effect	YES	YES		YES	YES	YES	
Aesthetics	YES	YES		YES	YES	YES	YES
Recreational Benefits	YES	YES		YES	YES	YES	YES
Noise Reduction							
Business Development & Jobs	YES			YES	YES	YES	YES
Crime Reduction							
Public Education/ Environmental Stewardship							

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Table of Contents

Table of Contents (continued)

List of Figures

Table of Contents (continued)

List of Tables

Acronyms

BCA – Benefit Cost Analysis
BES – Bureau of Environmental Services
BMP – Best Management Practice
Btu – British Thermal Unit

CAMX - California-Mexico Power Area
CEA – Cost-Effectiveness Analysis
CLRP – Comprehensive Load Reduction Plans
CNT – Center for Neighborhood Technology
CO2 – Carbon Dioxide
CSO – Combined Sewer Overflow

DOT – Department of Transportation

EIA – Economic Impact Analysis
EPA –Environmental Protection Agency

IDDE – Illicit Discharge, Detection, and Elimination

kWh – Kilowatt Hour

LACDPW – Los Angeles County Department of Public Works
LID – Low Impact Development

MMSD – Milwaukee Metropolitan Sewage District
MODA – Multi-Objective Decision Analysis
M Wh – Mega Watt Hour

NRDC – Natural Resources Defense Council
NOx - Nitric oxide and nitrogen dioxide
NPV – Net Present Value

O3 – Oxide

PFC – Permeable Friction Course
PM – Particulate Matter
PWD – Philadelphia Water District

SO2 – Sulfur Dioxide
SPU – Seattle Public Utilities
SROI – Sustainable Return on Investment

TBL – Triple Bottom Line
TIGER – Transportation Investment Generating Economic Recovery
TMDL – Total Maximum Daily Load

UTC – Urban Tree Canopy

WAMP – Watershed Asset Management Plan
WERF – Water Environment Research Foundation
WQIP – Water Quality Improvement Plan

1 Introduction

The City of San Diego Storm Water Division (Division) seeks a framework for prioritizing storm water management strategies that have been identified as part of the Water Quality Improvement Plans for each watershed. These strategies include a range of best management practices (BMPs) in structural systems (i.e., a constructed runoff reduction system, such as a bio-swale), and nonstructural activities (i.e. programs that promote installations of constructed systems, or reduce pollutants directly through education and outreach, for example). Each of the identified strategies is intended to contribute to meeting Total Maximum Daily Load (TMDL) regulatory requirements.

At the same time, each strategy can also provide *additional* benefits (sometimes called "Co-benefits") to the community. Depending on the type of strategy, such benefits can include flood risk reduction, reduced energy consumption and associated air quality emissions, improved aesthetics and habitat creation. Of course, not all BMPs generate positive benefits – property damage can occur if infiltration systems are poorly performing or additional street sweeping miles would increase air pollution costs. [3] Whatever the case, accounting for such benefits is challenging because each one is measured in different units and data is rarely available to quantify existing conditions and predicting changed conditions. Even so, estimating benefits can contribute to decision making. WERF (2014) notes that while a number of studies have shown storm water BMPs to be cost-effective and efficient at achieving water quality goals, traditional engineering costing methods fail to adequately value the multiple benefits and improved life-cycle costs that storm water BMPs provide.

The Division has contracted HDR to apply its *Sustainable Return on Investment (SROI)* process to develop a sound prioritization framework that accounts for storm water management benefits. SROI is an economics-based approach to evaluating and communicating the economic benefits and expenditure-based impacts across a *triple bottom line* – the financial, environmental and societal outcomes of a project. The process includes: (a) transparent review of evidence; (b) economic framework for evaluation; (c) workshop-based discussion of evidence; and (d) accounting for risk and uncertainty in key drivers of outcomes. SROI is a proven process, having been implemented in billions of dollars in capital projects over the last 8 years. In this project, we apply SROI to evaluate key economic benefits and use this to develop a sound framework for prioritizing strategies.

This document discusses our initial tasks in this effort. We report on findings from a literature review for substantiating the existence of such benefits, and an evaluation of strategies, to assess how different benefit categories may apply. We also discuss an initial assessment of the applicability of different types of benefits for individual BMP strategies. In addition, we report on an introductory workshop with stakeholders on the concept of storm water management benefits and frameworks to include estimated benefits in decision making. In addition, this phase will also determine the methods to account for co-benefits in qualitative, quantitative or monetized metrics.

[3] To make the discussion more concise, "Benefits" refer to both positive and negative outcomes.

2 Literature Review on Storm water Management Benefits

Conceptual frameworks and empirical evidence on economic benefits of storm water management have been developed in a number of studies. This chapter characterizes this evidence to establish a foundation for understanding the types of benefits from storm water management that are included in project evaluations in a SROI process. The findings of this literature also indicate that the estimation of benefits beyond water quality improvements is an emerging field. The potential for life cycle cost savings of green infrastructure in suitable locations has been fairly well established. Yet, it has been more difficult to establish standards for estimating the benefits from other aspects of BMPs that affect environmental and societal outcomes. Significant uncertainties remain over the degree to which a BMP can generate tangible benefits. In most cases, benefits depend largely on the design and site conditions.

2.1 What are Economic Benefits and Impacts?

Economic benefits are the fundamental measure of a project's overall worth to society.[4] Storm water management benefits,[5] whether they relate to avoided flood damage, improved air quality, or energy cost savings are evaluated in the same theoretical framework. Economic researchers assess the value for products and services from data on people's expenditures and their preferences for goods that are not sold (e.g. air quality).[6] Research can provide a basis for understanding how people value storm water benefits in terms of financial, environmental and societal benefits. Moreover, this evidence can support agency staff in developing strategies to manage environmental investments to maximize environmental benefits per dollar spent (WERF, 2014, Ecosystem Valuation, 2007).

A complementary measure of the worthiness of a project reflects the expenditures to build and maintain it. These expenditures and their connection to the broader economy are defined as *economic impacts*. The expenditures on materials, labor, land, and monitoring over the project lifecycle are implementation costs that are measureable and tangible. Economic impacts of storm water management spending are straightforward to

[4] Benefits are a somewhat esoteric theoretical economic construct of how people value a product or service. The benefit of a product or service is derived from the premise that some people gain greater *value* from the use of a product or service, especially its initial use, than the price they paid for it. For example, the first glass of water to a thirsty person would be much more highly valued and than the last one consumed, even if the price is the same for each glass. It is further assumed that they would be *willing to pay* some amount to gain that value from it, even if it is above the market price. The idea that a person's willingness to pay can be greater than a market price is a fundamental principal of the value gained by consumers.

[5] In standard economic terminology, benefits can be *positive* or *negative* depending on whether they are desirable or undesirable. A negative storm water management benefit can arise if flood control measures that entail infiltration cause damage to neighboring properties.

[6] Goods that are not sold in markets, such as the recreational value from natural areas, can be derived from the expenditures of persons who visit these areas, or the responses of people to responses to structured surveys which to determine a willingness to pay for the hypothetical avoidance of some undesirable impact to such areas.

estimate since expenditures are readily estimable and the wider economic impacts can be assessed using economic impact multipliers. Results from economic impact analysis, such as the numbers of jobs created from storm water management strategies reflect the impact on the overall economy and can be estimated at the local, regional and even national levels.

2.2 What are the Key Economic Benefits of Storm water Management?

A growing number of researchers have evaluated the economic benefits and impacts of storm water BMPs in addition to cost savings (See: EPA, 2013; WERF, 2014; and CNT, 2010). Some of the most commonly cited benefits stem from the functional ability of BMPs to reduce the risk of flood damage, costs of public infrastructure, and pollution and water treatment costs. EPA (2013) research on case studies of economic benefits of low impact development and green infrastructure revealed that a number of benefits can be characterized along the triple bottom line (Table 2).

Table 2: Examples of Potential Benefits from Green Infrastructure

Environmental benefits	Financial benefits	Societal benefits
Improved water quality	Reduced construction costs relative to grey infrastructure	Improved aesthetics
Improved air quality from trees	Reduced scale of grey infrastructure design	More urban greenways
Improved ground water recharge	–	Increase in public awareness of storm water management
Energy savings from reduced air conditioning	–	Reduced flash flooding
Reduced greenhouse gas emissions	–	Green jobs
Reduced urban heat stress	–	Increase in economic development from improved aesthetics
Reduced sewer overflow		

Source: EPA (2013)

Estimating benefits however can be challenging because of a lack of data on the physical changes and value of such changes. Data gaps can arise for either or both existing site conditions (prior to project implementation) or predicted changes in conditions (after implementation). In all cases, data must be collected at a specific site and project to develop credible benefit estimates. Where data gaps exist, analytical decisions can be made with respect to evaluating some types of benefits in qualitative terms (such as multi-objective decision analyses) or by quantifying uncertainty (using Monte Carlo simulation).

Several categories of benefits have been identified and described in published literature on storm water management benefits. This section reports on results from a literature review that focused on defining benefit categories and describing the conditions when it can arise. More detail on values and calculation methods are discussed in the Appendix 1. To facilitate the understanding of benefits, several groups of benefit categories are defined including: runoff retention/ detention, energy cost savings, air quality improvements, ecosystem services, and community livability. The categories of benefits in each of these groups are described below.

2.2.1 Runoff Retention/Detention Benefits

Several types of green infrastructure (e.g. green roofs, bio-retention, permeable pavement, rain barrels, etc.) are designed to detain, retain and/or infiltrate rain where it falls. Corresponding reductions in storm water runoff lower the total and peak volumes in the storm water system. Benefits of runoff retention / detention include a reduction in downstream flood risk to properties, and reduced irrigation costs for property owners, that is, if the retention systems can supplement irrigation needs. Another potential benefit includes any reduction in erosion in streams and corresponding habitat impacts, but this are rarely evaluated due to data limitations. The effectiveness of green infrastructure in reducing runoff and generating benefits is determined by several factors including local precipitation characteristics, design capacity and maintenance practices over its functional lifespan.

Flood Risk Reduction: Reduced runoff can reduce the frequency and severity of flooding in neighborhoods that are particularly susceptible to it. The effectiveness of green infrastructure on flooding depends on the design capacity and rainfall conditions, scale of implementation across a watershed, soil characteristics (for systems that facilitate infiltration), and watershed characteristics.[7] In addition, if the storm sewers are connected to combined sewer systems, the reduced volume can generate operational cost savings at the wastewater treatment plant.[8] The value of flood control is estimated as a reduction in property damage if flooding occurs.

Irrigation Cost Savings: On-site water retention in rain barrels or other similar systems can supplement irrigation needs in yards and gardens. Available captured water can generate an added benefit of reducing potable demand for irrigation and associated costs for owners. Key drivers of the life cycle cost savings for these systems include local rainfall characteristics (e.g. frequency and depth), storage capacity and water rates. The extent to which these systems can generate irrigation cost savings above installation costs (maintenance costs are often low), depends on the demand for irrigation and ability to meet this demand with stored water. For property owners, supplemental irrigation directly reduces the volumes demanded from public sources and its costs. From a utility and public perspective, reductions in water volumes demanded translate into lower levels of energy consumed for water treatment, which in turn reduces air contamination and greenhouse gas emissions (these benefits are discussed in Section 2.2.3).

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[7] Kane County, IL and Lenexa, KS evaluated flood control benefits of future land development scenarios (EPA, 2013). However, because these benefits are site-specific, the results cannot be generalized to other sites.

[8] Wastewater treatment operational cost savings, in the context of combined sewer systems, include reductions in: (a) treatment costs; (b) air pollution emissions; and (c) greenhouse gas emissions (CNT, 2010).

2.2.2 Energy Cost Savings Benefits

Several aspects of green infrastructure can lower energy use and generate cost savings. For instance, green roofs and trees can change the gain or loss of energy in buildings, and in turn decrease costs for heating or cooling (NRDC, 2013).[9] These benefits are influenced by several site and design factors and accrue directly to property owners.

Energy Cost Savings: Site-specific research has shown that the shade that trees provide adjacent buildings and the additional insulation of green roofs on buildings can lower the heating and cooling energy costs in buildings. Of course, the effectiveness of these BMPs in lowering energy use depends on many factors including the BMP design, type of plant material, building characteristics, and climate conditions (CNT, 2010). In addition, for trees, the benefits would not be realized for several years until they have reached a height and width that provides noticeable shading. In another example, green roofs and other storage systems have been installed at water utilities and have provided a supplemental water source that has reduced energy and operational costs for pumping (EPA, 2013).[10] These costs savings would constitute a benefit directly for the utility, and by extension to its rate-payers.

2.2.3 Emissions Reduction Benefits

Generation of electricity is reduced when green infrastructure (e.g. green roofs or trees) reduces energy demand in buildings, or when water harvesting reduces energy demand at treatment plants. Reductions in electricity demand means that some amount of burning fossil fuels is avoided. As a result, there would be a reduction in the harmful emissions of criteria air contaminants (e.g. NOx, SOx, PM, etc.) and greenhouse gas emissions. The U.S. electrical grid enables energy to flow from a large interconnected network and makes it nearly impossible to link a specific source of generation with a particular use. Still, it is possible to generalize over the types of energy consumed in a State and to use this information to characterize how a reduction in energy consumption leads to a reduction in pollution. The benefit of emissions reduction is then estimated using established economic valuation standards.

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[9] These cost savings are additive to air pollution emissions savings from avoided energy generation (EPA, 2013).

[10] The L.A. County Department of Public Works in its Sun Valley Watershed Management Plan accounted for decreased energy demand for pumping water because the harvested and infiltrated water provide supplemental supplies. (EPA, 2013)

Air Pollution Emission Reduction: The total amount of reduction in criteria air contaminant emissions from a power plant is directly tied to the reduction in energy use in a specific location. Energy savings are readily converted to its emission rate reductions by utilizing data from EPA and other public sources. The economic value of lower air pollutants is inferred from its impact on human health and lower medical costs. The reduction of each type of criteria air contaminant has a different economic benefit value per ton. Evidence of the conversion of a reduction in emissions to economic benefits relies on published economic research and from Federal regulatory rule-making, in which values are ultimately approved by the US Office of Management and Budget.[11]

Greenhouse Gas Emission Reduction: Similar to criteria air contaminants, greenhouse gas emissions from energy generation also cause economic damages. The tons of greenhouse gas emissions are computed from the same data sources as criteria air contaminants. The value of lower greenhouse gas emissions is linked to a reduction in in long-term damage to the global economy. While the Federal government provides guidelines on the value per ton of greenhouse gas emission reduction, other agencies have used different values. For example, the Portland Bureau of monetized this reduction in carbon emissions due to cooling and heat savings in buildings with Ecoroofs (EPA, 2013).

2.2.4 Ecosystem Service Benefits

Green infrastructure such as green roofs, bio-swales and trees can also provide a number of additional environmental and ecosystem services. These include entrainment of air particulates, carbon sequestration and habitat creation. Each of these benefit categories is directly related to the plant material that is installed as part of the green infrastructure system. Accrual of benefits depends on a variety of design and site conditions though research is available to quantify some of the physical performance measures of green infrastructure. Estimation of economic benefits at a new site would in most cases require new research at that site since limited information has been broadly developed.

Air Particle Entrainment: Some green infrastructure systems have the ability to uptake pollutants directly from the environment, which reduces adverse human health impacts. The criteria air contaminant pollutants that can be entrained include nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2) and particulate matter classifies as PM10.[12] Key drivers of these benefits include the amount (in square

[11] Many economic values originally come from regulatory rule-making in which an economic analysis is reviewed and ultimately accepted by the Office of Management and Budget before the rule becomes a law.

[12] The Charlotte-Mecklenburg Storm Water Services, serving an area of 526 square miles, included these entrainment benefits when analyzing their reforestation in their LID/GI approach, as it is relatively inexpensive but offers large benefits in terms of air quality and storm water management, the county has simply committed to making reforestation a priority (EPA, 2103)

footage, or number of trees) of green infrastructure, as well as the current levels of criteria pollutants, and size of the local population, especially those whose health is more vulnerable to environmental conditions. The quantified amount of pollutants entrained can be monetized using the same economic values per ton that are applied in the air pollution emission reduction calculations.

Carbon Sequestration: Carbon sequestration is the process of storing carbon in biomass and soils as atmospheric carbon dioxide is taken up by trees, grasses, and other plants through photosynthesis. The amount that can be sequestered is dependent on the above ground biomass of the tree, green roof or bio-swale. Sequestration benefits only last as long as the plants or trees are alive and that they vary with the age of the vegetation. Carbon sequestration rates depend on the type of species and location where it is grown (Pepper, 2012). Carbon sequestration in green roofs can have high variability due to roof age and substrate depth.[13] Other factors that affect carbon sequestration in green roofs are geographic region, plant species and roof management or maintenance (Getter, K. L. et al., 2009; Wise, S. et al., 2010; City of Portland BES, 2010; CNT, 2010). In addition, healthy and large trees can store about 1000 times more carbon than smaller trees and if those trees have a long lifespan they also tend to be the biggest contributor to carbon removal (Nowak, D. J. & Crane, D. E., 2001; Escobedo, et. al. 2012; McPherson, E. G. et al., 2007; CNT, 2010). The value of carbon sequestration is estimated with the same benefit parameters as with greenhouse gas emissions.

Habitat Related Benefits: Green roofs, rain gardens and other vegetated infiltration systems can improve the habitat for flora and fauna, such as bird and insect species. These different types of habitats are usually small in size and have limited impacts. But, it is conceivable that greater benefits may arise from large-scale strategies that are connected to habitat corridors. Limited research is available to directly assess the economic value of habitat creation. As a first step, a biological survey would be required to assess current conditions and to evaluate potential changes in flora and fauna habitat and other ecosystem services. Valuation of these changes though would remain difficult because of a lack of economic research on the benefits of small scale habitats. Potential proxy values may be drawn from wetland valuation research for some types of green infrastructure, but developing accurate estimates would be highly uncertain. Still, in some studies such as the benefit cost analysis in Ann Arbor, the value of habitat creation is estimated (ECONorthwest, 2011).

[13] One study indicated that three roofs with similar substrate depth had increased carbon with age of the roof and vegetation. Data from another study showed green roofs stored, on average, between 60 to 240 grams of carbon per square meter in the aboveground plant and between 30 and 185 g C·m-2 in belowground biomass.

2.2.5 Community Livability Benefits

A series of quantifiable and qualitative benefits also enhance the quality of life across a community. Emerging research on these benefits stems in part from the ways in which *social capital* forms and grows in a community. For example, the Portland Bureau of Environmental Services writes “social capital is the benefits that individuals and communities derive from having social contacts and networks throughout their communities and is based on the notion that individuals who interact with each other will support each other to the benefit of the entire community” (Portland BES, 2010). Green infrastructure, and especially ones that encourage use of the outdoors, can help induce interactions and connections across the community. This includes the personal value of health and recreation, as well as an improvement in the level of investment in business district.

Reduced Health Effects - Heat Island Related Impacts: The term "heat island" describes a landscape characteristic in which cities tend to be hotter than nearby rural areas.[14] These hotter temperatures come from the radiant heat off of impervious surfaces and buildings, and a lack of plant material to produce evapotranspiration that cools the air (EPA, 2008; Grimmond, C. et al., 2010; Wise, S. et al., 2010; Burden, D., 2006; City of Portland Bureau of Environmental Services, 2010; Grimmond, C. et al., 2010; and Stratus Consulting Inc., 2009). Across a city, higher temperatures can lead to adverse health effects on people (e.g. respiratory difficulties, exhaustion, heat stroke and heat-related mortality), particularly older and more vulnerable populations.[15] Green infrastructure can reduce temperatures and lead to lower health effects if implemented widely across a city. Urban trees, for example, emit low volatile organic compounds (VOC), and reduce air temperatures through transpiration. Research has shown that trees can reduce local temperatures up to 8.7°F compared to impervious surfaces. In Chicago, a study showed substantial differences in roof surface temperatures between green and conventional coverings. The effect of green infrastructure on mitigating heat island effects depends on wide scale implementation (Stratus, 2009). Data on the demographics of an area also influence related benefits because certain age cohorts are more susceptible to heat related illnesses than others.

Aesthetic Improvements: Some strategies improve the overall visual appearance of a community simply by having planted material among impervious surfaces. In addition, some BMPs strategies aim to directly reduce litter or debris from public spaces to make it more visually appealing. These aesthetic improvements are difficult to estimate directly but can be observed in differences in the prices on properties which are in the vicinity of aesthetically attractive areas. To estimate benefits of these improvements, property value studies are conducted to isolate

[14] http://www.epa.gov/heatisland/index.htm

[15] The heat island mitigation to lowering emission levels of air pollutants and greenhouse gases through the reduced energy demand (via greater air conditioning needs) and lower demand for outdoor irrigation needs. These effects, if they can be quantified, are discussed above.

only a small portion of price differences that relate to being near the green infrastructure installation. A number of researchers have evaluated such property value differences and used them in BCAs. For example, the Alachua County Environmental Protection Department and Public Works Department (in Florida) examined the changed in property values due to the county's green infrastructure programs and found that the increase in land values for properties adjacent to some measures (EPA, 2103). The application of findings from one site to another is not always straightforward and depends on site specific conditions.

Recreational Benefits: In addition to providing a pleasant visual experience, certain green infrastructure can provide recreational benefits as well. Philadelphia estimated the number of persons who would use (i.e. walk or bike on) a vegetated acre, as part of their triple bottom line analysis of the Combined Sewer Overflow Long Term Control Plan Update (PWD, 2009). The residents of Alachua County in Florida noted that recreational benefits that stem from green infrastructure were a top priority for the impacts of development. Their concerns for these issues have driven the county's pursuit of GI programs (EPA, 2013). For the Blackberry Creek Watershed Alternative Study, open spaces and natural greenways to preserve and connect significant natural features for valued for aesthetic, recreational, and/or alternative transportation uses (EPA, 2013). Valuation of recreational features stems from economic research on the time and money spent to reach a recreational area.

Noise Reduction: Some green infrastructure systems, such as wetlands or trees, are effective in reducing ambient noise because they can absorb it. CNT (2010) discusses the noise-reducing properties of GI for porous concrete and green roofs, but does not provide a methodology for quantifying these benefits. A case study in Lancaster County, PA notes that positive effects of green infrastructure can arise from noise pollution reduction (EPA, 2014).

Crime Reduction: Researchers from the University of Illinois asked the question "Does Vegetation Reduce Crime?" and came to the conclusion that the greener a buildings surroundings were, the fewer crimes reported (Kuo and Sullivan, 2001). This study examined crime activity levels around apartment buildings in Chicago, and measured differences in the amount of trees and grass cover between sites. Vegetation may deter crime both by increasing informal surveillance and by mitigating some of the psychological precursors to violence. While these are just theories and have not been comprehensively examined, what this research shows is that vegetation does not necessarily facilitate crime by providing cover – a long-held belief among some planners. Instead, a green environment encourages outdoor use, and as such, provides a deterrent because more people are in places where crimes can be committed. The benefits of crime reduction would be derived through data per crime on the avoided costs for the judicial system.

Public Education/Environmental Stewardship. Promoting strategies that seek to change people's behaviors and make them more aware of their environmental impacts helps to cultivate a stewardship perspective in the community about its local natural resources. CNT (2010) notes that community tree planting provides a valuable educational opportunity for residents since in this process they become more aware of the benefits of green infrastructure. Research on urban tree planting has shown that such environmental initiatives make environmentally sound behaviors more likely to occur in the future. Other strategies involving public education and advertising has appeared to be less effective in changing attitudes (Kuo and Sullivan, 2001; and Summitt and Sommer, 1997). The economic valuation of such changes though has not been sufficiently studied for it to be included in a BCA. In this case, only a qualitative assessment of changes in stewardship could be included in a decision framework.

Business Development: Green infrastructure, especially on the scale of a comprehensive green street design can lead to an enhanced sense of place, and increase in foot and bicycle traffic can support retail development. The NRDC found that consumers are willing to spend more on products, visit more frequently, or travel farther to shop in areas with attractive landscaping, good tree cover, or green streets (NRDC, 2013). Case studies by the New York City DOT examined before and after changes in Retail Sales Tax Filings, Commercial Leases & Rents, and City−Assessed Market Value. While the study's methodology does not ultimately prove causality between the street improvement projects and any resulting economic changes, some locations of green street development saw a significant increase in retail sales compared to the changes in retail sales for the borough as a whole.

Job Creation and Economic Impacts: Spending on capital investments and operations and maintenance (O&M) leads to job creation. Moreover, since installation and maintenance of most of these systems requires unskilled labor, the economic benefits of job creation often goes directly to those who may be in most need of work. The total economic impact of capital and O&M expenditures is measured in terms of the number of jobs created, change in income, gross regional product, and sales and property tax revenue. In addition, wider impacts across the region can also be estimated by applying appropriate economic *multipliers*. As an example, PWD (2009) focused on the fact that many of these jobs are for unskilled labor, which provides a valuable social benefit in an urban setting.

2.3 What Evidence Of Benefits Have Been Found Elsewhere?

Economic benefits of storm water management depend on site conditions and characteristics of the green infrastructure systems and program. While CNT (2010) establishes a number of methods for computing benefits, for each set of calculations it is necessary to collect (or establish assumptions) site specific data about BMPs performance and establish analytical standards for the suitability of economic valuation parameters. Despite these constraints and uncertainties, some agencies have pushed forward in collecting data and using these methods. The most recent review of economic evaluations of green infrastructure is found in EPA (2013). This document has developed a fairly comprehensive assessment of the efforts by some utilities to evaluate economic benefits of storm water management. Table 3 presents an excerpt from the EPA (2013) report and indicates that some of case studies performed BCAs, as opposed to other analytical approaches such as cost-effectiveness.

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Table 3: Excerpt of EPA Case Studies on Economic Evaluation of Storm water Management BMPs

Entity	LID/GI program description	Type of analysis	Outcome of analysis
Lenexa Public Works Department, KS	Adoption of LID/GI-oriented development standards, BMPs, and systems development fees as part of the Rain to Recreation program.	Capital cost assessment	Savings of tens to hundreds of thousands of dollars in site work and infrastructure costs with GI BMPs.
Charlotte-Mecklenburg Storm Water Services, NC	Restoration of streams damaged by runoff from development, and BMPs to reduce impacts of rapid development, were assessed to determine impacts on drinking water quality.	Cost-effectiveness	Analysis showed that stream restoration is the most cost-effective way to immediately control sediment in this area.
Capitol Region Watershed District (CRWD), MN	Eighteen BMPs in a 298-acre watershed designed to reduce localized flooding and storm water runoff, improve water quality, enhance recreation in local park.	•Capital cost assessment •Cost-effectiveness	Initial capital cost assessment found substantial cost savings with GI compared with grey infrastructure.
New York City Mayor's Office of Long-term Planning and Sustainability, NY	Distributed GI controls to reduce storm water runoff and CSOs, improve water quality, and increase public access to tributaries, compared to conventional CSO controls such as tunnels and basin storage.	Cost-effectiveness	Cost savings with GI compared to grey infrastructure
Seattle Public Utilities (SPU), WA	Natural drainage system (NDS) projects on residential streets; LID/GI-based storm water regulations and Residential Rainwise Program to encourage customers to reduce the volume of storm water sent to the public system.	Cost-effectiveness	By integrating LID/GI into asset management process, SPU can minimize life-cycle costs to meet established levels of service and balance the risks to minimize life-cycle costs.
West Union, IA	Pilot community for Iowa Sustainable Green Streets Initiative to replace aging infrastructure and reduce localized flooding in downtown area.	•Life-cycle cost analysis •Benefit valuation (avoided costs)	Lower maintenance and repair costs for deicing permeable pavement result in projected savings over the life-span of the pavement.
Kirkland Public Works Department, WA	Integration of LID/GI into conceptual design phase of all capital improvement projects within public rights-of-way.	Quantitative ranking of costs, benefits	LID/GI options for CIP projects are investigated as early in the planning phase as possible.
Kane County, IL	Adoption of county storm water ordinance and corresponding LID/GI-based BMPs, including development approaches that preserve natural areas and use naturalized drainage/retention/detention (i.e., conservation-based development).	Fiscal impact analysis	Study found that conservation development alternative incurs a lower public cost than the conventional alternative.

Table 3: Excerpt of EPA Case Studies on Economic Evaluation of Storm water Management BMPs (Continued)

Entity	LID/GI program description	Type of analysis	Outcome of analysis
Milwaukee Metropolitan Sewerage District (MMSD), WI	Integration of distributed LID/GI strategies into overall planning efforts including facilities plans and CSO control plan; projects on both public and private lands.	•Cost effectiveness •Benefit valuation	Results will be used to help select which projects to implement in the future, and to show where the use of GI is a valid and effective approach
Alachua County Environmental Protection and Public Works Departments, FL	County acquires and preserves open-space lands through ACF program to reduce development impacts and improve water quality.	Benefit-cost analysis (BCA)	Proximity to open space adds to parcel value, for an increase in property tax revenue of several million dollars per year.
Portland Bureau of Environmental Services (BES), OR	Ecoroof Program includes incentives for green roofs on privately owned buildings and green roof requirements for new city-owned buildings.	BCA analysis	Ecoroofs generate significant public and environmental benefits, as well as benefits to developers and building owners (due to extended life of ecoroofs compared to traditional roofs).
Sun Valley Watershed, LACDPW, CA	Goal of watershed-based project was to alleviate localized flooding while providing multiple benefits. Fifteen project elements with LID/GI components.	BCA analysis	Demonstrated potential for multi-objective storm water strategies to provide greater community value than a single-objective flood control strategy would provide.
PWD, PA	Green City Clean Waters Program aims to reduce CSOs and improve water quality in part through distributed GI controls and comprehensive stream restoration program.	BCA analysis	LID/GI-based approaches provide important environmental and social benefits that are generally not provided by grey infrastructure.

A summary of several case studies is presented below. These studies integrated local data with some aspects of the CNT (2010) framework to estimate quantifiable benefits.

Economic Benefits of Green Infrastructure in Milwaukee, WI and Ann Arbor, MI: ECONorthwest (2011), evaluated benefit analyses of storm water management efforts in Milwaukee, WI and Ann Arbor, MI. In *Milwaukee,* the Department of Public Works - Infrastructure Division, manages infrastructure consisting of about 300 miles of sewer pipes, 3,000 miles of municipal pipes, and 3,000 miles of private laterals. A primary focus is to reduce the quantity of total suspended solids entering its waterways by 40 percent by 2013, as required by the Wisconsin Department of Natural Resources (City of Milwaukee, 2011). The Systems Planning Unit in Ann Arbor has a much smaller management responsibility and consists of just 359 miles of underground pipes and over 11,000 inlets and catch basins to manage storm water (City of Ann Arbor, 2011). In both communities, monetizable, quantifiable and qualitative benefits are evaluated (see Table 4) using the methodology established by CNT (2010). Where appropriate and possible, local data was integrated into calculations to estimate benefits. A number of additional assumptions are made to illustrate the scale of benefits that could arise from a much larger future program.

Table 4: Benefits Evaluated in Great Lakes Study

Quantified and Monetized	Quantified, but not Monetized	Qualitative
Avoided costs of reduced storm water runoff and water quality	Flood Reduction	Public Education
Avoided costs related to water quality benefits	Heat Island Effect	
Avoided costs of additional future gray infrastructure capacity	Aesthetics	
Avoided costs of treatment operations and maintenance for combined sewer flows	Improved health and well-being from recreation	
Energy Cost Savings Benefits	Improving well-being by reducing noise pollution	
Decreased air pollution emissions from reduced energy use		
Improved air quality from vegetation on green roofs and trees		
Reduced CO2 equivalent emissions from reduced energy use		
Increased carbon sequestration from trees and green roofs		
Wetland habitat protection		

Economic Benefits of Green Infrastructure in Lancaster, PA: With a population of 60,000, the city has a combined sewer system (CSS) and needed to address burden on the treatment facility when intense precipitation events occurred. The EPA notes that combined sewer overflows (CSOs) discharge approximately 750 million gallons of untreated wastewater and storm water into the Conestoga River (EPA, 2014). To address this issue, Lancaster County published a Green Infrastructure plan which estimated water quality benefits, but not the additional environmental, social, and economic benefits. The EPA published this case study to highlight and bring awareness to quantify and highlight these benefits. The specific benefits they monetized were energy, air quality, and climate-related benefits. They also estimated the avoided capital costs of gray infrastructure, and the avoided wastewater pumping and treatment costs. The methodology used in quantifying and monetizing the benefits followed CNT (2010). They also made several high-level assumptions with regard to long-term reduction, the future distribution of green infrastructure projects, and when the monetary benefits would begin accruing.

Philadelphia Combined Sewer Overflow Long Term Control Plan Update: The purpose of the City's report was to demonstrate the full range of societal benefits of the Green City Clean Waters Program. The program aims to reduce CSOs and improve water quality in part through distributed GI controls and comprehensive stream restoration program. The analysis helped PWD to determine that a GI-based approach, coupled with targeted grey infrastructure, is their preferred approach for city to follow. A table of the monetized benefits over 40 years is presented below. It is assumed that these benefits arise from a 50% level of LID coverage throughout the city.

Table 5: City-wide present value benefits of key CSO options: Cumulative through 2049 (2009 Dollars)

Benefit categories	Value
Increased recreational opportunities	$524.50
Improved aesthetics/property value (50%)	$574.70
Reduction in heat stress mortality	$1,057.60
Water quality/aquatic habitat enhancement	$336.40
Wetland services	$1.60
Social costs avoided by green collar jobs	$124.90
Air quality improvements from trees	$131.00
Energy savings/usage	$33.70
Reduced (increased) damage from SO2 and NOx emissions	$46.30
Reduced (increased) damage from CO2 emissions	$21.20
Disruption costs from construction and maintenance	($5.60)
Total	$2,846.40

Alachua County Environmental Protection and Public Works Departments, FL: The county developed a comprehensive low impact development (LID) / green infrastructure (GI) program based on three different components: (1) LID/GI-based land development policies and regulations developed through the county's Comprehensive Plan; (2) Alachua County Forever (ACF), a conservation and land acquisition program; and (3) a unique governance structure designed to increase interdepartmental collaboration to promote the adoption of LID/GI program elements. To demonstrate the benefits of ACF and alleviate public concerns that the program reduces property tax revenue, the county calculated the benefits for the increase in property values from increased open space. This measure was used to compare with any lost tax revenue to acquire, protect, and manage environmentally significant lands in order to protect water resources, wildlife habitat, and natural areas suitable for resource-based recreation. Twelve thousand seven hundred parcels in the county are close enough to open space to show an increase in value due to their proximity to water. The total impact on their value is just under $150 million, which would result in additional property tax revenues of approximately $3.5 million per year.

Portland Bureau of Environmental Services, OR. The Portland BES performed an analysis of ecoroofs versus conventional roofs to gain support and increase implementation of ecoroofs in the city. Portland receives an average of 37 inches of precipitation per year, which creates an annual volume of storm water runoff of about 10 billion gallons. As part of its storm water management programs, BES has implemented the Sustainable Storm water Management Program, which focuses on green infrastructure initiatives, including the Ecoroof Program.

Table 6: Value of Benefits from 40,000 SQFT Ecoroof (2008 Dollars)

Benefit categories	Total Over 40 Years
Cooling demand reduction	$19,983
Heating demand reduction	$23,509
Carbon reduction	$845
Improved air quality	$104,576
Habitat creation	$25,300
Total	$174,213

Sun Valley Watershed, Los Angeles, California: The Sun Valley watershed is in the San Fernando Valley, about 14 miles northwest of downtown Los Angeles. It encompasses the communities of Sun Valley and North Hollywood. The watershed is approximately 4.4 square miles and six miles in length from north to south.

The economic analysis was undertaken because the county and other stakeholders needed to show that although the costs of the LID/GI-oriented solutions would be much greater than the cost of traditional infrastructure, and they would yield significantly higher benefits. The results of the analysis were used to help to gain public support, bring in outside partners, and raise funds. The tables below show the descriptions of each alternative the value of alternatives compared to a grey infrastructure scenario.

Table 7: Description of Alternatives for Sun Valley Watershed

	1 - Infiltration	2 - Water Conservation	3 - Storm water Reuse	4 - Urban Storm Protection
Description	Widely Distributed Small Projects	Maximizes Wildlife Habitat	Maximizes Storm water Reuse for Industry	Full Conveyance with Regional BMPs
Retention Basin Size	50-Year	50-Year: Subareas 1-6 10-Year: Subareas 7-8	50-Year	10-Year

Table 8: Values by benefit over 50 years (2002 Dollars)

Benefit	Grey Infrastructure	1	2	3	4
County Flood Control					
Regional damage avoidance	$64.46	$64.46	$64.46	$64.46	$64.46
Change in downstream flooding	-$1.03	$5.37	$3.65	$5.37	$3.22
City Flood Control	$10.01	$10.01	$10.01	$10.01	$10.01
Avoided cost of imported water	$0.00	$22.35	$17.89	$24.07	$22.65
Energy Reduction	$0.00	$4.30	$1.70	$4.30	$1.70
Air Quality	$0.00	$20.50	$8.10	$20.50	$8.10
Greenwaste	$0.00	$20.00	$10.00	$20.00	$10.00
Ecosystem Restoration	$0.00	$1.86	$4.04	$4.58	$4.48
Recreation	$0.00	$23.34	$23.34	$23.34	$23.34
Property Values	$0.00	$10.20	$3.90	$10.20	$3.90
Total Benefits	**$73.44**	**$270.47**	**$295.39**	**$274.93**	**$239.95**

3 Summary of Water Quality Improvement Strategies

3.1 Program Background

The Division has been working for several years with other jurisdictions and community groups to establish Water Quality Improvement Plans (WQIPs) for each of its watersheds. WQIPs draw from the processes in developing Watershed Asset Management Plans (WAMPs) and Comprehensive Load Reduction Plans (CLRPs) which aim to protect, preserve, enhance, and restore water quality in receiving waters. WAMPs provide an understanding of critical assets owned by the Division and the management and investment strategies necessary to deliver required services. CLRPs are efforts to identify BMPs and funding levels needed to comply with TMDL and other storm water regulations established by the Regional Water Quality Control Board. These efforts, as described below, have identified a series of projects and initiatives that have been defined as either structural or nonstructural initiatives.

3.2 Structural WQIP Strategies

3.2.1 Types of Strategies

Structural BMPs are physical infrastructures that are designed for site-specific conditions and placed strategically across a watershed to improve water quality. The effectiveness and feasibility of implementing any of these BMPs varies depending on the design and site conditions. For example, the effectiveness of a BMP in enhanced infiltration capacity of a watershed depends on amenable soil types. Other site-specific considerations include the physical land area available for effective implementation and maintenance. Also, the capital and maintenance costs of a BMP influence its feasibility for the Division, especially in comparison to other BMPs which can be implemented more cost-effectively.

Various types of structural strategies have been identified as potentially suitable for San Diego watersheds and have been classified as one of three types: (1) green infrastructure, (2) multiuse treatment areas, and (3) water quality improvement BMPs.[16] Each of these types of structural BMPs is discussed below.

Green Infrastructure

Green infrastructure covers a range of BMPs that are designed to be integrated in a broader site plan to maintain healthy waters, provide multiple environmental benefits, and support sustainable communities. Green infrastructure is distinguished from other methods by making deliberate and effective use of vegetation and soil to manage storm water (USEPA, 2014). Table 9 presents a series of green infrastructure BMPs that can be integrated into site designs and implemented at the site scale (on-site treatment) or street right-of-way scale (green streets).

[16] San Dieguito Potential Strategies Final Draft 4/11/14

Table 9: List of Structural BMPs – Green Infrastructure

BMP*	BMP Description
Bioretention	Shallow vegetated features constructed in green spaces alongside roads, sidewalks, and other paved surfaces. Bioretention includes an engineered soil media designed to encourage pollutant treatment and water storage.
Infiltration Trenches	Narrow, linear BMPs that have similar functions as bioretention areas with variable surface materials, including rock or decorative stone, designed to allow storm water to infiltrate into subsurface soils.
Bioswales	Shallow, open channels designed to reduce runoff volume through infiltration and pollutant removal by filtering water through vegetation within the channel and infiltration into bioretention soil media. Bioswales can serve as storm water conveyance, but the primary objective is water quality enhancement (often referred to as linear bioretention).
Planter Box	Fully contained system containing soil media and vegetation that functions similarly to a small biofiltration BMP, but includes an impermeable liner and underdrain.
Constructed Wetland	Engineered, shallow marsh systems designed to control and treat storm water runoff. Particle-bound pollutants are removed through settling and other pollutants are removed through biogeochemical activity.
Permeable Pavement	Allows streets, parking lots, sidewalks, and other impervious covers to retain their natural infiltration capacity while maintaining the structural and functional features of the materials they replace. Roads such as highways can include PFC overlays which provide water quality benefits when traditional permeable pavement is not suitable.
Sand Filters	Treatment systems that removes particulates and solids from storm water runoff by facilitating physical filtration.
Vegetated Swales	Shallow, open channels that are designed primarily for storm water conveyance. Pollutants such as trash and debris are removed by physically straining/filtering water through vegetation in the channel.
Vegetated Filter Strips	Bands of dense, permanent vegetation with a uniform slope, designed to provide pretreatment of runoff generated from impervious areas before flowing into another BMP as part of a treatment train.
Green Roofs	Roofing systems that layer a soil/vegetative cover over a waterproofing membrane and can reduce runoff through interception and evapotranspiration.

*Source: San Dieguito River WMA Water Quality Improvement Plan (2014)

Table 10 outlines the expected levels of effectiveness in green infrastructure in handling different types of impacts of storm water, including water chemistry and physical and biological impacts. This chart is adapted from the San Dieguito River WMA Water Quality Improvement Plan (2014) provides an initial indication of the kinds of benefits (beyond water quality improvements) that can be achieved by green infrastructure BMPs. In particular, while trash removal is a water chemistry benefit, its removal from streets can lead to more aesthetically pleasing neighborhoods, which in turn can foster economic value. In addition, depending on the extent to which these BMPs improve physical and biological factors, there can be follow-on improvements in recreational value and ecosystem value of streams and riparian areas. It is noted here that only constructed wetlands have the potential to generate tangible improvements in habitat or wildlife.

Table 10: Green Infrastructure BMPs and Pollutant Reduction BMP

	Water Chemistry Benefit									Physical and Biological Benefits			
	Bacteria[1]	Metals	Organics	Sediment	Pesticides	Nutrients	Oil and grease	Dissolved minerals	Trash	Flow rate	Volume reduction	Habitat or Wildlife	Aquatic Life
Bioretention	●	●	●	●	●	◗	●	◗	●	●	●	○	◗
Infiltration Trenches	●	●	●	●	●	●	●	●	●	●	●	○	●
Bioswales	●	●	●	●	●	◗	●	◗	●	●	●	○	◗
Planter Boxes	●	●	●	●	●	◗	●	◗	●	◗	◗	○	◗
Permeable Pavement	◗	●	◗	●	●	◗	◗	◗	◗	●	●	○	◗
Constructed Wetlands	●	●	◗	●	●	●	◗	◗	●	●	◗	●	◗
Sand Filters	●	●	●	●	●	◗	●	○	●	◗	◗	○	◗
Vegetated Swales	◗	◗	◗	●	◗	◗	◗	○	●	◗	◗	○	◗
Vegetated Filter Strips	◗	◗	◗	●	◗	◗	◗	○	●	◗	◗	○	◗
Green Roofs	◗	◗	○	●	○	○	○	○	○	●	◗	○	◗

Key: ● - Primary pollutant reduction; ◗ - Secondary pollutant reduction; ○ - Minimal or no pollutant reduction.

Multiuse Treatment Areas

San Dieguito River WMA WQIP (2014) identifies large-scale treatment areas such as multiuse basins and stream, channel, and habitat rehabilitation projects. These systems are designed as regional facilities that can receive flows from neighborhoods or larger areas and become cost-effective solutions that provide multiple benefits. For example, such systems can be integrated in public spaces such as active (soccer fields) and passive (parks) recreation areas and provide benefits in flood control, ground water recharge, restoration, habitat enhancement, and recreation. In addition streambank projects that reduce erosion can improve water quality and simultaneously improve habitat. Table 11 defines the list of measures considered in San Dieguito River WMA WQIP (2014).

Table 11: List of Structural BMPs – Multiuse Treatment Areas

BMP*	BMP Description
Infiltration and Detention Basins	Large multiuse surface BMPs (on public parcels) that provide treatment through the runoff detention and infiltration (e.g. infiltration basins and dry extended detention basins). These BMPs are designed to hold runoff for an extended period of time to allow water to evaporate into the atmosphere, infiltrate into native soils, or be transpired by vegetation, while accommodating for overflow and bypass during large storm events.
Stream, Channel, and Habitat Rehabilitation Projects	Stream, channel, and habitat restoration or enhancement projects can help sustain habitat for wildlife and provide water quality benefits downstream of these activities.
Other Opportunities	Construction of multiuse treatment areas BMPs on private land to achieve the load reductions. These BMPs are the cost effective and considered a low priority.

Water Quality Improvement BMPs

Additional structural BMPs include systems that supplement the design performance of existing infrastructure. For example, systems that segregate trash includes inlet devices, such as trash guards or racks that capture debris before they enter surface waters. Another example are proprietary commercial products that often aim to use settling, filtration, absorptive/adsorptive materials, vortex separation, and sometimes vegetative components to remove pollutants from runoff. Finally, dry weather flow separation and treatment projects target non-storm water dry season flows and divert these flows for treatment either on-site or to sanitary sewer systems and ultimately waste water treatment plants.

3.2.2 Measuring Impacts of Structural Strategies

The benefits of structural systems - both the type of benefit and the magnitude – depend on the system's design and surrounding site characteristics. Some strategies such as constructed wetlands can generate a range of benefits (which are partially indicated by Table 10) and may also include recreational and aesthetic values. Most of these benefits accrue to the general public who may have access or benefit from proximity to the wetland. Green roofs, on the other hand, create both public benefits in water retention as well as potential private benefits for property owners in terms of energy savings, from additional roof insulation.

The effectiveness of each structural system in generating benefits is determined directly from key physical features associated with its design. That is, each system benefit, whether it includes flood risk reduction, air quality improvement, or aesthetics, depends on a characteristic of the system that is measured in physical units. For example, flood risk reduction benefits depend fundamentally on the quantity of water retained by the BMP – that benefit's *unit of measure*.

The unit of measure of green streets (Figure 1) would certainly include the designs of various BMPs on the street such as bio-swales, permeable pavement and tree plantings. In aggregate however, a standard green street design would be measured by its length in miles. In addition, the features and length of the green street may also influence the value of properties on either side of it. Site specific characteristics associated with the type of neighborhood (e.g. mixed use, residential, commercial, etc.), population / employment density, socio-economic characteristics (e.g. income, household size), safety conditions and other factors could influence different types of benefits.

Figure 1: Illustration of Sample Structural BMP: Green Streets

Bioswales: can reduce runoff and downstream flood potential and create aesthetically appealing environment

Permeable Pavement: can reduce runoff and downstream flood potential

Tree Plantings: can reduce runoff and downstream flood potential, entrain harmful particulates, create aesthetically appealing environments, lower ambient temperatures

3.3 Nonstructural Strategies

3.3.1 Types of Strategies

The Division and its stakeholders have also identified nonstructural strategies that may achieve water quality improvements. Nonstructural strategies include "those actions and activities intended to reduce storm water pollution, which do not involve construction of a physical component or structure to filter and treat storm water." These strategies include administrative policies, creation and enforcement of municipal ordinances, education and outreach programs, rebate and other incentive programs, and cooperation and collaboration with other watershed or regional partners. In general, many of these initiatives have been implemented by the Division for many years and are considered to be integral to regulatory compliance on a watershed-specific basis.

WQIP documents have organized Nonstructural Strategies into a number of categories (see Table 12). These categories include: Development Planning, Construction Management, Existing Development, Illicit Discharge, Detection, and Elimination (IDDE) Program, Public Education and Participation, Enforcement Response Plan, and Non-JRMP Strategies. Across the watersheds and jurisdictions, a long list of potential nonstructural strategies in each category has been developed – reflecting the differing site characteristics in different locations. A comprehensive list of specific strategies across all of the watersheds is included in Appendix 2.

Table 12: Nonstructural Strategies

Strategy Category	Strategy Description
Development Planning	Program uses Responsible Agencies' land use and planning authority to require implementation of best management practices (BMPs) to address effects from new development and redevelopment.
Construction Management	Program addresses pollutant generation from construction activities associated with new development or redevelopment.
Existing Development	Program addresses pollutant generation from existing development including commercial, industrial, municipal, and residential land uses. It includes stream, channel, and habitat restoration and retrofitting in areas of existing development.
Illicit Discharge, Detection, and Elimination (IDDE) Program	Program actively detects and eliminates illicit discharges and improper disposal of wastes into the MS4.
Public Education and Participation	Promotes and encourages the development of programs, management practices, and behaviors that reduce the discharge of pollutants in storm water to the maximum extent practicable (MEP), prevent controllable non-storm water discharges from entering the MS4, and protect water quality standards in receiving waters.
Enforcement Response Plan	Enforcement of each JRMP is required.
Non-JRMP Strategies	Strategies that are outside of the JRMPs, but are designed to effectively prohibit non-storm water discharges to the MS4, protect the beneficial uses of receiving waters from MS4 discharges, or achieve the interim and final numeric goals identified in the Water Quality Improvement Plan.

3.3.2 Measuring Impacts of Nonstructural Strategies

The economics perspective on nonstructural strategies is manifested in the change that they create, which in turn causes a change in value for the community. In particular, the impact of some nonstructural strategies that are directly related to structural systems, such as new design standards for BMPs, generates value when the design standard is used to improve BMP performance. The value of this nonstructural strategy is captured through the value of the structural systems that are implemented. Other nonstructural strategies directly generate value that is separate from a structural BMP. For example, an educational campaign that aims to reduce litter would directly target people's behavior and its effectiveness would be determined by how many people's behavior is changed. The value of this change would be captured by benefit categories associated with improved community livability and business development.

To reflect these differences in nonstructural strategies, we have developed several categories to differentiate them in terms of how they generate value. These categories include strategies that: (a) Increase # of structural systems; (b) Improve structural systems performance; (c) Initiatives to change behavior; and (d) Initiatives to reduce pollutants directly. The revised grouping of specific nonstructural strategies is briefly described in Table 13.

Table 13: Nonstructural Categories by Type of Impact and Identified Strategies

Changing Behavior to reduce pollutants at the source
Implement pet waste program
Identify and reduce incidents of power washing discharges from nonresidential sites.
Require BMPs to address pesticides, herbicides, and fertilizers issues
Implement Illicit Discharge, Detection, and Elimination (IDDE) Program
Implement a public education and participation program
Enhance education and outreach
Technical education and outreach on the MS4 Permit and WQIP
Implement escalating enforcement responses to compel compliance
Continue participating in source reduction initiatives.
Improve / Maintain BMPs or LIDs
Update BMP Design Manual procedures
Administer an alternative compliance program
Oversee implementation of BMPs during the construction
Require implementation of minimum BMPs for existing development
Gather monitoring information about priority conditions or beneficial uses
Collaborate with entities potentially including, but not limited to:
Increasing # of BMPs or LIDs
For all development projects, ensure source control BMPs
Amend municipal code to encourage LID
Train staff on LID regulatory changes and LID Design Manual.
For PDPs, require implementation of on-site structural BMPs or LIDs
Promote and encourage implementing designated BMPs at residential areas.
Develop pilot project to identify and carry out site disconnections in targeted areas.
Promote and encourage implementation of designated BMPs in nonresidential areas.
Monitor for erosion, and slope stabilization on municipal property.
Identify sites for pilot study to test Permeable Friction Course (PFC)
Identify candidate areas for retrofitting projects
Identify areas for stream, channel, or habitat rehabilitation projects
Enforcement of actionable erosion and slope stabilization issues
Conduct a feasibility study on urban tree canopy (UTC) program
Removing pollutants or sources directly
Implement operation and maintenance activities
Implement controls to prevent infiltration of sewage into the MS4
Implement operation and maintenance activities for public streets
Require sweeping and maintenance of private roads and parking lots in targeted areas.
Develop a program to address and capture trash and debris.
Sanitation and trash management for persons experiencing homelessness.
Protect areas that are functioning naturally.

As mentioned above, the first two of these nonstructural categories relates directly to structural systems themselves. In this case, whether the change in BMP adoption is due to training in the community or general promotion of BMP adoption, the success of these strategies would be determined directly by how many additional BMPs are installed and then by the various benefits generated by their installation. Similarly, new design standards and performance monitoring would be measured by the improvement in the performance of installed structural systems.

On the other hand, nonstructural strategies can generate water quality and other benefits on their own. For example, some of these strategies entail education, enforcement and outreach activities which attempt to alter behavior that leads to water quality pollution. These strategies may at the same time lead to an overall aesthetically better environment with less litter on the street. In addition, programs to promote rain barrels and other water harvesting systems on private property can generate benefits to the property owner and the general public. Measured in terms of their water holding capacity, these systems have the potential to offset water demand for irrigation purposes which has the dual effect of reducing water costs for the owner and water treatment demand from the utility. Lower water demand would reduce energy demanded and associated pollutants.

Figure 2: Illustration of Nonstructural BMP: Water Harvesting

Each of these types of strategies will be discussed in greater detail relative to the benefits that they can generate in the next chapter.

4 Accounting for Benefits of BMP Strategies in San Diego

Discussions above on the economic benefits of storm water management and the varied types of structural and nonstructural BMPs strategies under consideration by that the Division sets up the potential to evaluate strategies with an economic framework. The challenge in performing an economic analysis is that some benefits may not be quantifiable, let alone monetizable. In that case, the Division faces some options in how to account for benefits that are perceived to be relevant in decision making. This section begins with an outline of the types of benefits which could be applicable to different categories of strategies and then closes with a discussion on the options for analytically accounting for benefits with different levels of information.

4.1 Evaluation of Benefits for BMP Strategies

This assessment of the applicability of benefits to different BMP strategies represents an initial effort to characterize and differentiate BMPs by the value that they may create for the economy, environment and community. In a series of tables (Table 14) through Table 17), each category of benefit is evaluated relative to applicability for each type of structural and nonstructural strategy. This initial assessment determines for each strategy type whether a benefit can be: (a) monetized; (b) monetized but depending on site specific conditions; (c) quantified but not monetized; or (d) qualitatively evaluated.

To facilitate the review of these tables, a standard symbol key is created to establish how benefits may be evaluated for each strategy.

Key to Symbols for Table 14 through Table 17	
●	Monetizable
☉	Monetizable, but site-specific
⊗	Quantifiable
○	Qualitative

The following delineation of how benefits can be evaluated for a general strategy can only be viewed as our initial assessment. Recall that Table 13 briefly identifies individual strategies under each of these major groups. At this stage, only a general indication of applicability of benefits is discussed. Further evaluation of benefits per strategy would be developed in a subsequent report.

4.1.1 Structural Strategies – Economic and Environmental Benefits

Table 14 represents the additional economic and environmental benefits that could arise from various structural strategies. As shown, many benefits are readily monetizable for *Green Infrastructure* strategies. This finding reflects the fact that much of the existing research that can be applied in San Diego has focused on the various BMPs identified as green infrastructure. Such research and the various storm water management BCA case studies that have been produced provide standardized methods, data, and evidence that can be applied to new sites and projects. As noted in the table, with some additional data on site conditions (e.g. evidence of flood risk, and irrigation demand, for example), many of the green infrastructure systems have the potential to be monetized. Only benefits related to habitat creation would be unlikely to be monetized. The reason is that not only to these types of benefit calculations require detailed biological surveys, but predictions on the improvement in habitat services with green infrastructure are not well understood at present. Any assessment of monetary benefits would be highly uncertainty and thus, this type of benefit is better characterized in quantitative terms, such as in units of habitat area created.

Multiuse Treatment Area strategies differ from green infrastructure because of the scale and placement of these systems. Benefits can arise from these strategies, especially in flood control because of the volumes that can be potentially detained but the quantification of benefits depends on whether there is a downstream flooding risk. The planted material in these systems can provide benefits in air particulate entrainment, carbon sequestration, and habitat creation but the evidence is not established well enough to characterize these impacts in monetary terms. Other benefits would entail a qualitative assessment.

Water Quality Improvement strategies do not have as clear an impact on economic and environmental benefits as green infrastructure and multi-use treatment areas. For example, trash guards or racks that capture debris before they enter surface waters can improve fish habitat but do not have enough supporting documentation to clearly assess benefits from some of the improved livability characteristics. If less trash in surface waters can be attributed to less trash on neighborhood streets, associated benefits in business development and social capital could arise, but such a connection is not likely to be quantifiable.

Table 14: Structural Strategies – Economic and Environmental Benefits

Strategy	Green Infrastructure	Multiuse Treatment Areas	Water Quality Improvement
Flood Risk Reduction	⊙	⊙	⊙
Irrigation Cost Savings	⊙	○	○
Energy Cost Savings	⊙	○	○
Air Particulate Entrainment	●	⊗	○
Climate Impacts	●	⊗	○
Habitat Related Benefits	⊗	⊗	⊗
Air Quality Emission Reduction	●	○	○
GHG Emission Reduction	●	○	○

4.1.2 Structural Strategies – Community Livability Benefits

Community livability benefits from structural systems (Table 15) represent benefits which directly or indirectly enhance local development and quality of life. These benefits are largely derived from the physical features of structural strategies in creating benefits to local residents and property owners. For example, green roofs are noted in their ability to provide noise insulation in a building and tree plantings along green streets can lead to local retail business development because the environment is a more pleasant place to shop.

Similar to economic and environmental benefits in the table above, the applicability of community livability benefits to *Green Infrastructure* also depends on site specific characteristics. For example, the influence of aesthetic improvements on property values usually depends on the type of neighborhood (e.g. residential, commercial, or mixed-use areas). In commercial districts, monetized benefits would be observed in property values, increased sales or employment levels.

The other types of strategies, *Multiuse Treatment Areas* and *Water Quality Improvements*, have fewer types of benefits which can be quantified, let alone monetized. *Multiuse Treatment Areas* certainly have the potential to be located in areas that by design can create recreational opportunities. However, the type of features at the site depends on how it can be used for recreational purposes. The choice of plant materials (e.g. tree species) at the site would affect aesthetics and heat island / health effects but it depends on the location and installation scale of these systems. For *Water Quality Improvements*, it is not clear if there are quantifiable benefits that extend beyond water quality improvements themselves and thus, these benefit categories may be evaluated only in qualitative terms.

Table 15: Structural Strategies – Community Livability Benefits

Strategy	Green Infrastructure	Multiuse Treatment Areas	Water Quality Improvement
Heat Island Effect	⊙	⊙	○
Aesthetics	⊙	⊙	○
Recreational Benefits	⊙	⊙	○
Noise Reduction	⊗	○	○
Business Development & Jobs	⊙	○	○
Crime Reduction	⊗	○	○
Public Education/ Environmental Stewardship	⊗	⊗	⊗

4.1.3 Nonstructural Strategies – Economic and Environmental Benefits

The potential applicability of economic and environmental benefits for *Nonstructural Strategies* is presented in (Table 16). As discussed above, some types of nonstructural strategies relate directly to structural systems by *Increasing the Number of Structural Systems* and *Improving the Structural Systems Performance*. Accordingly, estimating monetary benefits in of these is directly linked to whether the influence of a nonstructural strategy on implementing a structural system can be quantified. If so, then benefits are assessed relative to the structural system itself. The assessment of benefit estimation in the first two columns is therefore similar to that of structural systems, assuming though that the effectiveness of these nonstructural strategies can be estimated.

The two other nonstructural approaches, *Initiatives to Change Behavior* and *Initiatives to Reduce Pollutants Directly,* generate benefits from their own effectiveness in changing behavior or pollution control initiatives. Initiatives to Change Behavior primarily target efforts to encourage improved environmental stewardship and storm water protection throughout the community. Various types of actions then that people may take who are more area of environmental impacts include adoption of rain barrels, reducing litter, and reducing unnecessary levels of pesticides, herbicides and fertilizers. These types of activities could generate a range of economic and environmental benefits, some of which can be monetized if there is sufficient site specific information. In addition, *Initiatives to Reduce Pollutants Directly*, including a number of public agency initiatives in street sweeping, storm water system maintenance and trash removal, can also generate quantifiable and monetizable benefits. On the other hand, street sweeping initiatives entail some amount of environmental costs (or "negative benefits") associated with emissions from vehicle use. These costs could be compared with any benefits created from cleaner streets.

Table 16: Nonstructural Strategies – Economic and Environmental Benefits

Strategy	Increase # Of Structural Systems	Improve Structural Systems Performance	Initiatives to Change Behavior	Initiatives to Reduce Pollutants Directly
Flood Risk Reduction	⊙	⊙	⊙	○
Irrigation Cost Savings	⊙	⊙	⊙	○
Energy Cost Savings	●	⊗	⊙	●
Air Particulate Entrainment	●	⊗	⊙	⊙
Climate Impacts	●	⊗	⊙	⊙
Habitat Related Benefits	⊗	⊗	⊗	⊗
Air Quality Emission Reduction	●	⊗	⊙	●
GHG Emission Reduction	●	⊗	⊙	●

4.1.4 Nonstructural Strategies – Community Livability Benefits

The effectiveness of nonstructural strategies in enhancing various aspects of community livability are similar to those for economic and environmental outcomes. That is, some of these strategies influence the adoption and performance of structural systems and some aim to change behavior and municipal operations. Also, similar to the structural strategies for the same types of benefits, fewer of these benefits can be evaluated without some site specific information. For the most part though, the evaluation of potential benefits for green infrastructure has been applied to nonstructural systems that aim to increase the numbers and performance of these systems.

Strategies which seek to change behavior such as proper storage of pesticides or the use of rain barrels/water harvesting can have a positive impact, but the scale of that impact will be dependent upon factors such as the number of persons or households who change their behavior. This same uncertainty applies to strategies to reduce pollutants directly. While there is likely to be a net positive impact on society, these impacts on the broader quality of life are less clear. With respect to improved education and awareness, it is possible to quantify the numbers of people who attended a class or have been exposed to an advertising campaign, it is less clear how this information changes behavior or leads to increased number or maintenance of BMPs.

Table 17: Non Structural Strategies – Community Livability Benefits

Strategy	Increase # Of Structural Systems	Improve Structural Systems Performance	Initiatives to Change Behavior	Initiatives to Reduce Pollutants Directly
Heat Island Effect	⊙	⊙	⊙	○
Aesthetics	⊙	⊙	⊙	⊙
Recreational Benefits	⊙	⊙	⊙	⊙
Noise Reduction	⊗	⊗	⊗	⊗
Business Development & Jobs	⊙	⊙	⊙	⊙
Crime Reduction	⊗	⊗	⊗	○
Public Education/ Environmental Stewardship	⊗	⊗	⊗	⊗

4.2 Review of BMP Prioritization Frameworks

In consideration of the types of benefits that can and cannot be estimated with data for various types of BMP strategies, a number of options are available for summarizing the likely outcomes for decision making. As noted in the tables, some benefit categories are readily monetized under certain conditions and others require site specific information to perform computation. Many other benefits may arise from a specific BMP strategy but cannot be explicitly quantified. Evaluations of any of these benefits for consideration in decision making also entails some significant uncertainties.

Accordingly, several approaches for summarizing benefits and impacts for decision making are available including: cost-effectiveness, benefit-cost analysis, multi-criteria analysis, and SROI. Each of these approaches has strengths and weaknesses for meeting the Division's objectives in developing a prioritization strategy. Overall though, each method can be implemented in a process that applies principles of economics, even in multi-objective decision analyses which do not require monetization, so that the categories of benefits are not overlapping or over-estimating value.

Cost-Effectiveness Analysis (CEA): This type of analysis focuses on identifying the best value for money in achieving a specific goal, such as storm water reduction. The process is not necessarily identifying the least costly strategy but the one that generates the greatest quantity of a goal per unit of cost (e.g. dollars per gallon of water detained). Costs in these analyses include the capital, maintenance and operations for implementing. This type of analysis is suitable for evaluating projects in which outcomes (benefits) can not be measured in dollar units but can be quantified. Cost-effectiveness analyses often apply a 'knee-of-the-curve' criterion to identify selecting the most cost-effective strategy because beyond this level of investment cost the effectiveness may increase but at a declining rate. These analyses have been used by communities across the country to identify opportunities for saving money while achieving storm water management goals.

Benefit-Cost Analysis (BCA): Since storm water BMPs can offer more benefits than conventional storm water management systems, cost-effectiveness analysis fails to offer decision makers adequate information for evaluating the alternatives (MacMullen, 2007). Benefit-cost analyses attempt to monetize as many benefits as possible to compare results with costs. This approach is a more direct way of accounting for multiple environmental, societal and economic benefits on a common basis and is not limited to a single goal as is often performed in a conventional cost-effectiveness framework. In some cases, direct environmental value cannot be computed directly, but observed from avoided damage costs or inferred from changes in property values. BCAs account for separate evaluation of benefit categories provided that they are not overlapping. In addition, BCA can be used to evaluate the benefits and costs to individual stakeholders, and comparison with strictly financial benefits with combined environmental and societal benefits – all in the same units of measure. The comparison of costs and benefits allows an explicit consideration of the trade-offs in project options. A BCA can determine whether the benefits of preservation (or restoration) are "worth" the costs and when the project is best implemented. In this sense, it ensures that the limited resources used to provide goods and services to society are used in the most efficient way—that is, to achieve the greatest net benefit (NRC, undated). The overall economic worth of an option can be summarized with a Net Present Value (NPV) or Benefit/Cost Ratio (BCR).[17] BCA results do not incorporate perspectives on who gains or loses but whether the overall net

[17] The NPV is the difference between the present value of benefits and the present value of costs. The present value of benefits is the discounted sum of all future benefits. The present value of costs is the discounted sum of all future costs. The BCR is a ratio of the present value of benefits to the present value of costs. It measures how much benefit would be obtained for each unit of cost invested in a project or policy.

benefits justify the investment. [18] Also, where impacts are perceived to be important but a lack of data is available to assign monetary values to it, additional consideration must be given beyond BCA metrics. For example, a trade-off analysis can be used to compare monetary net benefits with non-monetary impacts to determine a best overall value.

Economic Impact Analysis (EIA): The creation of jobs and business development is a direct and tangible measure of value to the community from expenditures to install storm water BMPs. As mentioned above, since these systems can be installed by low-skilled labor, implementation of these types of systems can provide opportunities for some of those who are most in need. Economic impact analyses trace the levels of expenditures on BMPs through the economy to reveal a total impact for the region. Also, green infrastructure tends to use more local labor and materials compared to grey infrastructure and as such would generate a larger local economic impact. The results can be determined in units of numbers of jobs created, increased income, value added, output, and tax revenue. To many stakeholders, these outcomes are more tangible because the results are shown in units that can be related to the unemployment rate and in gross regional product. For decision making purposes, economic impacts are directly proportional to the level of expenditure. As a result, larger projects would appear to provide greater value even if they are not the most cost-effective. These analyses also do not account for benefits that affect the local community and environment.

Multi-Objective Decision Analysis (MODA): For some project impacts, quantitative and monetary metrics are difficult to determine and the appropriateness of any related assumptions would be highly uncertain. MODA formalizes the process of including non-monetary characteristics of a project into decision making. Just like monetary measures, non-monetary measures try to account in a transparent way stakeholders' preferences for certain characteristics. These preferences are the basis for weights on criteria, which are used to compute an index for ranking projects. Non-monetized performance measures may be weighted with monetary values to produce a single performance metric, or reported alongside monetized values for assessing tradeoffs in decisions. These approaches can be as simple as establishing an equal weight and equal score to all benefit categories – whether they can be monetized or not – to sophisticated frameworks in which non-monetary and monetary benefits are scored and weighted in ways that can be consistent with economic principles. The drawback is that weights are subjective and not based on economic theory or evidence.

[18] In theory, an initiative or project would be rated positively if the benefits to some are large enough to compensate the losses of others, assuming some mechanism existed.

Sustainable Return on Investment (SROI): SROI is a proven, economics-based method for appropriately estimating the monetary value of infrastructure. In such cases, the SROI process first identifies measurable performance indicators that can determine the impact of the infrastructure in specific categories of monetizable benefits. In the context of storm water, benefit categories can include those readily monetized as well as those with some quantitative indicators. In this way, SROI uses stakeholder input to estimate values for inclusion in monetary valuation. The SROI process has several notable features that separate it from more conventional evaluation methods. For instance, true to its economics roots, SROI ensures that key performance indicators do not measure overlapping outcomes which would 'double-count' benefits. In addition, the SROI process is marked by its transparency in accounting for uncertainty through Monte Carlo simulation. Uncertainty in the performance, cost and unit values of green infrastructure benefits would be modeled with probability distributions that account for the entire range of reasonable outcomes. Through Monte Carlo simulation, the full range of value for each strategy would be revealed and decisions can be made relative to the upside and downside risk. To be transparent, the probability distributions are established through facilitated discussions in a workshop setting.[19] The discussions are guided towards reaching consensus on how to best use available evidence, including the formation of quantitative descriptions of the uncertainty in the data.

Each of these approaches has strengths and weaknesses for the Division's purposes. For example, BCA is an established approach for evaluating the worthiness of an investment, such as green infrastructure. Benefits which cannot be monetized because they lack sufficient evidence would be treated in a qualitative assessment, but not included in a benefit-cost comparison. In such contexts a MODA approach can be taken to establish weights and scores for non-monetary outcomes and produce an index of value that can be compared with BCA results. Alternatively, an SROI approach can be undertaken that establishes monetary values for all key benefit categories through a collaborative review of evidence and then risk analysis methods are applied to quantify the uncertainty in quantitative and monetary parameters. MODA methods in establishing weights and scores can be used to support SROI results but ultimately with a SROI process, all key categories of benefits would be evaluated in monetary terms.

The next step for the Division is to develop a sound basis for using this information to prioritize BMPs across each watershed. Many challenges arise in prioritizing BMP strategies with the types of varying benefits presented in Chapter 4. Ideally, a prioritizing approach would be objective, based on site-specific and peer-reviewed evidence, account for life cycle outcomes and reflect various sources of uncertainty. Several prioritization options exist that address some of these goals for the framework.

[19] An initial workshop was held in May in San Diego to discuss benefit categories, strategies and decision making frameworks. Comments received from this workshop are included in Appendix 3.

5 Summary of Key Findings

Our findings in this report indicate that many types of benefits can accrue to local residents, businesses, and the general public. Computing benefits of BMPs has been standardized to some extent in the Center for Neighborhood Technology (CNT) report which outlines the data and calculations for a number of benefits (CNT, 2010). For the Division, a similar calculation process could be implemented and it would be consistent with efforts implemented in other cities. However, a significant level of uncertainty would arise in preparing such estimates without specific data on BMP designs and activities for each strategy as well as site specific information about where they would be implemented.

The next best evaluation strategy for the Division at present would entail a simplified assessment of the likely *existence* of quantifiable benefits for each strategy. In this report, we have evaluated the degree to which benefits can be quantified and potentially monetized for each type of strategy. Drawing from the previous tables in Chapter 4, the results of this assessment are shown in Table 18. A “Yes” in one of the table cells indicates that there would be sufficient evidence to quantifiably determine the value of a strategy, provided that information about the strategy and implementation location is better understood. In this high-level summary, it may be assumed that if a quantifiable benefit exists, they would be large enough to generate observable public value and influence decisions accordingly.

These initial findings however must be developed in more detail to provide practical use in prioritizing strategies for the Division. In particular, the feasibility of estimating benefits must assessed for each individually identified strategy (see Appendix 2), not its strategy group as shown in Table 18. With this information, the Division can establish an initial indication of specific strategies that provide the best value. This effort is planned for phase two of this project.

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Table 18: Summary of Evidence for Estimating Benefits for Structural and Nonstructural Strategies

	Structural			Nonstructural			
Strategy	Green Infrastructure	Multiuse Treatment Areas	Water Quality Improvement	Increase # Of Structural Systems	Improve Structural Systems Performance	Initiatives To Change Behavior	Initiatives To Reduce Pollutants Directly
Flood Risk Reduction	YES	YES	YES	YES	YES	YES	
Irrigation Cost Savings	YES			YES	YES	YES	
Energy Cost Savings	YES			YES		YES	YES
Air Particulate Entrainment	YES			YES		YES	YES
Climate Impacts	YES			YES		YES	YES
Habitat Related Benefits							
Air Quality Emission Reduction	YES			YES		YES	YES
GHG Emission Reduction	YES			YES		YES	YES
Heat Island Effect	YES	YES		YES	YES	YES	
Aesthetics	YES	YES		YES	YES	YES	YES
Recreational Benefits	YES	YES		YES	YES	YES	YES
Noise Reduction							
Business Development & Jobs	YES			YES	YES	YES	YES
Crime Reduction							
Public Education/ Environmental Stewardship							

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Appendix 1: Benefit Calculations

This appendix discusses the quantitative calculations and data involved in estimating benefits for those categories which can be converted to monetary values, given site specific data. Benefit categories that can be readily quantified and monetized are discussed here. Benefit categories that are not included here are: Habitat Creation Benefits, Heat Island Effects, and Environmental Awareness / Stewardship.

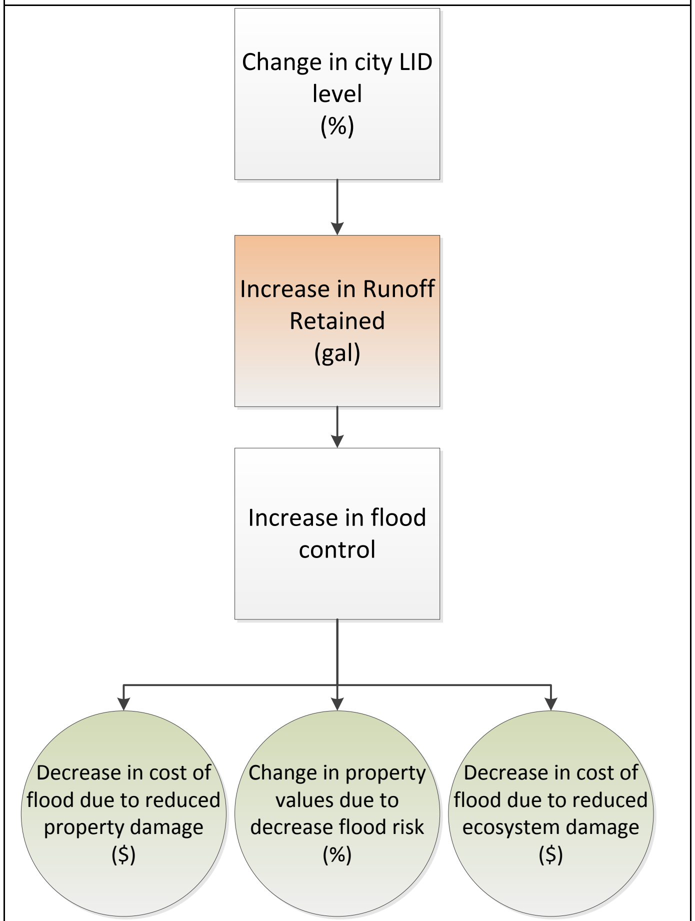
Flood Risk Reduction Benefits

By reducing the volume of storm water runoff, the proposed strategies can reduce the frequency and severity of flooding. The impact of green infrastructure on flooding is highly site and watershed specific, and thus this guide does not provide general instructions for quantifying the reduction in flood risk resulting from a green infrastructure program. There are several methods[20] for valuing the impact of flood control:

- Hedonic pricing to examine how flood risk is priced into real estate markets;
- Insurance premiums paid for flood damage insurance as a proxy for the value of reducing the risk of flood damage;
- Avoided damage cost approach; and
- Contingent valuation methods

The diagram presents a high level overview of how the benefits could be monetized. The 'Increase in Flood Control' could be monetized using any of the methods suggested above. Some methods have more robust information than others. CNT recommends using a range of 2–5 percent property value increase for removal from the floodplain (CNT, 2010).

Figure 3: Flood Control Benefits



[20] Downstream Economic Benefits From Storm-Water Management. Journal of Water Resources Planning and Management. Braden, J.B. and D.M. Johnston. November/December, 2004

Irrigation Cost Savings

The method for determining the irrigation cost savings begins with quantifying the reduction in water demand from utilities based on the amount that is harvested on site.

This amount can be calculated by using the various water retention factors for the various green infrastructure and multiplying by the annual precipitation.

A diagram is provided here that determines benefits of retention based on cost avoidance. This information would be used in calculating the Decrease in Potable Water. The cost of the water would be derived from local utilities.

Figure 4: Irrigation Cost Savings

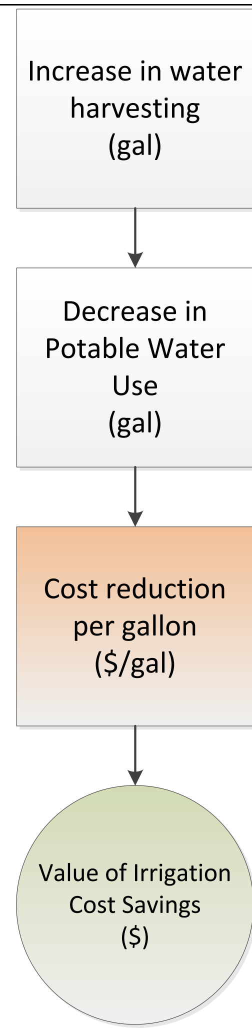


Table 19: Green Infrastructure Retention Parameters

	Amount Retained	Unit	Scale
Water Harvesting	0.62	Gallons of runoff	Per inch of Rain

Source: CNT, 2010, McPherson, E. et al. 2006

Energy Cost Savings

The most important step in this calculation will be the reduced energy needs which will depend on the number of buildings which will benefit from the temperature control provided by green infrastructure and LID and the scale of LID/GI implementation. The data on the physical characteristics of GI to insulate or reduce energy use are provided as well.

The first step to valuing the benefits of reduced energy use is determining the amount of energy saved by BMP. The benefit of energy savings can be terms of kilowatt hours (kWh) of electricity and British thermal units (Btu) of natural gas reduced.

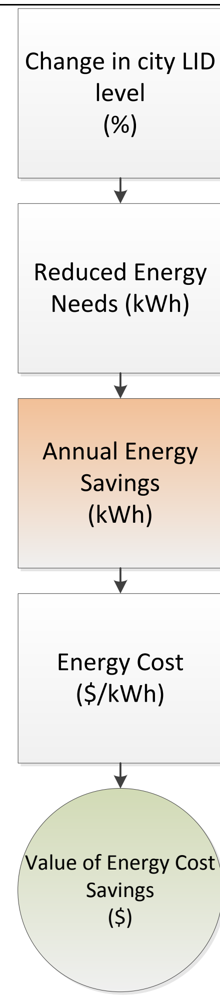
As noted, the total reduction is very specific to the type of improvement/change. The actual benefits realized in terms of energy savings due to the implementation of a green roof will be significantly impacted by the following variables:

- Growing media composition, depth and moisture content
- Plant coverage and type
- Building characteristics, energy loads and use schedules
- Local climate variables and rainfall distribution patterns

These characteristics will influence the R values for conventional and green roofs in region (which will be used to calculate the annual energy savings from reduced energy needs). Other data needs are:

- Annual number of cooling degree days (°F days) in your region
- Annual number of heating degree days (°F days) in your region

Figure 5: Energy Cost Savings



Having calculated the direct kWh and BTU saved in reduced building energy use, it is possible to assign a dollar value to these savings.

One may calculate the direct cost savings by multiplying the kilowatt hours or BTUs of electricity and natural gas, respectively, by local utility rates

Air Pollution Emission Reduction

Practices that indirectly lower emissions of air pollution include any practices that reduce energy consumption through decreased energy use in neighboring buildings or through reduced water treatment needs.

The kilowatt hours (or million BTUs) of reduced energy from the energy cost savings will be used in calculating the air pollution emission reduction benefit. The total amount of energy saved will be converted to the pounds of criteria pollutants reduced. The values, in dollars per pound, of the pollutants will come from existing guidance from the EPA and other sources that value these pollutants.

The EPA provides estimates for annual output emissions rates of national electricity production and natural gas:

Figure 6: Air Pollution Emission Reduction

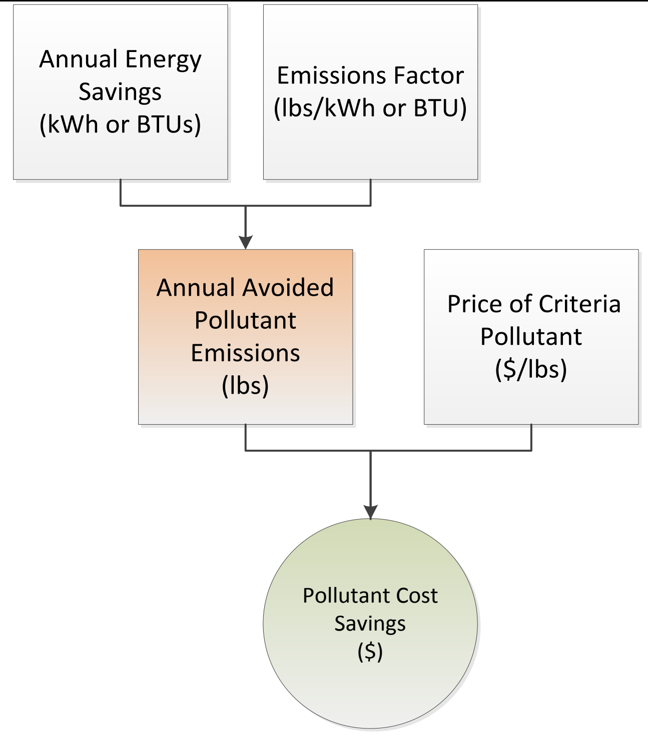


Table 20: Sample Criteria Pollutant Emission Factors

Pollutant	lbs/kWh	lbs/Million Btu
NO2	0.001937	0.721
SO2	0.005259	0.266

Table 21: Costs of Pollutants

Pollutant	Value per lb
NO2	$3.34
O3	$3.34
SO2	$2.06
PM-10	$2.84

Source: CNT (2010), McPherson et al. (2006), Wang and Santini (1995)

Greenhouse Gas Emission Reduction

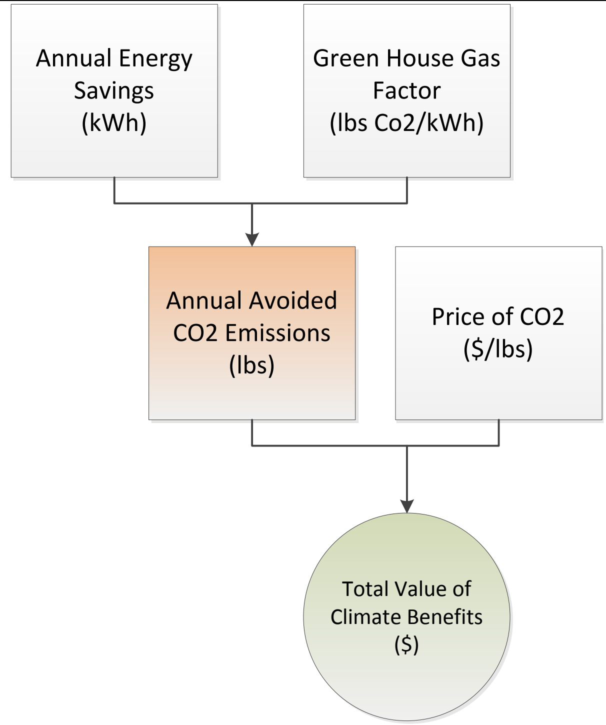
This benefit calculation follows the same methodology as the air pollution emission reduction benefit, only different conversion factors for CO2 will be used, and different monetary values.

The amount of CO2 emissions from power plants varies depending on the electricity source (e.g. coal, nuclear, wind, etc), so the EPA eGRID program should be consulted.

The CAMX subregion for 2010 has 932.82 lb per M Wh[21].

The current recommended price of CO2 is $40 per metric ton[22].

Figure 7: Greenhouse Gas Emission Reduction



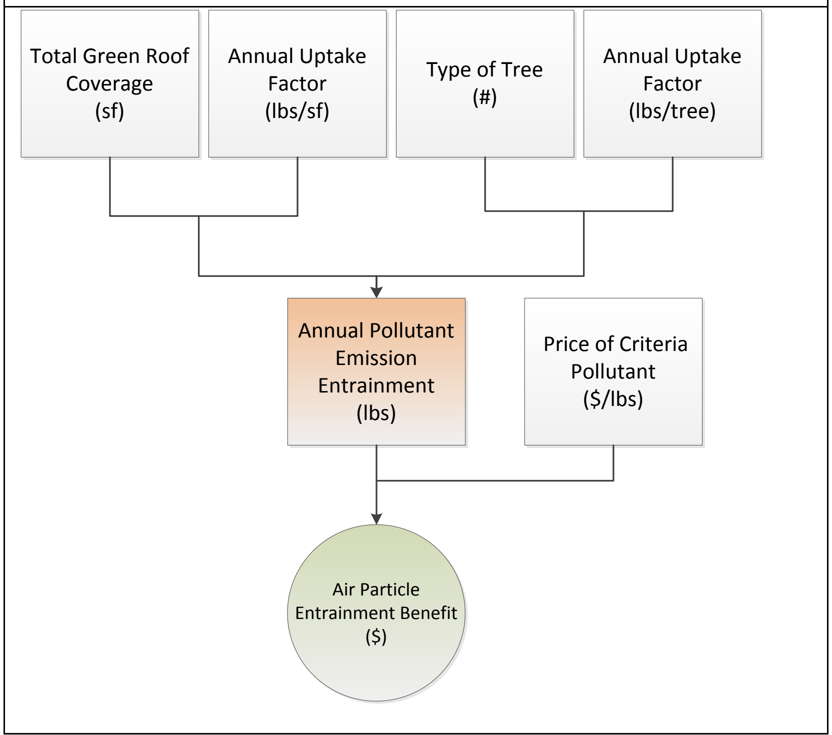
[21] http://www.epa.gov/cleanenergy/energy-resources/egrid/

[22] Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (May 2013; revised November 2013), page 18

Air Particle Entrainment

This section quantifies the direct uptake and deposition of air pollutants by green infrastructure and provides a framework for establishing value these impacts in monetary terms. The criteria pollutants addressed here are nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2) and particulate matter of aerodynamic diameter of ten micrometers or fewer (PM-10).

Figure 8: Air Particle Entrainment



Practices that provide a direct benefit of uptake and deposition include green roofs, trees and bio-infiltration. Similar to the methodology for emission cost savings from reduced energy use, the air particle entrainment benefits will quantify the amount (in pounds) of criteria pollutants removed from the environment. The total amount will depend on the scale of LID/GI and the type of GI. Table 22 provides values compiled by CNT (2010) per square foot of green roof installed. It should be noted that local values should be used if available (CNT, 2010). Factors such as local climates will influence plants ability to grow, and climates with longer growing seasons will see greater air quality improvements than those with shorter ones. Additionally, trees provide benefits in a similar manner. The Forest Service *Tree Guides* provides information for trees for particular climate regions (Table 23).

Table 22: Pollutant Removal Factors for Green Roofs

	Low (lbs/SF)	High (lbs/SF)
NO2	3.00×10^{-4}	4.77×10^{-4}
O3	5.88×10^{-4}	9.20×10^{-4}
SO2	2.29×10^{-4}	4.06×10^{-4}
PM-10	1.14x10-4	1.33x10-4

Table 23: Annual Criteria Pollutant Reductions, 40 year Average

	Small tree: Crabapple (22 ft tall, 21 ft spread)	Medium tree: Red Oak (40 ft tall, 27 ft spread)	Large tree: Hackberry (47 ft tall, 37 ft spread)
NO2	0.39 lbs	0.63 lbs	1.11 lbs
SO2	0.23 lbs	0.42 lbs	0.69 lbs
O3	0.15 lbs	0.2 lbs	0.28 lbs
PM-10	0.17 lbs	0.26 lbs	0.35 lbs

Carbon Sequestration

Similar to the air particle entrainment methodology, LID/GI can provide carbon sequestration benefits. The pounds of carbon sequestered per unit area depend on several local factors, including the specific practice, the types of species planted and the local climate.

For green roofs, the recommended range of grams of carbon sequestered per square meter from aboveground biomass, as determined by research synthesized in a Michigan State University report offers average carbon sequestration values provided by extensive green roofs' aboveground biomass (Getter et al. 2009).

Figure 9: Carbon Sequestration

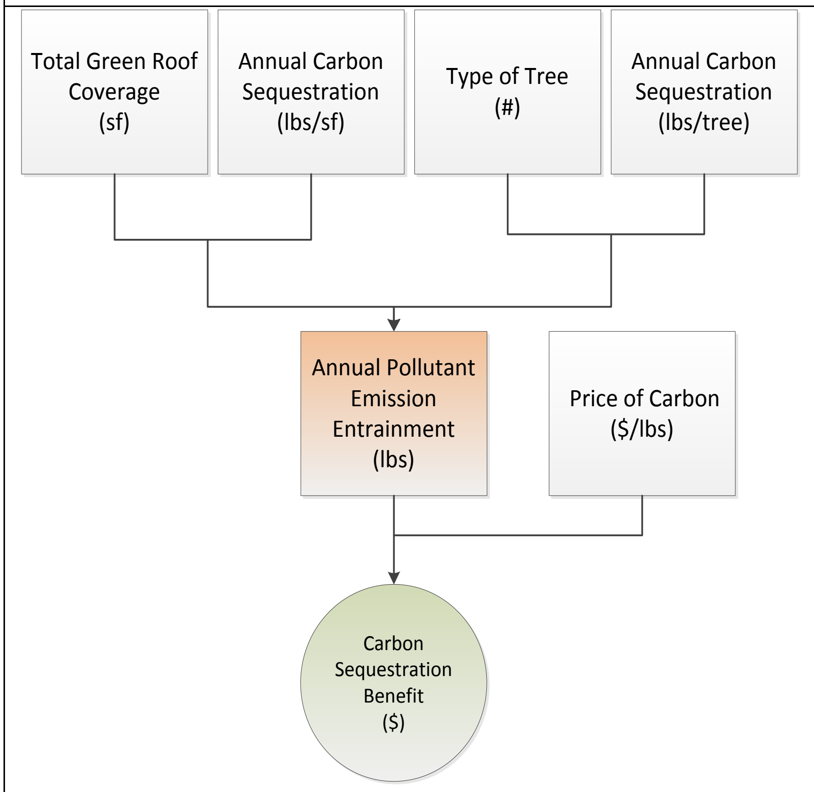


Table 24: Green Roof Carbon Sequestration Rates

	Low (lbs/SF)	High (lbs/SF)
CO2	0.0332	0.0344

Table 25: Sample Carbon Sequestration Rates for Different Trees

Net CO2 (lbs)	Residential Yard Opposite West-Facing Wall	Residential Yard Opposite South-Facing Wall	Residential Yard Opposite East-Facing Wall	Public Tree on a Street or in a Park
Small tree: Crabapple (22 ft tall, 21 ft spread)	390	226	335	336
Medium tree: Red Oak (40 ft tall, 27 ft spread)	594	212	487	444
Large tree: Hackberry (47 ft tall, 37 ft spread)	911	665	806	735

Aesthetic Improvements

The current method to calculate the benefit of aesthetics is to look at the changes in property values due to LID/GI. While the research on this subject supports the belief that there is a positive (increase) in property value due to LID/GI, there is much uncertainty regarding the size and scale of that. The methodology for calculating this benefit is to apply a premium on property that will capitalize on the aesthetic benefits of LID/GI.

Street trees and urban vegetation have been estimated by realtors to add $15,000 to $25,000 in value to a property compared to similar areas with o trees. The NRDC notes that buildings with green roofs can rent at a 16% premium.[23] Additionally, the NRDC reports that Tyrväinen and Miettinen (2000) found that units in multifamily buildings with views of trees or forest cover can increase rents by as much as 4.9 percent (Wolf 2007)[24].

Figure 10: Aesthetic Improvements

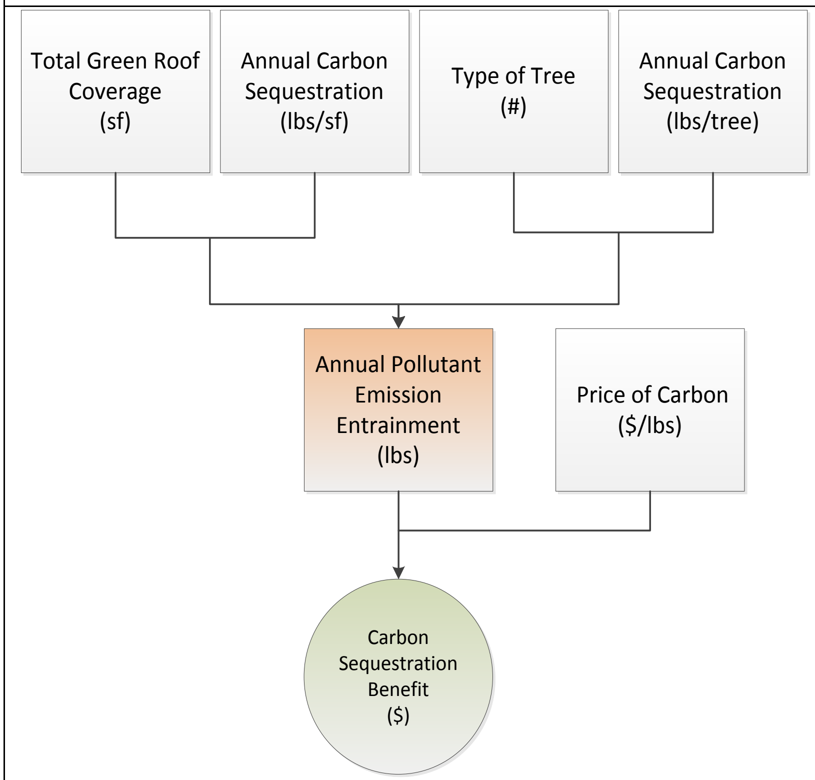


Table 26: Premiums on Property Value due to Aesthetics

Action	Monetized Benefit	Location	Source
LID and proximity to trees and other vegetation	0 to 7% Increase in Property Value	Philadelphia, PA	Stratus 2009
LID of adjacent properties	3.5 to 5% Increase in Property Value	King County, WA	Ward et al. 2008

[23] Natural Resources Defense Council 2013

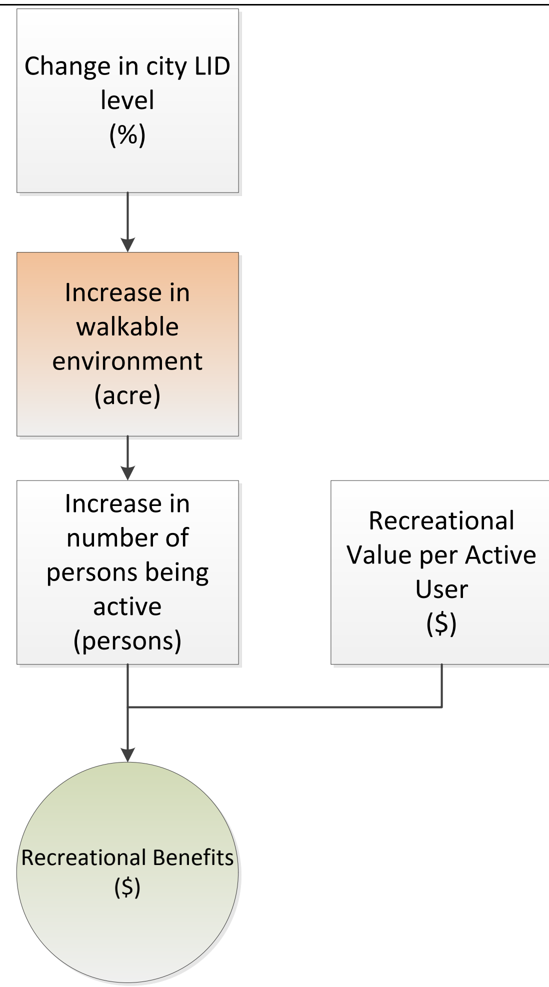
[24] Ibid

Recreation Benefits

The methodology for calculating this benefit will involve determining the total number of recreational users of the new LID/GI facilities and applying a monetary value per user to get total benefits.

The total number of users will be based on local information. The monetized value of recreational benefits comes from different research fields. Some research from the transportation literature suggests benefits can be determined on an individual user basis. A wide variety of studies of outdoor recreational activities (non-bicycling) generated typical values of about $40 per day (in 2004 dollars).[25]

Figure 11: Recreation Benefits



The value of time is estimated based on US DOT guidance for TIGER VI. The value of time for personal travel is $12.98 per hour. The benefit per trip for the appropriate facility is multiplied by the number of daily existing and induced commuters, and then doubled to include trips both to and from work. This results in a daily mobility benefit.

A premium on the value of a trip is developed from the January 2010 UK's Department of Transport *Guidance on the Appraisal of Walking and Cycling Schemes*. This Guidance reports a premium value of an off-road bicycle track versus an on-road facility. Hopkinson & Wardman (1996) developed estimates of on-road segregated cycle lane assuming benefits of £0.02 per minute. This benefit is assigned to existing recreational cyclists that would enjoy the new bike facility's quality, comfort and convenience.

[25] San Francisco County Transportation Authority Department of Parking and Traffic. *Maintain Bicycle Facilities (spreadsheet)*. 2004 2/28/2004, as cited in *Guidelines for Analyzing the Benefits and Costs of Bicycle Facilities*, Krizek et al., 2005.

Crime Reduction Benefits

Residents living in “greener” surroundings report lower levels of fear, fewer incivilities, and less aggressive and violent behavior. While there is not literature with respect to monetizing this benefit, there is research that looks at quantifying the benefit of crime reduction do to a greener environment. This study was performed in a public housing complex in an urban environment, so the actual percentage reduction may not be the same in other areas.

However, that does not mean there is no impact on crime. A possible methodology is to look at current crime levels in areas where proposed LID/GI will occur, and apply a reduction, but smaller in size than those listed below.

	Areas with Medium Level of Vegetation	Areas with High Levels of Vegetation
Total Crimes	42%	52%
Property Crimes	40%	48%
Violent Crimes	44%	56%

Source: Environment and Crime in the Inner City: Does Vegetation Reduce Crime? Kuo & Sullivan. Environment and Behavior, Volume 33 No.3, May, 2001

Business Development Benefits

In areas where green streets lead to an enhanced the sense of place, and increase in foot and bicycle traffic can support retail development. Case studies by the New York City DOT examined before and after changes in Retail Sales Tax Filings, Commercial Leases & Rents, and City−Assessed Market Value. The study's methodology does not ultimately prove causality between the street improvement projects and any resulting economic changes; however, some locations of green street development saw a significant increase in retail sales compared to the changes in retail sales for the borough as a whole.

Researchers do believe that any benefits from the green streets will be fully realized 2 years after development, and so applying this growth to retail sales further in the future is not applicable.

We can apply these percentages to current retail sales of businesses located along areas that will be developed into green streets to see the potential impact on businesses.

Table 27: Increase in Retail Sales after Street Development

Area	Change in Sales Year 1	Change in Sales Year 2
Vanderbilt Ave	39%	59%
Borough	27%	19%
Area	**Change in Sales Year 1**	**Change in Sales Year 2**
St. Nicholas Avenue/Amsterdam	18%	48%
Borough	17%	39%

Job Creation Benefits

Determining the number of jobs created, and the economic impact of those jobs, is simply a function of the total amount spent on the program. In general, the larger the area (or economic base) the larger the impact. Direct, indirect and induced economic impacts from spending on the strategies can be calculated using Economic Impact Analysis models.

The creation of jobs, and such, salaries for the workers to spend, would also have tax impacts at the State, Local, and Federal government level.

Current guidance on a methodology from the Council of Economic Advisors' [26] methodology as assumes that for every **$76,923** of additional government spending, one job-year is created. A job-year means one job for one year. To estimate the employment impacts in terms of job-years one simply adds up the number of jobs created every year over the analysis period.

The number of jobs created is a division of the total spending by the CEA recommended value.

[26] Executive Office of the President, Council of Economic Advisers, “Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009,” Washington, D.C., May 11, 2009; and September 2011 Update.

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Appendix 2: Comprehensive List of Nonstructural Strategies

This list of strategies has been compiled from a review of each WAMP, CLRP and WQIP document

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
Jurisdictional Runoff Management Program (JRMP) Strategies			
Development Planning			
All Development Projects			
1	For all development projects, administer a program to ensure implementation of source control BMPs to minimize pollutant generation at each project and implement low-impact development (LID) BMPs to maintain or restore hydrology of the area, where applicable and feasible.	For all development projects, ensure source control BMPs	Increasing # of BMPs or LIDs
2	Amend municipal code and ordinances, including zoning ordinances, to facilitate and encourage LID opportunities.	Amend municipal code to encourage LID	Increasing # of BMPs or LIDs
3	Train staff on LID regulatory changes and LID Design Manual.	Train staff on LID regulatory changes and LID Design Manual.	Increasing # of BMPs or LIDs
Priority Development Projects (PDPs)			
4	For PDPs, administer a program requiring implementation of on-site structural BMPs or LIDs to control pollutants and manage hydromodification. Includes confirmation of design, construction, and maintenance of PDP structural BMPs or LIDs.	For PDPs, require implementation of on-site structural BMPs or LIDs	Increasing # of BMPs or LIDs
5	Update BMP Design Manual procedures to determine nature and extent of storm water requirements applicable to development projects and to identify conditions of concern for selecting, designing, and maintaining appropriate structural BMPs or LIDs.	Update BMP Design Manual procedures	Improve / Maintain BMPs or LIDs
	1. Amend BMP Design Manual for trash areas. Require full four-sided enclosure, siting away from storm drains and cover. Consider the retrofit requirement.		Improve / Maintain BMPs or LIDs
	2. Amend BMP Design Manual for animal-related facilities.		Improve / Maintain BMPs or LIDs
	3. Amend BMP Design Manual for nurseries and garden centers.		Improve / Maintain BMPs or LIDs
	4. Amend BMP Design Manual for auto-related uses.		Improve / Maintain BMPs or LIDs

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
6	Administer an alternative compliance program to on-site structural BMP implementation (includes identifying Watershed Management Area Analysis [WMAA] candidate projects).	Administer an alternative compliance program	Improve / Maintain BMPs or LIDs
	1. Develop a mitigation policy for public and private development projects that links development with mitigation within the same watershed.		Improve / Maintain BMPs or LIDs
	1a. Create an In-Lieu Fee		Improve / Maintain BMPs or LIDs
	Construction Management		
7	Administer a program to oversee implementation of BMPs during the construction phase of land development. Includes inspections at an appropriate frequency and enforcement of requirements.	Oversee implementation of BMPs during the construction	Improve / Maintain BMPs or LIDs
Existing Development			
	Commercial, Industrial, Municipal, and Residential Facilities and Areas		
8	Administer a program to require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types, and PGAs, as appropriate. Includes inspecting existing development at appropriate frequencies and using appropriate methods. (Inspections for PGAs of concern: Vehicle Washing area inspections and inspections for food-related businesses, animal-related businesses, nurseries and garden centers, and auto-related businesses.)	Require implementation of minimum BMPs for existing development	Improve / Maintain BMPs or LIDs
	1. Update minimum BMPs for existing residential, commercial, and industrial development and enforce them.		Improve / Maintain BMPs or LIDs
	2. Design, implement, and enforce property- and PGA-based inspections.		Improve / Maintain BMPs or LIDs
	1. Review policies and procedures to ensure discharges from swimming pools meet permit requirements.		Improve / Maintain BMPs or LIDs
	3. Develop a self-reporting inspection option for select industrial and commercial facilities.		Improve / Maintain BMPs or LIDs
9	Implement pet waste program. May include installation and maintenance of pet waste bag dispensers and trash bins, signage and education, physical removal of pet waste, or enforcement.	Implement pet waste program	Changing Behavior to reduce pollutants at the source
10	Promote and encourage implementing designated BMPs at residential areas.	Promote and encourage implementing designated BMPs at residential areas.	Increasing # of BMPs or LIDs
	1. Expand residential BMP (irrigation, rainwater harvesting, and turf conversion) rebate programs to multi-family housing in target areas.		Increasing # of BMPs or LIDs

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
	2. Residential BMP: Rain Barrel		Increasing # of BMPs or LIDs
	3. Residential BMP: Irrigation Control (Turf Conversion)		Increasing # of BMPs or LIDs
	4. Residential BMP: Downspout Disconnect		Increasing # of BMPs or LIDs
	5. Provide financial incentives to property owners to convert landscaping to site-specific native plants.		Increasing # of BMPs or LIDs
11	Develop pilot project to identify and carry out site disconnections in targeted areas.	Develop pilot project to identify and carry out site disconnections in targeted areas.	Increasing # of BMPs or LIDs
12	Identify and reduce incidents of power washing discharges from nonresidential sites.	Identify and reduce incidents of power washing discharges from nonresidential sites.	Changing Behavior to reduce pollutants at the source
13	Promote and encourage implementation of designated BMPs in nonresidential areas.	Promote and encourage implementation of designated BMPs in nonresidential areas.	Increasing # of BMPs or LIDs
14	Proactively monitor for erosion, and complete minor repair and slope stabilization on municipal property.	Monitor for erosion, and slope stabilization on municipal property.	Increasing # of BMPs or LIDs
	MS4 Infrastructure		
15	Implement operation and maintenance activities (inspection and cleaning) for MS4 and related structures (catch basins, storm drain inlets, detention basins, etc.).	Implement operation and maintenance activities	Removing pollutants or sources directly
	1. Optimize catch basin cleaning to maximize pollutant removal.		Removing pollutants or sources directly
	2. Proactively repair and replace MS4 components to provide source control from MS4 infrastructure.		Removing pollutants or sources directly
	3. Increase frequency of open-channel cleaning and scour pond repair to reduce pollutant loads.		Removing pollutants or sources directly
16	Implement controls to prevent infiltration of sewage into the MS4 from leaking sanitary sewers.	Implement controls to prevent infiltration of sewage into the MS4	Removing pollutants or sources directly

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
	1. Identify sewer leaks and areas for sewer pipe replacement prioritization.		Removing pollutants or sources directly
Roads, Streets, and Parking Lots			
17	Implement operation and maintenance activities for public streets, unpaved roads, paved roads, and paved highways.	Implement operation and maintenance activities for public streets	Removing pollutants or sources directly
	1. Enhance street sweeping through equipment replacement and route optimization.		Removing pollutants or sources directly
	2. Initiate sweeping of medians on high-volume arterial roadways.		Removing pollutants or sources directly
	3. Increase maintenance on access roads and trails.		Removing pollutants or sources directly
18	Require sweeping and maintenance of private roads and parking lots in targeted areas.	Require sweeping and maintenance of private roads and parking lots in targeted areas.	Removing pollutants or sources directly
19	Identify sites for pilot study to test Permeable Friction Course (PFC), which is a porous asphalt that overlays impermeable asphalt.	Identify sites for pilot study to test Permeable Friction Course (PFC)	Increasing # of BMPs or LIDs
Pesticide, Herbicides, and Fertilizer Program			
20	Require implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers on commercial, industrial, and municipal properties. Includes education, permits, and certifications.	Require BMPs to address pesticides, herbicides, and fertilizers issues	Changing Behavior to reduce pollutants at the source
Retrofit and Rehabilitation in Areas of Existing Development			
21	Develop and implement a strategy to identify candidate areas of existing development appropriate for retrofitting projects and facilitate the implementation of such projects.	Identify candidate areas for retrofitting projects	Increasing # of BMPs or LIDs
22	Develop and implement a strategy to identify candidate areas of existing development for stream, channel, or habitat rehabilitation projects and facilitate implementation of such projects.	Identify areas for stream, channel, or habitat rehabilitation projects	Increasing # of BMPs or LIDs

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
IDDE Program			
23	Implement Illicit Discharge, Detection, and Elimination (IDDE) Program per the JRMPs. Requirements include maintaining an MS4 map, using municipal personnel and contractors to identify and report illicit discharges, maintaining a hotline for publicly reporting illicit discharges, monitoring MS4 outfalls, and investigating and addressing any illicit discharges.	Implement Illicit Discharge, Detection, and Elimination (IDDE) Program	Changing Behavior to reduce pollutants at the source
Public Education and Participation			
24	Implement a public education and participation program to promote and encourage development of programs, management practices, and behaviors that reduce pollutant discharge in storm water prioritized by high-risk behaviors, pollutants of concern, and target audiences.	Implement a public education and participation program	Changing Behavior to reduce pollutants at the source
	1. Expand outreach to homeowners' association (HOA) common lands and HOA rebates.		Changing Behavior to reduce pollutants at the source
	2. Develop an outreach and training program for property managers responsible for HOAs and maintenance districts.		Changing Behavior to reduce pollutants at the source
	3. Conduct trash cleanups through community-based organizations involving target audiences.		Changing Behavior to reduce pollutants at the source
	4. Target human behavior in parks and other public areas including trash reduction or other high-impact behavior to habitat, wildlife, and water quality.		Changing Behavior to reduce pollutants at the source
	5. Improve consistency and content of websites to highlight enforceable conditions and reporting methods.		Changing Behavior to reduce pollutants at the source
	6. Contribute to San Diego County-led effort through regional education group for outreach, education, and policy measures for the equestrian community and property owners.		Changing Behavior to reduce pollutants at the source
	1. Develop a targeted education and outreach program for homeowners adjacent to or with tributaries or streams within their property.		Changing Behavior to reduce pollutants at the source
	1. Develop a targeted education and outreach program for homeowners with orchards or other agricultural land uses on their property.		Changing Behavior to reduce pollutants at the source

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
	2. Enhance school and recreation-based education and outreach		Changing Behavior to reduce pollutants at the source
	3. Develop education and outreach to reduce over-irrigation		Changing Behavior to reduce pollutants at the source
	7. Develop regional training for water-using mobile businesses.		Changing Behavior to reduce pollutants at the source
25	Enhance education and outreach based on results of effectiveness survey and changing regulatory requirements.	Enhance education and outreach	Changing Behavior to reduce pollutants at the source
26	Provide technical education and outreach to the development community on the design and implementation requirements of the MS4 Permit and Water Quality Improvement Plan requirements.	Technical education and outreach on the MS4 Permit and WQIP	Changing Behavior to reduce pollutants at the source
Enforcement Response Plan			
27	Implement escalating enforcement responses to compel compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development in the Enforcement Response Plan.	Implement escalating enforcement responses to compel compliance	Changing Behavior to reduce pollutants at the source
	1. Increase enforcement of over-irrigation.		Changing Behavior to reduce pollutants at the source
	2. Focus locally on enforcement of water-using mobile businesses.		Changing Behavior to reduce pollutants at the source
28	Increase identification and enforcement of actionable erosion and slope stabilization issues on private property and require stabilization and repair.	Enforcement of actionable erosion and slope stabilization issues	Increasing # of BMPs or LIDs
Optional Strategies			
29	Continue participating in source reduction initiatives. (Varies. For example, the Brake Pad Partnership is existing. Considered may be a plastic bag ban, banning leaf blowers, banning pesticides or herbicide.)	Continue participating in source reduction initiatives.	Changing Behavior to reduce pollutants at the source
30	Develop a program to address and capture trash and debris.	Develop a program to address and capture trash and debris.	Removing pollutants or sources directly

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
31	Support partnership efforts by social service providers to provide sanitation and trash management for persons experiencing homelessness.	Sanitation and trash management for persons experiencing homelessness.	Removing pollutants or sources directly
32	Protect areas that are functioning naturally.	Protect areas that are functioning naturally.	Removing pollutants or sources directly
	1. Develop a policy to avoid additional hardscape development and degradation in unpaved open space areas.		Removing pollutants or sources directly
	2. Add permanent open space protections to undeveloped city-owned land.		Removing pollutants or sources directly
	3. Acquire privately owned undeveloped parcels of land.		Removing pollutants or sources directly
	Mapping and risk assessment of agricultural operations.		Removing pollutants or sources directly
	Implement a program to target on-site wastewater treatment (septic) systems. May include mapping and risk assessment, inspection, or maintenance practices.		Removing pollutants or sources directly
	Removal of invasive plants and animals.		Removing pollutants or sources directly
33	Conduct a feasibility study to determine if implementing an urban tree canopy (UTC) program would benefit water quality and other goals.	Conduct a feasibility study on urban tree canopy (UTC) program	Increasing # of BMPs or LIDs
	Investigate alternative pollutant removal or treatment strategies such as fungus used to remove soil contaminants.		Removing pollutants or sources directly
34	Conduct special studies to gather additional monitoring information about priority conditions or beneficial uses. (Monitoring may include investigative measures such as genetic tracking for bacteria sources or geomorphic studies for sediment sources or processes. - LOS PEN)	Gather monitoring information about priority conditions or beneficial uses	Improve / Maintain BMPs or LIDs

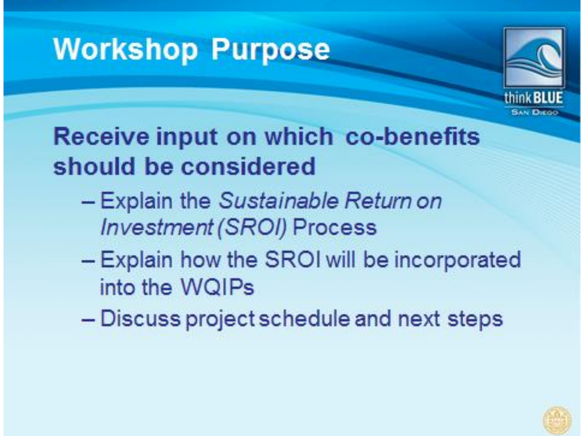
ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
35	Collaborate with entities potentially including, but not limited to:	Collaborate with entities potentially including, but not limited to:	Improve / Maintain BMPs or LIDs
	• Departments within the same Responsible Agency.		Improve / Maintain BMPs or LIDs
	• Other governmental agencies such as water, transportation, or public health agencies.		Improve / Maintain BMPs or LIDs
	• Nongovernmental agencies such as environmental and community groups and private corporations.		Improve / Maintain BMPs or LIDs
	• Dischargers regulated under other permits including the Phase II National Pollutant Discharge Elimination System (NPDES) Permit, Industrial General Permit, and Construction General Permit.		Improve / Maintain BMPs or LIDs
	Collaboration may take the form of joint participation in stakeholder meetings, studies or development studies or BMPs, hiring of a Watershed Coordinator to facilitate communication between community groups and the City, formation of a City Watershed team to protect and restore the watershed, or participating in existing groups, such as Integrated Regional Water Management (IRWM) groups.		Improve / Maintain BMPs or LIDs
	1. Funding for collaborative strategies may include providing in-kind services, shared costs through agreements, and preparation and competition for grant funding.		Improve / Maintain BMPs or LIDs
Added			
	Vehicle Washing areas supplemental standards		Improve / Maintain BMPs or LIDs
	Keeping of large animals		Improve / Maintain BMPs or LIDs
	Xeriscaping, turf conversion and other irrigation, pesticide and fertilizer reduction (Caltrans specific. CLRP P. E-19)		Changing Behavior to reduce pollutants at the source
	Garden and landscape practices (primarily for Contractors. Otherwise covered in W.)		Changing Behavior to reduce pollutants at the source
	Increase street sweeping frequency (otherwise covered in P.)		Improve / Maintain BMPs or LIDs
	Rebates/Incentives to residential and non-residential. (Otherwise covered in J.)		Improve / Maintain BMPs or LIDs

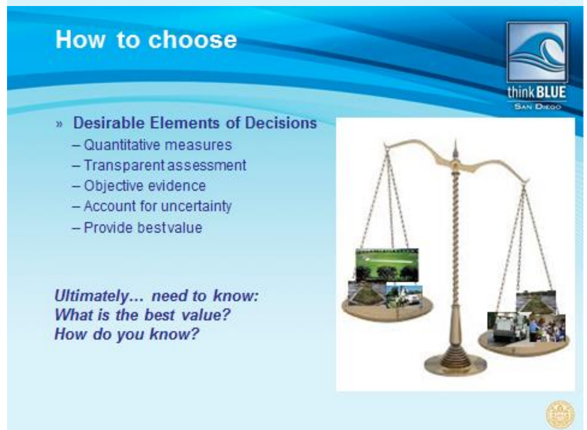
Notes: Purple highlighting where there was a modification between the "Potential Strategies" documents.

Appendix 3: Workshop Summary

This section includes the presentation provided to the stakeholders, which guided discussion on benefits. Stakeholder comments were written down post workshop and sent back to the Division for consideration. These comments are included below.

Workshop Presentation



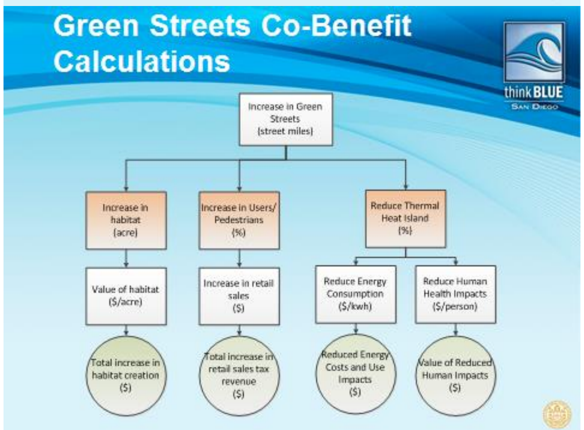


Structural Strategy (Examples)	Economic		Environmental				Societal (Quality of Life)				
	On-site Energy Savings	Operational Cost Savings	Carbon Sequestration	Carbon Emissions Reduction	Visual Aesthetics	Ecosystem / Habitat	Air Quality	Urban Heat (esp. with trees)	Property Value	Recreation (access dependent)	Jobs
Green roof	O	⊗	⊗	⊗		×	⊗		×		⊗
ROW bio-swales (with trees)		⊗	⊗	⊗		×	⊗	O	⊗		⊗
Large Bio-retention Facilities		⊗	⊗	⊗	O	×	⊗		O	⊗	⊗
Porous pavement		⊗		⊗			⊗		O		⊗

⊗ Measurable and Monetizable Benefit
× Measurable Benefit
O Perceived Benefit

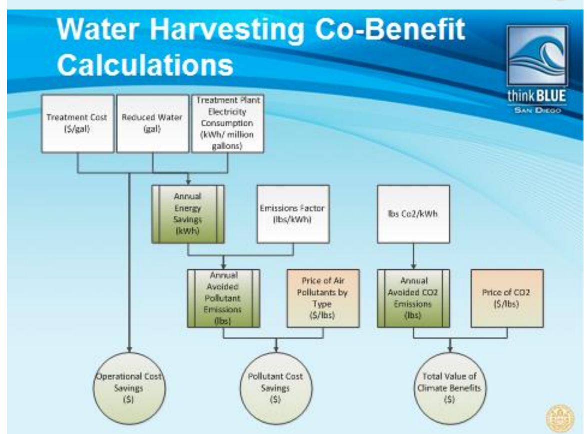

Potential Structural Strategies
thinkBLUE
SAN DIEGO
• Green Infrastructure
– Green streets, permeable pavement etc.
• Multiuse Treatment Areas
– Infiltration and detention basins, stream rehabilitation, etc.
• Water Quality Improvement
– Trash segregation, Proprietary BMPs, etc.


Co-Benefits of Green Streets
thinkBLUE
SAN DIEGO
» Unit of Measure
» Street miles of improvements
» Drivers of Impact
» Water retained
» Type of improvement (trees, etc.)
» Key Co-Benefits
» Habitat creation
» Business investment
» Human health improvement
» Energy Reduction

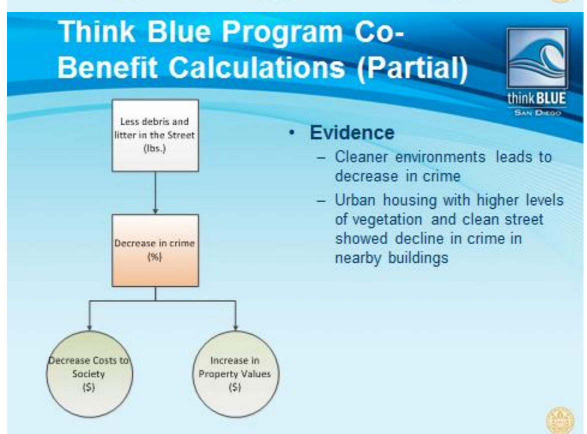

Green Streets Co-Benefit Calculations
thinkBLUE
SAN DIEGO
Increase in Green Streets (street miles)
Increase in habitat (acre)
Increase in Users/ Pedestrians (%)
Reduce Thermal Heat Island (%)
Value of habitat ($/acre)
Increase in retail sales ($)
Reduce Energy Consumption ($/kwh)
Reduce Human Health Impacts ($/person)
Total increase in habitat creation ($)
Total increase in retail sales tax revenue ($)
Reduced Energy Costs and Use Impacts ($)
Value of Reduced Human Impacts ($)


Potential Non-Structural Strategies
thinkBLUE
SAN DIEGO
» Increase # of structural systems
– Training, promotion, etc.
» Improve structural systems performance
– Design codes, monitor, etc.
» Initiatives to change behavior
– Education, enforcement, outreach, reduced pesticides, etc.
» Initiatives to reduce pollutants directly
– Street sweeping, protect natural areas, etc.

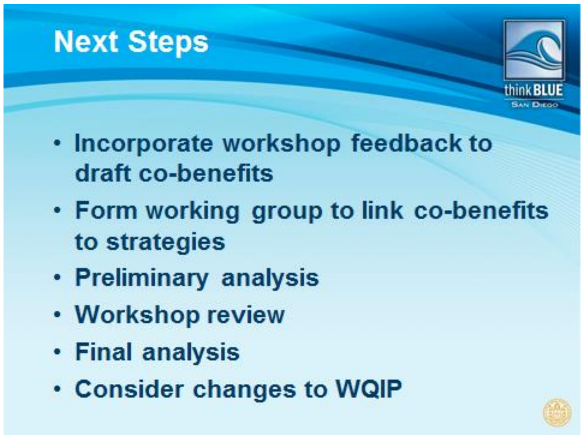

Co-Benefits of Water Harvesting Strategy
thinkBLUE
SAN DIEGO
» Unit of Measure
» Reduction in stormwater runoff
» Drivers of Impact
» Less water processed
» Key Co-Benefits
» Reduced water consumption, less municipal water diversion
» Reduced energy use and air pollution, GHG impacts


Water Harvesting Co-Benefit Calculations
thinkBLUE
SAN DIEGO
Treatment Cost ($/gal)
Reduced Water (gal)
Treatment Plant Electricity Consumption (kWh/ million gallons)
Annual Energy Savings (kWh)
Emissions Factor (lbs/kWh)
lbs Co2/kWh
Annual Avoided Pollutant Emissions (lbs)
Price of Air Pollutants by Type ($/lbs)
Annual Avoided CO2 Emissions (lbs)
Price of CO2 ($/lbs)
Operational Cost Savings ($)
Pollutant Cost Savings ($)
Total Value of Climate Benefits ($)


Co-Benefits of Education / Promotion of Think Blue Campaign
thinkBLUE
SAN DIEGO
» Unit of Measure
» # of people reached
» Drivers of Impact
» # of people who reduce litter
» Key Co-Benefits
» Improved residential neighborhoods aesthetics
» Increase in business investment reduction in crime


Think Blue Program Co-Benefit Calculations (Partial)
thinkBLUE
SAN DIEGO
Less debris and litter in the Street (lbs.)
Decrease in crime (%)
Decrease Costs to Society ($)
Increase in Property Values ($)
• Evidence
– Cleaner environments leads to decrease in crime
– Urban housing with higher levels of vegetation and clean street showed decline in crime in nearby buildings


Breakout Session
think BLUE
SAN DIEGO
Property Owners
Aesthetics
Flood Control
Business Investment
Environmental
Green House Gas Reductions
Habitat Creation
Soil Stabilization
General Public
Recreational
Human Health
Stewardship
Heat Island
Air Quality
Crime Reduction
Operational Cost Savings
Jobs
Other
?


Next Steps
think BLUE
SAN DIEGO
• Incorporate workshop feedback to draft co-benefits
• Form working group to link co-benefits to strategies
• Preliminary analysis
• Workshop review
• Final analysis
• Consider changes to WQIP


Closing Remarks
think BLUE
Questions?
Thanks for your participation!

Workshop Handout:

Water Quality Improvement Plans
Co-Benefits Description
Workbook

Co-Benefit: Aesthetics

Description: Visually appealing environments in communities, especially neighboring properties

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: # and Type of BMP, # of Affected Properties, Proximity to BMP, % increase in Property Value

Unit of Value: $ increase per property

Comments:

Co-Benefit: Air Quality

Description: Reduction of pollutants which cause health impacts

Unit of Measure: Tons of Pollutant

Drivers of Value: Reduction in Energy Use, Increase in Absorbtion of Air Pollutants

Unit of Value: $ per ton of pollutant reduced

Comments:

Co-Benefit: Business Development

Description: Increase in investment and revenue in clean, walkable environments

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: # and Type of BMP, # of Affected Properties,

Proximity to BMP, % pedestrian activity

Unit of Value: $ increase in retail sales

Comments:

Co-Benefit: Crime Reduction

Description: Clean/green neighborhods reduce incidents

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: # and Type of BMP, # of Affected Properties,

Proximity to BMP, % decrease in crime incidents

Unit of Value: $ per incident reduced

Comments:

Co-Benefit: Environmental Stewardship

Description: Increased awareness and environmental responsibility

Unit of Measure: # of persons educated

Drivers of Value: Population

Unit of Value: # of persons educated

Comments:

Co-Benefit: Flood control

Description: Reduced flood risk

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: $ Cost per flood

Unit of Value: $ per flood damage reduced

Comments:

Co-Benefit: Green House Gas Reduction

Description: Reduction of CO2

Unit of Measure: Tons of CO2

Drivers of Value: Reduction in Energy Use, Increase in Carbon Sequestration

Unit of Value: $ per ton of CO2 reduced

Comments:

Co-Benefit: Habitat Creation

Description: Protection or Creation of habitats

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: Acres of urban habitat protected/create

Unit of Value: $ per reduced heat related illness

Comments:

Co-Benefit: Heat Island Reduction

Description: Reduced ambient temperatures

Unit of Measure: Area of BMPs

Drivers of Value: # of Reduced Heating Degrees Days

Unit of Value: $ benefits from reduction in health

Comments:

Co-Benefit: Jobs

Description: Increase in # of local jobs in installation and maintenance

Unit of Measure: Capital & Maintenance Expenditures

Drivers of Value: $ spent

Unit of Value: Number of jobs created

Comments:

Co-Benefit: Operational Savings

Description: Reduction in energy use to process water

Unit of Measure: Gallons of water reduced

Drivers of Value: Cost per gallon processed

Unit of Value: $ per gallon of Water Reduced

Comments:

Co-Benefit: Public Health

Description: Reduced exposure to pesticides and other chemicals

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: # and Type of BMP, Ton of chemicals reduced

Unit of Value: $ per ton of chemicals reduced

Comments:

Co-Benefit: Recreation

Description: Increase in walkable environment

Unit of Measure: Size of recreational facility

Drivers of Value: Number of Recreational Users

Unit of Value: $ per recreational user

Comments:

Co-Benefit: Soil Stabilization

Description: Reduction in soil erosion

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: Acres of Stabilized Soil, Cost of Land Damage

Unit of Value: $ per acre of soil protect

Comments:

Workshop Comments Received

	Structural		
	Green Infrastructure (co-benefits)	Multi-Treatment Areas	Water Quality Improvements
1	Given that on the mesas, we have mostly clay soils that do not absorb storm water runoff, some of these potentials are limited. However, implementation of cisterns, vegetated filter strips, etc. have the potential to * Decrease flood risks as water is released into existing creeks over a longer period of time * Improve habitat as habitat is changing due to excessive water from urban run off (especially dry weather run off) * Dry water flow diversions will also reduce the excessive flows in many of our streams (compared to historical conditions)		
2	Topographic Blending of BMP/IMP approaches: upper watershed, mid, lower, coast Need to think beyond MS4 Parkways/sidewalks as filters, volume reduction, peakflow	Athletic Fields Parks - temp flooding,sedmiment capture	Micro - capture/treat; avoid regional systems Let habitat/green space do treatment
3	Comprehensive approach to improve water quality, reduce storm runoff and dry weather flows while providing education/outreach, as well as improving quality of life (improved feeling of "wellness", reduction in health costs associated with polluted and/or stressful environments). Weight native landscapes (endemic to location) to give higher value than standard palette approach that uses species that excel in erosion control and/or coverage to meet landscaping sign off criteria as quickly as possible	Construct facilities (e.g. detention basins) that are specifically designed for the location versus "cookie-cutter" approach to design and implementation. Favor designs that can be passively converted back to native landscapes (e.g. basin becomes a wetland). Weight native landscapes (endemic to location) to give higher value than standard palette approach that uses species that excel in erosion control and/or coverage to meet landscaping sign off criteria as quickly as possible. Factor in maintenance needs (costs, access, mitigation, permits) and responsibilities into design and implementation. Consult with other divisions and departments within the City, as well as consultation with key stakeholder groups (neighboring communities, jurisdictions, NGOs that include	KEY CO-BENEFITS - Eliminating dry weather flows and reducing peak flows of storm runoff will provide a suite of co-benefits. Freshwater itself causes problems when inputs become perennial (e.g. habitat conversion, non-native species introduction and establishment, vector breeding habitat). More effective management and (hopeful) elimination of dry weather inputs could provide co-benefits by reducing the aforementioned impacts and assist in efforts to mitigate and, eventually, remediate them. Eliminating dry weather inputs will be needed for compliance for the Los Penasquitos Lagoon's Sediment TMDL, since restoring salt marsh habitat within the lagoon in areas recently converted to brackish/freshwater habitat is one of the key compliance targets. Eliminating dry weather flows will also assist in compliance with the County-wide bacteria TMDL, since many "hot spots" are created or exacerbated by dry weather flows. Peak flows of storm runoff augmented by MS4 design or placement can create

	Structural		
	Green Infrastructure (co-benefits)	Multi-Treatment Areas	Water Quality Improvements
		non-profit management entities) to avoid conflicts in BMP implementation that include violation of NPDES permits, TMDLs, downstream impacts to receiving water bodies and valued habitats, creation of breeding habitat for harmful vectors, etc. Follow a comprehensive approach that considers benefits and impacts of both individual BMPs and a network of BMPs implemented throughout the watershed, including 9 receiving water body and valued habitats. Avoid knee-jerk reaction of putting out fires at specific locations. Rather, develop a comprehensive and adaptive approach that can be phased in over time to address water-quality priorities throughout their stages (shortterm, mid-term, long-term), take advantage of windows of opportunities (e.g. grant funding ops) and efficiently use available funding while setting up justification for future (and, when needed continuous) funding needs.	another suite of nasty things with regard to water quality that include loaded and delivery of contaminants to receiving water bodies, as well as contribute greatly to erosion and downstream sedimentation that create additional maintenance costs (e.g. digging out a box culvert or clearing sediment from a street) and can impact sensitive habitats that include receiving water bodies. Managing peak flows will also be needed to comply with the Lagoon's sediment TMDL, the county-wide bacteria TMDL, and load reductions for constitutes of concern and other harmful pollutants (e.g. pyrethroids) that cause impacts but have yet to be labeled "constituent of concern." Co-benefits of water quality improvements will need to consider improving the conditions of receiving water bodies (reduced bacteria loads, loss of functional habitats native to the region) rather than box checking to meet compliance targets (reduction of % of load by certain date, sending X amount of educational fliers out to communities). This will most likely involve consideration of qualitative data at some point, which should be captured some how (e.g. using it to weight criteria or alternatives under consideration. 10 Need to internalize costs associated with unintended and/or offsite consequences. For example - habitat conversion or creation of vector breeding habitat as a result of lowflow diversion that simply moves dry weather runoff somewhere else instead of addressing source(s) of the dry weather flows.
4	Possible portable water purification systems that operates on solar/wind energy	Treat the water before it enters the main body of water (canal, creek, river, lagoon, bay, ocean) by means of detention ponds, catch basins, vaults, diversion systems, sump wells, or any underground storage unit.	Removing bacteria and metals that are associated with trash and run-off.
5			

	Non-Structural			
	Increase Number of Structural Systems (co-benefits)	Improve Structural System Performance	Initiatives to Change Behavior (co-benefits)	Reduce Pollutants directly
1	Stream and/or habitat rehabiliation projects will increase biological diversity and provide more nature in our neighborhoods. Multi-treatment areas when focused on habitat restoration will enhance recreational opportunities, improve air quality, enhance aesthetics, contribute to heat island reduction, create jobs for upkeep and maintenance and providing living laboratories for our children to take their classroom learning into the field.		Initiatives to educate public and professional users of pesticides, herbicides and fertilizers will increase human health. Requiring interagency teams to deal with issues of homelessness will increase public safety while at the same time reducing feces and other toxic substances in our water. Initiatives to encourage proper disposal of pet waste will increase human health Initiatives to more quickly remove trash from recreational areas to keep them out of surface water will also improve recreational experiences and increase human health by limiting the amount of food available to rodents and hence reduce the rat population. Insuring that trash containers are available in all areas will keep trash out of surface water and will also improve recreational experiences and increase human health by limiting the amount of food available to rodents and hence reduce the rat population.	

	Non-Structural			
	Increase Number of Structural Systems (co-benefits)	Improve Structural System Performance	Initiatives to Change Behavior (co-benefits)	Reduce Pollutants directly
2	School Cirriculum, Incentives			
3	Improve or replace existing MS4 structures before building new ones when feasible (the City cannot maintain what it has now, let alone new structures) Hire additional staff to manage permits and contracts to third-parties hired to assist Storm Water Division. improve enforcement actions (e.g. controlling dry weather runoff that meets water quality criteria or circumvents MS4 (e.g. freshwater mounding) but still creates impacts to receiving waters, such as habitat conversion, invasive plant establishment, breeding habitat for disease transmitting vectors).	Design and implement monitoring programs that make sense (e.g. answers questions or generates useful data) rather than just following programmatic lines. Review and enforce third-party agreements (e.g. HOAs maintaining private BMPs). Provide incentives to landowners and businesses to comply with hydromod requirements in areas already developed (and exempt from hydromod regs)	Coordinate with other stakeholder groups (e.g. NGOs) to help promote efforts that provide co-benefits to local communities and clarify/modify resource regulation that does not apply or should not in certain cases where lines of evidence support the effort over the regulation. Promote and incentivize native landscapes and water re-use	Improve controls over dry weather flows to address freshwater mounding and seepage into the MS4 or open space areas. Remove City infrastructure (e.g. MS4, sewer lines, water lines) from sensitive lands (e.g. Los Peñasquitos Lagoon).
	Include lessons learned from case studies regarding design, implementation and maintenance. Use site specific design and implementation rather than cookie-cutter approach to BMP and private properties (e.g. Hansen Agregate). Re-locate businesses built and operating in the flood zone (e.g. Sorrento Valley) as a longterm solution that is more cost-effective than annual maintenance and lawsuits.			

	Non-Structural			
	Increase Number of Structural Systems (co-benefits)	Improve Structural System Performance	Initiatives to Change Behavior (co-benefits)	Reduce Pollutants directly
4	Private properties, as mentioned by the participants of the meeting on May 20th. (My company has had the privilege or working with Barona Casino I Barona Creek Golf where we found that they recycle all or their water run-off including rain, pavement, parking structure, landscaping and irrigation, which they all filter into one pond system for treatment. In addition, they are in the process of building reservoirs.}	Retrofit new proprietary technologies into existing structures by enhancing performance, focusing on set goals of contaminants of concern as overseen by SDRWQCB, EPA, etc. (Quantum Ozone has retrofitted into an existing vault/Catch Detention System prior to entering into a State Park, into a County Flood Tunnel, and also into existing ponds/lakes/reservoirs. We are open to any county/city or private property that would be willing to co-venture on a pilot project.)	Research outside the box of standard set BMP guidelines, to more natural /innovative technologies that are not part of existing BMPs. For example, ozone is 3,125 times more powerful than chlorine, and the misconception of it being "harmful" is due to lack of education. When properly applied, ozone will not cause negative bi-products, as Quantum Ozone has proved by not producing one negative bi-product in 7 years. We are an ozone planet, constantly having 0.02 parts per million of ozone constantly around us naturally.	Ground level education and awareness to future generations (3rd grade on up) to have Environmental Stewardship as part of the school curriculum along with' history and math, so that the governments that they create in the future will have these ideas naturally implemented into city maintenance and daily living.
5				Strategy: Elimination, to the maximum extent possible, of toxic chemicals in the environment, including herbicides, pesticides, detergents, poisons, paints, and petrochemicals. Co-benefit: an urban ecosystem that supports, to the maximum extent possible, a functioning food web from micro organisms to invertebrates and vertebrates. Co-benefit: recreation and educational opportunities in the form of diverse and inter-dependent organisms to observe and study. Co--benefit: swimmable and fishable waters.

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