Appendix A

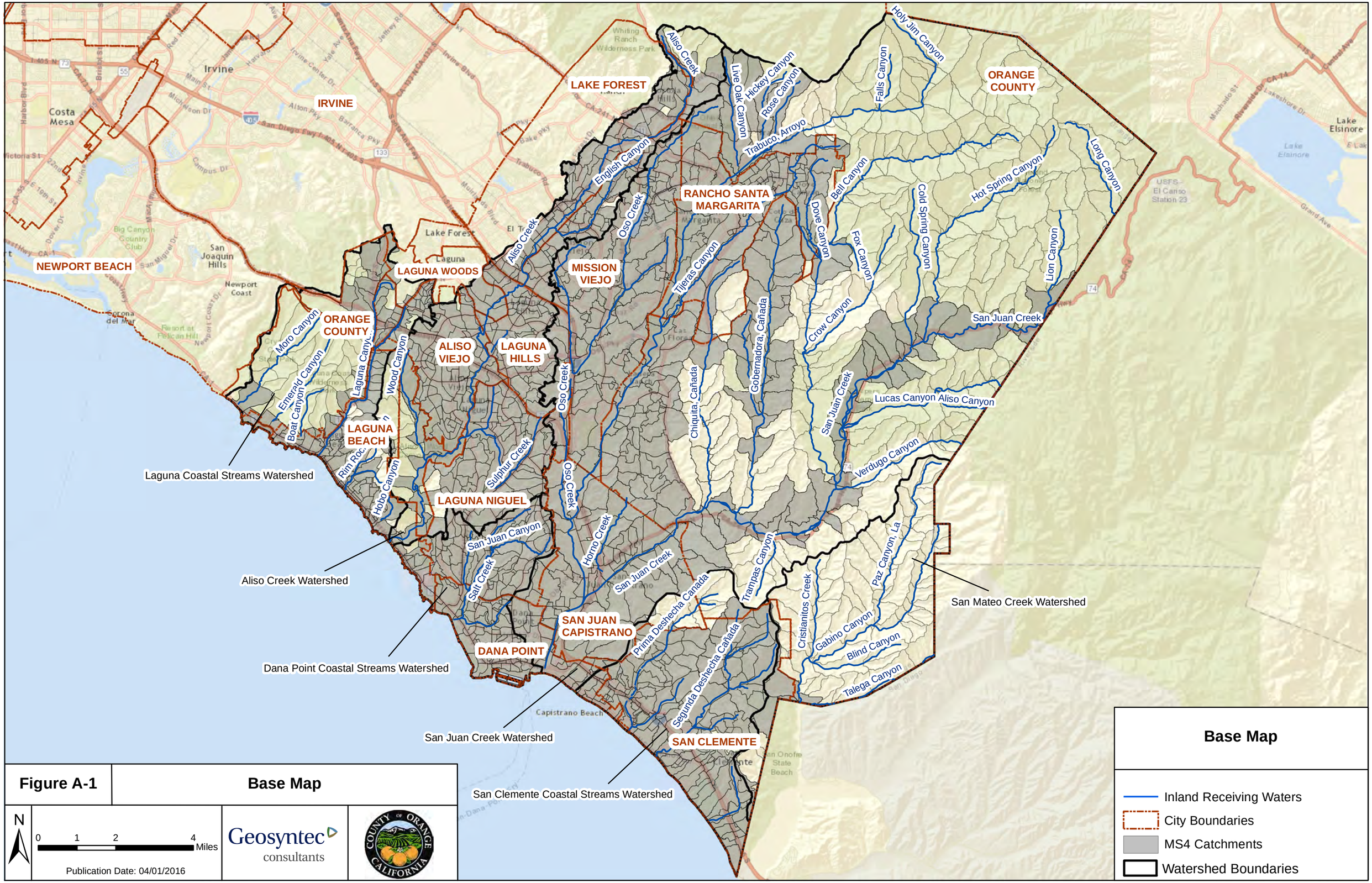


Figure A-1 **Base Map**

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Laguna Coastal Streams Watershed

Aliso Creek Watershed

Dana Point Coastal Streams Watershed

San Juan Creek Watershed

San Clemente Coastal Streams Watershed

San Mateo Creek Watershed

Dry Weather Flow Condition

In-channel Points
- Dry
- Ponded
- Flow

Coastal Points
- Dry
- Ponded
- Flow

Outfall Points
- Dry
- Ponded
- Flow

- Springs
- Inland Receiving Waters
- Watershed Boundaries
- MS4 Catchments

Figure A-2 | **Dry Weather Flow Condition**

N

0 1 2 4 Miles

Publication Date: 04/01/2016

Geosyntec consultants

Laguna Coastal Streams Watershed

Aliso Creek Watershed

Dana Point Coastal Streams Watershed

San Juan Creek Watershed

San Clemente Coastal Streams Watershed

San Mateo Creek Watershed

Figure A-3 | **Channel Type**

N

0 1 2 4 Miles

Publication Date: 04/01/2016

Geosyntec consultants

Channel Type

- Engineered
- Engineered Earth
- Natural Watercourse

Watershed Boundaries

MS4 Catchments

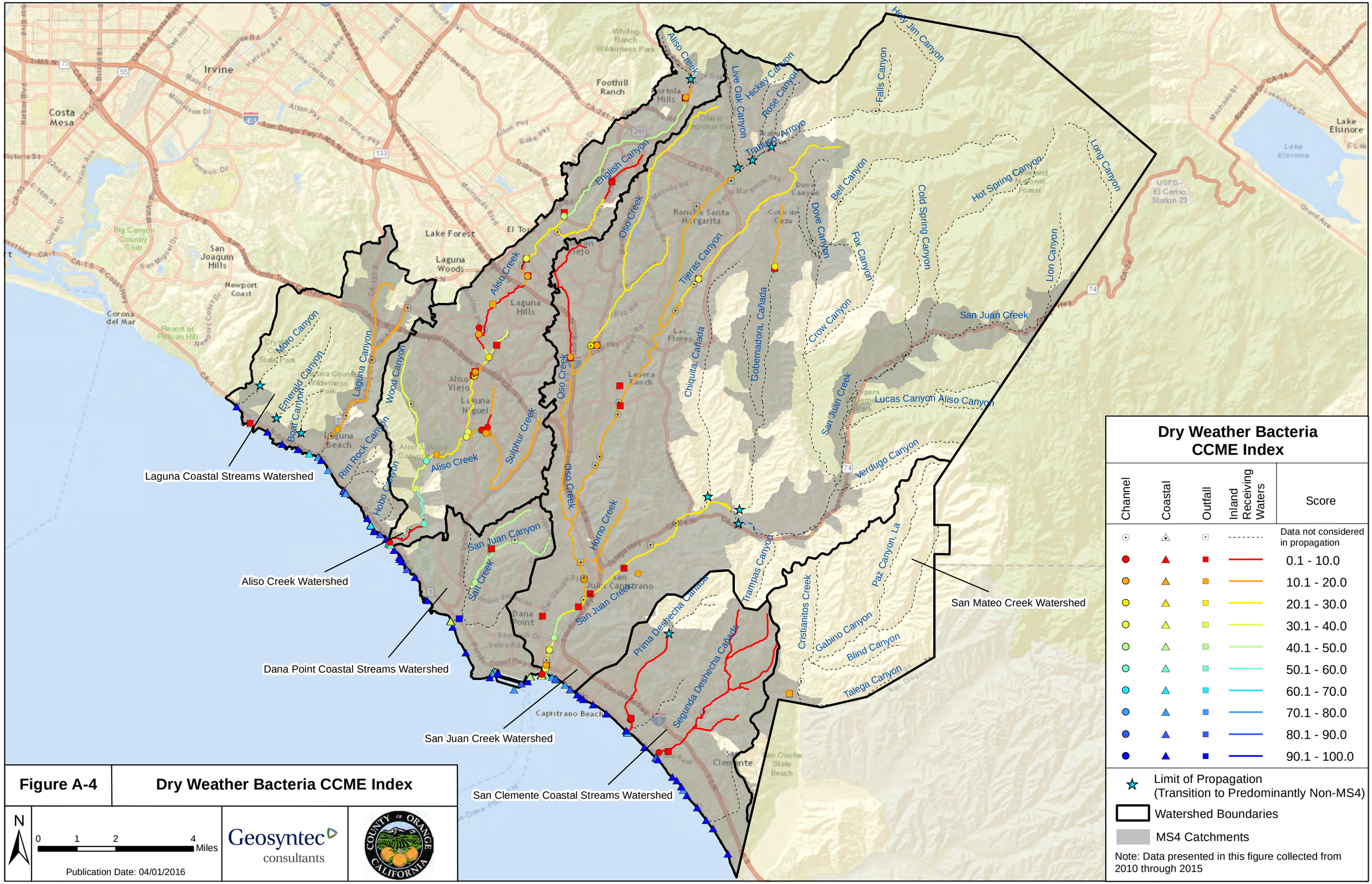


Figure A-4 | **Dry Weather Bacteria CCME Index**

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Laguna Coastal Streams Watershed

Aliso Creek Watershed

Dana Point Coastal Streams Watershed

San Juan Creek Watershed

San Clemente Coastal Streams Watershed

Boat Canyon

Rim Rock Canyon

Hobo Canyon

Aliso Creek

Sulphur Creek

Oso Creek

Horno Creek

San Juan Canyon

Salt Creek

San Juan Creek

Trampas Canyon

Deshecha Canada

Prima Deshecha Cañada

Segunda Deshecha Cañada

Verdugo Canyo

Paz Canyon, La

Lucas Ca

Laguna Niguel

San Juan Capistrano

San Clemente

Dry Weather Bacteria CCME Index

Channel	Coastal	Outfall	Inland Receiving Waters	Score
⊙	△	⊡	- - - - - -	Data not considered in propagation
●	▲	■	———	0.1 - 10.0
●	▲	■	———	10.1 - 20.0
●	▲	■	———	20.1 - 30.0
●	▲	■	———	30.1 - 40.0
●	▲	■	———	40.1 - 50.0
●	▲	■	———	50.1 - 60.0
●	▲	■	———	60.1 - 70.0
●	▲	■	———	70.1 - 80.0
●	▲	■	———	80.1 - 90.0
●	▲	■	———	90.1 - 100.0

★ Limit of Propagation (Transition to Predominantly Non-MS4)

Watershed Boundaries

MS4 Catchments

Note: Data presented in this figure collected from 2010 through 2015

Figure A-5 | **Coastal Dry Weather Bacteria CCME Index**

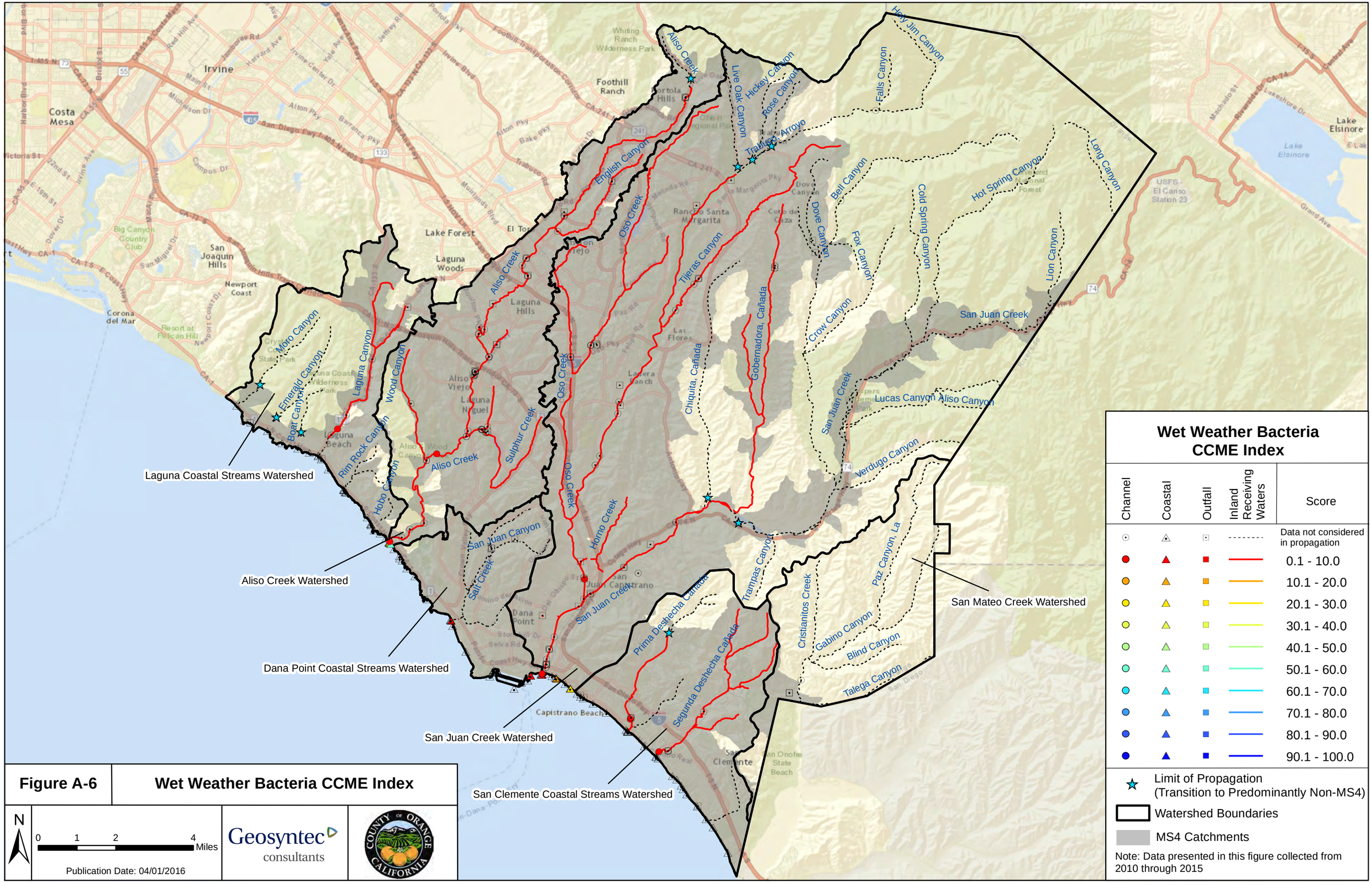
N

0 0.5 1 2 Miles

Publication Date: 04/01/2016

Geosyntec consultants

COUNTY OF ORANGE CALIFORNIA


Wet Weather Bacteria
CCME Index
Channel
Coastal
Outfall
Inland Receiving Waters
Score
Data not considered in propagation
0.1 - 10.0
10.1 - 20.0
20.1 - 30.0
30.1 - 40.0
40.1 - 50.0
50.1 - 60.0
60.1 - 70.0
70.1 - 80.0
80.1 - 90.0
90.1 - 100.0
Limit of Propagation (Transition to Predominantly Non-MS4)
Watershed Boundaries
MS4 Catchments
Note: Data presented in this figure collected from 2010 through 2015
Laguna Coastal Streams Watershed
Aliso Creek Watershed
Dana Point Coastal Streams Watershed
San Juan Creek Watershed
San Clemente Coastal Streams Watershed
San Mateo Creek Watershed
Irvine
Costa Mesa
Newport Coast
Corona del Mar
Laguna Beach
Laguna Hills
Laguna Woods
Lake Forest
Foothill Ranch
Rancho Santa Margarita
Dana Point
San Juan Capistrano
Capistrano Beach
San Clemente
Lake Elsinore
Aliso Creek
Live Oak Canyon
Hicky Jim Canyon
Hickey Canyon
Rose Canyon
Falls Canyon
Trabuco Arroyo
English Canyon
Oso Creek
Bell Canyon
Dove Canyon
Fox Canyon
Cold Spring Canyon
Hot Spring Canyon
Long Canyon
Lion Canyon
Tijeras Canyon
Chiquita, Cañada
Gobernadora, Cañada
Crow Canyon
San Juan Creek
Lucas Canyon
Aliso Canyon
Verdugo Canyon
Moro Canyon
Emerald Canyon
Boat Canyon
Laguna Canyon
Wood Canyon
Rim Rock Canyon
Hobo Canyon
Sulphur Creek
Horno Creek
San Juan Canyon
Salt Creek
Prima Deshecha Cañada
Segunda Deshecha Cañada
Trampas Canyon
Cristianitos Creek
Paz Canyon, La
Gabino Canyon
Blind Canyon
Talega Canyon
Figure A-6
Wet Weather Bacteria CCME Index
N
0 1 2 4 Miles
Publication Date: 04/01/2016
Geosyntec consultants
Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Laguna Coastal Streams Watershed

Aliso Creek Watershed

Dana Point Coastal Streams Watershed

San Juan Creek Watershed

San Clemente Coastal Streams Watershed

Boat Canyon

Rim Rock Canyon

Hobo Canyon

Aliso Creek

Sulphur Creek

Oso Creek

Horno Creek

San Juan Canyon

Salt Creek

San Juan Creek

Prima Deshecha Cañada

Segunda Deshecha Cañada

Trampas Canyon

Verdugo Canyo

Paz Canyon, La

Lucas C

Viejo

Laguna Niguel

Laguna Beach

Aliso & Wood Canyons Park

Saddleback College

Arroyo Trabuco Golf Club

San Juan Hills Golf Club

San Clemente

Monarch Beach Golf

Selva Rd

Del Prado Ave

Camino del Avion

Pacific Coast Hwy

Ortega Hwy

Crown Valley Pkwy

Antonio Pkwy

Oso Pkwy

Marguerite Pkwy

Aliso Creek Rd

Niguel Rd

Del Obispo St

Camino Capistrano

San Diego Creek

Wet Weather Bacteria CCME Index

Channel	Coastal	Outfall	Inland Receiving Waters	Score
				Data not considered in propagation
				0.1 - 10.0
				10.1 - 20.0
				20.1 - 30.0
				30.1 - 40.0
				40.1 - 50.0
				50.1 - 60.0
				60.1 - 70.0
				70.1 - 80.0
				80.1 - 90.0
				90.1 - 100.0

Limit of Propagation (Transition to Predominantly Non-MS4)

Watershed Boundaries

MS4 Catchments

Note: Data presented in this figure collected from 2010 through 2015

Figure A-7 | **Coastal Wet Weather Bacteria CCME Index**

N

0 0.5 1 2 Miles

Publication Date: 04/01/2016

Geosyntec consultants

COUNTY OF ORANGE CALIFORNIA

Laguna Coastal Streams Watershed

Aliso Creek Watershed

Dana Point Coastal Streams Watershed

San Juan Creek Watershed

San Clemente Coastal Streams Watershed

San Mateo Creek Watershed

Eutrophication Issues

Average of Nutrient CCME Indices (Wet and Dry) and H20 Algal Index

Inland Receiving Waters

Score

- Data not considered in propagation
- 0.1 - 10.0
- 10.1 - 20.0
- 20.1 - 30.0
- 30.1 - 40.0
- 40.1 - 50.0
- 50.1 - 60.0
- 60.1 - 70.0
- 70.1 - 80.0
- 80.1 - 90.0
- 90.1 - 100.0
- Limit of Propagation (Transition to Predominantly Non-MS4)
- Watershed Boundaries
- MS4 Catchments

Note: Data presented in this figure collected from 2010 through 2015

Figure A-8 **Eutrophication Issues**

N

0 1 2 4 Miles

Publication Date: 04/01/2016

Geosyntec consultants

Geomorphic Impact Related to Biology

Geomorphic Condition with IBI* Overlay

Channel	Coastal	Outfall	Inland Receiving Waters	Score
⊙	△	⊡	----------	Data not considered in propagation
●	▲	■	———	0.1 - 10.0
●	▲	■	———	10.1 - 20.0
●	▲	■	———	20.1 - 30.0
●	▲	■	———	30.1 - 40.0
●	▲	■	———	40.1 - 50.0
●	▲	■	———	50.1 - 60.0
●	▲	■	———	60.1 - 70.0
●	▲	■	———	70.1 - 80.0
●	▲	■	———	80.1 - 90.0
●	▲	■	———	90.1 - 100.0

- Limit of Propagation (Transition to Predominantly Non-MS4)
- > 10% Cumulative Impervious Cover (Elevated Hydromodification Risk)
- Major Hydromodification Impact (Rapid Aerial Survey)
- Watershed Boundaries
- MS4 Catchments

Note: Data presented in this figure collected from 2010 through 2015

* IBI: Index of Biological Integrity

Laguna Coastal Streams Watershed

Aliso Creek Watershed

Dana Point Coastal Streams Watershed

San Juan Creek Watershed

San Clemente Coastal Streams Watershed

San Mateo Creek Watershed

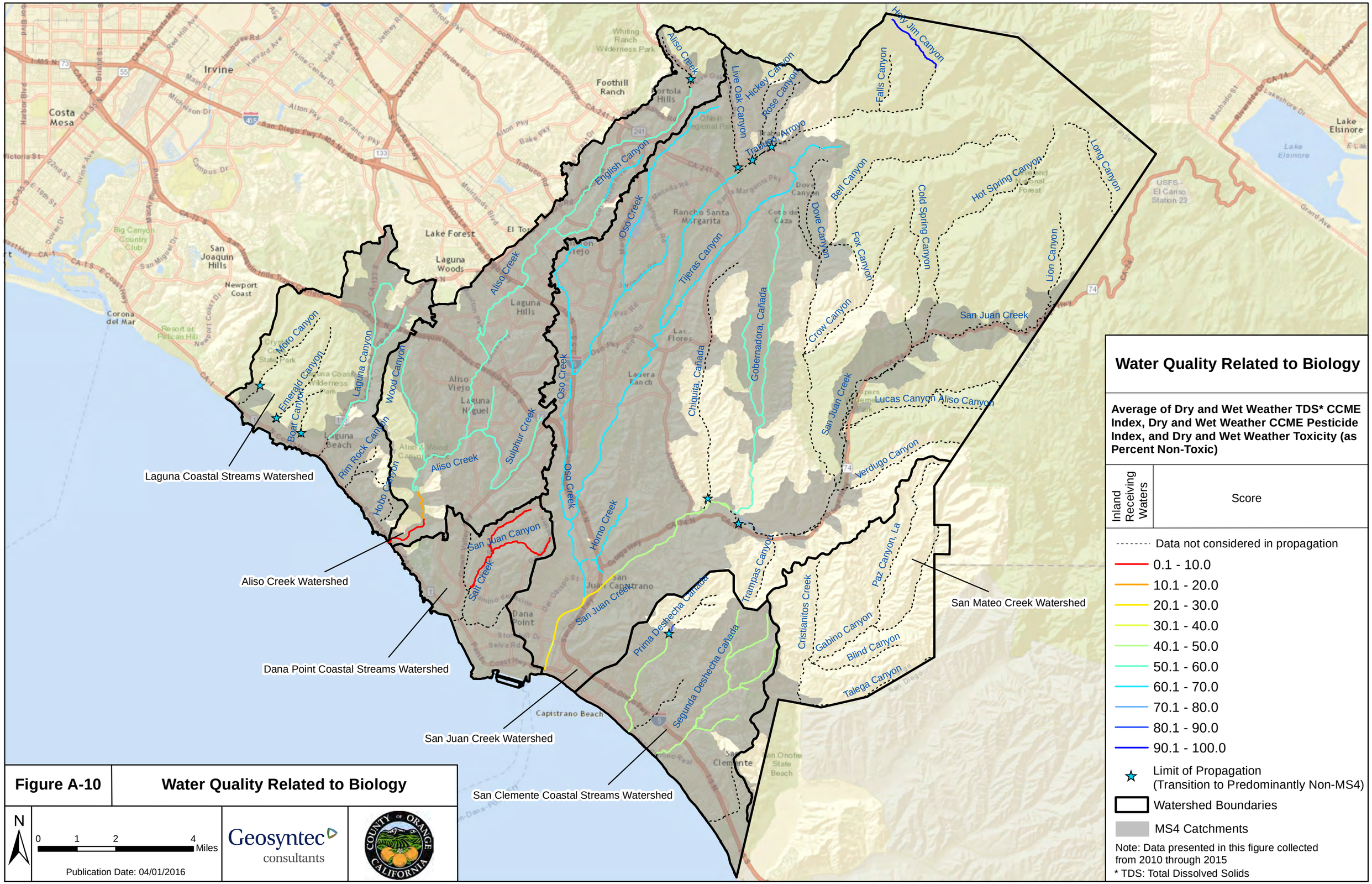
Figure A-9 **Geomorphic Impact Related to Biology**

N

0 1 2 4 Miles

Publication Date: 04/01/2016

Geosyntec consultants



Water Quality Related to Biology

Average of Dry and Wet Weather TDS* CCME Index, Dry and Wet Weather CCME Pesticide Index, and Dry and Wet Weather Toxicity (as Percent Non-Toxic)

Inland Receiving Waters — Score

- Data not considered in propagation
- 0.1 - 10.0
- 10.1 - 20.0
- 20.1 - 30.0
- 30.1 - 40.0
- 40.1 - 50.0
- 50.1 - 60.0
- 60.1 - 70.0
- 70.1 - 80.0
- 80.1 - 90.0
- 90.1 - 100.0
- Limit of Propagation (Transition to Predominantly Non-MS4)
- Watershed Boundaries
- MS4 Catchments

Note: Data presented in this figure collected from 2010 through 2015

* TDS: Total Dissolved Solids

Figure A-10 — **Water Quality Related to Biology**

N

0 1 2 4 Miles

Publication Date: 04/01/2016

Geosyntec consultants

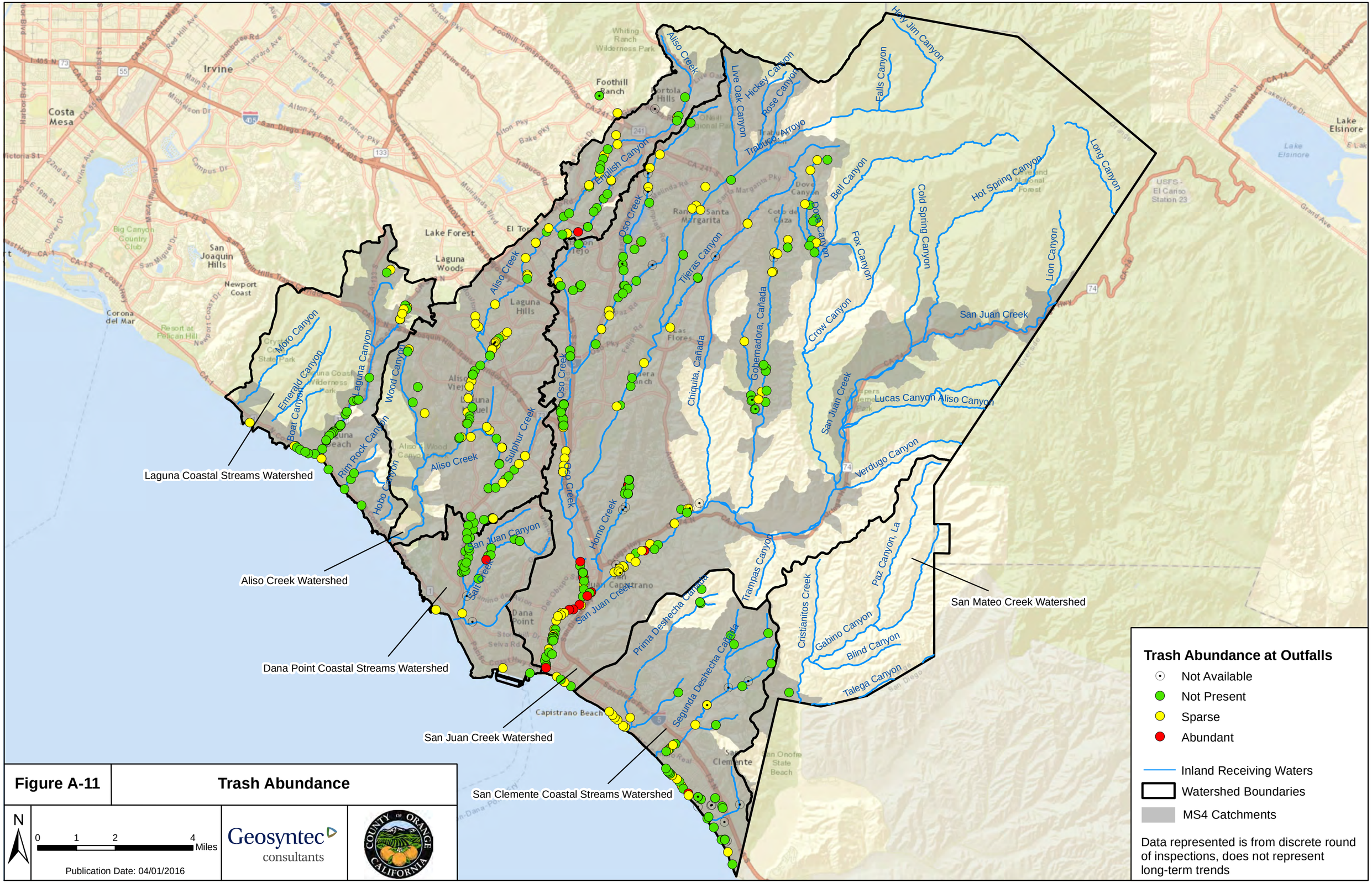


Figure A-11 **Trash Abundance**

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Laguna Coastal Streams Watershed

Aliso Creek Watershed

Dana Point Coastal Streams Watershed

San Juan Creek Watershed

San Clemente Coastal Streams Watershed

San Mateo Creek Watershed

Figure A-12 **Invasive Plant Species**

N

0 1 2 4 Miles

Publication Date: 04/01/2016

Geosyntec consultants

Inland Receiving Waters

Invasive Species

Watershed Boundaries

MS4 Catchments

Laguna Coastal Streams Watershed

Aliso Creek Watershed

Dana Point Coastal Streams Watershed

San Juan Creek Watershed

San Clemente Coastal Streams Watershed

San Mateo Creek Watershed

Maritime Limits

Sensitive Resources

- Inland Receiving Waters
- Maritime Limits
- Areas of Special Biological Significance
- Crystal Cove State Marine Conservation Area
- Dana Point State Marine Conservation Area
- Laguna Beach State Marine Conservation Area
- Laguna Beach State Marine Reserve
- Estuaries
- Wetlands
- Coastal Marsh Areas
- Watershed Boundaries
- MS4 Catchments

Data Source: California Department of Fish and Wildlife

Figure A-13 | **Sensitive Resources**

N

0 1 2 4 Miles

Publication Date: 04/01/2016

Geosyntec consultants

COUNTY OF ORANGE CALIFORNIA

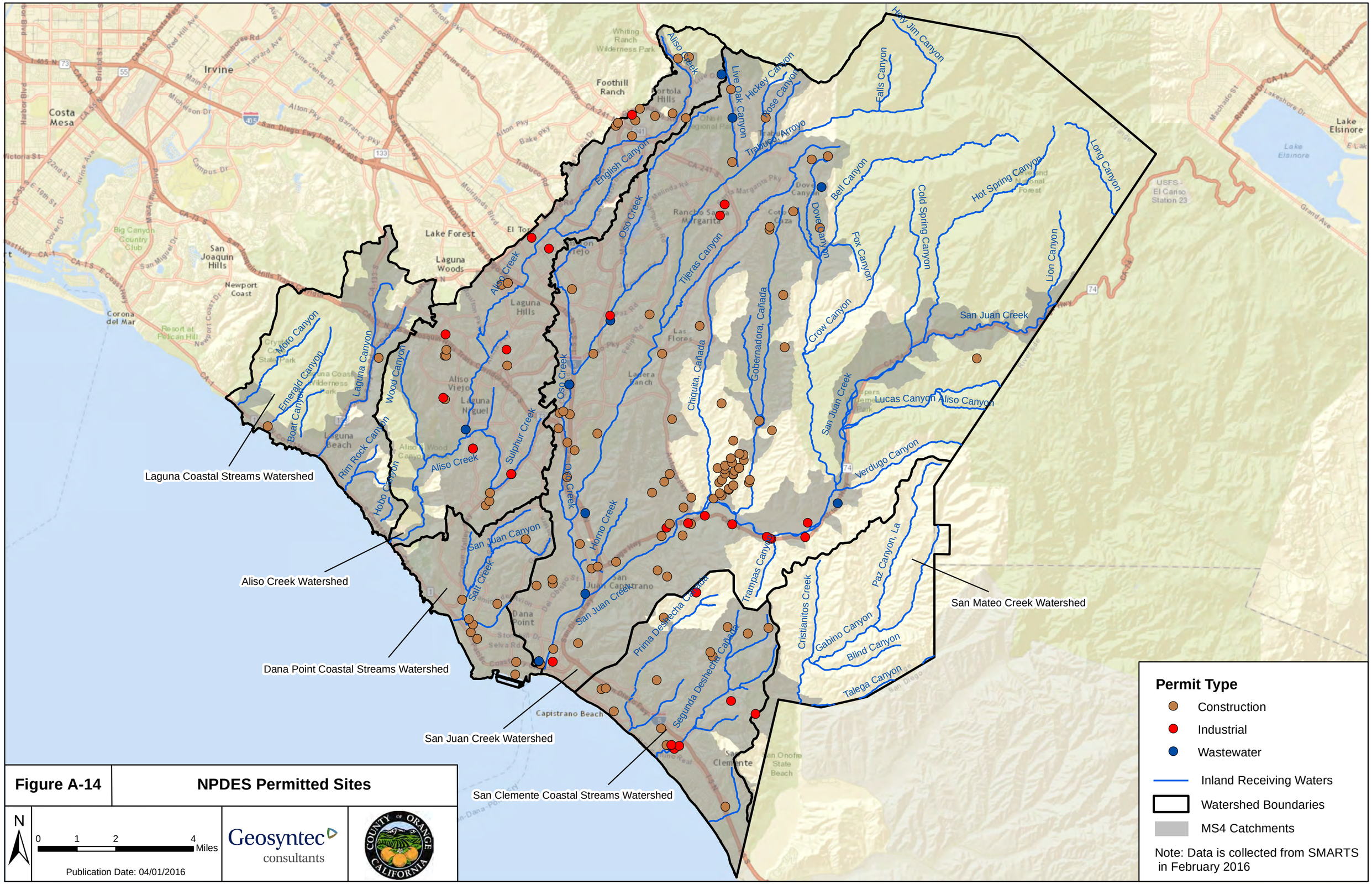
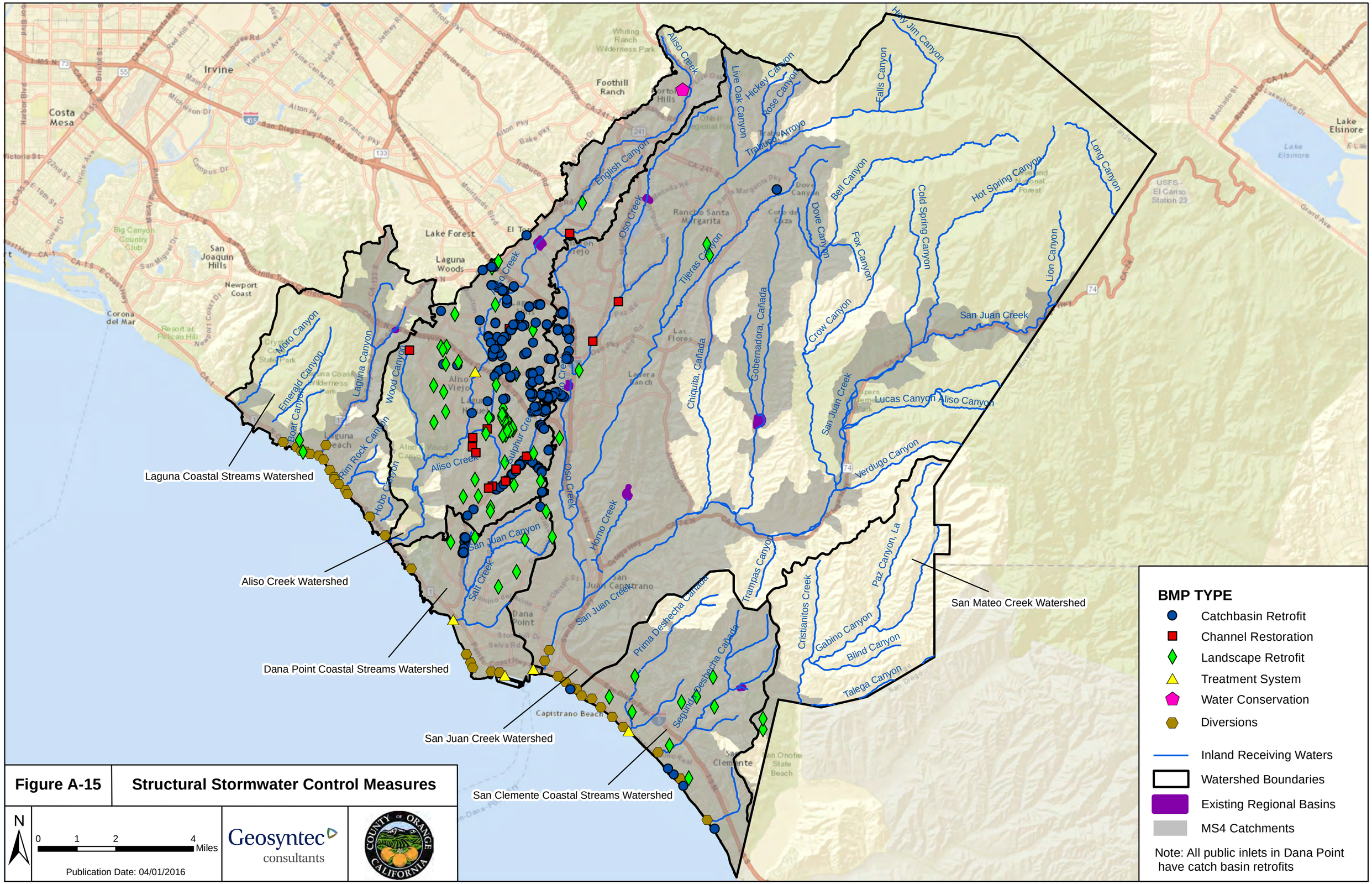
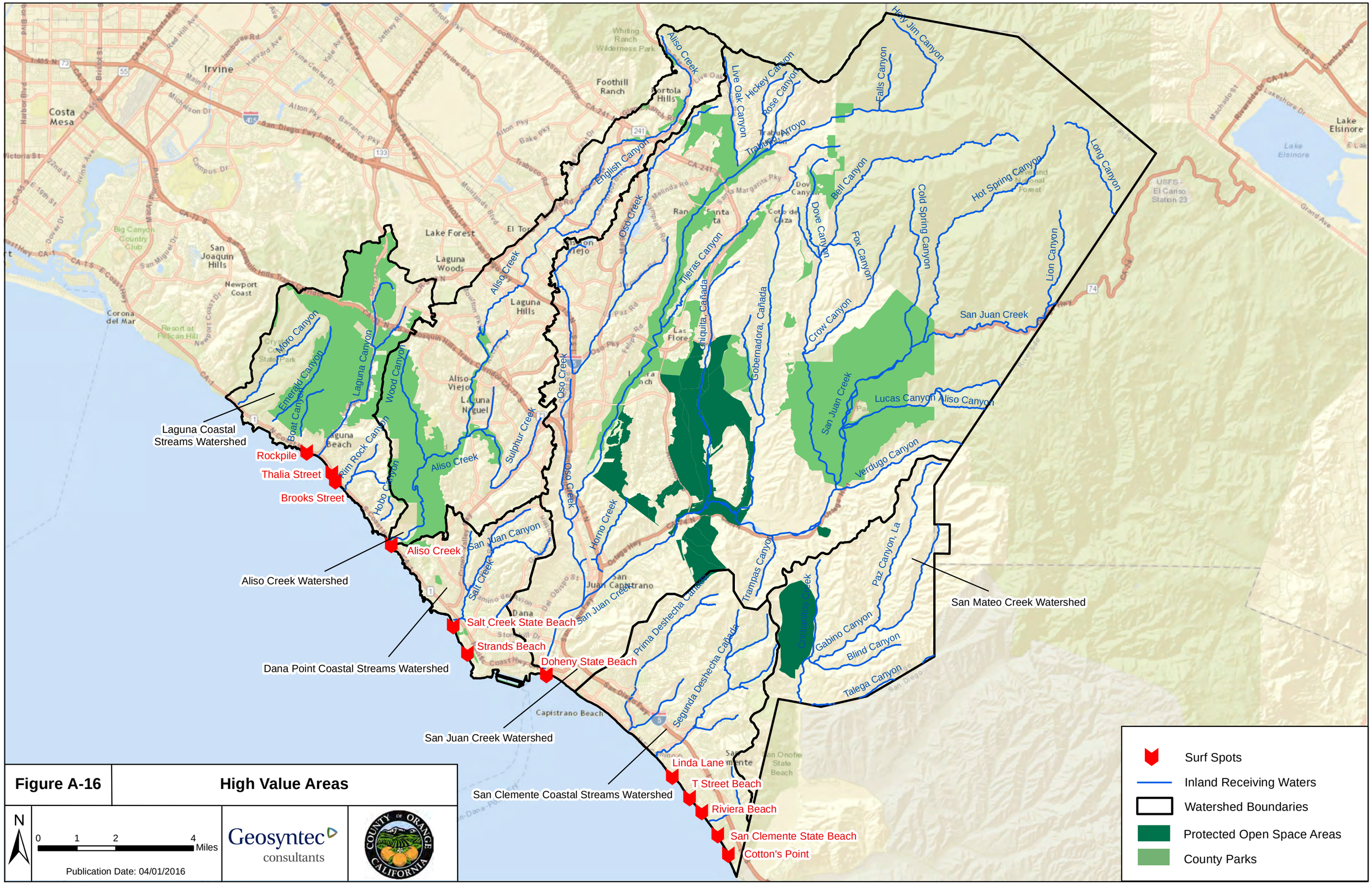
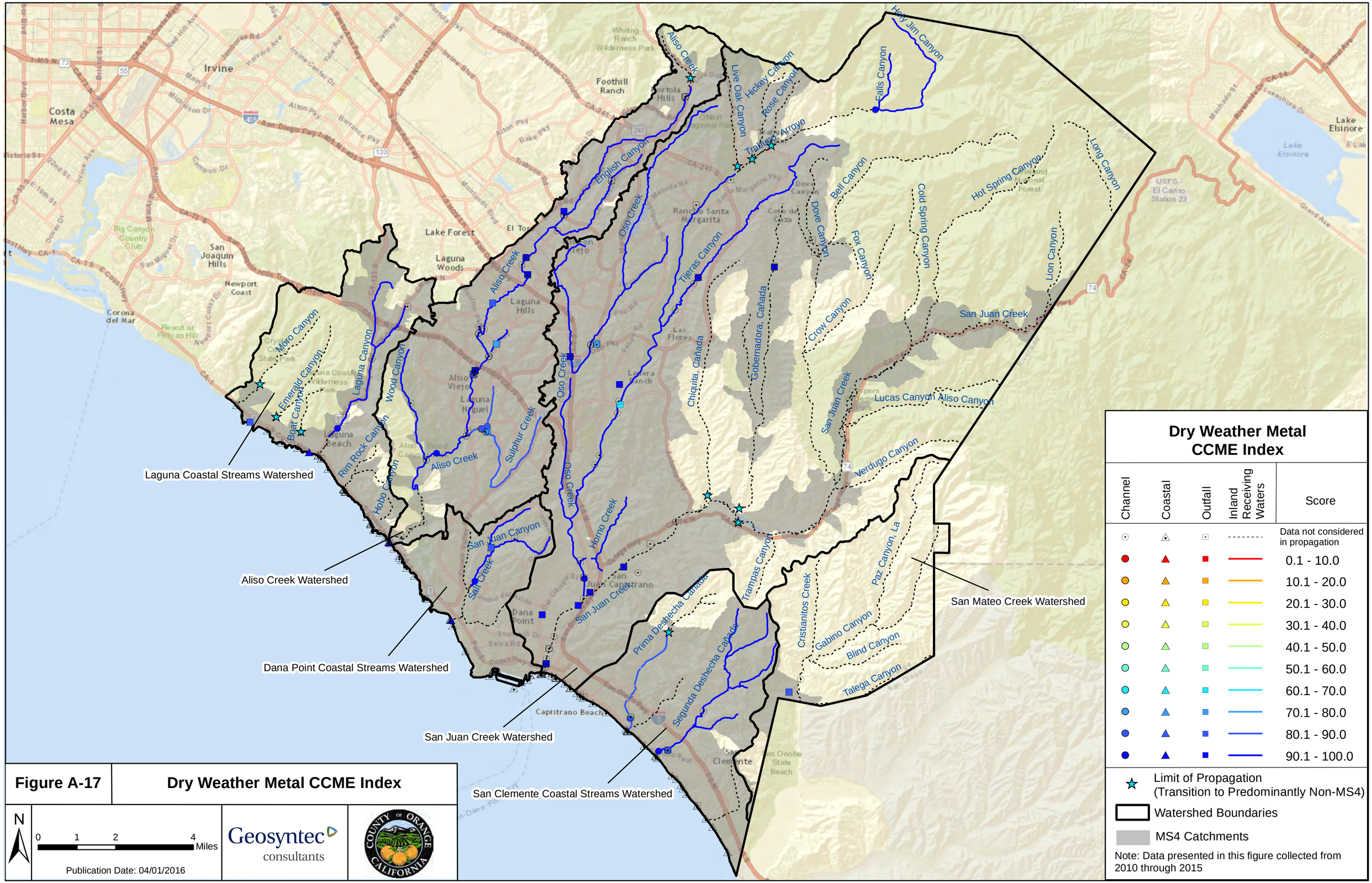


Figure A-14 **NPDES Permitted Sites**


Laguna Coastal Streams Watershed
Aliso Creek Watershed
Dana Point Coastal Streams Watershed
San Juan Creek Watershed
San Clemente Coastal Streams Watershed
San Mateo Creek Watershed
Irvine
Costa Mesa
Newport Coast
Corona del Mar
Laguna Woods
Lake Forest
Foothill Ranch
Rancho Santa Margarita
Las Flores
Ladera Ranch
Aliso Viejo
Laguna Beach
Dana Point
San Juan Capistrano
Capistrano Beach
San Clemente
Lake Elsinore
USFS - El Cariso Station 23
Aliso Creek
Oso Creek
Horno Creek
San Juan Creek
Salt Creek
Sulphur Creek
English Canyon
Live Oak Canyon
Hicky Jim Canyon
Hickey Canyon
Rose Canyon
Falls Canyon
Trabuco Arroyo
Bell Canyon
Dove Canyon
Fox Canyon
Cold Spring Canyon
Hot Spring Canyon
Long Canyon
Lion Canyon
Tijeras Canyon
Crow Canyon
Gobernadora, Cañada
Chiquita, Cañada
Moro Canyon
Emerald Canyon
Boat Canyon
Laguna Canyon
Wood Canyon
Rim Rock Canyon
Hobo Canyon
San Juan Canyon
Lucas Canyon
Aliso Canyon
San Juan Creek
Verdugo Canyon
Trampas Canyon
Prima Deshecha Cañada
Segunda Deshecha Cañada
Cristianitos Creek
Paz Canyon, La
Gabino Canyon
Blind Canyon
Talega Canyon
BMP TYPE
Catchbasin Retrofit
Channel Restoration
Landscape Retrofit
Treatment System
Water Conservation
Diversions
Inland Receiving Waters
Watershed Boundaries
Existing Regional Basins
MS4 Catchments
Note: All public inlets in Dana Point have catch basin retrofits
Figure A-15
Structural Stormwater Control Measures
N
0 1 2 4 Miles
Publication Date: 04/01/2016
Geosyntec consultants
COUNTY OF ORANGE CALIFORNIA
Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community



Dry Weather Metal CCME Index

Channel	Coastal	Outfall	Inland Receiving Waters	Score
⊙	△	⊡	----------	Data not considered in propagation
●	▲	■	———	0.1 - 10.0
●	▲	■	———	10.1 - 20.0
●	▲	■	———	20.1 - 30.0
●	▲	■	———	30.1 - 40.0
●	▲	■	———	40.1 - 50.0
●	▲	■	———	50.1 - 60.0
●	▲	■	———	60.1 - 70.0
●	▲	■	———	70.1 - 80.0
●	▲	■	———	80.1 - 90.0
●	▲	■	———	90.1 - 100.0

★ Limit of Propagation (Transition to Predominantly Non-MS4)

Watershed Boundaries

MS4 Catchments

Note: Data presented in this figure collected from 2010 through 2015

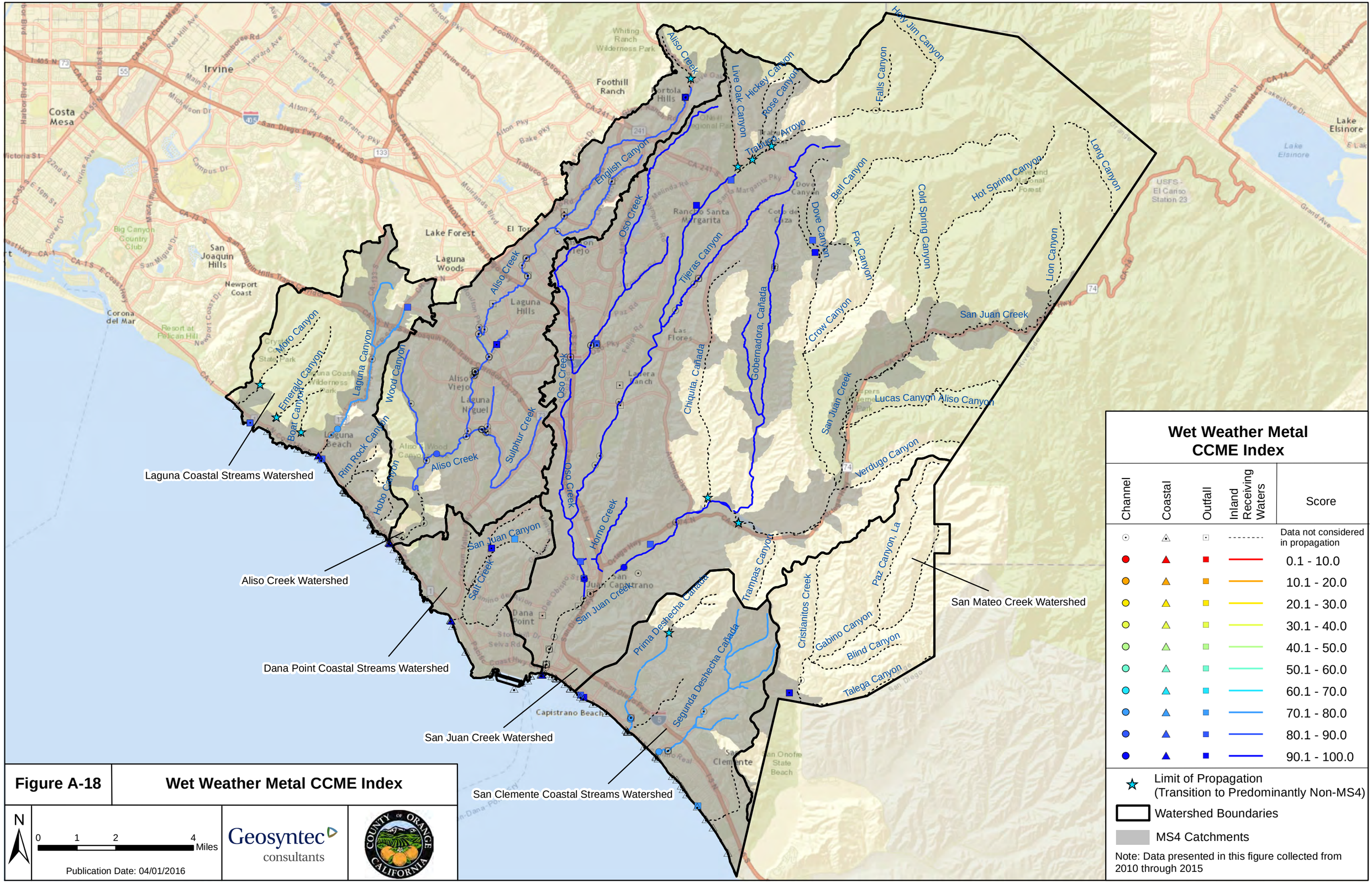
Figure A-17 | **Dry Weather Metal CCME Index**

N

0 1 2 4 Miles

Publication Date: 04/01/2016

Geosyntec consultants



Wet Weather Metal CCME Index

Channel	Coastal	Outfall	Inland Receiving Waters	Score
⊙	△	⊡	----------	Data not considered in propagation
●	▲	■	———	0.1 - 10.0
●	▲	■	———	10.1 - 20.0
●	▲	■	———	20.1 - 30.0
●	▲	■	———	30.1 - 40.0
●	▲	■	———	40.1 - 50.0
●	▲	■	———	50.1 - 60.0
●	▲	■	———	60.1 - 70.0
●	▲	■	———	70.1 - 80.0
●	▲	■	———	80.1 - 90.0
●	▲	■	———	90.1 - 100.0

★ Limit of Propagation (Transition to Predominantly Non-MS4)

Watershed Boundaries

MS4 Catchments

Note: Data presented in this figure collected from 2010 through 2015

Figure A-18 | **Wet Weather Metal CCME Index**

N

0 1 2 4 Miles

Publication Date: 04/01/2016

Geosyntec consultants

Appendix B

LIST OF DATA SOURCES AND REFERENCES TO SUPPORT WATER QUALITY IMPROVEMENT PLAN FOR THE SOUTH ORANGE COUNTY WATERSHED MANAGEMENT AREA
November 4, 2015

Orange County Public Works Data Sources and References

1. 2003 Drainage Area Management Plan (DAMP)
2. Program Effectiveness Assessment (PEA) Reports (2000-01 through 2013-14 reporting periods)
3. San Diego Region Report of Waste Discharge (ROWD) State of the Environment Report (2014)
4. Aliso Creek Watershed Runoff Management Plan (WRMP) Water Quality Data Assessment (2014)
5. Aliso Creek Comprehensive Load Reduction Plan (2014 update)
6. San Juan Creek Comprehensive Load Reduction Plan (2015 update)
7. San Juan Creek Watershed Bacterial Study (2002)
8. South Orange County Watershed Management Area (WMA) Integrated Regional Watershed Management (IRWM) Plan (2002)
9. San Juan Creek Watershed Management Plan (2002)
10. San Juan Creek Watershed Management Study F5 Report (2002)
11. South OC WMA Integrated Regional Watershed Management Plan (2013)
12. South Orange County Hydromodification Management Plan (2015)
13. Annual Progress Report for the Trash and Litter Investigation Special Study (2013)
14. Model Water Quality Management Plan (WQMP) for South Orange County (2013)
15. Baby Beach Dana Point Harbor Bacterial Indicator Total Maximum Daily Load Annual Progress Report (FY 2012-13)
16. Poche Clean Beach Project Annual Water Quality Report (2013)
17. San Mateo Creek Watershed Workplan (2013)
18. San Juan Creek Watershed Workplan (2013)
19. San Clemente Coastal Streams Watershed Workplan (2013)
20. Laguna Coastal Streams Watershed Workplan (2013)
21. Dana Point Coastal Streams Watershed Workplan (2013)
22. Aliso Creek Watershed Workplan (2013)
23. Regional Harbor Monitoring Program Pilot Project 2005-08 Final Report
24. Feasibility Scoping Meeting Documentation - Aliso Creek Mainstem Ecosystem Restoration Study (2009)
25. 2013-14 Baby Beach Bacteria Test Results - Appendix A
26. Baby Beach Annual Progress Report (FY13-14) Appendix B - BMP Implementation Timeline
27. Distribution of Data across the South Orange County Watersheds – Summary
28. OC Watersheds Monitoring Program Data for the San Diego Region (2001 – 2015)
29. Doheny State Beach Sewer Infrastructure Dye Study (2014 - 2015)
30. Technical Investigative Report of the L01S03 Drainage Area Source Investigation and Identification Study - San Juan Creek Watershed (2011)
31. Flood Plan for the South Orange County Integrated Regional Watershed Management Plan (2013)

32. Characterization of Total Dissolved Solids, Chloride, and Sulfate within the Oso Creek Watershed (2012)

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2. Heal the Bay: Annual Beach Report Cards (1999-2000 through 2013-14 reporting periods)
3. City of San Clemente: Poche Beach Bacterial Source Tracking Investigation, Final Report (2013)
4. Stormwater Monitoring Coalition (SMC): Bioassessment of Perennial Streams in Southern California: A Report on the First Five Years of the Stormwater Monitoring Coalition's Regional Stream Survey (2015)
5. Stormwater Monitoring Coalition (SMC): Ecological Condition of Watersheds in Coastal Southern California: Summary of Stormwater Monitoring Coalition's Stream Monitoring Program First Year -2009 (2011)
6. Southern California Coastal Water Research Project (SCCWRP): Sources, patterns and mechanisms of storm water pollutant loading from watersheds and land uses of the greater Los Angeles area, California, USA (2007)
7. Southern California Coastal Water Research Project (SCCWRP): Assessing Areas of Special Biological Significance Exposure to Stormwater Plumes Using a Surface Transport Model (2014)
8. Stormwater Monitoring Coalition (SMC): Bioassessment Survey of Stormwater Monitoring Coalition – Workplan for years 2015 through 2019 Version 1.0 (2015)
9. United States Environmental Protection Agency (EPA): Linking Nutrients to Alterations in Aquatic Life in California Wadeable Streams (2014)
10. Southern California Coastal Water Research Project (SCCWRP): Wet and Dry Weather Natural Background Concentrations of Fecal Indicator Bacteria in San Diego, Orange, and Ventura County, California Streams (2015)
11. Southern California Coastal Water Research Project (SCCWRP): Fecal Indicator Bacteria (FIB) Levels During Dry Weather from Southern California Reference Streams (2008)
12. Southern California Coastal Water Research Project (SCCWRP): Organophosphorous Pesticides in Stormwater Runoff from Southern California (2001)
13. Southern California Coastal Water Research Project (SCCWRP): Estimating Wet and Dry Deposition of Nitrogen to Southern California Streams: Final Report (2014)
14. Surface Water Ambient Monitoring Program (SWAMP): Report on the San Juan Hydrologic Unit (2008)
15. California Department of Pesticide Regulation (DPR): Ambient and Mitigation Monitoring in Urban Areas in Southern California during Fiscal Year 2014 – 2015
16. California Department of Pesticide Regulation (DPR): Monitoring Surface Water for Selected Insecticides in Red Imported Fire Ant Treatment Areas (1999)
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18. California Department of Pesticide Regulation (DPR): Urban Pesticide Monitoring in Southern California (2010)
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22. Bardsley, A.; Hammond, D. E.; von Bitner, T.; Nikolaus H. Buenning; Amy Townsend-Small (2015). Shallow Groundwater Conveyance of Geologically Derived Contaminants to Urban Creeks in Southern California.
23. City of Laguna Niguel: Upper Sulphur Creek Restoration Project - Final Report (2007)
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26. California State Water Resources Control Board (SWRCB): The Sulphur Solution: Prevent, Control, Restore Project – Final Report (2008)
27. City of Laguna Niguel: The Wetland Capture and Treatment Network (WetCAT) – Final Report (2004)
28. Municipal Water District of Orange County: Smart Timer Edgescape Evaluation Project (SEEP) – Final Report (2008)
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31. Surfrider Foundation: Blue Water Task Force - San Clemente Beaches Enterococcus Data (2000 – 2015)
32. City of Dana Point: Salt Creek Data (2008 - 2015)
33. Southern California Coastal Water Research Project (SCCWRP): Doheny State Beach Microbial Source Tracking Study (2014)
34. OC Coastal Cleanup Day Site Results (2014 & 2015)
35. City of Dana Point: San Juan Creek Observations (2006 – 2015)
36. South Orange County Wastewater Authority (SOCWA): Salt and Nutrient Management Plan for the South Orange County Aliso Creek, San Juan Creek and Portions of Other Basins (2014 Draft Report)
37. City of Dana Point: Recycled Water Fingerprint
38. South Orange County Recycled Water Systems Map (2014)
39. City of Dana Point: San Juan Creek Historical Photos, Maps, Narratives
40. Rancho Mission Viejo Company: San Juan Creek Watershed Stream Monitoring Program (2008)
41. Rancho Mission Viejo Company: Runoff Management Plan (2006)
42. Rancho Mission Viejo Company: Southern Subregion Natural Communities Conservation Plan
43. Audubon Starr Ranch: Bioassessment Data (2004-2014)

44. City of Aliso Viejo: Wood Canyon Wetland Water Quality Data (2006-2010)
45. City of Aliso Viejo: Dairy Fork Monitoring Data (2001-2011)
46. U.S. Army Corps of Engineers: Alternatives Analysis for San Juan Creek and Western San Mateo Creek Watersheds - Potential Impacts to Waters of the United States and Riparian Ecosystems (2005)
47. Dorsey, J.H. (2010). Improving Water Quality Through California's Clean Beach Initiative: an assessment of 17 projects.
48. Municipal Water District of Orange County: Doheny Desalination Project Reports - San Juan Creek and Costal Lagoon Baseline Environmental Monitoring Revised Scope

All the above listed data sources and references can be found at the following link:
https://ocgov.box.com/s/q7t3k92dn12mqmn3eswbrd1vftrlin10

Appendix C

APPENDIX C: QUANTITATIVE DATA SOURCES AND ASSOCIATED TECHNICAL DOCUMENTATION

C.1 Purpose

The purpose of this appendix is to provide technical documentation related to the data sources and analyzes utilized in the preparation of Chapter 2. This appendix includes information related to:

- Data sources and inventory
- Calculation of CCME indices
- Upstream propagation of point values, including propagation rules, limits of propagation.
- Downstream accumulation of catchment values.

This appendix supports the map exhibits in Appendix A and the description of methods described in Chapter 2.

C.2 Data Sources and Inventory

Datasets were compiled from a number of sources, primarily associated with Orange County and regional monitoring programs. Tables C-1 and C-2 provide inventories of these datasets by constituent and by station, respectively. Toxicity constituents are expressed as percent non-toxic for score calculation

Table C-1: Sample Count by Constituent

Constituent	Dry Weather	Wet Weather	Notes
Bifenthrin	73	100	
Cd	728	396	
Chronic *Ceriodaphnia dubia* survival	56	47	A
Acute *Ceriodaphnia dubia* survival	57	32	A
Chlorpyrifos	346	133	
Cr	728	396	
Cu	730	396	
Cyfluthrin	73	100	
Cypermethrin	73	100	
Diazinon	346	133	
Dimethoate	346	133	
E. coli	250	20	

Constituent	Dry Weather	Wet Weather	Notes
Enterococcus	7620	164	
Enterococcus Geomean	4191	48	
Fecal Coliform	7620	164	
Fecal Coliform Geomean	4194	48	
Chronic *Pimephales promelas* survival	8		A
Acute *Pimephales promelas* survival	8		A
H20 Algal Index	14		A
Chronic *Hyalella azteca* survival	8	5	A
Acute *Hyalella azteca* survival	65	25	A
Hyalella azteca survival, sediment	6		A
Index of Biotic Integrity	20		A
Malathion	346	133	
Acute *Americamysis bahia* survival	29	55	A
Ni	728	396	
Pb	728	396	
Permethrin	73	100	
Rapid Trash Assessment Score	12	12	A
Strongylocentrotus purpuratus fertilization	37	67	A
Total Coliform	7620	164	
Total Coliform Geomean	4193	48	
Total Dissolved Solids	3111	317	
Total Nitrogen	502	253	
Total Phosphorus	503	253	
Zn	728	396	
Total	**46170**	**5030**	

A: No CCME Index calculated for this constituent (see Section C.3)

Table C-2: Sample Count by Station

Watershed	Station Type	Station	Dry Weather	Wet Weather
San Juan Creek	Channel	901M14118	1	
San Clemente Coastal Streams	Channel	901M14124	1	
Aliso Creek	Channel	ACJ01	1468	595
Aliso Creek	Channel	ACM1	191	44
Aliso Creek	Coastal	ACM1d	366	168
Laguna Coastal Streams	Coastal	ACM1u	33	
Aliso Creek	Coastal	ACM1z	171	
Aliso Creek	Channel	ARJ01	787	
Laguna Coastal Streams	Outfall	AVI02P14		36

Watershed	Station Type	Station	Dry Weather	Wet Weather
Aliso Creek	Outfall	AVJ01P27	243	
Aliso Creek	Channel	AVJ01P27d	60	
Aliso Creek	Channel	AVJ01P27u	60	
Aliso Creek	Outfall	AVJ01P28	220	
Aliso Creek	Channel	AVJ01P28d	60	
Aliso Creek	Channel	AVJ01P28u	60	
Dana Point Coastal Streams	Coastal	BDP07	279	
Dana Point Coastal Streams	Coastal	BDP08	267	
Dana Point Coastal Streams	Coastal	BDP12	1059	3
Dana Point Coastal Streams	Coastal	BDP13	462	3
Dana Point Coastal Streams	Coastal	BDP14	1479	18
Dana Point Coastal Streams	Coastal	BDP15	1134	12
Dana Point Coastal Streams	Coastal	BDP16	279	
Dana Point Coastal Streams	Coastal	BDP17	279	
Laguna Coastal Streams	Coastal	BLUBRDd	27	
Laguna Coastal Streams	Coastal	BLUBRDu	27	
Laguna Coastal Streams	Coastal	BLUBRDz	198	
Laguna Coastal Streams	Coastal	BLULGNd	18	
Laguna Coastal Streams	Coastal	BLULGNu	21	
Laguna Coastal Streams	Coastal	BLULGNz	39	
San Mateo Creek	Channel	CC-CR	1	
Laguna Coastal Streams	Coastal	CLEOz	198	
San Juan Creek	Outfall	COL02P55	240	
San Juan Creek	Outfall	COL07P16	217	
San Juan Creek	Channel	COL07P16d	67	
San Juan Creek	Channel	COL07P16u	63	
San Juan Creek	Coastal	CSBBR1z	72	
San Juan Creek	Coastal	CSBMP1z	75	
Aliso Creek	Channel	CTPJ01	889	
San Juan Creek	Outfall	DPL01S02	221	
San Clemente Coastal Streams	Outfall	DPM00P05	28	36
San Juan Creek	Coastal	DSB1d	363	39
San Juan Creek	Coastal	DSB1z	174	
San Juan Creek	Coastal	DSB4d	375	39
San Juan Creek	Coastal	DSB4z	174	
San Juan Creek	Coastal	DSB5d	378	27
San Juan Creek	Coastal	DSB5z	174	
Laguna Coastal Streams	Coastal	DUMONDz	198	
Newport Coastal Streams	Coastal	ELMOROz	198	
Laguna Coastal Streams	Coastal	EMRLDz	198	
Laguna Coastal Streams	Coastal	HEISLRz	198	

Watershed	Station Type	Station	Dry Weather	Wet Weather
Laguna Coastal Streams	Outfall	IRVCOVE	29	104
Aliso Creek	Channel	J01dJ02	773	
Aliso Creek	Channel	J01dJ03	779	
Aliso Creek	Outfall	J01P08	9	45
Aliso Creek	Channel	J01P08d	715	
Aliso Creek	Outfall	J01P08DIS	707	
Aliso Creek	Channel	J01P08u	553	
Aliso Creek	Treatment System	J01P28 Ccin	39	
Aliso Creek	Treatment System	J01P28 Ccout	117	
Aliso Creek	Channel	J01P28d	716	
Aliso Creek	Outfall	J01P28DIS	294	
Aliso Creek	Channel	J01P28u	546	
Aliso Creek	Channel	J01uJ02	571	
Aliso Creek	Channel	J01uJ03	572	
Aliso Creek	Channel	J04	849	
Aliso Creek	Channel	J04d	701	
Aliso Creek	Channel	J04dX	55	
Aliso Creek	Channel	J04u	536	
Aliso Creek	Channel	J04uX	45	
Aliso Creek	Channel	J04Wet	807	
Aliso Creek	Channel	J05	717	
Aliso Creek	Channel	J05d	716	
Aliso Creek	Outfall	J05P01		36
Aliso Creek	Channel	J05u	539	
Aliso Creek	Channel	J06	713	
Aliso Creek	Channel	J06d	722	
Aliso Creek	Channel	J06u	550	
Aliso Creek	Outfall	J07P02	700	
Aliso Creek	Channel	J07P02d	711	
San Juan Creek	Outfall	J08TBN2		36
Dana Point Coastal Streams	Outfall	K01P07	9	45
Dana Point Coastal Streams	Outfall	K01TBN1		36
San Juan Creek	Channel	L01-PCH	170	
San Juan Creek	Outfall	L01S02	519	
San Juan Creek	Channel	L01S02d/s	295	
San Juan Creek	Channel	L01S02u/s	226	
San Juan Creek	Outfall	L01S04	202	
San Juan Creek	Channel	L01S04d/s	108	
San Juan Creek	Channel	L01S04u/s	88	
San Juan Creek	Channel	L01-SDu/s	340	
San Juan Creek	Outfall	L01TBN2	8	109

Watershed	Station Type	Station	Dry Weather	Wet Weather
San Juan Creek	Outfall	L02P32		51
San Juan Creek	Outfall	L02TBN2		70
San Juan Creek	Outfall	L03P09	9	80
San Juan Creek	Outfall	L08TBN1	9	43
San Clemente Coastal Streams	Outfall	LADERA		106
San Clemente Coastal Streams	Coastal	LADERAz	81	
Laguna Coastal Streams	Coastal	LB2d	186	52
Laguna Coastal Streams	Coastal	LB3d	23	104
Laguna Coastal Streams	Outfall	LBIRVCOVE	133	
Laguna Coastal Streams	Channel	LC-133	2	
Laguna Coastal Streams	Channel	LCWI02	371	540
Aliso Creek	Outfall	LFJ01P01	242	
Aliso Creek	Channel	LFJ01P01d	60	
Aliso Creek	Channel	LFJ01P01u	60	
Aliso Creek	Outfall	LFJ01P05	153	
Aliso Creek	Channel	LFJ01P05d	36	
Aliso Creek	Channel	LFJ01P05u	36	
Aliso Creek	Outfall	LHJ05P01	174	
San Juan Creek	Outfall	LHL04P02	178	
San Juan Creek	Channel	LHL04P02d	60	
San Juan Creek	Channel	LHL04P02u	55	
San Clemente Coastal Streams	Coastal	LINDALz	66	
Aliso Creek	Outfall	LNJ03P13	226	
Aliso Creek	Channel	LNJ03P13d	56	
Aliso Creek	Channel	LNJ03P13u	57	
Dana Point Coastal Streams	Outfall	LNK01P07	214	
Aliso Creek	Outfall	LWJ01ASVM	108	
San Clemente Coastal Streams	Outfall	M00P01	17	35
San Clemente Coastal Streams	Outfall	M03P01	8	98
Laguna Coastal Streams	Coastal	MAINBCz	198	
San Clemente Coastal Streams	Coastal	MARIPOz	54	
Dana Point Coastal Streams	Coastal	MDP10	279	
Dana Point Coastal Streams	Coastal	MDP11	279	
Dana Point Coastal Streams	Coastal	MDP18	261	
Aliso Creek	Outfall	MVJ01P03	260	
Aliso Creek	Channel	MVJ01P03d	60	
Aliso Creek	Channel	MVJ01P03u	60	
Aliso Creek	Outfall	MVL02P14	222	
San Juan Creek	Outfall	MVL03P09	243	
San Juan Creek	Channel	MVL03P09b	23	
San Juan Creek	Channel	MVL03P09d	59	

Watershed	Station Type	Station	Dry Weather	Wet Weather
San Juan Creek	Channel	MVL03P09u	59	
Laguna Coastal Streams	Coastal	OLB05	198	
San Clemente Coastal Streams	Channel	PDCM01	304	521
San Clemente Coastal Streams	Coastal	PDOM01d	47	3
Laguna Coastal Streams	Coastal	PEARLd	21	
Laguna Coastal Streams	Coastal	PEARLu	21	
Laguna Coastal Streams	Coastal	PEARLz	135	
San Clemente Coastal Streams	Coastal	PICOd	12	
San Clemente Coastal Streams	Coastal	PICOz	69	
San Clemente Coastal Streams	Coastal	PIERz	69	
San Clemente Coastal Streams	Coastal	POCHEd	33	
San Clemente Coastal Streams	Coastal	POCHEu	39	
San Clemente Coastal Streams	Coastal	POCHEz	72	
San Juan Creek	Channel	REF-BC	1	
San Juan Creek	Channel	REF-TCAS	160	
San Clemente Coastal Streams	Coastal	RIVERAz	57	
San Juan Creek	Outfall	RSML02P25	36	36
San Juan Creek	Outfall	RSML11P01	239	
San Juan Creek	Channel	RSML11P01d	60	
San Juan Creek	Channel	RSML11P01u	60	
San Juan Creek	Coastal	S-0	216	
Dana Point Coastal Streams	Coastal	S1	198	
San Juan Creek	Coastal	S-1	174	
Laguna Coastal Streams	Coastal	S10	171	
Laguna Coastal Streams	Coastal	S11	176	
San Juan Creek	Coastal	S-11	78	
Laguna Coastal Streams	Coastal	S12	171	
San Juan Creek	Coastal	S-13	81	
San Clemente Coastal Streams	Coastal	S-15	78	
San Clemente Coastal Streams	Coastal	S-17	81	
San Clemente Coastal Streams	Coastal	S-19	81	
Dana Point Coastal Streams	Coastal	S2	198	
San Juan Creek	Coastal	S-2	174	
San Clemente Coastal Streams	Coastal	S-21	81	
San Clemente Coastal Streams	Coastal	S-23	66	
Laguna Coastal Streams	Coastal	S3	173	
San Juan Creek	Coastal	S-3	174	
Laguna Coastal Streams	Coastal	S4	183	
Laguna Coastal Streams	Coastal	S5	159	
San Juan Creek	Coastal	S-5	174	
Laguna Coastal Streams	Coastal	S6	174	

Watershed	Station Type	Station	Dry Weather	Wet Weather
Dana Point Coastal Streams	Coastal	S-6	198	
Laguna Coastal Streams	Coastal	S7	180	
Laguna Coastal Streams	Coastal	S8	174	
Aliso Creek	Coastal	S9	352	36
San Juan Creek	Coastal	S-9	78	
San Clemente Coastal Streams	Outfall	SCBS@M02	296	
San Clemente Coastal Streams	Channel	SCBS@M02d	60	
San Clemente Coastal Streams	Channel	SCBS@M02u	60	
San Clemente Coastal Streams	Coastal	SCCS52z	39	
San Clemente Coastal Streams	Outfall	SCM01CGV	178	
San Clemente Coastal Streams	Channel	SCM01CGVd	54	
San Clemente Coastal Streams	Channel	SCM01CGVu	54	
San Clemente Coastal Streams	Outfall	SCM03P01	249	
Dana Point Coastal Streams	Coastal	SCM1d	465	166
Salt Creek	Coastal	SCM1u	198	
Dana Point Coastal Streams	Coastal	SCM1z	198	
Dana Point Coastal Streams	Channel	SC-MB	138	
San Clemente Coastal Streams	Channel	SD-AP	2	
San Clemente Coastal Streams	Channel	SDCM02	389	620
San Juan Creek	Channel	SJC1	240	
San Juan Creek	Coastal	SJC1d	452	161
San Juan Creek	Coastal	SJC1u	17	
San Juan Creek	Coastal	SJC1z	216	
San Juan Creek	Channel	SJC-74	2	
San Juan Creek	Channel	SJCL01	324	33
San Juan Creek	Outfall	SJCL01@CC	110	
San Juan Creek	Outfall	SJCL01S01	68	
San Juan Creek	Outfall	SJCL01S01N	135	
San Juan Creek	Outfall	SJCL01S09	178	
San Juan Creek	Channel	SJCL01S09b	24	
San Juan Creek	Outfall	SJCL01TBN1	199	
San Juan Creek	Outfall	SJCL02P02	28	36
San Juan Creek	Channel	SJNL01	50	228
San Juan Creek	Channel	SMC00206	2	
Laguna Coastal Streams	Channel	SMC00531	2	1
San Juan Creek	Channel	SMC00873	3	1
Aliso Creek	Channel	SMC00910	2	1
San Juan Creek	Channel	SMC00963	3	1
Tijeras Creek	Channel	SMC01257	3	1
Laguna Coastal Streams	Channel	SMC01555	3	1
San Juan Creek	Channel	SMC01678	1	1

Watershed	Station Type	Station	Dry Weather	Wet Weather
San Juan Creek	Channel	SMC01934	2	1
Aliso Creek	Channel	SMC01987	2	1
Aliso Creek	Channel	SMC03011	2	1
San Juan Creek	Channel	SMC03523	2	1
San Juan Creek	Channel	SMC03779	1	1
San Juan Creek	Channel	TC-DO	2	
San Juan Creek	Channel	TCOL02	367	524
San Clemente Coastal Streams	Coastal	TRFCYNz	81	
Laguna Coastal Streams	Outfall	VICTRA	8	44
Laguna Coastal Streams	Coastal	VICTRAz	198	
Laguna Coastal Streams	Coastal	WESTz	174	
Total			**46170**	**5030**

C.3 CCME Indices

The Canadian Council of Ministers of the Environment (CCME) index (CCME, 2001) was used to develop water quality scores for those constituents with applicable standards that could be used to assess exceedance). This index accounts for:

- Scope of exceedance (F1): The average percentage of indicators within a category that exceeded standards in each year (0 to 100). For example, if 2 of 3 indicators exceeded at least once in year 1, and 1 of 3 indicators exceeded in year 2, and 2 of 3 indicators exceeded in year three, then the average scope of exceedance (F1) would be 1.67 out of 3, or 56%.
- Frequency of exceedance (F2): The percentage of individual samples that exceeded applicable standards (0 to 100). For example, if 6 out of 9 individual measurements exceeded the applicable standard, then the average frequency of exceedance (F2) would be 67%.
- Magnitude of exceedance (F3): The average magnitude by which exceedance values exceeded the applicable standard (0 to 100).

The magnitude of exceedance (F3) is calculated based on the normalized sum of excursion where (NSE).

$$nse = \frac{\sum_{i=1}^{n} excursion_i}{\#\ of\ tests}$$

Where

$$excursion_i = \left(\frac{FailedTestValue_i}{Objective_j} \right) - 1$$

The magnitude of exceedance (F3) is then calculated as:

$$F_3 = \left(\frac{nse}{0.01nse + 0.01} \right)$$

For example, based on a simplified hypothetical dataset in Table C-3, the NSE and F3 parameters would be calculated as 2.63 and 72, respectively.

Table C-3: Example calculation of NSE and F3 parameters

Sample #	Standard, mg/L	Measurement, mg/L	Excursion$_i$
1	0.5	0.25	-
2	0.5	0.7	1.4
3	0.5	2	4
4	0.5	1.3	2.6
5	0.5	0.4	-
6	2	0.3	-
7	2	2.5	1.25
8	2	8	4
9	2	5	2.5
		Sum of Excursions	15.75
		# of Tests with Excursion	6
		Normalized Sum of Excursion (NSE)	**2.63**
		Magnitude of Excursion (F_3)	**72**

The composite CCME index is then calculated as:

$$CCMEWQI = 100 - \left(\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732} \right)$$

For the example values described above, the CCME Index would be:

$$CCMEWQI = 100 - \left[\frac{\sqrt{56^2+67^2+72^2}}{1.732}\right] = 14$$

A minimum sample count of 4 was used to develop the each score to ensure statistical stability, consistent with the approach utilized by the Central Coast Regional Water Quality Control Board. This sample count was enforced at each monitoring point, but was not applied on an annual basis (i.e., did not require at least 4 samples in a given year).

Table C-4 describes the applicable standards that were used to evaluate scope, frequency, and magnitude of exceedance.

Table C-4: Water quality standards applied for calculation of CCME WQI

Constituent	Units	Water Quality Benchmark
Total Coliform	CFU/100 mL	4000
Fecal Coliform	CFU/100 mL	200
Enterococcus	CFU/100 mL	35
E. coli	CFU/100 mL	126
Bifenthrin	ng/L	2
Chlorpyrifos	ng/L	40
Cyfluthrin	ng/L	7
Cypermethrin	ng/L	69
Diazinon	ng/L	110
Dimethoate	ng/L	500
Malathion	ng/L	35
Permethrin	ng/L	5
Total Dissolved Solids	mg/L	1000
Total Nitrogen	mg/L	1
Total Phosphorus	mg/L	0.1
Lead	ug/L	CTR*
Cadmium	ug/L	CTR*
Chromium	ug/L	CTR*
Nickel	ug/L	CTR*
Copper	ug/L	CTR*
Zinc	ug/L	CTR*

* CTR: California Toxics Rule

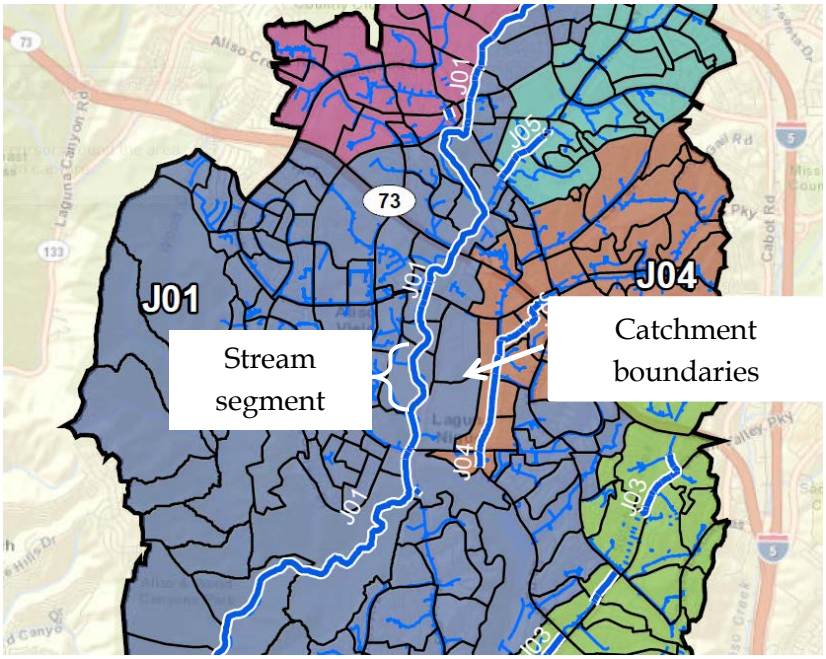
C.4 GIS Routines for Propagation and Accumulation

Indices or parameter values at discrete monitoring points were propagated to stream reaches using an algorithm based on methods used by the Central Coast Regional Water Quality

Control Board for its stream conditions report card. Additionally, an accumulation algorithm was developed to assign cumulative watershed parameters to each stream reach.

An example of the spatial resolution of catchments and stream reaches used in propagation and accumulation routines is provided in Figure 1.

Figure C-1: Example Spatial Resolution of Propagation and Accumulation



Propagation Rules

The following rules were applied to propagating point values. Propagation was done independently for each parameter or score.

1. Break stream reaches at catchment boundaries and associated each reach segment with the catchment it lies within. Catchments are the basis for upstream/downstream routing and propagation through the watershed network.
2. Filter monitoring points to only those reflecting in-stream conditions (i.e., excluding points associated with lateral inputs from outfalls).
3. Associate each in-stream monitoring point ("channel" point) with a catchment based on location:
    a. Where a single monitoring point with non-zero value (zero in dataset represents not available data) lies inside of a catchment polygon, assign the score associated with that point to the catchment.

b. If more than one monitoring point lies inside of a catchment and both contain a value for the parameter or score of interest, take the average of points with non-zero values.

4. Assign the score from step 3 to all stream reaches that are upstream of that reach, including lateral branches, until a catchment/reach containing a new monitoring point is reached that has a new non-zero score for the same metric.
5. Switch to the new score and repeat step 4.
6. Stop when the limits of propagation are reached.
7. For reaches that are not upstream of a monitoring point with a score for a given metrics, do not assign a score.
8. Repeat process for all metrics.

Propagation using the tool was conducted for the individual metrics within the metric groupings (e.g. eutrophication, water quality-related issues), afterwhich the individual propagation results were averaged within each grouping for display on the figures.

Limits of Propagation

Limits of propagation were defined manually based on limits of urbanization, location of monitoring points, and location of regional stormwater management facilities. In concept, water quality monitoring data from downstream of urban influence may not represent water quality in areas without urban influence. Additionally, reaches that do not receive discharges from the MS4 are not of interest in this Plan. The following types of transition were included:

Transitions between MS4 and non-MS4 land uses: These points were relatively apparent based on review of land uses and the local drainage system data. Notably, the limits of propagation are not final. If a reach transitions from MS4 to non-MS4 land uses and another monitoring point lied above that transition, scoring was resumed at the monitoring point.

Transition to Ranch Mission Viejo development area: This limit was set based on (1) existing water quality is not representative of future developed condition, and (2) an extensive water quality planning effort has been undertaken including the CEQA process and RWQCB Section 401 certification for the proposed development.

Canada Gobernadora downstream of Gobernadora Basin: The Gobernadora Basin operates as a full diversion of dry weather flows. There are no MS4 discharges downstream of this facility, therefore data in San Juan Creek are not representative of current conditions in Canada Gobernadora. This limit of propagation was only applied for dry weather.

Downstream Accumulation Rules

The downstream accumulation routine applies the following process:

1. Break stream reaches at catchment boundaries and associated each reach segment with the catchment it lies within. Catchments are the basis for upstream/downstream routing and propagation through the watershed network.
2. Determine the catchments tributary to each catchment/reach in the watershed.
3. Accumulate values
    a. For normalized values (e.g., imperviousness), apply area weighting to calculate the cumulative composite value associated with the tributary area to each catchment (inclusive of current catchment).
    b. For absolute values (e.g., land use X), sum the values of the tributary catchments (inclusive of current catchment).
4. Apply to each catchment independently.
5. Assign the accumulated values for each catchment to the respective segment of the stream reach that lies within each catchment.

Both propagator and accumulator tools can apply different aggregation methods including: average, mean, minimum, maximum, weighted average, median, and percentiles of parameters or scores.

C.5 Rapid Aerial Survey Methodology to Identify Major Hydromodification Impacts

A rapid survey based on historic aerial photography was undertaken as a first screening level approach to identify major hydromodification impacts, specifically areas of major stream instability. A summary of the steps and criteria associated with this approach is provided in the following bullets.

- Identify potentially susceptible channels that define the scope of the survey. Channels were identified as potentially susceptible if they were located downstream of developed area and were not fully armored. The mapping of cumulative impervious cover at each reach (described in Section C.4 and show in Exhibit A-9) were also used to focus efforts.
- Within GoogleEarth, search each reach of potentially susceptible channels by toggling between historic aerial photographs obtained at various time increments.
    - In general, the earliest aerial photographs are from around 1990. At least 5 distinct time periods can be reviewed between 1990 and present, often more, sometimes obtained in different seasons.
    - For the purpose of this analysis, survey reaches were defined by the length of channel that fits within the viewing screen at an altitude of 4,000 to 5,000 feet.

    - Survey tended to focus first at storm drain outfalls, road crossings, and other distinct features, as these provide a consistent frame of reference and are often associated with most acute impacts.
- Within each series of historical photographs for a given reach, inspect for clear signals of hydromodification impacts, such as:
    - Major overall changes in channel vegetation (bare vs vegetated), active channel width, and channel alignment. Seasonal changes in vegetation, typical to the region, were not considered to be clear signals of hydromodification impact.
    - Major temporary changes in vegetation (such as soon after development), which may become less distinguishable after vegetation has re-established.
    - Response to channel after major El Nino winters (e.g., 1998, 2005) in comparison to other channels. Even natural channels will tend to evolve over time, though response to major events is often more noticeable in channels experiencing hydromodification impacts.
    - Clear signs of infrastructure exposure/damage.
    - Clear signs of cut banks, knick points, or other forms of erosion.
- Save images for reaches with possible or clear hydromodification impacts. The possible impacts were then revisited at the end of the survey and reviewed by multiple professionals to determine whether they should be included.

The purpose of this step was to identify only those reaches that could clearly be confirmed as being development-induced hydromodification using this method. Additional levels of survey are needed to identify less pronounced impacts. This method was more limited and may need to be augmented with more rigorous survey methods in the following conditions:

- Areas developed prior to 1990 where the most obvious impacts occurred prior to the period of aerial photography reviewed.
- Reaches with significant vegetative cover that obscured aerial photography.
- Smaller channels where resolution of current or historical aerial photography limited interpretation.
- Channels that were significantly modified as part of land development designs, which changed stream form and vegetation, but is not necessarily resulting in macro-scale instability.

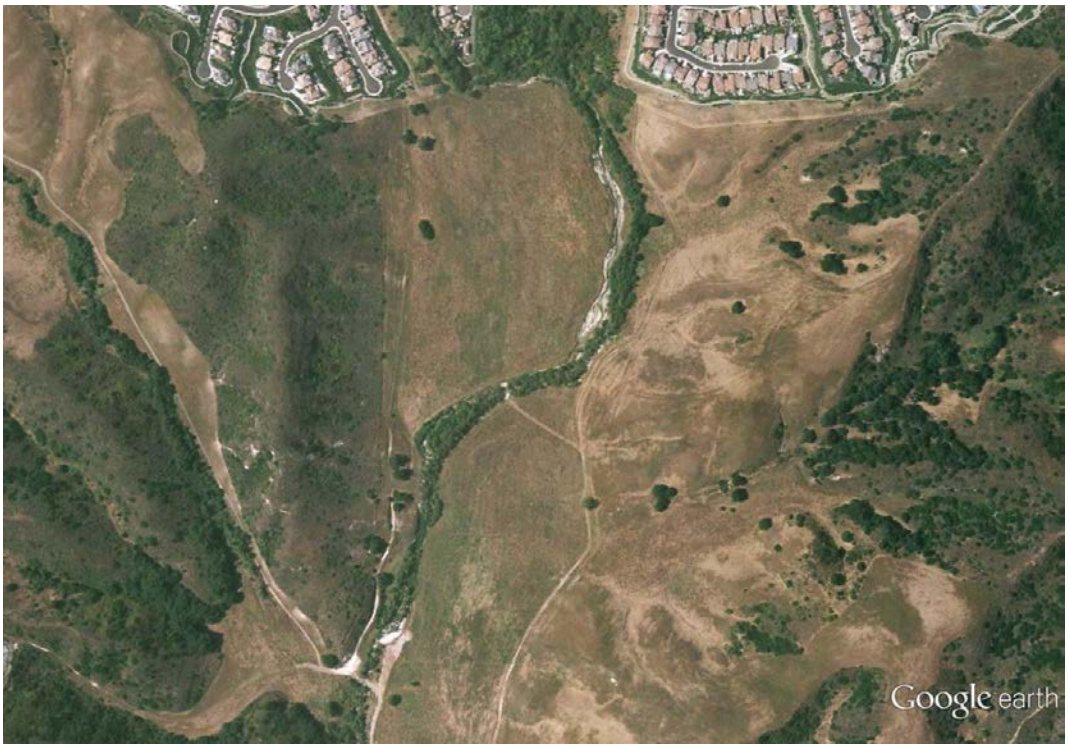
The photographs below provide examples from Gobernadora Canyon at just less than 5,000-ft altitude. Note that this reach has since been rehabilitated and is not included as a major hydromodification impact in Exhibit A-9.

5/31/1994 pre-development

6/14/2002 post development: channel avulsion to the west of previous active channel is noticeable.

1/20/2004: avulsed channel gets wider

12/31/2004: avulsed channel gets wider in downstream direction.

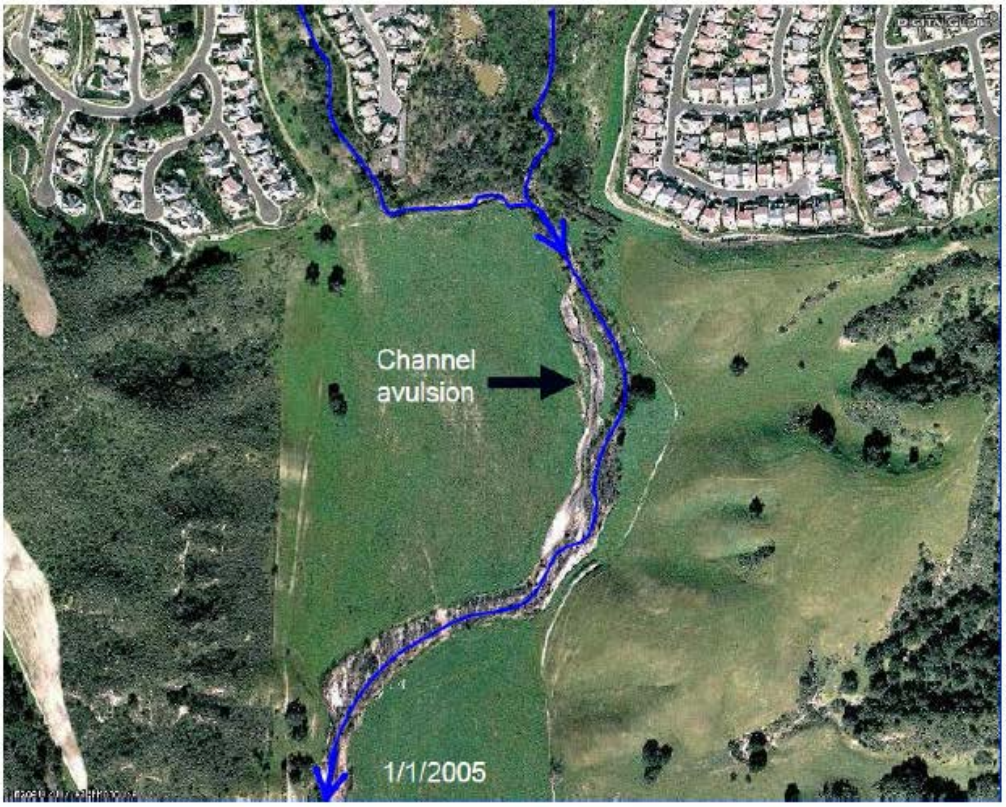


2/28/2007: avulsed channel begins to stabilize with vegetation established in avulsed channel.

11/14/2009: in-channel vegetation established in avulsed channel

3/7/2011: vegetation lost within avulsed channel indicating continued instability.

The pictures below provide an example of what that channel avulsion in the aerial looked like in the field (Balance Hydrologics, 2006).




March 2004


March 2005

C.6 References

Balance Hydrologics, Inc. 2006. Stream Response to Hydromodification in a Sandy Watershed, Gobernadora Canyon, Orange County, California. Technical Presentation.

Appendix D

APPENDIX D: GLOSSARY OF KEY TERMS

Adaptive management – The iterative approach by which Permittees can adapt the Water Quality Improvement Plan, monitoring and assessment program, and jurisdictional runoff management programs to become more effective towards achieving water quality compliance.

Bed and bank material – Bed material refers to substrate (e.g., sand, silt, clay, rock, bedrock) that makes up the bottom of a stream. Bank material refers to the soil material composition that forms the sides of natural channel walls.

Best management practices (BMPs) - The practice or combination of practices that are determined to be the most effective, practicable means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals (including technological, economic, and institutional considerations).

Beneficial use - The uses of water necessary for the survival or well-being of humans, plants, and wildlife. These uses of water serve to promote the tangible and intangible economic, social, and environmental goals or benefits associated with water bodies. "Beneficial Uses" of the waters of the State that may be protected include, but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. Beneficial Uses for South Orange County receiving waters are designated in the Water Quality Control Plan for the San Diego Basin (Basin Plan).

Biological integrity – A balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region, also referred to as ecosystem health.

Causal linkage – The establishment of a cause-and-effect relationship between pollutants, stressors, and conditions.

CCME index – Canadian Council of Ministers of the Environment (CCME) methodology used to develop water quality scores for constituents with applicable standards that are used to assess water quality exceedances for the protection of aquatic life.

Coarse sediment supply/reduction – Coarse sediment is the fraction of sediment transported by watershed runoff processes to and within stream channels that supports channel stability. Reductions in sediment load, if severe enough, can starve downstream channel reaches of the bed material load naturally transported by the channel and thus the water flowing in the channel becomes "sediment hungry flow", meaning the water is more prone to eroding in-stream bed and bank material.

Coastal waters – The territorial marine waters of the State as defined by California law to the extent these waters are outside of enclosed bays, estuaries, and coastal lagoons. Discharges to ocean waters are regulated in accordance with the State Board's California Ocean Plan.

Composite imperviousness – The total percent of impervious surface covering the land. This includes the composite of all sources of impervious cover.

Consultation Panel – The panel of advisors representing environmental, development, and regulatory communities and other stakeholders convened to provide input on the development of the Water Quality Improvement Plan.

Controllable source (by MS4) – Stormwater or non-stormwater discharges that are considered to be controllable either as discharges to or from the MS4. This term is introduced to distinguish the sources that can be controlled by actions described within the Water Quality Improvement Plan from those sources that cannot be controlled (i.e., natural sources) within the authority of MS4 permittees.

Data propagation – A mapping process to extrapolate in-channel water quality data measurements at discrete monitoring locations to the reaches that may be represented by these data. The specific methods for data propagation used in the Water Quality Improvement Plan are described in this Plan.

Dry weather – Weather is considered dry if the preceding 72 hours has been without measurable precipitation (>0.1 inch).

Dry weather flows – Flows in and from the MS4 resulting from natural sources (e.g., groundwater seeps), non-stormwater discharges (e.g., irrigation overspray), and/or small precipitation events (<0.1 inches).

Ecological flows – The quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems.

Ephemeral (channel or stream) - Water bodies, or segments thereof, that contain water only for a short period following precipitation events.

Eutrophication – Excessive richness of nutrients in bodies of water which causes a dense growth of plant life and can cause death of aquatic life due to lack of oxygen.

Fecal indicator bacteria - Bacterial surrogates, including total and fecal coliforms, *E. coli* and enterococci, that are used to measure the potential presence of fecal material and associated fecal pathogens. Indicator bacteria are not a direct measure of human health risk.

Flood conveyance – Denotes a particular purpose of a drainage feature, whether a natural stream system or an engineered system.

Flow regime – The variability of flow magnitude, frequency, duration, timing, and rate of change within stream systems over time in response to precipitation, other inputs, temperature, evapotranspiration, and drainage basin characteristics.

Functional groupings – Groupings of individual physical, chemical and biological processes or metrics that occur in ecosystems based on potential causal or coincidental relationships between these processes or metrics to assist with identifying priority conditions.

Function-based framework – A framework for prioritizing conditions or actions that includes consideration of the functional relationships among physical, chemical and biological processes that occur in ecosystems and the relationship of these processes to beneficial uses.

Geographic information system (GIS) – A mapping system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.

Goals – Numeric goals required by the Permit to be included in the Water Quality Improvement Plan with associated schedules that will be used to measure progress towards achieving the desired outcomes of improvements in water quality.

Green street – A form of green infrastructure that provides source control of stormwater, limits stormwater transport and pollutant conveyance to the collection system, restores predevelopment hydrology to the extent possible, and provides environmentally enhanced roads by incorporating vegetated swales, sidewalk planters, curb extensions, permeable surfaces, green gutters, rain gardens, and trees and/or tree boxes. Successful application of green street elements should encourage soil and vegetation contact and infiltration and retention of stormwater.

H20 algal taxonomic index – an algal index of biological integrity (IBI) developed and used for assessment of Southern California streams, based on diatoms and soft algae.

High value areas – The areas considered within the San Juan Hydrologic Unit to have the highest intensity of recreational use or having the greatest need for avoidance of impacts related to urban runoff. These include popular surfing areas along the beach that are frequented during both wet and dry weather, as well as large park and open space areas having stream and creek systems that have retained their natural form and function to a significant degree.

Highest priority water quality condition (HPWQC) – Pollutants, stressors and/or receiving water conditions that are identified by the Permittees to be the highest threat to receiving water quality or that most adversely affect the quality of receiving waters.

Human health risk – The nature and probability of adverse health effects in humans who may be exposed to a hazardous substance or pathogen. Human health risk is a function of the degree of exposure and the dose-response relationship.

Human pathogens – A microorganism, such as a virus, bacterium, prion, parasite, or fungus, that causes disease in humans.

Hydromodification – The change in the natural watershed hydrologic processes and runoff characteristics (i.e., interception, infiltration, overland flow, interflow and groundwater flow) caused by urbanization or other land use changes that result in increased stream flows and sediment transport. In addition, alteration of stream and river channels, installation of dams and water impoundments, and excessive stream-bank and shoreline erosion are also considered hydromodification, due to their disruption of natural watershed hydrologic processes.

Hydromodification impacts – Locations where adverse erosion occurs that alters the form and function of a natural stream system, typically in response to excess flow quantity, energy, or duration of flow resulting from the alteration of upland areas from natural to developed condition.

Impairment – The condition of a water segment that exhibits significant degradation in biological populations and/or communities as compared to reference conditions (as defined by standards or reference site(s)) and is associated with water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash.

Impervious surface – Any material that prevents or substantially reduces infiltration of water into the soil. Common impervious surfaces include rooftops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and oiled surfaces.

Index of biological integrity (IBI) – A single multi-metric index used to characterize biological integrity, typically assembled from measurements related to the community of organisms found at a site. In this Plan, IBI generally refers to the Southern California Index of Biological Integrity.

Inland waters – Includes all surface waters of the State that do not include the ocean, enclosed bays, or estuaries.

Intermittent (channel or stream) - Water bodies, or segments thereof, that contain water for extended periods during the year, but not at all times.

Invasive species – Plants, animals, or pathogens that are non-native to the ecosystem under consideration and whose introduction causes or is likely to cause harm.

Low impact development (LID) – A stormwater management and land development strategy that emphasizes conservation and the use of onsite natural features integrated with engineered, small-scale hydrologic controls to more closely reflect pre-development hydrologic functions.

Municipal separate storm sewer system (MS4) – A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned by a state, city, town, or other public body that is designed or used for collecting or conveying stormwater, which is not a combined sewer and which is not part of a publicly owned treatment works.

MS4 catchments – For the purpose of this Plan, this term refers to land segments that include MS4 infrastructure and impervious area associated with urban or suburban development as determined through aerial and GIS-data inspection; these land segments catchments are associated with potentially-controllable MS4 pollutant sources and stressors that may be related to water quality conditions observed in downstream receiving waters. This term is not intended to define the regulatory extents of the MS4.

National pollutant discharge elimination system (NPDES) – A permit program, created in 1972 by the Clean Water Act (CWA), that helps address water pollution by regulating point sources that discharge pollutants to waters of the United States.

Non-MS4 catchments – Land segments that are predominantly devoid of MS4 infrastructure and impervious area as determined through aerial and GIS-data inspection. This category of catchments is complementary to "MS4 catchments" defined above. This term is not intended to define the regulatory extents of the MS4.

Non-priority water quality conditions – Pollutants, stressors and/or receiving water conditions that do not appear to warrant consideration as priority conditions as part of this Plan. Criteria for determining non-priority water quality conditions are described in this Plan.

Non-structural BMPs - Institutional, educational or pollution prevention practices designed to limit the amount of stormwater runoff or pollutants that are generated in the landscape.

Nuisance water – As defined in the Porter-Cologne Water Quality Control Act, a nuisance is "anything which meets all of the following requirements: 1) Is injurious to health, or is indecent, or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property. 2) Affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal. 3) Occurs during, or as a result of, the treatment or disposal of wastes." For practical purposes in this Plan, nuisance water is a non-stormwater discharge that contributes to a dry weather discharge or an unnatural flow regime.

Onsite wastewater treatment system – Decentralized wastewater treatment systems that collect and treat wastewater from a home or business and return treated wastewater back into the receiving environment.

Perennial (channel or stream) – Watercourses such as flood control channels, streams, and rivers that contain water year-round.

Permitted discharge – For the purpose of this Plan, this term refers to point discharges of stormwater or wastewater permitted with an individual permit or covered under a general permit besides the MS4 permit that are made directly to a receiving water or to a receiving water via the MS4.

Physical habitat – Geomorphologic characteristics and biological attributes that determine habitat structure and affect energy inputs (e.g., channel substrate, diversity of channel form, flow regime, presence of macrophytes and riparian vegetation).

Physicochemical parameters – Measureable parameters pertaining to both physical and chemical properties of waters such as pH, turbidity, conductivity, suspended and dissolved solids, nutrients, and heavy metals.

Priority water quality condition (PWQC) – Pollutants, stressors and/or receiving water conditions that are identified by the Copermittees to be a threat to receiving water quality or that most adversely affect the quality of receiving waters.

Quantitative microbial risk assessment (QMRA) - A probabilistic risk assessment method used to quantify the risk of an adverse health effect due to the exposure to a specific microbial pathogen.

Receiving waters - Surface bodies of water, including naturally occurring wetlands, streams (perennial, intermittent, and ephemeral (exhibiting bed, bank, and ordinary high water mark)), creeks, rivers, reservoirs, lakes, lagoons, estuaries, harbors, bays and the Pacific Ocean which directly or indirectly receive discharges from stormwater conveyance systems.

Riparian ecology – The ecosystem defined by linear corridors of variable width occurring along rivers, streams, and creeks. Hydrologic interaction with a river, stream or creek, and distinct geomorphic features are two unique components of this ecosystem.

Sensitive resource – The habitat and associated flora and fauna located along inland stream corridors and ocean coastline that have the potential to be adversely impacted by stormwater inputs.

Strategies – The jurisdictional- and watershed-scale practices and structural control measures identified for implementation to achieve the numeric goals established in the Water Quality Improvement Plan.

Stream energy – Energy dissipation that occurs as water flows against the bed and banks of a stream.

Stream erosion – The ability of flowing water to dislodge and transport rock particles or sediment (hydraulic action), scour soil, and cut channel banks or bed.

Stream erosion impacts – The impacts associated with stream erosion including loss of habitat or adverse impacts to embedded infrastructure or adjacent property.

Stream form – A stream channel's bed and bank material as well as its channel geometry (in plan, cross-section, and profile).

Stream function – The special purpose or activity for which a stream exists.

Stream rehabilitation - Remedial measures or activities for the purpose of improving or restoring the beneficial uses of streams, channels or river systems. Techniques may vary from in-stream restoration techniques to off-line stormwater management practices installed in the system corridor or upland areas, or a combination of in-stream and out of stream techniques. Rehabilitation techniques may include, but are not limited to the following: riparian zone restoration, constructed wetlands, channel modifications that improve habitat and stability, and daylighting of drainage systems.

Stream restoration – See stream rehabilitation (terms are used interchangeably in this Plan).

Structural BMPs – A subset of BMPs which detains, retains, filters, removes, or prevents the release of pollutants to surface waters from development projects in perpetuity, after construction of a project is completed.

Temporal extent – The time-dependent or seasonal extent of a priority water quality condition (e.g., dry weather and/or wet weather).

Toxicity (aquatic) – Adverse responses of organisms to chemicals or physical agents ranging from mortality to physiological responses such as impaired reproduction or growth anomalies.

Water balance – An accounting of all inflows and outflows of water in a hydrological system. In this Plan, the principal elements of the water balance include rainfall, evapotranspiration, discharges resulting from imported or recycled water, infiltration, stormwater runoff, baseflow, aquifer recharge, and aquifer withdrawal.

Water quality – Defined by both a set of concentrations, speciations, and physical partitions of organic and inorganic substances, and the composition and state of aquatic biota found in a waterbody.

Wet weather – Weather is considered wet up to 72 hours after a storm event of 0.1 inches and greater, unless otherwise defined by another regulatory mechanism (e.g. a TMDL).