Appendix 4B – Watershed Management Area Analysis

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Santa Margarita Watershed Management Area Analysis

June 2018; Revised January 2019; Errata January 2020

Murrieta Creek downstream of 1st Street

Prepared by the Santa Margarita
Watershed Management Area
Co-Permittees

1 Introduction 1

1.1 Background 1

1.2 Watershed Management Area Analysis 2

1.3 Scope of Work for Regional WMAA and Upper Santa Margarita River (within Riverside County) 3

1.4 Report Organization 5

2 Watershed Management Area Characterization 6

2.1 Dominant Hydrologic Processes 6

2.1.1 Hydrologic Response Unit 7

2.1.2 Geology and Groundwater Basins 9

2.1.3 Groundwater Basins 11

2.1.4 Hydrologic Characteristics and Evapotranspiration (ET) 11

2.1.5 Uncertain HRUs 12

2.1.6 Dominant Hydrologic Process Results. 12

2.1.7 Limitations 12

2.2 Existing Streams in the Watershed and Locations of Existing Flood Control Structures 12

2.2.1 Summary of Datasets 13

2.2.2 Methodology 13

2.3 Current and Anticipated Land Uses 15

2.3.1 Summary of Datasets 15

2.3.2 Methodology 16

2.4 Potential Coarse Sediment Yield Analysis 16

2.5 Data Types and Acquisition 17

2.5.1 Geologic Categories 18

2.5.2 Land Cover 19

2.5.3 Slope Classes 19

2.6 GLU Results 19

2.7 Relative Sediment Production 19

2.8 Potential Critical Coarse Sediment Yield Results 21

2.9 Limitations for Potential Critical Coarse Sediment Yield Areas 22

3 Potential Candidate Projects 23

3.1 Candidate Project for the Upper SMR Subwatershed 23
3.2 Candidate Projects for the Lower SMR Subwatershed 25
3.2.1 Santa Margarita River Habitat Assessment and Enhancement Plan 25
3.2.2 Santa Margarita River Fish Passage Design - Sandia Creek 25
3.2.3 Fallbrook Public Utilities District Recycled Water Storage 25
3.2.4 Implementing Nutrient Management in the Santa Margarita River Watershed - Phase I/II 26
3.2.5 Implementing Nutrient Management in the Santa Margarita River Watershed Phase III 26
4 Hydromodification Exempt Areas 28
4.1 Additional Analysis for Hydromodification Management Exemptions 28
4.2 Approach for Evaluating Hydromodification Management Exemptions 30
4.2.1 Erosion Potential Analysis 31
4.2.2 Sediment Supply Potential Analysis 32
4.2.3 Criteria for Exemption 33
4.3 Santa Margarita River 33
4.3.1 Erosion Potential Analysis 33
4.3.2 Sediment Supply Potential (Sp) Analysis 37
4.3.3 Recommendation 38
4.4 Temecula Creek 39
4.4.1 Temecula Creek between Pechanga Parkway and Avenida de Missiones 41
4.4.2 Recommendation 47
4.4.3 Murrieta Creek 47
4.4.4 Murrieta Creek Flood Control, Environmental Restoration and Recreation Project 48
4.4.5 Erosion Potential Analysis 51
4.4.6 Recommendation 52
4.5 Conclusion 52
4.5.1 Factors of Safety 53
4.5.2 Limitations 53
5 Conclusions 55
6 References 56
7 Glossary 58

Attachment A. Dominant Hydrologic Processes 60
Attachment B. Potential Critical Coarse Sediment Yield Areas 61
Attachment C. Existing Stream Structures 62
Attachment D. Hydrographic Category 63
Attachment E. Current Land Use Map 64
Attachment F. Anticipated Land Use Map 65
Attachment G. Upper Santa Margarita River Hydrologic Response Unit and Critical Coarse Sediment Yield Analysis 66
Attachment H. Hydromodification Management Exemptions 67
Attachment I. San Diego County Regional Watershed Management Area Analysis 68
Attachment J. Candidate Projects for the Upper SMR Subwatershed 69
Attachment K. Riverside County Flood Control Interim Criteria 70
Attachment L. Santa Margarita Watershed Impervious Area Summary Table 71

Figures

Figure 1-1. Santa Margarita River Watershed Management Area 2
Figure 2-1. Hydrologic Response Unit and Hydrologic Process Flow Chart 7
Figure 2-2. Potential Critical Coarse Sediment Field Analysis Flow Chart 17
Figure 4-1. WMAA Reach Overview 29
Figure 4-2. Santa Margarita River: Main Channel Elevation Profile 35
Figure 4-3. Upstream Representative Channel 36
Figure 4-4. Upstream Representative Floodplain 36
Figure 4-5. Downstream Representative Channel 37
Figure 4-6. Downstream Bed Material 37
Figure 4-7.: Temecula WMAA Reach Overview 40
Figure 4-8. Temecula Creek at Pechanga Parkway, October 1995 42
Figure 4-9. Temecula Creek at Pechanga Parkway, October 2003 42
Figure 4-10. Temecula Creek at Pechanga Parkway, July 2004 43
Figure 4-11. Temecula Creek at Pechanga Parkway, January 2006 43
Figure 4-12. Temecula Creek at Pechanga Parkway, June 2012 44
Figure 4-13. Temecula Creek at Pechanga Parkway, October 2016 44
Figure 4-14. Temecula Creek at Pechanga Parkway, September 2017. Vertical cut along the north bank of the Creek 45
Figure 4-15. Temecula Creek at Pechanga Parkway, September 2017. Vertical cut along the south bank of the Creek 45
Figure 4-16. Temecula Creek at Pechanga Parkway, September 2017. Vertical cuts along the south bank of the Creek, adjacent to Pala Community Park 46

Figure 4-17. Temecula Creek at Pechanga Parkway, September 2017. Vertical cuts along the north bank of the Creek. Exposed tree roots shown 46
Figure 4-18: Murrieta WMAA Reach Overview 47
Figure 4-19. Murrieta Creek Flood Control, Environmental Restoration and Recreation Project 49
Figure 4-20. Typical existing and proposed cross section for Phase 2 49
Figure 4-21. Looking downstream near the Murrieta Creek and Santa Gertrude Creek confluence. Heavily vegetated channel bed and concrete side slope. 50
Figure 4-22. Looking towards east riverbank 80 feet upstream of Washington Avenue overpass. Sandy gravel riverbanks showing a 25 foot high erosion cut. 50

Tables

Table 1-1. WMAA corresponding Permit requirements......5
Table 2-1. Hydrologic Response Unit Data Types and Source......7
Table 2-2. Geologic Unit and Groundwater Basin Data Type and Source 9
Table 2-3. GLU Public Domain Data Sources 17

1 Introduction

1.1 Background

On May 8, 2013 the California Regional Water Quality Control Board, San Diego Region (San Diego Water Board) adopted Order No. R9-2013-0001; NPDES No. CAS 0109266, National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements for Discharges from the Municipal Separate Storm Sewer Systems (MS4s) Draining the Watersheds within the San Diego Region (Regional MS4 Permit). Order No. R9-2015-0001 extended the permit to Orange County Region 9 Co-permittees on February 11, 2015 and Order No. R9-2015-0100 extended the permit to Riverside County Region 9 Co-permittees. The Regional MS4 Permit, which became effective on June 27, 2013, replaces the previous MS4 Permits that covered portions of the Counties of San Diego, Orange, and Riverside within the San Diego Region. There were two main goals for the Regional MS4 Permit:

- To have more consistent implementation, as well as improve inter-agency communication (particularly in the case of watersheds that cross jurisdictional boundaries), and minimize resources spent on the permit renewal process.
- To establish requirements that focused on the achievement of water quality improvement goals and outcomes rather than completing specific actions, thereby giving the Co-permittees more control over how their water quality programs are implemented.

To achieve the second goal, the Regional MS4 Permit requires that a Water Quality Improvement Plan (WQIP) be developed for each Watershed Management Area (WMA) within the San Diego Region. As part of the development of WQIPs, the Regional MS4 Permit provides Co-permittees an option to perform a Watershed Management Area Analysis (WMAA) through which watershed-specific requirements for structural BMP implementation for Priority Development Projects can be developed for each WMA. This report presents the Co-permittees' approach and results for the regional elements of the WMAA developed for the Santa Margarita River within the San Diego County area and the results of additional analysis that was developed for the upper Santa Margarita River within the Riverside County area.

This Santa Margarita WMAA builds upon the work completed in the 2015 San Diego County Regional WMAA (Geosyntec Consultants and Rick Engineering Company, 2015). The regional analysis developed the tools for the Santa Margarita Region Watershed Management Area (SMR) and began the mapping effort in the lower SMR. Figure 1-1 shows and overall map of the SMR. San Diego County's mapping elements can be found in the 2015 San Diego County Regional WMAA located in Attachment I.

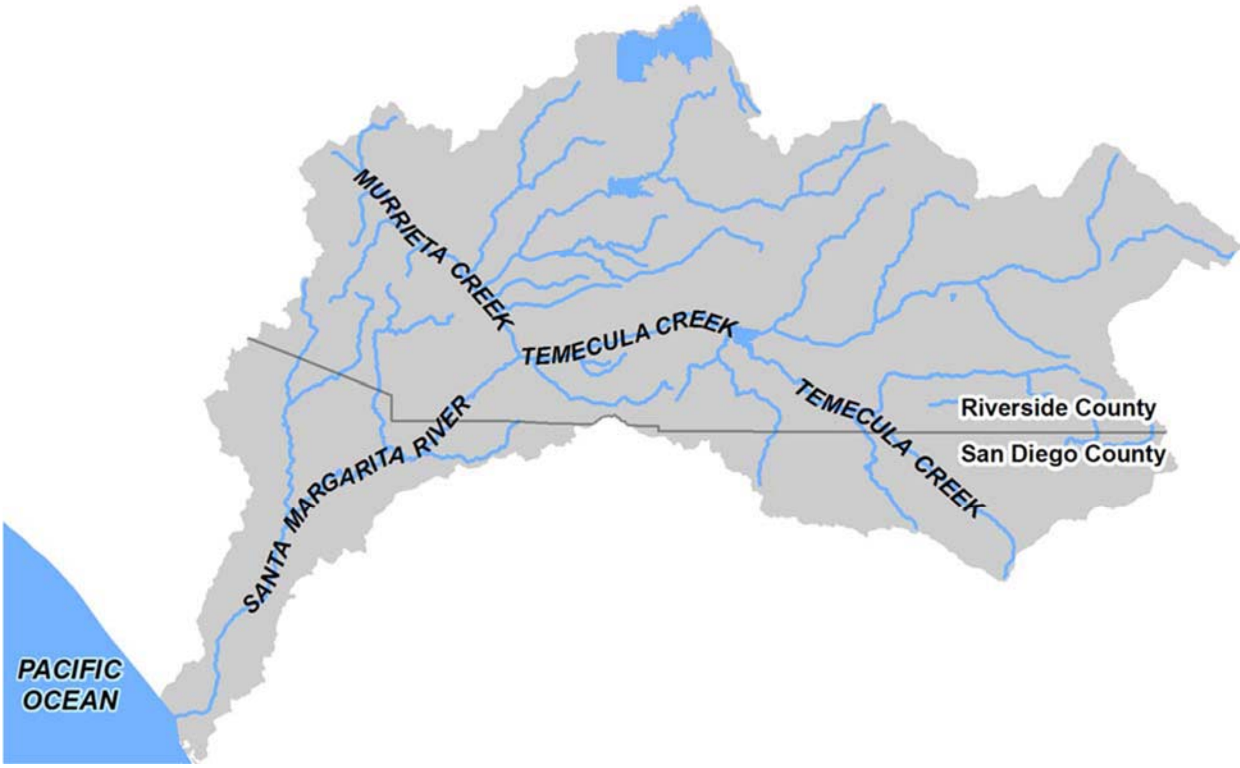


Figure 1-1. Santa Margarita River Watershed Management Area

1.2 Watershed Management Area Analysis

The Regional MS4 Permit, through inclusion of the WMAA, provides an optional pathway for Co-permittees to develop an integrated approach for their land development programs by promoting evaluation of multiple strategies for water quality improvement and development of watershed-scale solutions for improving overall water quality in the watershed. The WMAA comprises the following three components as indicated in the Regional MS4 Permit:

- Perform analysis and develop Geographic Information System (GIS) layers (maps) by gathering information pertaining to the physical characteristics of the WMA (referred to herein as WMA Characterization). This includes, for example, identifying potential areas of coarse sediment supply, present and anticipated future land uses, and locations of physical structures within receiving streams and upland areas that affect the watershed hydrology (such as bridges, culverts, and flood management basins).
- Additionally, using the WMA Characterization maps, identify areas within the watershed management area where it is appropriate to allow for exemptions from hydromodification management requirements that are in addition to those already allowed by the Regional MS4 Permit for Priority Development Projects (PDP). The Co-permittees shall identify such cases on a watershed basis and include them in the WMAA with supporting rationale to support claims for exemptions.
- Using the WMA Characterization results, compile a list of candidate projects that could potentially be used as alternative compliance options for Priority Development Projects.

Priority Development Projects (PDPs), at the discretion of the Co-Permittees, may participate in an alternative compliance program to provide greater overall water quality benefit to the watershed management area and offset Stormwater Pollutant Control Impacts and Hydromodification Control Impacts associated with the PDP. A PDP may be allowed to utilize alternative compliance in lieu of complying with the storm water pollutant control BMP performance requirements. The PDP must mitigate for the portion of the pollutant load in the design capture volume not retained onsite. If a PDP can utilize alternative compliance, flow-thru treatment control BMPs must be implemented to treat the portion of the design capture volume that is not reliably retained onsite.

For projects to participate in an Alternative Compliance Program, the Water Quality Improvement Plan (WQIP) must include the optional WMAA; and Water Quality Equivalency calculations must have been accepted by the San Diego Water Board's Executive Officer. The San Diego Water Board accepted the Water Quality Equivalency Guidance Document in December 2015. Furthermore, a fee structure program is required to complete the Alternative Compliance Program.

On December 17, 2015 the California Regional Water Quality Control Board accepted the Water Quality Equivalency Guidance Document and Water Quality Equivalency Automated Calculation Worksheets (WQE Guidance Documents). The effective date of the WQE Guidance Documents is the date of the acceptance letter and serves as the single, region-wide, applicable date after which Copermitee-approved alternative compliance projects may begin generating credits for potential future banking, tracking, trading, and selling. The WQE Guidance Documents form the regional and technical basis to determine the water quality benefits associated with BMPs implemented as part of an alternative compliance program. Since approval of the WQE Guidance documents, the Co-permittees have convened a Technical Advisory Group of regional stakeholders to develop a credit framework for facilitating the use of alternative compliance in those jurisdictions. The current status of the credit framework is as follows:

1. Technical working group was established in 2016 to develop an Alternative Compliance Program for the subregion and gather input from co-permittees and the private sector.
2. Western Riverside Council of Governments (WRCOG) met with San Diego Regional Water Quality Control Board in August 2017 to introduce the technical working group, its findings, and plan to develop program.
3. Technical working group has developed a Draft Credit System Policy Manual handbook that will provide details on eligible project type, credits, credit eligibility, bank, and roles.
4. WRCOG has sent a request to Regional Board staff to present program and details to San Diego Regional Water Quality Control Board and acquire feedback.

1.3 Scope of Work for Regional WMAA and Upper Santa Margarita River (within Riverside County)

In July 2013, the Co-permittees elected to fund a regional effort to develop elements of the regional WMAA for the 9 San Diego-area WMAs within the County of San Diego that are currently subject to the Regional MS4 Permit, which include:

- Santa Margarita River (for portion in San Diego County)

- San Luis Rey River
- Carlsbad
- San Dieguito River
- Los Peñasquitos
- Mission Bay & La Jolla Watershed
- San Diego River
- San Diego Bay
- Tijuana River (for portion in San Diego County)

The regional-level information developed is intended to provide consistency across WMAs and serve as the foundation for developing watershed-specific information for each WMA to be developed through the WQIP process. The regional effort excluded the upper portion of the Santa Margarita River within Riverside County. Therefore, the scope of this WMAA will combine watershed specific information from the regional effort with additional studies performed on the Upper Santa Margarita Watershed within Riverside County. The regional WMAA will be used as a guide for developing information within Riverside County. This effort included:

- Development of GIS map layers that characterize the WMA using data previously collected, readily available, and provided by the Co-permittees, including:
- Description of dominant hydrologic processes, such as areas where infiltration or overland flow likely dominates;
- Description of existing streams in the watershed, including bed material and composition, and if they are perennial or ephemeral;
- Current and anticipated future land uses;
- Potential coarse sediment yield areas;
- Locations of existing flood control structures and channel structures, such as stream armoring, constrictions, grade control structures, and hydromodification or flood management basins;
- Development of a list of candidate projects for an optional alternative compliance program; and
- Development of additional criteria and analyses to support proposed exemptions that were originally developed in the approved 2013 Santa Margarita Region Hydromodification Management Plan.

The scope of work for the Upper Santa Margarita River effort and the regional effort within San Diego County excluded performing analysis within the following areas unless data was readily available, as Co-permittees do not have jurisdiction over these areas:

1. State Lands;
2. U.S. Departments of Defense land;
3. U.S. National Forest land;
4. U.S. Department of Interior land; and
5. Tribal lands.

1.4 Report Organization

This report references the regional WMAA for San Diego County for the Lower Santa Margarita River Watershed within San Diego County. Additional supporting information has been developed for the Upper Santa Margarita River Watershed to supplement the regional WMAA and provide a complete data set that covers the entire Santa Margarita River Watershed. This report is organized as follows:

- Chapter 1 provides the project background and purpose.
- Chapter 2 describes the technical basis for characterizing the WMA.
- Chapter 3 describes potential candidate projects for the Upper and Lower Santa Margarita Watershed.
- Chapter 4 summarizes the analyses performed to support reinstating select exemptions from hydromodification control requirements for PDPs.
- Chapter 5 presents the WMAA conclusions.
- Chapter 6 presents the references used for the WMAA.
- Chapter 6 presents the Glossary used for the WMAA.
- Attachments A-F presents the exhibits for watershed management area characterization within the Santa Margarita River Watershed.
- Attachment G presents the supporting information for Hydrologic Response Unit and Critical Course Sediment Yield Analysis for the Upper Santa Margarita River within Riverside County.
- Attachment H presents the supporting information for Hydromodification Exemptions on Santa Margarita Rivers and Murrieta Creek.
- Attachment I provides the San Diego County Regional Watershed Management Area Analysis.
- Attachment J presents the Candidate Projects for the Upper Santa Margarita Subwatershed.

Table 1.1 summarizes the Permit sections that identify specific WMAA requirements and the corresponding sections in this WMAA that comply with the Permit.

Table 1-1. WMAA corresponding Permit requirements

Corresponding Permit Section	WMAA Section
Provision B.3.b.(4).a.i	2.1. Dominant Hydrologic Processes
Provision B.3.b.(4).a.ii **Provision B.3.b.(4).a.v**	2.2. Existing Streams in the Watershed and Locations of Existing Flood Control Structures
Provision B.3.b.(4).a.iii	2.3. Current and Anticipated Land Uses
Provision B.3.b.(4).a.v	2.4. Potential Coarse Sediment Yield Analysis
Provision B.3.b.(4).b	3. Potential Candidate Projects
Provision B.3.b.(4).c	4. Hydromodification Exempt Areas

2 Watershed Management Area Characterization

2.1 Dominant Hydrologic Processes

The Regional MS4 Permit requires that the WMAA include a description of dominant hydrologic processes, such as areas where groundwater recharge, interflow, or overland flow likely dominate (San Diego RWQCB, 2015). Figure 2-1 displays the screening level analysis used to define the hydrologic response unit (HRU) and to then associate the HRU to a final dominant hydrologic process endpoint (e.g., overland flow; interflow; or groundwater recharge). The evaluation of dominant hydrologic processes in the SMR, however, should also consider evapotranspiration (ET). ET is the quantity of water transpired by plants, retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces (Department of Water Resources, 2005). A comparison of the estimated mean annual precipitation (4 – 10 inches) with the estimated fraction of precipitation lost to ET (90 – 99 percent) over a thirty year timespan in the Riverside-area watersheds suggests that ET is the dominant hydrologic process (Sanford and Selnick, 2013). Therefore, theoretically, if all the annual precipitation for Riverside County watersheds remained stationary where it fell and did not infiltrate or flow downstream to receiving waterbodies, then the precipitation would be loss to ET. Rain events, however, do not remain stationary and often produce runoff in these watersheds, especially in the urbanized areas, where the topography and land cover tend to accelerate the runoff rate downstream. Furthermore, this analysis focuses on developing information and mapping to gain an understanding of the macro-scale opportunities for locating projects that take advantage of either capturing overland flow for treatment or for supplementing the groundwater regime. Therefore, this analysis is based on the methodology illustrated in Figure 2-1 and described in Technical Report 605 titled *Hydromodification Screening Tools: GIS-Based Catchment Analyses of Potential Changes in Runoff and Sediment Discharge* (Booth et al. 2010). After considering the effects of ET (see Section 2.1.4), and an intermediate category of infiltration, the predicted fate of runoff within the Santa Margarita watershed management area was evaluated based on the hydrologic process endpoints - overland flow, interflow, or groundwater recharge.

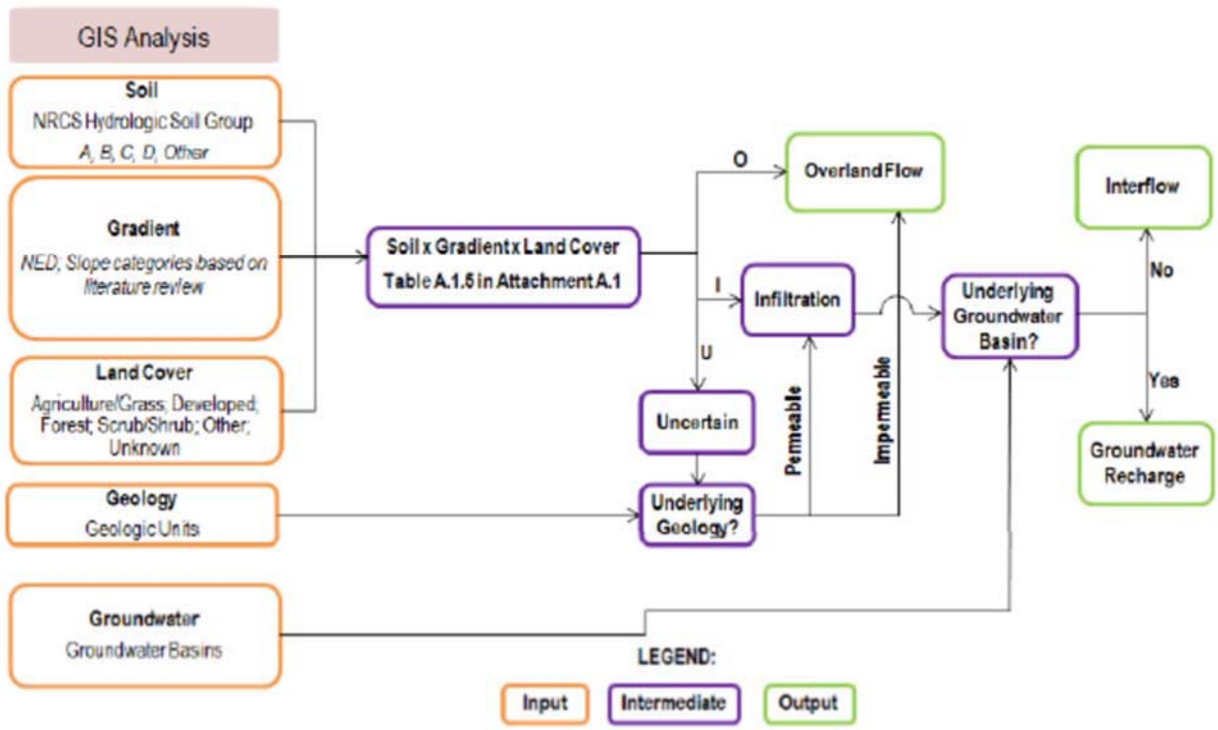


Figure 2-1. Hydrologic Response Unit and Hydrologic Process Flow Chart

2.1.1 Hydrologic Response Unit

The hydrologic process endpoint (e.g., overland flow, interflow, or groundwater recharge) was derived by first integrating soil, gradient, and land cover datasets into hydrologic response units (HRUs) using a geographic information system (GIS). HRUs are regions within a watershed which are presumed to have similar hydrologic attributes based on the combination of soil, gradient, and land cover. The GIS data acquired from public-domain sources are listed in Table 2.1.

Table 2-1. Hydrologic Response Unit Data Types and Source

GIS	Dataset	Source	Year	Description
Gradient	Elevation	USGS	2013	1/3rd Arc Second (~10 meter cells) digital elevation model for San Diego County
		USGS	2016	1/3 arc-second digital elevation model digital elevation model for Riverside County https://nationalmap.gov/elevation.html
Soils	Hydrologic Soils Group	SanGIS	2013	NRCS (SSURGO) Database for San Diego County downloaded from SanGIS

GIS	Dataset	Source	Year	Description
		USDA/ NRCS	2017	(USDA/NRCS) Web Soil Survey and Digital General Soil Map of the United States for Riverside County https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
Land Cover	Vegetation Type	SanGIS	2013	Ecology-Vegetation layer for San Diego County downloaded from SanGIS
		Riverside County GIS	1994	*https://gis.countyofriverside.us/arcgis_public/rest/services/OpenData/NaturalFeaturesAndHazards/MapServer/4*

SOURCE: GEOSYNTEC CONSULTANTS AND RICK ENGINEERING COMPANY, 2015 AND WSP, 2017

Soil Categories

Soil categories were based on United States Department of Agriculture/National Resources Conservation Service (USDA/NRCS) Hydrologic Soil Group (HSG) classifications, which are commonly used to describe runoff/infiltration potential of soils on a regional scale. There are four HSGs: A, B, C, and D and three dual groups: A/D, B/D and C/D. HSGs are based on the rate of water infiltration, with Group A having the highest rates and Group D having the lowest rates. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas. The following describes the methodology used to assign a single HSG rating for each of the dual groups identified in the upper SMR.

Over two hundred polygons, equating to an area of approximately 7,000 acres in the Riverside County portion of the Santa Margarita watershed management area GIS were rated with a dual HSG. Dual HSG ratings were evaluated based on the mapped geologic unit as determined by published geologic mapping information, a desktop evaluation, and soils laboratory results. Specifically, the mapped geologic units were compiled into similar categories and then referenced with a geologic unit name. Geologic units were then categorized as either "coarse" or "fine" based on typical weathering characteristics for the bedrock unit or primary grain size of the sedimentary unit. For example, some geologic units weather to a coarse material such as silty sand and were therefore classified as "coarse". Geologic units that weather to a sandy clay were classified as "fine". Regarding sedimentary formations that are usually associated with variable amounts of coarse and fine units, the final classification was based on the predominating composition, i.e., sandstone/silty sand versus claystone. Finally, given that silty sands drain very quickly, any geologic unit identified as coarse was considered drained and was identified as either HSG A, B, or C. Whereas, geologic units classified as "fine" were considered undrained and were rated as HSG D in the GIS database.

HSG data were not available for some of the areas of the Santa Margarita WMA. These areas are designated as Uncertain (U) in the GIS. For HRUs considered uncertain (U), the underlying regional geology was used to evaluate whether overland flow or infiltration were dominant. This analysis was performed using GIS and is discussed further in Section 2.1.5.

Gradient Categories

The hillslope digital elevation model (DEM) for San Diego County and Riverside County was analyzed to produce a grid of slope values, which were subsequently classified into discrete categories: 0 - 2 percent; 2 - 6 percent; 6 - 10 percent; and greater than 10 percent. The greater than 10 percent slope category was considered the maximum limit given that slopes steeper than 10 percent are assumed to be dominated by overland flow. This limit is also consistent with Technical Report 605 (Booth et al. 2010).

Land Cover

Land cover categories for the Riverside County portion of the Santa Margarita WMA were defined using the ecology vegetation GIS map layers developed for Western Riverside County in the Santa Margarita region (Riverside County GIS, 2014). For the San Diego County portion of the Santa Margarita watershed management area, land cover categories were defined using the Ecology Vegetation GIS map layer developed for the City of San Diego, the County of San Diego and SANDAG. This GIS map layer was downloaded from SanGIS (2013). The vegetation categories in the GIS layers were grouped to match the following land cover categories: Agriculture/Grass; Developed; Forest; Scrub/Shrub, Other and Other (Water) (see Tables A.1 and A.2, Attachment A). Land cover categories for Agriculture/Grass, Forest, Scrub/Shrub, Unknown Other and Other (Water) were then related to land use categories using Table A.3 in Attachment A. A land use category for the Developed land cover category was not determined because this land cover was assumed to have overland flow as its dominant hydrologic endpoint. Table A.4 in Attachment A displays the results showing how the land cover categories related to land use.

2.1.2 Geology and Groundwater Basins

As indicated in Figure 2-1, the intermediate process is implemented after the HRUs are defined. This process entails identifying the geologic units and groundwater basins in the Santa Margarita WMA. The GIS data acquired from public-domain sources for identifying geologic units and groundwater basins are listed in Table 2.2.

Table 2-2. Geologic Unit and Groundwater Basin Data Type and Source

GIS	Dataset	Source	Year	Description
Geologic Unit	Geology	Kennedy, M.P. and Tan, S.S.	2002	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale for San Diego County
		Kennedy, M.P. and Tan, S.S.	2008	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale for San Diego County
		Todd, V.R.	2004	Preliminary Geologic Map of the El Cajon 30'x60' Quadrangle, Southern California, United States Geological Survey, Southern California Aerial

GIS	Dataset	Source	Year	Description
				Mapping Project (SCAMP), Open File Report 2004-1361, 1:100,000 scale for San Diego County
		Jennings et al.	2010	"Geologic Map of California," California Geological Survey, Map No. 2 – Geologic Map of California, 1:750,000 scale for San Diego County
		Department of Conservation	2015	Geology layer for Riverside County, California Geological Survey, Geologic Atlas of California, Map No. 019, 1:250,000 scale, Compilation 1965. *http://www.conservation.ca.gov/cgs/information/geologic_mapping*
Groundwater Basin	Ground water Basin	SanGIS	2013	Groundwater Basins in San Diego County downloaded from SanGIS
	Ground water	Metropolitan Water District of Southern California	2007	Groundwater assessment study was used to determine the Dominant Hydrologic Process

SOURCE: GEOSYNTEC CONSULTANTS AND RICK ENGINEERING COMPANY, 2015 AND WSP, 2017

Geologic Unit

The geology layer was categorized based on rock types, the predominant sediment size generated upon erosion, and their associated erodibility (Booth, et al., 2010). The attribution (and thus the naming) of the geology classes included the following categories:

- Coarse Bedrock (CB),
- Coarse Sedimentary Impermeable (CSI),
- Coarse Sedimentary Permeable (CSP),
- Fine Bedrock (FB),
- Fine Sedimentary Impermeable (FSI),
- Fine Sedimentary Permeable (FSP), and
- Other (O).

The underlying geology was then evaluated to determine if it was permeable or impermeable. This determination was based on a desktop evaluation using the best professional judgment of a Certified Engineering Geologist. All geologic units identified as permeable were considered to have infiltration as the hydrologic process endpoint, whereas all impermeable layers were considered to have overland flow as the hydrologic process endpoint. The Certified Engineering Geologist also performed a desktop evaluation of any HRUs that were identified as uncertain. Again, if the underlying geology was considered permeable, then these uncertain areas were presumed to be dominated by infiltration. Likewise, if the underlying geology was considered impermeable, then these uncertain areas were categorized as overland flow.

2.1.3 Groundwater Basins

For HRUs with relatively high infiltration the presence or absence of a regional groundwater basin underlying these areas determined whether the dominant hydrologic process was designated as interflow or groundwater recharge. The groundwater recharge hydrologic process was assigned as dominant for those applicable areas which have an underlying groundwater basin. The interflow hydrologic process was assigned as dominant for those applicable areas which did not have an underlying groundwater basin.

2.1.4 Hydrologic Characteristics and Evapotranspiration (ET)

For each of the land cover/land use categories the ratio of precipitation lost to evapotranspiration (i.e. an evapotranspiration coefficient) was estimated using the process described by Geosyntec Consultants and Rick Engineering Company (2015) as indicated below as Equation 1 (Eq 1). Since precipitation is the sum of the resulting runoff, infiltration, and evapotranspiration, the coefficients for these three hydrologic pathways sum to one using Equation (Eq) 1.

$$\text{Runoff Coefficient} + \text{Infiltration Coefficient} + \text{Evapotranspiration Coefficient} = 1 \quad \text{(Eq. 1)}$$

2.1.4.1 Evapotranspiration Estimate

To estimate the evapotranspiration (ET) coefficient for each land cover, the runoff coefficient was identified by evaluating the highest runoff potential for the most common storm conditions. Using this, the ET coefficient was calculated as the difference (i.e., ET Coefficient = 1 – Runoff Coefficient). The ET coefficient calculated for the highest runoff potential was then applied to all soil types and slopes within each land use category.

2.1.4.2 Infiltration Estimate

The infiltration coefficient for each applicable HRU (i.e., combination of soil, gradient, and land cover) was estimated by subtracting both the runoff coefficient, and the ET coefficient, from one (i.e., Infiltration Coefficient = 1 – Runoff Coefficient – ET Coefficient).

2.1.4.3 Runoff Estimate

For each applicable HRU, the runoff coefficient was divided by the infiltration coefficient to obtain a ratio representing the potential for runoff or infiltration. The higher the ratio, the greater the potential for runoff to be a more dominant hydrologic process than infiltration. Similarly, the lower the ratio, the greater the potential for infiltration to be a more dominant hydrologic process than runoff.

2.1.4.3.1 Associate Runoff and Infiltration HRUs

The following designations were assigned to each applicable HRU based on the runoff to infiltration ratio (i.e., runoff coefficient/infiltration coefficient). These designations were based on best engineering judgment with the underlying assumption that if a runoff or infiltration coefficient is more than 50 percent greater than its counterpart, then the prevailing process is considered dominant. Table A.5 in Attachment A summarizes these findings for Riverside County and San Diego County.

- HRUs with runoff to infiltration ratios greater than 1.5 (3:2 ratio) were assumed to have relatively high runoff and overland flow was considered its dominant hydrologic process. These HRUs are designated by the letter "O" (Overland flow is dominant process).

- HRUs with runoff to infiltration ratios less than 0.67 (2:3 ratio) were assumed to have relatively high infiltration and its dominant hydrologic process was either interflow or groundwater recharge, based on analysis described in subsequent steps. These HRUs are designated by the letter "I" (Interflow is dominant process) in Table A.5 of Attachment A.
- For HRUs with runoff to infiltration ratios ranging from 0.67 to 1.5, it was uncertain whether it was dominated by overland flow or infiltration. These HRUs are designated by the letter "U" (Dominant process is uncertain).
- For HRUs that have a Developed land cover or a gradient greater than 10 percent, the runoff to infiltration ratios were not calculated because these HRUs were assumed to have overland flow as the dominant hydrologic process. These HRUs are designated by the letter "O" (Overland flow is dominant process).

2.1.5 Uncertain HRUs

For HRUs considered uncertain (U), the underlying regional geology (Kennedy and Tan, 2002 and 2008; Todd, 2004 and Jennings et al., 2010) was used to evaluate whether overland flow or infiltration were dominant. If the underlying geology was considered impermeable, then these uncertain areas were considered to have overland flow as its dominant hydrologic process. If the underlying geology was considered permeable, then these uncertain areas were dominated by infiltration. The determination of whether a geologic unit is impermeable or permeable was based on desktop evaluation and the best professional judgment of a Certified Engineering Geologist (CEG). This analysis was performed in GIS and the results are displayed in Table A.6 of Attachment A.

2.1.6 Dominant Hydrologic Process Results

The resulting GIS map displaying the spatial distribution of dominant hydrologic processes within the Santa Margarita WMA is provided as Figure A.1 in Attachment A. Based on this analysis, overland flow is the predominant hydrologic process in the Santa Margarita watershed management area. This endpoint was verified by the Riverside Co-permittees as part of their review process and was also found to be consistent with the experience of engineering professionals familiar with the hydrology of the County of San Diego. An exhibit summarizing the 2016-2017 public participation efforts for the SMR WMAA is provided as Table A.7 in Attachment A.

2.1.7 Limitations

This analysis identified the dominant hydrologic processes in the SMR WMA. The methodology was based on utilizing regional, public domain datasets. Although the analysis provided a useful, rapid framework to identify the dominant hydrologic processes, it was performed as a screening-level analysis. When more precise estimates are required, it is recommended that the SMR GIS be augmented with site specific analysis.

2.2 Existing Streams in the Watershed and Locations of Existing Flood Control Structures

Murrieta Creek, Temecula Creek and Santa Margarita River are the three major watercourses examined for the stream characterization. The Permit requires a description of existing streams in the watershed, including bed material and composition, and if they are perennial or ephemeral; and locations of existing flood control structures and channel structures, such as stream armoring, constrictions, grade control structures, and hydromodification or flood management basins.

2.2.1 Summary of Datasets

The following datasets were used to characterize existing streams:

- Riverside County Flood Control and Water Conservation District (District) Facilities Area – "RCFC_WCD.RCFC_FACILITIES_AREA"
- RCFC&WCD As-Built Drawings
- Riverside County 2014 Hydromodification Susceptibility Report and Mapping
- National Hydrography Dataset – Flow lines in Riverside County
- Riverside County GIS Major Hydrology – "RIVCO.MAJOR_HYDROLOGY"
- Google Earth to assist in determining category selection (categories included in Section 2.2.2.1)
- USGS National Hydrography Dataset for San Diego County, downloaded from USGS November 2013
- USGS 7.5-minute quadrangles, compiled image of quadrangles covering San Diego County, various dates
- Floodplains: "National Flood Hazard Layer," for San Diego County provided by Federal Emergency Management Agency, October 2012
- Various datasets provided by San Diego County Co-Permittees depicting existing storm water conveyance infrastructure within their jurisdictions.
- Aerial photography of San Diego County by Digital Globe dated 2012

2.2.2 Methodology

2.2.2.1 Streambed Material and Composition

The Riverside County 2014 Santa Margarita Hydromodifcation Susceptibility Report and Mapping (2014 HMP) categorized existing streams and channel segments based on information obtained by the Co-Permittees and the National Hydrography Dataset. The Hydromodification Mapping identified streambed material and composition based on the categories described below:

> **Engineered, Fully Hardened and Maintained (EFHM):** This category includes channel segments that are fully armored (e.g. concrete, soil cement, rock rip rap, etc.) on three sides and verified by as-built drawings, aerial photographs and/or a site visit. This category also includes channel segments with reinforced concrete pipes or boxes. The channel segments and associated armoring must be designed based on specific engineering criteria (e.g. specific storm event and duration), and maintained. Co-Permittees typically engineer the EFHM channels to completely contain the 100-year flow based on ultimate landuse conditions and remain stable under these flow conditions. Co-Permittees inspect the facilities regularly to maintain the improvements per design.

> **Engineered, Partially Hardened and Maintained (EPHM):** This category includes channel segments that have some armoring (e.g. concrete, soil cement, rock rip rap, turf reinforcing mats, etc.) on less than three sides, and verified through the review of as-built plans, aerial photographs

and/or a site visit. The armoring placed in the channel may include bank and/or invert lining that has been design per specific engineering criteria. The channel segment and associated armoring must also be maintained.

Engineered, Earthen and Maintained (EEM): This category includes channel segments that are not armored, however, they have been constructed to resist Hydromodification as verified through the review of as-built plans. The channel segment must also be maintained to control invasive vegetation, correct any significant localized scouring identified during routine inspections, and maintain design grades in the channel. This category is intended to include channel segments constructed for flood conveyance, which generally have a design capacity in excess of a 10-year storm event.

Not Engineered and Earthen (NEE): This category includes natural channel segments that have been modified by anthropogenic activities. These may include floodplain encroachments by development, culverts, bridges, privately owned bank and/or invert stabilization (such as rip-rap or other forms of bank protection, roads, etc.), and other man-made modifications to the channel segment that are not necessarily continuous or designed to meet any specific engineering standard, but have modified the natural hydrologic characteristics of the channel segment. The improvements may or may not be maintained.

Natural (NAT): This category includes channel segments that are in a natural state, where the geometry has not been modified. The channel segment may or may not be maintained.

This information is shown on the "Existing Stream Structures – Santa Margarita Watershed" map in Attachment C.

2.2.2.2 Stream Structure Mapping

In addition to streambed material, the attached "Existing Streams and Structures – Santa Margarita River Watershed" map includes information for locations of physical structures. Determining the location of these structures was determined through a desktop analysis utilizing Google Earth and District as-built drawings. The following categories of structures were identified:

- Bridges
- Culverts
- Dams
- Streambed Stabilizer

A Streambed Stabilizer is an energy dissipater designed to reduce velocity of flow, maintain channel grade, and protect downstream areas from erosion.

2.2.2.3 Stream Hydrography

The Permit requires the WMAA to include information, "to the extent it is available" describing whether streams in the watershed are perennial or ephemeral. However, the available USGS National Hydrography Dataset (NHD) data used to describe streams provided information for "perennial" and "intermittent" streams, but not for "ephemeral" streams. For reference, the NHD defines "ephemeral" as: "contains water only during or after a local rainstorm or heavy snowmelt." None of the stream reaches were classified as ephemeral in the NHD. Therefore, none are classified as ephemeral in this WMAA. Rather, consistent with the NHD classifications, existing streams in the watershed are described as either perennial or intermittent. This information is shown on the "Hydrographic Category – Santa Margarita River Watershed" map in Attachment D. This information was obtained from the USGS National Hydrography Dataset – Flowlines. The Flowlines dataset contains an attribute for streams called "Hydrographic Category", which is defined as the portion of the year a particular feature contains water. The definitions of these categories in the USGS NHD are:

- **Intermittent** – Contains water for only part of the year, but more than just after rainstorms and snowmelt.
- **Perennial** – Contains water throughout the year, except for infrequent periods of severe drought.

USGS NHD includes hydrographic category classification for many, but not all of the streams. To classify reaches of streams that did not already contain this data in NHD, these assumptions were made:

- The USGS NHD information for the stream hydrographic category has been used when available.
- When USGS NHD has “artificial paths” for portions of the stream, the hydrographic category of the upstream portion of the stream have been assigned to the stream unless other assumptions took precedence.
- If aerial photography shows large waterbody (lake, pond, irrigation pond, etc.) perennial has been assumed for the hydrographic category.
- For ponded areas shown on the aerial photography and if the USGS 7.5-minute quadrangles shows cross hatching for the area, intermittent has been assigned unless the upstream portion of the stream was assigned as perennial pursuant to the USGS NHD then assigned perennial for the ponded area.
- USGS has a dashed line for intermittent streams. USGS has a solid line for perennial streams. In some situations this information was used to assist in the determination of assigning perennial or intermittent to a stream.

The remaining stream reaches not classified as either perennial or intermittent are presumed to be ephemeral based on extensive field reconnaissance.

2.3 Current and Anticipated Land Uses

2.3.1 Summary of Datasets

The following datasets were referenced to meet this requirement:

- 2012 Existing Land Use - (SCAG, 2015)
- Anticipated Land Use – General Plan Land Use from Riverside County, 2015
- Anticipated Land Use – General Plan Land Use from the City of Menifee, 2010
- Anticipated Land Use – General Plan Land Use from the City of Murrieta, 2010
- Anticipated Land Use – General Plan Land Use from the City of Temecula, 2005
- Anticipated Land Use – General Plan Land Use from the City of Wildomar, 2016
- Ownership: "Parcels" dated December 2013, available from SanGIS/SANDAG

- Existing land use: "SANGIS.LANDUSE_CURRENT" dated December 2012, available from SanGIS/SANDAG (existing land use)
- Planned land use: "PLANLU" (Planned Land Use for the Series 12 Regional Growth Forecast (2050)), dated December 2010, available from SanGIS/SANDAG
- Developable land: "DEVABLE" (Land available for potential development for the Series 12 Regional Growth Forecast), dated December 2010, available from SanGIS/SANDAG
- Redevelopment and infill areas: "REDEVINF" (Redevelopment and infill areas for the Series 12 Regional Growth Forecast), dated December 2010, available from SanGIS/SANDAG
- Floodplains: "National Flood Hazard Layer" in San Diego County provided by Federal Emergency Management Agency October 2012
- Multiple Species Conservation Program (MSCP), total of four datasets available from SanGIS/SANDAG: "MHPA_SD," dated 2012, (Multiple Habitat Planning Areas for City of San Diego); "MSCP_CN," dated 2009 (designations of the County of San Diego's Multiple Species Conservation Program South County Subregional Plan); "MSCP_EAST_DRAFT_CN," dated 2009 (draft East County MSCP Plan); and "Draft_North_County_MSCP_Version_8.0_Categories," dated 2008 (draft North County MSCP Plan)

2.3.2 Methodology

The "Current Land Use Map – Santa Margarita River Watershed" map, Attachment E, is based on the SCAG 2012 existing land use dataset, updated in February 2015. The "Anticipated Land Use Map – Santa Margarita River Watershed" map, Attachment F, is based on a compilation of General Plan Land Use data from the Co-Permittees (see 2.3.1). This analysis did not include specific land uses within Tribal lands.

2.4 Potential Coarse Sediment Yield Analysis

The Critical Coarse Sediment Yield analysis predicts the potential critical coarse sediment yield areas and is largely based on the Geomorphic Landscape Unit (GLU) methodology described by Booth et al. (2010). GLUs characterize the magnitude of sediment production from areas using three factors judged to exert the greatest influence on the variability of sediment-production rates: geology types, hillslope gradient, and land cover. The GLU layer was derived by overlaying hillslope, land cover, and geology, and then assigning a relative sediment-production rate (i.e., Low, Medium, and High) to each of the resulting categories. The relative sediment production rate was then estimated for each GLU using the Revised Universal Soil Loss Equation (RUSLE) following the method applied in the San Diego WMAA by Geosyntec Consultants and Rick Engineering Company (2015). An area that was identified as coarse bedrock (CB), coarse sedimentary impermeable (CSI) or coarse sedimentary permeable (CSP) coupled with a relative RUSLE rate of Medium was considered as a potential coarse sediment yield area. Whereas, an area that was identified as CB, CSI or CSP coupled with a relative RUSLE rate of High was considered as a potential critical coarse sediment yield area. The GLU approach plus the RUSLE equation application provided a useful, rapid framework to model sediment-delivery attributes of the SMR watershed. Potential critical coarse sediment yield analysis was performed in GIS and the analytical process is illustrated as a flowchart in Figure 2-2.

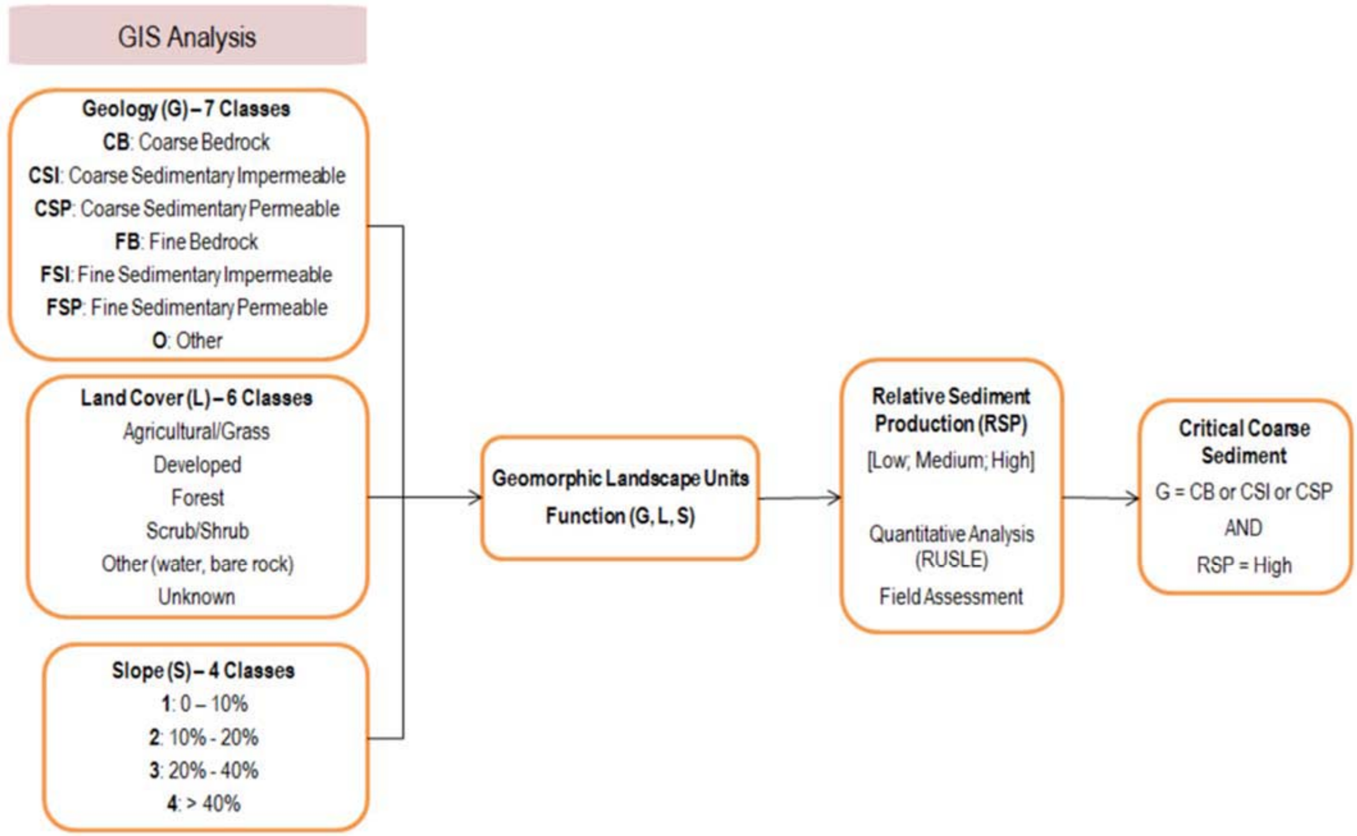


Figure 2-2. Potential Critical Coarse Sediment Field Analysis Flow Chart

2.5 Data Types and Acquisition

The geomorphic landscape unit was determined using data from the public-domain sources referenced in Table 2.3.

Table 2-3. GLU Public Domain Data Sources

GIS	Dataset	Source	Year	Description
Gradient	Elevation	USGS	2013	1/3rd Arc Second (~10 meter cells) digital elevation model for San Diego County
		USGS	2016	1/3 arc-second digital elevation model digital elevation model for Riverside County : *https://catalog.data.gov/dataset/usgs-national-elevation-dataset-ned* *https://viewer.nationalmap.gov/basic/*
Land Cover	Vegetation Type	SanGIS	2013	Ecology-Vegetation layer for San Diego County downloaded from SanGIS
		Riverside County GIS	1994	*https://gis.countyofriverside.us/arcgis_public/rest/services/OpenData/NaturalFeaturesAndHazards/MapServer/4*

GIS	Dataset	Source	Year	Description
Geologic Unit	Geology	Kennedy, M.P. and Tan, S.S.	2002	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale for San Diego County
		Kennedy, M.P. and Tan, S.S.	2008	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale for San Diego County
		Todd, V.R.	2004	Preliminary Geologic Map of the El Cajon 30'x60' Quadrangle, Southern California, United States Geological Survey, Southern California Aerial Mapping Project (SCAMP), Open File Report 2004-1361, 1:100,000 scale for San Diego County
		Jennings et al.	2010	"Geologic Map of California," California Geological Survey, Map No. 2 – Geologic Map of California, 1:750,000 scale for San Diego County
		Department of Conservation	2015	http://www.conservation.ca.gov/cgs/information/geologic_mapping

2.5.1 Geologic Categories

The geology layer was categorized based on rock types, the predominant sediment size generated upon erosion, and their associated erodibility. The attribution (and thus the naming) of the geology classes included the following categories:

- Coarse Bedrock (CB),
- Coarse Sedimentary Impermeable (CSI),
- Coarse Sedimentary Permeable (CSP),
- Fine Bedrock (FB),
- Fine Sedimentary Impermeable (FSI),
- Fine Sedimentary Permeable (FSP), and
- Other (O).

Using GIS, 35 map units were identified in the Riverside County portion Santa Margarita watershed management area and 46 map units were identified in the San Diego County portion. Table B.1 and Table B.2 in Attachment B summarize how each of the map units related to a geologic category. The geologic categories considered to have the potential to generate coarse sediment are coarse bedrock (CB); coarse sedimentary impermeable (CSI); and coarse sedimentary permeable (CSP). An exhibit displaying the geologic categories in the Santa Margarita watershed management area is presented as Figure B.1 in Attachment B.

2.5.2 Land Cover

Land cover categories were defined using the ecology vegetation GIS map layers developed for Western Riverside County for the Riverside County portion of the Santa Margarita region (Riverside County GIS, 2014). For area within San Diego County, land cover categories were defined using the Ecology Vegetation GIS map layer developed for the City of San Diego, the County of San Diego and SANDAG. The vegetation categories in the GIS layer were grouped to match the following categories: Agriculture/Grass; Developed; Forest; Scrub/Shrub, Other (Water), and Unknown.

2.5.3 Slope Classes

The hillslope DEM was analyzed to produce a grid of slope values, which were subsequently classified into discrete categories. The following category percentages were used to categorize hillslope gradients: 0 to 10 percent; 10 to 20 percent; 20 to 40 percent; and greater than 40 percent.

2.6 GLU Results

The result of evaluating geology, land cover and slope equated to 133 GLUs within the Riverside County portion of the study area and 112 GLUs within the San Diego County portion of the study area. The GIS analysis indicated that the Santa Margarita watershed management area is predominated by CB, CSI and CSP geologic categories and is therefore considered as an area with the potential to contribute coarse sediment. These GLUs were then evaluated to determine their relative sediment production to identify potential critical coarse sediment yield areas.

2.7 Relative Sediment Production

Relative sediment production was estimated for each GLU using the Revised Universal Soil Loss Equation (RUSLE) (see Equation 2).

A = R x K x LS x C x P (Equation 2), where

A = estimated average soil loss in tons/acre/year
R = rainfall-runoff erosivity factor
K = soil erodibility factor
LS = slope length and steepness factor
C = cover-management factor
P = support practice factor; assumed 1 for this analysis

Datasets used to estimate the average soil loss were acquired from public-domain sources as indicated below.

- RUSLE R Factor:
  ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_R_Factor/[1]

[1] R-Factor database provided by Geosyntec, January 2017.

- RUSLE K Factor: State Water Resources Control Board: *ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_K_Factor/*
- RUSLE LS Factor: State Water Resources Control Board: *ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_LS_Factor/*
- RUSLE C Factor: US EPA, EMAP West Metric Browser: *https://archive.epa.gov/esd/archive-nerl-esd1/web/html/wemap_download.html* for the Riverside County portion of the study area and *http://www.epa.gov/esd/land-sci/emap_west_browser/pages/wemap_mm_sl_rusle_c_qt.htm#mapnav* for the San Diego portion.

GIS analysis was used to calculate the area weighted estimate of R, K, LS and C factors using the datasets listed above. For the developed land[2] cover the C factor was adjusted to 0 for the regional estimate to account for management actions implemented on developed sites (e.g., impervious surfaces). The estimated average annual soil loss ranged from 0 to 15.2 tons/acre/year in the San Diego County portion of the Santa Margarita WMA, whereas, the estimated average annual soil loss in the Riverside County area ranged from 0 to 23 tons/acre/year.

To assess the amount of relative risk to stream channels resulting from watershed-scale changes in sediment yield and/or water delivery, the following opinions included in Technical Report 605 (Booth et al. 2010) were considered:

"The challenge in implementing this step is that presently we have insufficient basis to defensibly identify either low-risk or high-risk conditions using these metrics. For example, channels that are close to a threshold for geomorphic change may display significant morphological changes under nothing more than natural year-to-year variability in flow or sediment load.

Acknowledging this caveat, we nonetheless anticipate that changes of less than 10 percent in either driver are unlikely to instigate, on their own, significant channel changes. This value is a conservative estimate of the year-to-year variability in either discharge or sediment flux that can be accommodated by a channel system in a state of dynamic equilibrium. It does not "guarantee," however, that channel change may not occur—either in response to yet modest alterations in water or sediment delivery, or because of other urbanization impacts (e.g., point discharge of runoff or the trapping of the upstream sediment flux; see Booth 1990) that are not represented with this analysis.

In contrast, recognizing a condition of undisputed "high risk" must await broader collection of regionally relevant data. We note that >60 percent reductions in predicted sediment production have resulted in both minimal (McGonigle) and dramatic (Agua Hedionda) channel changes, indicating that "more data" may never provide absolute guidance. At present, we suggest using predicted watershed changes of 50 percent or more in either runoff (as indexed by change in impervious area) or sediment production as provisional criteria for requiring a more detailed evaluation of both the drivers and the resisting factors for channel change, regardless of other screening-level assessments. Clearly, however, only more experience with the application of such

[2] Developed (i.e., impervious) area data layer provided by WRCOG, January 2017.

"thresholds," and the actual channel conditions that accompany them, will provide a defensible basis for setting numeric standards."

Considering the thresholds indicated above, the relative sediment production rating for each GLU followed the criterion indicated as follows:

Riverside County

Low: Soil Loss < 3.4 tons/acre/year (GLUs that have a soil loss of 0 to 3.39 tons/acre/year produce approximately 10 percent of the total potential coarse sediment soil loss from the Riverside County portion of the Santa Margarita WMA)

Medium: 3.4 tons/acre/year < Soil Loss < 9.55 tons/acre/year (GLUs that have a soil loss ranging from 3.40 to 9.55 tons/acre/year produce approximately 50 percent of the total potential coarse sediment soil loss from the Riverside County portion of the Santa Margarita WMA)

High: >9.6 tons/acre/year (GLUs that have a soil loss greater than 9.57 tons/acre/year produce approximately 40 percent of the total potential coarse sediment soil loss from the Riverside County portion of the Santa Margarita WMA)

San Diego County

Low: Soil Loss < 5.6 tons/acre/year (GLUs that have a soil loss of 0 to 5.6 tons/acre/year produce approximately 10 percent of the total potential coarse sediment soil loss from the study area)

Medium: 5.6 tons/acre/year < Soil Loss < 8.4 tons/acre/year (GLUs that have a soil loss ranging from 5.6 to 8.4 tons/acre/year)

High: >8.4 tons/acre/year (GLUs that have a soil loss greater than 8.4 tons/acre/year produce approximately 42 percent of the total potential coarse sediment soil loss from the study area)

2.8 Potential Critical Coarse Sediment Yield Results

Attachment B provides tables displaying GLUs that were rated as critical coarse sediment yield areas in Riverside County and San Diego County. This analysis is summarized in tabular format as Table B.3 and Table B.4, for Riverside County and San Diego County, respectively.

The resulting GIS map showing the spatial distribution of the potential critical coarse sediment yield areas within the Santa Margarita WMA is provided as Figure B.2 in Attachment B. Based on this analysis it was estimated that 28 percent of the of the Riverside County portion of the Santa Margarita WMA is a potential coarse sediment yield area and 9 percent of the study area is a potential critical coarse sediment yield area. Most of the potential critical coarse sediment yield areas were identified to be in the Scrub/ Shrub land cover areas with hillslope gradients ranging from 20 to 40 percent.

For the San Diego County portion of the Santa Margarita WMA, approximately 39 percent of the study area is a potential coarse sediment yield area and 30 percent of the study area is a potential critical coarse sediment yield area. Most of the potential critical coarse sediment yield areas were identified to be on slopes greater than 30 percent.

2.9 Limitations for Potential Critical Coarse Sediment Yield Areas

The potential critical coarse sediment yield analysis utilized regional, public domain datasets and provided a useful, rapid framework to perform a screening level analysis for the Santa Margarita WMA. This mapping effort essentially provided a high-level analysis to provide informed decision making at a regional scale. Because of the regional-scale datasets, and commensurate data resolution used to map the potential critical coarse sediment yield areas, some areas may have been mapped that do not produce critical coarse sediment as they are existing developed areas. Furthermore, the analysis did not consider instream sediment supply or fire-induced sediment production (Lave and Burbank 2004) as this was beyond the scope of a regional study. In addition, the resolution differences among the R-factor data resulted in differences in potential critical coarse sediment yield areas near the county border (see Technical Memo in Attachment B). As such, for future projects within the Santa Margarita WMA, especially along the county border, more precise data should be required by performing a site-specific analysis along with a careful interpretation of the results. The Santa Margarita WMA area GIS should then be supplemented with this site-specific data. Ultimately, the Santa Margarita WMA data for the potential critical coarse sediment yield areas should be verified in the field according to the procedures outlined in the Model BMP Design Manual and/or jurisdiction specific BMP Design Manual.

3 Potential Candidate Projects

The Permit requires Co-Permittees to use the results of the WMAA to identify and compile a list of candidate projects that Priority Development Projects could potentially use as alternative compliance options. Criteria for selecting candidate projects includes (San Diego RWQCB, 2015):

Structural Projects

1. Stream or riparian area rehabilitation; projects will restore streams to a natural, stabilized condition that can accommodate both historic and future hydromodification impacts.
2. Retrofittingexistinginfrastructuretoincorporatestormwaterretentionortreatment; projects will add or modify structural BMPs where practices do not currently exist, are ineffective, or can be significantly enhanced.
3. Regional; projects will treat stormwater, improve water quality, protect downstream channels, or reduce flooding, from a drainage area consisting of more than one development.
4. Water supply; projects will capture stormwater and infiltrate, pump or otherwise recharge groundwater, surface reservoirs, or other water supply systems.

Natural System Management Practices

5. Land Restoration; projects will restore currently developed land back to a stabilized, predevelopment condition.
6. Land Preservation; projects will prevent increases in stormwater runoff volumes and preserve floodplain function through preservation of undeveloped land.
7. Stream Rehabilitation; projects that restore a stream to a natural, stabilized condition that can accommodate both historical and future hydromodification impacts.

Potential candidate projects within the SMR are described below.

3.1 Candidate Projects for the Upper SMR Subwatershed

MEADOWVIEW STREAM RESTORATION PILOT PROJECT: The project will reduce public and water quality hazards due to existing erosion by removing vertical cut banks and restoring the natural functions of the stream using primarily soft-armoring and vegetative techniques. The project is located in the City of Temecula. This project will be a stream restoration project and be eligible for hydromodification flow control credit by providing permanent stabilization of the stream.

MEADOWVIEW EROSION REDUCTION AND STORMWATER INFILTRATION PROJECT
The project will address upland and stream erosion and impacts to public safety, private property, and water quality. USFWS will contribute funds and technical support to map all the sites on the property where road runoff is draining into the meadow, will map the resulting erosion and gullies that form, rank the erosion by severity, create a set of Low Impact Development (LID) solutions that will be low-cost and low-tech, secure an umbrella permit for all of these treatments, and implement one pilot project. The treatments will use natural materials such as compost, mulch, compost soxx, and native vegetation and rock where necessary to convert stormwater, traditionally considered a nuisance, into an asset that will help support the existing natural area as well as recharge the aquifer below it. Additionally, the MCA and USFWS will do educational outreach to demonstrate these much-needed sustainable solutions to erosion

control in our arid region.

MEADOWVIEW STREAM RESTORATION PROJECT PHASE II
The Meadowview Stream Restoration Project Phase II addresses 1,600 linear feet of incised creek with vertical banks in excess of six feet in places. The project is being designed by the Natural Resources Conservation Service (NRCS) which will grade back the banks at a 3:1 slope, use rock stream barbs, compost soxx and willow and mule fat to stabilize the toe. The newly graded slope will be covered with mulch, planted with native container plants, and seeded with native seeds. The slopes will be irrigated until establishment, estimated to be five years. The project is a continuation of the existing upstream award-winning bioengineered project, which removed 1,200 feet of dangerous vertical banks.

MORGAN VALLEY WASH
Riverside County Flood Control and Water Conservation District would construct a facility that will convey Morgan Valley Wash stormwater from El Chimisal Road to Woolpert Lane. The goals of this facility are to address flood and erosion control issues, improve water quality, and provide environmental enhancement. Proposed alternatives include an improved channel, a storm drain bypass, and basins or a combination of these features.

- The improved channel alternative would span Morgan Valley Wash between El Chimisal Road and Woolpert Lane. A concrete channel and a soft-bottom channel will be analyzed as alternatives. Based on preliminary calculations, the concrete channel would span 25 feet while the soft-bottom channel would span 107 feet. See attached "Alternative 1" for a proposed layout.
- The storm drain bypass alternative would start on El Chimisal Road and follow Monte Verde before turning onto Woolpert Lane. Based on preliminary calculations, the storm drain would be 9 feet in diameter. See attached "Alternative 2" for a proposed layout.
- The basin alternative would most likely be used in conjunction with a channel or storm drain system. The proposed basin locations are on the North and South sides of Monte Verde near the intersection with El Chimisal Road. See attached "Alternative 3" and Alternative 4" for proposed layouts.

SANTA GERTRUDIS VALLEY- BROWNING STREET WATER QUALITY BASIN: The project will alleviate water quality concerns associated with dry weather flows at the system outfall at the northwest corner of Encanto Road, in the French Valley area in unincorporated Riverside County. This will be a regional project that improves water quality. Given the primary purpose of the project is to treat dry weather flows, it is unclear what benefit will be provided to stormwater. Coordination will continue to determine if dry weather flow treatment is eligible for stormwater pollutant control credits.

WILDOMAR MDP LATERAL C BASIN: The project will reduce flooding along Bundy Canyon Wash in the City of Wildomar. The project consists of a 19-acre footprint detention basin and outlet proposed at the southeast corner of Monte Vista Drive and Bundy Canyon Road to collect and attenuate runoff. The detention basin will incorporate water quality features to alleviate dry weather concerns in the City of Wildomar. This project will be a regional project. The project has the potential to generate both hydromodification and/or stormwater pollutant control credit depending on the final design of the facility.

COUNTY OF RIVERSIDE INTEGRATED MITIGATION PROJECT: The project is located in the French Valley area in unincorporated Riverside County and proposes to restore and enhance habitats that have been lost or degraded as a result of past agricultural and other human activities. The proposed project includes channel grading, diversion channels, check dams, habitat preservation, and habitat enhancement and creation. The project will be a stream rehabilitation project with the potential to generate hydromodification and/or stormwater pollutant control credit.

TEMECULA CREEK STREAMBED STABILIZATION: The project proposes to restore and stabilize the reach of Temecula Creek between Pechanga Parkway and Avenida Missiones, just downstream of the existing engineered channel. The project will reduce erosion susceptibility along this reach of the creek to reinstate the Temecula Creek hydromodification exemption. This will be a stream rehabilitation project with the potential to generate hydromodification credit.

MURRIETA CREEK CHANNEL FLOOD CONTROL PROJECT: The project includes construction of a 250 acre detention basin that will attenuate flows from the over 150 square mile watershed. It includes: Creation of over 160 acres of wildlife habitat, Development of a 50 acre regional sports park, reduction in downstream flood flow peaks, creation of regional sports park within the detention basin. This will be a regional project that will have the potential to provide hydromodification credit and stormwater pollutant control credit.

MURRIETA CREEK PROTECTION AND REHABILITATION

This project proposes to secure right-of-way along the Murrieta Creek to protect, improve, and maintain the existing floodplain and rehabilitate the Murrieta Creek from McVicar St. to the southern City limits (approximately 9000 LF or 1.70 miles). The project will close an existing gap in the Murrieta Creek floodplain. The areas upstream and downsteam of the project are either currently publicly owned and maintained or are proposed to be dedicated to the public by developers. By securing the right-of-way for the public in this segment, this project will close the gap by allowing for public maintenance of the floodplain/Murrieta Creek through the City of Wildomar south into the City of Murrieta. In doing so, the project will increase safety to the community by protecting and improving the floodplain and drainage. This will provide better drainage and flood protection to adjacent and upstream properties and infrastructure. The project will also protect/restore/improve the habitat along the Murrieta Creek. The project can also repair existing erosion and minimize future erosion and sediment runoff/transport.

MURRIETA CREEK – PHASE 2B

The District, in partnership with the U.S. Army Corps of Engineers (USACE) and the Cities of Murrieta and Temecula, is proposing to continue construction of the Murrieta Creek Flood Control, Environmental Restoration, and Recreation Project (Project) located in southwest Riverside County. The proposed Project, which is being built in four distinct phases, features a 7.5-mile multi-use greenbelt channel running along Murrieta Creek from Highway 79 through "Old Town" Temecula and continuing upstream to Tenaja Road in Murrieta. The Project also features a 270-acre multi-use detention/sedimentation basin that includes 160 acres of environmentally enchanced habitat and wetlands and 50 acres designated for public recreation. Additionally, the Project features a public trails component incorporated into the Project's maintenance/access roads located on either side of the channel. Restoration of native habitat and establishment of a permanent riparian habitat corridor are integral to the Project's purpose along with reduction of flood hazards and providing increased public recreation opportunities. Total Project cost is currently estimated at approximately $139 million. The construction contracts for Phase 1 and 2A are complete. Phase 2B of the Project extends from Winchester Road in Temecula downstream to Rancho California Road in 'Old Town' Temecula, a distance of approximately 8,700 feet.

Murrieta Creek courses southeasterly through the rapidly urbanizing cities of Murrieta and Temecula until reaching its confluence with Temecula Creek at the mouth of the Santa Margarita River gorge. Located just downstream of the confluence is the Santa Margarita River Ecological Reserve managed by San Diego State University. Bank erosion, sedimentation, and infestation of competitive non-native plant species have degraded native habitat function and adversely affected Murrieta Creek's riparian functions and values. Recurring flood events and flood response measures currently limit the opportunities to establish a permanent habitat corridor within the existing watercourse. One of the Project's principal objectives is to restore native riparian plant species and invite the return of desirable avian, aquatic, and terrestrial species through the establishment of a permanent non-maintained habitat corridor. This is to be accomplished by expanding the current channel section, where practicable, and establishing a permanent strip of native riparian vegetation within the channel bottom throughout the Project's 7.5 mile length.

SANTA ANA TO PALOMAR MOUNTAINS LINKAGE - TEMECULA CREEK CORRIDOR RESTORATION AND PROTECTION PROJECT

The proposed project entails the implementation of habitat restoration and protective fencing for a 50 acre area of Temecula Creek, including the I-15 Temecula Creek Bridge, to address ongoing threats to wildlife habitat (human trespass/dumping, noise, invasive plants, sedimentation), with the goal of enhancing water quality, habitat quality, and the site's function as a regional wildlife movement corridor between the Peninsular Ranges east of I-15 and Santa Ana Mountains west of I-15, an area identified in as the Santa Ana-Palomar Mountains Linkage (South Coast Wildlands, 2008, Spencer et al. 2010). The plan will include 1) invasive plant control, 2) riparian habitat restoration, 3) fencing and signage to keep humans out and wildlife in the creek corridor, and 4) a 5 year restoration, trespass, water quality monitoring and maintenance plan to ensure project success. Planning and regulatory compliance related to this implementation project are currently proposed for funding through a separate Wildlife Conservation Board Grant for Wildlife Corridors and Fish Passage.

Exhibit showing approximate project location for upper SMR candidate projects can be found in the Candidate Projects for the Upper SMR Subwatershed map located in Attachment J.

The projects above represent those projects planned by the District as Principal Permittee. The co-permittees have convened a Technical Advisory Group of regional stakeholders to develop a framework for facilitating the use of Alternative Compliance in those jurisdictions that choose to adopt an alternative compliance program. As part of these discussions, the Co-permittees have noted that a variety of individual and programmatic actions may be taken that potentially can be credited using the adopted Water Quality Equivalency (WQE) framework (San Diego RWQCB, 2017). Such actions may include, but are not limited to, implementing stormwater runoff treatment and control measures for dirt and gravel roadways; modifying drainage and surfacing at municipal facilities to provide treatment and control of previously untreated surfaces; "over-sizing" stormwater treatment measures in conjunction with public roadway projects; and providing enhanced stormwater treatment within linear projects such as recreation pathways.

While many of these approaches would fall under the broad category of (2) above, "retrofitting existing infrastructure to incorporate storm water retention or treatment," it is not possible to identify all potential project options that may emerge over the period that this WMAA is in effect. These types of retrofits or regional projects, which have the potential to support enhanced water quality and robust implementation of Alternative Compliance, typically are identified in the course of regular planning and design processes for

private development or public works projects. Therefore, the Co-Permittees emphasize that projects that are identified in the design process, and that can be credited properly in a manner consistent with the adopted WQE, are considered to be Candidate Projects for Alternative Compliance. These projects will be added to the WMAA on an annual update basis as they are identified by the Co-Permittees.

3.2 Candidate Projects for the Lower SMR Subwatershed

Analysis for the Lower SMR Subwatershed was previously conducted for the 2015 San Diego County Regional WMAA. Summaries of candidate projects within the Lower SMR Subwatershed are provided in the following sections.

3.2.1 Santa Margarita River Habitat Assessment and Enhancement Plan

The purpose of the Santa Margarita River Steelhead Habitat Assessment and Enhancement Plan is to develop a Watershed Management Area (WMA) restoration plan for the anadromous waters of the Santa Margarita River and major tributaries that emphasizes the needs of southern steelhead. The primary objective is to document existing WMA conditions, identify limiting factors to steelhead recovery, and provide prioritized solutions to address limiting factors to steelhead recovery. This objective will be accomplished through the following tasks: 1) Compile information on existing and historical conditions, including available data from studies on Camp Pendleton, and solicit input from stakeholders; 2) Conduct a WMA habitat assessment using California Department of Fish and Wildlife (CDFW) protocols that documents passage barriers and limiting habitat factors; 3) Develop prioritized recommendations for restoration opportunities and prepare a Steelhead Habitat Assessment and Enhancement Plan.

3.2.2 Santa Margarita River Fish Passage Design - Sandia Creek

A completed steelhead habitat assessment study by Cardno ENTRIX and Trout Unlimited – South Coast Chapter mapped habitat quality and fish passage barriers in detail upstream of Camp Pendleton (2013) and cited two barriers (SMR01 and SMR02) that need to be remediated in the main stem for fish passage upstream. This project has requisite engineering tasks by the WEST Consultants engineering team to arrive at design alternatives for the barriers. These include fish passage and flood flow determination, topographic survey, hydraulic analysis and fish passage evaluation, sediment transport and scour analysis, basis of design report (30-40% plans) and 65% design plans for review by relevant Co-Permittees. This project will capitalize on the opportunity for public outreach and education in this area. The project site has public access to the Santa Margarita River and to local hiking and riding trails from the nearby communities of Fallbrook and Temecula that have close regional ties to the River. The development of backcountry communities in the priority WMAs presents challenges to habitat and connectivity, and increases demand on limited water resources. This indicates a need for raising public awareness to mitigate human impact, restore ecosystems and improve water and resource management practices.

3.2.3 Fallbrook Public Utilities District Recycled Water Storage

The project would construct a recycled water storage tank that would allow for the Fallbrook Public Utility District (FPUD) to store and utilize recycled water during periods of the day when recycled demands exceed wastewater supplies. Currently, the FPUD utilizes make-up potable water to supplement the recycled water supply. Because there is currently no storage and the high demand periods occur during the day when wastewater flows are low, a large volume of make-up water is required to maintain service. It is projected that 132 acre-feet of make-up water will be used in 2010, which would be 25% of the total recycled water supply. This project would construct a below grade uncovered storage structure located adjacent to the existing equalization basin at the Water Recycling Facility. The project would be connected hydraulically to the recycled water wet well in the contact tank, which would allow utilization of stored recycled water in place of potable make-up water.

3.2.4 Implementing Nutrient Management in the Santa Margarita River Watershed - Phase I/II

The project aims to establish the science and stakeholder consensus to support the adoption of alternative nutrient Water Quality Objectives (WQOs) in the SMR WMA through the San Diego RWQCB Basin Plan triennial update. It will optimize irrigation practices by coordinating with local Resource Conservation Districts. Major tasks include: 1) facilitate SMR WMA stakeholder group to guide activities; 2) conduct monitoring and special studies to address data; 3) develop proposed nutrient WQOs for the SMR and estuary based, and 4) optimize irrigation on agricultural lands. This effort would model for the region, reduce nutrient loads and conserve water. The project leverages an investment of over $2 million contributed by WMA stakeholders since 2007.

3.2.5 Implementing Nutrient Management in the Santa Margarita River Watershed Phase III

This project aims to establish the science and seek stakeholder consensus to support the adoption of alternative nutrient Water Quality Goals (WQGs) in SMR watershed and to implement nutrient management activities. The project is the third phase of the overall project that will develop proposed nutrient WQGs for the SMR Estuary (Phase I), provide additional site-specific studies and modeling of nutrient sources and responses in the main stem of the Lower SMR River (Phase II), and in Upper SMR River and selected tributaries (Phase III) that may lead to development of nutrient site-specific objectives (SSOs) or other regulatory alternative by the SDRWQCB that are protective of beneficial uses. Nutrient management activities will include agricultural irrigation system evaluations, residential and equestrian property conservation plans and educational workshops, and will include a rebate program to encourage irrigation retrofits.

The project goals are to:

1. Maximize community involvement in SMR watershed by continued stakeholder group facilitation (established in Phase I).
2. Continue work with the group to obtain feedback and critical review of technical work products to achieve consensus on proposed WQGs.
3. Continue core monitoring and special studies to address data gaps required to develop WQGs for the SMR and tributaries.
4. Develop proposed nutrient WQGs for the SMR and tributaries, as needed, based on sound science and local data.
5. Develop proposed nutrient WQGs for selected streams in SMR watershed that are protective of beneficial uses.
6. Encourage the implementation of BMPs to reduce nutrient loading into the SMR and its tributaries.

Monitoring, Special Studies and Modeling will be conducted in selected SMR tributaries to further refine WQGs that are protective of beneficial uses for the SMR Watershed. Collected data and model-generated information will be used to track nutrient loads and sources, and where warranted, this data and information will be used to identify areas of the watershed where implementation of nutrient management activities would be the most beneficial. Collected data and model-generated information efforts during Phase III can be used alone or in combination with any existing data collected during Phases I and II, and any other available studies.

4 Hydromodification Exempt Areas

Hydromodification, which is caused by both altered stormwater flow and altered sediment flow regimes, can cause degradation of creeks, streams, and associated habitats. The purpose of the hydromodification management requirements in the Regional MS4 Permit is to maintain or restore more natural hydrologic flow regimes to prevent accelerated erosion and other impacts in downstream receiving waters.

In some cases, priority development projects may be exempt from hydromodification management requirements if the project site discharges runoff to receiving waters that are not susceptible to erosion (e.g., a lake, bay, or the Pacific Ocean) either directly or via an engineered facility. According to Section F.1.h.4 of the Permit. Each Copermittee has the discretion to exempt a priority development project from hydromodification management where the project:

(a) Discharges stormwater runoff into underground storm drains discharging directly to water storage reservoirs and lakes;

(b) Discharges stormwater runoff into conveyance channels whose bed and bank are concrete lined all the way from the point of discharge to water storage reservoirs and lakes; or

(c) Discharges stormwater runoff into other areas identified in the HMP as acceptable to not need to meet the requirements of Section F.1.h by the San Diego Water Board Executive Officer.

The June 2013 Santa Margarita Region Hydromodification Management Plan (HMP) identified certain exemptions from hydromodification management requirements by presenting "HMP Exemptions." The Regional MS4 Permit maintains some of these HMP exemptions. However, some of the exemptions are not included under the Regional MS4 Permit unless the area or receiving water is mapped in the WMAA. The intent of this section is to provide supporting technical analyses for exemptions that are recommended by the WMAA.

4.1 Additional Analysis for Hydromodification Management Exemptions

This section documents additional analysis performed to further evaluate the following exemptions (See Figure 4-1) that were approved by the San Diego Regional Board with the June 2013 Santa Margarita Region Hydromodification Management Plan. This study provides additional analysis, data, and rationale for supporting or eliminating the following existing exemptions but does not propose or study any new exemptions.

- Santa Margarita River
  - Upstream Limit: At Origin, i.e. Confluence with Temecula Creek and Murrieta Creek
  - Downstream Limit: Outfall to Pacific Ocean
- Temecula Creek
  - Upstream Limit: Outflow of Vail Lake
  - Downstream Limit: Confluence with Santa Margarita River
- Murrieta Creek
  - Upstream Limit: 850 feet upstream of Hawthorn Street
  - Downstream Limit: Confluence with Santa Margarita River

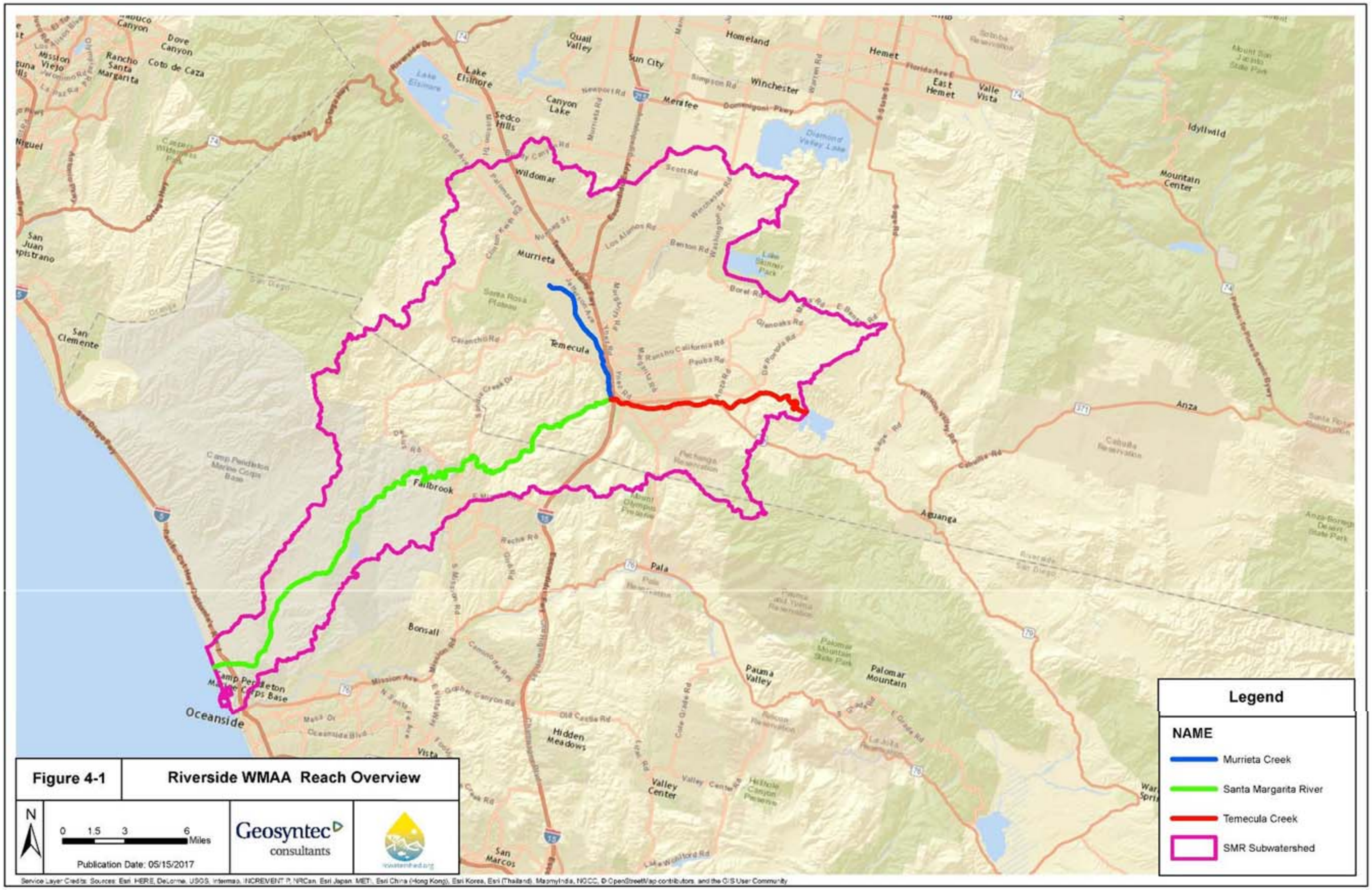
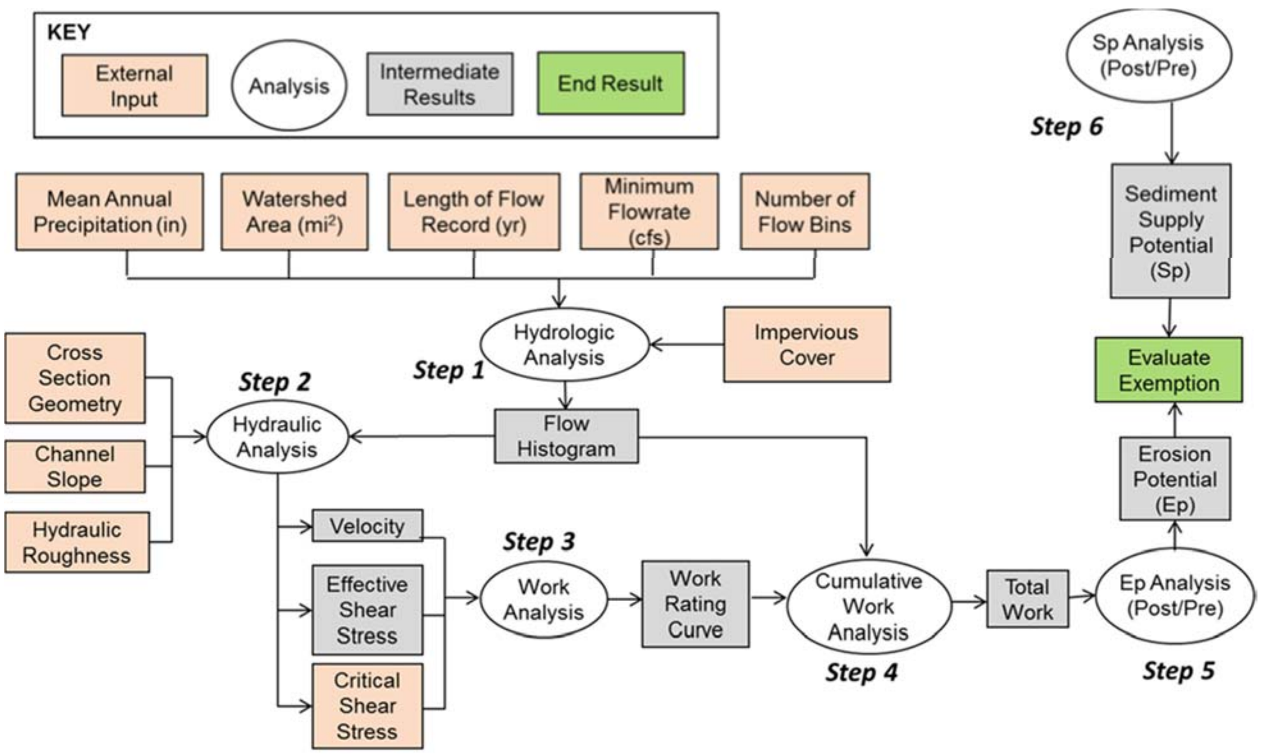


Figure 4-1. WMAA Reach Overview

4.2 Approach for Evaluating Hydromodification Management Exemptions

The approach (see diagram below) in this cumulative hydromodification impacts study accounts for: (1) hydrology, (2) channel geometry, (3) bed and bank material, and (4) sediment supply. This approach compares long-term changes in sediment transport capacity, or in-stream work, and sediment supply at specific sections of the creek for existing and future land use conditions. The ratio of future to existing condition transport capacity, or work, is termed Erosion Potential (Ep). The ratio of future/existing condition bed sediment supply is termed Sediment Supply Potential (Sp). To calculate Ep, the hydrology, channel geometry, and bed/bank materials are characterized for the existing and future conditions. To calculate Sp, the sediment supply factor is characterized for the existing and future conditions.



The findings in this study propose exemption for a given river reach if the analysis satisfies the following criteria:

- Ep < 1.05 when d50 < 16 mm or Ep < 1.20 when d50 > 16 mm, and;
- Sp > 0.5

The following bullet points provide basis for the criteria listed above:

- For Ep

  According to the Journal of Hydrology article titled Channel Enlargement in Semiarid Suburbanizing Watersheds: A Southern California Case Study (Hawley and Bledsoe, 2013): "The threshold corresponding to the presence/absence of headcutting varied based on substrate type, and was roughly quantified as a sediment-transport ratio greater than ~1.20 in systems with a median grain size > 16mm, and [Ep] ~ 1.05 when d50 < 16 mm"

- For Sp
- Technical Advisory Committee (TAC) recommendation
- County of San Diego BMP Manual Appendix H requires Sp > 0.5

According to SCCCWRP Technical Report 605, 2010, When the criteria for Ep and Sp are met, then changes in sediment supply and erosion potential are not anticipated to instigate, on their own, significant channel changes that would destabilize the stream. At present, the report suggests using predicted watershed changes of 50% or more in either runoff (as indexed by change in impervious area) or sediment production as provisional criteria for requiring a more detailed evaluation of both the drivers and the resisting factors for channel change, regardless of other screening-level assessments (SCCWRP Technical Report 605, 2010).

4.2.1 Erosion Potential Analysis

The following steps were implemented to estimate Erosion Potential (Ep):

- **Step 1** – Hydrologic Analysis
  - Due to limited flow data, a flow duration equation developed for Southern California (Hawley and Bledsoe, 2011) was used to estimate existing and future flow histograms for each watershed.
  - The change in impervious cover between existing and future development conditions was estimated using the existing and anticipated land use layer summarized in section 2.3.
    - Planning land use layers from Section 2.3 were used to estimate the existing impervious area and identify the developable parcels in each watershed. A GIS exercise was performed to identify the developable parcels in each watershed that will be exempt from hydromodification management requirements if the exemption is granted.
    - GLU analysis and its associated quantitative analysis described in Section 2.4 were used to determine Sp metric for each watershed. In this study coarse sediment supply changes were limited to changes in hill slope erosion between existing condition and future condition (for parcels that are proposed to be exempt from hydromodification management) of the watershed. It was assumed that the changes in instream sediment supply between existing and future condition for these large depositional river systems are very minimal.
    - The process for quantifying existing vs future land use is as follows
  - Obtain and process land use data and impervious raster
    - Clip impervious raster (https://www.mrlc.gov/) to watershed boundary. Values of raster vary from 0 to 100 and represent % impervious
    - Process land use data based on SCAG codes from 1100 to 9999
  - Perform zonal statistical analysis using ArcGIS
    - Imperviousness for each type of land use is calculated
  - Analyze results for imperviousness in each SCAG code
    - Determine total area corresponding to each SCAG code

        - Using simple average for each impervious surface coefficient associated with each SCAG code global imperviousness is calculated for each jurisdiction
    - Assumptions for percent imperviousness for each land use type were based on:
        - Office of Environmental Health Hazard Assessment (OEHHA) tool for the impervious fraction determination for areas within Riverside County.
        - The information provided in the San Diego County Imperviousness Study (County of San Diego, 2010) for areas within San Diego County.

- **Step 2** -Hydraulic Analysis
    - Critical cross section was selected for performing hydraulic analysis for each reach.
- **Step 3**: Work Analysis: The simplified effective work equation shown below is used to calculate the work done for each flow bin.
- $W = (\tau - \tau_c)^{1.5} V$

  Where
  W = Work (dimensionless)
  τ = effective Shear Stress [lb/ft^2]
  τ_c = Critical Shear Stress [lb/ft^2]
  V = Flow Velocity [ft/s]

- **Step 4**: Cumulative Work Analysis: Cumulative work is a measure of the long-term total work or sediment transport capacity performed at a given stream location. Cumulative work incorporates both discharge magnitude and flow duration distributions for the full range of simulated flow rates. Cumulative work is calculated by multiplying work and duration for each bin. Total work is calculated through summation of work from all flow bins.
- **Step 5**: Ep Analysis: Ep is calculated by dividing the total work of the future condition by that of the existing condition. The existing river reaches analyzed appear relatively stable and have not experienced excessive geomorphic instability due to the alteration of the drainage areas. Given the stable condition of the existing channels, the existing condition was used as the baseline condition instead of natural.

Steps 1 to 5 were performed in Excel. Ep estimates are included in the attachments and are summarized in a table in the corresponding section.

4.2.2 Sediment Supply Potential Analysis

- **Step 6** – Sp Analysis; Sp was estimated using the following equation; it was developed with input from Technical Advisory Committee members formed by the San Diego County Co-Permittees to develop streamlined guidance that provides applicants with simplified methods to determine impacts to coarse sediment delivery based on robust scientific principles. Sp is a metric to evaluate the changes in bed sediment supply for susceptible receiving channels of concern. Sp is directly proportional to Ep (Erosion potential). Sp has to be greater than 0.5, to substantiate a hydromodification exemption, based on current understanding of risks to receiving waters arising from changes in sediment production. Sp is estimated based on the following equation

  $Sp = 0.7*SY_{RUSLE}+0.3*SY_{NHD}$.

The hillslope coarse sediment supply (SY_{RUSLE}) was estimated using the quantitative results from Section 2.4. First, the watershed coarse sediment soil loss was estimated for all GLUs producing coarse sediment below the reservoirs in the existing condition. Then, the future-condition coarse sediment soil loss was estimated by subtracting the developed parcel below the reservoirs soil loss from the existing soil loss.

4.2.3 Criteria for Exemption

The following assessments were performed to evaluate if the projects directly discharging to the reaches discussed in Section 4.1 (see Figure 4.1) should be exempt from hydromodification management requirements. The criteria used in this analysis are consistent with the criteria approved in the San Diego Regional WMAA for determining if exemptions are appropriate, and are summarized below:

- For Flow Control:
  - Erosion potential (Ep) for the fully built-out condition compared to the existing condition shall be less than 1.20 when the median grain size (d_{50}) > 16 mm (Hawley and Bledsoe, 2013).
- For Coarse Sediment Supply:
  - Sediment supply potential (Sp) shall be greater than 0.5, based on current understanding of risks to receiving waters arising from changes in sediment production (SCCWRP Technical Report 605, 2010). Refer to the San Diego Regional WMAA report (Prepared by Geosyntec and RICK, 2015) and the San Diego Model BMP Design Manual for additional details about this criterion.

The watershed characterization maps summarized in Chapter 2 were used to evaluate the applicability of hydromodification management requirements.

4.3 Santa Margarita River

The extents of the Santa Margarita River (Upstream Limit: At Origin, i.e. Confluence with Temecula Creek and Murrieta Creek; Downstream Limit: Outfall to Pacific Ocean) for which hydromodification assessment is performed is shown in Figure 4-1. The river flows southwest through Temecula Canyon at the south end of the Santa Ana Mountains and then enters the coastal region where the river forms a large flood plain as it crosses Camp Pendleton Marine Corps Base before it enters the Pacific Ocean. The upper 15 miles of the river is characterized by a relatively narrow channel, slopes of approximately 1%, significant meanders and rocky terrain. The lower 15 miles within the coastal plain is characterized by a broader channel, shallower slopes of approximately 0.3%, and sandy substrate. Due to the two discrete channel types with varying substrate and associated particle size, two field assessments were conducted to characterize d50 and evaluate stability. Given that erosion potential (Ep) is greatest in the steepest channel, a critical section will be considered at the steepest point in the river profile. Sediment Supply (Sp) will be applied to the tributary watershed for existing and future conditions to quantify reductions in future critical course sediment supply. An additional assessment was conducted in the coastal plain to quantify the (Ep) and evaluate stability.

4.3.1 Erosion Potential Analysis

See section 4.2.1 for a description of the entire erosion potential analysis. This section includes specific information on erosion potential in the extents of the Santa Margarita River:

- The table below presents the input parameters used to construct flow histograms, as well as the estimated channel slope at the two cross sections.

Exempt River Reach	Area below the reservoirs (sq. miles)	Mean Annual Precipitation (in)	Length of Daily Flow Record (Years)	Channel Slope (ft/ft)
Upstream Santa Margarita River	352	16.3	30	0.025
Down Stream Santa Margarita River	352	16.4	30	0.003

- The upstream critical cross section along the reach for Ep analysis was selected by plotting the longitudinal profile of the reach (Figure 4-2) and selecting a cross section along the steeper portion of the channel where flow velocities would tend to be higher. A critical flow rate of 0.5Q2 was assigned to estimate the critical shear stress for the analyzed cross section.
- The downstream cross section along the reach for EP analysis was selected based on its locations within the coastal region. The specific section investigated was selected on what could be accessed safely within Camp Pendleton. Critical shear stress for the reach was estimated based on Fischenich 2001, Stability Thresholds for Stream Restoration Materials. A value of 0.02 was assigned to estimate the critical shear stress for the analyzed cross section.

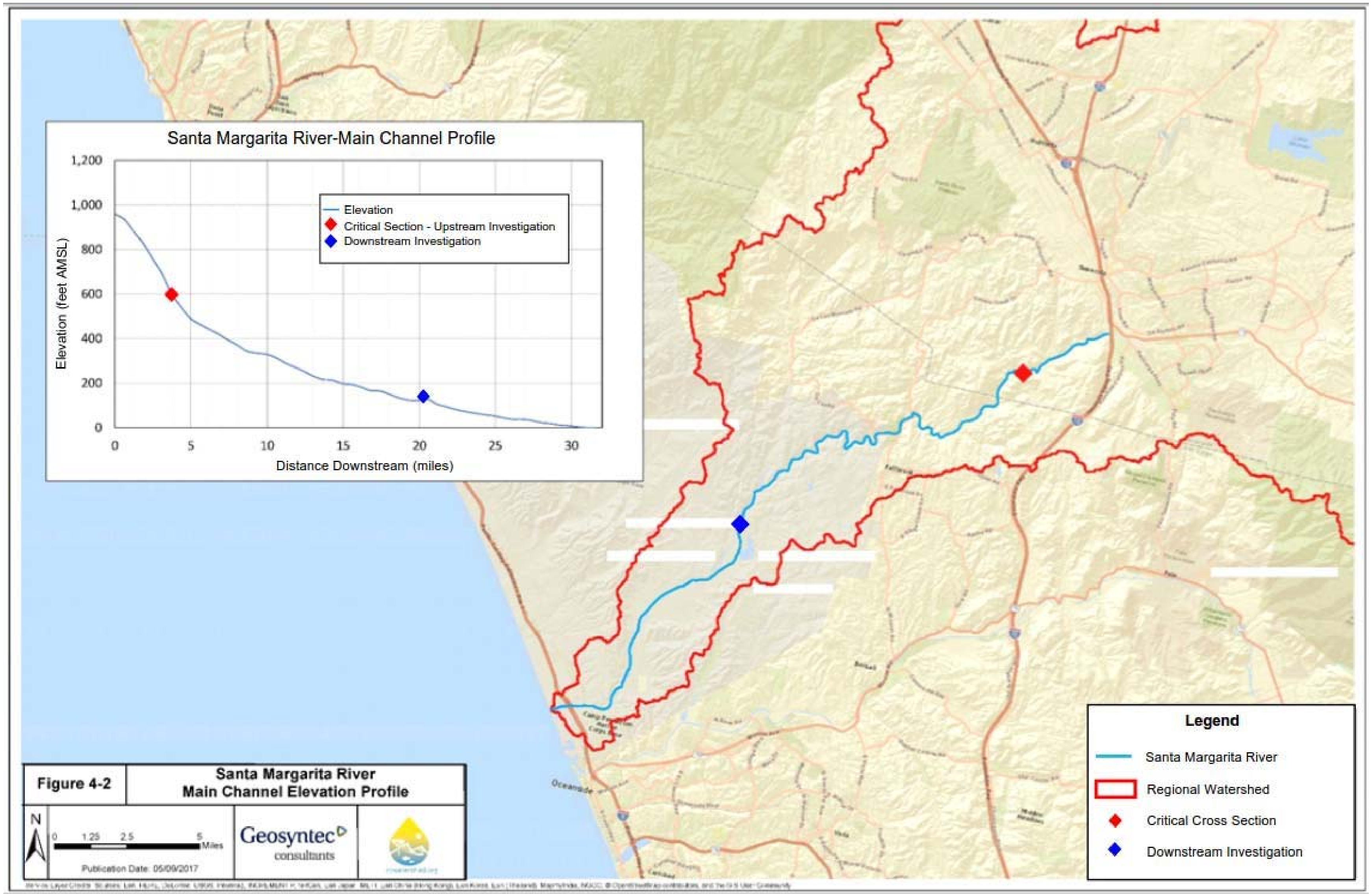


Figure 4-2. Santa Margarita River: Main Channel Elevation Profile

Upstream Investigation

- Field assessment was conducted on June 16, 2017 by Geosyntec Consultants (Geosyntec) within the vicinity of the critical cross section on the Santa Margarita River to assess channel stability and estimate the median grain size of the channel bed material. Based on the results of the field screening performed, the equivalent grain size for the reach with the critical cross section was determined to be greater than 16 mm. Representative channel and flood plain photos based on the field visit are shown in Figure 4-3 and Figure 4-4 below. As can be seen in both photos, the bed material is comprised mostly of large cobble and boulders well in excess of 128 mm. No evidence of downcutting or lateral adjustment was observed. Per SCCWRP Technical Report No. 606, the channel was determined to be consistent with a CEM Type 1 channel.
- Bed Material – Coarse/Armored Bed with boulders/cobbles, d50>128 mm
- Channel Evolution Model - CEM Type 1

Figure 4-3. Upstream Representative Channel

Figure 4-4. Upstream Representative Floodplain

Downstream Investigation

- Field assessment was conducted on March 20, 2018 by WSP within the downstream reach in the vicinity of Camp Pendleton on the Santa Margarita River to assess channel stability and estimate the median grain size of the channel bed material. Based on the results of the field screening performed, the equivalent grain size for the reach was determined to be greater than 16 mm. Representative channel and flood plain photos based on the field visit are shown in Figure 4-5 and Figure 4-6 below. As can be seen in both photos, the bed material is comprised mostly of sands, silts and gravel in excess of 16 mm. No evidence of downcutting or lateral adjustment was observed. Sedimentation was apparent throughout the stream bed. Per SCCWRP Technical Report No. 606, the channel was determined to be consistent with a CEM Type 1 channel.
- Bed Material – Sand and Gravel, d50>16 mm
- Channel Evolution Model - CEM Type 1

Figure 4-5. Downstream Representative Channel

Figure 4-6. Downstream Bed Material

EP estimates are included in Attachment H and are summarized in table below.

Exempt River Reach	Area below the reservoirs (Vail Lake and Skinner Reservoir) (acres)	Impervious Area (acres) [%]			Upstream Ep (Post/Pre) [Criteria <1.20]	Downstream Ep (Post/Pre) [Criteria <1.20]
		Pre	Post	Increase		
Santa Margarita River	225,505	29,772 [13.2]	40,106 [17.8]	10,334 [4.6]	1.13	1.13

The estimated Ep is smaller than the threshold value of 1.20, hence the flow control criteria for Ep is considered to be met. Ep values less than 1.2 indicate the transport capacity of instream work for pre and post conditions will not be significantly altered or lead to unstable conditions. The factor of safety = 1.13/1.20 = 0.94, or a 6-7% factor of safety.

4.3.2 Sediment Supply Potential (Sp) Analysis

Results from this calculation (see Section 4.2.2 for approach) are presented in the below table.

Exempt River Reach	Coarse Sediment Soil Loss (tons/yr.)			SY_{RUSLE}
	Pre	Developed Parcels (downstream of Reservoirs)	Post [Pre – Developed Parcels]	
Santa Margarita River	1,352,421	432,298	920,123	0.68

Disturbance to NHDPlus channels are protected through 401 water quality certifications or waste discharge requirements issued by the RWQCB, so it is assumed that SY_{NHD} =1.

$$\text{Estimated Sp} = 0.7*SY_{RUSLE}+0.3*SY_{NHD} = 0.7*0.68 + 0.3*1 = 0.78.$$

The estimated Sp is greater than 0.5 so the reach meets the sediment supply potential criteria. The value being greater than 0.5 indicate that sediment supply for pre and post conditions will not be significantly different and adequate sediment supplies to the stream will continue. The factor of safety = 0.78/0.5 = 1.56 or 56% factor of safety.

4.3.3 Recommendation

Based on the results from this study, it is recommended that hydromodification management exemption be reinstated for projects discharging runoff directly to the Santa Margarita River (Upstream Limit: At Origin, i.e. Confluence with Temecula Creek and Murrieta Creek; Downstream Limit: Outfall to Pacific Ocean).

Each municipality must define/approve “direct discharge” based on the project site conditions. To qualify for the potential exemption, the outlet elevation must be between the river bottom elevation and the 100-year flood plain elevation and properly designed energy dissipation must be provided.

The Santa Margarita River Estuary (Estuary) is on the 303(d) impairment list for eutrophic conditions. While no analysis has been performed within this assessment, the proposed exemption is not anticipated to conflict with water quality objectives in the Estuary for the following reasons.

1. Nitrogen and Phosphorus loading from the watershed will not be measurably different with or without the proposed hydromodification management exemption. The primary driver of the eutrophic conditions in the Estuary is during dry weather. The exemption has no effect on dry weather discharges or rising groundwater inputs to the Estuary in which the eutrophication symptoms are most prevalent.
2. According to the exemption analysis, this stream system is anticipated to be stable, (i.e., excessive or accelerated erosion is not expected), such that, sediments carrying nutrients would not increase downstream. Furthermore, Ep and Sp analysis indicate that channel erosion and transport will not be significantly changed and therefore instream channel derived sediment and associated nutrients are not expected to increase.
3. WASP model results, included in the Model Application Report, notes that the hydromodification controls are unlikely to have a significant impact on the Estuary. Implications of the findings is that wet weather structural BMPs, which generally cost an order of magnitude or higher to implement, may not provide any additional environmental benefits to the Estuary than implementation of dry weather BMPs alone.
4. The watershed of the Santa Margarita River downstream from the reservoirs totals 352 square miles. The area being evaluated for the proposed hydromodification exemption totals approximately 10 square miles or 2.8 % of the total watershed. Given the relatively small area in which the proposed hydromodification exemption will be applied within the greater Santa Margarita watershed, the exemption is not expected to exacerbate eutrophic conditions.
5. Within the hydromodification exemption area, priority development projects in the absence of hydromodification requirements will still be required to provide treatment of the 85^{th} percentile rainfall with an effective combination of BMPs that target the constituents of concern such as nitrogen and phosphorus. Additionally, all priority development projects will implement peak flow control BMPs as required by Riverside County Flood Control and Water Conservation District to preserve the 2 to 10-year peak flow rates generated by the project site. Treatment of stormwater runoff through effective BMPs combined with preservation of 2-10 year peak flow rates will ensure target pollutants such as nitrogen and phosphorus are effectively treated and the drainage response is preserved. This strategy will effectively provide a similar level of mitigation required by hydromodification.
6. Hydromodification BMPs are designed to release stored volume over an extended period which effectively increases the duration of low flows. Increasing durations will expand the wet weather

response and could contribute to dry weather flow volume, thereby contributing to dry weather flows. This could conflict with the effort to reduce dry weather input of nitrogen and phosphorus to the estuary. The proposed hydromodification exemption could serve to minimize these potential adverse impacts.

7. Other contributors such as lateral inputs and tidal exchange will not be impacted by the hydromodification exemption. The agricultural fields near the Santa Margarita River Estuary have been identified as a significant source of sediment and nutrients from erosion and subsequent sedimentation in the estuary. Additionally, lack of tidal exchange has been identified as contributing to lower levels of dissolved oxygen. These contributing factors will not be exacerbated from a hydromodification exemption.

These findings strongly support the determination that a hydromodification exemption will not contribute to further degradation of the Santa Margarita River Estuary. The condition of the estuary and the stability of the Santa Margarita River will continue to be monitored and ongoing evaluations will continue as permits are reissued to verify the river is stable.

4.4 Temecula Creek

The extents of the Temecula Creek (Upstream Limit: Outflow of Vail Lake; Downstream Limit: Confluence with Santa Margarita River) for which hydromodication assessment is performed is shown in Figure 4-5.

On September 14, 2017, a field team from Geosyntec investigated segments along Temecula Creek to assess channel stability and susceptibility to erosion, and hydromodification impacts. An initial desktop assessment of aerial maps was used to determine areas of interest showing signs of erosion or geomorphic change. Information was collected based on Hydromodification Screening Tools: Field Manual for Assessing Channel Susceptibility (Booth et al., 2010).

Although multiple locations along the creek were visited, this report is focused on the downstream reach of Temecula Creek, particularly between Pechanga Parkway, at the downstream end, and Avenida de Missiones, at the upstream end. Aerial and field photographs are presented below to highlight observed susceptibility to erosion in the Creek.

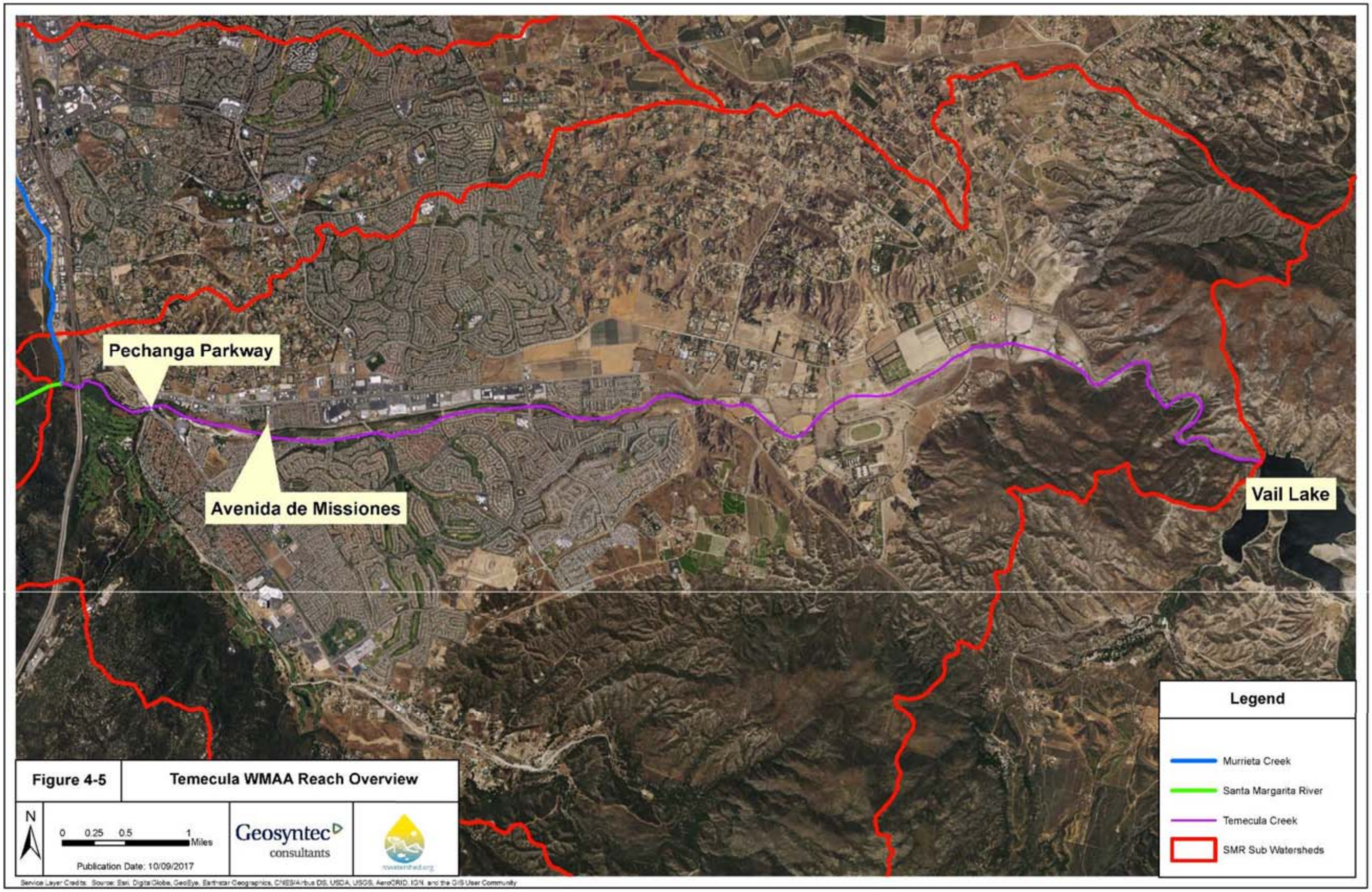


Figure 4-7.: Temecula WMAA Reach Overview

4.4.1 Temecula Creek between Pechanga Parkway and Avenida de Missiones

This segment of Temecula Creek was observed to be wide and heavily vegetated in parts; however, the main portion of the Creek that handles flows was deeply incised at points, with eight-to-nine-foot vertical cuts, soft banks, and a sandy bed. The historical aerials below (Figures 4-6 to 4-11) demonstrate how the channel planform has changed since 1995, and particularly show how concentrated flow has affected the channel form. Field photographs from September 14, 2017 (Figures 4-12 to 4-15) provide documentation of current conditions within the channel.

Figure 4-6 shows Temecula Creek upstream of Pechanga Parkway in late 1995. Per historical aerials, development of the Redhawk community was partially complete by this point, and development of a small residential neighborhood on Temecula Parkway between Country Glen Way and Avenida De Missiones was complete (partially shown in the top-right corner of Figure 4-6). The majority of the remainder of the upstream watershed was not yet developed, though some grading along the north bank of the Creek had begun.

The yellow arrow on the left side of Figure 4-6 shows a drainage lateral to the Creek. Subsequent aerial photos show the lateral enlarging and the effect on Temecula Creek is noticeable. For example, Figure 4-9 shows the Creek in January 2006, after this storm drain channel appears to have been completed. The Creek bed has widened substantially at this confluence and threatens the integrity of the adjacent parking lot. This area is circled in yellow on the left of Figures 4-6 to 4-11.

The yellow circle in the middle of Figure 4-6 shows Creek adjustment near a park on the south bank. This geomorphic adjustment appears to threaten to the structural integrity of the adjacent park.

The yellow arrow on the right side of Figure 4-6 shows the concentrated flow path for upstream flows in the Creek, including flows coming from the Country Glen Way development. Over time, as demonstrated in subsequent aerial photos, the flow path in this portion of Temecula Creek has adjusted. The Creek at this point becomes incised, with eroded vertical banks along the southern bank of the Creek. In addition, the southern bank of the Creek grows wider over time, and gets nearer and nearer to Strawberry Tree Lane.

Figure 4-8. Temecula Creek at Pechanga Parkway, October 1995

Figure 4-9. Temecula Creek at Pechanga Parkway, October 2003

Figure 4-10. Temecula Creek at Pechanga Parkway, July 2004

Figure 4-11. Temecula Creek at Pechanga Parkway, January 2006

Figure 4-12. Temecula Creek at Pechanga Parkway, June 2012

Figure 4-13. Temecula Creek at Pechanga Parkway, October 2016

Figure 4-14. Temecula Creek at Pechanga Parkway, September 2017. Vertical cut along the north bank of the Creek

Figure 4-15. Temecula Creek at Pechanga Parkway, September 2017. Vertical cut along the south bank of the Creek

Figure 4-16. Temecula Creek at Pechanga Parkway, September 2017. Vertical cuts along the south bank of the Creek, adjacent to Pala Community Park

Figure 4-17. Temecula Creek at Pechanga Parkway, September 2017. Vertical cuts along the north bank of the Creek. Exposed tree roots shown

4.4.2 Recommendation

Based on the historical aerial photo review and field investigation conducted by Geosyntec staff, the downstream end of Temecula Creek is susceptible to erosion. Aerial photographs demonstrate a widening of flow path over the past 20 years. The field investigation observed soft, unconsolidated sand bed material and eroded channel banks, some of which threaten the physical integrity of infrastructure along the southern bank between Pachanga Parkway, at the downstream end, and Via Del Coronado, at the upstream end (e.g., parking lot, park with soccer field, and Strawberry Tree Lane). (Note: The calculations described in Section 4.2 only apply to channels that are stable in present condition; therefore, no calculations are provided for this reach of Temecula Creek being analyzed).

In light of the creek's susceptibility to erosion and existing infrastructure concerns associated with geomorphic adjustment, it is recommended that the hydromodification exemption not be reinstated at this time. Temecula Creek can be considered a potential candidate for an in-stream restoration/stabilization project to remedy current stability issues and manage for future hydromodification effects associated with new development in its tributary watershed.

4.4.3 Murrieta Creek

The extents of the Murrieta Creek (Upstream Limit: 850 feet upstream of Hawthorn Street; Downstream Limit: Confluence with Santa Margarita River) for which hydromodication assessment is performed is shown in Figure 4-16. Section 4.5.1 presents an overview of the Murrieta Creek Flood Control, Environmental Restoration and Recreation Project.

Figure 4-18: Murrieta WMAA Reach Overview

4.4.4 Murrieta Creek Flood Control, Environmental Restoration and Recreation Project

Murrieta Creek traverses the cities of Temecula and Murrieta in the densely populated southwest region of Riverside County. At the confluence with Temecula Creek, it forms the Santa Margarita River which flows through Camp Pendleton Marine Base and on to the Pacific Ocean. As a result of repeated flood events, culminating with the catastrophic flood in 1993, the U.S. Army Corps of Engineers initiated a study on a 7.5-mile section of the creek, which led to the 2000 Congressional recognition of the 4-phase Murrieta Creek Flood Control, Environmental Restoration and Recreation Project.

The project is anticipated to:

- Improve flood control and storm water retention
- Enhance water conservation and supply
- Provide recreation-related opportunities along the Santa Margarita River and its tributaries in Riverside and San Diego counties

Flood Control Features include:

- Widening and deepening of Murrieta Creek from the USGS stream gauge in Temecula to Tenaja Road in Murrieta
- A flood control detention basin occupying approximately 250 acres on the eastern side of Murrieta Creek between Santa Gertrudis Channel to approximately 500 feet upstream of the confluence with Warm Springs Creek and bordering Adams Avenue, Cherry Street and Jefferson Avenue
- Stream bank protection features between Rancho California Road and First Street

Locally Funded Recreation Features include:

- Construction of a public park of about 50 acres in size within the easternmost portion of the detention basin. This will include parking lot, children's play area, shade structures, comfort station, barbecues, open space, walks, baseball and soccer fields, security lighting, pedestrian/bicycle/equestrian bridges spanning Santa Gertrudis Creek and Murrieta Creek
- Bicycle and equestrian/hiking trails along the eastern and western park in the detention basin, with undercrossing structures beneath the bridges on First Street, Rancho California Road, Winchester Road, Guava Street and Ivy Street

Environmental Restoration Features include:

- Constructing a low flow channel with natural backwaters
- Creating a transitional wetland habitat from freshwater marsh habitat to willow riparian woodland with an upland buffer of mulefat scrub and coastal sage scrub within a 163 acre site
- A 13.7 acre sediment catchment area at the confluence of Murrieta and Warm Springs Creeks

The four phases of the project are shown in Figure 4-17. Phase 1 construction is complete. Phase 2 construction is anticipated to be complete by January 2018. Typical existing and proposed cross section for phase 2 is shown in Figure 4-18.

Figure 4-19. Murrieta Creek Flood Control, Environmental Restoration and Recreation Project

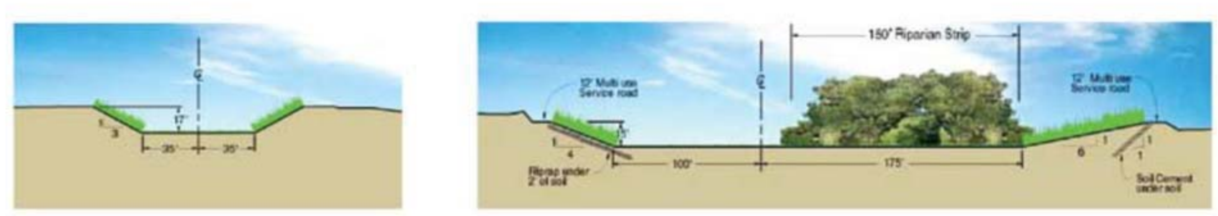


Figure 4-20. Typical existing and proposed cross section for Phase 2

Based on the field visit and assessment conducted by Geosyntec staff on September 14, 2017 the existing phase 3 reach is stable (see Figure 4-19). In the Phase 4 area, walking from downstream to upstream the first sign of erosion was observed at around 80 feet upstream of Washington Avenue (see Figure 4-20).

Figure 4-21. Looking downstream near the Murrieta Creek and Santa Gertrude Creek confluence. Heavily vegetated channel bed and concrete side slope.

Figure 4-22. Looking towards east riverbank 80 feet upstream of Washington Avenue overpass. Sandy gravel riverbanks showing a 25 foot high erosion cut.

Based on the findings from the field visit and consideration of the ongoing Phase 2 of the Murrieta Creek Flood Control, Environmental Restoration and Recreation Project that is anticipated to be complete by

January 2018, the exemption analysis extents were revised for Murrieta Creek (Upstream Limit: Washington Avenue; Downstream Limit: Confluence with Santa Margarita River). The same approach that was used for Forester Creek (engineered channels that are stabilized with materials other than concrete, such as riprap, turf reinforcement mat, or vegetation) as part of the San Diego River WQIP was implemented for Murrieta Creek and summarized below.

4.4.5 Erosion Potential Analysis

See section 4.2.1 for a description of the entire erosion potential analysis. This section includes specific information on erosion potential in the extents of the Murrieta Creek:

The following steps were implemented to estimate the Erosion Potential:

- The table below presents the input parameters used to construct flow histograms. The critical slope and cross-section was obtained from Phase 2 design plans.

Stabilized Conveyance System	Area below the reservoirs/lakes (sq. miles)	Mean Annual Precipitation (in)	Length of Daily Flow Record (Years)	Channel Slope (ft/ft)
Murrieta Creek	149	14.7	30	0.002

- The critical cross section was based on the narrowest cross section (140 feet wide trapezoidal channel) and the steepest slope (0.2% longitudinal slope) in the phase 2 plans.
- Critical shear stress was estimated to be greater than or equal to 1.2 pounds per square foot (lb/ft2), based on review of permissible shear stress values presented in "Stability Thresholds for Stream Restoration Materials" (Fischenich 2001) and "Streambank Soil Bioengineering Considerations for Semi-Arid Climates" (Hoag and Fripp 2005). Based on Fischenich 2001, permissible shear stress for "long native grasses" is approximately 1.2 to 1.7 lb/ft2. The side slopes are generally either turn reinforcement mat, soil cement protection, rip-rap or dense vegetation all of which have critical shear stress greater than or equal to 8 pounds per square foot (lb/ft2)

Steps 1 to 5 were performed in Excel. Ep estimates for the exempt river reaches are included as an Attachment H. Results from the Ep analysis are summarized in table below.

Stabilized Conveyance System	Area below the reservoirs (Skinner Reservoir) (acres)	Impervious Area (acres) [%]			Ep (Post/Pre)
		Pre (existing)	Post (built out)	Increase	
Murrieta Creek	95,251	13,762 [14.4]	20,634 [21.7]	6872 [7.3]	1

The analysis results, presented in Attachment H, show that for both the existing and future condition, the shear stress for all geomorphically-effective flows is less than the estimated critical shear stress of 1.2 lb/ft^2. This means that no excess shear stress or "work" occurs in the channel in either the existing or future condition. Therefore, there is no increase in the duration of "work" (cumulative work), in the future condition, and erosion potential is 1.0.

Note that while the flow rates are the same in both the existing and future condition analyses, the duration of each flow rate is increased in the future condition. The flow rates in the flow bins are based on the watershed area, mean annual precipitation, and length of the synthetic record. The synthetic record means the modeled or analytically- derived series of hydrology parameters such as flow rate and duration of flow at points or nodes in the system. Available measures parameters such as precipitation, catchment area, catchment slopes, channel conditions, and are used as inputs to the model or algorithm. Watershed area, mean annual precipitation, and length of the synthetic record do not change from existing to future condition. The duration for each flow bin is related to the watershed area, mean annual precipitation, length of the synthetic record, and the impervious area. The duration increases in the future condition based on the increased impervious area. The increase in duration would result in increased cumulative work in the future condition if any of the flow rates resulted in shear stress greater than the estimated critical shear stress (excess shear stress, or "work"), because cumulative work is the product of work times duration.

The scenario that occurred in the Murrieta Creek analysis, in which no work occurred in the expected range of geomorphically-effective flow rates, is a potential scenario for engineered channels because engineered conveyance systems are typically engineered for flood flows much greater and less frequent than the geomorphically-effective flows. For example, Murrieta Creek is being engineered to convey a 100-year flow rate of approximately 30,900 cubic feet per second (cfs) (100-year flow estimate is from FEMA Flood Insurance Study). The maximum geomorphically-effective flow rate for Murrieta Creek is 11,000 cfs.

In addition, the USACE report states that for the Phase 2 design it is anticipated that flows of about seven feet/second and above could cause erosion and scouring of the unmaintained riparian/low-flow corridor. These occurrences of erosion and scour are expected to be within the range of current conditions. It is anticipated that the larger trees would remain in place once established; however, the smaller trees and shrubs may be washed out during significant storm events. Natural recruitment is expected within areas of scour as has occurred within the Phase I area, where riparian and wetland vegetation within the channel invert has re-established after completion of construction. The estimated velocity for the maximum geomorphically-effective flow rate of 11,000 cfs for Murrieta Creek is 5.8 feet/second. This also supports the hydromodification management exemption.

4.4.6 Recommendation

Based on the results from this study, it is recommended that hydromodification management exemption be reinstated for projects discharging runoff directly to the Murrieta Creek (Upstream Limit: Washington Avenue; Downstream Limit: Confluence with Santa Margarita River).

Hydromodification management exemption from Washington Avenue to 850 feet upstream of Hawthorn Street is not reinstated at this time. Based on the field visit and assessment by Geosyntec staff, this segment of channel appeared to be unstable and susceptible to erosion.

4.5 Conclusion

Based on the results from this study, it is recommended that hydromodification management exemption be reinstated for projects discharging runoff directly to the following exempt river reaches:

- Santa Margarita River

  - Upstream Limit: At Origin, i.e. Confluence with Temecula Creek and Murrieta Creek
  - Downstream Limit: Outfall to Pacific Ocean
- Murrieta Creek
  - Upstream Limit: Washington Avenue
  - Downstream Limit: Confluence with Santa Margarita River

Each municipality must define/approve "direct discharge" based on the project site conditions. To qualify for the potential exemption, the outlet elevation must be between the river bottom elevation and the 100-year floodplain elevation and properly designed energy dissipation must be provided.

4.5.1 Factors of Safety

The analysis conducted to evaluate the applicability of hydromodification management requirements to priority development projects directly discharging to the exempt river reaches have the following implicit factors of safety:

- The analysis assumes all projects within the watershed will be exempt from hydromodification management requirements for erosion potential and coarse sediment supply calculations (note: during actual implementation only projects directly discharging to the exempt reach will be exempt). This conservative assumption provides an implicit (non-quantified) factor of safety.
- The analysis assumes all impervious area in the watershed is directly connected impervious area. In actuality, some portion of these impervious areas will sheet flow through pervious areas prior to discharging to the streams. This dispersion will result in attenuation of flow rates and durations that are not accounted for when estimating the sediment transport capacity of the built-out condition. This conservative assumption provides an implicit (non-quantified) factor of safety.
- New priority development projects, including projects that are proposed to be exempt from hydromodification management requirements through this study, must implement retention BMPs to the extent feasible if participation in alternative compliance is not selected or allowed. This requirement will result in attenuation of flow rates and durations that are not accounted for when estimating the sediment transport capacity of the built-out condition. This conservative assumption provides an implicit (non-quantified) factor of safety.
- Redevelopment priority development projects in the watershed that do not directly discharge to the river reach that is exempt by this study must mitigate flows to the pre-developed condition. This will result in over mitigation of flow rates and durations for redevelopment projects which are not accounted for when estimating the sediment transport capacity of the built-out condition. This conservative assumption provides an implicit (non-quantified) factor of safety.

4.5.2 Limitations

The analysis and associated recommendations as presented above were based on instream erosion as the primary consideration to support reinstatement of exemptions from hydromodification management controls for discharges directly to these river reaches. While it is recognized that other factors contribute to adverse impacts (e.g., salinity imbalance, pollutants) to instream habitat and resulting biotic integrity, hydromodification management control has traditionally been considered an "umbrella process" that encompasses most of the highest risk stressors (percent sands and fines present, channel alteration, and riparian disturbance) to physical habitat.

The current assessment methods may yield inconclusive results when attempting to identify causal relationships between degraded instream habitat solely due to increased flows and erosive force from hydromodification. A causal assessment recently conducted in the lower reaches of the San Diego River, conducted as a partnership between the Southern California Coastal Water Research Project (SCCWRP), the City of San Diego, the County of San Diego, and the San Diego RWQCB, focused on stressors potentially responsible for known biological impairment of the river. Once the data of the causal assessment become available, it may be useful in classifying the potential stressors such as altered physical habitat as likely, unlikely, or an uncertain cause to biological impairment.

With respect to adverse impacts to habitat as a result of pollutants entrained in storm water discharges, these areas will still be subject to the pollutant control requirements of the Regional MS4 Permit as areas develop or redevelop. The current requirements require development to maximize retention of the design storm volume which will mitigate a portion of the volume that would otherwise be controlled with hydromodification management BMPs. In some cases, this offsetting of volume reduction through pollutant control BMPs may exceed the HMP volumes. In addition, the development that occurs within the exempted watershed areas is still required to provide any applicable flood control measures. Risk of flooding as a result of exemption from hydromodification controls is unlikely as the control thresholds are significantly lower (order of magnitude) than flood control requirements implemented to protect life and property.

5 Conclusions

This WMAA used available regional data to understand watershed-scale characteristics and processes in the SMR. The results of this analysis are shown on the maps in Attachment A. This analysis combined with the San Diego Water Quality Equivalency guidance can be used to provide flexibility with meeting the Permit's land development requirements. The WMAA mapping includes readily available regional datasets and specific projects will be augmented with site-specific analysis. As such, projects will also consult the future BMP Design manual for options to meet the Permit requirements. The Co-Permittees continue to develop the BMP Manual and are looking for additional compliance options for small projects, single-family residences or sites that substantially mimic predevelopment conditions.

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7 Glossary

Term	Definition
Alternative Compliance Program	An optional program that may be implemented by individual Co-Permittees to allow for offsite ACPs to offset stormwater pollutant control and hydromodification impacts that are not fully addressed at PDP sites.
Best Management Practice (BMP)	Any procedure or device designed to minimize the quantity of Pollutants that enter the MS4 or to control stormwater flow.
Bioretention	A type of BMP that is designed to capture a certain volume of stormwater within a biologically active soil media. Retained water is evapotranspired by plants in the BMP or allowed to slowly infiltrate into the underlying soils.
Hydromodification	The change in the natural watershed hydrologic processes and runoff characteristics (i.e., interception, infiltration, overland flow, 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, such as stream channelization, concrete lining, installation of dams and water impoundments, and excessive streambank and shoreline erosion are also considered hydromodification, due to their disruption of natural watershed hydrologic processes.
Municipal Separate Storm Sewer System (MS4)	A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels or storm drains) as defined in 40 CFR 122.26(b)(8).
Priority Development Project	New development and redevelopment projects defined under Provision E.3.b of the Permit.
Structural BMP	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.
Water Quality Improvement Plan (WQIP)	A planning document which describes programs which will be implemented to meet water quality requirements as described in Provision B of the Permit.
Water Quality Equivalency	Methodologies and calculations used to determine water quality benefits and water quality impacts, and to apply them toward the design, review, and approval of PDPs and ACPs in meeting the Section E.3.c.(3) requirements of the Permit.
SMR Co-Permittees	The SMR Co-Permittees include County of Riverside, Riverside County Flood Control and Water Conservation District, City of Wildomar, City of Murrieta, City of Temecula, City of Menifee and County of San Diego.

Attachments

Attachment A. Dominant Hydrologic Processes

Table A.1
Land Cover Categories
Riverside County

ID	Vegetation Category	Land Cover Grouping
1	Annual Grassland	Agricultural/Grass
2	Cropland, Orchard - Vineyard	Agricultural/Grass
3	Urban	Developed
4	Barren	Forest
5	Coastal Oak Woodland	Forest
6	Eucalyptus	Forest
7	Jeffrey Pine	Forest
8	Mixed Chaparral	Forest
9	Montane Hardwood	Forest
10	Montane Hardwood - Conifer	Forest
11	Montane Hardwood, Montane Hardwood - Conifer	Forest
12	Montane Riparian, Valley Foothill Riparian	Forest
13	Pinyon - Juniper	Forest
14	Sierran Mixed Conifer	Forest
15	Valley Foothill Riparian	Forest
16	White Fir, Sierran Mixed Conifer	Forest
17	Desert Riparian, Desert Wash	Other
18	Fresh Emergent Wetland	Other
19	Lacustrine	Other
20	Riverine, Lacustrine	Other
21	Wet Meadow	Other
22	Lacustrine	Other
23	Alkali Desert Scrub	Scrub/Shrub
24	Chamise-Red Shank Chaparral	Scrub/Shrub
25	Coastal Scrub	Scrub/Shrub
26	Mixed Chaparral	Scrub/Shrub
27	Sagebrush	Scrub/Shrub

Three scenerios led to an overide or modification of the Land Cover value

1. Impervious layer union resulted in a Developed value
2. Aerial shows urban development for a given area
3. Road ROW union resulted in a Developed value

Table A.2 Land Cover Grouping
San Diego County

ID	Vegetation Category	Land Cover Grouping
1	42000 Valley and Foothill Grassland	Agricultural/Grass
3	42110 Valley Needlegrass Grassland	Agricultural/Grass
5	42200 Non-Native Grassland	Agricultural/Grass
11	45110 Wet Montane Meadow	Agricultural/Grass
12	45120 Dry Montane Meadows	Agricultural/Grass
19	18000 General Agriculture	Agricultural/Grass
20	18100 Orchards and Vineyards	Agricultural/Grass
22	18200 Intensive Agriculture - Dairies, Nurseries, Chicken Ranches	Agricultural/Grass
23	18300 Extensive Agriculture - Field/Pasture, Row Crops	Agricultural/Grass
24	18310 Field/Pasture	Agricultural/Grass
26	18320 Row Crops	Agricultural/Grass
27	12000 Urban/Developed	Developed
29	81100 Mixed Evergreen Forest	Forest
32	81320 Canyon Live Oak Forest	Forest
33	81340 Black Oak Forest	Forest
36	84000 Lower Montane Coniferous Forest	Forest
39	84150 Bigcone Spruce (Bigcone Douglas Fir)-Canyon Oak Forest	Forest
41	84500 Mixed Oak/Coniferous/Bigcone/Coulter*	Forest
42	85100 Jeffrey Pine Forest	Forest
43	11100 Eucalyptus Woodland	Forest
45	61000 Riparian Forests	Forest
46	61300 Southern Riparian Forest	Forest
47	61310 Southern Coast Live Oak Riparian Forest	Forest
48	61320 Southern Arroyo Willow Riparian Forest	Forest
49	61330 Southern Cottonwood-willow Riparian Forest	Forest
50	61510 White Alder Riparian Forest	Forest
56	62400 Southern Sycamore-alder Riparian Woodland	Forest
58	71000 Cismontane Woodland	Forest
59	71100 Oak Woodland	Forest
60	71120 Black Oak Woodland	Forest
61	71160 Coast Live Oak Woodland	Forest
62	71161 Open Coast Live Oak Woodland	Forest
63	71162 Dense Coast Live Oak Woodland	Forest
66	71181 Open Engelmann Oak Woodland	Forest
67	71182 Dense Engelmann Oak Woodland	Forest
74	79000 Undifferentiated Dense Woodland*	Forest
76	52120 Southern Coastal Salt Marsh	Other
78	52310 Cismontane Alkali Marsh	Other
80	52410 Coastal and Valley Freshwater Marsh	Other
87	13110 Marine	Other
96	13140 Freshwater	Other
97	13200 Non-Vegetated Channel, Floodway, Lakeshore Fringe	Other
99	13400 Beach	Other
100	21230 Southern Foredunes	Scrub/Shrub
106	63300 Southern Riparian Scrub	Scrub/Shrub
107	63310 Mule Fat Scrub	Scrub/Shrub
109	63320 Southern Willow Scrub	Scrub/Shrub
112	63400 Great Valley Scrub	Scrub/Shrub
120	32500 Diegan Coastal Sage Scrub	Scrub/Shrub
123	32700 Riversidian Sage Scrub	Scrub/Shrub
125	32720 Alluvial Fan Scrub	Scrub/Shrub
137	35200 Sagebrush Scrub	Scrub/Shrub
142	37000 Chaparral	Scrub/Shrub
143	37120 Southern Mixed Chaparral	Scrub/Shrub
145	37121 Granitic Southern Mixed Chaparral	Scrub/Shrub
148	37130 Northern Mixed Chaparral*	Scrub/Shrub
149	37131 Granitic Northern Mixed Chaparral*	Scrub/Shrub
150	37132 Mafic Northern Mixed Chaparral*	Scrub/Shrub
151	37200 Chamise Chaparral	Scrub/Shrub
154	37300 Red Shank Chaparral	Scrub/Shrub
156	37500 Montane Chaparral	Scrub/Shrub
158	37520 Montane Manzanita Chaparral	Scrub/Shrub
160	37540 Montane Scrub Oak Chaparral	Scrub/Shrub
162	37830 Ceanothus crassifolius Chaparral	Scrub/Shrub
163	37900 Scrub Oak Chaparral	Scrub/Shrub
166	37G00 Coastal Sage-Chaparral Scrub	Scrub/Shrub
167	37K00 Flat-topped Buckwheat*	Scrub/Shrub
168	39000 Upper Sonoran Subshrub Scrub	Scrub/Shrub
175	11300 Disturbed Habitat	Unknown

Table A.3 Runoff Coefficients versus Land Use, Hydrologic Soil Group and Slope Range

	A			B			C			D		
Land Use	0–2%	2–6%	6%+	0–2%	2–6%	6%+	0–2%	2–6%	6%+	0–2%	2–6%	6%+
Cultivated land	0.08[a]	0.13	0.16	0.11	0.15	0.21	0.14	0.19	0.26	0.18	0.23	0.31
	0.14[b]	0.18	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Pasture	0.12	0.20	0.30	0.18	0.28	0.37	0.24	0.34	0.44	0.30	0.40	0.50
	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Meadow	0.10	0.16	0.25	0.14	0.22	0.30	0.20	0.28	0.36	0.24	0.30	0.40
	0.14	0.22	0.30	0.20	0.28	0.37	0.26	0.35	0.44	0.30	0.40	0.50
Forest	0.05	0.08	0.11	0.08	0.11	0.14	0.10	0.13	0.16	0.12	0.16	0.20
	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Residential lot size 1/8 acre	0.25	0.28	0.31	0.27	0.30	0.35	0.30	0.33	0.38	0.33	0.36	0.42
	0.33	0.37	0.40	0.35	0.39	0.44	0.38	0.42	0.49	0.41	0.45	0.54
Residential lot size 1/4 acre	0.22	0.26	0.29	0.24	0.29	0.33	0.27	0.31	0.36	0.30	0.34	0.40
	0.30	0.34	0.37	0.33	0.37	0.42	0.36	0.40	0.47	0.38	0.42	0.52
Residential lot size 1/3 acre	0.19	0.23	0.26	0.22	0.26	0.30	0.25	0.29	0.34	0.28	0.32	0.39
	0.28	0.32	0.35	0.30	0.35	0.39	0.33	0.38	0.45	0.36	0.40	0.50
Residential lot size 1/2 acre	0.16	0.20	0.24	0.19	0.23	0.28	0.22	0.27	0.32	0.26	0.30	0.37
	0.25	0.29	0.32	0.28	0.32	0.36	0.31	0.35	0.42	0.34	0.38	0.48
Residential lot size 1 acre	0.14	0.19	0.22	0.17	0.21	0.26	0.20	0.25	0.31	0.24	0.29	0.35
	0.22	0.26	0.29	0.24	0.28	0.34	0.28	0.32	0.40	0.31	0.35	0.46
Industrial	0.67	0.68	0.68	0.68	0.68	0.69	0.68	0.69	0.69	0.69	0.69	0.70
	0.85	0.85	0.86	0.85	0.86	0.86	0.86	0.86	0.87	0.86	0.86	0.88
Commercial	0.71	0.71	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.89	0.89	0.90
Streets	0.70	0.71	0.72	0.71	0.72	0.74	0.72	0.73	0.76	0.73	0.75	0.78
	0.76	0.77	0.79	0.80	0.82	0.84	0.84	0.85	0.89	0.89	0.91	0.95
Open space	0.05	0.10	0.14	0.08	0.13	0.19	0.12	0.17	0.24	0.16	0.21	0.28
	0.11	0.16	0.20	0.14	0.19	0.26	0.18	0.23	0.32	0.22	0.27	0.39
Parking	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97

[a] Runoff coefficients for storm recurrence intervals less than 25 years.

[b] Runoff coefficients for storm recurrence intervals of 25 years or longer.

Source: Table 7-9 in *Hydrologic Analysis and Design* (McCuen, 2005)

Table A.4
Land Cover and Land Use

Land Cover Categories	Land Use per Table A.3
Agriculture/Grass	Meadow
Forest	Forest
Scrub/Shrub	Average (Meadow,Forest)
Unknown/Other	Meadow

Table A.5 Hydrologic Response Unit Calculations

Land Cover	HSG	Gradient	Runoff Coefficient	ET Coefficient	Infiltration Coefficient	Runoff/ Infiltration Ratio	Hydrologic Process Designation
Agriculture/Grass	A	0-2%	0.1	0.6	0.3	0.33	I
Agriculture/Grass	A	2-6%	0.16	0.6	0.24	0.67	U
Agriculture/Grass	A	6-10%	0.25	0.6	0.15	1.67	O
Agriculture/Grass	B	0-2%	0.14	0.6	0.26	0.54	I
Agriculture/Grass	B	2-6%	0.22	0.6	0.18	1.22	U
Agriculture/Grass	B	6-10%	0.3	0.6	0.1	3	O
Agriculture/Grass	C	0-2%	0.2	0.6	0.2	1	U
Agriculture/Grass	C	2-6%	0.28	0.6	0.12	2.33	O
Agriculture/Grass	C	6-10%	0.36	0.6	0.04	9	O
Agriculture/Grass	D	0-2%	0.24	0.6	0.16	1.5	U
Agriculture/Grass	D	2-6%	0.3	0.6	0.1	3	O
Agriculture/Grass	D	6-10%	0.4	0.6	0	infinite	O
Forest	A	0-2%	0.05	0.8	0.15	0.33	I
Forest	A	2-6%	0.08	0.8	0.12	0.67	U
Forest	A	6-10%	0.11	0.8	0.09	1.22	U
Forest	B	0-2%	0.08	0.8	0.12	0.67	U
Forest	B	2-6%	0.11	0.8	0.09	1.22	U
Forest	B	6-10%	0.14	0.8	0.06	2.33	O
Forest	C	0-2%	0.1	0.8	0.1	1	U
Forest	C	2-6%	0.13	0.8	0.07	1.86	O
Forest	C	6-10%	0.16	0.8	0.04	4	O
Forest	D	0-2%	0.12	0.8	0.08	1.5	U
Forest	D	2-6%	0.16	0.8	0.04	4	O
Forest	D	6-10%	0.2	0.8	0	infinite	O
Scrub/Shrub	A	0-2%	0.08	0.7	0.23	0.33	I
Scrub/Shrub	A	2-6%	0.12	0.7	0.18	0.67	U
Scrub/Shrub	A	6-10%	0.18	0.7	0.12	1.5	U
Scrub/Shrub	B	0-2%	0.11	0.7	0.19	0.58	I
Scrub/Shrub	B	2-6%	0.17	0.7	0.14	1.22	U
Scrub/Shrub	B	6-10%	0.22	0.7	0.08	2.75	O
Scrub/Shrub	C	0-2%	0.15	0.7	0.15	1	U
Scrub/Shrub	C	2-6%	0.21	0.7	0.1	2.16	O
Scrub/Shrub	C	6-10%	0.26	0.7	0.04	6.5	O
Scrub/Shrub	D	0-2%	0.19	0.7	0.12	1.5	U
Scrub/Shrub	D	2-6%	0.23	0.7	0.07	3.29	O
Scrub/Shrub	D	6-10%	0.3	0.7	0	infinite	O

Hydrologic process designation: I = Interflow; O = Overland Flow; U = Uncertain

Table A.6
Hydrologic Response Unit Designations

Land Cover	Slope	Soil Type				
		A	B	C	D	Other
Agricultural/Grass/ Unknown/Other	0-2%	I	I	U	U	U
	2-6%	U	U	O	O	U
	6-10%	O	O	O	O	O
	>10%	O	O	O	O	O
Developed	0-2%	O	O	O	O	O
	2-6%	O	O	O	O	O
	6-10%	O	O	O	O	O
	>10%	O	O	O	O	O
Forest	0-2%	I	U	U	U	U
	2-6%	U	U	O	O	U
	6-10%	U	O	O	O	U
	>10%	O	O	O	O	O
Scrub/Shrub	0-2%	I	I	U	U	U
	2-6%	U	U	O	O	U
	6-10%	U	O	O	O	U
	>10%	O	O	O	O	O

Hydrologic Process Designation: I = Interflow; O = Overland Flow; U = Uncertain

Dominant Hydrologic Processes - Santa Magarita River Watershed

Figure A.1

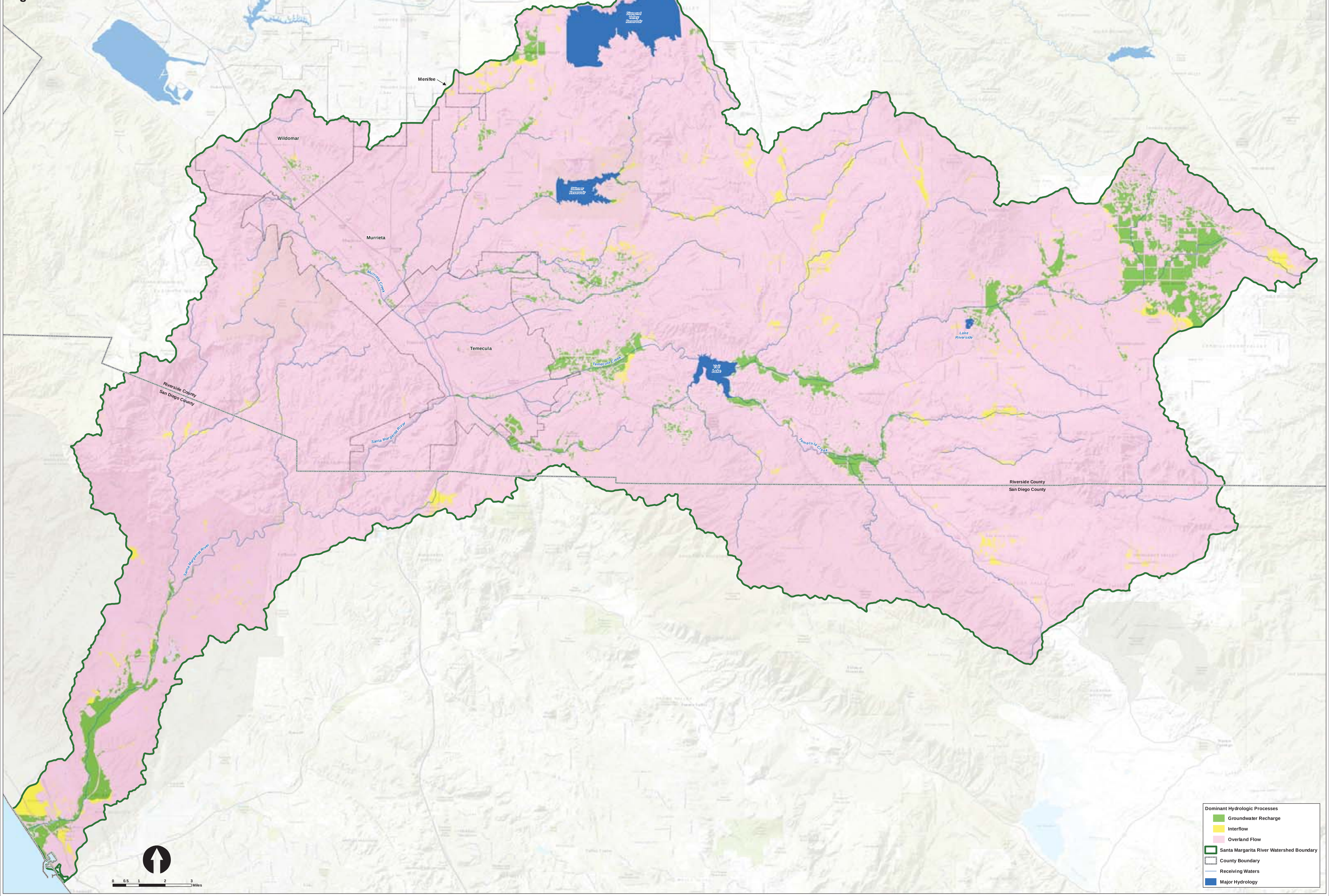


Table A.7. Summary of Consultation Committee Meetings

Consultation Committee Meeting Date/Location	Key Meeting Content
February 24, 2017 Western Riverside Council of Governments Technical Advisory Committee	• Upper SMR Hydrologic Response Unit and Critical Coarse Sediment Yield Report
May 17, 2017 City of Wildomar	• Revisions to Prioritization Process • Priority Water Quality Conditions • Proposed goals and scheduled • Overview of strategies and schedules • Watershed Management Area Analysis
May 25, 2017 Riverside County Flood Control & Water Conservation District	• Comments on the Draft Hydrologic Response Unit and Critical Coarse Sediment Yield Report (WSP 2017)
October 17, 2017 City of Temecula	• Watershed Management Area Analysis • Monitoring and Assessment Program • Adaptive Management

Attachment B. Potential Critical Coarse Sediment Yield Areas

Table B.1 Riverside County
Geologic Map Units

Map Unit	Map Name	Anticipated Grain Size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
gr	santa_ana_30x60_reference.pdf	Coarse	Bedrock	Impermeable	CB
gr-m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
grMz	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Kgd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kt	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ktc	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ktc-w	San Diego & Oceanside 30' x 60	Coarse	Bedrock	Impermeable	CB
af	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Impermeable	CSI
Qvoa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvof	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tt	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qa+Qya	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qds	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qf	palm_springs_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Qoa	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Qp	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qss	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Qsu	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Qw	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Qya	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qya+Qoa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyf	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Tss	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Ttl	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Ttu	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
JTrm	San Diego & Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kat	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgb	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
pKm	palm_springs_30x60_reference.pdf	Fine	Bedrock	Impermeable	FB
Qls	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
sp	santa_ana_30x60_reference.pdf	Fine	Bedrock	Impermeable	FB
Tv	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
water	San Diego & Oceanside 30' x 60'	Water	Water	Impermeable	Other

Table B.2 San Diego County Geologic Map Units

Map Unit	Map Name	Anticipated Grain Size of Weathered Material	Bedrock or Sedimentary	Impermeable/Permeable	Geology Grouping
gr-m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
grMz	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Kat	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgb	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgdf	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Khg	San Diego 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kt	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ktr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Mzu	San Diego & Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Q	Jennings; CA	Coarse	Sedimentary	Permeable	CSP
Qa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qd	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qls	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Qmb	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop1	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop2-4	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop3	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop4	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop6	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop6-7	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qvoa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop10	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop10-13	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop11	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop12	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop3	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop4	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop7	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop8	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop9	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qw	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qya	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Tmo	Oceanside 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
Tsa	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsi	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsm	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tso	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tta	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
water	San Diego & Oceanside 30' x 60'	Water	Water	Impermeable	Other

SANTA MARGARITA WATERSHED MANAGEMENT AREA ANALYSIS
GEOLOGY GROUPING

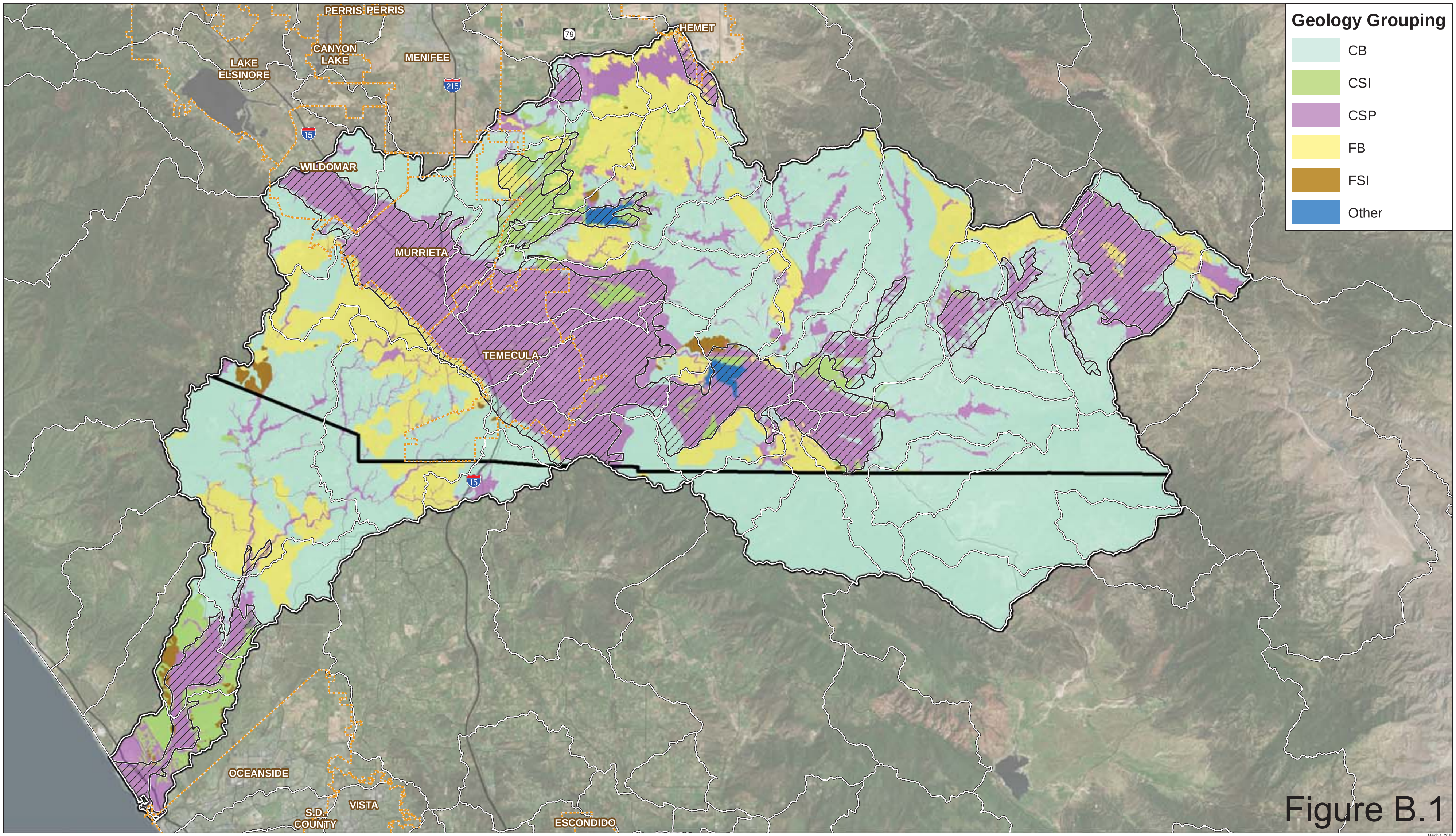


Figure B.1

March 1, 2018

Legend

Cities | Hydrologic Basin Units | Groundwater Basins

0 1 2 Miles

Table B.3
Riverside County - Critical Coarse Sediment and Geomorphic Landscape Units

GLU	Acreage	K	LS	C	R	A	Relative Sediment Production	Critical
CB-Agricultural/Grass-1	7686.98	0.27	3.33	0.15	33.50	4.62	Medium	No
CB-Agricultural/Grass-2	3485.75	0.27	3.67	0.15	34.57	5.22	Medium	No
CB-Agricultural/Grass-3	2935.80	0.27	4.10	0.15	36.97	6.23	Medium	No
CB-Agricultural/Grass-4	739.22	0.26	5.95	0.15	44.70	10.08	High	Yes
CB-Developed-1	14499.35	0.25	3.67	0.00	33.15	0.00	Low	No
CB-Developed-2	7885.00	0.25	4.02	0.00	34.34	0.00	Low	No
CB-Developed-3	3648.28	0.26	4.38	0.00	36.45	0.00	Low	No
CB-Developed-4	460.94	0.27	5.64	0.00	41.16	0.00	Low	No
CB-Forest-1	2142.78	0.26	4.74	0.15	36.70	6.78	Medium	No
CB-Forest-2	1510.57	0.26	5.11	0.15	37.38	7.41	Medium	No
CB-Forest-3	1752.29	0.26	5.56	0.15	38.95	8.45	High	Yes
CB-Forest-4	1244.47	0.26	6.57	0.15	41.37	10.40	High	Yes
CB-Other-1	165.35	0.21	3.07	0.15	28.24	3.18	Low	No
CB-Other-2	39.22	0.23	3.70	0.15	29.37	4.49	Medium	No
CB-Other-3	12.13	0.25	4.18	0.15	32.31	5.83	Medium	No
CB-Other-4	0.95	0.29	5.60	0.15	36.56	9.77	High	Yes
CB-Other-Water-1	23.37	0.28	4.12	0.00	35.42	0.00	Low	No
CB-Other-Water-2	11.73	0.27	4.53	0.00	37.00	0.00	Low	No
CB-Other-Water-3	6.23	0.26	4.66	0.00	36.60	0.00	Low	No
CB-Other-Water-4	0.83	0.24	6.66	0.00	46.89	0.00	Low	No
CB-Scrub/Shrub-1	33188.03	0.24	4.38	0.14	30.60	4.89	Medium	No
CB-Scrub/Shrub-2	34452.62	0.24	4.67	0.14	31.57	5.41	Medium	No
CB-Scrub/Shrub-3	36432.18	0.25	5.06	0.14	33.11	6.21	Medium	No
CB-Scrub/Shrub-4	15560.57	0.25	5.94	0.14	35.14	7.72	Medium	No
CSI-Agricultural/Grass-1	3933.40	0.30	2.13	0.15	33.96	3.27	Low	No
CSI-Agricultural/Grass-2	245.71	0.31	2.76	0.15	33.62	4.30	Medium	No
CSI-Agricultural/Grass-3	24.22	0.32	3.00	0.15	34.45	4.87	Medium	No
CSI-Agricultural/Grass-4	0.17	0.31	3.46	0.15	36.14	5.59	Medium	No
CSI-Developed-1	4949.47	0.31	2.39	0.00	34.67	0.00	Low	No
CSI-Developed-2	289.72	0.32	2.81	0.00	35.67	0.00	Low	No
CSI-Developed-3	75.91	0.33	2.84	0.00	38.36	0.00	Low	No
CSI-Developed-4	1.91	0.33	2.93	0.00	39.88	0.00	Low	No
CSI-Forest-1	126.74	0.33	3.69	0.15	34.41	6.18	Medium	No
CSI-Forest-2	35.16	0.34	4.07	0.15	35.01	7.02	Medium	No
CSI-Forest-3	20.59	0.34	4.50	0.15	36.44	7.64	Medium	No
CSI-Forest-4	4.16	0.33	5.17	0.15	38.21	8.63	High	Yes
CSI-Other-1	33.59	0.30	2.53	0.15	34.16	4.03	Medium	No
CSI-Other-2	4.04	0.32	3.48	0.15	33.28	5.33	Medium	No
CSI-Other-3	1.07	0.33	3.77	0.15	32.83	5.42	Medium	No
CSI-Other-4	0.07	0.37	3.35	0.15	34.00	6.11	Medium	No
CSI-Other-Water-1	170.42	0.32	2.79	0.00	32.63	0.00	Low	No
CSI-Other-Water-2	7.18	0.35	3.44	0.00	33.42	0.00	Low	No
CSI-Other-Water-3	1.74	0.34	3.52	0.00	32.63	0.00	Low	No
CSI-Other-Water-4	0.47	0.24	1.19	0.00	25.00	0.00	Low	No
CSI-Scrub/Shrub-1	1256.01	0.32	3.77	0.14	34.26	6.01	Medium	No
CSI-Scrub/Shrub-2	986.87	0.33	3.91	0.14	34.40	6.26	Medium	No
CSI-Scrub/Shrub-3	665.98	0.34	4.02	0.15	35.40	6.81	Medium	No
CSI-Scrub/Shrub-4	121.03	0.35	4.45	0.15	37.65	8.20	Medium	No
CSP-Agricultural/Grass-1	16856.07	0.30	2.63	0.14	35.30	4.18	Medium	No
CSP-Agricultural/Grass-2	2418.68	0.32	2.97	0.15	38.00	5.12	Medium	No
CSP-Agricultural/Grass-3	814.48	0.34	2.98	0.15	40.64	5.74	Medium	No
CSP-Agricultural/Grass-4	13.06	0.34	3.81	0.15	41.82	7.60	Medium	No
CSP-Developed-1	37033.30	0.30	2.68	0.00	36.94	0.00	Low	No
CSP-Developed-2	9045.81	0.32	2.98	0.00	39.41	0.00	Low	No
CSP-Developed-3	3979.17	0.33	2.87	0.00	41.28	0.00	Low	No
CSP-Developed-4	86.40	0.34	3.13	0.00	42.37	0.00	Low	No
CSP-Forest-1	3380.20	0.29	3.98	0.14	37.90	6.41	Medium	No
CSP-Forest-2	985.24	0.29	4.41	0.15	38.58	7.13	Medium	No
CSP-Forest-3	634.95	0.29	4.66	0.15	39.92	7.77	Medium	No
CSP-Forest-4	111.73	0.28	5.46	0.15	41.14	8.78	High	Yes
CSP-Other-1	1406.81	0.26	3.17	0.15	31.96	4.47	Medium	No
CSP-Other-2	75.01	0.28	4.30	0.15	33.31	6.21	Medium	No
CSP-Other-3	17.08	0.29	4.88	0.15	35.96	7.70	Medium	No
CSP-Other-4	1.38	0.30	6.92	0.15	40.57	11.22	High	Yes
CSP-Other-Water-1	3386.44	0.27	3.21	0.00	32.49	0.00	Low	No
CSP-Other-Water-2	67.29	0.28	3.82	0.00	34.34	0.00	Low	No
CSP-Other-Water-3	41.31	0.28	3.78	0.00	32.42	0.00	Low	No
CSP-Other-Water-4	42.07	0.26	3.25	0.00	30.71	0.00	Low	No
CSP-Scrub/Shrub-1	11329.78	0.29	3.54	0.14	32.61	5.05	Medium	No
CSP-Scrub/Shrub-2	6414.46	0.30	3.81	0.14	34.60	5.74	Medium	No
CSP-Scrub/Shrub-3	6519.26	0.32	3.94	0.14	36.53	6.39	Medium	No
CSP-Scrub/Shrub-4	1843.69	0.33	4.17	0.15	39.09	7.53	Medium	No
FB-Agricultural/Grass-1	4547.24	0.31	3.99	0.14	35.62	6.98	Medium	No
FB-Agricultural/Grass-2	2155.70	0.32	4.34	0.14	36.65	7.71	Medium	No
FB-Agricultural/Grass-3	2086.05	0.32	4.58	0.15	37.80	8.32	High	No
FB-Agricultural/Grass-4	627.53	0.31	5.58	0.15	42.30	10.91	High	No
FB-Developed-1	3018.49	0.30	4.32	0.00	35.91	0.00	Low	No
FB-Developed-2	1985.30	0.31	4.71	0.00	38.10	0.00	Low	No

FB-Developed-3	2097.08	0.31	5.00	0.00	39.75	0.00	Low	No
FB-Developed-4	509.12	0.31	5.50	0.00	42.18	0.00	Low	No
FB-Forest-1	652.90	0.30	5.64	0.14	38.88	9.38	High	No
FB-Forest-2	712.38	0.29	5.84	0.15	39.15	9.66	High	No
FB-Forest-3	1179.81	0.29	6.13	0.15	39.56	10.04	High	No
FB-Forest-4	645.91	0.28	6.71	0.15	39.70	10.61	High	No
FB-Other-1	151.43	0.31	5.43	0.15	40.66	9.70	High	No
FB-Other-2	15.22	0.31	5.65	0.15	39.00	9.56	High	No
FB-Other-3	7.31	0.31	6.05	0.15	39.51	10.46	High	No
FB-Other-4	3.80	0.30	7.10	0.15	38.08	11.66	High	No
FB-Other-Water-1	859.14	0.28	3.72	0.00	26.66	0.00	Low	No
FB-Other-Water-2	175.43	0.29	4.35	0.00	27.68	0.00	Low	No
FB-Other-Water-3	67.09	0.29	4.52	0.00	28.05	0.00	Low	No
FB-Other-Water-4	24.94	0.29	3.92	0.00	25.29	0.00	Low	No
FB-Scrub/Shrub-1	4818.92	0.29	5.30	0.14	31.65	7.09	Medium	No
FB-Scrub/Shrub-2	6638.89	0.29	5.48	0.14	32.25	7.39	Medium	No
FB-Scrub/Shrub-3	15147.82	0.29	5.69	0.14	32.72	7.68	Medium	No
FB-Scrub/Shrub-4	9728.58	0.29	6.21	0.14	33.62	8.39	High	No
FSI-Agricultural/Grass-1	33.74	0.30	6.94	0.15	40.81	12.03	High	No
FSI-Agricultural/Grass-2	43.33	0.29	7.05	0.15	41.36	11.83	High	No
FSI-Agricultural/Grass-3	77.58	0.30	7.02	0.15	41.29	12.18	High	No
FSI-Agricultural/Grass-4	3.74	0.32	6.27	0.15	39.92	11.47	High	No
FSI-Developed-1	12.99	0.22	7.02	0.00	44.93	0.00	Low	No
FSI-Developed-2	46.62	0.23	7.16	0.00	44.62	0.00	Low	No
FSI-Developed-3	43.93	0.23	7.47	0.00	44.88	0.00	Low	No
FSI-Developed-4	15.22	0.28	7.22	0.00	44.81	0.00	Low	No
FSI-Forest-1	10.50	0.24	7.74	0.15	44.50	11.91	High	No
FSI-Forest-2	68.88	0.24	7.57	0.15	44.36	11.55	High	No
FSI-Forest-3	127.41	0.25	7.44	0.15	43.79	11.84	High	No
FSI-Forest-4	49.55	0.27	7.46	0.15	43.33	12.60	High	No
FSI-Other-1	0.34	0.29	5.63	0.15	37.25	9.01	High	No
FSI-Other-2	1.35	0.27	6.06	0.15	38.80	9.24	High	No
FSI-Other-3	1.80	0.31	4.90	0.15	35.00	8.69	High	No
FSI-Other-4	1.04	0.31	4.90	0.15	35.00	8.69	High	No
FSI-Scrub/Shrub-1	39.79	0.30	7.01	0.15	41.11	12.48	High	No
FSI-Scrub/Shrub-2	198.57	0.30	6.85	0.15	40.91	11.77	High	No
FSI-Scrub/Shrub-3	667.72	0.30	7.01	0.15	41.02	12.15	High	No
FSI-Scrub/Shrub-4	519.27	0.30	7.17	0.15	41.29	12.80	High	No
Other-Agricultural/Grass-1	7.15	0.37	4.07	0.00	39.17	0.00	Low	No
Other-Agricultural/Grass-2	0.04	0.37	3.86	0.00	38.50	0.00	Low	No
Other-Agricultural/Grass-3	0.00	0.37	3.86	0.00	38.00	0.00	Low	No
Other-Developed-1	15.09	0.33	3.10	0.00	37.00	0.00	Low	No
Other-Forest-1	154.61	0.37	3.79	0.00	39.15	0.00	Low	No
Other-Forest-2	10.34	0.37	3.85	0.00	39.82	0.00	Low	No
Other-Forest-3	3.98	0.37	3.86	0.00	39.89	0.00	Low	No
Other-Forest-4	0.03	0.37	3.82	0.00	40.00	0.00	Low	No
Other-Other-1	23.14	0.37	4.08	0.00	39.50	0.00	Low	No
Other-Other-2	0.00	0.37	4.48	0.00	41.00	0.00	Low	No
Other-Other-Water-1	1396.46	0.35	2.96	0.00	36.65	0.00	Low	No
Other-Other-Water-2	13.62	0.36	3.44	0.00	38.00	0.00	Low	No
Other-Other-Water-3	1.58	0.37	3.82	0.00	40.00	0.00	Low	No
Other-Scrub/Shrub-1	7.07	0.37	3.80	0.00	39.46	0.00	Low	No
Other-Scrub/Shrub-2	4.92	0.37	3.87	0.00	39.65	0.00	Low	No
Other-Scrub/Shrub-3	2.17	0.37	3.79	0.00	39.84	0.00	Low	No
Other-Scrub/Shrub-4	0.22	0.37	3.82	0.00	40.00	0.00	Low	No

Table B.4
San Diego County - Critical Coarse Sediment and Geomorphic Landscape Units

GLU	Acreage	K	LS	C	R	A	RSP	Critical
CB-Agricultural/Grass-1	4207.12025	0.4	9.34	0.28	100	12.98	Medium	No
CB-Agricultural/Grass-2	2602.294916	0.42	10.38	0.28	112	16.68	Medium	No
CB-Agricultural/Grass-3	3201.956796	0.22	6.04	0.14	57	10.57	High	Yes
CB-Agricultural/Grass-4	1452.123019	0.23	7.38	0.14	57	13.46	High	Yes
CB-Developed-1	2192.483367	0.66	11.31	0	147	0	Low	No
CB-Developed-2	911.1252571	0.44	8.56	0	100	0	Low	No
CB-Developed-3	388.2247298	0.22	4.86	0	49	0	Low	No
CB-Developed-4	79.85684775	0.22	5.63	0	48	0	Low	No
CB-Forest-1	2042.769347	0.4	12.76	0.28	78	13.64	Medium	No
CB-Forest-2	1388.228004	0.2	7.2	0.13	45	8.76	High	Yes
CB-Forest-3	2586.360015	0.2	8.14	0.13	48	10.57	High	Yes
CB-Forest-4	4161.260102	0.2	9.95	0.14	50	13.63	High	Yes
CB-Other-1	44.27957187	0.2	5.52	0.13	45	6.48	Medium	No
CB-Other-2	15.91897875	0.2	6.46	0.13	45	7.92	Medium	No
CB-Other-3	9.964938052	0.2	6.96	0.14	43	8.32	Medium	No
CB-Other-4	1.616170372	0.21	6.84	0.14	41	8.18	Medium	No
CB-Scrub/Shrub-1	11016.60072	0.2	5.66	0.14	33	5.27	Low	No
CB-Scrub/Shrub-2	13033.61337	0.2	6.51	0.14	37	6.77	Medium	No
CB-Scrub/Shrub-3	21329.28411	0.21	7.33	0.14	41	8.37	Medium	No
CB-Scrub/Shrub-4	21470.71697	0.21	8.28	0.14	42	9.84	High	Yes
CB-Unknown-1	11.48018908	0.21	5.32	0.13	44	6.3	Medium	No
CB-Unknown-2	12.6556765	0.21	5.95	0.13	44	7.09	Medium	No
CB-Unknown-3	15.21557361	0.22	6.21	0.13	44	7.67	Medium	No
CB-Unknown-4	1.645373006	0.22	6.61	0.13	44	8.44	High	Yes
CSI-Agricultural/Grass-1	925.5538264	0.34	2.72	0.14	39	4.82	Low	No
CSI-Agricultural/Grass-2	1278.657552	0.37	3.61	0.14	47	8.7	High	Yes
CSI-Agricultural/Grass-3	1922.868841	0.38	3.99	0.14	47	9.8	High	Yes
CSI-Agricultural/Grass-4	554.6779845	0.37	4.33	0.14	47	10.47	High	Yes
CSI-Developed-1	86.87776816	0.28	2.51	0	39	0	Low	No
CSI-Developed-2	60.59757587	0.3	2.66	0	41	0	Low	No
CSI-Developed-3	46.82102408	0.3	2.89	0	40	0	Low	No
CSI-Developed-4	15.24581302	0.27	3.2	0	39	0	Low	No
CSI-Forest-1	15.58893957	0.27	4.26	0.13	43	6.6	Medium	No
CSI-Forest-2	17.34311817	0.25	5.11	0.13	44	7.49	Medium	No
CSI-Forest-3	10.03886387	0.29	4.43	0.13	44	7.4	Medium	No
CSI-Forest-4	1.660919051	0.3	4.49	0.13	43	7.61	Medium	No
CSI-Other-1	18.02047788	0.31	2.5	0.13	32	3.19	Low	No
CSI-Other-2	9.615652947	0.27	3.01	0.13	39	4.3	Low	No
CSI-Other-3	5.485885584	0.28	3.03	0.13	39	4.49	Low	No
CSI-Other-4	0.7418804	0.24	4.01	0.14	39	5.17	Low	No
CSI-Scrub/Shrub-1	282.584646	0.26	3.53	0.13	39	4.67	Low	No
CSI-Scrub/Shrub-2	473.1055229	0.27	4.36	0.13	41	6.35	Medium	No
CSI-Scrub/Shrub-3	1117.895224	0.26	4.82	0.13	41	6.69	Medium	No
CSI-Scrub/Shrub-4	927.690404	0.26	5.52	0.13	41	7.8	Medium	No
CSP-Agricultural/Grass-1	2737.802423	0.22	3.01	0.14	44	3.97	Low	No
CSP-Agricultural/Grass-2	387.1522554	0.23	3.81	0.14	42	5.17	Low	No
CSP-Agricultural/Grass-3	155.4903262	0.24	4.05	0.14	41	5.56	Low	No
CSP-Agricultural/Grass-4	6.713337103	0.22	6.28	0.14	52	10.09	High	Yes
CSP-Developed-1	2980.902158	0.27	2.1	0	42	0	Low	No
CSP-Developed-2	140.0082488	0.26	2.77	0	42	0	Low	No
CSP-Developed-3	34.81810133	0.27	2.7	0	40	0	Low	No

Table B.4
San Diego County - Critical Coarse Sediment and Geomorphic Landscape Units

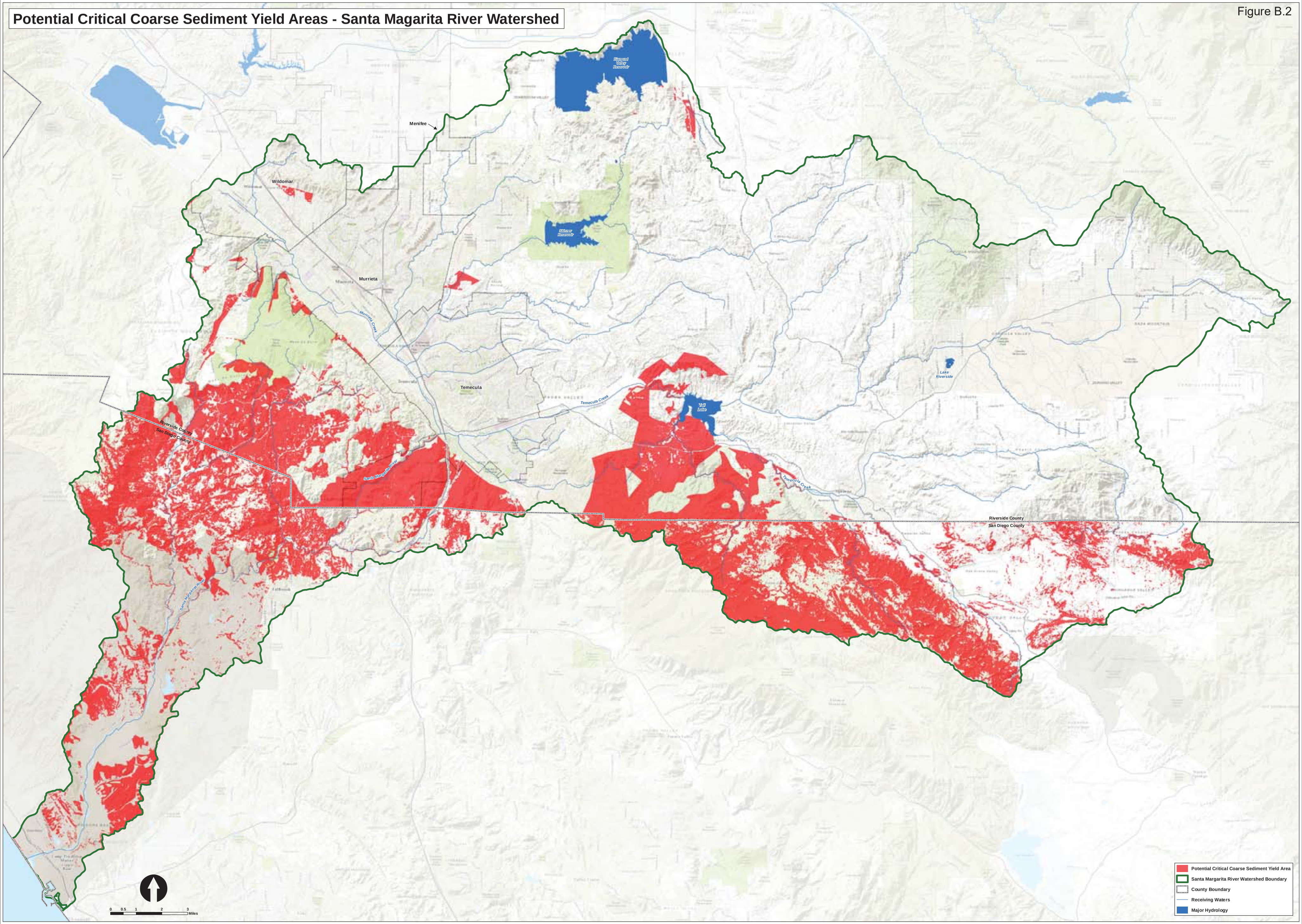
CSP-Developed-4	0.887532855	0.27	2.76	0	38	0	Low	No
CSP-Forest-1	1859.036483	0.22	4.52	0.14	44	5.97	Medium	No
CSP-Forest-2	356.6859183	0.22	5.99	0.14	45	8.15	Medium	No
CSP-Forest-3	190.1243432	0.21	6.42	0.14	45	8.49	High	Yes
CSP-Forest-4	43.14434988	0.21	7.62	0.14	48	10.25	High	Yes
CSP-Other-1	1038.483925	0.23	2.61	0.14	39	3.18	Low	No
CSP-Other-2	46.16538313	0.24	3.68	0.13	40	4.76	Low	No
CSP-Other-3	9.527040963	0.24	3.76	0.13	40	4.86	Low	No
CSP-Other-4	0.406388289	0.24	4.19	0.13	39	5.27	Low	No
CSP-Scrub/Shrub-1	1727.23043	0.23	3.75	0.14	41	4.85	Low	No
CSP-Scrub/Shrub-2	400.7401323	0.24	5.63	0.14	40	7.14	Medium	No
CSP-Scrub/Shrub-3	285.098895	0.23	6.15	0.13	39	7.51	Medium	No
CSP-Scrub/Shrub-4	65.82252137	0.22	7.16	0.14	43	9.32	High	Yes
CSP-Unknown-1	2.168837488	0.25	2.63	0.13	40	3.45	Low	No
CSP-Unknown-2	0.400864075	0.27	3.49	0.13	39	4.76	Low	No
FB-Agricultural/Grass-1	588.4165067	0.25	5.49	0.14	49	9.15	High	No
FB-Agricultural/Grass-2	482.1666445	0.25	5.87	0.14	51	10.12	High	No
FB-Agricultural/Grass-3	499.3422436	0.24	6.43	0.14	53	11.26	High	No
FB-Agricultural/Grass-4	239.6396713	0.22	8.62	0.14	57	15.19	High	No
FB-Developed-1	79.8775956	0.28	3.94	0	46	0	Low	No
FB-Developed-2	78.73206254	0.28	4.41	0	45	0	Low	No
FB-Developed-3	67.68640109	0.27	4.72	0	44	0	Low	No
FB-Developed-4	17.15389025	0.27	5.08	0	43	0	Low	No
FB-Forest-1	125.3517506	0.21	7.24	0.13	39	8.04	Medium	No
FB-Forest-2	180.3094439	0.21	7.53	0.13	43	8.84	High	No
FB-Forest-3	311.2361877	0.22	8.02	0.13	43	9.67	High	No
FB-Forest-4	232.2978921	0.26	9.63	0.13	35	11.54	High	No
FB-Other-1	17.24708788	0.26	5.72	0.13	44	8.63	High	No
FB-Other-2	0.69688975	0.26	5.97	0.13	38	7.73	Medium	No
FB-Other-3	0.202063574	0.28	6.27	0.13	34	7.61	Medium	No
FB-Other-4	0.035280176	0.31	6.7	0.13	33	8.64	High	No
FB-Scrub/Shrub-1	624.4951848	0.24	6.94	0.14	36	8.26	Medium	No
FB-Scrub/Shrub-2	1569.395997	0.25	7.24	0.14	38	9.04	High	No
FB-Scrub/Shrub-3	3844.606579	0.25	7.89	0.13	38	10	High	No
FB-Scrub/Shrub-4	4008.360006	0.26	9.05	0.14	39	12.12	High	No
FB-Unknown-1	0.622954589	0.3	5.33	0.13	37	7.56	Medium	No
FB-Unknown-2	4.191995085	0.29	5.26	0.13	40	7.92	Medium	No
FB-Unknown-3	12.71576486	0.29	5.54	0.13	39	8.21	Medium	No
FB-Unknown-4	4.603722008	0.28	6.02	0.13	38	8.43	High	No
FSI-Agricultural/Grass-1	84.66480013	0.32	3.91	0.13	24	3.92	Low	No
FSI-Agricultural/Grass-2	267.2869696	0.33	4.29	0.13	31	5.67	Medium	No
FSI-Agricultural/Grass-3	295.4970826	0.34	4.26	0.13	34	6.31	Medium	No
FSI-Agricultural/Grass-4	72.45552697	0.35	4.11	0.13	36	6.69	Medium	No
FSI-Developed-1	0.72730955	0.29	3.09	0	34	0	Low	No
FSI-Developed-2	3.807619001	0.31	3.22	0	37	0	Low	No
FSI-Developed-3	1.048132455	0.29	3.3	0	36	0	Low	No
FSI-Forest-1	4.7383172	0.33	4.62	0.13	37	7.21	Medium	No
FSI-Forest-2	0.867669898	0.35	4.47	0.13	39	7.95	Medium	No
FSI-Forest-3	0.044445413	0.37	4.71	0.13	40	9.21	High	No
FSI-Other-1	2.327768318	0.31	3.11	0.13	24	2.87	Low	No
FSI-Other-2	1.252340665	0.3	3.29	0.13	25	3.1	Low	No
FSI-Other-3	0.065239224	0.31	3.04	0.13	27	3.23	Low	No

Table B.4
San Diego County - Critical Coarse Sediment and Geomorphic Landscape Units

FSI-Scrub/Shrub-1	21.39582291	0.27	4.46	0.13	29	4.49	Low	No
FSI-Scrub/Shrub-2	65.84035365	0.28	4.96	0.13	31	5.65	Medium	No
FSI-Scrub/Shrub-3	97.16588596	0.29	5.05	0.13	34	6.35	Medium	No
FSI-Scrub/Shrub-4	80.40557523	0.3	5.14	0.13	37	7.54	Medium	No
O-Agricultural/Grass-1	3.402172805	0.2	2.93	0.14	34	2.8	Low	No
O-Agricultural/Grass-2	0.144075102	0.21	3.44	0.14	32	3.21	Low	No
O-Developed-1	3.585648795	0.27	1.37	0	39	0	Low	No
O-Other-1	120.1921569	0.25	3.86	0.13	36	4.31	Low	No
O-Other-2	0.277422913	0.24	3.32	0.13	35	3.53	Low	No

Figure B.2

Potential Critical Coarse Sediment Yield Areas - Santa Magarita River Watershed



MEMO

TO: Matt Yeager, D.Env, CPSWQ, QSD/P

FROM: Veronica Seyde

SUBJECT: Santa Margarita Watershed Management Area – RUSLE Analysis

DATE: June 29, 2018

INTRODUCTION

A review of the potential critical coarse sediment yield areas within the Santa Margarita watershed management area was conducted as a response to San Diego Regional Water Quality Control Board (San Diego RWQCB) comments. Differences in potential critical coarse sediment yield areas along the county line were noted, focusing within the northeastern portion of the watershed management area (see Exhibit 1). This memo evaluates the critical coarse sediment yield analysis conducted in this area to identify the data sources that were attributable to the final results that indicated these differences.

CRITICAL COARSE SEDIMENT YIELD ANALYSIS

GEOMORPHIC LANDSCAPE UNIT

Critical coarse sediment yield analysis is based on the Geomorphic Landscape Unit (GLU) method described by Booth et al. (2010). GLUs characterize the magnitude of sediment production from areas using three factors judged to exert the greatest influence on the variability of sediment-production rates: geology types, hillslope gradient and land cover. The geologic categories considered to have the potential to generate coarse sediment are coarse bedrock (CB), coarse sedimentary impermeable (CSI) and coarse sedimentary permeable (CSP). Exhibit 2 displays the geologic categories in the Santa Margarita watershed management area. Based on the GIS analysis, the Santa Margarita watershed management area is predominantly characterized with geologic categories that contribute coarse sediment (i.e., CB, CSI and CSP). Once the GLUs were identified, they were then evaluated to determine their relative sediment production to identify potential critical coarse sediment yield areas.

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RELATIVE SEDIMENT PRODUCTION

Relative sediment production is estimated for each GLU using the Revised Universal Soil Loss Equation (RUSLE) (see Equation 2).

$$A = R \times K \times LS \times C \times P \quad \text{(Equation 2), where}$$

A = estimated average soil loss in tons/acre/year

R = rainfall-runoff erosivity factor

K = soil erodibility factor

LS = slope length and steepness factor

C = cover-management factor

P = support practice factor; assumed 1 for this analysis

An area that is identified as CB, CSI or CSP coupled with a relative RUSLE rate of High is considered as a potential critical coarse sediment yield area.

Evaluation of the K, LS and C factors indicated that the results along the San Diego and Riverside county border are similar. The P factor results are also similar because this factor was assumed as equal to 1 for both the San Diego County and Riverside County analyses. Although the same public domain data sources were used for these data sets, among the five data sets, it was noted that the R factor, or the rainfall-runoff erosivity factor[1], was attributable to the difference in critical coarse sediment yield areas along the county border (See Exhibit 3).

For the Santa Margarita watershed management area in San Diego County, a broad approach was used where one R value was assigned for each GLU by estimating the area weighted number. For example, a R value of 30 was assigned if a GLU was located between the 40 and 20 isoerodent contours (see Exhibit 3, Figure 3.A). Whereas, for the study area in Riverside County, the R factor varies spatially by using specific available R value isoerodent contour data, resulting in a very fine resolution R value (see Exhibit 3, Figure 3.A, Figure 3.B and Figure 3.C).

These area resolution differences among the R factor data along the county border resulted in identified differences in potential critical coarse sediment yield areas. These differences are solely due to the broad assumption method versus the use of specific contour data.

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[1] The R factor is the total storm kinetic energy (E) times the maximum 30-minute intensity (I30). The numerical value of R is the average annual sum of EI30 for storm events during a rainfall record of at least 22 years.

BORDER PROJECTS

The potential critical coarse sediment yield analysis utilized regional, public domain datasets and provided a useful, rapid framework to perform a screening level analysis for the Santa Margarita watershed management area. This mapping effort essentially provided a high-level analysis to provide informed decision making at a regional-scale. Because of the regional-scale datasets, and commensurate data resolution used to map the potential critical coarse sediment yield areas, some areas may have been mapped that do not produce critical coarse sediment as they are existing developed areas. Furthermore, the analysis did not consider instream sediment supply or fire-induced sediment production (Lave and Burbank 2004). In addition, the resolution differences among the R-factor data resulted in differences in potential critical coarse sediment yield areas along the county border. Given the GLU characteristics in the watershed, however, a further evaluation of hydrologic soil groups and sand and gravel deposits along the border and in the northeastern portion of the watershed was performed.

GRAVEL AND SAND DEPOSITS

To verify the differences in potential critical coarse sediment yield areas along the county border, an evaluation of hydrologic soil groups (HSG) and gravel and sand deposits was conducted. HSG type A and type B soils are considered sands, gravelly sands and coarse textured soils which would contribute coarse sediment. The custom HSG report for the study area along the border indicated that only 22 percent of the soil material in this area was considered as deep, well drained to excessively well drained sands or gravelly sands (HSG A) or moderately well drained soils that have moderately fine texture to moderately coarse texture (HSG B) (Natural Resources Conservation Service 2018). Of special interest is the area in the northeastern part of the watershed. According to the HSG report, this area is predominated by HSG type D soils and would therefore not be expected to exhibit the characteristics associated with a coarse sediment yield area. The HSG reports generated for this evaluation are provided as a Supplemental Attachment.

Another line of evidence to support potential critical coarse sediment areas was provided by evaluating United States Geological Survey mineral resource maps online (USGS 2018). Based on the area of interest along the border, there are no sand and gravel deposits within a 2-mile radius north and south of the border. Sand and gravel deposits, however, were noted in areas generally downstream of CB, CSI, and CSP geologic units. These deposits were therefore considered as an area that may be a potential sediment source area and it was decided that further evaluation was warranted.

The identification of potential sediment source areas was determined using the following process:

- Overlay sand/gravel deposits onto Geology Grouping GIS layer
- Using USGS quad maps, identify the tributary drainage area for each deposit located in a CB, CSI or CSP area
- Exclude the following areas:
    - Agricultural Land
    - Developed Land
    - Non-Permittee Area
        - Camp Pendleton
    - Protected Lands

The resulting GIS map showing the spatial distribution of the potential critical coarse sediment yield areas along with potential sediment source areas within the SMR is provided as Exhibit 4.

REFERENCES

Booth, D. B., S. R. Dusterhoff, E. D. Stein, and B. P. Bledsoe. 2010. Technical Report 605: Hydromodification Screening Tools: GIS-based Catchment Analyses of Potential Changes in Runoff and Sediment Discharge. March 2010.

Lavé, J. and D. Burbank 2004. Denudation processes and rates in the Transverse Ranges, southern California: Erosional response of a transitional landscape to external and anthropogenic forcing. Journal of Geophysical Research 109.

Natural Resources Conservation Service. Custom HSG Report for San Diego County Area, California and Western Riverside Area, California. http://websoilsurvey.nrcs.usda.gov/app/. March 13, 2018.

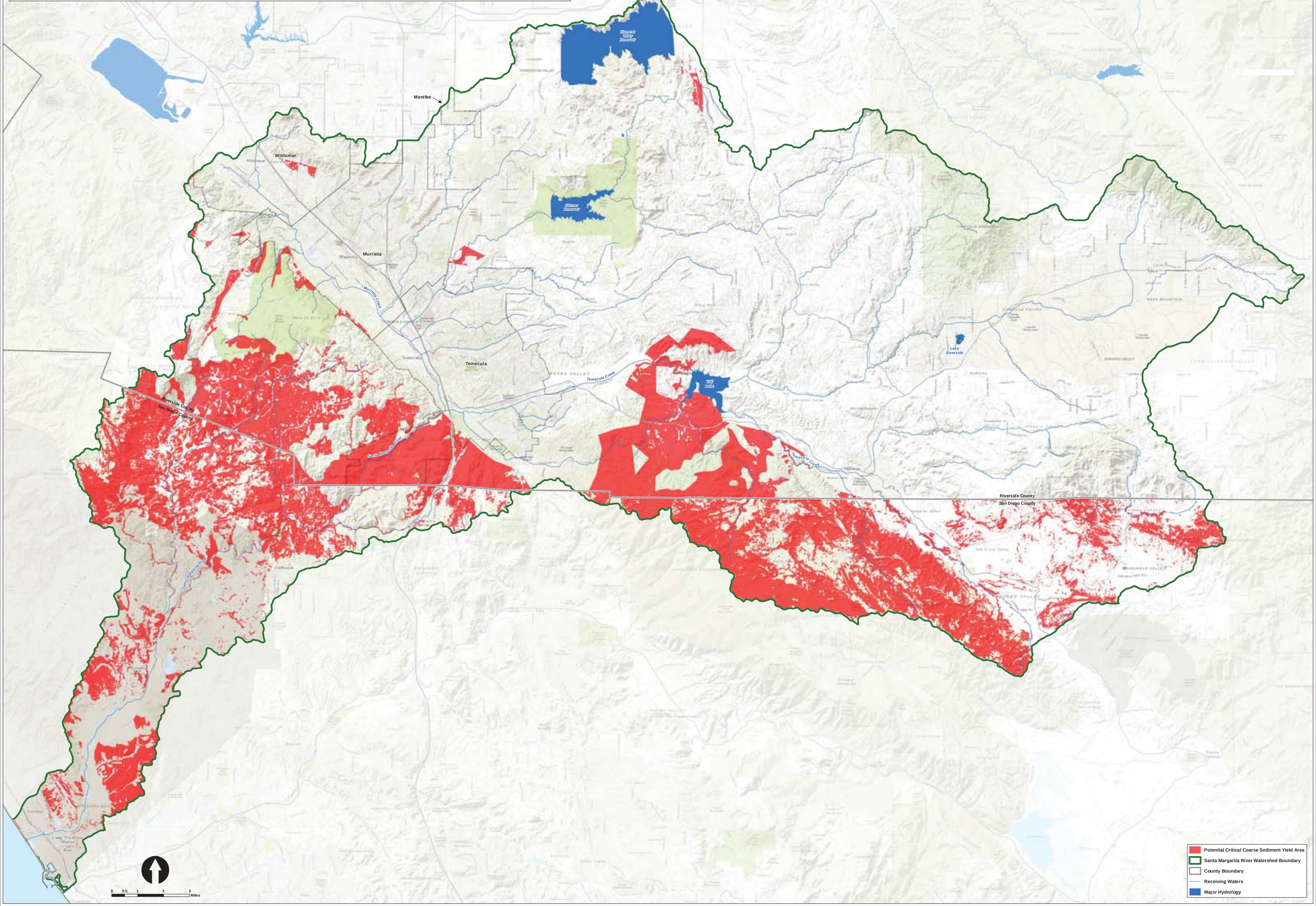
Sanford, W. E. and D. L. Selnick, 2013. Estimation of Evapotranspiration Across the Conterminous United States Using a Regression with Climate and Land-Cover Data. Journal of the American Water Resources Association. February 2013.

United States Geological Survey. Custom Sand and Gravel Map for San Diego County Area, California and Riverside County Area, California. https://mrdata.usgs.gov/general/map.html. March 13, 2018.

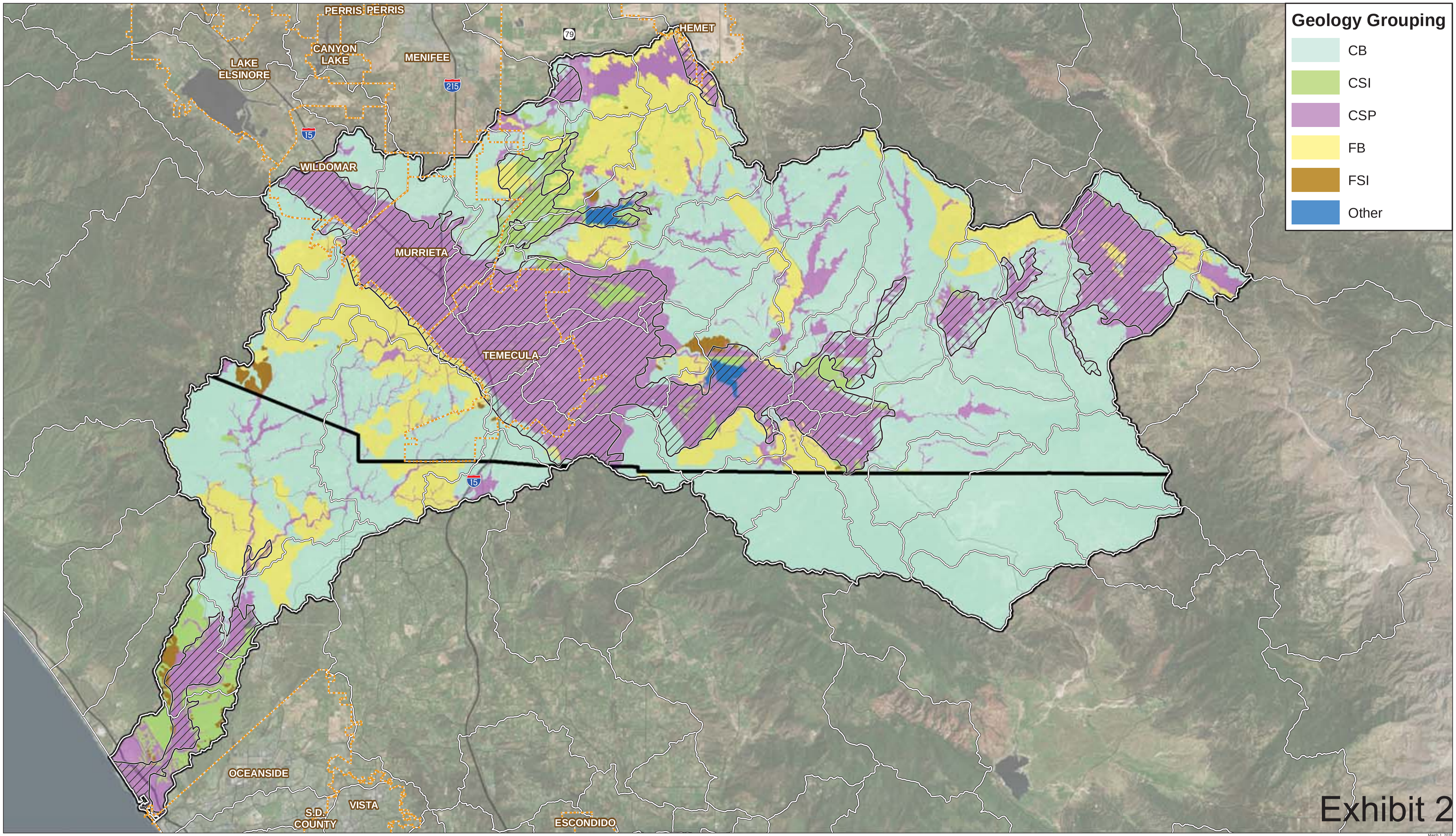
EXHIBITS

Exhibit 1

Potential Critical Coarse Sediment Yield Areas - Santa Magarita River Watershed



SANTA MARGARITA WATERSHED MANAGEMENT AREA ANALYSIS
GEOLOGY GROUPING



March 1, 2018

Legend

Cities | Hydrologic Basin Units | Groundwater Basins

0 1 2
Miles

wsp

Exhibit 3
R Factor Differences Along Riverside/San Diego County Border

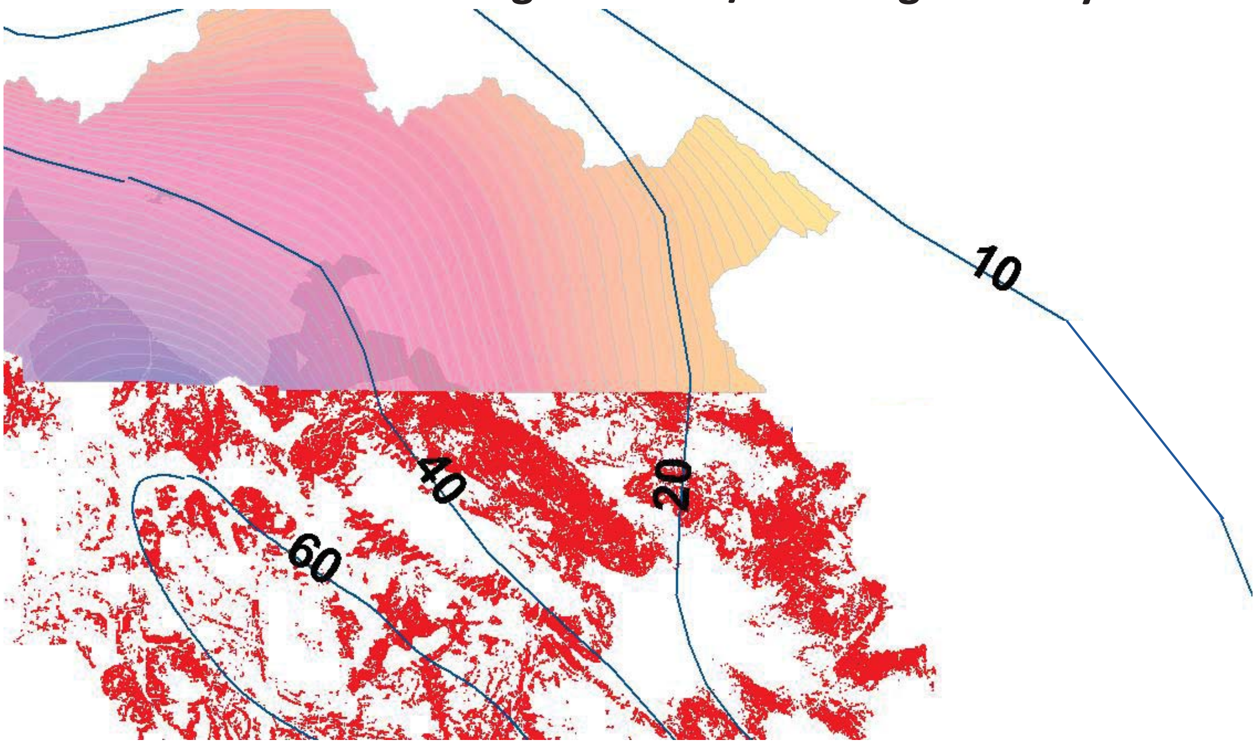


Figure 3.A Isoerodent Contour Lines – Santa Margarita Watershed Management Area – San Diego County and Riverside County

Figure 3.B Zoom in of Isoerodent contour lines (Compare area between the 40 and 10 Isoerodent contour lines with Figure 6.C)

Figure 3.C

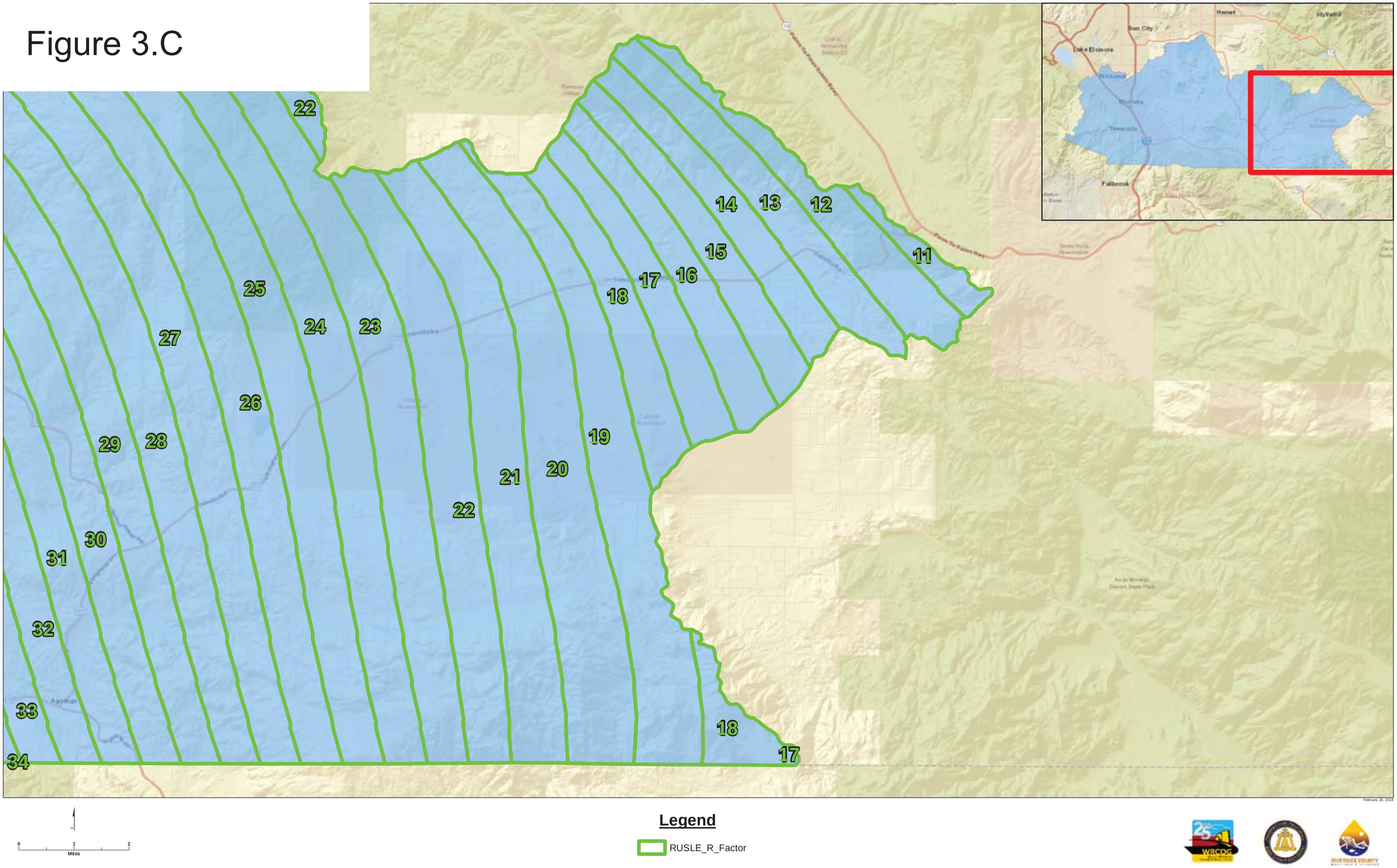


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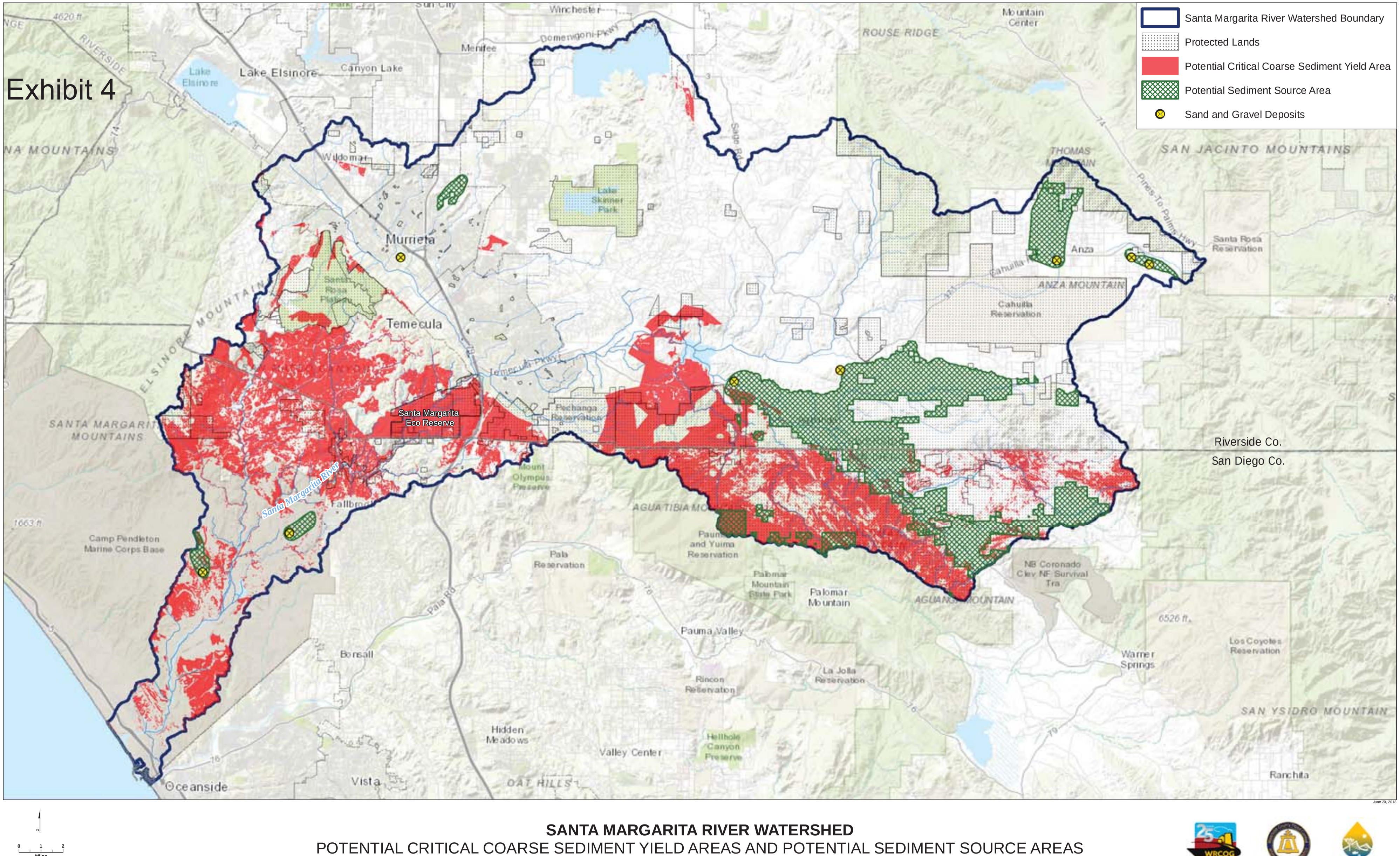
Exhibit 4

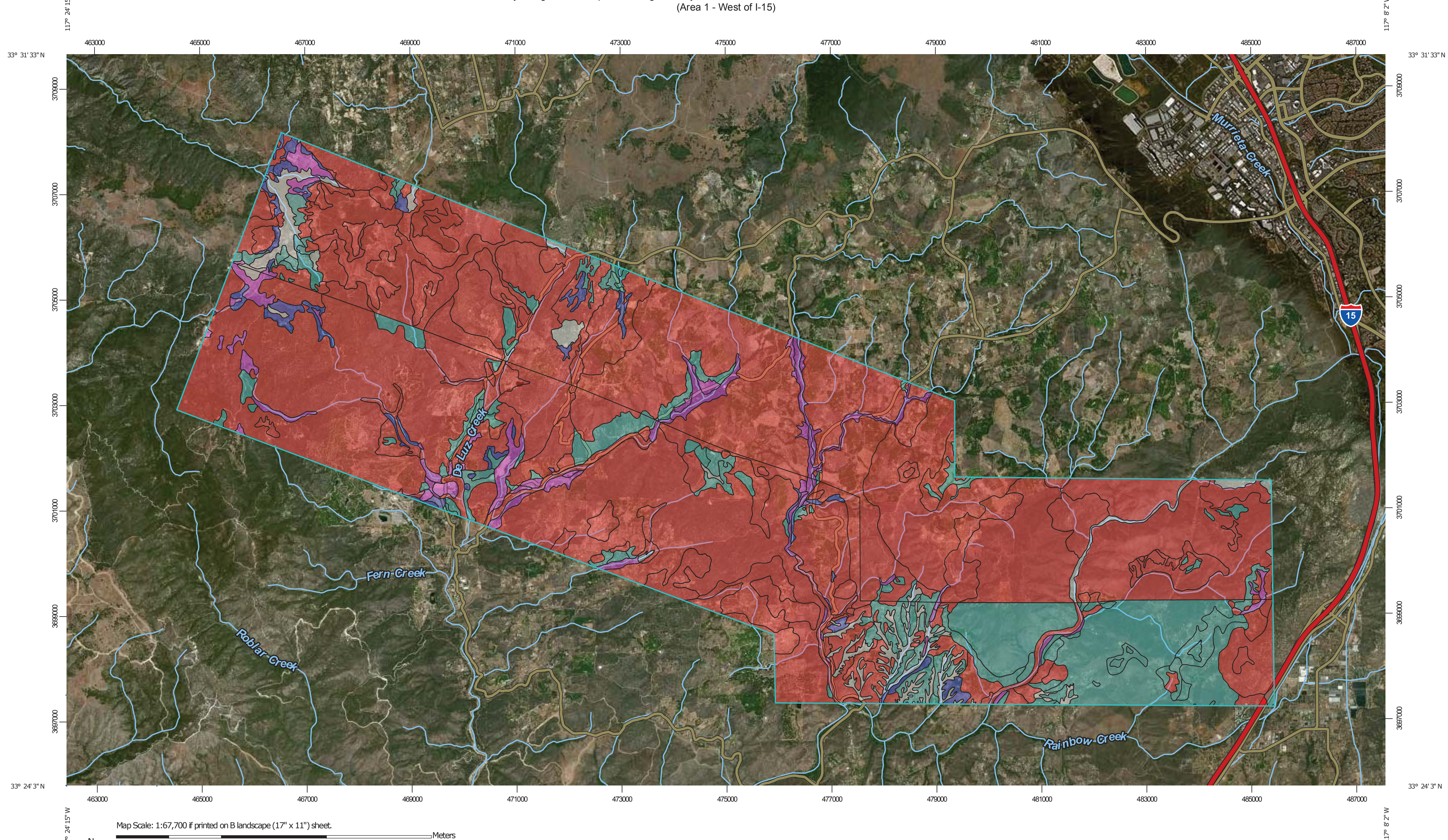


SANTA MARGARITA RIVER WATERSHED
POTENTIAL CRITICAL COARSE SEDIMENT YIELD AREAS AND POTENTIAL SEDIMENT SOURCE AREAS

wsp

SUPPLEMENTAL ATTACHMENTS

Hydrologic Soil Group—San Diego County Area, California, and Western Riverside Area, California
(Area 1 - West of I-15)



Map Scale: 1:67,700 if printed on B landscape (17" x 11") sheet.

N

Meters: 0 1000 2000 4000 6000

Feet: 0 3000 6000 12000 18000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:15,800 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Diego County Area, California
Survey Area Data: Version 12, Sep 13, 2017

Soil Survey Area: Western Riverside Area, California
Survey Area Data: Version 10, Sep 12, 2017

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Feb 2, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AcG	Acid igneous rock land	D	616.9	2.3%
AvC	Arlington coarse sandy loam, 2 to 9 percent slopes	C	12.4	0.0%
BlC	Bonsall sandy loam, 2 to 9 percent slopes	D	3.5	0.0%
BlC2	Bonsall sandy loam, 2 to 9 percent slopes, eroded	D	3.3	0.0%
BuC	Bull Trail sandy loam, 5 to 9 percent slopes	C	8.9	0.0%
CaD2	Calpine coarse sandy loam, 9 to 15 percent slopes, eroded	A	0.1	0.0%
CbF2	Cajalco rocky fine sandy loam, 15 to 50 percent slopes, eroded	D	97.8	0.4%
ClD2	Cieneba coarse sandy loam, 5 to 15 percent slopes, erod ed	D	75.9	0.3%
ClE2	Cieneba coarse sandy loam, 15 to 30 percent slopes, ero ded	D	448.2	1.7%
ClG2	Cieneba coarse sandy loam, 30 to 65 percent slopes, ero ded	D	477.4	1.8%
CmE2	Cieneba rocky coarse sandy loam, 9 to 30 percent slopes , eroded	D	401.8	1.5%
CmrG	Cieneba very rocky coarse sandy loam, 30 to 75 percent slopes	D	5,877.4	21.7%
CnE2	Cieneba-Fallbrook rocky sandy loams, 9 to 30 percent slopes, eroded	D	177.9	0.7%
CnG2	Cieneba-Fallbrook rocky sandy loams, 30 to 65 percent slopes, eroded	D	567.1	2.1%
Co	Clayey alluvial land		21.4	0.1%
EsC	Escondido very fine sandy loam, 5 to 9 percent slopes	C	11.6	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
EsE2	Escondido very fine sandy loam, 15 to 30 percent slopes , eroded	C	24.9	0.1%
FaC	Fallbrook sandy loam, 5 to 9 percent slopes	C	68.5	0.3%
FaC2	Fallbrook sandy loam, 5 to 9 percent slopes, eroded	C	17.9	0.1%
FaD2	Fallbrook sandy loam, 9 to 15 percent slopes, eroded	C	69.5	0.3%
FaE2	Fallbrook sandy loam, 15 to 30 percent slopes, eroded	C	34.2	0.1%
FcF2	Fallbrook rocky sandy loam, shallow, 15 to 50 percents lopes, eroded	D	585.5	2.2%
FeE	Fallbrook rocky sandy loam, 9 to 30 percent slopes	C	26.3	0.1%
FeE2	Fallbrook rocky sandy loam, 9 to 30 percent slopes, eroded	C	12.0	0.0%
FfC2	Fallbrook fine sandy loam, 2 to 8 percent slopes, eroded	C	1.0	0.0%
FvD	Fallbrook-Vista sandy loams, 9 to 15 percent slopes	C	38.4	0.1%
FvE	Fallbrook-Vista sandy loams, 15 to 30 percent slopes	C	9.8	0.0%
FxE	Friant rocky fine sandy loam, 9 to 30 percent slopes	D	21.9	0.1%
FxG	Friant rocky fine sandy loam, 30 to 70 percent slopes	D	3.1	0.0%
HcC	Hanford coarse sandy loam, 2 to 8 percent slopes	A	5.4	0.0%
LpC2	Las Posas fine sandy loam, 5 to 9 percent slopes, eroded	C	3.8	0.0%
LpD2	Las Posas fine sandy loam, 9 to 15 percent slopes, eroded	C	8.8	0.0%
LpE2	Las Posas fine sandy loam, 15 to 30 percent slopes, eroded	C	3.9	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
LrE	Las Posas stony fine sandy loam, 9 to 30 percent slopes	C	317.6	1.2%
LrE2	Las Posas stony fine sandy loam, 9 to 30 percent slopes, eroded	C	6.4	0.0%
LrG	Las Posas stony fine sandy loam, 30 to 65 percent slopes	C	1,820.0	6.7%
PfC	Placentia sandy loam, thick surface, 2 to 9 percent slo pes	D	20.8	0.1%
RaC	Ramona sandy loam, 5 to 9 percent slopes	C	101.4	0.4%
RaC2	Ramona sandy loam, 5 to 9 percent slopes, eroded	C	126.0	0.5%
RaD2	Ramona sandy loam, 9 to 15 percent slopes, eroded	C	221.7	0.8%
RcD	Ramona gravelly sandy loam, 9 to 15 percent slopes	C	154.8	0.6%
RcE	Ramona gravelly sandy loam, 15 to 30 percent slopes	C	24.2	0.1%
Rm	Riverwash	D	414.8	1.5%
RuG	Rough broken land	D	72.3	0.3%
StG	Steep gullied land		337.9	1.2%
SvE	Stony land	A	25.5	0.1%
TeF	Terrace escarpments		10.2	0.0%
TuB	Tujunga sand, 0 to 5 percent slopes	A	47.5	0.2%
VaA	Visalia sandy loam, 0 to 2 percent slopes	A	70.2	0.3%
VaB	Visalia sandy loam, 2 to 5 percent slopes	A	257.4	0.9%
VaC	Visalia sandy loam, 5 to 9 percent slopes	A	72.9	0.3%
VaD	Visalia sandy loam, 9 to 15 percent slopes	A	8.4	0.0%
VbB	Visalia gravelly sandy loam, 2 to 5 percent slopes	A	30.0	0.1%
VbC	Visalia gravelly sandy loam, 5 to 9 percent slopes	A	10.4	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
VsC	Vista coarse sandy loam, 5 to 9 percent slopes	B	55.4	0.2%
VsD	Vista coarse sandy loam, 9 to 15 percent slopes, MLRA 20	B	19.4	0.1%
VsD2	Vista coarse sandy loam, 9 to 15 percent slopes, eroded	B	11.2	0.0%
VsE	Vista coarse sandy loam, 15 to 30 percent slopes, MLRA 20	B	67.6	0.2%
VsE2	Vista coarse sandy loam, 15 to 30 percent slopes, eroded	B	43.4	0.2%
VvD	Vista rocky coarse sandy loam, 5 to 15 percent slopes	B	17.8	0.1%
VvE	Vista rocky coarse sandy loam, 15 to 30 percent slopes	B	54.6	0.2%
W	Water		7.0	0.0%
WmC	Wyman loam, 5 to 9 percent slopes	C	71.3	0.3%
Subtotals for Soil Survey Area			**14,234.1**	**52.4%**
Totals for Area of Interest			**27,142.5**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
144	Cieneba-Rock outcrop complex, 9 to 30 percent slopes	D	21.6	0.1%
192	Rock outcrop-Cieneba complex, 30 to 75 percent slopes		0.8	0.0%
213	Vista coarse sandy loam, 9 to 15 percent slopes, MLRA 20	B	15.8	0.1%
CaC2	Cajalco fine sandy loam, 2 to 8 percent slopes, eroded	C	14.8	0.1%
CaD2	Cajalco fine sandy loam, 8 to 15 percent slopes, eroded	C	24.2	0.1%
CbF2	Cajalco rocky fine sandy loam, 15 to 50 percent slopes, eroded	D	401.2	1.5%
CkD2	Cieneba rocky sandy loam, 8 to 15 percent slopes, eroded	D	218.3	0.8%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CkF2	Cieneba rocky sandy loam, 15 to 50 percent slopes, eroded	D	1,529.8	5.6%
Co	Clayey alluvial land		6.5	0.0%
EcD2	Escondido fine sandy loam, 8 to 15 percent slopes, eroded	C	38.4	0.1%
FaD2	Fallbrook sandy loam, 8 to 15 percent slopes, eroded	C	39.3	0.1%
FaE2	Fallbrook sandy loam, 15 to 25 percent slopes, eroded	C	25.2	0.1%
FbF2	Fallbrook sandy loam, shallow, 15 to 35 percent slopes, eroded	D	12.2	0.0%
FcD2	Fallbrook rocky sandy loam, shallow, 8 to 15 percent slopes, eroded	D	27.0	0.1%
FcF2	Fallbrook rocky sandy loam, shallow, 15 to 50 percent slopes, eroded	D	4,129.3	15.2%
FfC2	Fallbrook fine sandy loam, 2 to 8 percent slopes, eroded	C	60.0	0.2%
FkD2	Fallbrook fine sandy loam, shallow, 8 to 15 percent slopes, eroded	D	23.1	0.1%
FwE2	Friant fine sandy loam, 5 to 25 percent slopes, eroded	D	22.7	0.1%
FyE2	Friant rocky fine sandy loam, 8 to 25 percent slopes, e roded	D	31.2	0.1%
GyC2	Greenfield sandy loam, 2 to 8 percent slopes, eroded	A	35.9	0.1%
HcC	Hanford coarse sandy loam, 2 to 8 percent slopes	A	153.2	0.6%
HfD	Hanford sandy loam, 2 to 15 percent slopes	A	185.5	0.7%
HnC	Honcut sandy loam, 2 to 8 percent slopes	A	0.6	0.0%
LaC	Las Posas loam, 2 to 8 percent slopes	D	8.6	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
LaD2	Las Posas loam, 8 to 15 percent slopes, eroded	D	97.7	0.4%
LaE3	Las Posas loam, 8 to 25 percent slopes, severely eroded	D	7.3	0.0%
LcD2	Las Posas stony loam, 8 to 15 percent slopes, eroded	D	9.2	0.0%
LkD2	Las Posas rocky loam, 8 to 15 percent slopes, eroded	D	119.4	0.4%
LkF3	Las Posas rocky loam, 15 to 50 percent slopes, severely eroded	D	3,000.2	11.1%
LpF2	Lodo rocky loam, 25 to 50 percent slopes, eroded	D	1,072.6	4.0%
MuE	Murrieta stony clay loam, 2 to 25 percent slopes	D	673.9	2.5%
PoC	Porterville clay, 0 to 8 percent slopes	C	29.6	0.1%
RaB3	Ramona sandy loam, 0 to 5 percent slopes, severely eroded	C	19.5	0.1%
RaC2	Ramona sandy loam, 5 to 8 percent slopes, eroded	C	18.9	0.1%
RaD2	Ramona sandy loam, 8 to 15 percent slopes, eroded	C	119.2	0.4%
RaD3	Ramona sandy loam, 8 to 15 percent slopes, severely eroded	C	41.6	0.2%
RcD	Ramona gravelly sandy loam, 9 to 15 percent slopes	C	4.1	0.0%
RsC	Riverwash		64.6	0.2%
RtF	Rockland		106.1	0.4%
TeG	Terrace escarpments		22.7	0.1%
VaB	Visalia sandy loam, 2 to 5 percent slopes	A	12.2	0.0%
VsC	Vista coarse sandy loam, 2 to 8 percent slopes	B	48.1	0.2%
VsD2	Vista coarse sandy loam, 8 to 15 percent slopes, eroded	B	52.6	0.2%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
VtF2	Vista rocky coarse sandy loam, 2 to 35 percent slopes, eroded	B	66.6	0.2%
WeD	Wet alluvial land		176.7	0.7%
WxD2	Wyman fine sandy loam, 8 to 15 percent slopes, eroded	C	51.0	0.2%
WyC2	Wyman loam, 2 to 8 percent slopes, eroded	C	69.5	0.3%
Subtotals for Soil Survey Area			**12,908.4**	**47.6%**
Totals for Area of Interest			**27,142.5**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

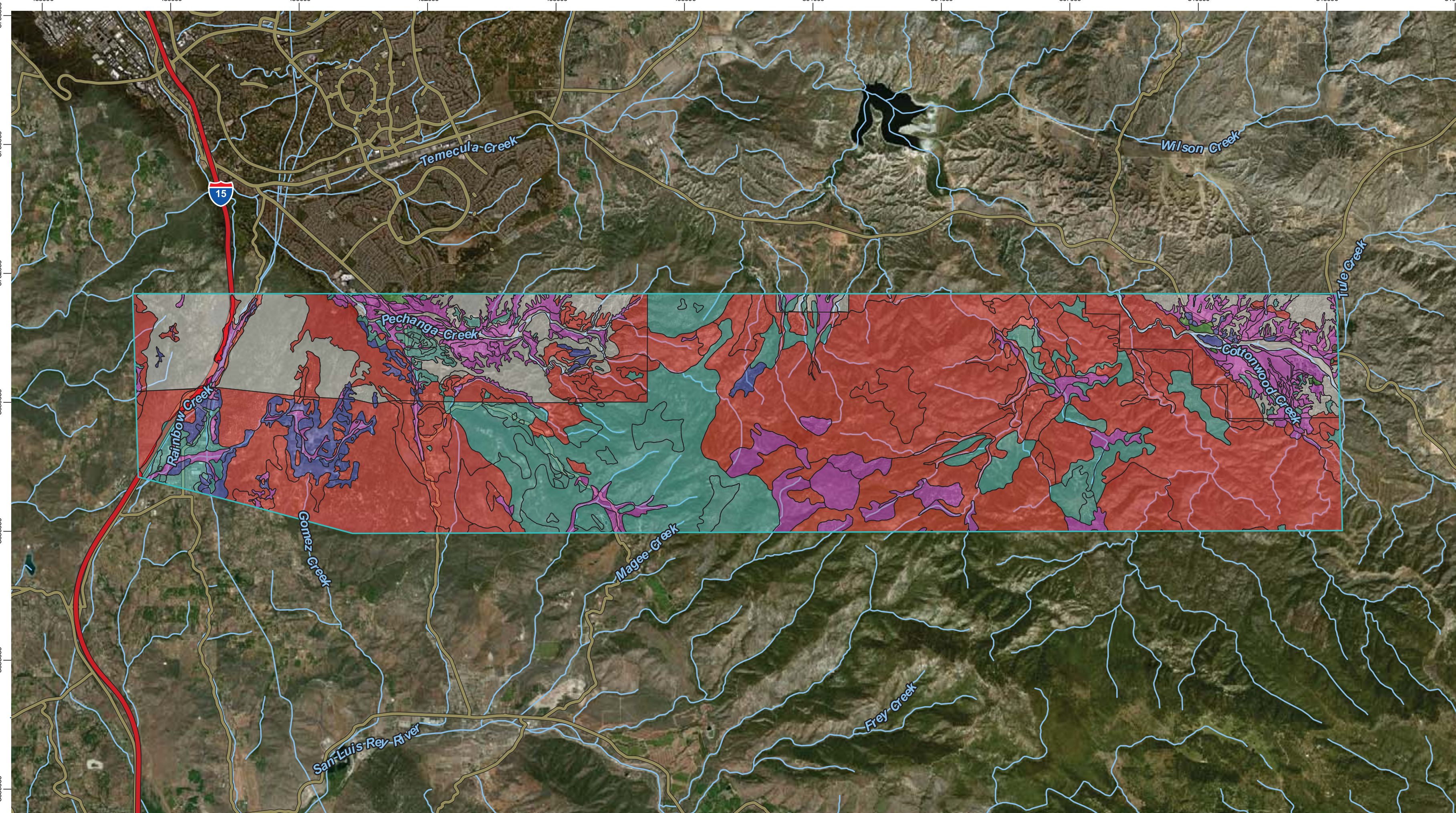
Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Hydrologic Soil Group—San Diego County Area, California, and Western Riverside Area, California
(Area 2 - I-15 to Aguanga)



Map Scale: 1:91,600 if printed on B landscape (17" x 11") sheet.

N

Meters: 0 1000 2000 4000 6000

Feet: 0 4000 8000 16000 24000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:15,800 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Diego County Area, California
Survey Area Data: Version 12, Sep 13, 2017

Soil Survey Area: Western Riverside Area, California
Survey Area Data: Version 10, Sep 12, 2017

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Feb 2, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AcG	Acid igneous rock land	D	2,786.9	7.4%
AvC	Arlington coarse sandy loam, 2 to 9 percent slopes	C	204.3	0.5%
BbE	Bancas stony loam, 5 to 30 percent slopes	C	378.7	1.0%
BbE2	Bancas stony loam, 5 to 30 percent slopes, eroded	C	188.4	0.5%
CbF2	Cajalco rocky fine sandy loam, 15 to 50 percent slopes, eroded	D	16.3	0.0%
ClD2	Cieneba coarse sandy loam, 5 to 15 percent slopes, erod ed	D	3.4	0.0%
CmE2	Cieneba rocky coarse sandy loam, 9 to 30 percent slopes , eroded	D	1,442.6	3.8%
CmrG	Cieneba very rocky coarse sandy loam, 30 to 75 percent slopes	D	6,070.8	16.0%
CnE2	Cieneba-Fallbrook rocky sandy loams, 9 to 30 percent slopes, eroded	D	3.9	0.0%
CnG2	Cieneba-Fallbrook rocky sandy loams, 30 to 65 percent slopes, eroded	D	14.2	0.0%
CuE	Crouch rocky coarse sandy loam, 5 to 30 percent slopes	A	242.5	0.6%
CuG	Crouch rocky coarse sandy loam, 30 to 70 percent slopes	A	725.7	1.9%
FaC2	Fallbrook sandy loam, 5 to 9 percent slopes, eroded	C	6.0	0.0%
FaD2	Fallbrook sandy loam, 9 to 15 percent slopes, eroded	C	2.0	0.0%
FaE2	Fallbrook sandy loam, 15 to 30 percent slopes, eroded	C	5.8	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
FxE	Friant rocky fine sandy loam, 9 to 30 percent slopes	D	164.9	0.4%
FxG	Friant rocky fine sandy loam, 30 to 70 percent slopes	D	271.7	0.7%
GoA	Grangeville fine sandy loam, 0 to 2 percent slopes	B	37.6	0.1%
GrB	Greenfield sandy loam, 2 to 5 percent slopes	A	9.5	0.0%
GrC	Greenfield sandy loam, 5 to 9 percent slopes	A	45.8	0.1%
GrD	Greenfield sandy loam, 9 to 15 percent slopes	A	15.6	0.0%
GzG	Gullied land		6.0	0.0%
HcC	Hanford coarse sandy loam, 2 to 8 percent slopes	A	5.8	0.0%
HdD2	Hanford cobbly coarse sandy loam, 2 to 15 percent slopes, eroded	A	23.5	0.1%
LcE	La Posta rocky loamy coarse sand, 5 to 30 percent slopes	A	183.6	0.5%
LpB	Las Posas fine sandy loam, 2 to 5 percent slopes	C	7.1	0.0%
LpC	Las Posas fine sandy loam, 5 to 9 percent slopes	C	10.2	0.0%
LpD2	Las Posas fine sandy loam, 9 to 15 percent slopes, eroded	C	11.1	0.0%
LpE2	Las Posas fine sandy loam, 15 to 30 percent slopes, eroded	C	39.0	0.1%
LrE	Las Posas stony fine sandy loam, 9 to 30 percent slopes	C	897.4	2.4%
LrE2	Las Posas stony fine sandy loam, 9 to 30 percent slopes, eroded	C	496.7	1.3%
LrG	Las Posas stony fine sandy loam, 30 to 65 percent slopes	C	3,658.0	9.7%
MmD2	Monserate sandy loam, 8 to 15 percent slopes, eroded	C	1.4	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
MrG	Metamorphic rock land	D	96.9	0.3%
PeA	Placentia sandy loam, 0 to 2 percent slopes, warm MAAT, MLRA 19	C	169.6	0.4%
PeC	Placentia sandy loam, 2 to 9 percent slopes, warm MAAT, MLRA 19	C	17.6	0.0%
RaB	Ramona sandy loam, 2 to 5 percent slopes	C	80.5	0.2%
RaC	Ramona sandy loam, 5 to 9 percent slopes	C	2.5	0.0%
RcD	Ramona gravelly sandy loam, 9 to 15 percent slopes	C	422.0	1.1%
RcE	Ramona gravelly sandy loam, 15 to 30 percent slopes	C	119.1	0.3%
RkB	Reiff fine sandy loam, 2 to 5 percent slopes	A	44.6	0.1%
RkC	Reiff fine sandy loam, 5 to 9 percent slopes	A	135.9	0.4%
Rm	Riverwash	D	229.7	0.6%
RuG	Rough broken land	D	713.1	1.9%
SpG2	Sheephead rocky fine sandy loam, 30 to 65 percent slopes, eroded	D	3,586.7	9.5%
SsE	Soboba stony loamy sand, 9 to 30 percent slopes	A	18.8	0.0%
SvE	Stony land	A	202.4	0.5%
ToG	Tollhouse rocky coarse sandy loam, 30 to 65 percent slopes	D	2,380.5	6.3%
TuB	Tujunga sand, 0 to 5 percent slopes	A	1.9	0.0%
VaA	Visalia sandy loam, 0 to 2 percent slopes	A	105.3	0.3%
VaB	Visalia sandy loam, 2 to 5 percent slopes	A	208.1	0.5%
VaC	Visalia sandy loam, 5 to 9 percent slopes	A	75.2	0.2%
VbC	Visalia gravelly sandy loam, 5 to 9 percent slopes	A	10.7	0.0%
VsC	Vista coarse sandy loam, 5 to 9 percent slopes	B	8.9	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
VsD2	Vista coarse sandy loam, 9 to 15 percent slopes, eroded	B	369.1	1.0%
VsE2	Vista coarse sandy loam, 15 to 30 percent slopes, eroded	B	10.3	0.0%
VvD	Vista rocky coarse sandy loam, 5 to 15 percent slopes	B	88.4	0.2%
VvE	Vista rocky coarse sandy loam, 15 to 30 percent slopes	B	233.6	0.6%
VvG	Vista rocky coarse sandy loam, 30 to 65 percent slopes	B	169.7	0.4%
WmB	Wyman loam, 2 to 5 percent slopes	C	35.4	0.1%
WmC	Wyman loam, 5 to 9 percent slopes	C	50.7	0.1%
Subtotals for Soil Survey Area			**27,563.7**	**72.7%**
Totals for Area of Interest			**37,907.0**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AnD	Arlington fine sandy loam, 8 to 15 percent slopes	C	2.5	0.0%
AtC2	Arlington and Greenfield fine sandy loams, 2 to 8 percent slopes , eroded	C	108.3	0.3%
AtD2	Arlington and Greenfield fine sandy loams, 8 to 15 percent slopes, eroded	C	68.6	0.2%
AtF3	Arlington and Greenfield fine sandy loams, 15 to 35 percent slopes, severely eroded	C	23.3	0.1%
BaG	Badland		76.7	0.2%
CaD2	Cajalco fine sandy loam, 8 to 15 percent slopes, eroded	C	12.1	0.0%
CbF2	Cajalco rocky fine sandy loam, 15 to 50 percent slopes, eroded	D	326.6	0.9%
ChF2	Cieneba sandy loam, 15 to 50 percent slopes, eroded	D	8.4	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CkD2	Cieneba rocky sandy loam, 8 to 15 percent slopes, eroded	D	71.3	0.2%
CkF2	Cieneba rocky sandy loam, 15 to 50 percent slopes, eroded	D	1,073.1	2.8%
EcD2	Escondido fine sandy loam, 8 to 15 percent slopes, eroded	C	4.6	0.0%
FaD2	Fallbrook sandy loam, 8 to 15 percent slopes, eroded	C	5.6	0.0%
FcD2	Fallbrook rocky sandy loam, shallow, 8 to 15 percent slopes, eroded	D	0.9	0.0%
FkD2	Fallbrook fine sandy loam, shallow, 8 to 15 percent slopes, eroded	D	17.8	0.0%
FwE2	Friant fine sandy loam, 5 to 25 percent slopes, eroded	D	19.6	0.1%
FyE2	Friant rocky fine sandy loam, 8 to 25 percent slopes, e roded	D	573.9	1.5%
FyF2	Friant rocky fine sandy loam, 25 to 50 percent slopes, eroded	D	157.0	0.4%
GhC	Gorgonio loamy sand, 0 to 8 percent slopes	A	165.8	0.4%
GhD	Gorgonio loamy sand, 8 to 15 percent slopes	A	8.9	0.0%
GkD	Gorgonio loamy sand, channeled, 2 to 15 percent slopes	A	7.2	0.0%
GlC	Gorgonio loamy sand, deep, 2 to 8 percent slopes	A	76.9	0.2%
GmD	Gorgonio gravelly loamy fine sand, 2 to 15 percent slop es	A	9.0	0.0%
GrB	Grangeville sandy loam, sandy substratum, drained, 0 to 5 percent slopes	A/D	1.6	0.0%
GtA	Grangeville fine sandy loam, drained, 0 to 2 percent sl opes	A/D	70.8	0.2%
GtD	Grangeville fine sandy loam, drained, 5 to 15 percent s lopes	A/D	10.7	0.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
GuB	Grangeville fine sandy loam, poorly drained, saline-alk ali, 0 to 5 percent slopes	B/D	0.2	0.0%
GvB	Grangeville fine sandy loam, saline-alkali, 0 to 5 percent slopes	B/D	3.7	0.0%
GyA	Greenfield sandy loam, 0 to 2 percent slopes	A	9.6	0.0%
GyC2	Greenfield sandy loam, 2 to 8 percent slopes, eroded	A	236.3	0.6%
GyD2	Greenfield sandy loam, 8 to 15 percent slopes, eroded	A	66.8	0.2%
GzG	Gullied land		636.6	1.7%
HaC	Hanford loamy fine sand, 0 to 8 percent slopes	A	8.7	0.0%
HcA	Hanford coarse sandy loam, 0 to 2 percent slopes	A	7.3	0.0%
HcC	Hanford coarse sandy loam, 2 to 8 percent slopes	A	778.4	2.1%
HcD2	Hanford coarse sandy loam, 8 to 15 percent slopes, eroded	A	226.1	0.6%
HdD2	Hanford cobbly coarse sandy loam, 2 to 15 percent slopes, eroded	A	48.9	0.1%
HeC2	Hanford coarse sandy loam, deep, 2 to 8 percent slopes, eroded	A	146.5	0.4%
HfD	Hanford sandy loam, 2 to 15 percent slopes	A	1.6	0.0%
HgA	Hanford fine sandy loam, 0 to 2 percent slopes	A	39.1	0.1%
HnC	Honcut sandy loam, 2 to 8 percent slopes	A	16.0	0.0%
HnD2	Honcut sandy loam, 8 to 15 percent slopes, eroded	A	14.9	0.0%
HuC2	Honcut loam, 2 to 8 percent slopes, eroded	A	8.2	0.0%
LaD2	Las Posas loam, 8 to 15 percent slopes, eroded	D	24.1	0.1%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
LaE3	Las Posas loam, 8 to 25 percent slopes, severely eroded	D	4.0	0.0%
LcD2	Las Posas stony loam, 8 to 15 percent slopes, eroded	D	25.8	0.1%
LkF3	Las Posas rocky loam, 15 to 50 percent slopes, severely eroded	D	441.3	1.2%
LoF2	Lodo gravelly loam, 15 to 50 percent slopes, eroded	D	2.9	0.0%
MmB	Monserate sandy loam, 0 to 5 percent slopes	C	1.1	0.0%
MmD2	Monserate sandy loam, 8 to 15 percent slopes, eroded	C	25.8	0.1%
MmE3	Monserate sandy loam, 15 to 25 percent slopes, severely eroded	C	3.8	0.0%
MnE3	Monserate sandy loam, shallow, 15 to 25 percent slopes, severely eroded	D	0.6	0.0%
PaC2	Pachappa fine sandy loam, 2 to 8 percent slopes, eroded	B	68.8	0.2%
RaB2	Ramona sandy loam, 2 to 5 percent slopes, eroded	C	15.9	0.0%
RaC2	Ramona sandy loam, 5 to 8 percent slopes, eroded	C	1.7	0.0%
RaD3	Ramona sandy loam, 8 to 15 percent slopes, severely eroded	C	8.8	0.0%
RaE3	Ramona sandy loam, 15 to 25 percent slopes, severely eroded	C	6.5	0.0%
RmE3	Ramona and Buren sandy loams, 15 to 25 percent slopes, severely eroded	C	132.4	0.3%
RnE3	Ramona and Buren loams, 5 to 25 percent slopes, severely eroded	C	8.6	0.0%
RsC	Riverwash		478.3	1.3%
RtF	Rockland		2,330.6	6.1%
RuF	Rough broken land		798.2	2.1%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
SgC	San Emigdio loam, 2 to 8 percent slopes	A	53.4	0.1%
SmE2	San Timoteo loam, 8 to 25 percent slopes, eroded	B	7.1	0.0%
SsD	Soboba stony loamy sand, 2 to 15 percent slopes	A	4.8	0.0%
TeG	Terrace escarpments		201.8	0.5%
TuB	Tujunga loamy sand, 0 to 5 percent slopes	A	120.1	0.3%
TvC	Tujunga loamy sand, channeled, 0 to 8 percent slopes	A	67.0	0.2%
VaB	Visalia sandy loam, 2 to 5 percent slopes	A	4.9	0.0%
VaC	Visalia sandy loam, 5 to 9 percent slopes	A	10.0	0.0%
VlC2	Visalia sandy loam, 0 to 8 percent slopes, eroded	A	24.4	0.1%
VmA	Visalia fine sandy loam, 0 to 2 percent slopes	A	2.5	0.0%
VmC	Visalia fine sandy loam, 2 to 8 percent slopes	A	2.4	0.0%
VsC	Vista coarse sandy loam, 2 to 8 percent slopes	B	3.1	0.0%
VsD2	Vista coarse sandy loam, 8 to 15 percent slopes, eroded	B	28.2	0.1%
VsF2	Vista coarse sandy loam, 15 to 35 percent slopes, eroded	B	37.8	0.1%
VtF2	Vista rocky coarse sandy loam, 2 to 35 percent slopes, eroded	B	105.0	0.3%
WmC	Wyman loam, 5 to 9 percent slopes	C	7.6	0.0%
WyC2	Wyman loam, 2 to 8 percent slopes, eroded	C	4.6	0.0%
YbC	Yokohl loam, 2 to 8 percent slopes	D	19.5	0.1%
YbD2	Yokohl loam, 8 to 15 percent slopes, eroded	D	36.5	0.1%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
YbE3	Yokohl loam, 8 to 25 percent slopes, severely eroded	D	73.5	0.2%
Subtotals for Soil Survey Area			**10,343.2**	**27.3%**
Totals for Area of Interest			**37,907.0**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

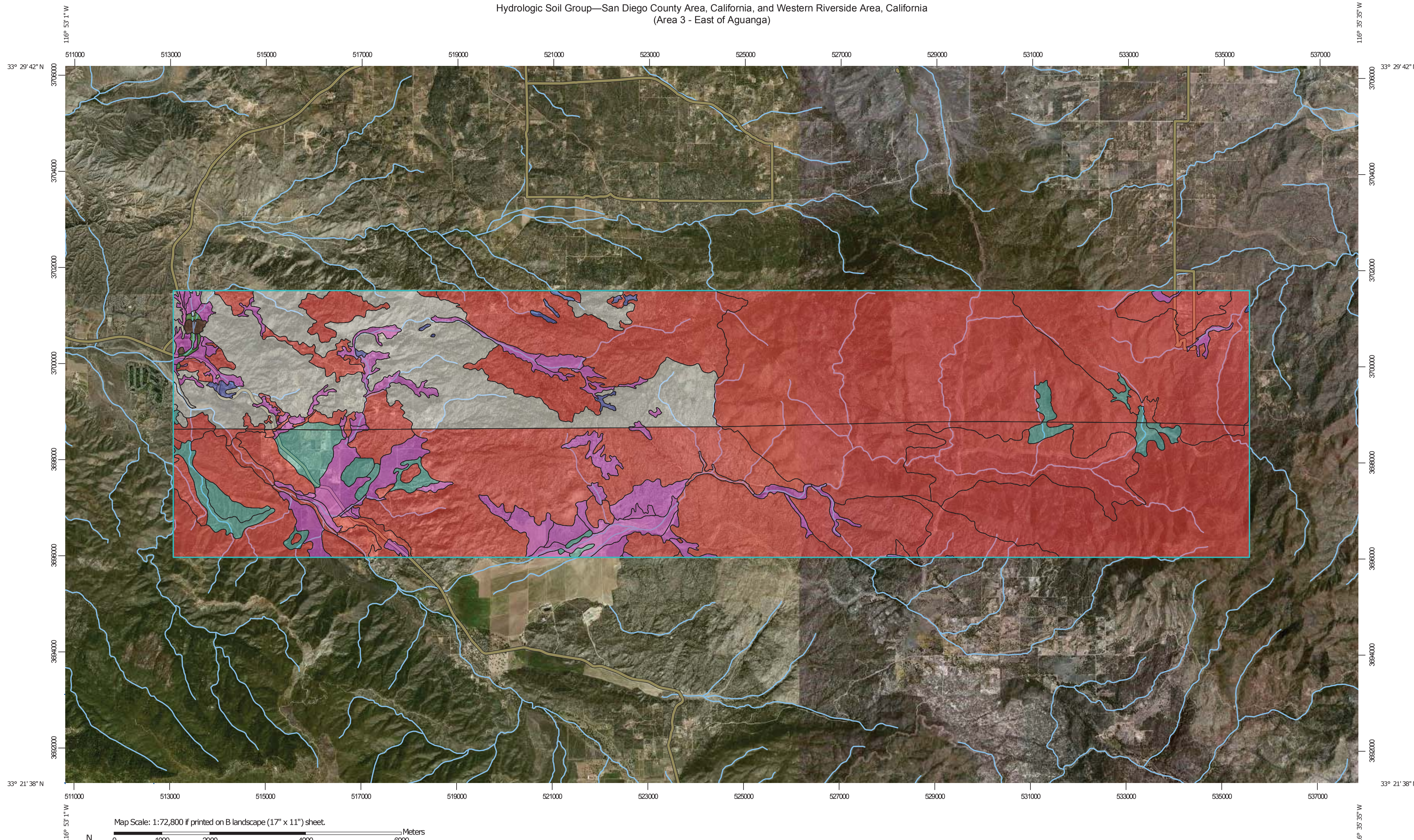
Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Hydrologic Soil Group—San Diego County Area, California, and Western Riverside Area, California
(Area 3 - East of Aguanga)



Map Scale: 1:72,800 if printed on B landscape (17" x 11") sheet.

N

Meters: 0, 1000, 2000, 4000, 6000

Feet: 0, 3500, 7000, 14000, 21000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

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- Major Roads
- Local Roads

Background

- Aerial Photography

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Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Diego County Area, California
Survey Area Data: Version 12, Sep 13, 2017

Soil Survey Area: Western Riverside Area, California
Survey Area Data: Version 10, Sep 12, 2017

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Date(s) aerial images were photographed: Dec 31, 2009—Feb 2, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AcG	Acid igneous rock land	D	4,341.6	14.0%
BuC	Bull Trail sandy loam, 5 to 9 percent slopes	C	90.8	0.3%
BuD2	Bull Trail sandy loam, 9 to 15 percent slopes	C	188.5	0.6%
BuE2	Bull Trail sandy loam, 15 to 30 percent slopes, eroded	C	62.8	0.2%
CaC	Calpine coarse sandy loam, 5 to 9 percent slopes	A	105.3	0.3%
CmE2	Cieneba rocky coarse sandy loam, 9 to 30 percent slopes , eroded	D	44.7	0.1%
CmrG	Cieneba very rocky coarse sandy loam, 30 to 75 percent slopes	D	143.2	0.5%
LaE2	La Posta loamy coarse sand, 5 to 30 percent slopes, eroded	A	26.4	0.1%
LcE2	La Posta rocky loamy coarse sand, 5 to 30 percent slopes, eroded	A	120.6	0.4%
LcF2	La Posta rocky loamy coarse sand, 30 to 50 percent slopes, eroded	A	181.1	0.6%
MnE3	Monserate sandy loam, shallow, 15 to 25 percent slopes, severely eroded	D	4.8	0.0%
MvC	Mottsville loamy coarse sand, 2 to 9 percent slopes	A	725.7	2.3%
MvD	Mottsville loamy coarse sand, 9 to 15 percent slopes	A	62.4	0.2%
RcD	Ramona gravelly sandy loam, 9 to 15 percent slopes	C	393.8	1.3%
RcE	Ramona gravelly sandy loam, 15 to 30 percent slopes	C	168.4	0.5%
Rm	Riverwash	D	73.2	0.2%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
RuG	Rough broken land	D	144.7	0.5%
SpE2	Sheephead rocky fine sandy loam, 9 to 30 percent slopes, eroded	D	1,245.4	4.0%
SpG2	Sheephead rocky fine sandy loam, 30 to 65 percent slopes, eroded	D	4,980.6	16.1%
SsE	Soboba stony loamy sand, 9 to 30 percent slopes	A	123.0	0.4%
SvE	Stony land	A	37.0	0.1%
ToE2	Tollhouse rocky coarse sandy loam, 5 to 30 percent slopes, eroded	D	796.1	2.6%
ToG	Tollhouse rocky coarse sandy loam, 30 to 65 percent slopes	D	870.7	2.8%
TuB	Tujunga sand, 0 to 5 percent slopes	A	263.0	0.8%
VaC	Visalia sandy loam, 5 to 9 percent slopes	A	11.6	0.0%
VaD	Visalia sandy loam, 9 to 15 percent slopes	A	7.1	0.0%
Subtotals for Soil Survey Area			**15,212.6**	**49.2%**
Totals for Area of Interest			**30,947.3**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AtF3	Arlington and Greenfield fine sandy loams, 15 to 35 percent slopes, severely eroded	C	6.1	0.0%
BsC2	Bull Trail sandy loam, 5 to 8 percent slopes, eroded	C	39.6	0.1%
BsE3	Bull Trail sandy loam, 8 to 25 percent slopes, severely eroded	D	54.4	0.2%
BtD2	Bull Trail stony sandy loam, 8 to 15 percent slopes, eroded	C	54.5	0.2%
ChD2	Cieneba sandy loam, 8 to 15 percent slopes, eroded	D	1.6	0.0%
CkD2	Cieneba rocky sandy loam, 8 to 15 percent slopes, eroded	D	158.0	0.5%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CkF2	Cieneba rocky sandy loam, 15 to 50 percent slopes, eroded	D	570.9	1.8%
CvD2	Crouch loamy sand, 8 to 15 percent slopes, eroded	B	64.9	0.2%
CwD2	Crouch sandy loam, 8 to 15 percent slopes, eroded	B	4.8	0.0%
GhC	Gorgonio loamy sand, 0 to 8 percent slopes	A	7.0	0.0%
GhD	Gorgonio loamy sand, 8 to 15 percent slopes	A	21.9	0.1%
GlC	Gorgonio loamy sand, deep, 2 to 8 percent slopes	A	3.4	0.0%
GrB	Grangeville sandy loam, sandy substratum, drained, 0 to 5 percent slopes	A/D	16.8	0.1%
GtA	Grangeville fine sandy loam, drained, 0 to 2 percent sl opes	A/D	10.8	0.0%
GuB	Grangeville fine sandy loam, poorly drained, saline-alk ali, 0 to 5 percent slopes	B/D	27.3	0.1%
GvB	Grangeville fine sandy loam, saline-alkali, 0 to 5 percent slopes	B/D	3.7	0.0%
GzG	Gullied land		33.5	0.1%
HcC	Hanford coarse sandy loam, 2 to 8 percent slopes	A	133.8	0.4%
HcD2	Hanford coarse sandy loam, 8 to 15 percent slopes, eroded	A	124.4	0.4%
MnD2	Monserate sandy loam, shallow, 5 to 15 percent slopes, eroded	D	37.2	0.1%
MnE3	Monserate sandy loam, shallow, 15 to 25 percent slopes, severely eroded	D	37.6	0.1%
MoC	Mottsville loamy sand, 2 to 8 percent slopes	A	67.0	0.2%
MoD	Mottsville loamy sand, 8 to 15 percent slopes	A	363.0	1.2%
RcD	Ramona gravelly sandy loam, 9 to 15 percent slopes	C	30.1	0.1%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
RsC	Riverwash		18.1	0.1%
RtF	Rockland		4,132.2	13.4%
RuF	Rough broken land		15.7	0.1%
SpG2	Sheephead rocky fine sandy loam, 15 to 75 percent slopes, eroded	D	5,234.9	16.9%
TfF2	Tollhouse rocky coarse sandy loam, 8 to 50 percent slopes, eroded	D	4,384.8	14.2%
TuB	Tujunga loamy sand, 0 to 5 percent slopes	A	0.1	0.0%
TvC	Tujunga loamy sand, channeled, 0 to 8 percent slopes	A	31.6	0.1%
VaC	Visalia sandy loam, 5 to 9 percent slopes	A	8.9	0.0%
VaD	Visalia sandy loam, 9 to 15 percent slopes	A	7.8	0.0%
VsF2	Vista coarse sandy loam, 15 to 35 percent slopes, eroded	B	28.1	0.1%
Subtotals for Soil Survey Area			**15,734.7**	**50.8%**
Totals for Area of Interest			**30,947.3**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

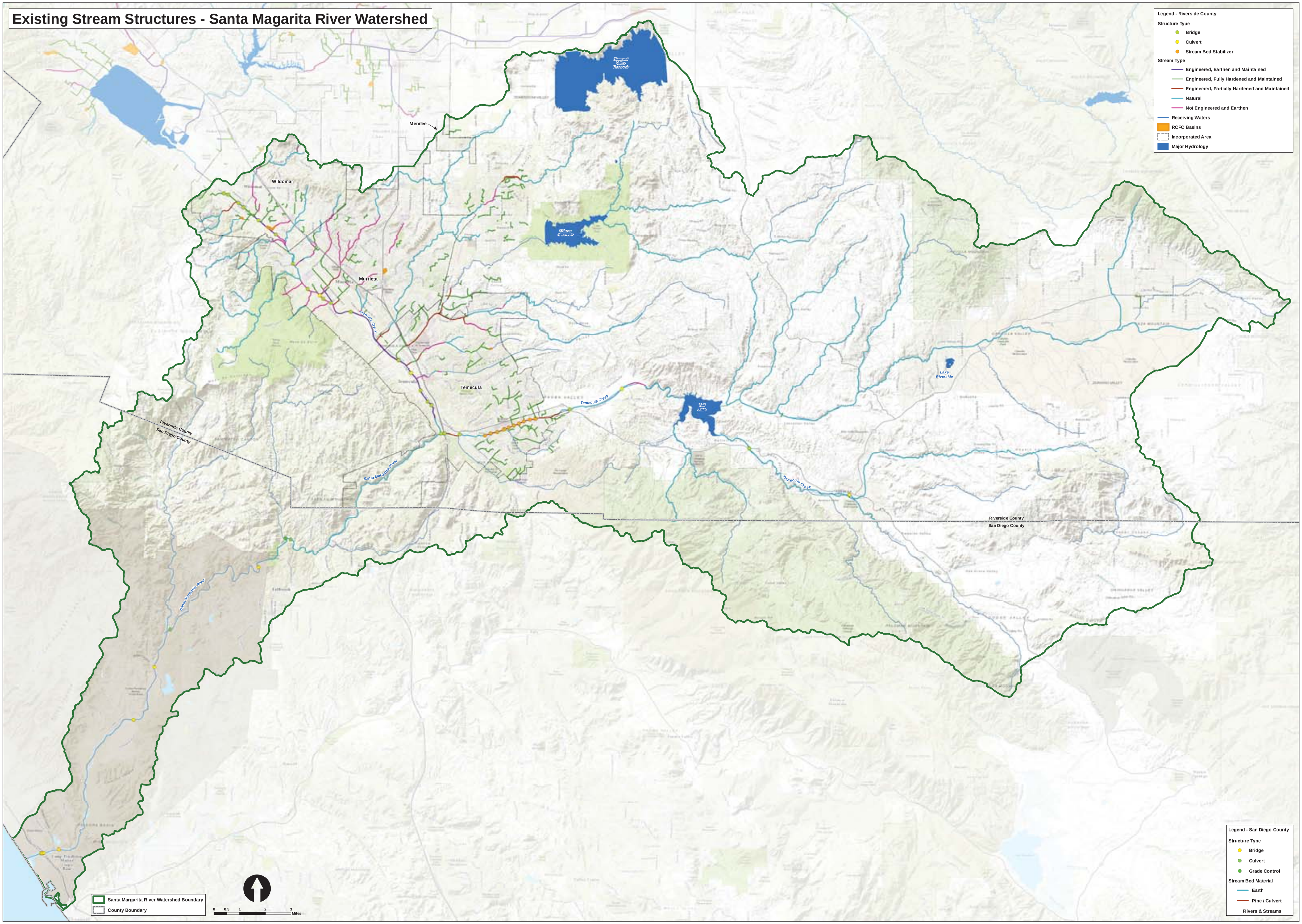
Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

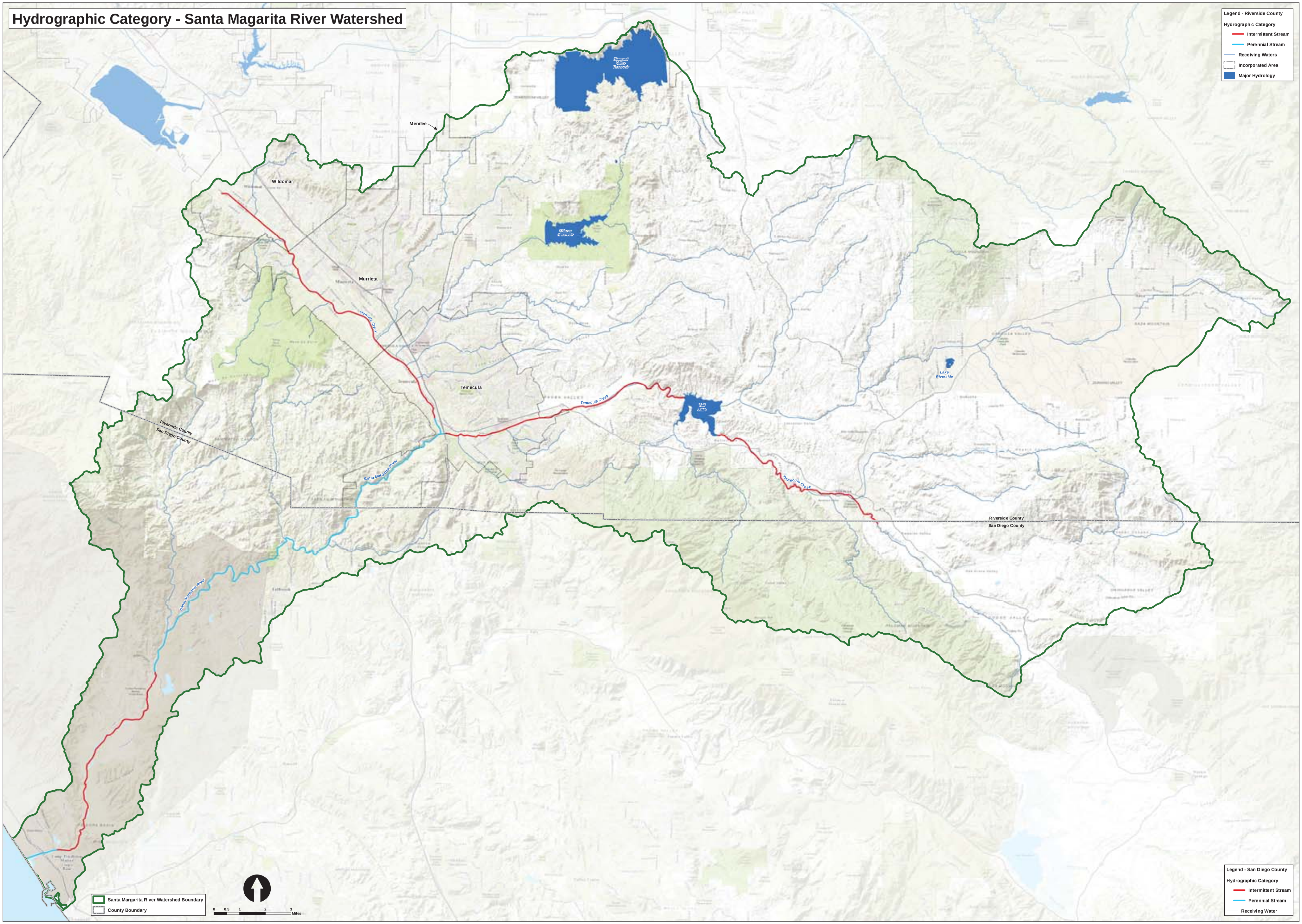
Attachment C. Existing Stream Structures

Existing Stream Structures - Santa Magarita River Watershed



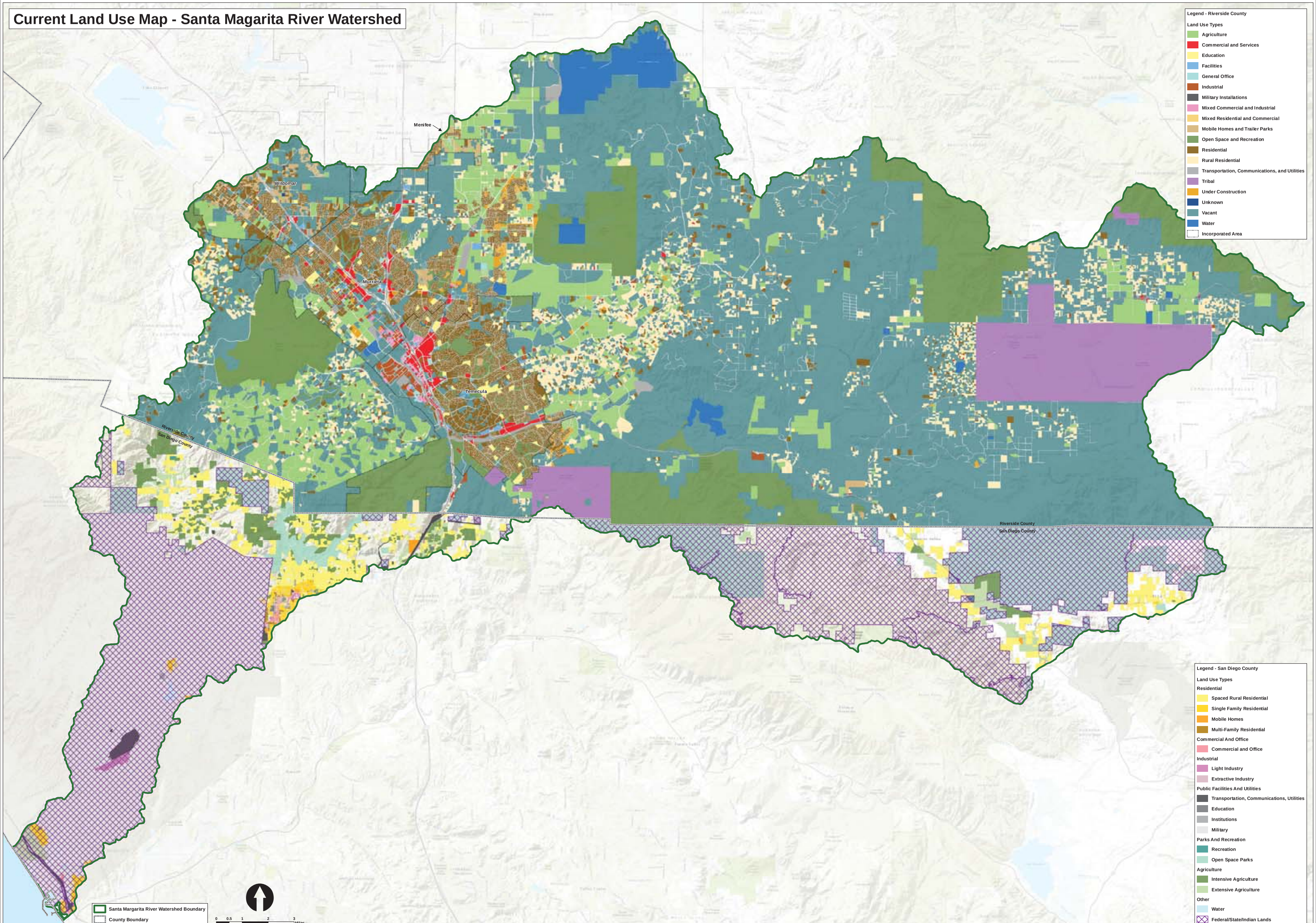
Attachment D. Hydrographic Category

Hydrographic Category - Santa Magarita River Watershed



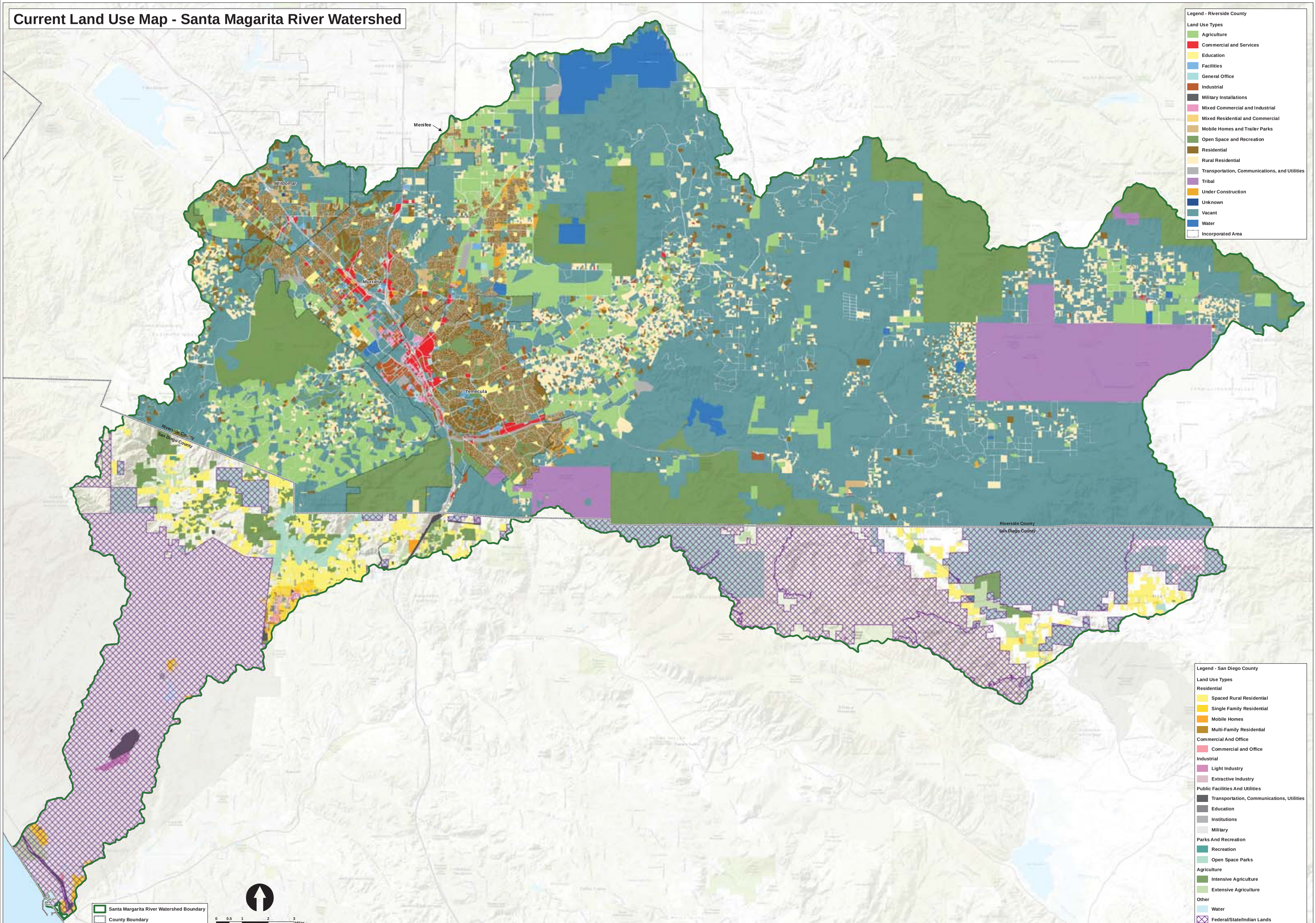
Attachment E. Current Land Use Map

Current Land Use Map - Santa Magarita River Watershed



Attachment F. Anticipated Land Use Map

Current Land Use Map - Santa Magarita River Watershed



Attachment G. Upper Santa Margarita River Hydrologic Response Unit and Critical Coarse Sediment Yield Analysis

WESTERN RIVERSIDE COUNCIL OF GOVERNMENTS

UPPER SANTA MARGARITA RIVER

HYDROLOGIC RESPONSE UNIT AND CRITICAL COARSE SEDIMENT YIELD ANALYSIS

JUNE 29, 2018

UPPER SANTA MARGARITA RIVER

HYDROLOGIC RESPONSE UNIT AND CRITICAL COARSE SEDIMENT YIELD ANALYSIS

WESTERN RIVERSIDE COUNCIL OF GOVERNMENTS

PROJECT NO.: 12853-T01
DATE: JUNE 2018

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TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 Background 2

2 HYDROLOGIC RESPONSE UNIT 3

2.1 Hydrologic Response Unit End Points 3

2.2 Data Types and Acquisition 4

2.2.1 Upper Santa Margarita River Watershed 4

2.2.2 Hydrologic Soil Groups 4

2.2.3 Slope Classes 5

2.2.4 Land Cover 5

2.2.5 Geologic Unit 6

2.2.6 Groundwater Basins 7

2.2.7 Dominant Hydrologic Process Results 7

3 CRITICAL COARSE SEDIMENT YIELD ANALYSIS .. 8

3.1 Data Types and Acquisition 8

3.1.1 Geologic Units 9

3.1.2 Land Cover 9

3.1.3 Slope Classes 9

3.1.4 Geologic Groups 10

3.1.5 GLU and Sediment Production 10

4 SITE ASSESSMENT 12

4.1 Pre-Field Activities 12

4.2 Site Reconnaissance 12

4.3 Site and Geologic Conditions 12

4.3.1 Surface Conditions 12

4.3.2 Surficial Deposits 13

4.3.3 Geologic Conditions 13

4.4 Results 13

5 POTENTIAL SEDIMENT SOURCE AREA 14

5.1 San Diego RWQCB Comments 14

6 CONCLUSIONS 15
6.1 Upper Santa Margarita River WMAA 15
7 WORKS CITED 16

FIGURES

FIGURE 1. JURISDICTIONS ASSOCIATED WITH THE SANTA MARGARITA RIVER WATERSHED 1
FIGURE 2. HYDROLOGIC RESPONSE UNIT AND HYDROLOGIC PROCESS FLOW CHART.................. 3
FIGURE 3. POTENTIAL CRITICAL COARSE SEDIMENT YIELD ANALYSIS.. 8

APPENDICES

APPENDIX A .... HYDROLOGIC RESPONSE UNIT TABLES

APPENDIX B ... HYDROLOGIC RESPONSE UNIT SPATIAL DISTRIBUTION EXHIBIT

APPENDIX C .... EVALUATION OF Qw AND Qsu GEOLOGIC UNITS

APPENDIX D .... MAP UNITS AND GEOLOGY GROUPING

APPENDIX E .... REGIONAL GEOLOGIC GROUPING

APPENDIX F... SITE ASSESSMENT

APPENDIX G ..... CRITICAL COARSE SEDIMENT YIELD ARCMAP EXHIBIT

APPENDIX H…………... POTENTIAL SEDIMENT SOURCE AREA EXHIBIT

1 INTRODUCTION

The Western Riverside Council of Governments (WRCOG) comprises the County of Riverside and each city located within Western Riverside County. WRCOG was established to provide an agency to conduct studies and projects designed to improve and coordinate the common governmental responsibilities and services on an area-wide and regional basis. Some of the functions performed by WRCOG include serving as a forum for consideration, study and recommendation on area-wide regional problems; assembling information helpful in the consideration of problems peculiar to Western Riverside County; exploring practical avenues for intergovernmental cooperation, coordination and action in the interest of local public welfare and means of improvements in the administration of governmental services; and serving as the clearinghouse review body for Federally-funded projects in conjunction with the Southern California Association of Governments[1]. To this end, and in the spirit of respecting local control while providing a regional perspective, WRCOG is collaborating with the Riverside County Flood Control and Water Conservation District (RCFCWCD) for the development of a Watershed Management Area Analysis (WMAA) of the upper Santa Margarita River watershed which is under the jurisdiction of the San Diego Regional Water Quality Control Board (RWQCB). An exhibit that displays these jurisdictional boundaries as they relate to the Santa Margarita River watershed is provided as Figure 1.

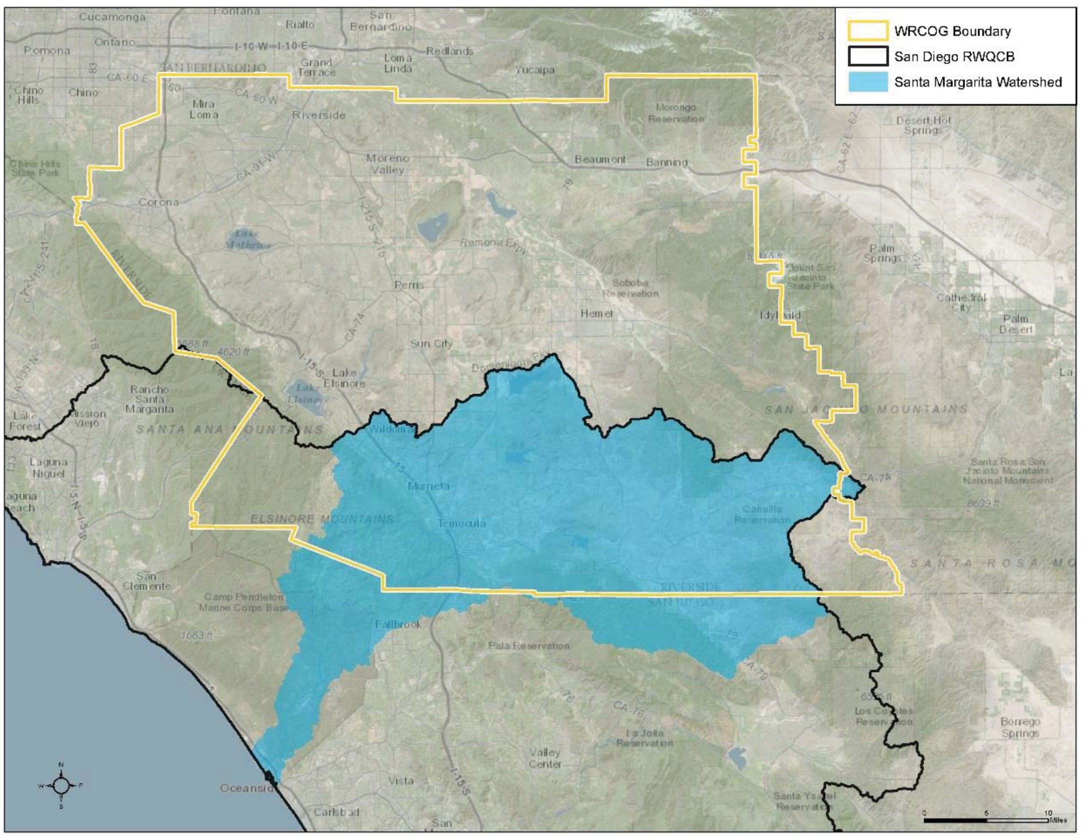

Figure 1. Jurisdictions Associated with the Santa Margarita River Watershed

This report documents the results of two macro scale, regional mapping elements developed by WRCOG. Specifically, WRCOG is evaluating potential changes in runoff and sediment discharge using a geographic information system (GIS)-based watershed-scale analysis of the upper Santa Margarita River watershed (SMR). This report includes a description of the

[1] http://www.wrcog.cog.ca.us/DocumentCenter/View/151

GIS data inputs that were utilized to determine the hydrologic response unit (HRU), the dominant hydrologic process and the potential coarse sediment yield for the SMR.

1.1 BACKGROUND

This report is being developed in response to the National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements for Discharges from the Municipal Separate Storm Sewer Systems (MS4s) Draining the Watersheds within the San Diego Region, (MS4 Permit), which was adopted on May 8, 2013, became effective on June 27, 2013 and was amended by Order No. R9-2015-0001 and Order No. R9-2015-0100. The MS4 Permit requires a Water Quality Improvement Plan (WQIP) for each of the Watershed Management Areas under the jurisdiction of the San Diego RWQCB. The purpose of the WQIP is to further the Clean Water Act's objective to protect, preserve, enhance, and restore the water quality and designated beneficial uses of waters of the state (San Diego RWQCB 2015). A WQIP is required for each Watershed Management Area and therefore requires a Watershed Management Area Analysis (WMAA). A WMAA is a watershed-scale analysis that identifies important characteristics, such as hydrologic processes, sediment yield and stream descriptions. The WMAA is specific to the Santa Margarita Region which includes the County of Riverside, the RCFCWCD, the City of Wildomar, City of Murrieta and the City of Temecula (Copermittees). By working together and sharing resources for development of the SMR WMAA, RCFCWCD is evaluating and summarize existing streams; flood control structures; and current and anticipated land use in the SMR. As part of their contribution to the SMR WMAA, WRCOG is evaluating dominant hydrologic processes and potential coarse sediment yield. The final output of the analyses includes GIS layers to identify candidate projects as alternative compliance options. The SMR WMAA will also provide information to support exemptions from the on-site hydromodification management requirements (RCFCWCD, 2017).

The GIS analysis described herein includes two subtasks which will support development of the SMR WMAA. The SMR WMAA elements described herein leverage and build upon work and mapping already conducted, including but not limited to Technical Report 605 (Booth et al. 2010), the 2014 Santa Margarita Hydromodification Management Plan (HMP)[2] and the 2015 San Diego County Regional WMAA (SD WMAA)[3]. The SD WMAA already includes a preliminary analysis of the lower Santa Margarita River. Therefore, given that the analysis of the upper SMR will be integrated with the analysis of the lower SMR, to maintain a consistent, standardized approach among the lower and upper SMR analyses, the methodology described in in this report is the same methodology developed for the SD WMAA (Geosyntec Consultants and Rick Engineering Company, 2015).

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[2] http://rcflood.org/npdes/SantaMargaritaWS.aspx#SMdocs

[3] http://www.projectcleanwater.org/index.php?option=com_content&view=article&id=248&Itemid=219

2 HYDROLOGIC RESPONSE UNIT

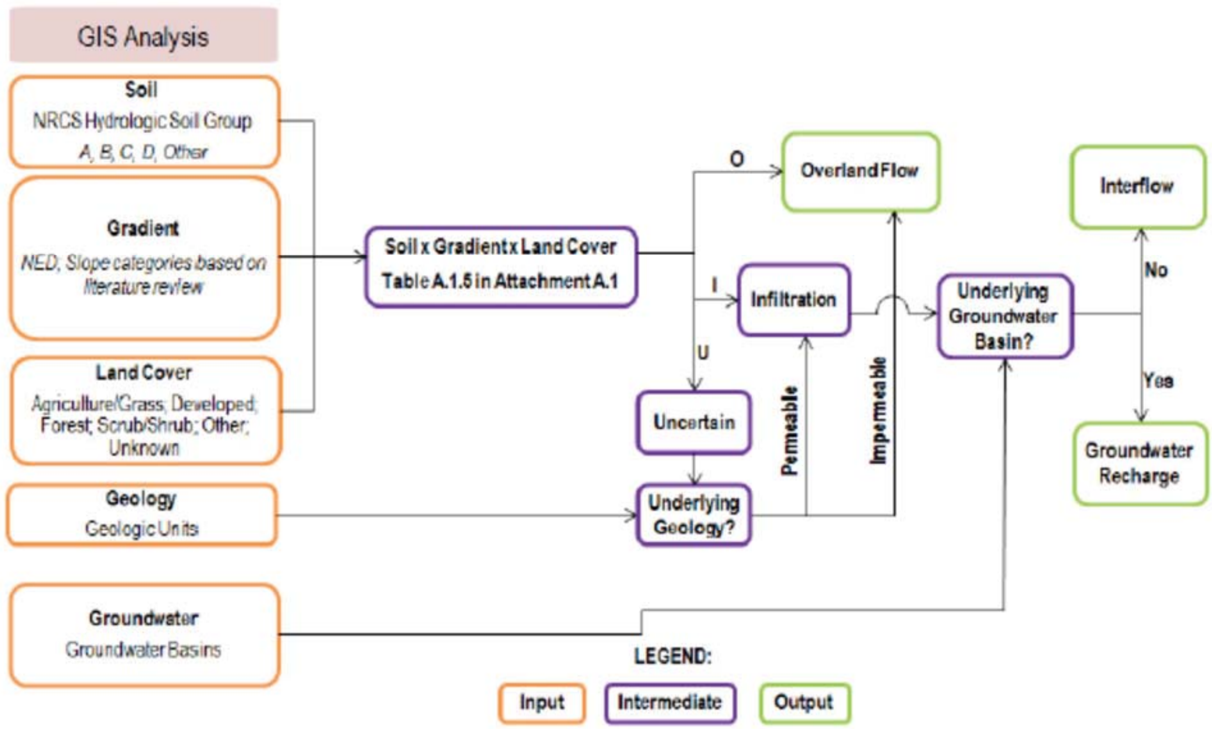

Figure 2. Hydrologic Response Unit and Hydrologic Process Flow Chart

2.1 HYDROLOGIC RESPONSE UNIT END POINTS

The MS4 Permit requires that the WMAA analysis includes a description of dominant hydrologic processes, such as areas where groundwater recharge, interflow or overland flow likely dominate (San Diego RWQCB, 2015). An evaluation of dominant hydrologic processes in the SMR watershed, however, should also consider evapotranspiration (ET). ET is the quantity of water transpired by plants, retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces (Department of Water Resources, 2005). A comparison of the estimated mean annual precipitation, (4 – 10 inches), over a thirty-year timespan in the Riverside-area watersheds with the estimated fraction of precipitation lost to evapotranspiration (90 – 99 percent) in the same area and over the same time frame, suggests that ET is the dominant hydrologic process in Riverside-area watersheds (Sanford and Selnick, 2013). Therefore, theoretically, if all the annual precipitation for the Riverside-area watersheds remained stationary where it fell and did not either infiltrate or runoff to downstream receiving waterbodies, then the precipitation would be loss to ET. Rain events, however, often produce runoff in these watersheds, especially in the urbanized areas, where the topography and land cover tend to accelerate the runoff rate downstream rather than allowing the runoff to be stored or collected and thus maximizing ET.

This analysis, however, is focused on developing information and mapping to gain an understanding of the macro-scale opportunities for locating projects that take advantage of either capturing overland flow for treatment or for supplementing the groundwater regime (Figure 2). Therefore, after considering the effects of ET and an intermediate category of infiltration, the predicted fate of runoff within the SMR was evaluated based on the hydrologic process endpoints - overland flow, interflow[4], or groundwater recharge.

The hydrologic response endpoint (i.e., overland flow, infiltration, interflow or groundwater recharge) was derived by first integrating soil, gradient and land cover datasets into hydrologic response units (HRUs). The HRUs were then incorporated as a layer onto a basemap and the data were grouped into several discrete categories and ultimately classified across the SMR. This process is summarized as Figure 2 (Geosyntec Consultants and Rick Engineering Company, 2015).

2.2 DATA TYPES AND ACQUISITION

GIS data were acquired from public-domain sources as indicated below.

- United States Department of Agriculture/National Resources Conservation Service (USDA/NRCS) Web Soil Survey: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm and USDA/NRCS Digital General Soil Map of the United States: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629
- USGS National Elevation Data Set (NED) 1/3 arc-second DEM: https://catalog.data.gov/dataset/usgs-national-elevation-dataset-ned
- https://viewer.nationalmap.gov/basic/
- Land Cover/Vegetation: https://gis.countyofriverside.us/arcgis_public/rest/services/OpenData/NaturalFeaturesAndHazards/MapServer/4
- Soils - National Resource Conservation Service: http://www.ncgc.nrcs.usda.gov/products/datasets/ssurgo/
- Geologic Units: http://www.conservation.ca.gov/cgs/information/geologic_mapping
- Groundwater: Metropolitan Water District of Southern California. 2007. Groundwater assessment study

2.2.1 UPPER SANTA MARGARITA RIVER WATERSHED

The San Diego Association of Governments (SANDAG) Hydrologic Basins Layer was utilized to delineate the SMR. A vector dataset (shapefile) with basin and sub-basin delineations organized by the 8-digit hydrologic unit code from the USGS Hydrologic Unit Maps was available from CalWater. After the SMR was extracted, an examination of its boundaries was compared against a 10-m DEM hillshade. In cases where the boundary seemed inadequate, the DEM was used to improve the watershed delineation with ArcInfo Hydrology routines. After the area of analysis was sufficiently well-defined, the analysis layers were 'clipped' to its boundaries and re-projected to a common coordinate system.

2.2.2 HYDROLOGIC SOIL GROUPS

Soil categories were based on NRCS Hydrologic Soil Group (HSG) classifications, which are commonly used to describe runoff/infiltration potential of soils on a regional scale. There are four HSGs: A, B, C, and D and three dual groups: A/D, B/D and C/D. HSGs are based on the rate of water infiltration, with Group A having the highest rates and Group D having the lowest rates. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas. The following describes the methodology used to assign a single HSG rating for each of the dual groups identified.

Over two hundred polygons, equating to an area of approximately 7,000 acres in the SMR watershed GIS were rated with a dual HSG. Dual HSG ratings were evaluated based on the mapped geologic unit as determined by published geologic mapping information, a desktop evaluation and soils laboratory results. Specifically, the mapped geologic units were compiled into similar categories and then referenced with a geologic unit name. Geologic units were then categorized as either "coarse" or "fine" based on typical weathering characteristics for the bedrock unit or primary grain size of the

[4] Interflow takes place following storm events as shallow subsurface flow (usually within 3 to 6 feet of the surface) occurring in a more permeable soil layer above a less permeable substrate (Geosyntec Consultants and Rick Engineering Company 2015).

sedimentary unit. For example, some geologic units weather to a coarse material such as silty sand and were therefore classified as “coarse”. Geologic units that weather to a sandy clay were classified as “fine”. Regarding sedimentary formations that are usually associated with variable amounts of coarse and fine units, the final classification was based on the predominating composition, i.e., sandstone/silty sand versus claystone. Finally, given that silty sands drain very quickly, any geologic unit identified as coarse was considered drained and was identified as either HSG A, B, or C. Whereas, geologic units classified as “fine” were considered undrained and were rated as HSG D in the GIS database.

For HRUs considered uncertain (U), the underlying regional geology was used to evaluate whether overland flow or infiltration were dominant, consistent with the San Diego County WMAA analysis (Geosyntec Consultants and Rick Engineering Company, 2015). For HRUs considered uncertain (U), the underlying regional geology (Department of Conservation 2015) was used to evaluate whether overland flow or infiltration were dominant. If the underlying geology was considered impermeable, then these uncertain areas were considered to have overland flow as its dominant hydrologic process. If the underlying geology was considered permeable, then these uncertain areas were dominated by infiltration. The determination of whether a geologic unit is impermeable or permeable was based on desktop evaluation and the best professional judgment of a Geotechnical Engineer. This analysis was performed in GIS.

2.2.3 SLOPE CLASSES

The hillslope digital elevation model (DEM) was analyzed to produce a grid of slope values, which were subsequently classified into discrete categories. Based on the SD WMAA, the following percentage categories were used to group hillslope gradients: 0 - 2 percent; 2 - 6 percent; 6 - 10 percent; and greater than 10 percent. According to Technical Report 605 (Booth et al. 2010), the 10 percent slope threshold was used because it was determined that slopes steeper than 10 percent are assumed to be dominated by overland flow.

2.2.4 LAND COVER

Land cover categories were defined using the ecology vegetation GIS map layers developed for Western Riverside County in the Santa Margarita region. The vegetation categories in the GIS layer were grouped to match the following land cover categories used in SD WMAA: Agriculture/Grass; Developed; Forest; Scrub/Shrub, Other and Other (Water) (see Table A.1, Appendix A). Land cover categories for Agriculture/Grass, Forest, Scrub/Shrub, Unknown Other and Other (Water) were then related to land use categories using Table A.2 in Appendix A. A land use category for the Developed land cover category was not determined because this land cover was assumed to have overland flow as its dominant hydrologic process. Table A.3 in Appendix A displays the results showing how the land cover categories related to land use.

HYDROLOGY CHARACTERISTICS BASED ON LAND COVER

For each of the land cover/land use categories the ratio of precipitation lost to evapotranspiration (i.e. an evapotranspiration coefficient) was estimated using the process described below as provided in the SD WMAA (Geosyntec Consultants and Rick Engineering Company, 2015). Since precipitation is considered as the sum of the resulting runoff, infiltration, and evapotranspiration, the coefficients for these three hydrologic pathways sum to one using Equation (Eq) 1.

Runoff Coefficient + Infiltration Coefficient + Evapotranspiration Coefficient = 1 (Eq. 1)

EVAPOTRANSPIRATION ESTIMATE

To estimate the evapotranspiration (ET) coefficient for each land cover, the runoff coefficient was identified by evaluating the highest runoff potential for the most common storm conditions. Using this, the ET coefficient was calculated as the difference (i.e., ET Coefficient = 1 –Runoff Coefficient). The ET coefficient calculated for the highest runoff potential was then applied to all soil types and slopes within each land use category.

INFILTRATION ESTIMATE

The infiltration coefficient for each applicable HRU (i.e., combination of soil, gradient, and land cover) was estimated by subtracting both the runoff coefficient, and the ET coefficient, from one (i.e., Infiltration Coefficient = 1 – Runoff Coefficient – ET Coefficient).

RUNOFF ESTIMATE

For each applicable HRU, the runoff coefficient was divided by the infiltration coefficient to obtain a ratio representing the potential for runoff or infiltration. The higher the ratio, the greater the potential for runoff to be a more dominant hydrologic process than infiltration. Similarly, the lower the ratio, the greater the potential for infiltration to be a more dominant hydrologic process than runoff.

ASSOCIATE RUNOFF AND INFILTRATION HRUS

The following designations were assigned to each applicable HRU based on the runoff to infiltration ratio (i.e., runoff coefficient/infiltration coefficient). These designations were based on best engineering judgment with the underlying assumption that if a runoff or infiltration coefficient is more than 50 percent greater than its counterpart, then the prevailing process is considered dominant.

- HRUs with runoff to infiltration ratios greater than 1.5 (3:2 ratio) were assumed to have relatively high runoff and overland flow was considered its dominant hydrologic process. These HRUs are designated by the letter "O" (Overland flow is dominant process). Table A.4 in Appendix A summarizes these findings in tabular format.
- HRUs with runoff to infiltration ratios less than 0.67 (2:3 ratio) were assumed to have relatively high infiltration and its dominant hydrologic process was either interflow or groundwater recharge, based on analysis described in subsequent steps. These HRUs are designated by the letter "I" (Interflow is dominant process) in Table A.4, Appendix A.
- For HRUs with runoff to infiltration ratios ranging from 0.67 to 1.5, it was uncertain whether it was dominated by overland flow or infiltration. These HRUs are designated by the letter "U" (Dominant process is uncertain) in Table A.4, Appendix A.
- For HRUs that have a Developed land cover or a gradient greater than 10 percent, the runoff to infiltration ratios were not calculated because these HRUs were assumed to have overland flow as the dominant hydrologic process. These HRUs are designated by the letter "O" (Overland flow is dominant process) and are summarized in Table A.5, Appendix A.

2.2.5 GEOLOGIC UNIT

The geology layer was categorized based on rock types, the predominant sediment size generated upon erosion, and their associated erodibility (Booth, et al., 2010). The attribution (and thus the naming) of the geology classes included the following categories:

- Coarse Bedrock (CB),
- Coarse Sedimentary Impermeable (CSI),
- Coarse Sedimentary Permeable (CSP),
- Fine Bedrock (FB),
- Fine Sedimentary Impermeable (FSI),
- Fine Sedimentary Permeable (FSP), and
- Other (O).

The underlying geology was then evaluated to determine if it was permeable or impermeable. This determination was based on a desktop evaluation using the best professional judgment of a Certified Engineering Geologist. All geologic units identified as permeable were considered to have infiltration as the hydrologic endpoint. All impermeable layers were considered to have overland flow as the hydrologic endpoint. The Certified Engineering Geologist also performed a desktop evaluation of any HRUs that were identified as uncertain. Again, if the underlying geology was considered permeable, then these uncertain areas were considered to be dominated by infiltration. Likewise, if the underlying geology was considered impermeable, then these uncertain areas were considered to be dominated by overland flow.

2.2.6 GROUNDWATER BASINS

For HRUs with relatively high infiltration the presence or absence of a regional groundwater basin underlying these areas determined whether the dominant hydrologic process was designated as interflow or groundwater recharge. The groundwater recharge hydrologic process was assigned as dominant for those applicable areas which have an underlying groundwater basin. The interflow hydrologic process was assigned as dominant for those applicable areas which did not have an underlying groundwater basin.

2.2.7 DOMINANT HYDROLOGIC PROCESS RESULTS

The resulting GIS map displaying the spatial distribution of dominant hydrologic processes (i.e., overland flow, interflow and groundwater recharge) within the SMR is provided in Appendix B. Based on this analysis, overland flow, is the predominant hydrologic process in the SMR, which was verified by the Copermittees as part of their review process.

3 CRITICAL COARSE SEDIMENT YIELD ANALYSIS

The Critical Coarse Sediment Yield analysis predicts the potential critical coarse sediment yield areas and is based on the Geomorphic Landscape Unit (GLU) methodology presented in Technical Report 605 (Booth et al. 2010) and the SD WMAA (Geosyntec Consultants and Rick Engineering Company, 2015). The GLU methodology characterizes the magnitude of sediment production from areas using three factors judged to exert the greatest influence on the variability of sediment-production rates: geology types, hillslope gradient, and land cover. The GLU layer was derived by overlaying hillslope, land cover, and geology, and then assigning a relative sediment-production rate (i.e., Low, Medium, and High) to each of the resulting categories. The GLU approach provided a useful, rapid framework to identify sediment-delivery attributes of the SMR. The process to integrate these factors into GLUs is indicated as a flow chart in Figure 3 (Geosyntec Consultants and Rick Engineering Company 2015).

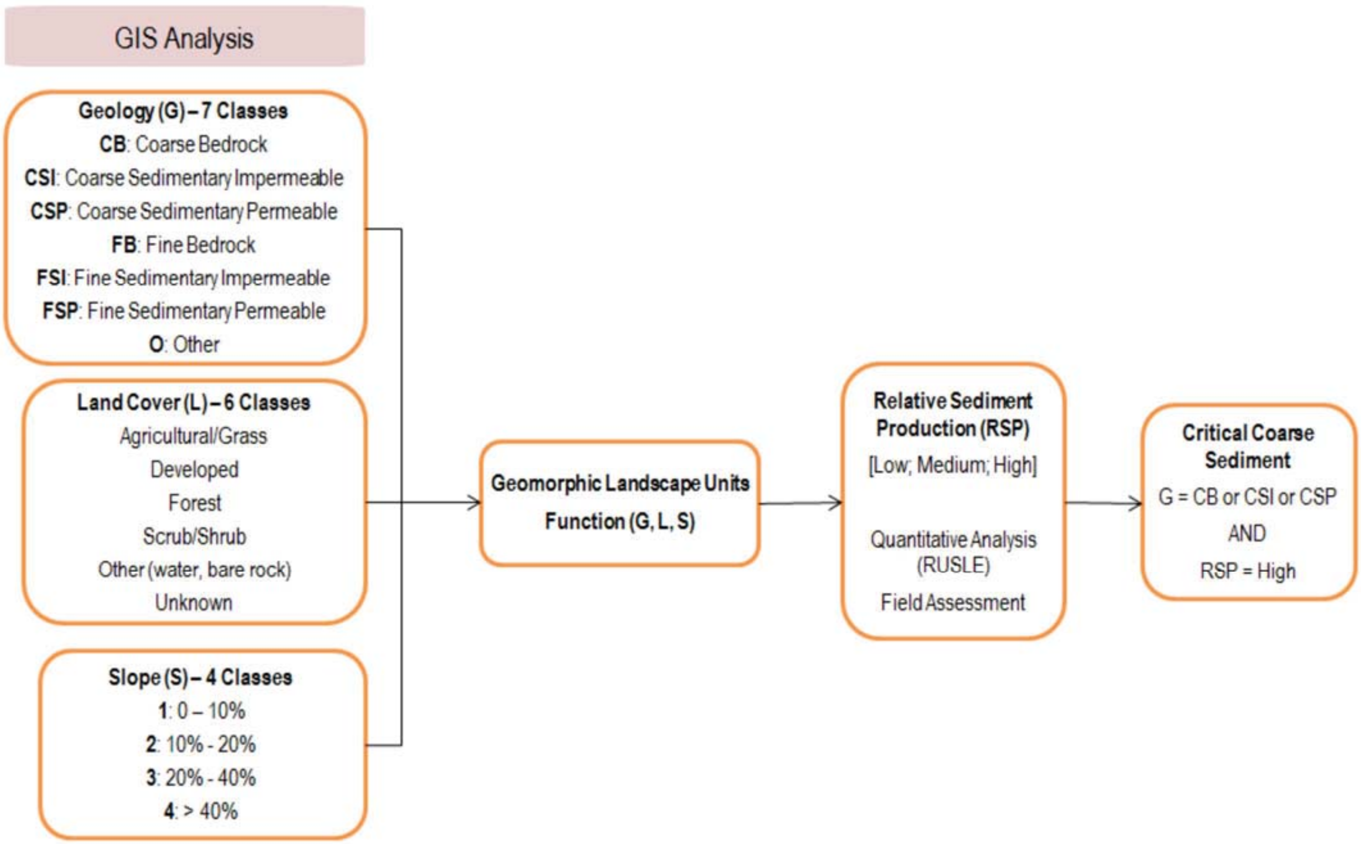

Figure 3. Potential Critical Coarse Sediment Yield Analysis

3.1 DATA TYPES AND ACQUISITION

GIS data were acquired from public-domain sources as indicated below.

- Geologic Units: http://www.conservation.ca.gov/cgs/information/geologic_mapping
- Land Cover/Vegetation: https://gis.countyofriverside.us/arcgis_public/rest/services/OpenData/NaturalFeaturesAndHazards/MapServer/4

- USGS National Elevation Data Set (NED) 1/3 arc-second DEM: https://catalog.data.gov/dataset/usgs-national-elevation-dataset-ned
- https://viewer.nationalmap.gov/basic/

3.1.1 GEOLOGIC UNITS

The geology layer was categorized based on rock types, the predominant sediment size generated upon erosion, and their associated erodibility. The attribution (and thus the naming) of the geology classes included the following categories:

- Coarse Bedrock (CB),
- Coarse Sedimentary Impermeable (CSI),
- Coarse Sedimentary Permeable (CSP),
- Fine Bedrock (FB),
- Fine Sedimentary Impermeable (FSI),
- Fine Sedimentary Permeable (FSP), and
- Other (O).

Of the 34 Geologic Units, 20 required a desktop evaluation by a Geotechnical Engineer to determine if the geologic units would weather to a coarse material such as silty sand or to a fine sandy clay. The desktop evaluation yielded results for all of the geologic units except two, Qsu and Qw. Given that these two units represented approximately 4 percent of the data, a site visit, including soil sample collection, was conducted to verify the grain size of the weathered material.

At the Qw site, the soils were classified as a yellowish brown Silty Sand with little (7 percent) gravels. The grain size of the sand varied between fine to coarse. It was determined that the sediment production from this geologic unit is considered medium to high due to its coarseness and looseness. In addition, this material is considered permeable with a hydrologic soil group rating of A.

At the Qsu site, the soils were classified as a yellowish brown Silty Sand with trace (2 percent) gravels. It was determined that the sediment production from this geologic unit is considered medium to high due to its coarseness and looseness. In addition, this material is considered permeable with a hydrologic soil group rating of A. The field and laboratory report documenting the confirmed results are provided in Appendix C. Table D.1 in Appendix D summarizes how each of the map units related to a geologic grouping.

3.1.2 LAND COVER

Land cover categories were defined using the ecology vegetation GIS map layers developed for Western Riverside County in the Santa Margarita region. The vegetation categories in the GIS layer were grouped to match the following categories used in the SD WMAA: Agriculture/Grass; Developed; Forest; Scrub/Shrub, Other (Water), and Unknown.

3.1.3 SLOPE CLASSES

The hillslope DEM was analyzed to produce a grid of slope values, which were subsequently classified into discrete categories. Based on the SD WMAA, the following category percentages were used to categorize hillslope gradients: 0 to 10 percent; 10 to 20 percent; 20 to 40 percent; and greater than 40 percent.

GLU RESULTS

The result of evaluating geology, land cover and slope equated to approximately 130 GLUs within SMR. These GLUs were then evaluated to determine their relative sediment production.

3.1.4 GEOLOGIC GROUPS

Per the SD WMAA, the geologic groups considered to have the potential to generate coarse sediment are: Coarse Bedrock (CB); Coarse Sedimentary Impermeable (CSI); and Coarse Sedimentary Permeable (CSP). An exhibit showing the regional geologic groupings is presented in Appendix E.

3.1.5 GLU AND SEDIMENT PRODUCTION

Relative sediment production was estimated for each GLU using the Revised Universal Soil Loss Equation (RUSLE) (see Eq. 2).

A = R x K x LS x C x P (Eq. 2), where

A = estimated average soil loss in tons/acre/year
R = rainfall-runoff erosivity factor
K = soil erodibility factor
LS = slope length and steepness factor
C = cover-management factor
P = support practice factor; assumed 1 for this analysis

Datasets used to estimate the average soil loss were acquired from public-domain sources as indicated below.

- RUSLE R Factor: ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_R_Factor/5
- RUSLE K Factor: State Water Resources Control Board: ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_K_Factor/
- RUSLE LS Factor: State Water Resources Control Board: ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_LS_Factor/
- RUSLE C Factor: US EPA, EMAP West Metric Browser: https://archive.epa.gov/esd/archive-nerl-esd1/web/html/wemap_download.html

GIS analysis was used to calculate the area weighted estimate of R, K, LS and C factors using the datasets listed above. For the developed land[6] cover the C factor was adjusted to 0 for the regional estimate to account for management actions implemented on developed sites (e.g., impervious surfaces). The estimated average annual soil loss ranged from 0 to 23 tons/acre/year.

To assess the amount of relative risk to stream channels resulting from watershed-scale changes in sediment yield and/or water delivery, the following opinions included in Technical Report 605 (Booth et al. 2010) were considered:

> *"The challenge in implementing this step is that presently we have insufficient basis to defensibly identify either low-risk or high-risk conditions using these metrics. For example, channels that are close to a threshold for geomorphic change may display significant morphological changes under nothing more than natural year-to-year variability in flow or sediment load.*
>
> *Acknowledging this caveat, we nonetheless anticipate that changes of less than 10 percent in either driver are unlikely to instigate, on their own, significant channel changes. This value is a conservative estimate of the year-to-year variability in either discharge or sediment flux that can be accommodated by a channel system in a state of dynamic equilibrium. It does not "guarantee," however, that channel change may not occur—either in response to yet modest alterations in water or sediment delivery, or because of other urbanization impacts (e.g., point discharge of runoff or the trapping of the upstream sediment flux; see Booth 1990) that are not represented with this analysis.*
>
> *In contrast, recognizing a condition of undisputed "high risk" must await broader collection of regionally relevant data. We note that >60 percent reductions in predicted sediment production have resulted in both minimal*

[5] R-Factor database provided by Geosyntec, January 2017.

[6] Developed (i.e., impervious) area data layer provided by WRCOG, January 2017.

(McGonigle) and dramatic (Agua Hedionda) channel changes, indicating that "more data" may never provide absolute guidance. At present, we suggest using predicted watershed changes of 50 percent or more in either runoff (as indexed by change in impervious area) or sediment production as provisional criteria for requiring a more detailed evaluation of both the drivers and the resisting factors for channel change, regardless of other screening-level assessments. Clearly, however, only more experience with the application of such "thresholds," and the actual channel conditions that accompany them, will provide a defensible basis for setting numeric standards."

Considering the thresholds indicated above, the relative sediment production rating for each GLU followed the criterion indicated below:

- Low: Soil Loss < 3.4 tons/acre/year (GLUs that have a soil loss of 0 to 3.39 tons/acre/year produce approximately 10 percent of the total potential coarse sediment soil loss from the SMR)
- Medium: 3.4 tons/acre/year < Soil Loss <9.6 tons/acre/year (GLUs that have a soil loss ranging from 3.40 to 9.55 tons/acre/year produce approximately 50 percent of the total potential coarse sediment soil loss from the SMR)
- High: >9.6 tons/acre/year (GLUs that have a soil loss greater than 9.57 tons/acre/year produce approximately 40 percent of the total potential coarse sediment soil loss from the SMR)

Results from the quantitative analysis along with GLUs that were rated as critical coarse sediment yield areas are summarized in tabular format in Appendix E.

The resulting GIS map showing the spatial distribution of the potential critical coarse sediment yield areas within the SMR is provided in Appendix G. Based on this analysis it was estimated that 28 percent of the of the SMR study area is a potential coarse sediment yield area and 9 percent of the SMR study area is a potential critical coarse sediment yield area. The majority of the potential critical coarse sediment yield areas were identified to be in the Scrub/Shrub land cover areas with hillslope gradients ranging from 20 to 40 percent.

As a result of the regional-scale datasets, and commensurate data resolution, used to map the potential critical coarse sediment yield areas, some areas may have been mapped that in reality do not produce critical coarse sediment as they are existing developed areas. As such, an opportunity for Copermittees to incorporate more refined data into the preliminary SMR WMAA GIS dataset based on local knowledge and review of current aerial images was provided. The City of Temecula, the City of Wildomar, the City of Murrietta, and RCFCWCD evaluated the data for their respective jurisdictional areas during the review process.

4 SITE ASSESSMENT

After developing the GIS that related the GLUs to a relative sediment production, WSP conducted a series of site visits within the SMR to compare GIS-based predictions with field-based observations. Forty-three sites were selected (see Figure F.1, Appendix F) for the assessment based on their accessibility and their distribution according to the following criteria:

- Geologic grouping
- Land cover
- Slope category

The following section includes a discussion of the protocol utilized for the site assessment and is based on the field assessment strategy described in the SD WMAA (Geosyntec Consultants and Rick Engineering Company, 2015).

4.1 PRE-FIELD ACTIVITIES

Prior to conducting field activities, the consultant team reviewed available published geologic information at each site location and prepared satellite imagery of each site using Google Earth. Pre-field activities consisted of evaluating site access at each location using aerial imagery and logistics were coordinated based on regional site locations to maximize field efficiency.

4.2 SITE RECONNAISSANCE

The WSP geology team performed site reconnaissance at forty-three locations on 9 and 10 May 2017. The reconnaissance consisted of:

- Visual soil classification,
- Assessing existing vegetative cover (0-100 percent),
- Qualitative assignment of existing sediment production (low, medium, and high) [based on existing vegetative cover],
- Qualitative assignment of potential sediment production (low, medium, and high) [assuming there is 0 percent vegetative cover], and
- Identifying existing erosional features.

Descriptions and visual classifications of the surficial materials were based on the Unified Soil Classification System (USCS). Underlying geologic units were confirmed where exposed formations were observed within the individual site limits.

4.3 SITE AND GEOLOGIC CONDITIONS

Site condition knowledge was developed from a review of available geologic literature, previous geologic and geotechnical investigations by the WSP team in the study region, professional experience and site reconnaissance.

4.3.1 SURFACE CONDITIONS

Site locations were selected in areas with open space with the exception of sites 1, 21, 22, 30 and 31 which were situated within developed areas with paved streets and sidewalks. The surface conditions at the site locations were typically characterized by relatively flat terrain (< 5 percent) with a few instances where slope gradients ranged from 10 to 40 percent. At the time of the site visit the natural hillsides along the areas of interest were covered by varying degrees of moderate to dense growth scrub brush, low grasses, and scattered trees. The only observed erosional feature included potential erosional gullies at Site 64 within the access road to the site where no ground cover existed. No geomorphic features were observed and the only sources of ground disturbance were noted as active construction at Sites 54 and 55 and active construction 100-200 feet south and east of Site 59. An evaluation of the existing and potential sediment production for each site was determined based on surface conditions. Sediment production was assigned as "high, medium, or low" based on the existing conditions and the geology team's professional experience.

4.3.2 SURFICIAL DEPOSITS

Surficial deposits observed included alluvium, colluvium, and debris (e.g., silt, sand, silty sand and fine gravel). The composition and grain size of these materials were variable (fine to medium grained; fine to coarse grained) depending on the age, parent sources, and mode of deposition. Granite boulders were also observed in portions of the study area.

4.3.3 GEOLOGIC CONDITIONS

Knowledge of the subsurface conditions at the site locations was based on a review of available published geologic information, professional experience, site reconnaissance, previous explorations and geotechnical investigations performed by the team in the study region.

4.4 RESULTS

The results of the site assessment along with photographic documentation are provided in Appendix F. Overall, there were 133 GLU's associated with the SMR and the field team was tasked with evaluating GLUs at 43 sites. The 43 sites represented 25 unique GLUs which equated to verifying approximately 20 percent of the entire GLU dataset. Of the 129 GIS-based predictions (e.g., 43 GLUs with 3 characteristics per GLU), 116 GIS-based predictions (or 90 percent) matched the field-based observations for land cover, geologic grouping and slope category. Of the 13 GIS-based predictions that resulted in mismatches, 2 of the sites (Sites 54 and 55) were within active construction areas, making verification of the GLU impossible. Nine of the mismatches were attributed to the assignment of the geologic grouping. Specifically, 8 sites were classified as a Granitic (gr) geologic unit, whereas in the field, the geologists determined that the geologic units represented Alluvial deposits or fill. There were a few instances, (Sites 49, 53 and 58), where large granitic boulders were adjacent to the site and the field team indicated that this may have been the reason why the site was classified as granitic. For the final mismatch at Site 51, the geologic unit was classified as Granitic and the field team classified the geologic unit as Qvoa or fill. It should be noted that the Qvoa geologic unit weathers as a coarse grain which is similar to the granitic geologic unit that also weathers to a coarse grain (see Table D.1 in Appendix D). In general, these mismatches may be attributed to a function of the public domain data used which does not reflect changes to particular areas that have occurred since the underlying data was developed. The relatively high agreement (90 percent) between the GIS-based predictions and the field-based observations may be attributed to scrutinizing the land cover data by comparing some of the land cover areas with aerial images and having to concentrate the locations to ensure ease of access. Therefore, the GLU assignments were considered valid for estimating relative sediment production.

5 POTENTIAL SEDIMENT SOURCE AREA

5.1 SAN DIEGO RWQCB COMMENTS

A comparison between the potential critical coarse sediment yield areas within the Upper SMR and within the San Diego County portion of the Santa Margarita watershed management area was conducted as a response to San Diego Regional Water Quality Control Board (San Diego RWQCB) comments. Differences in potential critical coarse sediment yield areas along the county line were noted in the eastern portion of the watershed along with a lack of potential critical coarse sediment areas within the northeastern portion of the watershed management area.

To verify these differences, the San Diego RWQCB requested an evaluation of United States Geological Survey mineral resource maps online (USGS 2018). Along the border, it was noted that sand and gravel deposits were absent within a 2-mile radius north and south of the border. Sand and gravel deposits, however, were noted in areas generally downstream of CB, CSI, and CSP geologic units. These deposits were therefore considered as an area that may be a potential sediment source area and it was decided that further evaluation was warranted.

The identification of potential sediment source areas was determined using the following process:

- Overlay sand/gravel deposits onto Geology Grouping GIS layer
- Using USGS quad maps, identify the tributary drainage area for each deposit located in a CB, CSI or CSP area
- Exclude the following areas:
  - Agricultural Land
  - Developed Land
  - Non Permittee Area
    - Camp Pendleton
  - Protected Lands

The resulting GIS map showing the spatial distribution of the potential critical coarse sediment yield areas along with potential sediment source areas within the SMR is provided in Appendix H.

6 CONCLUSIONS

6.1 UPPER SANTA MARGARITA RIVER WMAA

The SMR WMAA will be developed by integrating the mapping results of the HRU and coarse sediment analyses provided in this report with the mapping results of existing streams, future land uses and physical structures developed by RCFCWCD. Under the conditions of the NPDES MS4 Permit, the Copermittees may use the integrated analyses and information provided in the SMR WMAA to support exemptions from the on-site hydromodification BMP requirements. Moreover, the Copermittees may also use the results of the SMR WMAA to identify and compile a list of candidate projects that Priority Development Projects may use as an alternative compliance option. (RCFCWCD 2017). Opportunities being considered as candidate projects are provided in the Santa Margarita Watershed Management Area Analysis dated June 2018.

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APPENDIX

A HYDROLOGIC RESPONSE UNIT TABLES

Table A.1. Land Cover Grouping

ID	Vegetation Category	Land Cover Grouping
1	Annual Grassland	Agricultural/Grass
2	Cropland, Orchard - Vineyard	Agricultural/Grass
3	Urban	Developed
4	Barren	Forest
5	Coastal Oak Woodland	Forest
6	Eucalyptus	Forest
7	Jeffrey Pine	Forest
8	Mixed Chaparral	Forest
9	Montane Hardwood	Forest
10	Montane Hardwood - Conifer	Forest
11	Montane Hardwood, Montane Hardwood - Conifer	Forest
12	Montane Riparian, Valley Foothill Riparian	Forest
13	Pinyon - Juniper	Forest
14	Sierran Mixed Conifer	Forest
15	Valley Foothill Riparian	Forest
16	White Fir, Sierran Mixed Conifer	Forest
17	Desert Riparian, Desert Wash	Other
18	Fresh Emergent Wetland	Other
19	Lacustrine	Other
20	Riverine, Lacustrine	Other
21	Wet Meadow	Other
22	Lacustrine	Other
23	Alkali Desert Scrub	Scrub/Shrub
24	Chamise-Red Shank Chaparral	Scrub/Shrub
25	Coastal Scrub	Scrub/Shrub
26	Mixed Chaparral	Scrub/Shrub
27	Sagebrush	Scrub/Shrub

Three scenerios led to an overide or modification of the Land Cover value

1. Impervious layer union resulted in a Developed value
2. Aerial shows urban development for a given area
3. Road ROW union resulted in a Developed value

Table A.2. Land Use Categories

Land Use	A 0–2%	A 2–6%	A 6%+	B 0–2%	B 2–6%	B 6%+	C 0–2%	C 2–6%	C 6%+	D 0–2%	D 2–6%	D 6%+
Cultivated land	0.08[a]	0.13	0.16	0.11	0.15	0.21	0.14	0.19	0.26	0.18	0.23	0.31
	0.14[b]	0.18	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Pasture	0.12	0.20	0.30	0.18	0.28	0.37	0.24	0.34	0.44	0.30	0.40	0.50
	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Meadow	0.10	0.16	0.25	0.14	0.22	0.30	0.20	0.28	0.36	0.24	0.30	0.40
	0.14	0.22	0.30	0.20	0.28	0.37	0.26	0.35	0.44	0.30	0.40	0.50
Forest	0.05	0.08	0.11	0.08	0.11	0.14	0.10	0.13	0.16	0.12	0.16	0.20
	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Residential lot size 1/8 acre	0.25	0.28	0.31	0.27	0.30	0.35	0.30	0.33	0.38	0.33	0.36	0.42
	0.33	0.37	0.40	0.35	0.39	0.44	0.38	0.42	0.49	0.41	0.45	0.54
Residential lot size 1/4 acre	0.22	0.26	0.29	0.24	0.29	0.33	0.27	0.31	0.36	0.30	0.34	0.40
	0.30	0.34	0.37	0.33	0.37	0.42	0.36	0.40	0.47	0.38	0.42	0.52
Residential lot size 1/3 acre	0.19	0.23	0.26	0.22	0.26	0.30	0.25	0.29	0.34	0.28	0.32	0.39
	0.28	0.32	0.35	0.30	0.35	0.39	0.33	0.38	0.45	0.36	0.40	0.50
Residential lot size 1/2 acre	0.16	0.20	0.24	0.19	0.23	0.28	0.22	0.27	0.32	0.26	0.30	0.37
	0.25	0.29	0.32	0.28	0.32	0.36	0.31	0.35	0.42	0.34	0.38	0.48
Residential lot size 1 acre	0.14	0.19	0.22	0.17	0.21	0.26	0.20	0.25	0.31	0.24	0.29	0.35
	0.22	0.26	0.29	0.24	0.28	0.34	0.28	0.32	0.40	0.31	0.35	0.46
Industrial	0.67	0.68	0.68	0.68	0.68	0.69	0.68	0.69	0.69	0.69	0.69	0.70
	0.85	0.85	0.86	0.85	0.86	0.86	0.86	0.86	0.87	0.86	0.86	0.88
Commercial	0.71	0.71	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.89	0.89	0.90
Streets	0.70	0.71	0.72	0.71	0.72	0.74	0.72	0.73	0.76	0.73	0.75	0.78
	0.76	0.77	0.79	0.80	0.82	0.84	0.84	0.85	0.89	0.89	0.91	0.95
Open space	0.05	0.10	0.14	0.08	0.13	0.19	0.12	0.17	0.24	0.15	0.21	0.28
	0.11	0.16	0.20	0.14	0.19	0.26	0.18	0.23	0.32	0.22	0.27	0.39
Parking	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97

[a] Runoff coefficients for storm recurrence intervals less than 25 years.

[b] Runoff coefficients for storm recurrence intervals of 25 years or longer.

Source: Table 7-9 in *Hydrologic Analysis and Design* (McCuen, 2004)

Table A.3. Land Cover and Land Use

Land Cover Categories	Land Use per Table A.2
Agriculture/Grass	Meadow
Forest	Forest
Scrub/Shrub	Average (Meadow,Forest)
Unknown/Other	Meadow

Table A.4. Hydrologic Response Unit Calculations

Land Cover	HSG	Gradient	Runoff Coefficient	ET Coefficient	Infiltration Coefficient	Runoff/ Infiltration Ratio	Hydrologic Process Designation
Agriculture/Grass	A	0-2%	0.1	0.6	0.3	0.33	I
Agriculture/Grass	A	2-6%	0.16	0.6	0.24	0.67	U
Agriculture/Grass	A	6-10%	0.25	0.6	0.15	1.67	O
Agriculture/Grass	B	0-2%	0.14	0.6	0.26	0.54	I
Agriculture/Grass	B	2-6%	0.22	0.6	0.18	1.22	U
Agriculture/Grass	B	6-10%	0.3	0.6	0.1	3	O
Agriculture/Grass	C	0-2%	0.2	0.6	0.2	1	U
Agriculture/Grass	C	2-6%	0.28	0.6	0.12	2.33	O
Agriculture/Grass	C	6-10%	0.36	0.6	0.04	9	O
Agriculture/Grass	D	0-2%	0.24	0.6	0.16	1.5	U
Agriculture/Grass	D	2-6%	0.3	0.6	0.1	3	O
Agriculture/Grass	D	6-10%	0.4	0.6	0	infinite	O
Forest	A	0-2%	0.05	0.8	0.15	0.33	I
Forest	A	2-6%	0.08	0.8	0.12	0.67	U
Forest	A	6-10%	0.11	0.8	0.09	1.22	U
Forest	B	0-2%	0.08	0.8	0.12	0.67	U
Forest	B	2-6%	0.11	0.8	0.09	1.22	U
Forest	B	6-10%	0.14	0.8	0.06	2.33	O
Forest	C	0-2%	0.1	0.8	0.1	1	U
Forest	C	2-6%	0.13	0.8	0.07	1.86	O
Forest	C	6-10%	0.16	0.8	0.04	4	O
Forest	D	0-2%	0.12	0.8	0.08	1.5	U
Forest	D	2-6%	0.16	0.8	0.04	4	O
Forest	D	6-10%	0.2	0.8	0	infinite	O
Scrub/Shrub	A	0-2%	0.08	0.7	0.23	0.33	I
Scrub/Shrub	A	2-6%	0.12	0.7	0.18	0.67	U
Scrub/Shrub	A	6-10%	0.18	0.7	0.12	1.5	U
Scrub/Shrub	B	0-2%	0.11	0.7	0.19	0.58	I
Scrub/Shrub	B	2-6%	0.17	0.7	0.14	1.22	U
Scrub/Shrub	B	6-10%	0.22	0.7	0.08	2.75	O
Scrub/Shrub	C	0-2%	0.15	0.7	0.15	1	U
Scrub/Shrub	C	2-6%	0.21	0.7	0.1	2.16	O
Scrub/Shrub	C	6-10%	0.26	0.7	0.04	6.5	O
Scrub/Shrub	D	0-2%	0.19	0.7	0.12	1.5	U
Scrub/Shrub	D	2-6%	0.23	0.7	0.07	3.29	O
Scrub/Shrub	D	6-10%	0.3	0.7	0	infinite	O

Hydrologic process designation: I = Interflow; O = Overland Flow; U = Uncertain

Table A.5. Hydrologic Response Unit Designations

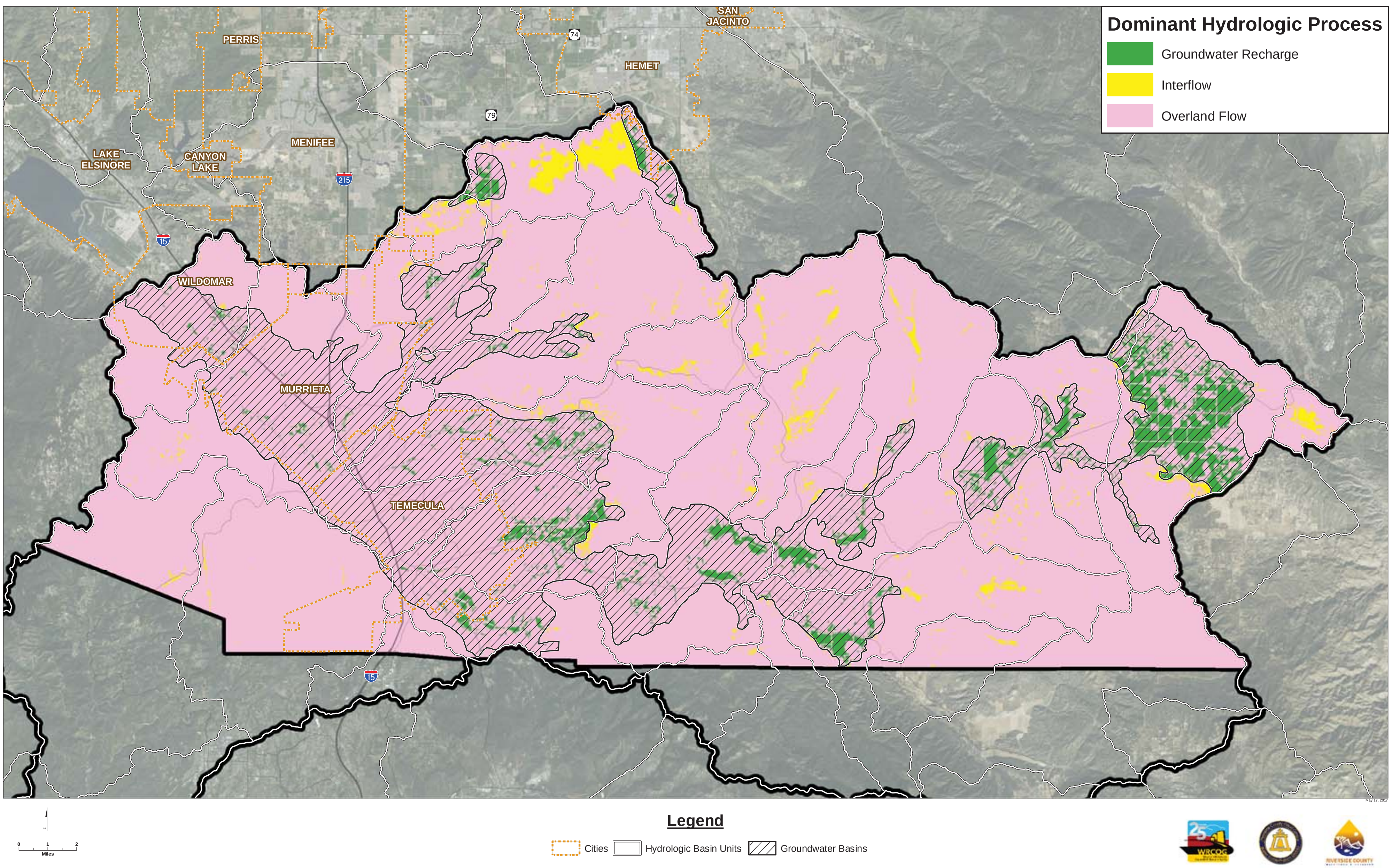
Land Cover	Slope	Soil Type				
		A	B	C	D	Other
Agricultural/Grass/ Unknown/Other	0-2%	I	I	U	U	U
	2-6%	U	U	O	O	U
	6-10%	O	O	O	O	O
	>10%	O	O	O	O	O
Developed	0-2%	O	O	O	O	O
	2-6%	O	O	O	O	O
	6-10%	O	O	O	O	O
	>10%	O	O	O	O	O
Forest	0-2%	I	U	U	U	U
	2-6%	U	U	O	O	U
	6-10%	U	O	O	O	U
	>10%	O	O	O	O	O
Scrub/Shrub	0-2%	I	I	U	U	U
	2-6%	U	U	O	O	U
	6-10%	U	O	O	O	U
	>10%	O	O	O	O	O

Hydrologic Process Designation: I = Interflow; O = Overland Flow; U = Uncertain

APPENDIX

B

HYDROLOGIC RESPONSE UNIT SPATIAL DISTRIBUTION EXHIBIT


Dominant Hydrologic Process
Groundwater Recharge
Interflow
Overland Flow
SAN JACINTO
PERRIS
HEMET
74
79
MENIFEE
LAKE ELSINORE
CANYON LAKE
215
15
WILDOMAR
MURRIETA
TEMECULA
May 17, 2017
Legend
Cities
Hydrologic Basin Units
Groundwater Basins
0
1
2
Miles

wsp

APPENDIX

C

EVALUATION OF Qw AND Qsu GEOLOGIC UNITS

Memorandum

Project #: 12853

Date: March 17, 2017

To: Veronica Seyde

From: S. V. (Jag) Jagannath, PhD, PE, GE and Ian Lau, PE

Subject: WSP I PB Site Visit Observation for SMR WMAA

Previously, we had provided geologic / geotechnical desktop study of about 20 Geologic Units within the Santa Margarita River Watershed study area with respect to nature of anticipated grain size of weathered material from these geologic units and to aid the GIS team in determination of Hydrologic Units. Based on that study, you had identified following two Geologic Units that required further evaluation.

- Qw - Wash deposits (late Holocene)-Unconsolidated boulders to sandy alluvium of active and recently active washes
- Qsu - Undifferentiated Surficial Deposits; includes colluvium, slope wash, talus deposits, and other surface deposits of all ages; mostly consolidated

Purpose of this memo is to summarize the findings of the field reconnaissance / observation conducted on March 8, 2017 for these Geologic Units, collection of soil samples and soil classification based on laboratory testing. Site maps showing the sample locations, field notes, photographs during site visit and laboratory test results of representative samples are provided in the attachments.

Field Observation:

On March 8, 2017, WSP I PB engineers conducted field observation to evaluate the above two geologic units (Qw and Qsu). The two locations were determined using aerial imagery, site access and available geologic maps. Two bulk bags of near-surface representative soil samples (one each from these Geologic Units) were collected for initial visual classification in the field and laboratory testing for grain size distribution.

Sample S-1 is selected to evaluate geologic unit Qw. The site is located west of the intersection of De Portola Road and Belle Chaine Loop (approximate latitude / longitude: N33°29'50.3", W117°2'1.5"). General topography of the site is relatively flat and is located within a developed ranch and agricultural farmland area. Minimal existing vegetation (<5%) is observed adjacent to the sampling location, although scattered trees and scrubs can be seen within several privately owned parcels nearby.

Based on the visual and laboratory test result, the soil is classified as yellowish brown Silty Sand with little (7%) gravels. Grain size of sand varies between fine to coarse. It is determined that the sediment production from this geologic unit when without ground cover is considered medium to high due to its grain coarseness and looseness. In addition, this material is considered as permeable with a Hydrologic Unit A.

Sample S-2 is selected to evaluate geologic unit Qsu. The site is generally located in the walking trails, generally southwest of the paved Butterfield Stage Road (dirt path towards Morgan Hill Trail) (approximate latitude / longitude: N33º28'11.5", W117º3'40.9"). The site is near the bottom of foothill and general topography of the site varies from relatively flat to fairly-sloped (20-30%). Majority of the area is currently covered with low lying vegetation (except the dirt covered walkways connecting to the southeasterly trails). A concrete V-ditch separated the trail area from the existing track homes development to the west of the sample location..

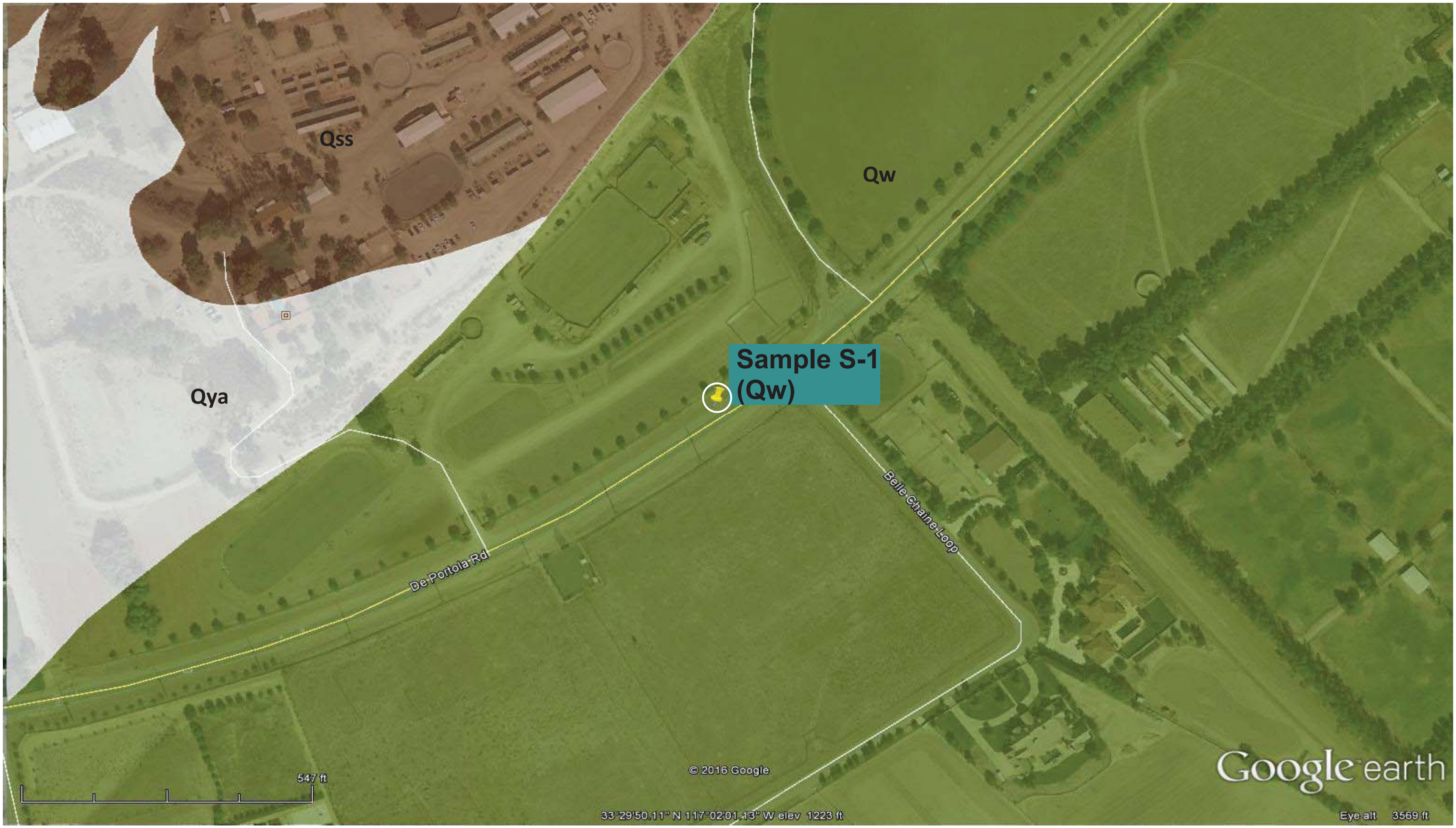
Based on the visual and laboratory test result, the soil is classified as yellowish brown Silty Sand (consist of mostly fine to medium sand) with trace (2%) gravels. It is determined that the sediment production from this geologic unit when without ground cover is considered medium to high due to its grain coarseness and looseness. In addition, this material is considered as permeable with a Hydrologic Unit A.

Distribution: n/a

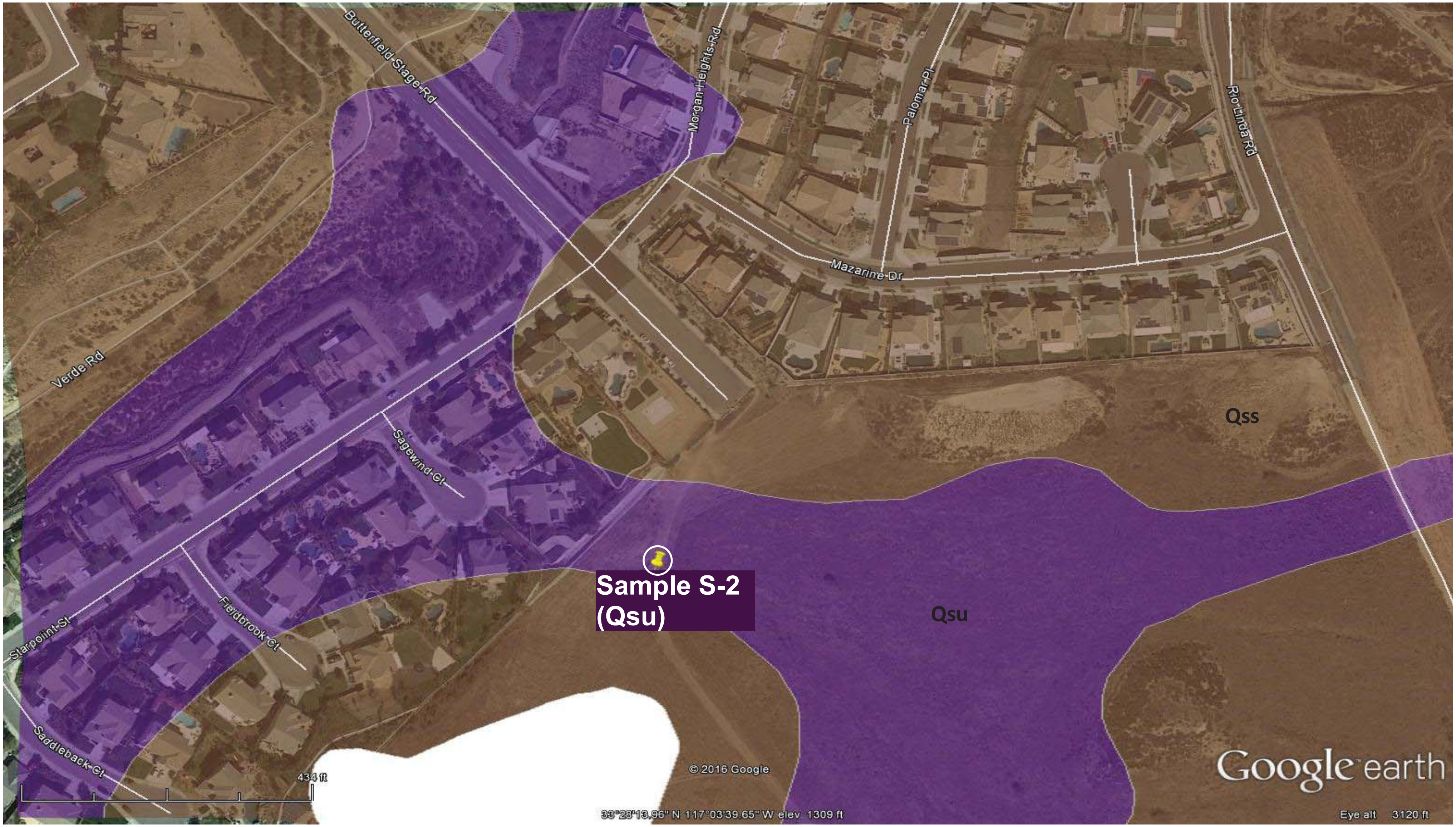
Attachments

1. Site Maps
2. Field Notes
3. Photos
4. Laboratory Test Results

Attachment 1a - Site Maps (Sample S-1)



Attachment 1b - Site Maps (Sample S-2)



Attachment 2 - Field Notes

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 3/8/2017

Field Team: IAN LAU & JAG

Location ID: S-1 (DE PORTOLA RD & BELLE CHAINE LOOP)

GLU Classification: SEE SITE MAP

Photo ID: ~~IGM~~ IMG_4864 (FACE NW)

GPS (Lat/Long): 33°28'50.3", -117°2'1.5"

Geologic Unit: Qw

Surficial Material Type: YELLOWISH BROWN SILTY SAND; LITTLE GRAVELS; SCATTERED COBBLES (<4"); WELL-GRADED (F to C) SAND; SOME LOW PLASTIC to NON-PLASTIC FINES; DRY to SLIGHTLY MOIST.

Existing Vegetative Cover Estimate (Percent): <5%

Existing Sediment Risk (High, Med, Low): MED to HIGH

Potential Sediment Risk (High, Med, Low): MED to HIGH

100% Vegetative Cover Sediment Risk (High, Med, Low): LOW to MED

Notes: RELATIVELY LEVEL GROUND. DEVELOPED RANCH, FARMLAND AREA.

Attachment 2 - Field Notes (cont.)

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 3 / 8 / 2017

Field Team: IAN LAU & JAG

Location ID: S-2 (BUTTERFIELD STAGE RD. OFF ROAD TOWARDS MORGAN HILL TRAIL)

GLU Classification: SEE SITE MAP

Photo ID: IMG_4868 (FACE E). IMG 4866 (FACE SE).

GPS (Lat/Long): 33°28'11.5, -117°3'40.9"

Geologic Unit: QSu

Surficial Material Type: MED YELLOWISH BROWN SILTY SAND; TRACE GRAVEL; FINE TO COARSE SAND; SOME LOW PLASTIC TO NON-PLASTIC FINES; DRY TO SL. MOIST.

Existing Vegetative Cover Estimate (Percent): 5% ALONG WALK PATH. 100% OUTSIDE OF TRAIL (GRASS)

Existing Sediment Risk (High, Med, Low): MED TO HIGH

Potential Sediment Risk (High, Med, Low): MED TO HIGH

100% Vegetative Cover Sediment Risk (High, Med, Low): LOW TO MED

Notes: RELATIVE FLAT AREA, LOCATED BEHIND RESIDUAL AREA (END OF BUTTERFIELD STAGE RD, OFF ROAD DIRT PATH TOWARDS MORGAN HILL TRAILS).

Attachment 3a - Photos During Site Visit (Sample Location S-1 Face NW)

Attachment 3b - Photos During Site Visit (Sample Location S-2 Face SE)

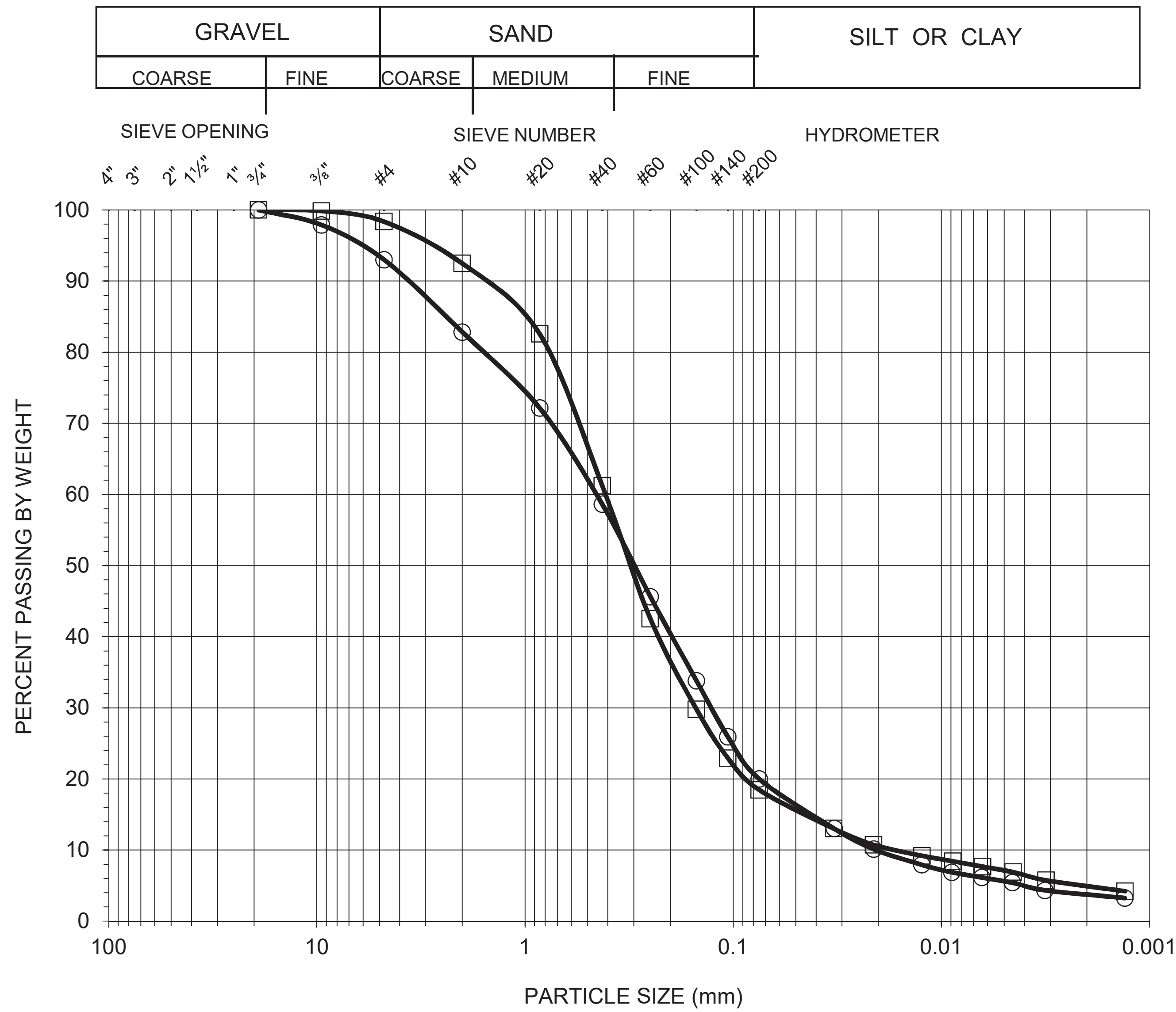
Attachment 3c - Photos During Site Visit (Sample Location S-2 Face E)

Attachment 3d - Photos During Site Visit (Sample Location S-2 Face SW)

AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

GRAIN SIZE DISTRIBUTION CURVE
ASTM D 422

Client Name:	Parsons Brinckerhoff	Tested by:	NG	Date:	03/16/17
Project Name:	SMR WMAA	Computed by:	JP	Date:	03/16/17
Project Number:	12853	Checked by:	AP	Date:	03/16/17



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Type U.S.C.S
				Gravel	Sand	Silt & Clay		
○	-	S-1	0	7	73	20	N/A	SM
□	-	S-2	0	2	80	18	N/A	SM

APPENDIX

D

MAP UNITS AND GEOLOGY GROUPING

Table D.1 Geologic Grouping for Different Map Units

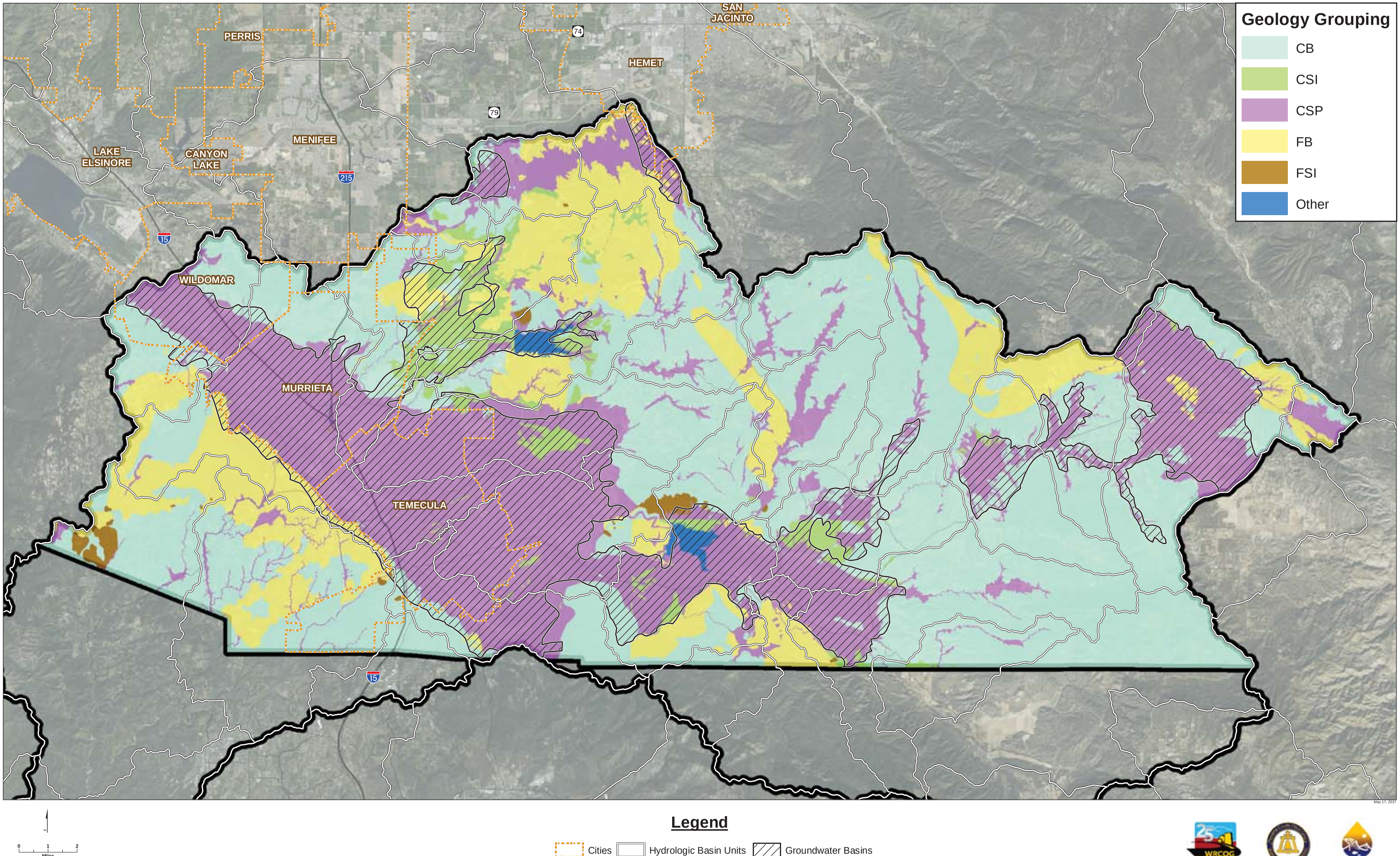
Map Unit	Map Name	Anticipated Grain Size of Weathered Material	Bedrock or Sedimentary	Impermeable/Permeable	Geology Grouping
gr	santa_ana_30x60_reference.pdf	Coarse	Bedrock	Impermeable	CB
gr-m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
grMz	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Kgd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kt	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ktc	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ktc-w	San Diego & Oceanside 30' x 60	Coarse	Bedrock	Impermeable	CB
af	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Impermeable	CSI
Qvoa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvof	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tt	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qa+ Qya	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qds	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qf	palm_springs_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Qoa	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Qp	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qss	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Qsu	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Qw	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Qya	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qya+ Qoa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyf	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Tss	santa_ana_30x60_reference.pdf	Coarse	Sedimentary	Permeable	CSP
Ttl	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Ttu	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
JTrm	San Diego & Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kat	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgb	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
pKm	palm_springs_30x60_reference.pdf	Fine	Bedrock	Impermeable	FB
Qls	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
sp	santa_ana_30x60_reference.pdf	Fine	Bedrock	Impermeable	FB
Tv	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
water	San Diego & Oceanside 30' x 60'	Water	Water	Impermeable	Other

APPENDIX

E

REGIONAL GEOLOGIC GROUPING

UPPER SANTA MARGARITA WATERSHED MANAGEMENT AREA ANALYSIS
GEOLOGY GROUPING

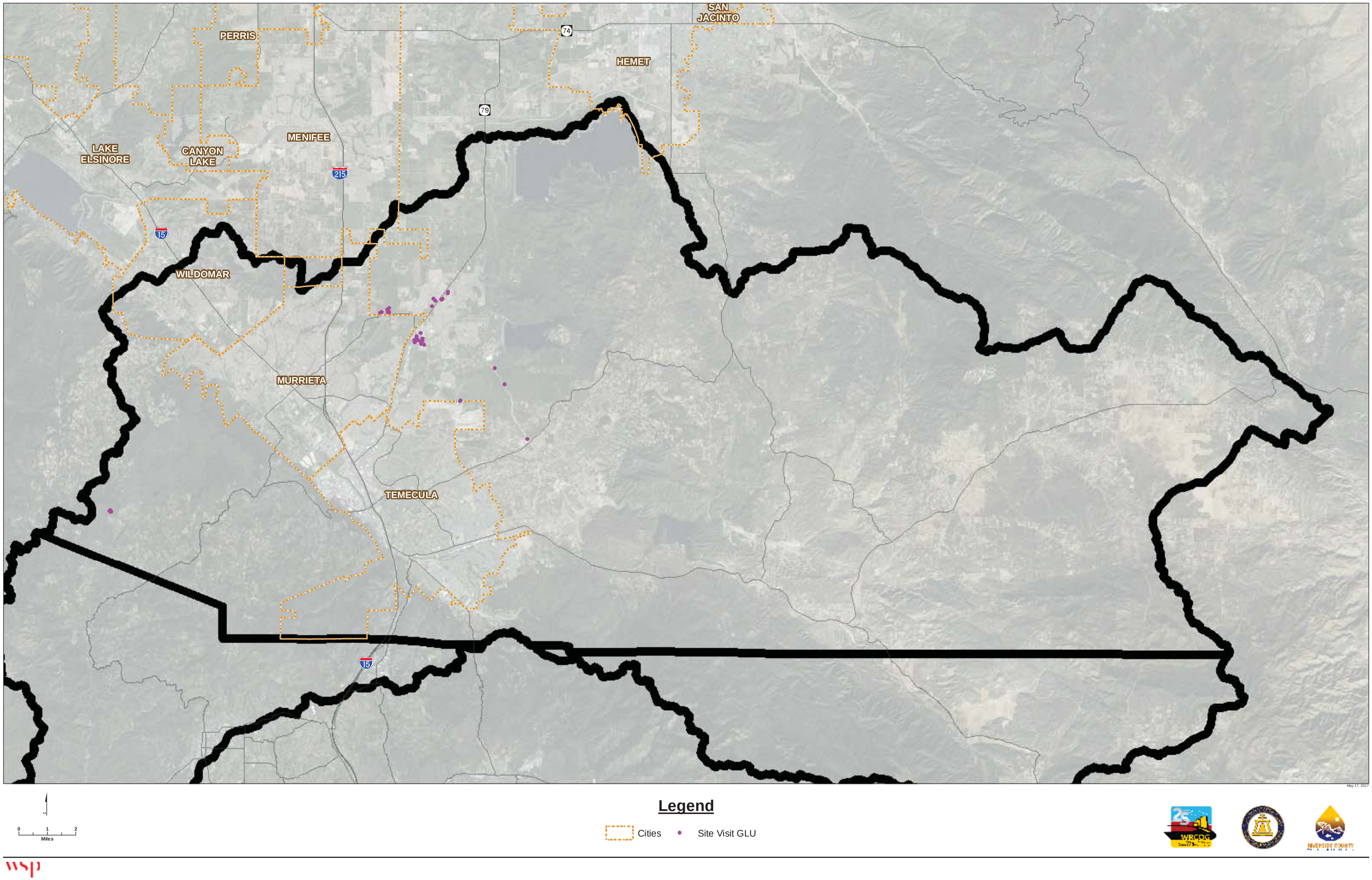


wsp

APPENDIX

F SITE ASSESSMENT

UPPER SANTA MARGARITA WATERSHED MANAGEMENT AREA ANALYSIS
GLU - Site Visit Locations



wsp

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 1

GLU Classification: FSI-DEVELOPED-1

Photo ID: 1 looking SE; 2 looking SE

GPS (Lat/Long):

33.49632207 -117.3111578

Geologic Unit: Qls

Surficial Material Type: Asphalt covered cul-de-sac bounded with dark brown silty SAND colluvium, covered with cobbles/boulders and shallow vegetation.

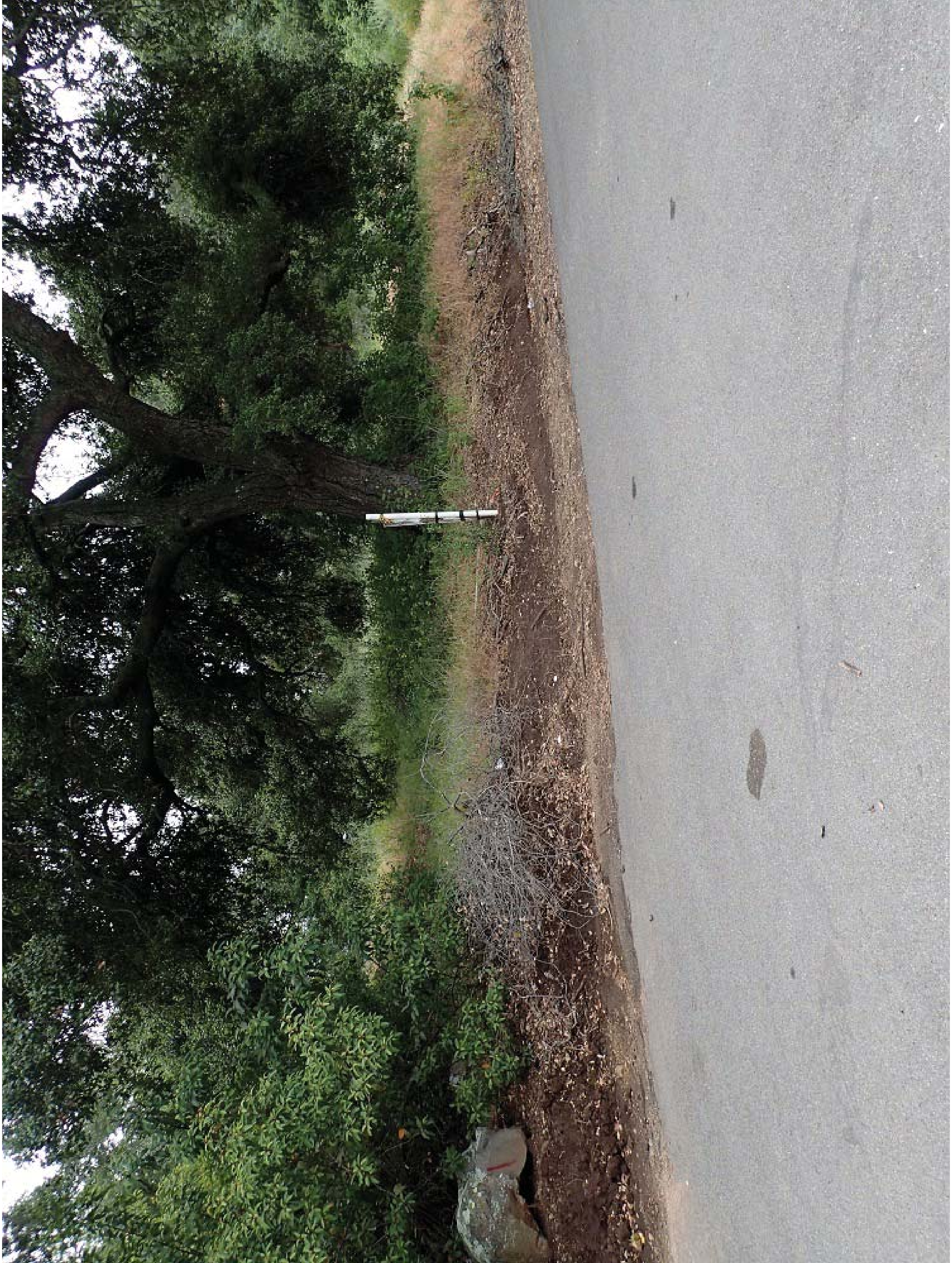
Existing Vegetative Cover Estimate (Percent): 20%

Existing Sediment Risk (High, Med, Low): Low to Med

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:



Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 2

GLU Classification: FSI-FOREST-3

Photo ID: 1 looking NE; 2 looking SE

GPS (Lat/Long):

33.49680079 -117.3105827

Geologic Unit: gr

Surficial Material Type: Granitic boulders covered with old tree branches and brushes

Existing Vegetative Cover Estimate (Percent): 75-80%

Existing Sediment Risk (High, Med, Low): Med (steepness)

Potential Sediment Risk (High, Med, Low): Low to Med

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 3

GLU Classification: CB-SCRUB/SHRUB-3

Photo ID: 1 looking NE; 2 looking NW

GPS (Lat/Long):

33.49618209 -117.3100543

Geologic Unit: gr

Surficial Material Type: Light yellowish brown colluvium / Qls debris with granite boulders 4 to 5 feet in size. Flat area with little vegetation cover.

Existing Vegetative Cover Estimate (Percent): <10%

Existing Sediment Risk (High, Med, Low): Med

Potential Sediment Risk (High, Med, Low): Med to High

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 4

GLU Classification: FSI-Scrub/Shrub-3

Photo ID: 1 looking NE; 2 looking NW

GPS (Lat/Long):

33.49616612 -117.3104793

Geologic Unit: Qls

Surficial Material Type: Light yellowish brown colluvium / Qls debris with granite boulders 4 to 5 feet in size. Flat area with little vegetation cover.

Existing Vegetative Cover Estimate (Percent): <10%

Existing Sediment Risk (High, Med, Low): Med

Potential Sediment Risk (High, Med, Low): Med to High

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 18

GLU Classification: CSI-OTHER-1

Photo ID: 1 looking S; 2 looking SW

GPS (Lat/Long):

33.58540235 -117.1255313

Geologic Unit: Qvoa Alluvium, possible shallow granite

Surficial Material Type: large boulders 20 feet south. Large group of trees south west. Brown silty SAND, fine to medium grained, covered by grass.

Existing Vegetative Cover Estimate (Percent): 10 to 15%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 19

GLU Classification: CB-OTHER-1

Photo ID: 1 looking SW; 2 looking N

GPS (Lat/Long):

33.58507168 -117.1264493

Geologic Unit: Alluvium

Surficial Material Type: large boulders/granite 200 feet West. Actual site on brown silty SAND, very moist, fine to medium grained, covered by shallow brushes (some dry, some green). Depression 20 feet North, possible creek. Slope 1% South to North

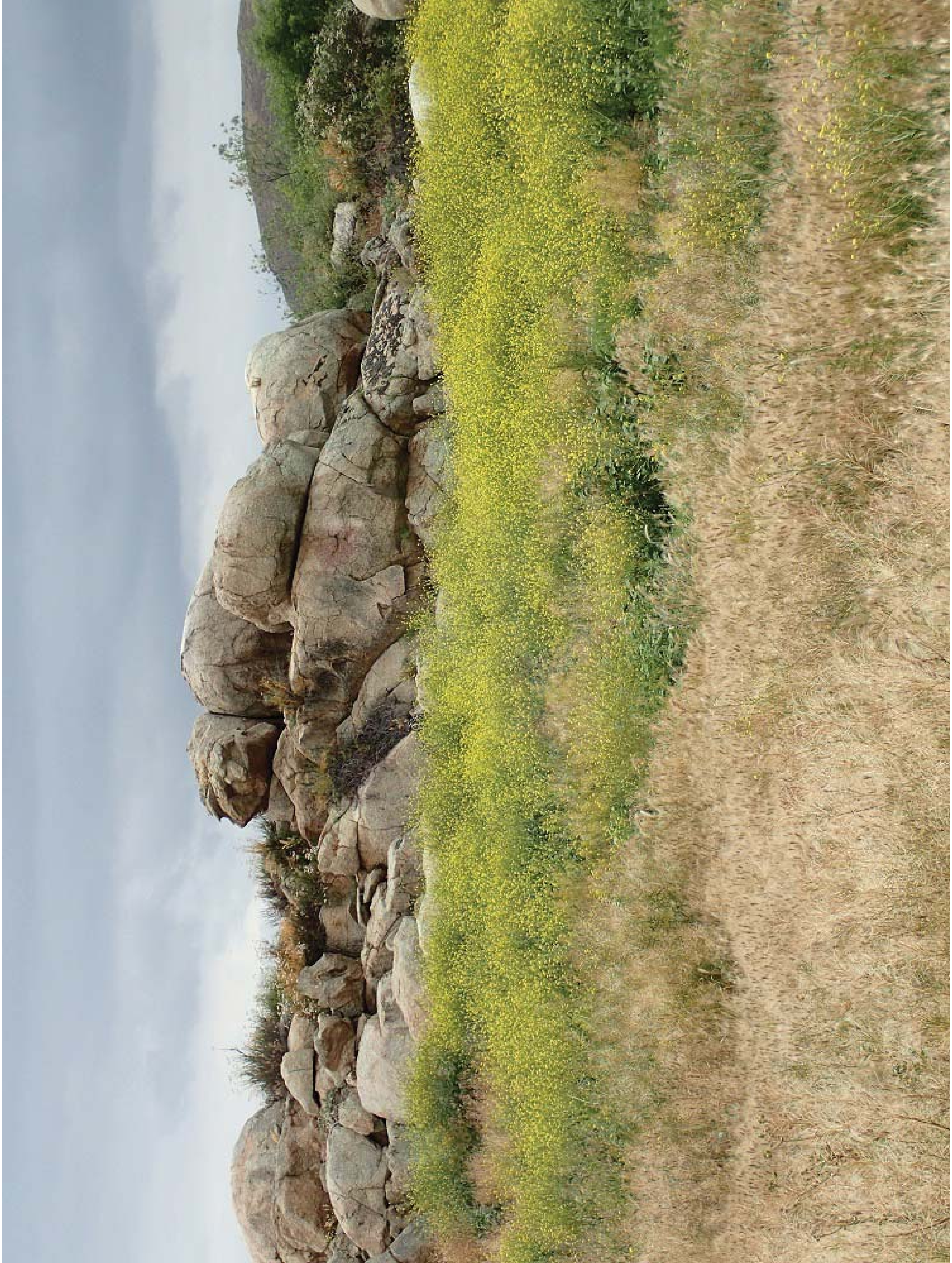
Existing Vegetative Cover Estimate (Percent): 10%. 25% in creek

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes: Large Trees 100 feet NorthWest



Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: ___5/9/2017______________________________

Field Team: ____Jag Jagannath & Dario Leekam _____________

Location ID: ____20_____________________________________

GLU Classification: CSI-OTHER-WATER-1_________________________________

Photo ID: ____

GPS (Lat/Long):

33.58430838 -117.122567
____

Geologic Unit: ____Qvoa____(filled with at least 5 feet of water)______________________________

Surficial Material Type: ___Water filled area with lots of vegetation growth. Banks are well covered with brown vegetation and trees____
____

Existing Vegetative Cover Estimate (Percent): _____None but with water___________________________

Existing Sediment Risk (High, Med, Low): ____Low____

Potential Sediment Risk (High, Med, Low): ____Low____

100% Vegetative Cover Sediment Risk (High, Med, Low): ____Low_________________________________

Notes: ____

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 21

GLU Classification: CSI-DEVELOPED-1

Photo ID: 1 looking SW

GPS (Lat/Long):

33.58307841 -117.1221918

Geologic Unit: Asphalt

Surficial Material Type: Pavement. Parking Lot

Existing Vegetative Cover Estimate (Percent): None

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 22

GLU Classification: CB-DEVELOPED-1

Photo ID: 1 looking SW

GPS (Lat/Long):

33.58279133 -117.1203132

Geologic Unit: Qvoa (Asphalt / Parking Lot)

Surficial Material Type: Pavement

Existing Vegetative Cover Estimate (Percent): None

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 23

GLU Classification: CB-FOREST-1

Photo ID: 1 looking NE; 2 looking E

GPS (Lat/Long):

33.599266 -117.1418295

Geologic Unit: Alluvium or fill

Surficial Material Type: light brown silty SAND, moist, fine to coarse grained. Lots of brushes, trees and branches. Located in divet/depression

Existing Vegetative Cover Estimate (Percent): 50%

Existing Sediment Risk (High, Med, Low): Med to High

Potential Sediment Risk (High, Med, Low): High

100% Vegetative Cover Sediment Risk (High, Med, Low): Med to High

Notes: Line of trees on a dried up creek

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: ____5/10/2017____________________________

Field Team: _____Paulina Chilingar & Dario Leekam_________

Location ID: ____24_____________________________________

GLU Classification: CSP-FOREST-1________________________________

Photo ID: ___1 looking NW_______________________________________

GPS (Lat/Long):

33.5992614 -117.1420466

____

Geologic Unit: _qyf____

Surficial Material Type: ___light bron silty SAND, fine to medium grained, covered with shallow brushes and tree branches. Boulders in the south west direction. 1-2% slope west to east. 2% slope south to north____

Existing Vegetative Cover Estimate (Percent): ____20-30%____________________________________

Existing Sediment Risk (High, Med, Low): ___Low_______________________________________

Potential Sediment Risk (High, Med, Low): ___Low-Med___________________________________

100% Vegetative Cover Sediment Risk (High, Med, Low): ___Low__________________________________

Notes: __Line of trees 40 feet East; located in divet/depression_________________________________

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 25

GLU Classification: CSP-SCRUB/SHRUB-1

Photo ID: 1 looking SE

GPS (Lat/Long):

33.59916853 -117.1422226

Geologic Unit: Qyf

Surficial Material Type: light brown silty SAND, fine to medium grained, covered with shallow brushes and tree branches. Boulders in the south east direction. 1-2% slope west to east, 2% slope south to north.

Existing Vegetative Cover Estimate (Percent): 5%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low-Med

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 26

GLU Classification: CSP-AGRICULTURAL/GRASS-1

Photo ID: 1 looking NE, 2 looking NW

GPS (Lat/Long):

33.59935027 -117.1422154

Geologic Unit: qyf

Surficial Material Type: light brown Silty SAND with gravel, fine to medium grained, covered with shallow brushes, creed 150 feet east. Construction site 250 feet north. 1-2% slope west to east.

Existing Vegetative Cover Estimate (Percent): 5-10%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low-Med

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 27

GLU Classification: CB-AGRICULTURAL/GRASS-1

Photo ID: 1 looking West, 2 looking S

GPS (Lat/Long):

33.5992189 -117.1426501

Geologic Unit: Alluvium and/or fill

Surficial Material Type: light brown silty SAND with some gravel, fine to medium grained, covered with shallow brushes and branches. 1-2% slope from west to east.

Existing Vegetative Cover Estimate (Percent): 10%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low-Med

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes: Construction site 500 feet north

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 28

GLU Classification: CB-SCRUB/SHRUB-1

Photo ID: 1 looking SE

GPS (Lat/Long):

33.59917183 -117.1424015

Geologic Unit: Alluvium or Fill

Surficial Material Type: light brown silty SAND, covered with shallow brushes and weeds. 1-2% slope from west to east. 5% slope from south to north.

Existing Vegetative Cover Estimate (Percent): 15-20%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low to Med

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes: 100 feet away from Los Alamos Road.

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 29

GLU Classification: CSI-OTHER-1

Photo ID: 1 looking W; 2 looking NW

GPS (Lat/Long):

33.60241017 -117.1159333

Geologic Unit: Qvoa

Surficial Material Type: light brown silty SAND, covered with short to medium brushes. Line of trees 50 feet west. 3% slope east to west.

Existing Vegetative Cover Estimate (Percent): 5%, 20% in line of trees

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 30

GLU Classification: FB-DEVELOPED-1

Photo ID: 1 looking SE; 2 looking SE (close up)

GPS (Lat/Long):

33.60507867 -117.1137576

Geologic Unit: Qya

Surficial Material Type: Actual location on pavement. Depression about 20 feet south east. Brown silty SAND, covered by tall brushes

Existing Vegetative Cover Estimate (Percent): None

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes: Actual site on pavement

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 31

GLU Classification: CSP-DEVELOPED-1

Photo ID: 1 looking W

GPS (Lat/Long):

33.60632224 -117.1150386

Geologic Unit: pKm

Surficial Material Type: Residential area

Existing Vegetative Cover Estimate (Percent): None

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes: ***Site may not be accessible.***


STOP

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 32

GLU Classification: CSI-FOREST-1

Photo ID: 1 looking SE; 2 looking S

GPS (Lat/Long):

33.60587748 -117.1101113

Geologic Unit: Qvoa

Surficial Material Type: light brown silty SAND, wet, fine to medium grained, covered by medium brushes and tall grass

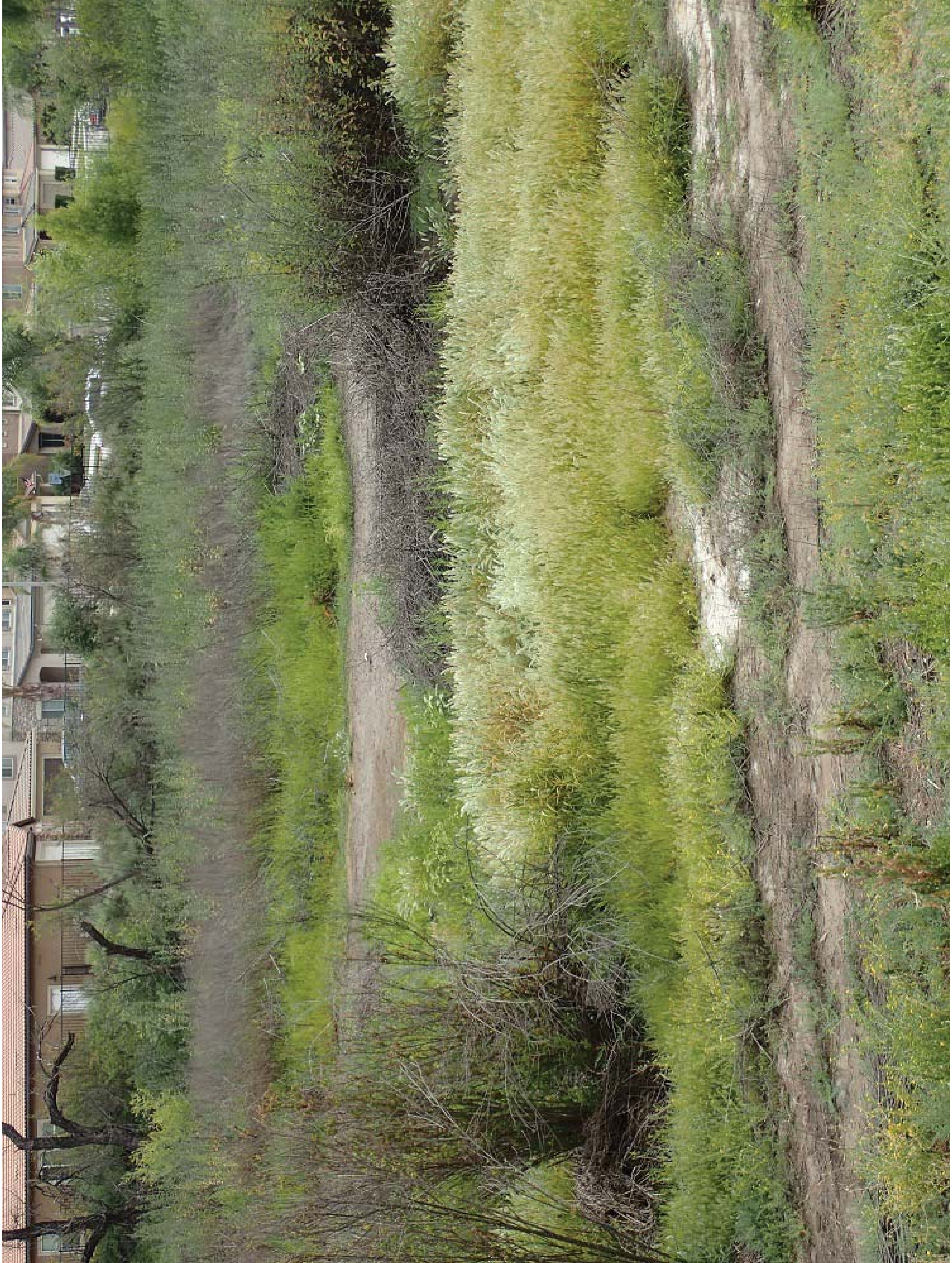
Existing Vegetative Cover Estimate (Percent): 80% by the grass, 10% by the trees

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:



Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 33

GLU Classification: CSP-OTHER-1

Photo ID: 1 looking S (by the tall trees)

GPS (Lat/Long):

33.60594675 -117.109581

Geologic Unit: Qya

Surficial Material Type: light brown wet silty SAND, fine to medium grained, covered by brushes and trees

Existing Vegetative Cover Estimate (Percent): 50-75%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 34

GLU Classification: CSI-OTHER-1

Photo ID: 1 looking SE; 2 looking E

GPS (Lat/Long):

33.60630641 -117.1093173

Geologic Unit: Qvoa

Surficial Material Type: light brown & brown silty SAND, wet, fine to medium grained, covered with short to tall brushes.

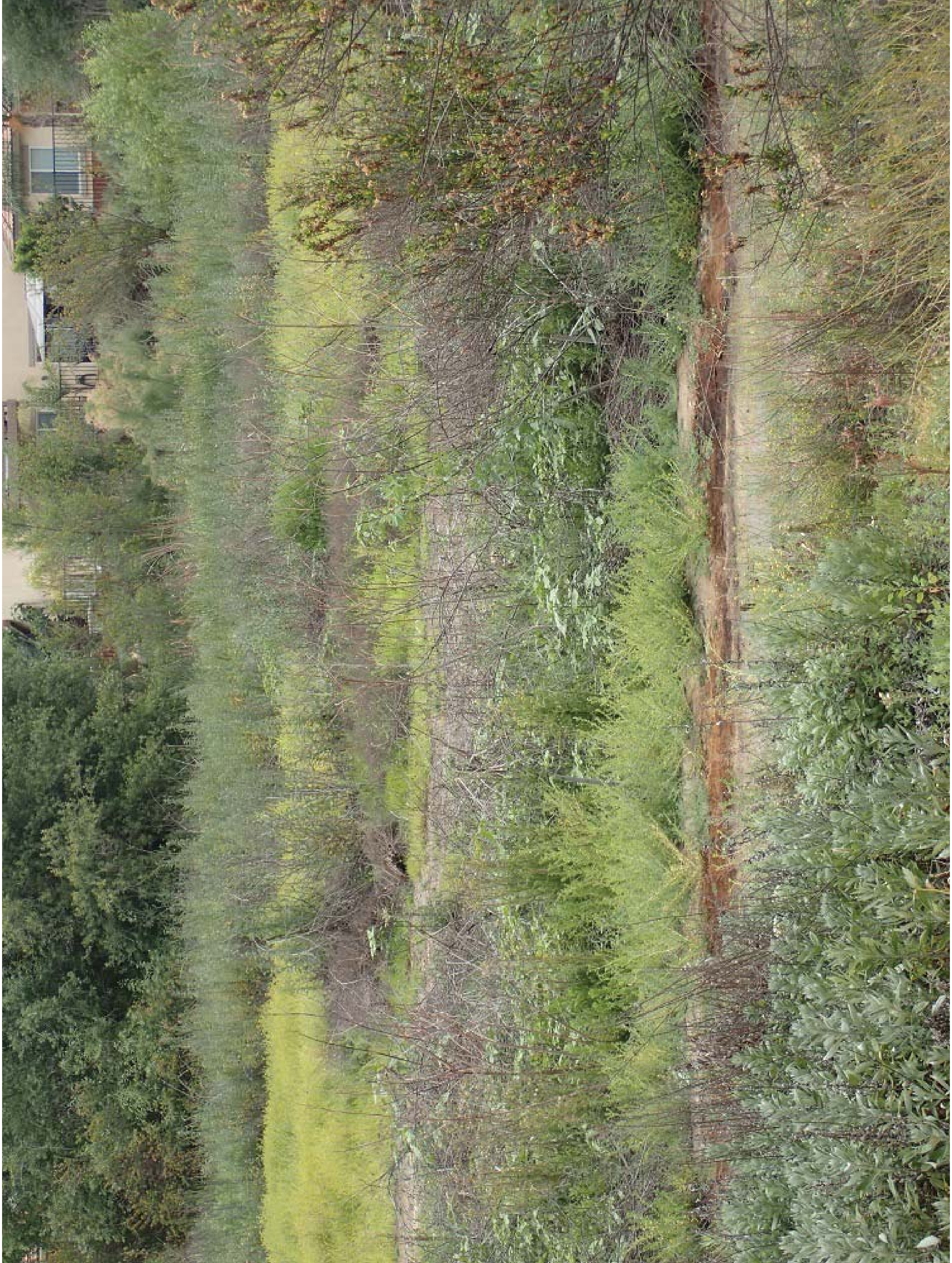
Existing Vegetative Cover Estimate (Percent): 10%, 20% by the yellow brushes

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:



Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 43

GLU Classification: CSI-Agricultural/Grass-1

Photo ID: 1 looking S; 2 looking SE

GPS (Lat/Long):

33.58700097 -117.1251153

Geologic Unit: Qvoa

Surficial Material Type: light brown silty SAND with fine gravel, Site is located on a mild depression, 3% slope from east to west and west to east

Existing Vegetative Cover Estimate (Percent): 5-10%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 44

GLU Classification: CSI-Agricultural/Grass-1

Photo ID: 1 looking E

GPS (Lat/Long):

33.58866329 -117.1226646

Geologic Unit: Qvoa

Surficial Material Type: light brown silty SAND with gravel, covered by shallow brushes.

Existing Vegetative Cover Estimate (Percent): 5-10%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: ______5/10/2017____________________

Field Team: ___Paulina Chilingar & Dario Leekam ______

Location ID: ____45________________________________

GLU Classification: ______CB-Scrub/Shrub-1___________________________

Photo ID: ___1 looking SE; 2 looking SE (close up)________________________

GPS (Lat/Long):

33.58492738 -117.1246554

____

Geologic Unit: ___Alluvium___________________________________

Surficial Material Type: ___light brown silty SAND, wet, fine to medium grained. Site Populated by tall brushes and trees. 3% slope from to north west to south west.________________________________

____

Existing Vegetative Cover Estimate (Percent): _____50-75%____________________________________

Existing Sediment Risk (High, Med, Low): _____Low_____________________________________

Potential Sediment Risk (High, Med, Low): _____Low_____________________________________

100% Vegetative Cover Sediment Risk (High, Med, Low): ___Low________________________________

Notes: ____

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 46

GLU Classification: CSI-Agricultural/Grass-1

Photo ID: 1 looking E; 2 looking SE

GPS (Lat/Long):

33.58406325 -117.1262236

Geologic Unit: Qvoa

Surficial Material Type: brown silty SAND, fine to medium grained, covered by shallow brushes. 1-2% slope from east to west.

Existing Vegetative Cover Estimate (Percent): <5%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 47

GLU Classification: CB-Agricultural/Grass-1

Photo ID: 1 looking N, 2 looking NW

GPS (Lat/Long):

33.58456966 -117.1262663

Geologic Unit: Qvoa

Surficial Material Type: brown silty SAND, fine to medium grained, covered by shallow brushes. 5-10% slope south to north.

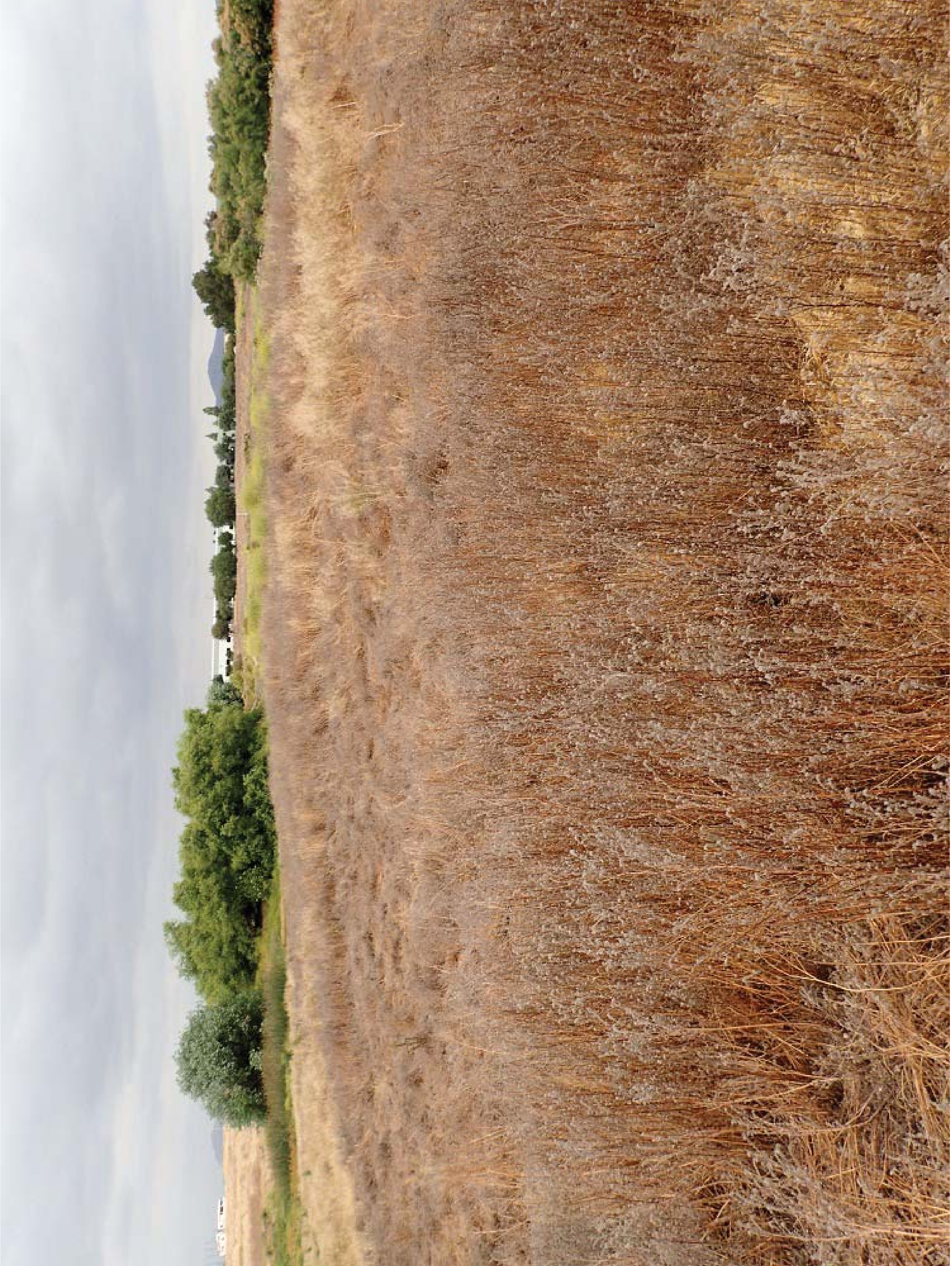
Existing Vegetative Cover Estimate (Percent): <5%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low to Med

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:



Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 48

GLU Classification: CSI-Forest-1

Photo ID: 1 looking E, 2 looking SE (inside large tree area)

GPS (Lat/Long):

33.58531294 -117.124538

Geologic Unit: Qvoa

Surficial Material Type: Actual site highly populated by trees and brushes. Site soil likely wet. 3% slope from north west to south east.

Existing Vegetative Cover Estimate (Percent): 50-75%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 49

GLU Classification: CB-Agricultural/Grass-1

Photo ID: ____________________

GPS (Lat/Long):

33.58439784 -117.1215382

Geologic Unit: Alluvial or fill deposits

Surficial Material Type: Medium to fine grained brown silty SAND, <3% ground slope, <10% covered with brushes

Existing Vegetative Cover Estimate (Percent): <10%

Existing Sediment Risk (High, Med, Low): Med to High

Potential Sediment Risk (High, Med, Low): Med to High

100% Vegetative Cover Sediment Risk (High, Med, Low): Low to Med

Notes: Row of granitic boulders to the right of the site (10 to 15 feet wide, 8 to 12 feet tall). Perhaps this is the reason why the site was previously incorrectly classified as granitic.

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 50

GLU Classification: CB-Scrub/Shrub-1

Photo ID:

GPS (Lat/Long):

33.58475897 -117.121478

Geologic Unit: Alluvial or fill deposits

Surficial Material Type: Medium to fine grained brown silty SAND, <3% ground slope, <10% covered with brushes

Existing Vegetative Cover Estimate (Percent): <10%

Existing Sediment Risk (High, Med, Low): Med to High

Potential Sediment Risk (High, Med, Low): Med to High

100% Vegetative Cover Sediment Risk (High, Med, Low): Low to Med

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: ___5/9/2017________________________________

Field Team: ____Jag Jagannath & Dario Leekam ____________

Location ID: ____51_______________________________

GLU Classification: __CB-Agricultural/Grass-1________________________________

Photo ID: ____

GPS (Lat/Long):

33.58583659 -117.121325
____

Geologic Unit: _____Qvoa or fill_________________________________

Surficial Material Type: ______fill or alluvium. 5 to 8% gradient toward West. Light brown Silty SAND fine to medium grained.____
____

Existing Vegetative Cover Estimate (Percent): ___80%____

Existing Sediment Risk (High, Med, Low): ____Low____

Potential Sediment Risk (High, Med, Low): ____Low____

100% Vegetative Cover Sediment Risk (High, Med, Low): ____Low__________________________________

Notes: ____

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 52

GLU Classification: CSI-Agricultural/Grass-1

Photo ID:

GPS (Lat/Long):

33.58575539 -117.1216484

Geologic Unit: Qvoa (1 foot of water)

Surficial Material Type: 1 ft of water. Ground covered with brushes.

Existing Vegetative Cover Estimate (Percent): <5%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: ____5/10/2017_________________________

Field Team: ____Paulina Chilingar & Dario Leekam ____

Location ID: ____53_______________________________

GLU Classification: _CB-Scrub/Shrub-1_______________________________

Photo ID: __1 looking SE, 2 looking SW___________________________

GPS (Lat/Long):

33.5998075 -117.1427446

____

Geologic Unit: _____Alluvium or fill_____________________________________

Surficial Material Type: __light brown silty SAND with gravel and some cobbles. Large boulders 300 feet west of site (possibly why site was incorrectly characterized as granitic). 10% slope north to south____

Existing Vegetative Cover Estimate (Percent): _____5%_______________________________________

Existing Sediment Risk (High, Med, Low): ______Low_____________________________________

Potential Sediment Risk (High, Med, Low): ____Low to Med________________________________

100% Vegetative Cover Sediment Risk (High, Med, Low): ____Low________________________________

Notes: ___Bordering construction site (to the north)____

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: ____5/10/2017______________________________

Field Team: ____Paulina Chilingar & Dario Leekam ___

Location ID: ____54_______________________________________

GLU Classification: CB-AGRICULTURAL/GRASS-1___________________________________

Photo ID: ____

GPS (Lat/Long):

33.60059087 -117.1431417

____

Geologic Unit: ______________gr__________________

Surficial Material Type: _Within construction site____

Existing Vegetative Cover Estimate (Percent): ____None____

Existing Sediment Risk (High, Med, Low): ______Low_______________________________________

Potential Sediment Risk (High, Med, Low): ______Low_______________________________________

100% Vegetative Cover Sediment Risk (High, Med, Low): ___Low_________________________________

Notes: ____

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 55

GLU Classification: FB-SCRUB/SHRUB-3

Photo ID:

GPS (Lat/Long):

33.60128715 -117.1418556

Geologic Unit: pKm

Surficial Material Type: Within construction site

Existing Vegetative Cover Estimate (Percent): None

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 58

GLU Classification: CB-SCRUB/SHRUB-1

Photo ID: 1 looking NW; 2 looking N

GPS (Lat/Long):

33.59920428 -117.1464568

Geologic Unit: Alluvium

Surficial Material Type: light brown silty SAND with gravel and cobbles, fine to medium grained. Boulders in the north and east direction (perhaps why site was incorrectly characterized as granitic). Creek down slope 50-70 feet away. 30% slope south to north.

Existing Vegetative Cover Estimate (Percent): 10% top of slope, 50% down slope near creek.

Existing Sediment Risk (High, Med, Low): High

Potential Sediment Risk (High, Med, Low): High

100% Vegetative Cover Sediment Risk (High, Med, Low): High

Notes: Construction site 200-300 feet south, on Clinton Keith Road.

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 59

GLU Classification: CB-SCRUB/SHRUB-1

Photo ID: 1 looking NE; 2 looking W, 3 looking S

GPS (Lat/Long):

33.598792333 -117.147565

Geologic Unit: gr

Surficial Material Type: light brown silty SAND, fine to medium grained, on top of granite, large boulders in all directions. Site covered in shallow to medium brushes. Slope 5-10% from west to east. 40% slope from south to north

Existing Vegetative Cover Estimate (Percent): 5%

Existing Sediment Risk (High, Med, Low): Low to Med

Potential Sediment Risk (High, Med, Low): Med

100% Vegetative Cover Sediment Risk (High, Med, Low): Med to High

Notes: 100 to 200 feet south and east from construction site

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 64

GLU Classification: CSP-SCRUB/SHRUB-3

Photo ID: 1 looking N; 2 looking N (close up view)

GPS (Lat/Long):

33.55416725 -117.0982825

Geologic Unit: Qss

Surficial Material Type: 2 to 3% slopes easterly. Covered by 2 to 3 feet tall grassy brushes. Light brown silty SANDSTONE, med to fine grained, potential erosional gullies visible in access road to site where no ground cover exist.

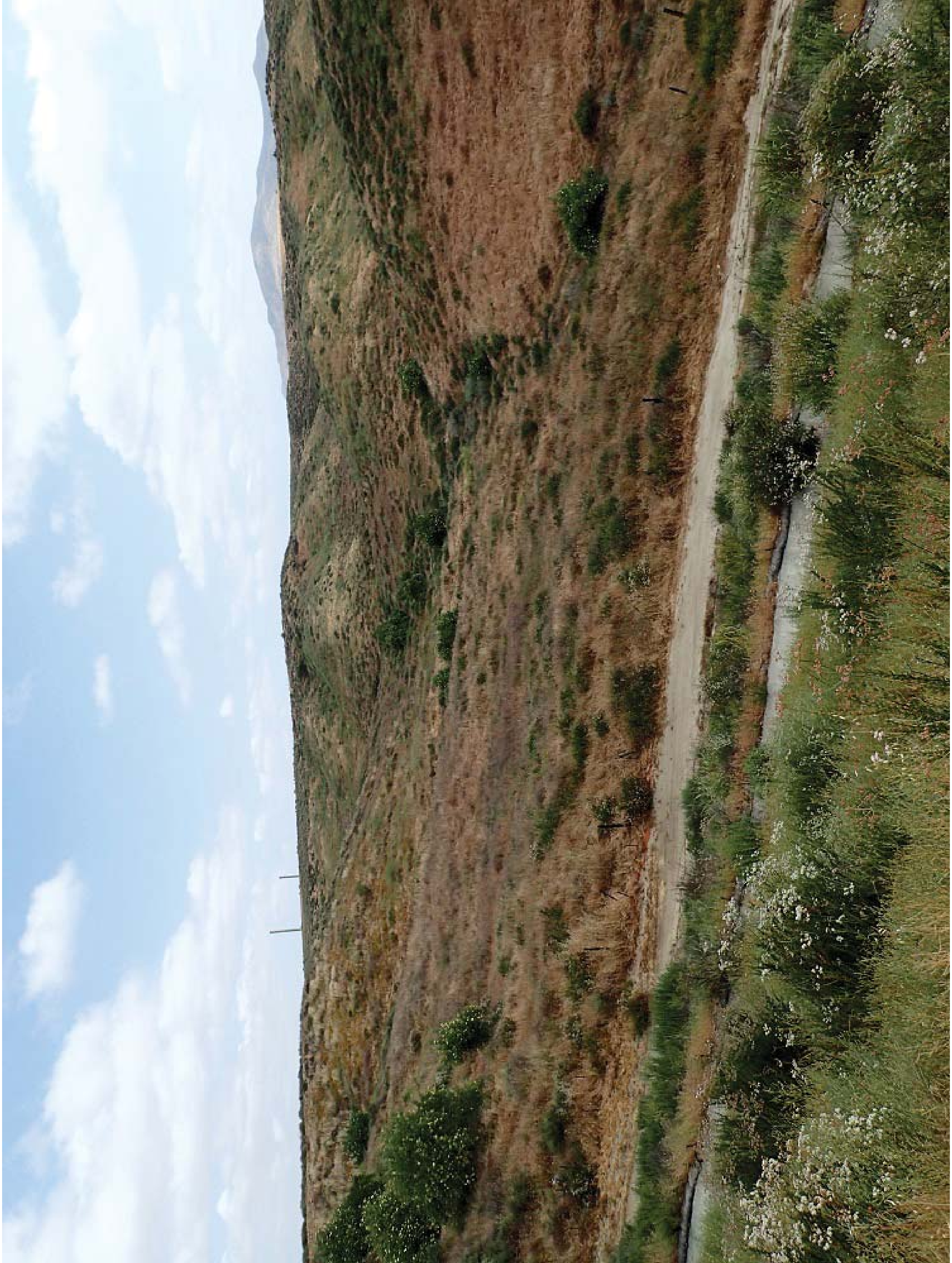
Existing Vegetative Cover Estimate (Percent): 75 to 80%

Existing Sediment Risk (High, Med, Low): Low to Med

Potential Sediment Risk (High, Med, Low): Med to High

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes: ***Site may not be accessible.***



Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 65

GLU Classification: CSP-AGRICULTURAL/GRASS-3

Photo ID: 1 looking N; 2 looking NE

GPS (Lat/Long):

33.55446283 -117.0978426

Geologic Unit: Qss

Surficial Material Type: 3 to 5% westerly slope. Ground covered by 2 to 3 feet tall brushes/grass. Light brown silty SANDSTONE, medium to fine grained.

Existing Vegetative Cover Estimate (Percent): 80%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low to Med (steepness)

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes: ***Site may not be accessible.***

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 66

GLU Classification: FB-AGRICULTURAL/GRASS-1

Photo ID: 1 looking N; 2 looking SW

GPS (Lat/Long):

33.56286659 -117.0713212

Geologic Unit: pKm (unit questionable)

Surficial Material Type: On either side of sandy GRAVEL access road, the ground is covered with 2 to 3 feet tall grassy brown brushes. Light brown silty SANDSTONE, trace gravel, 3 to 5% ground gradient in N-S direction.

Existing Vegetative Cover Estimate (Percent): 80%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low to Med

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes: Low point of N-S drainage crosses sandy Gravel covered access road.


DIP

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 67

GLU Classification: FB-FOREST-1

Photo ID: 1 (looking W); 2 (looking E)

GPS (Lat/Long):

33.57116408 -117.0773157

Geologic Unit: pKm (questionable unit)

Surficial Material Type: up to 5% slope and ground covered with low grass/brushes. Light yellowish brown silty SANDSTONE, trace gravel.

Existing Vegetative Cover Estimate (Percent): 80%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low to Med

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes:


MOORE

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/9/2017

Field Team: Jag Jagannath & Dario Leekam

Location ID: 68

GLU Classification: CSI-AGRICULTURAL/GRASS-1

Photo ID: 1 looking S; 2looking SE (close up view)

GPS (Lat/Long):

33.53498683 -117.0571629

Geologic Unit: Qvoa

Surficial Material Type: Percolation pond with no ground cover. Side slopes have less than 10% vegetable cover. Silty SAND, light yellow brown, fine t o grained.

Existing Vegetative Cover Estimate (Percent): Less than 5%

Existing Sediment Risk (High, Med, Low): Med

Potential Sediment Risk (High, Med, Low): Med

100% Vegetative Cover Sediment Risk (High, Med, Low): Med

Notes:

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 69

GLU Classification: CSP-OTHER-1

Photo ID: 1 looking NE

GPS (Lat/Long):

33.60893715 -117.1062468

Geologic Unit: Qya

Surficial Material Type: light brown silty SAND with gravel and cobbles, very moist.

Existing Vegetative Cover Estimate (Percent): 70-80%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes: Site is located in a natural vegetation habitat that is currently being restored. Picture was taken about 250 feet away from actual site.

Upper Santa Margarita River Watershed
Coarse Sediment Yield Analysis

Date: 5/10/2017

Field Team: Paulina Chilingar & Dario Leekam

Location ID: 70

GLU Classification: CSP-AGRICULTURAL/GRASS-1

Photo ID: 1 looking N (actual site by yellow brush in picture)

GPS (Lat/Long):

33.60977095 -117.1061386

Geologic Unit: Qya

Surficial Material Type: light brown silty SAND with gravel and cobbles, very moist.

Existing Vegetative Cover Estimate (Percent): 70-80%

Existing Sediment Risk (High, Med, Low): Low

Potential Sediment Risk (High, Med, Low): Low

100% Vegetative Cover Sediment Risk (High, Med, Low): Low

Notes: Site is located in a natural vegetation habitat that is currently being restored. Picture was taken about 250 feet away from actual site.

APPENDIX

G

CRITICAL COARSE SEDIMENT YIELD ARCMAP EXHIBIT

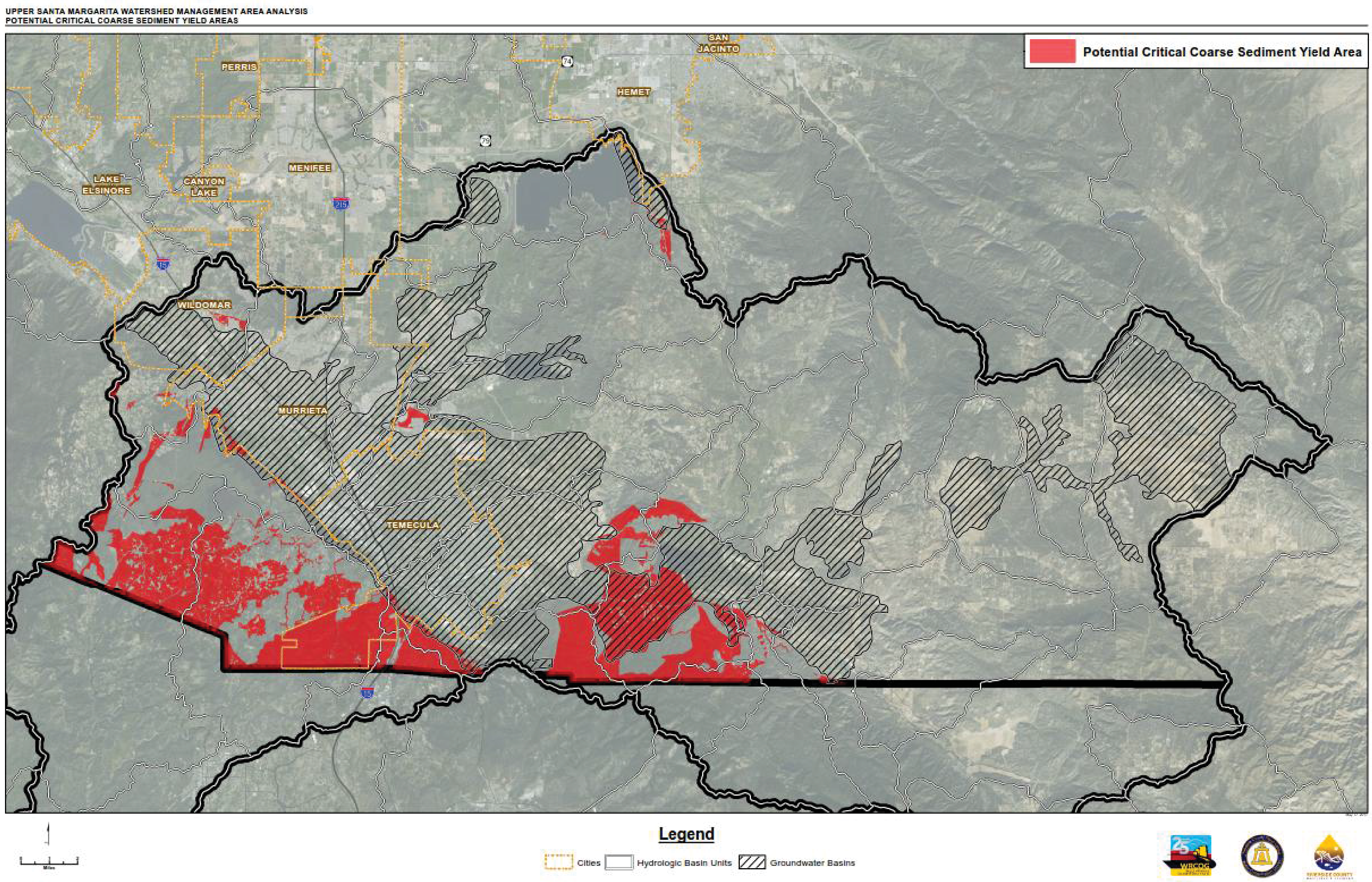
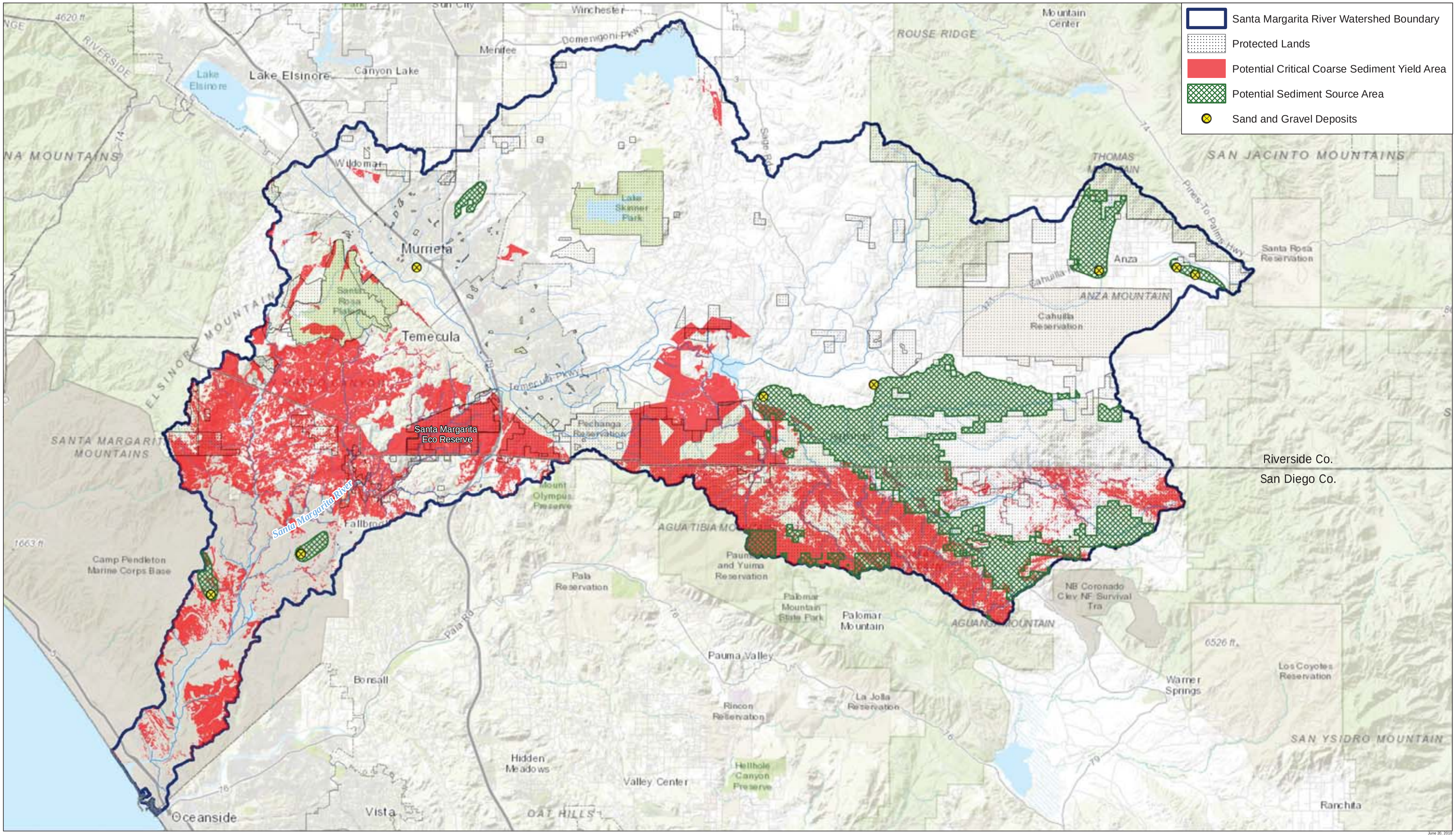


Figure G.1 Potential Critical Coarse Sediment Yield Areas in the upper Santa Margarita River Watershed

APPENDIX

H

POTENTIAL SEDIMENT SOURCE AREA EXHIBIT



SANTA MARGARITA RIVER WATERSHED

POTENTIAL CRITICAL COARSE SEDIMENT YIELD AREAS AND POTENTIAL SEDIMENT SOURCE AREAS

Attachment H. Hydromodification Management Exemptions

Santa Margarita River

Upstream Section

Erosion Potential	1.13

Tributary Area	*A*	sq mi	352		352
Mean Annual Precip	*MAP*	in/yr	16.3		16.3
Length of Daily Flow Record	*Yr*	yr	30		30
Imperviousness	*Impav*	mi^2/mi^2	0.13200		0.1780
Maximum Flow of Record	*Qmax*	cfs	15635.9		15635.9
Minimum Flow of Record	*Qmin*	cfs	0.01		0.01
10-year peak flow	*Q10*	cfs	25114.4		25114.4
Coefficient of DDF	*day1*	days & cfs	13813.87		26061.86
Exponent of DDF	*day2*	days & cfs	-0.70		-0.75
Number of Bins	N_B	--	25		25
Bin Size	$H_{B\text{-}log}$	--	0.594		0.594

Channel Slope	0.0250	ft/ft
Critical Shear	3.042	lb/sq. ft
γ	62.4	lb/ft^3

Bin Number	Lower Bound of Bin Number	Upper Bound of Bin Number	Flow	Hydraulic Radius	Flow Velocity	Shear Stress	Work	Duration	Cumulative Work	Duration	Cumulative Work
B	$B_{lwr\text{-}log}$	$B_{upr\text{-}log}$	*Q*	*R*	*v*	τ	*W*	*days*	*W*days*	*days*	*W*days*
--	cfs	cfs	cfs	ft	ft/s	psf	--	days	--	days	--
1	0	25	12.50	0.34	3.30	0.530	0.000	2357.4	0.00	3875.8	0.00
2	25	50	37.50	0.52	4.34	0.811	0.000	1092.5	0.00	1691.9	0.00
3	50	100	75.00	0.67	5.16	1.045	0.000	672.5	0.00	1002.8	0.00
4	100	500	300.00	1.13	7.30	1.763	0.000	254.8	0.00	352.3	0.00
5	500	1000	750.00	1.60	9.17	2.496	0.000	134.2	0.00	176.5	0.00
6	1000	1500	1250.00	1.95	10.49	3.042	0.000	93.8	0.00	120.0	0.00
7	1500	2000	1750.00	2.28	11.64	3.557	4.299	74.1	318.76	93.1	400.38
8	2000	2500	2250.00	2.56	12.56	3.994	11.659	62.2	724.98	77.0	898.21
9	2500	3000	2750.00	2.82	13.41	4.399	21.203	54.0	1145.61	66.2	1403.93
10	3000	4000	3500.00	3.19	14.55	4.976	39.146	45.6	1786.52	55.2	2160.77
11	4000	5000	4500.00	3.61	15.81	5.632	65.884	38.3	2521.74	45.7	3008.53
12	5000	6000	5500.00	3.99	16.88	6.224	95.831	33.3	3187.24	39.2	3761.16
13	6000	8000	7000.00	4.48	18.24	6.989	143.019	28.1	4017.76	32.7	4679.34
14	8000	10000	9000.00	5.04	19.73	7.862	208.810	23.6	4919.69	27.1	5651.86
15	10000	12000	11000.00	5.53	20.99	8.627	277.028	20.5	5671.55	23.3	6444.76
16	12000	14000	13000.00	5.97	22.08	9.313	346.757	18.2	6315.60	20.5	7111.59
17	14000	16000	15000.00	6.36	23.05	9.922	415.926	16.5	6853.29	18.4	7657.12
18	16000	18000	17000.00	6.73	23.92	10.499	487.068	15.1	7352.26	16.8	8158.79
19	18000	20000	19000.00	7.07	24.72	11.029	558.008	14.0	7792.12	15.4	8594.67
20	20000	22900	21450.00	7.45	25.61	11.622	643.636	12.8	8256.24	14.1	9046.61
									60863.36		68977.72
									1.000		1.133

StreamStats Report

Region ID:

CA

Workspace ID:

CA20170507223540559000

Clicked Point (Latitude, Longitude):

33.23810, -117.39224

Time:

2017-05-07 21:36:38 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	738.5	square miles
PRECIP	Mean Annual Precipitation	16.3	inches

Peak-Flow Statistics Parameters [100 Percent (738 square miles) 2012 5113 Region 5 South Coast]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	738.5	square miles	0.04	850
PRECIP	Mean Annual Precipitation	16.3	inches	10	45

Peak-Flow Statistics Flow Report [100 Percent (738 square miles) 2012 5113 Region 5 South Coast]

Statistic	Value	Unit	Average standard error of prediction	Lower Prediction Interval	Upper Prediction Interval
2 Year Peak Flood	2490	ft^3/s	134.2	446	13900
5 Year Peak Flood	11200	ft^3/s	83.1	3270	38100
10 Year Peak Flood	22900	ft^3/s	64	8420	62300
25 Year Peak Flood	45700	ft^3/s	51.5	19800	106000
50 Year Peak Flood	69900	ft^3/s	47.6	32000	152000
100 Year Peak Flood	99800	ft^3/s	47.2	45500	219000
200 Year Peak Flood	138000	ft^3/s	47.7	61900	306000
500 Year Peak Flood	194000	ft^3/s	52	82700	453000

Peak-Flow Statistics Citations

Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, Charles,2012, Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012–5113, 38 p., 1 pl. (http://pubs.usgs.gov/sir/2012/5113/)

Downstream Section

Erosion Potential	1.13

Tributary Area	*A*	sq mi	352		352
Mean Annual Precip	*MAP*	in/yr	16.4		16.4
Length of Daily Flow Record	*Yr*	yr	30		30
Imperviousness	*Impav*	mi^2/mi^2	0.13200		0.1780
Maximum Flow of Record	*Qmax*	cfs	15794.8		15794.8
Minimum Flow of Record	*Qmin*	cfs	0.01		0.01
10-year peak flow	*Q10*	cfs	25213.8		25213.8
Coefficient of DDF	*day1*	days & cfs	14122.77		26644.65
Exponent of DDF	*day2*	days & cfs	-0.70		-0.76
Number of Bins	N_B	--	25		25
Bin Size	$H_{B\text{-}log}$	--	0.595		0.595

Channel Slope	0.0030	ft/ft
Critical Shear	0.020	lb/sq. ft
γ	62.4	lb/ft^3

Bin Number	Lower Bound of Bin Number	Upper Bound of Bin Number	Flow	Hydraulic Radius	Flow Velocity	Shear Stress	Work	Duration	Cumulative Work	Duration	Cumulative Work
B	$B_{lwr\text{-}log}$	$B_{upr\text{-}log}$	*Q*	*R*	*v*	τ	*W*	*days*	*W*days*	*days*	*W*days*
--	cfs	cfs	cfs	ft	ft/s	psf	--	days	--	days	--
1	0.01	0.01	0.008	0.002	0.03	0.000	0.000	428755.8	0.00	1054070.3	0.00
2	0.01	0.02	0.014	0.002	0.04	0.000	0.000	282351.9	0.00	672015.2	0.00
3	0.02	0.03	0.03	0.003	0.05	0.001	0.000	185939.5	0.00	428438.7	0.00
4	0.03	0.06	0.05	0.004	0.06	0.001	0.000	122448.2	0.00	273148.1	0.00
5	0.06	0.11	0.08	0.006	0.07	0.001	0.000	80636.8	0.00	174143.7	0.00
6	0.11	0.20	0.15	0.008	0.09	0.001	0.000	53102.4	0.00	111024.1	0.00
7	0.20	0.35	0.28	0.012	0.12	0.002	0.000	34969.9	0.00	70782.7	0.00
8	0.35	0.64	0.50	0.017	0.15	0.003	0.000	23029.0	0.00	45127.0	0.00
9	0.64	1.16	0.90	0.024	0.19	0.004	0.000	15165.5	0.00	28770.4	0.00
10	1.16	2.11	1.64	0.035	0.24	0.007	0.000	9987.0	0.00	18342.4	0.00
11	2.11	3.83	2.97	0.049	0.30	0.009	0.000	6576.8	0.00	11694.1	0.00
12	3.83	6.93	5.38	0.07	0.38	0.013	0.000	4331.1	0.00	7455.5	0.00
13	6.93	12.57	9.75	0.10	0.48	0.018	0.000	2852.2	0.00	4753.2	0.00
14	12.57	22.78	17.67	0.14	0.61	0.026	0.000	1878.3	0.58	3030.4	0.94
15	22.78	41.29	32.03	0.20	0.77	0.037	0.002	1236.9	2.18	1932.0	3.41
16	41.29	74.83	58.06	0.28	0.96	0.053	0.006	814.6	4.61	1231.7	6.97
17	74.83	135.63	105.23	0.39	1.20	0.074	0.015	536.4	7.99	785.3	11.70
18	135.63	245.82	190.72	0.55	1.50	0.102	0.035	353.3	12.47	500.6	17.67
19	245.82	445.54	345.68	0.75	1.85	0.141	0.078	232.6	18.04	319.2	24.75
20	445.54	807.53	626.53	1.02	2.27	0.191	0.161	153.2	24.66	203.5	32.76
21	807.53	1463.62	1135.57	1.37	2.77	0.257	0.319	100.9	32.20	129.7	41.41
22	1463.62	2652.77	2058.20	1.82	3.34	0.341	0.606	66.4	40.28	82.7	50.14
23	2652.77	4808.08	3730.43	2.38	4.00	0.446	1.110	43.8	48.56	52.7	58.52
24	4808.08	8714.51	6761.30	3.08	4.75	0.576	1.968	28.8	56.71	33.6	66.17
25	8714.51	15794.81	12254.66	3.94	5.60	0.738	3.404	19.0	64.59	21.4	72.96
									1.000		1.130

StreamStats Report

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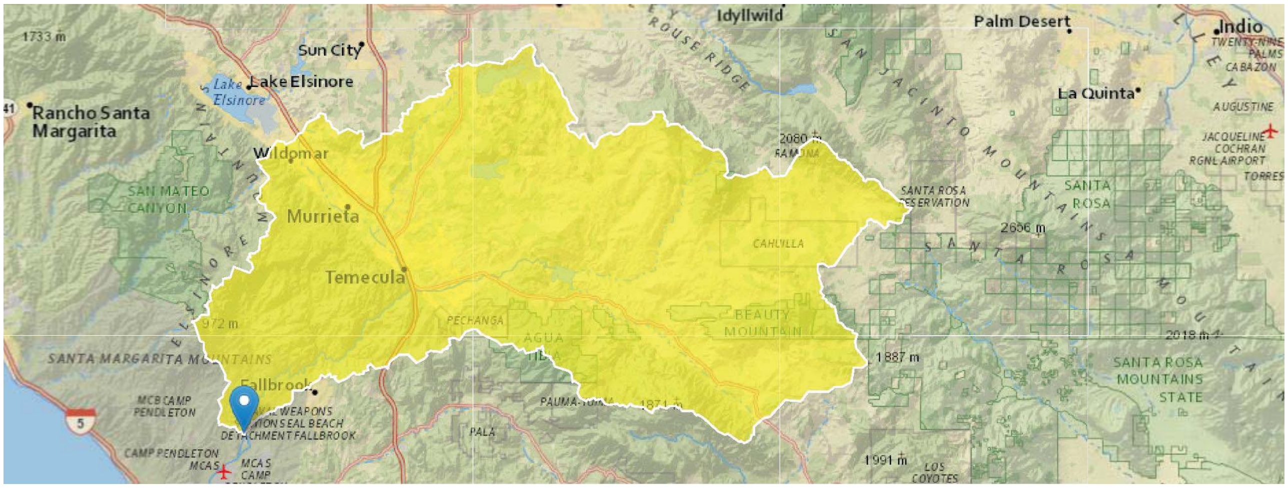

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	706.2	square miles
ELEV	Mean Basin Elevation	2394	feet
PRECIP	Mean Annual Precipitation	16.4	inches
LFPLENGTH	Length of longest flow path	62	miles

Peak-Flow Statistics Parameters [100 Percent (706 square miles) 2012 5113 Region 5 South Coast]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	706.2	square miles	0.04	850
PRECIP	Mean Annual Precipitation	16.4	inches	10	45

Peak-Flow Statistics Flow Report [100 Percent (706 square miles) 2012 5113 Region 5 South Coast]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp
2 Year Peak Flood	2430	ft^3/s	436	13600	134
5 Year Peak Flood	10900	ft^3/s	3180	37000	83.1
10 Year Peak Flood	22300	ft^3/s	8190	60500	64
25 Year Peak Flood	44400	ft^3/s	19200	102000	51.5
50 Year Peak Flood	67900	ft^3/s	31100	148000	47.6
100 Year Peak Flood	96800	ft^3/s	44200	212000	47.2
200 Year Peak Flood	133000	ft^3/s	60200	296000	47.7
500 Year Peak Flood	188000	ft^3/s	80300	438000	52

Peak-Flow Statistics Citations

Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, Charles,2012, Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012–5113, 38 p., 1 pl. (http://pubs.usgs.gov/sir/2012/5113/)

Murrieta Creek

Erosion Potential	#DIV/0!

Tributary Area	*A*	sq mi	149		149
Mean Annual Precip	*MAP*	in/yr	14.7		14.7
Length of Daily Flow Record	*Yr*	yr	30		30
Imperviousness	*Impav*	mi^2/mi^2	0.14400		0.2170
Maximum Flow of Record	*Qmax*	cfs	5596.6		5596.6
Minimum Flow of Record	*Qmin*	cfs	0.01		0.01
10-year peak flow	*Q10*	cfs	10992.9		10992.9
Coefficient of DDF	*day1*	days & cfs	6210.50		17007.29
Exponent of DDF	*day2*	days & cfs	-0.72		-0.80
Number of Bins	N_B	--	25		25
Bin Size	$H_{B\text{-}log}$	--	0.551		0.551

Channel Slope	0.0020	ft/ft
Critical Shear	1.200	lb/sq. ft
γ	62.4	lb/ft^3

Bin Number	Lower Bound of Bin Number	Upper Bound of Bin Number	Flow	Hydraulic Radius	Flow Velocity	Shear Stress	Work	Duration	Cumulative Work	Duration	Cumulative Work
B	$B_{lwr\text{-}log}$	$B_{upr\text{-}log}$	*Q*	*R*	*v*	τ	*W*	*days*	*W*days*	*days*	*W*days*
--	cfs	cfs	cfs	ft	ft/s	psf	--	days	--	days	--
1	0	25	12.50	0.30	0.59	0.037	0.000	1012.3	0.00	2228.3	0.00
2	25	50	37.50	0.38	0.70	0.047	0.000	459.8	0.00	920.5	0.00
3	50	100	75.00	0.57	0.91	0.071	0.000	279.5	0.00	527.0	0.00
4	100	300	200.00	1.02	1.34	0.127	0.000	138.2	0.00	239.3	0.00
5	300	500	400.00	1.52	1.76	0.190	0.000	84.0	0.00	137.0	0.00
6	500	1000	750.00	2.18	2.23	0.272	0.000	53.5	0.00	82.6	0.00
7	1000	1500	1250.00	2.90	2.70	0.362	0.000	37.1	0.00	54.8	0.00
8	1500	2000	1750.00	3.49	3.06	0.436	0.000	29.1	0.00	41.8	0.00
9	2000	2500	2250.00	4.24	3.48	0.529	0.000	24.3	0.00	34.1	0.00
10	2500	3000	2750.00	4.46	3.60	0.557	0.000	21.0	0.00	29.0	0.00
11	3000	3500	3250.00	4.88	3.82	0.609	0.000	18.7	0.00	25.4	0.00
12	3500	4000	3750.00	5.26	4.02	0.656	0.000	16.8	0.00	22.6	0.00
13	4000	4500	4250.00	5.62	4.20	0.701	0.000	15.4	0.00	20.5	0.00
14	4500	5000	4750.00	5.95	4.36	0.743	0.000	14.2	0.00	18.7	0.00
15	5000	6000	5500.00	6.42	4.59	0.801	0.000	12.8	0.00	16.6	0.00
16	6000	7000	6500.00	6.99	4.86	0.872	0.000	11.3	0.00	14.5	0.00
17	7000	8000	7500.00	7.51	5.10	0.937	0.000	10.2	0.00	13.0	0.00
18	8000	9000	8500.00	8.00	5.31	0.998	0.000	9.4	0.00	11.7	0.00
19	9000	10000	9500.00	8.45	5.51	1.055	0.000	8.6	0.00	10.7	0.00
20	10000	11000	10500.00	8.87	5.70	1.107	0.000	8.0	0.00	9.9	0.00
									0.00		0.00
									#DIV/0!		#DIV/0!

Murrieta StreamStats Report

Region ID: CA
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Clicked Point (Latitude, Longitude): 33.47765, -117.14194
Time: 2017-10-10 04:44:51 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	221.1	square miles
ELEV	Mean Basin Elevation	1710	feet
PRECIP	Mean Annual Precipitation	14.7	inches
LFPLENGTH	Length of longest flow path	31	miles

Peak-Flow Statistics Parameters [2012 5113 Region 5 South Coast]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	221.1	square miles	0.04	850
PRECIP	Mean Annual Precipitation	14.7	inches	10	45

Peak-Flow Statistics Flow Report [2012 5113 Region 5 South Coast]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	1030	ft^3/s	185	5680	134
5 Year Peak Flood	4180	ft^3/s	1230	14200	83.1
10 Year Peak Flood	7980	ft^3/s	2960	21500	64
25 Year Peak Flood	14600	ft^3/s	6380	33400	51.5
50 Year Peak Flood	21200	ft^3/s	9810	45700	47.6
100 Year Peak Flood	28900	ft^3/s	13300	62700	47.2
200 Year Peak Flood	38300	ft^3/s	17400	84000	47.7
500 Year Peak Flood	51400	ft^3/s	22300	119000	52

Peak-Flow Statistics Citations

Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, Charles,2012, Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012–5113, 38 p., 1 pl. (http://pubs.usgs.gov/sir/2012/5113/#)

Attachment I. San Diego County Regional Watershed Management Area Analysis

San Diego County Regional Watershed Management Area Analysis

Lake Henshaw

October 1, 2015

Prepared for:
San Diego County Copermittees

Prepared by:

Geosyntec consultants
engineers | scientists | innovators

RICK ENGINEERING COMPANY

TABLE OF CONTENTS

1. INTRODUCTION 1
   - 1.1. Background 1
   - 1.2. Watershed Management Area Analysis (WMAA) 1
   - 1.3. Scope of Work for Regional WMAA 2
   - 1.4. Project Process 3
   - 1.5. Report Organization 4
   - 1.6. Terms of Reference 4
2. WATERSHED MANAGEMENT AREA CHARACTERIZATION 5
   - 2.1. Dominant Hydrologic Processes 6
     - *2.1.1. Datasets Used for identifying dominant hydrologic processes 7*
     - *2.1.2. Methodology/Assumptions/Criteria for identifying dominant hydrologic processes 8*
     - *2.1.3. Results for identifying dominant hydrologic processes 12*
     - *2.1.4. Limitations for identifying dominant hydrologic processes 13*
   - 2.2. Stream Characterization 14
     - *2.2.1. Datasets Used for stream characterization 14*
     - *2.2.2. Methodology/Assumptions/Criteria for stream characterization 15*
     - *2.2.3. Results for stream characterization 19*
     - *2.2.4. Limitations for stream characterization 20*
   - 2.3. Land Uses 21
     - *2.3.1. Datasets Used for land uses 21*
     - *2.3.2. Methodology/Assumptions/Criteria for land uses 21*
     - *2.3.3. Results for land uses 22*
     - *2.3.4. Limitations 23*
   - 2.4. Potential Critical Coarse Sediment Yield Areas 24
     - *2.4.1. Datasets Used for identifying potential critical coarse sediment yield areas 24*
     - *2.4.2. Methodology/Assumptions/Criteria for identifying potential critical coarse sediment yield areas 25*
     - *2.4.3. Results for identifying potential critical coarse sediment yield areas 27*
     - *2.4.4. Limitations for identifying potential critical coarse sediment yield areas 27*
   - 2.5. Physical Structures 29
     - *2.5.1. Approach for identifying physical structures 29*
     - *2.5.2. Results for identifying physical structures 29*
3. TEMPLATE FOR CANDIDATE PROJECT LIST 30
4. HYDROMODIFICATION MANAGEMENT APPLICABILITY/EXEMPTIONS 32
   - 4.1. Additional Analysis for Hydromodification Management Exemptions 32
     - *4.1.1. Exempt River Reaches 33*
     - *4.1.2. Stabilized Conveyance Systems Draining to Exempt Water Bodies 37*
     - *4.1.3. Highly Impervious/Highly Urbanized Watersheds and Urban Infill 44*
     - *4.1.4. Tidally Influenced Lagoons 47*
5. CONCLUSIONS 48
   - 5.1. Watershed Management Area Characterization 48
   - 5.2. Template for Candidate Project List 49
   - 5.3. Hydromodification Management Exemptions 49
6. REFERENCES 51

TABLE OF CONTENTS CONTINUED

ATTACHMENT A WATERSHED MANAGEMENT AREA CHARACTERIZATION

A.1 Dominant Hydrologic Process
A.2 Stream Characterization
A.3 Land Uses
A.4 Potential Critical Coarse Sediment Yield Areas
A.5 Physical Structures

ATTACHMENT B HYDROMODIFICATION MANAGEMENT APPLICABILITY/EXEMPTIONS

B.1 Additional Analysis for Hydromodification Management Exemptions
B.2 Hydromodification Management Applicability/Exemption Mapping

ATTACHMENT C ELECTRONIC FILES

ATTACHMENT D REGIONAL MS4 PERMIT CROSSWALK

ATTACHMENT E METHODOLOGY FOR HYDROMODIFICATION MANAGEMENT EXEMPTION

ACRONYMS AND ABBREVIATIONS

%	percent
>	greater than
<	less than
BMP	Best Management Practice
CB	Coarse Bedrock
CEG	Certified Engineering Geologist
CIP	Capital Improvement Project
CLRP	Comprehensive Load Reduction Plan
CSI	Coarse Sedimentary Impermeable
CSP	Coarse Sedimentary Permeable
E_P	Erosion Potential
ET	Evapotranspiration
FB	Fine Bedrock
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
FSI	Fine Sedimentary Impermeable
FSP	Fine Sedimentary Permeable
GIS	Geographic Information System
GLU	Geomorphic Landscape Unit
HA	Hydrologic Area
HCP	Hydromodification Control Plan
HMP	Hydromodification Management Plan
HRU	Hydrologic Response Unit
HSA	Hydrologic Sub Area
HSG	Hydrologic Soil Group
IRWM	Integrated Regional Water Management
JURMP	Jurisdictional Urban Runoff Management Plan
LDW	Land Development Workgroup
LID	Low Impact Development
MAP	Mean Annual Precipitation

ACRONYMS AND ABBREVIATIONS continued

MHPA	Multiple Habitat Planning Area
MS4	Municipal Separate Storm Sewer System
MSCP	Multiple Species Conservation Program
NED	National Elevation Dataset
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
PDP	Priority Development Project
RCB	Reinforced Concrete Box
RCP	Reinforced Concrete Pipe
SCAMP	Southern California Aerial Mapping Project
SCCWRP	Southern California Coastal Water Research Project
SD	San Diego
SDRWQCB	San Diego Regional Water Quality Control Board
S_P	Sediment Supply Potential
SSURGO	Soil Survey Geographic Database
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WMA	Watershed Management Area
WMAA	Watershed Management Area Analysis
WQIP	Water Quality Improvement Plan
WURMP	Watershed Urban Runoff Management Plan

1. Introduction

1.1. Background

On May 8, 2013 the California Regional Water Quality Control Board, San Diego Region adopted Order No. R9-2013-0001; NPDES No. CAS 0109266, National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements for Discharges from the Municipal Separate Storm Sewer Systems (MS4s) Draining the Watersheds within the San Diego Region (Regional MS4 Permit). The Regional MS4 Permit, which became effective on June 27, 2013, replaces the previous MS4 Permits that covered portions of the Counties of San Diego, Orange, and Riverside within the San Diego Region. There were two main goals for the Regional MS4 Permit:

1. To have more consistent implementation, as well as improve inter-agency communication (particularly in the case of watersheds that cross jurisdictional boundaries), and minimize resources spent on the permit renewal process.
2. To establish requirements that focused on the achievement of water quality improvement goals and outcomes rather than completing specific actions, thereby giving the Copermittees more control over how their water quality programs are implemented.

To achieve the second goal, the Regional MS4 Permit requires that Water Quality Improvement Plans (WQIPs) be developed for each Watershed Management Area (WMA) within the San Diego Region. As part of the development of WQIPs, the Regional MS4 Permit provides Copermittees an option to perform a Watershed Management Area Analysis (WMAA) through which watershed-specific requirements for structural BMP implementation for Priority Development Projects can be developed for each WMA. This report presents the Copermittees' approach and results for the regional elements of the WMAA developed for the San Diego County area.

1.2. Watershed Management Area Analysis (WMAA)

The Regional MS4 Permit, through inclusion of the WMAA, provides an optional pathway for Copermittees to develop an integrated approach for their land development programs by promoting evaluation of multiple strategies for water quality improvement and development of watershed-scale solutions for improving overall water quality in the watershed. The WMAA comprises the following three components as indicated in the Regional MS4 Permit:

1. Perform analysis and develop Geographic Information System (GIS) layers (maps) by gathering information pertaining to the physical characteristics of the WMA (referred to herein as WMA Characterization). This includes, for example, identifying potential areas of coarse sediment supply, present and anticipated future land uses, and locations of physical structures within receiving streams and upland areas that affect the watershed hydrology (such as bridges, culverts, and flood management basins).
2. Using the WMA Characterization results, compile a list of candidate projects that could potentially be used as alternative compliance options for Priority Development Projects. Such projects may include, for example, opportunities for stream or riparian area

rehabilitation, opportunities for retrofitting existing infrastructure to incorporate storm water retention or treatment, or opportunities for regional BMPs, among others. Prior to implementing these candidate projects the Copermittees must demonstrate that implementing such a candidate project would provide greater overall benefit to the watershed than requiring implementation of the onsite structural BMPs. Note, compilation or evaluation of potential projects was not performed as part of this regional effort. Identification and listing of candidate projects will be performed for each WMA through the WQIP process for WMAs that elect to submit the optional WMAA as part of the WQIP.

3. Additionally, using the WMA Characterization maps, identify areas within the watershed management area where it is appropriate to allow for exemptions from hydromodification management requirements that are in addition to those already allowed by the Regional MS4 Permit for Priority Development Projects. The Copermittees shall identify such cases on a watershed basis and include them in the WMAA with supporting rationale to support claims for exemptions.

1.3.Scope of Work for Regional WMAA

In July 2013, the Copermittees elected to fund a regional effort to develop elements of the regional WMAA for the 9 San Diego-area WMAs within the County of San Diego that are currently subject to the Regional MS4 Permit, which include:

- Santa Margarita River (for portion in San Diego County)
- San Luis Rey River
- Carlsbad
- San Dieguito River
- Los Peñasquitos
- Mission Bay & La Jolla Watershed
- San Diego River
- San Diego Bay
- Tijuana River (for portion in San Diego County)

The regional-level information developed through this effort is intended to provide consistency across WMAs and serve as the foundation for developing watershed-specific information for each WMA to be developed through the WQIP process. The regional effort scope of work included:

1. Development of GIS map layers that characterize the WMAs using data previously collected, readily available, and provided by the Copermittees, including:
    a. Description of dominant hydrologic processes, such as areas where infiltration or overland flow likely dominates;
    b. Description of existing streams in the watershed, including bed material and composition, and if they are perennial or ephemeral;

   c. Current and anticipated future land uses;
   d. Potential coarse sediment yield areas; and
   e. Locations of existing flood control structures and channel structures, such as stream armoring, constrictions, grade control structures, and hydromodification or flood management basins.
2. Development of a Microsoft® Excel (Excel) template for use by Copermittees to compile lists of candidate projects for an optional alternative compliance program.
3. Development of additional criteria and analyses to support reinstating the following proposed exemptions that were originally developed in the approved 2011 Final Hydromodification Management Plan but not included in the Regional MS4 Permit unless provided by the Copermittees in the WMAA. In addition, development of the associated Hydromodification Applicability/Exemption Mapping.
   a. Exempt River Reaches including:
      i. San Diego River;
      ii. Otay River;
      iii. San Dieguito River;
      iv. San Luis Rey River; and
      v. Sweetwater River
   b. Stabilized Conveyance Systems Draining to Exempt Water Bodies
   c. Highly Impervious/Highly Urbanized Watersheds and Urban Infill, and
   d. Tidally Influenced Lagoons (where data/study provided)

The scope of work for the regional effort excluded performing analysis within the following areas unless data was readily available, as Copermittees do not have jurisdiction over these areas:

1. State Lands;
2. U.S. Departments of Defense land;
3. U.S. National Forest land;
4. U.S. Department of Interior land and
5. Tribal land

Additional description of excluded areas, for the purposes of the Regional WMAA, is indicated in Section 2.3 Land Uses.

1.4.Project Process

The process for developing the Regional WMAA included close coordination with the Land Development Workgroup (LDW) at key points during the project. The LDW is composed of the 21 San Diego-area Copermittees and serves to develop and implement regional land development plans and programs necessary to support the requirements of the Regional MS4 Permit. The consultant team (Geosyntec Consultants and Rick Engineering Company) presented preliminary project assumptions and methodologies proposed to be used to develop the Regional WMAA to meet the requirements of the Regional MS4 Permit in December 2013. The consultant team incorporated workgroup feedback from this meeting and subsequently presented the preliminary Regional WMAA project results to the LDW in March 2014, again to receive direction and incorporate input on the preliminary results. Subsequently, the draft report was released to the public in July 2014, by a public workshop that included Consultation Panel members from each of the WMAs on July 29, 2014. This version of the report including all of the input described above is being issued for optional inclusion into the respective WQIP Provision B.3 submittals to the SDRWQCB in December 2014.

1.5. Report Organization

This report is organized as follows:

- Chapter 1 provides the project background and purpose;
- Chapter 2 describes the technical basis for characterizing the WMAs;
- Chapter 3 describes the template that can be used by Copermittees to compile the list of candidate projects;
- Chapter 4 summarizes the analyses performed to support reinstating select exemptions from hydromodification control requirements for PDPs;
- Chapter 5 presents the Regional WMAA conclusions;
- Chapter 6 presents the references used for the Regional WMAA;
- Attachment A presents the exhibits and additional supporting information for watershed management area characterization;
- Attachment B presents the exhibits and additional supporting information for hydromodification management applicability/exemptions;
- Attachment C expands on the structure of the geodatabase that hosts the GIS data developed by the WMAA; and
- Attachment D provides a crosswalk between the Regional MS4 Permit requirements for WMAA and this report.

1.6.Terms of Reference

The work described in this report was conducted by Geosyntec Consultants (Geosyntec) and Rick Engineering Company (RICK) on behalf of the County of San Diego and the regional Copermittees.

2. Watershed Management Area Characterization

Watershed health and function are strongly influenced by hydrological and geomorphological processes occurring in the watershed. Both hydrological response and geomorphological response of the watershed are dependent on a variety of physical characteristics of the watershed. To this end, the Regional MS4 Permit specifies a set of data that is required to adequately characterize overall watershed processes as a foundation to enhancing integration and effectiveness of watershed management and water quality programs. The following GIS map layers were developed to characterize the hydrological and geomorphological processes within the 9 WMAs:

- Dominant Hydrologic Processes: A description of dominant hydrologic processes, such as areas where infiltration or overland flow likely dominates;
- Stream Characterization: A description of existing streams in the watershed, including bed material and composition, and if they are perennial or ephemeral;
- Land Uses: Current and anticipated future land uses;
- Potential Critical Coarse Sediment Yield Areas; and
- Physical Structures: Locations of existing flood control structures and channel structures, such as stream armoring, constrictions, grade control structures, and hydromodification or flood management basins.

These GIS layers can be used to:

- Identify the nature and distribution of key macro-scale watershed processes;
- Identify potential opportunities and constraints for regional and sub-regional storm water management facilities that can play a critical role in meeting water quality, hydromodification, water supply, and/or habitat goals within the watershed;
- Assist with determining the most appropriate management actions for specific portions of the watershed; and
- Suggest where further study is appropriate.

2.1. Dominant Hydrologic Processes

The Regional MS4 Permit identifies in the provisions related to the WMAA that a description of dominant hydrologic processes within the watershed must be developed, with GIS layers (maps) as output. The Permit specifically calls for processes "*such as areas where infiltration or overland flow likely dominates*." These particular aspects of the hydrological mechanics of watersheds are particularly important when attempting to understand the macro-scale opportunities for locating projects that take advantage of either capturing overland flow for treatment or for infiltration.

Investigation of the dominant hydrologic processes in the San Diego-area watersheds indicates that evapotranspiration (ET) is the most dominant hydrologic process for the region based on review of a published study (Sanford and Selnick, 2013). ET is the sum of evaporation and plant transpiration in the hydrologic cycle that transports water from land surfaces to the atmosphere. This is conclusion is supported by comparing the 30-year average annual rainfall for the study area (San Diego County east of the peninsular divide) of between 15 and 18 inches per year (San Diego County, 2005) to the average annual ET rates. According to the California Irrigation Management Information System (CIMIS) Reference Evapotranspiration Map (CIMIS, 1999), the study area (within Zones 4, 6, and 9) experiences annual reference ET of 46.6, 49.7 and 59.9 inches, respectively. Therefore, theoretically, if all of the annual precipitation for the San Diego-area watersheds remained stationary where it fell and did not either infiltrate or runoff to local waterbodies where it would be conveyed downstream ultimately to the ocean, it all would be consumed by ET. As such, the effect of ET on the overall hydrologic processes within the San Diego watersheds is a function of the temporal scale over which it acts. Precipitation events often produce runoff in these watersheds, particularly in the urbanized portions, based on the topography and land cover that tend to accelerate the conveyance of runoff downstream rather than collecting, storing, or spreading out that then would maximize the effect of ET.

Because this study is focused on developing information and mapping for the portion of the hydrologic process that informs watershed management decisions, i.e., locating beneficial projects in areas of greatest opportunity, the next tier of dominant hydrologic processes are studied and mapped by this project. As such, the study area was characterized, based on the methodology described in the following section, according to the predicted fate of runoff within the watersheds being either overland flow or infiltration after considering the effects of ET (as well as an intermediate category of interflow). Areas that were mapped as overland flow do not necessarily preclude infiltration but rather indicate the dominant expected process that runoff would experience if not intercepted for the express purpose of infiltrating storm water runoff. The Model BMP Design Manual will provide more detailed guidance and procedures for determining the potential for infiltrating captured storm water at the project level irrespective of the mapping produced in the WMAA. To reiterate, the WMAA mapping is to provide macro-scale processes for high-level analysis and to inform decisions affecting regional scales. Furthermore, the Model BMP Design Manual will indicate the degree to which site-scale BMPs can expect to benefit from ET or how ET is considered in the sizing of BMPs. In brief, typical storm water BMPs only store water for a few days and therefore are not really capable of significant volume disposal through ET. However, pervious area dispersion (i.e., directing storm water runoff to flat areas for spreading and infiltration) has appreciable benefits with regard to ET and is a practice promoted in the BMP Design Manual.

The processes of interest are further defined as follows:

Overland flow: This process can be thought of as the inverse of infiltration; precipitation reaching the ground surface that does not immediately soak in must run over the land surface (thus, "overland" flow). It reflects the relative rates of rainfall intensity and the soil's infiltration capacity: wherever and whenever the rainfall intensity exceeds the soil's infiltration capacity, some overland flow will occur. Most uncompacted, vegetated soils have infiltration capacities of one to several inches per hour at the ground surface, which exceeds the rainfall intensity of even unusually intense storms. In contrast, pavement and hard surfaces reduce the effective infiltration capacity of the ground surface to zero, ensuring overland flow regardless of the meteorological attributes of a storm, together with a much faster rate of runoff relative to vegetated surfaces.

Infiltration and groundwater recharge: These closely linked hydrologic processes are most apparent near ephemeral and perennial conveyances in the San Diego region. Their widespread occurrence is expressed by the common absence of surface-water channels on even steep (undisturbed) hillslopes. Thus, on virtually any geologic material on all but the steepest slopes (or bare rock), infiltration of rainfall into the soil is inferred to be widespread, if not ubiquitous. With urbanization, changes to the process of infiltration are also quite simple to characterize: some (typically large) fraction of that once infiltrating water is now converted to overland flow.

Interflow: Interflow takes place following storm events as shallow subsurface flow (usually within 3 to 6 feet of the surface) occurring in a more permeable soil layer above a less permeable substrate. In the storm response of a stream, interflow provides a transition between the rapid response from surface runoff and much slower stream discharge from deeper groundwater. In some geologic settings, the distinction between "interflow" and "deep groundwater" is artificial and largely meaningless; in others, however, there is a strong physical discrimination between "shallow" and "deep" groundwater movement. Development reduces infiltration and thus interflow as discussed previously, as well as reducing the footprint of the area supporting interflow volume.

The datasets used, methodology for creating the dominant hydrologic processes maps, and the results are described in the sections below.

2.1.1. Datasets Used for identifying dominant hydrologic processes

The following datasets were used in the analysis:

Dataset	Source	Year	Description
Elevation	USGS	2013	1/3rd Arc Second (~10 meter cells) digital elevation model for San Diego County
Soils Data	SanGIS	2013	NRCS (SSURGO) Database for San Diego County downloaded from SanGIS
Land Cover	SanGIS	2013	Ecology-Vegetation layer for San Diego County downloaded from SanGIS

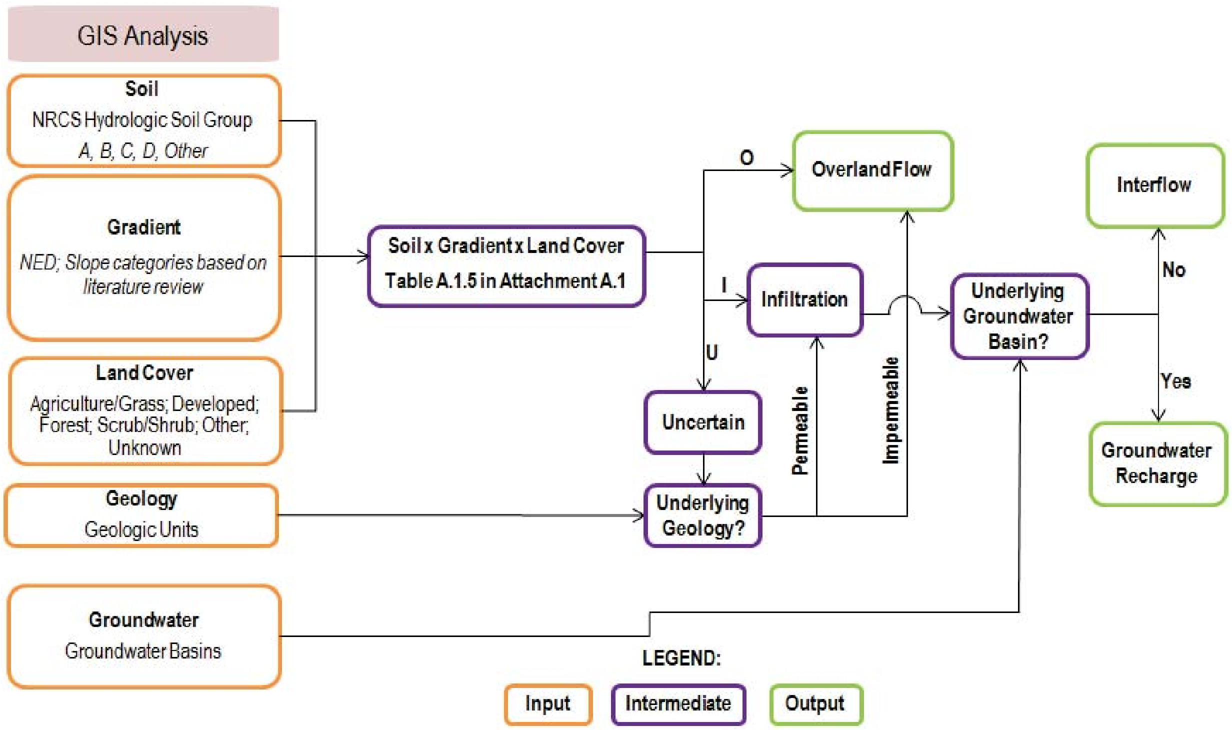
Dataset	Source	Year	Description
Geology	Kennedy, M.P., and Tan, S.S.	2002	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale.
	Kennedy, M.P., and Tan, S.S.	2008	Geologic Map of the San Diego 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 3, 1:100,000 scale.
	Todd, V.R.	2004	Preliminary Geologic Map of the El Cajon 30'x60' Quadrangle, Southern California, United States Geological Survey, Southern California Aerial Mapping Project (SCAMP), Open File Report 2004-1361, 1:100,000 scale.
	Jennings et al.	2010	"Geologic Map of California," California Geological Survey, Map No. 2 – Geologic Map of California, 1:750,000 scale
Groundwater Basins	SanGIS	2013	Groundwater Basins in San Diego County downloaded from SanGIS

2.1.2. Methodology/Assumptions/Criteria for identifying dominant hydrologic processes

The methodology used to describe dominant hydrologic processes is based on recommendations included in the Southern California Coastal Water Research Project's (SCCWRP) Technical Report 605 titled "Hydromodification Screening Tools: GIS-Based Catchment Analyses of Potential Changes in Runoff and Sediment Discharge" (SCCWRP, 2010). The foundation for this analysis was to incorporate the Report's concept of grouping common hydrologic attributes into Hydrologic Response Units (HRUs). The report states the following:

> *"Grouping common hydrologic attributes across a watershed into a tractable number of Hydrologic Response Units (HRUs: a term first used by England and Holtan 1969) has become a well-established approach for condensing the near-infinite variability of a natural watershed into a tractable number of different elements. The normal procedure for developing HRUs is to identify presumptively similar rainfall–runoff characteristics across a watershed by combining spatially distributed climate, geology, soils, land use, and topographic data into areas that are approximately homogeneous in their hydrologic properties (Green and Cruise 1995, Becker and Braun 1999, Beven 2001, Haverkamp et al. 2005). As noted by Beighley et al (2005), this process of merging the landscape into discrete HRUs is a common and effective method for reducing model complexity and data requirements. Using watershed characteristics to predict runoff is the explicit task of hydrologic models, and there is a host of such models available for application to hydromodification evaluation. For purposes of "screening," however, the goal is simplicity and ease of application even if the precision of the resulting analysis is crude."*

The following process describes the methodology used to define Hydrologic Response Units (HRUs) and then relate the HRUs to the dominant hydrologic processes (i.e., overland flow, interflow, and groundwater recharge) in the 9 WMAs in San Diego County.



The first step is to define the HRUs. Once these are defined, the remaining steps determine the dominant hydrologic process.

1. **Integrate data sets used to determine HRU**: Categories for soil type, gradient, and land cover were defined based on readily available GIS datasets for the region and classifications found in relevant literature, as indicated below. The different combinations of these three categories comprise the distinct HRUs.

   - **Soil Categories**: based on National Resource Conservation Service (NRCS) Hydrologic Soil Group (HSG) classifications, which are commonly used to describe runoff/infiltration potential of soils on a regional scale. These categories include: A, B, C, and D. HSG A soils have the lowest runoff potential, while HSG D soils have the highest runoff potential.

   - **Gradient Categories**: based on slope ranges found in a review of relevant literature identified in Chapter 6. The spatial processing of the slope categories utilized the United States Geologic Survey (USGS) National Elevation Dataset (NED). Slopes were grouped (bins) into the following ranges: 0% to 2%; 2% to 6%; 6% to 10%; and greater than 10%. The 2% and 6% slope thresholds were based on slope ranges included in Table A.1.1 (McCuen, 2005) presented in Attachment A.1. This table provides runoff coefficients as a function of slope, soil group, land cover, and return period and was used for subsequent steps in the mapping effort. The 10% slope threshold was used in SCCWRP's Technical

Report 605 (SCCWRP, 2010) and is a logical cutoff since slopes steeper than 10% are assumed to be dominated by overland flow.

- **Land Cover Categories**: were defined using the Ecology Vegetation GIS map layer developed by the City of San Diego, the County of San Diego and SANDAG and downloaded from SanGIS (2013). The vegetation categories in the GIS layer were grouped (Table A.1.2 in Attachment A.1) to match the following categories used in SCCWRP's Technical Report 605 (SCCWRP, 2010): Agriculture/Grass; Developed; Forest; Scrub/Shrub, Other (Water), and Unknown.

2. **Evaluate Land Cover**: Land cover categories for Agriculture/Grass, Forest, Scrub/Shrub and Other were related to land use categories defined in Table A.1.1 as shown in Table A.1.3 in Attachment A.1. Relating a land use category for the Developed land cover category was not necessary because all Developed cover was assumed to have overland flow as its dominant hydrologic process.
3. **Determine Hydrology Characteristics for Land Covers**: For each of the land cover/land use categories listed in Table A.1.3, the ratio of precipitation lost to evapotranspiration (i.e. an evapotranspiration coefficient) was estimated using Table A.1.1 using the process described below. Since precipitation is considered to be the sum of the resulting runoff, infiltration, and evapotranspiration, the coefficients for these three hydrologic pathways sum to one, as indicated below.

   Runoff Coefficient + Infiltration Coefficient + Evapotranspiration Coefficient = 1

   i) **Estimate Evapotranspiration**: To estimate the evapotranspiration (ET) coefficient for each land cover, first the runoff coefficient was identified in Table A.1.1 for the highest runoff potential (i.e., Group D soil and 6%+ slope) and most common storm conditions (i.e., storm recurrence intervals less than 25 years). The infiltration for these high runoff conditions was assumed to be negligible, resulting in an infiltration coefficient of zero. Since the sum of the three coefficients should sum to one, the ET coefficient was assumed to be the remaining difference (i.e., ET Coefficient = 1 – Runoff Coefficient). The ET coefficient calculated for the highest runoff potential was then applied to all soil types and slopes within that land use category. The calculated ET coefficient for each applicable HRU is provided in Table A.1.4 in Attachment A.1. The ET coefficient for HRUs that have a Developed land cover or a gradient greater than 10% were not calculated since these HRUs were assumed to have overland flow as the dominant hydrologic process.

   ii) **Estimate Infiltration**: The infiltration coefficient for each applicable HRU (i.e., combination of soil, gradient, and land cover) was estimated by subtracting both the runoff coefficient, provided in Table A.1.1, and the ET coefficient, calculated in step 3(i), from one (i.e., Infiltration Coefficient = 1 – Runoff Coefficient – ET Coefficient). The calculated infiltration coefficient for each applicable HRU is provided in Table A.1.4 in Attachment A.1.

   iii) **Estimate Runoff**: For each applicable HRU, the runoff coefficient was divided by the infiltration coefficient to obtain a ratio representing the potential for runoff or infiltration. The higher the ratio, the greater the potential for runoff to be a more dominant hydrologic process than infiltration. Similarly, the lower the ratio, the greater the potential for infiltration to be a more dominant hydrologic process than runoff. The calculated runoff to infiltration ratios are provided in Table A.1.4 in Attachment A.1.

4. **Associate Runoff and Infiltration to HRUs**: The following designations were assigned to each applicable HRU based on the runoff to infiltration ratio (i.e., runoff coefficient/infiltration coefficient). These designations were based on best engineering judgment with the underlying assumption that if a runoff or infiltration coefficient is more than 50% greater than its counterpart, then the prevailing process is considered dominant.

   - HRUs with runoff to infiltration ratios greater than 1.5 (3:2 ratio) were assumed to have relatively high runoff and overland flow was considered its dominant hydrologic process. These HRUs are designated by the letter "O" (Overland flow is dominant process) in Tables A.1.4 and A.1.5 in Attachment A.1.
   - HRUs with runoff to infiltration ratios less than 0.67 (2:3 ratio) were assumed to have relatively high infiltration and its dominant hydrologic process was either interflow or groundwater recharge, based on analysis described in subsequent steps. These HRUs are designated by the letter "I" (Interflow is dominant process) in Tables A.1.4 and A.1.5.
   - For HRUs with runoff to infiltration ratios between, and including, 1.5 and 0.67 it was uncertain whether it was dominated by overland flow or infiltration. These HRUs are designated by the letter "U" (Dominant process is uncertain) in Tables A.1.4 and A.1.5.
   - For HRUs that have a Developed land cover or a gradient greater than 10%, the runoff to infiltration ratios were not calculated because these HRUs were assumed to have overland flow as the dominant hydrologic process. These HRUs are designated by the letter "O" (Overland flow is dominant process) in Table A.1.5.

5. **Uncertain HRUs Assignment**: For HRUs with an uncertain designation ("U") in Table A.1.5 in Attachment A.1, the underlying regional geology (Kennedy and Tan, 2002 & 2008; Todd, 2004 and Jennings et al., 2010) was used to evaluate whether overland flow or infiltration were dominant. If the underlying geology was considered impermeable, then these uncertain areas were considered to have overland flow as its dominant hydrologic process. If the underlying geology was considered permeable, then these uncertain areas were considered to be dominated by infiltration. The determination of whether a geologic unit is impermeable or permeable was based on desktop evaluation and the best professional judgment of a Certified Engineering Geologist (CEG). This analysis was performed in GIS and is illustrated in the flowchart above.

6. **Associate Infiltration HRUs with Known Groundwater Basins**: For HRUs with relatively high infiltration and have a designation of "I" in Table A.1.5 in Attachment A.1, the presence or absence of a regional groundwater basin (SanGIS, 2013) underlying these areas determined whether the dominant hydrologic process was designated as interflow or groundwater recharge. The groundwater recharge hydrologic process was assigned as dominant for those applicable areas which had an underlying groundwater basin. The interflow hydrologic process was assigned as dominant for those applicable areas which did not have an underlying groundwater basin directly below it. This analysis was performed in GIS and is illustrated in the flowchart above.
7. **Resulting HRU Data:** The resulting GIS map of dominant hydrologic processes was reviewed by engineering professionals familiar with the hydrology in the County of San Diego to confirm that the mapping is consistent with their experience working in the region.

2.1.3. Results for identifying dominant hydrologic processes

The resulting GIS map showing the spatial distribution of dominant hydrologic processes (i.e., overland flow, interflow, and groundwater recharge) within the 9 WMAs is provided in Attachment A.1. An ArcMap document which presents the results from each step of the methodology is included in Attachment C, as well as a Google Earth KMZ file. Based on this analysis, overland flow is the predominant hydrologic process in all 9 WMAs, which is consistent with the experience of engineering professionals familiar with the hydrology of the County of San Diego.

Summary of Deliverables for Dominant Hydrologic Processes

<table>
<tr><th>Format</th><th>Item</th><th>Description</th><th>Location</th></tr>
<tr><td>Report</td><td>Figure</td><td>"Dominant Hydrologic Processes"</td><td>Attachment A.1</td></tr>
<tr><td rowspan="5">GIS</td><td>Map Group Title</td><td>Hydrologic Processes</td><td rowspan="5">Attachment C</td></tr>
<tr><td>Map Layer Title</td><td>Soil
Land Cover
Slope
Hydrologic Response Unit
Initial Rating
Permeability
Groundwater Basin
Dominant Hydrologic Processes</td></tr>
<tr><td>Geodatabase Feature Dataset</td><td>HydrologicProcesses</td></tr>
<tr><td>Geodatabase Feature Class</td><td>HRUAnalysis</td></tr>
<tr><td>Geodatabase Geometry Type</td><td>Polygon</td></tr>
<tr><td>KMZ [1]</td><td>KMZ File Name</td><td>Dominant Hydrologic Processes</td><td>Attachment C</td></tr>
<tr><td colspan="4">[1] To enhance the utilization of this data, the Dominant Hydrological Processes map is provided in both traditional GIS file format (ESRI software license purchase required) and as a Google Earth KMZ (Keyhole Markup Language/Zipped) file that can be viewed with the free download version of Google Earth (http://www.google.com/earth/).</td></tr>
</table>

2.1.4. Limitations for identifying dominant hydrologic processes

The resulting GIS map layer only lists the dominant hydrological process (i.e., an HRU assigned a dominant process of overland flow can also experience small amounts of infiltration) and provides a useful, rapid framework to perform screening-level analysis that is appropriate for watershed-scale planning studies. When more precise estimates are required for a particular site and subarea it is recommended that this analysis be augmented with site-specific analysis.

2.2. Stream Characterization

For the purpose of WMAA, the Regional MS4 Permit requires a description of existing streams in the watershed, including bed material and composition, and if they are perennial or ephemeral. This analysis was prepared for 27 streams throughout the San Diego Region agreed upon by the consultant team and Copermittees. The 27 streams are listed below and are identified on the exhibit titled "Watershed Management Area Streams" located in Attachment A.2. Streams were selected to provide at least one in each WMA and at least one in each jurisdiction. There is no numeric threshold defining a "stream" for the purpose of the Regional WMAA. Throughout the Regional WMAA, the term "stream" is used as a general term to call out any of the reaches selected for analysis, regardless of watershed area, stream order, flow rate, channel size, length, or designation of "Creek" or "River" within the name.

Regional WMAA Streams:

1. Santa Margarita River
2. San Luis Rey River
3. Buena Vista Creek
4. Agua Hedionda Creek
5. San Marcos Creek
6. Encinitas Creek
7. Cottonwood Creek (Carlsbad WMA)
8. Escondido Creek
9. San Dieguito River – Reach 1
10. San Dieguito River – Reach 2
11. Lusardi Creek
12. Los Peñasquitos/Poway Creek
13. Rattlesnake Creek
14. Carroll Canyon Creek
15. Rose Creek
16. San Diego River
17. Sycamore Creek
18. Woodglen Vista Creek
19. San Vicente Creek
20. Forrester Creek
21. Chollas Creek
22. Sweetwater River – Reach 1
23. Sweetwater River – Reach 2
24. Otay River
25. Jamul/Dulzura Creek
26. Tijuana River
27. Cottonwood Creek (Tijuana WMA)

2.2.1. Datasets Used for stream characterization

The following data were referenced for the purpose of stream characterization:

- USGS National Hydrography Dataset, downloaded from USGS November 2013

- USGS 7.5-minute quadrangles, compiled image of quadrangles covering San Diego County, various dates
- Floodplains: "National Flood Hazard Layer," provided by Federal Emergency Management Agency October 2012
- Various datasets provided by Copermittees depicting existing storm water conveyance infrastructure within their jurisdictions.
- Aerial photography by Digital Globe dated 2012

2.2.2. Methodology/Assumptions/Criteria for stream characterization

The analysis was prepared by digitizing each of the 27 streams based on review of data listed above. Within the pre-existing datasets depicting streams, floodplains, or infrastructure, no single dataset included a complete, accurate alignment of each stream. Digitizing the streams based on review of all of the data listed above allowed creation of GIS linework with a continuous corrected alignment for each stream. The following data were recorded as GIS attributes for each stream as the stream was digitized:

- River name
- Reach type (engineered or natural, constrained or un-constrained)
- Bed material
- Bank material
- Hydrographic category (perennial or intermittent)

The attributes listed above were collected manually based on interpretation of the reference data. Assumptions used in making the interpretations are listed below. The ***Hydrographic Category*** section below will provide the rationale as to why perennial and intermittent were the hydrographic categories chosen for this WMAA and not perennial and ephemeral.

Note that stream classification was not prepared within areas of Federal/State/Indian lands unless data was readily available. Stream lines were prepared within these areas for continuity, but some data fields were not populated within these areas.

Reach Type

Streams were classified as either engineered or natural, and either constrained or un-constrained. See the exhibit titled, "Watershed Management Area Streams by Reach Type" in Attachment A.2. The purpose of this exercise was to identify whether the stream has been modified by human activity within the stream itself, which may include addition of crossing structures, stabilization of banks, dredging, or any other human activity. This aids the identification of physical structures including stream armoring, constrictions, grade control, and other modifications as required by the Regional MS4 Permit.

Classification of the streams as either “**engineered”** or **“natural”** was based on the following criteria:

<u>Engineered</u>

- A classification of "engineered" was assigned where the stream itself has been modified by human activity.
- All culvert/bridge/pipe crossings either provided in the Copermittees' storm water conveyance system data or clearly visible on the aerial photo have been assigned as engineered within the limits of the crossing.
- If the Copermittees did not provide storm water conveyance system data for the dirt road crossings/dip sections the streams have been assigned as engineered within the limits of the crossing. These crossings may or may not have culverts.
- If the Copermittees' storm water conveyance system data stated the facility is a detention or desilting basin, they were assigned as engineered.
- Golf courses have been assigned as engineered.
- If aerial photography showed large water bodies (lake, pond, irrigation pond, etc.) they were assigned as engineered.
- If the storm water conveyance system data provided by the Copermittees has identified the stream as "rockbs", the assumption has been made that these streams have rocks on their bottom and the sides ("bs"), and have been assigned as engineered.
- Sand mining operations have been assigned as engineered. Sand mining is an operation that is in continuous flux and does not typically result in a discrete, engineered geometry in any given channel cross section until restoration is implemented at the conclusion of the sand mining operation. It is assigned as engineered to acknowledge human alteration of the stream.

<u>Natural</u>

- Streams that have no apparent alteration within the stream itself by human activity have been assigned as natural.

Classification of the streams as either **"constrained"** or **"un-constrained"** was based on the following criteria:

<u>Constrained</u>

- All culvers/bridge/pipe crossings either provided in the Copermittees' storm water conveyance system data or clearly visible on the aerial photo have been assigned as constrained.
- If the Copermittees did not provide storm water conveyance system data for the dirt road crossings/dip sections the streams have been assigned as constrained. These crossings may or may not have culverts.
- If the Copermittees' storm water conveyance system data stated the facility is a detention or desilting basin, they were assigned as constrained.
- Golf courses have been assigned as constrained if located within the Federal Emergency Management Agency (FEMA) floodway based on the "National Flood Hazard Layer" data.

- The USGS National Hydrographic Dataset in their hydrographic category had assigned some reaches as artificial paths. In these situations and if the aerial photography shows large water bodies (lake, pond, irrigation pond, etc.) these streams have been assigned as constrained.
- Sand mining operations located within the FEMA floodway based on the "National Flood Hazard Layer" have been assigned as constrained.

<u>Un-constrained</u>

- Golf courses have been assigned as un-constrained if not located within the FEMA floodway based on the "National Flood Hazard Layer" data.
- Sand mining operations not located within the FEMA floodway based on the "National Flood Hazard Layer" data have been assigned un-constrained.
- If the stream is located within the FEMA floodway based on the "National Flood Hazard Layer" and there is available land in the floodway fringe (the area between the floodway and the 100-yeaer floodplain) the area has been assigned un-constrained. Note that there may be only one side or both sides of the stream with available land in the floodway fringe therefore a note was added as to which side of the stream is constrained and un-constrained.
- If the stream is located within a FEMA 100-year floodplain based on the "National Flood Hazard Layer" data with no floodway and the FEMA floodplain width is not within an existing development or bordered by roads have been assigned as un-constrained.

Bed Material and Bank Material

The following bed and bank materials were identified:

- Concrete
- Riprap
- Pipe / culvert
- Earth

The assumptions made to identify the streams bed and bank materials were based on the following criteria:

- If the data provided by the Copermittees provided information about the stream bed and bank material, the provided data was used for the bed and bank material.
- Generally the data provided by the Copermittees did not identify the crossing type (pipe, box culvert, bridge with or without piers, etc.) or the material (RCP, RCB, earth, riprap, concrete, etc.). In that case, all culvert/bridge/pipe crossings were assigned as pipe/culvert for the bed and bank material.
- If the Copermittees did not provide data for the dirt road crossings/dip sections the bed and bank material have been assigned as pipe/culvert. These crossings may or may not have culverts.

- If the Copermittees' storm water conveyance system data stated the facility is a detention or desilting basin, the bed and bank material have been assigned as earth.
- If aerial photography showed large water bodies (lake, pond, irrigation pond, etc.) they were assigned as earth bed and bank material. The USGS National Hydrographic Dataset in their hydrographic category had assigned some of these types of reaches as artificial paths.
- Sand mining operations within the stream have been assigned as earth for bed and bank material.
- If the Copermittees did not provide data for the stream material the bed and bank material have been assigned based on the aerial photography.

See exhibits titled, "Watershed Management Area Streams by Bed Material" in Attachment A.2.

After stream bed and bank material was classified, earthen reaches were further classified by geologic group. This was accomplished by intersecting the streams with the geologic group layer that had been prepared for use in the dominant hydrologic process and potential coarse sediment yield analyses. The result is displayed in exhibits titled, "Watershed Management Area Streams by Geologic Group" in Attachment A.2.

Hydrographic Category

Streams were classified as "perennial" or "intermittent." See exhibits titled, "Watershed Management Area Streams by Hydrographic Category" in Attachment A.2. Classification was obtained from the USGS National Hydrography Dataset (NHD). The definitions of these categories in the USGS National Hydrography Dataset are:

- **Perennial**: Contains water throughout the year, except for infrequent periods of severe drought.
- **Intermittent**: Contains water for only part of the year, but more than just after rainstorms and at snowmelt.

While the specific Regional MS4 Permit language requested classification of perennial or ephemeral, rather than perennial or intermittent, the data that was referenced in order to classify streams did not include "ephemeral" streams. For reference, the USGS National Hydrography Dataset definition of "ephemeral" is: "contains water only during or after a local rainstorm or heavy snowmelt." None of the stream reaches in the study were classified as ephemeral in the NHD dataset, therefore none are classified as ephemeral in the WMAA product. The City of San Diego provided a map titled “City of San Diego Stream Survey” dated April 3, 2013 prepared by AMEC that shows streams that are “dry” and streams that are “flowing”. This information in conjunction with the other parameters listed in this section was used to determine if a stream was perennial or intermittent.

USGS NHD includes hydrographic category classification for many of the streams. However data was not available for all reaches of all streams. In order to classify reaches of streams that did not already contain this data in NHD, these assumptions were made:

- The USGS NHD information for the stream hydrographic category has been used when available.
- When USGS NHD has “artificial paths” for portions of the stream, the hydrographic category of the upstream portion of the stream have been assigned to the stream unless other assumptions took precedence.
- If aerial photography shows large waterbody (lake, pond, irrigation pond, etc.) perennial has been assumed for the hydrographic category.
- For ponded areas shown on the aerial photography and if the USGS 7.5-minute quadrangles shows cross hatching for the area, intermittent has been assigned unless the upstream portion of the stream was assigned as perennial pursuant to the USGS National Hydrography Dataset then assigned perennial for the ponded area.
- USGS has a dashed line for intermittent streams. USGS has a solid line for perennial streams. In some situations this information was used to assist in the determination of assigning perennial or intermittent to a stream.

2.2.3. Results for stream characterization

The 27 streams and data are contained in a GIS file titled "SD_Regional_WMAA_Streams" located in Attachment C. The streams are shown in watershed maps included in Attachment A.2.

Summary of Deliverables for Stream Characterization

Format	Item	Description	Location
Report	Title of Figures	• "Watershed Management Area Streams" • "Watershed Management Area Streams by Hydrographic Category" • "Watershed Management Area Streams by Bed Material" • "Watershed Management Area Streams by Geologic Group" • "Watershed Management Area Streams by Reach Type"	Attachment A.2
GIS	Map Group Title	Not Grouped	Attachment C
	Map Layer Title	SD_Regional_WMAA_Streams	
	Geodatabase Feature Dataset	Streams	
	Geodatabase Feature Class	SD_Regional_WMAA_Streams	
	Geodatabase Geometry Type	Line	
KMZ [1]	KMZ File Name	SD_Regional_WMAA_Streams	Attachment C

[1] To enhance the utilization of this data, the Stream Characterization map is provided in both traditional GIS file format (ESRI software license purchase required) and as a Google Earth KMZ (Keyhole Markup Language/Zipped) file that can be viewed with the free download version of Google Earth (http://www.google.com/earth/).

In addition to the 27 streams that were subject of detailed analysis, NHD streams have been included on maps and within the geodatabase for reference. The NHD stream alignments have not been corrected and in some cases may be inconsistent with the existing infrastructure. The NHD streams are contained in a GIS file titled, "SD_NHD_Streams."

2.2.4. Limitations for stream characterization

- Only a desktop analysis was performed and no field verification was conducted.
- Infrastructure is only based on storm water conveyance system data provided by Copermittees or clearly visible on aerial photography. If the Copermittee used a numbering or lettering system for describing bed and bank material for example, since the metadata was not provided the bed and bank material could not be verified.
- In some instances concrete channels cannot be identified on aerial photography if it is filled with sediment and/ or vegetation.

2.3. Land Uses

For the purpose of the WMAA, the Regional MS4 Permit requires a description of current and anticipated future land uses. This is presented in the final GIS deliverable as "Land Use Planning" and includes the following representations of land uses in the watersheds: existing land uses, planned land uses, developable lands, redevelopment and infill areas, floodplains, Multiple Species Conservation Program (MSCP) designated areas, and areas not within the Copermittees' jurisdictions (tribal lands, state lands, and federal lands).

2.3.1. Datasets Used for land uses

The following existing regional datasets were referenced to meet this requirement:

- Municipal boundaries: "Municipal_Boundaries" dated August 2012, available from SanGIS/SANDAG
- Ownership: "Parcels" dated December 2013, available from SanGIS/SANDAG
- Existing land use: "SANGIS.LANDUSE_CURRENT" dated December 2012, available from SanGIS/SANDAG (existing land use)
- Planned land use: "PLANLU" (Planned Land Use for the Series 12 Regional Growth Forecast (2050)), dated December 2010, available from SanGIS/SANDAG
- Developable land: "DEVABLE" (Land available for potential development for the Series 12 Regional Growth Forecast), dated December 2010, available from SanGIS/SANDAG
- Redevelopment and infill areas: "REDEVINF" (Redevelopment and infill areas for the Series 12 Regional Growth Forecast), dated December 2010, available from SanGIS/SANDAG
- Floodplains: "National Flood Hazard Layer" provided by Federal Emergency Management Agency October 2012
- Multiple Species Conservation Program (MSCP), total of four datasets available from SanGIS/SANDAG: "MHPA_SD," dated 2012, (Multiple Habitat Planning Areas for City of San Diego); "MSCP_CN," dated 2009 (designations of the County of San Diego's Multiple Species Conservation Program South County Subregional Plan); "MSCP_EAST_DRAFT_CN," dated 2009 (draft East County MSCP Plan); and "Draft_North_County_MSCP_Version_8.0_Categories," dated 2008 (draft North County MSCP Plan)

2.3.2. Methodology/Assumptions/Criteria for land uses

The existing regional datasets for existing land use, planned land use, developable land, redevelopment and infill areas, floodplains, and MSCP designated areas were referenced with no modifications. Areas not within the Copermittees' jurisdictions (tribal lands, state lands, and federal lands) were compiled from SanGIS parcel data (December 2013) based on the "ownership" value. The owners listed below were excluded from the Copermittees jurisdictions and represent the "Federal/State/Indian" layer, which is displayed on various maps included in Attachment A.2.

- Bureau of Land Management
- California Department of Fish and Game
- Indian Reservations
- Military Reservations

- Other Federal
- State
- State of California Land Commission
- State Parks
- U.S. Fish and Wildlife Service
- U.S. Forest Service

When available, relevant data from these areas was included in analyses (e.g., developable land areas within Federal/State/Indian areas). Stream lines were prepared within these areas for continuity. However, stream classification (e.g., bed and bank material) was not prepared within these areas unless data was readily available (e.g., hydrographic category data available from NHD)

2.3.3. Results for land uses

The existing regional datasets are compiled into the Geodatabase in a group titled, "Land Use Planning." Current and anticipated future land uses are depicted in watershed maps included in Attachment C. Federal/State/Indian Lands are also referenced on all other map exhibits included in Attachment A.2.

Summary of Deliverables for Land Uses

<table>
<tr><th>Format</th><th>Item</th><th>Description</th><th>Location</th></tr>
<tr><td>Report</td><td>Title of Figures</td><td>• "Existing Land Use"
• "Planned Land Use"
• "Developable Land"
• "Redevelopment and Infill Areas"</td><td>Attachment A.3</td></tr>
<tr><td rowspan="4">GIS</td><td>Map Group Title</td><td>Land Use Planning</td><td rowspan="4">Attachment C</td></tr>
<tr><td>Map Layer Title</td><td>Municipal Boundaries
Federal/State/Indian Lands
SanGIS_ExistingLandUse
SanGIS_PlannedLandUse
SanGIS_DevelopableLand
SanGIS_RedevelopmentandInfill
FEMA Floodplain
MHPA_SD
MSCP_CN
MSCP_EAST_DRAFT_CN
Draft_North_County_MSCP_Version_8_Categories</td></tr>
<tr><td>Geodatabase Feature Dataset</td><td>LandUsePlanning</td></tr>
<tr><td>Geodatabase Feature Class</td><td>SanGIS_MunicipalBoundaries
Federal_State_Indian_Lands
SanGIS_ExistingLandUse
SanGIS_PlannedLandUse</td></tr>
</table>

Format	Item	Description	Location
		SanGIS_DevelopableLand SanGIS_RedevelopmentandInfill FEMA_NFHL SanGIS_MHPA_SD SanGIS_MSCP_CN SanGIS_MSCP_EAST_DRAFT_CN SanGIS_Draft_North_County_MSCP_Version_8_Categories	
	Geodatabase Geometry Type	Polygon	
KMZ [1]	KMZ File Name	Municipal Boundaries Federal/State/Indian Lands Floodplains Due to file size limitations, SanGIS land use datasets were not converted to KMZ.	Attachment C

[1] To enhance the utilization of this data, the Land Uses map is provided in both traditional GIS file format (ESRI software license purchase required) and as a Google Earth KMZ (Keyhole Markup Language/Zipped) file that can be viewed with the free download version of Google Earth (http://www.google.com/earth/).

2.3.4. Limitations

Some jurisdictions may have compiled GIS land use layers that include more detailed or more current information than the regional datasets available from SanGIS. SanGIS layers were selected for the Regional WMAA to provide consistent land use characterization region-wide, and to provide for repeatability of GIS analyses when a land use layer is required for input data. The definition of non-Copermittee areas identified in this document as "Federal/State/Indian Lands" is for the Regional WMAA. Some WQIPs may define non-Copermittee areas differently.

2.4. Potential Critical Coarse Sediment Yield Areas

The Regional MS4 Permit identifies in the provisions related to the WMAA that potential coarse sediment yield areas within the watershed be identified, with GIS layers (maps) as output. With regard to the function and importance of coarse sediment, SCCWRP Technical Report 667 titled “Hydromodification Assessment and Management in California” states the following:

“Coarse sediment functions to naturally armor the stream bed and reduce the erosive forces associated with high flows. Absence of coarse sediment often results in erosion of in-channel substrate during high flows. In addition, coarse sediment contributes to formation of in-channel habitats necessary to support native flora and fauna.”

This report identifies the potential critical coarse sediment yield areas for the 9 WMAs in compliance with this permit provision. The applied datasets and methodologies for identifying the coarse sediment yield areas, along with their respective results, are described in the sections below.

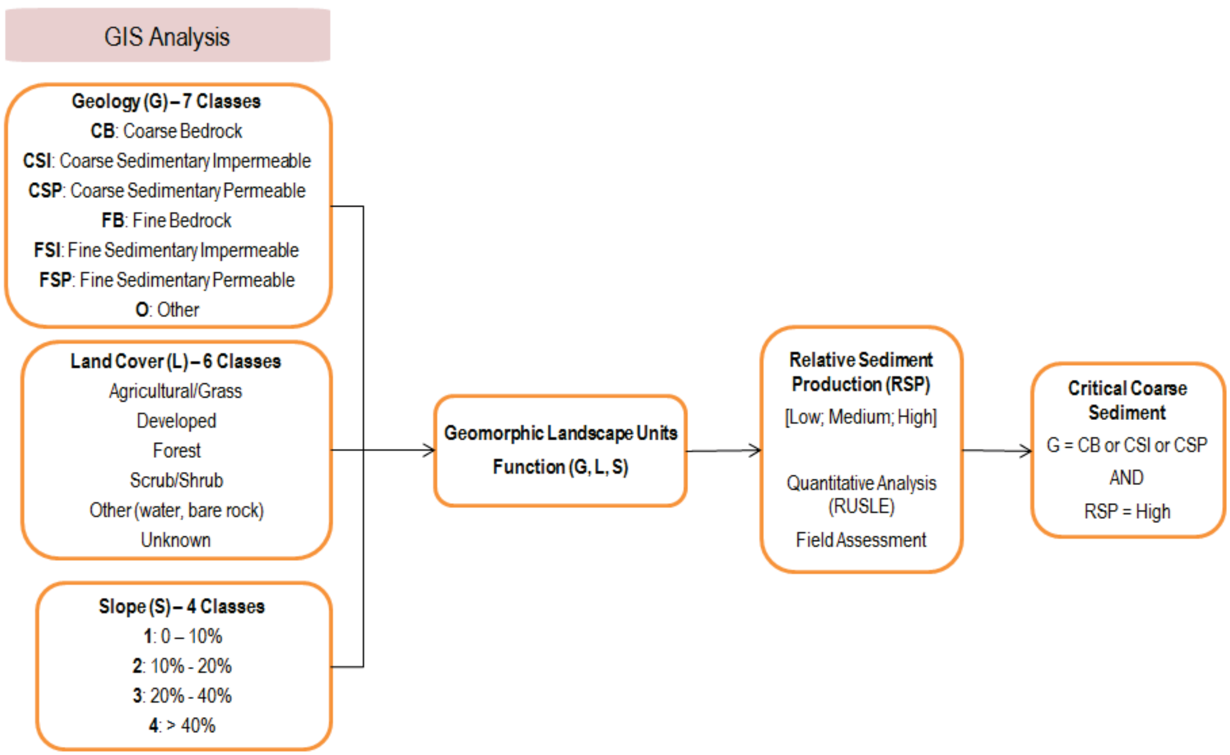
2.4.1. Datasets Used for identifying potential critical coarse sediment yield areas

The following datasets were used in the analysis

Dataset	Source	Year	Description
Elevation	USGS	2013	1/3rd Arc Second (~10 meter cells) digital elevation model for San Diego County
Land Cover	SanGIS	2013	Ecology-Vegetation layer for San Diego County downloaded from SanGIS
Geology	Kennedy, M.P., and Tan, S.S.	2002	Geologic Map of the Oceanside 30’x60’ Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale.
	Kennedy, M.P., and Tan, S.S.	2008	Geologic Map of the San Diego 30’x60’ Quadrangle, California, California Geological Survey, Regional Geologic Map No. 3, 1:100,000 scale.
	Todd, V.R.	2004	Preliminary Geologic Map of the El Cajon 30’x60’ Quadrangle, Southern California, United States Geological Survey, Southern California Areal Mapping Project (SCAMP), Open File Report 2004-1361, 1:100,000 scale.
	Jennings et al.	2010	“Geologic Map of California,” California Geological Survey, Map No. 2 – Geologic Map of California, 1:750,000 scale

2.4.2. Methodology/Assumptions/Criteria for identifying potential critical coarse sediment yield areas

The methodology used to identify coarse sediment yield areas is based on Geomorphic Landscape Unit (GLU) methodology presented in the SCCWRP Technical Report 605 titled "Hydromodification Screening Tools: GIS-Based Catchment Analyses of Potential Changes in Runoff and Sediment Discharge" (SCCWRP, 2010). Geomorphic Landscape Units characterize the magnitude of sediment production from areas through three factors judged to exert the greatest influence on the variability on sediment-production rates: geology types, hillslope gradient, and land cover. The GLU approach provides a useful, rapid framework to identify sediment-delivery attributes of the watershed. The process to integrate these factors into GLUs is indicated in the flow chart below.



The following steps were used to define Geomorphic Landscape Units (GLUs), which were then related to the coarse sediment and critical coarse sediment yield areas in the 9 WMAs in San Diego County.

1. **Integrate data sets used to determine GLU:** Categories for geology, gradient, and land cover were defined based on readily available GIS datasets for the region and classifications found in relevant literature listed in Chapter 6. The different combinations of these categories make up distinct GLUs.

   - **Geologic Categories**: based on methodology listed in Attachment A.4.1 of Attachment A.4. Resulting geologic categories from this analysis are: Coarse Bedrock (CB), Coarse Sedimentary Impermeable (CSI), Coarse Sedimentary Permeable (CSP), Fine Bedrock (FB), Fine Sedimentary Impermeable (FSI), Fine Sedimentary

Permeable (FSP), and Other (O). An exhibit showing the regional geology groupings is presented in Attachment A.4.

- **Land cover categories**: defined using the Ecology Vegetation GIS map layer developed by the City of San Diego, the County of San Diego and SANDAG which were downloaded from SanGIS (2013). The vegetation categories in the GIS layer were grouped (Table A.1.2 in Attachment A.1) to match the following categories used in SCCWRP's Technical Report 605 (SCCWRP, 2010): Agriculture/Grass; Developed; Forest; Scrub/Shrub, Other (Water) and Unknown.

- **Gradient Categories**: based on slope ranges found in a review of relevant literature (GLU methodology applied in California) listed in Chapter 6. The spatial processing of the slope categories utilized the USGS National Elevation Dataset (NED). Slope ranges used include: 0% to 10%, 10% to 20%, 20% to 40%, and greater than 40%.

2. **GLU Union Results**: GIS mapping exercise for the study area resulted in 166 GLUs within the 9 WMAs in San Diego County. Table A.4.2 in Attachment A.4 provides the list of the 166 GLUs.

For implementing hydromodification management performance standards in the Regional MS4 Permit, the Copermittees need to identify Critical Coarse Sediment Yield areas in the study region. To provide information on the identification of Critical Coarse Sediment yield, the study assumed that critical coarse sediment would be generated from GLUs that are composed of geologic units likely to generate coarse sediment (based on the methodology listed in Step 3) and have the potential for high relative sediment production (as estimated using the methodology listed in Step 4).

3. **Define Pertinent Geologic groups**: the geologic groups (Attachment A.4.1) considered in this study to have the potential to generate coarse sediment are Coarse Bedrock (CB), Coarse Sedimentary Impermeable (CSI), and Coarse Sedimentary Permeable (CSP). An exhibit showing the regional geologic grouping is presented in Attachment A.4.

4. **Relate GLU to Sediment Production**: For assigning GLUs with a relative sediment production, the following methodology was utilized:

   - Conducted quantitative analysis to assign relative sediment production. Analysis was performed based on the assumption that sediment production from an area is proportional to the soil loss from the area, as evaluated using standard soil loss equation. Detailed analysis steps are documented in Attachment A.4.2;

   - To validate the quantitative assignment above, a qualitative field assessment was conducted for 40 sites. Site selection and findings from the field assessment is documented in Attachment A.4.3.

   - The result of the field assessment indicated a 65% match between field conditions and the quantitative assignments. The mismatches are attributed to differences in percent land cover as assumed for the quantitative analysis and those observed in the field. As such, the quantitative assignments were considered to be valid for the purposes of assigning relative sediment production.

2.4.3. Results for identifying potential critical coarse sediment yield areas

The resulting GIS maps showing the spatial distribution of geologic grouping and critical coarse sediment yield areas within the 9 WMAs in San Diego Region are provided in Attachment A.4. An ArcMap document which presents the results from each step of the methodology is included in Attachment C. Based on this analysis it was estimated that 82% of the study area is a potential coarse sediment yield area and 20% of the study area is a potential critical coarse sediment yield area. The majority of the potential critical coarse sediment yield areas were identified to be on slopes greater than 25% and/or on federal/state lands.

As a result of the regional-scale datasets, and commensurate data resolution, used to map the potential critical coarse sediment yield areas, some areas may have been mapped that in reality do not produce critical coarse sediment as they are existing developed areas. As such, an opportunity for jurisdictions to incorporate more refined data into the preliminary WMAA GIS dataset based on local knowledge and review of current aerial images was provided. The City of Escondido, the City of Encinitas, the City of Del Mar, the City of Poway, National City, and the County of San Diego provided augmented data in their respective jurisdictional areas.

Summary of Deliverables for Potential Critical Coarse Sediment Yield Areas

Format	Item	Description	Location
Report	Figures	"Geologic Grouping" "Potential Critical Coarse Sediment Yield Areas"	Attachment A.4
GIS	Map Group Layer Name	Potential Coarse Sediment Yield	Attachment C
	Map Layer Title	Geologic Grouping Land Cover Slope Category Geomorphic Landscape Unit Potential Coarse Sediment Yield Area Relative Sediment Production Potential Critical Coarse Sediment Yield Area	
	Geodatabase Feature Dataset	PotentialCoarseSedimentYield	
	Geodatabase Feature Class	GLUAnalysis PotentialCoarseSedimentYieldAreas PotentialCriticalCoarseSedimentYieldAreas	
	Geodatabase Geometry Type	Polygon	
KMZ [1]	KMZ File Name	Potential Critical Coarse Sediment Yield Areas	Attachment C

[1] To enhance the utilization of this data, the Geomorphic Landscape Unit Analysis is provided in both traditional GIS file format (ESRI software license purchase required) and as a Google Earth KMZ (Keyhole Markup Language/Zipped) file that can be viewed with the free download version of Google Earth (http://www.google.com/earth/).

2.4.4. Limitations for identifying potential critical coarse sediment yield areas

The resulting GIS layers were developed using regional datasets and provide a useful, rapid framework to perform screening-level analysis that is appropriate for watershed-scale planning studies. The methodology used to identify potential coarse sediment yield areas does not account for instream sediment supply and sediment production from mass failures like landslides which are difficult to estimate on a regional scale without performing extensive field investigation. This data set also does not account for potential existing impediments that may hinder delivery of coarse sediment to receiving waters or downstream locations within the watershed as this was beyond the scope of a regional study. Where more precise estimates are required for a particular site or subarea it is recommended that this analysis be augmented with site-specific analysis. It is also recognized that this regional data set is a function of the inherent data resolution and therefore may not conform to all site conditions, or does not reflect changes to particular areas that have occurred since the underlying data was developed. As such, the Regional WMAA data for the potential critical coarse sediment yield areas should be verified in the field according to the procedures outlined in the Model BMP Design Manual and/or jurisdiction specific BMP Design Manual.

2.5. Physical Structures

The Regional MS4 Permit requires the Copermittees to identify information regarding locations of existing flood control structures and channel structures, such as stream armoring, constrictions, grade control structures, and hydromodification or flood management basins with GIS layers (maps) as output, for each WMA being analyzed for the purpose of developing watershed-specific requirements for structural BMP implementation. This study identified the physical structures using a desktop-level analysis for the 27 streams identified in Section 2.2 in the 9 WMAs in compliance with this permit provision.

2.5.1. Approach for identifying physical structures

The intent of this portion of the WMAA project was to provide an initial assessment of the structures of interest for the 27 river reaches identified in Section 2.2. This desktop-level analysis was conducted primarily as a visual survey of aerial imagery and FEMA flood insurance study (FIS) profiles where available. The collected information was entered into a GIS layer for inclusion into the overall WMAA geodatabase containing the characterization layers required by the Regional MS4 Permit. To support overall WMA characterization, the information derived in this task provides insight into water and sediment movement through the watershed (SCCWRP, 2012), the opportunities and limitations for infrastructure retrofits and also informs efforts to identify appropriate locations for habitat or riparian area rehabilitation in relation to proximate infrastructure. Specific information regarding how the survey was performed and the attributes of the generated data is presented in Attachment A.5. Note that concrete channels, pipes/culverts, riprap or other artificial stream armoring, and basins have also been identified in the linework generated for the 27 streams (see Section 2.2).

2.5.2. Results for identifying physical structures

The resulting GIS maps showing the spatial locations of the physical structures within the 9 WMAs are provided in Attachment A.5.

Summary of Deliverables for Physical Structures

<table>
<tr><th>Format</th><th>Item</th><th>Description</th><th>Location</th></tr>
<tr><td>Report</td><td>Figure</td><td>Watershed Management Area Streams by Reach Type with Channel Structures</td><td>Attachment A.5</td></tr>
<tr><td rowspan="5">GIS</td><td>Map Group Layer Name</td><td>Channel Structures</td><td rowspan="5">Attachment C</td></tr>
<tr><td>Map Layer Title</td><td>Channel Structures</td></tr>
<tr><td>Geodatabase Feature Dataset</td><td>ChannelStructures</td></tr>
<tr><td>Geodatabase Feature Class</td><td>ChannelStructures</td></tr>
<tr><td>Geodatabase Geometry Type</td><td>Point</td></tr>
<tr><td>KMZ [1]</td><td>Kmz File Name</td><td>ChannelStructures</td><td>Attachment C</td></tr>
<tr><td colspan="4">[1] To enhance the utilization of this data, the Physical Structures map is provided in both traditional GIS file format (ESRI software license purchase required) and as a Google Earth KMZ (Keyhole Markup Language/Zipped) file that can be viewed with the free download version of Google Earth (http://www.google.com/earth/).</td></tr>
</table>

3. Template for Candidate Project List

The Regional MS4 Permit requires each WMA to use the results from the WMA characterization to compile a list of candidate projects that could potentially be used as alternative compliance options for Priority Development Projects should an agency or jurisdiction opt to develop an alternative compliance program. Copermittees must first conclude that implementing such a candidate project would provide greater overall benefit to the watershed than requiring implementation of structural BMPs onsite prior to implementing these candidate projects as alternative compliance projects.

The Copermittees elected to identify potential candidate projects as a separate effort from this regional project, and therefore the process for identifying candidate projects is not documented in this report. Instead, this project only developed a template, in a spreadsheet format, for use by the Copermittees to compile lists of potential candidate projects. The template is intended to enhance regional consistency of the information that is gathered for candidate projects. The template spreadsheet file was distributed to the Copermittees on January 28, 2014. A table of the template components is indicated below:

Column	Primary Heading	Secondary Heading	Guidance for Completing the Project List
A	Project Identifier	-	Unique identifier for the project.
B	Watershed Management Area	-	Dropdown menu to select the watershed management area the project is located in
C	Hydrologic Area (HA)	-	Dropdown menu to select the hydrologic area the project is located in Select a WMA in column B for HA (Column C) dropdown menu to activate.
D	Hydrologic Subarea (HSA)	-	Dropdown menu to select the hydrologic subarea the project is located in. Select a HA in column C for HSA (Column D) dropdown menu to activate.
E	Jurisdiction	-	Dropdown menu to select the jurisdiction the project is located in. Select a HSA in column D for Jurisdiction (Column E) dropdown menu to activate.
F	Project Name	-	Indicate the name of the project.
G	Ownership	Type	Dropdown menu to select if the project is a public project, private project, or public-private partnership.
H	Ownership	Ownership Information	List the details for the owner.
I	Project Location	Address	List the address of the project site.
J	Project Location	APN	List the APN of the parcel.
K	Project Location	Latitude	List the latitude of the project site.
L	Project Location	Longitude	List the longitude of the project site.

Column	Primary Heading	Secondary Heading	Guidance for Completing the Project List
M	Project Origination/ Originator	Name	List the name of the report/organization/individual that provided the idea for the project. Potential origination sources: WQIP, WMAA, JURMPs, WURMPs, CLRPs, IRWM, MSCP, MHPA, Other.
N	Project Origination/ Originator	Contact Information	Link or report title if the proposed project is from a report [or] contact information if from an organization/individual.
O	Project Category	-	Drop Down menu to select the project category; In addition to the 6 project categories explicitly listed in the Regional MS4 Permit, the drop down menu also has a category "Other project types allowed by the MS4 Permit". Example for "Other" project types are agency CIP programs such as Green Streets, LID conversions (medians, parks), agency filter installation, etc.
P	Specific Project Type	-	List the subcategory of the project; for example, list Regional BMP type (i.e. infiltration basin, wetland, etc.).
Q	Potential Pollutant	-	Identify the potential pollutant(s) that can be treated by the proposed project.
R	Project Size & Parameters	Contributing Drainage Area (acres)	List the contributing drainage area to the project.
S	Project Size & Parameters	Parcel Size (acres)	List the size of the parcel the project is located on.
T	Project Size & Parameters	Project Footprint (acres)	List the size of the project footprint.
U	Project Size & Parameters	Parameters (with units as necessary)	Parameters needed to quantify benefits from the project; i.e. for an infiltration basin, list the water quality volume, long-term infiltration rate, depth of the basin, etc.
V	Regulatory Requirement	-	Indicate if the project is proposed to meet particular regulatory requirement such as TMDL, etc.
W	Project Timeline	-	Indicate if a project must be implemented by certain date to meet a grant deadline or other time commitment.
X	Other Notes	-	List any other relevant notes; for example, when retrofitting existing infrastructure project category is selected, input parameters needed to quantify benefits from existing infrastructure into this column as these will be needed to estimate additional benefits that can be used for alternative compliance. If N/A is selected in any dropdown menus, add additional explanation in here

4. Hydromodification Management Applicability/Exemptions

Hydromodification, which is caused by both altered storm water flow and altered sediment flow regimes, is largely responsible for degradation of creeks, streams, and associated habitats in the San Diego Region. The purpose of the hydromodification management requirements in the Regional MS4 Permit is to maintain or restore more natural hydrologic flow regimes to prevent accelerated, unnatural erosion in downstream receiving waters.

The Regional MS4 Permit allows exemptions at the discretion of the local agencyfor priority development projects that discharge runoff to receiving waters that are not susceptible to erosion (e.g., a reservoir, lake, enclosed embayment, or the Pacific Ocean) either directly or via hardened systems including concrete-lined channels or existing underground storm drain systems.

The March 2011 Final Hydromodification Management Plan (HMP) identified certain exemptions from hydromodification management requirements by presenting "HMP applicability criteria." The Regional MS4 Permit maintains some of these HMP applicability criteria. However, some of the applicability criteria are not included under the Regional MS4 Permit unless the area or receiving water is mapped in the WMAA. The intent of this Section is to provide supporting technical analyses for exemptions that are recommended by the WMAA, and to provide mapping of areas exempt from hydromodification management requirements.

4.1.Additional Analysis for Hydromodification Management Exemptions

This section documents additional analysis performed to further evaluate the following exemptions that were already approved by the San Diego Regional Board with the 2011 Final HMP. This study only provides additional analysis, data, and rationale for supporting or eliminating the following existing exemptions and does not propose or study any new exemptions.

- Exempt River Reaches
- Stabilized Conveyance Systems Draining to Exempt Water Bodies
- Highly Impervious Watersheds and Urban Infill and
- Tidally Influenced Lagoons

4.1.1. Exempt River Reaches

4.1.1.1. History

The March 2011 Final HMP, approved by the SDRWQCB under the 2007 MS4 Permit, provided a potential exemption from hydromodification management requirements for projects discharging runoff directly to certain major river reaches, provided that the outlet elevation of the project's outfall(s) to an identified exempt river reach are between the river bottom elevation and the 100-year floodplain elevation, and properly sized energy dissipation is provided at the outfall(s).

Exempt river systems/reaches from the 2011 Final HMP:

River	Downstream Limit	Upstream Limit
Otay River	Outfall to San Diego Bay	Lower Otay Reservoir Dam
San Diego River	Outfall to Pacific Ocean	Confluence with San Vicente Creek
San Dieguito River	Outfall to Pacific Ocean	Lake Hodges Dam
San Luis Rey River	Outfall to Pacific Ocean	Upstream river limit of Basin Plan subwatershed 903.1 upstream of Bonsall and near Interstate 15
Sweetwater River	Outfall to San Diego Bay	Sweetwater Reservoir Dam

Exemptions related to runoff discharging directly to the above river reaches were based on the flow duration analysis performed for the San Diego River in the Final HMP and the Technical Advisory Committee (formed to provide input on the development of the Final HMP) members' opinion (based on field observations and years of historical perspective) that the above river reaches have very low gradients, were depositional (aggrading), have very wide floodplain areas when in the natural condition and that the effects of cumulative watershed impacts to these reaches is minimal provided that properly sized energy dissipation is provided at outfalls to the rivers.

4.1.1.2. Status under 2013 Regional MS4 Permit

Under the Regional MS4 Permit, exempt river reaches would not qualify for exemption from hydromodification management controls unless the optional WMAA is developed with additional rationale/analyses to support reinstating exemptions to these river reaches. Additional analysis performed as part of the WMAA to evaluate hydromodification management control exemptions to the previously exempt reaches is presented below.

4.1.1.3. Research, Approach and Results

Hydromodification impacts can be caused due to increase in flows, changes in sediment transport capacity and changes in sediment supply to the streams (SCCWRP, 2012). In order to evaluate the cumulative impacts due to development and determine if hydromodification management control exemptions can be reinstated for the river reaches that were exempt in the previous permit term, erosion potential (Ep) analysis was used to evaluate the increase in flows and changes in sediment transport capacity. In addition, sediment supply potential (Sp) analysis was used to evaluate the changes in sediment supply in this study. In regards to Ep analysis

SCCWRP Technical Report 667 "Hydromodification Assessment and Management in California" states:

> *"The underlying premise of the erosion potential approach advances the concept of flow duration control by addressing in-stream processes related to sediment transport. An erosion potential calculation combines flow parameters with stream geometry to assess long term (decadal) changes in the sediment transport capacity. The cumulative distribution of shear stress, specific stream power and sediment transport capacity across the entire range of relevant flows can be calculated and expressed using an erosion potential metric, Ep (e.g., Bledsoe, 2002)."*

The approach used in this study is explained in detail in Attachment B.1.1.1. The following WMA characterization maps developed in Section 2 were used to select inputs for the exempt river reach analysis:

- Planning land use layers from Section 2.3 were used to estimate the existing impervious area and identify the developable parcels in each watershed. A GIS exercise was performed to identify the developable parcels in each watershed that will be exempt from hydromodification management requirements if the exemption is granted.
- Stream type classification analysis from Section 2.2 was used to select a conservative cross section (segments that are assigned naturally constrained) to be used in analysis for each watershed.
- GLU analysis and its associated quantitative analysis described in Section 2.4 were used to determine Sp metric for each watershed. In this study coarse sediment supply changes were limited to changes in hill slope erosion between existing condition and future condition (for parcels that are proposed to be exempt from hydromodification management) of the watershed. It was assumed that the changes in instream sediment supply between existing and future condition for these large depositional river systems are very minimal.

Selection of inputs for the analysis is explained in detail in Attachment B.1.1.2 and results from the analysis are presented in Attachment B.1.1.3 in tabular format. The Ep analysis performed in this study does not account for the following Regional MS4 permit requirements as a conservative assumption. If accounted for, it will result in a smaller Ep than what is currently reported in Attachment B.1.1.3:

- New development priority development projects including projects that are proposed to be exempt from hydromodification management requirements through this WMAA study must implement retention BMPs to the extent feasible if alternative compliance option is not selected or not available.
- Redevelopment priority development projects must mitigate to the pre-developed condition.

4.1.1.4. Recommendation

Based on the results from this study reported in Attachment B.1.1.3, the flow duration analysis performed in the Final HMP, and the Technical Advisory Committee (TAC) recommendations provided during the Final HMP development, it is recommended that hydromodification management exemption be reinstated for projects discharging runoff directly to the following exempt river reaches:

River	Downstream Limit	Upstream Limit
Otay River	Outfall to San Diego Bay	Interstate 805
San Diego River	Outfall to Pacific Ocean	Confluence with San Vicente Creek
San Dieguito River	Upstream edge of the railroad crossing	Lake Hodges Dam
San Luis Rey River	Outfall to Pacific Ocean	Upstream river limit of Basin Plan subwatershed 903.1 upstream of Bonsall and near Interstate 15
Sweetwater River	Outfall to San Diego Bay	Sweetwater Reservoir Dam

Each municipality must define/approve "direct discharge" based on the project site conditions. To qualify for the potential exemption, the outlet elevation must be between the river bottom elevation and the 100-year floodplain elevation and properly designed energy dissipation must be provided. Mapping of these exempt river reaches is presented in Attachment B.2.

Additional studies to establish a site-specific allowable Ep metric for the Otay River from east of Interstate 805 to Lower Otay Reservoir Dam, more closely representing actual measured and observed characteristics of this river system, may result in allowing hydromodification management exemptions not currently supported by this desktop assessment which was based on an allowable Ep metric from literature. However, any future proposed HMP exemptions would need to be approved through the WQIP Annual Update process (Regional MS4 Permit Section F.1.2.c.).

4.1.1.5. Limitations

The analysis and associated recommendations as presented above were based on instream erosion as the primary consideration to support reinstatement of exemptions from hydromodification management controls for discharges directly to these river reaches. While it is recognized that other factors contribute to adverse impacts (e.g., salinity imbalance, pollutants) to instream habitat and resulting biotic integrity, hydromodification management control has traditionally been considered an "umbrella process" that encompasses most of the highest risk stressors (percent sands and fines present, channel alteration, and riparian disturbance) to physical habitat. Beyond demonstrating that instream erosion is not anticipated as a result of reinstating hydromodification management control exemptions for discharges to these river reaches, a focused method for correlating physical and biotic integrity to modified hydrological conditions has not been performed in this analysis, as an assessment method has not yet been developed.

The current assessment methods may yield inconclusive results when attempting to identify causal relationships between degraded instream habitat solely due to increased flows and erosive force from hydromodification. A causal assessment recently conducted in the lower reaches of the San Diego River, conducted as a partnership between the Southern California Coastal Water

Research Project (SCCWRP), the City of San Diego, the County of San Diego, and the San Diego RWQCB, focused on stressors potentially responsible for known biological impairment of the river. Once the data of the causal assessment become available, it may be useful in classifying the potential stressors such as altered physical habitat as likely, unlikely, or an uncertain cause to biological impairment.

With respect to adverse impacts to habitat as a result of pollutants entrained in storm water discharges, these areas will still be subject over time to the pollutant control requirements of the Regional MS4 Permit as areas develop or redevelop. The current requirements obligate development to maximize retention of the design storm volume which will mitigate a portion of the volume that would otherwise be controlled with hydromodification management BMPs. In some cases, this offsetting of volume reduction through pollutant control BMPs may exceed the HMP volumes. In addition, the development that occurs within the exempted watershed areas is still required to provide any applicable flood control measures. Risk of flooding as a result of exemption from hydromodification controls is unlikely as the control thresholds are significantly lower (order of magnitude) than flood control requirements implemented to protect life and property.

4.1.2. Stabilized Conveyance Systems Draining to Exempt Water Bodies

4.1.2.1. History

The March 2011 Final HMP, approved by the SDRWQCB under the 2007 MS4 Permit, provided a potential exemption from hydromodification management requirements for projects discharging runoff directly to hardened or rehabilitated systems that extend to exempt receiving waters. As described in the HMP, hardened or rehabilitated systems could include existing storm drain systems, existing concrete channels, or stable engineered unlined channels. To qualify for this exemption, the existing hardened or rehabilitated conveyance system must continue uninterrupted to the exempt system. In other words, the hardened or rehabilitated conveyance system cannot discharge to an unlined, non-engineered channel segment prior to discharge to the exempt system. Additionally, the project proponent must demonstrate that the hardened or rehabilitated conveyance system has capacity to convey the 10-year ultimate condition flow through the conveyance system. The 10-year flow should be calculated based upon single-event hydrologic criteria as detailed in the San Diego County Hydrology Manual.

This exemption was consistent with 2007 MS4 Permit language allowing exemption for discharges into "channels that are concrete-lined or significantly hardened (e.g., with rip-rap, sackrete, etc.) downstream to their outfall in bays or the ocean." The HMP language also allowed for channels stabilized by soft methods such as turf reinforcement mat or vegetation to be considered for exemption. Under these criteria, an engineered channel that is stabilized with riprap, turf reinforcement mat, vegetation, or other materials other than concrete could be determined to be exempt from hydromodification management requirements, pending demonstrating that it has capacity to convey the 10-year ultimate condition flow.

4.1.2.2. Status under 2013 Regional MS4 Permit

A significant change under the Regional MS4 Permit is the requirement that exempt systems draining to exempt water bodies either be "existing underground storm drain systems," or "conveyance channels whose bed and banks are concrete lined" all the way to exempt water bodies. The Regional MS4 Permit language does not include engineered channels that are stabilized with materials other than concrete, such as riprap, turf reinforcement mat, or vegetation. However, areas identified by Copermittees as appropriate for an exemption may be identified in the optional WMAA incorporated into the WQIP.

4.1.2.3. Research and Results

To provide a process for engineered channels that are stabilized with materials other than concrete, such as riprap, turf reinforcement mat, or vegetation to be identified in the WMAAs, an example study was prepared for an existing engineered channel stabilized with vegetation. The study demonstrates that a channel stabilized with materials other than concrete can be stable or have minimal potential for erosion. In order to allow for other channels that are stabilized with materials other than concrete to be identified in each WMAA, criteria for defining what is "stable" or "minimal potential for erosion" was determined.

Forrester Creek in the City of Santee was selected for the sample channel analysis. Forrester Creek is stabilized with vegetation from its confluence with the San Diego River downstream to Prospect Avenue upstream. For the purpose of this discussion, the confluence is the location where the floodplain of Forrester Creek meets the San Diego River floodplain, just west of

Gorge Avenue and Willowgrove Avenue, at the eastern side of the Carlton Oaks Golf Course. Stabilization occurred in two separate projects. The reach from the San Diego River confluence downstream to Mission Gorge Road upstream was constructed in 1990. The reach from Mission Gorge Road downstream to Prospect Avenue upstream is known as the Forrester Creek Improvement Project and was constructed in 2006-2007. Forrester Creek includes energy dissipators stabilized with riprap, concrete, and articulated concrete block at Mission Gorge Road undercrossing and Prospect Avenue undercrossing. Other than at bridge crossings, the engineered un-lined reach of Forrester Creek is stabilized with native vegetation. There is dense growth of trees in the channel.

Vegetation in Forrester Creek Downstream of Mission Gorge Road

Vegetation in Forrester Creek Upstream of Mission Gorge Road between Mission Gorge Road and State Route 52

Vegetation in Forrester Creek between State Route 52 and Olive Lane

Upstream of Prospect Avenue, Forrester Creek is a concrete-lined channel serving an urban area that is almost fully built out and served by existing underground storm drain systems and concrete-lined channels. Because of the vegetated reaches of Forrester Creek extending to the San Diego River, the concrete-lined portion of Forrester Creek and tributary underground storm drain systems and concrete-lined channels are not exempt from hydromodification management requirements unless the vegetated reaches of Forrester Creek are identified in the optional WMAA incorporated into the WQIP.

An erosion potential analysis was prepared for the vegetated reaches of Forrester Creek. An erosion potential analysis compares cumulative excess shear stress over all flows capable of transporting the channel-bed material from post-development to pre-development condition. The analysis used the same methods for determining erosion potential as presented in Section 4.1.1 and Attachment B.1.1 for the major river reaches.

For the purpose of determining flow rates and durations (hydrologic analysis), a regional scaling procedure developed by Hawley & Bledsoe in 2011 was used, the same method as presented in Section 4.1.1 and Attachment B.1.1 for the major river reaches. The method uses Duration Density Functions (DDFs) presented in the 2011 paper, "How do flow peaks and durations change in suburbanizing semi-arid watersheds? A southern California case study," to estimate cumulative durations for geomorphically-effective flows in a logarithmically-binned histogram format. Using these flows, long-term sediment transport can be subsequently estimated. The analysis requires the following data, summarized below.

Summary of Input Data for Hydrologic Calculations for Forrester Creek Erosion Potential Analysis

Data	Units	Forrester Creek Watershed Existing Condition	Forrester Creek Watershed Future Condition
Tributary Area, A	square miles (mi^2)	23.36	23.36
Mean Annual Precipitation, MAP	inches	14	14
Length of Daily Flow Record	Years	30	30
Minimum Flow Rate	cubic feet per second	0.01	0.01
Number of Flow Bins	--	25	25
Impervious Cover	mi^2/ mi^2	0.4634	0.4792

Impervious cover for the Forrester Creek watershed was determined by assigning land-use specific imperviousness values to the land use categories presented in the SanGIS land use data sets (existing land use in 2012 and planned land use, described in Chapter 2.3). The composite imperviousness of the watershed was then calculated based on the existing condition and future condition land use distribution within the watershed. The Forrester Creek watershed is nearly fully built out therefore there is little change in imperviousness from existing to future condition. Impervious area calculations for the Forrester Creek watershed are provided in Attachment B.1.2.

For the purpose of determining shear stress in the channel (hydraulic analysis), normal depth calculations for the binned flow rates determined from the DDF analysis were prepared for two channel cross sections. One cross section was taken in the reach constructed in 1990, and one cross section in the Forrester Creek Improvement Project reach. For each reach, the cross section expected to experience the greatest shear stress was selected, based on channel width and slope. The analysis requires the following data, summarized below.

Summary of Input Data for Hydraulic Calculations for Forrester Creek Erosion Potential Analysis

Data	Units	Forrester Creek Watershed Cross Section 1300	Forrester Creek Watershed Cross Section 2475
Channel Bottom Width, b	feet	84	155
Channel Side Slopes, z1 and z2	Horizontal:Vertical	z1 = 1.5:1 z2 = 2:1	z1 = z2 = 2:1
Channel Slope	foot/foot	0.006	0.003
Channel Roughness (Manning's n)	--	0.100	0.100
Critical Shear Stress	pounds per square foot (lb/ft^2)	2.1	2.1

Critical shear stress for the reaches was estimated to be greater than or equal to 2.1 pounds per square foot (lb/ft2), based on review of permissible shear stress values presented in "Stability Thresholds for Stream Restoration Materials" (Fischenich 2001) and "Streambank Soil Bioengineering Considerations for Semi-Arid Climates" (Hoag and Fripp 2005). Based on Fischenich 2001, permissible shear stress for "live willow stakes" is approximately 2.10 to 3.10 lb/ft2.

The analysis results, presented in Attachment B.1.2, show that for both the existing and future condition, the shear stress for all geomorphically-effective flows based on the DDF analysis is less than the estimated critical shear stress of 2.1 lb/ft2. This means that no excess shear stress or "work" occurs in the channel in either the existing or future condition. Therefore, there is no increase in the duration of "work" (cumulative work), in the future condition, and erosion potential is 1.0.

Note that while the flow rates are the same in both the existing and future condition analyses, the duration of each flow rate is increased in the future condition. The flow rates in the flow bins are based on the watershed area, mean annual precipitation, and length of the synthetic record. These do not change from existing to future condition. The duration for each flow bin is related to the watershed area, mean annual precipitation, length of the synthetic record, and the impervious area. The duration increases in the future condition based on the increased impervious area. The increase in duration would result in increased cumulative work in the future condition if any of the flow rates resulted in shear stress greater than the estimated critical shear stress (excess shear stress, or "work"), because cumulative work is the product of work times duration.

The scenario that occurred in the Forrester Creek analysis, in which no work occurred in the expected range of geomorphically-effective flow rates, is a potential scenario for engineered channels because engineered conveyance systems are typically engineered for flood flows much greater and less frequent than the geomorphically-effective flows. For example, Forrester Creek is engineered to convey a 100-year single-storm event flow rate of approximately 12,450 to 13,840 cubic feet per second (cfs) within the channel. ForresterThe maximum geomorphically-effective flow rate for Forrester Creek based on the DDF analysis is 836 cfs.

4.1.2.4. Recommendation

Based on the study that was prepared for this Regional WMAA, the vegetated reaches of Forrester Creek from its confluence with the San Diego River downstream to Prospect Avenue upstream are recommended to be exempt from hydromodification management requirements. The analysis has shown that future increases in impervious area within the watershed are not expected to increase the erosion potential in Forrester Creek. The concrete-lined portion of Forrester Creek and existing storm drain systems draining directly to the concrete-lined portion of Forrester Creek should also be exempt. Storm drain systems draining directly to the vegetated reaches of Forrester Creek would also be exempt if there is no evidence of localized erosion issues at the storm drain outfall.

Because engineered conveyance systems are typically engineered to convey flood flows much greater than the geomorphically-effective flows, some engineered conveyance systems may be capable of conveying all geomorphically-effective flows at very low depths with shear stress less than critical shear stress, as was the case for Forrester Creek. Based on this, other engineered conveyance systems that are stabilized with materials other than concrete, such as riprap, turf reinforcement mat, or vegetation, including rehabilitated stream systems, and/or existing natural stream systems that appear stable based on visual inspection may be studied using the exemption methodology presented in Attachment E. Systems evaluated using this methodology and that meet the criteria presented below, may be recommended as exempt systems in the optional WMAA incorporated into the WQIP. However, any future proposed HMP exemptions would need to be approved through the WQIP Update process (Regional MS4 Permit Section F.2.c.).

The following are additional requirements and criteria for the qualifying for potential exemption:

- To qualify for exemption, the studied conveyance system must discharge to an exempt system (i.e., an exempt water body, an exempt river reach, or an existing storm drain system or concrete-lined channel that extends all the way to an exempt water body or exempt river reach). In other words, the studied conveyance system cannot discharge to a non-exempt channel segment prior to discharge to the exempt system.
- The river reach exemptions were established based on assumptions that certain stabilized conveyance systems were exempt and associated tributary developments were exempt from hydromodification management flow control requirements. Therefore if a conveyance system that is being studied for exemption is tributary to an exempt river reach, exemption of the studied conveyance system is only feasible if the conveyance system was included in the analysis of the exempt river reach (see Attachment B.1.1), or pending submittal of an updated analysis for the exempt river reach to include the additional stabilized conveyance system.
- Channel cross section(s) must be selected to represent the condition where the greatest shear stress is expected in the channel(s).

4.1.3. Highly Impervious/Highly Urbanized Watersheds and Urban Infill

4.1.3.1. History

The March 2011 Final HMP, approved by the SDRWQCB under the 2007 MS4 Permit, provided a potential exemption from hydromodification management requirements for projects discharging runoff to a highly urbanized watershed (defined as an existing, pre-project impervious percentage greater than 70 percent) (herein "highly impervious / highly urbanized watersheds exemption") and another potential exemption for urban infill projects discharging runoff to an existing hardened or rehabilitated conveyance system, where the existing impervious area percentage in the watershed exceeds 40 percent (herein "urban infill exemption").

To qualify for the highly impervious / highly urbanized watersheds exemption, watershed impervious area calculations must be measured between the project site discharge location and the connection to a downstream exempt system. If a tributary area connects with the main line drainage path between the project site and the exempt system, then the entire watershed area contributing to the tributary shall be included in the calculation.

To apply the urban infill exemption for a project, the domain of analysis must be determined and the existing hardened or rehabilitated conveyance system must extend beyond the downstream terminus of the domain of analysis. The hardened or rehabilitated conveyance system must discharge to a receiving channel with a Low potential for channel susceptibility for this exemption to be granted (channel susceptibility determined using SCCWRP tool). Additionally, the exemption could only be granted if the potential future development impacts in the watershed would increase the watershed's impervious area percentage by less than 3 percent (as compared to the existing condition in the year 2010). If the potential future cumulative impacts in the watershed could increase the impervious area percentage by more than 3 percent (as compared to existing condition), then no exemption could be granted based on this item. Watershed impervious area calculations for this potential exemption must be measured upstream from the outfall of the urban conveyance system (to a non-concrete, non-riprap-lined or non-engineered channel) to the contributing watershed boundary (the entire watershed contributing to the discharge outfall).

4.1.3.2. Status under 2013 Regional MS4 Permit

Under the Regional MS4 Permit, highly impervious / highly urbanized watersheds and urban infill areas would fall under the category of areas identified by Copermittees as appropriate for an exemption. These areas may be identified in the optional WMAA incorporated into the WQIP.

4.1.3.3. Research and Results

The highly impervious / highly urbanized watersheds exemption was based on 2007 MS4 Permit language that exempted "construction of projects where the sub-watersheds below the projects' discharge points are highly impervious (e.g., >70%) and the potential for single-project and/or cumulative impacts is minimal." No modeling was prepared in support of this exemption during development of the March 2011 Final HMP – the exemption was provided by the 2007 MS4 Permit.

The urban infill exemption was based on a sensitivity analysis presented in Appendix F of the March 2011 Final HMP. The analysis was prepared using continuous simulation modeling of synthetic unit watersheds. The level of imperviousness was progressively increased for each synthetic unit watershed to simulate infill development. The flow duration statistics were examined to determine at what level of increased development the statistics became noticeably altered. Based on the study it was determined that urban infill projects have a relatively minor effect on the overall watershed's flow duration curve if the future cumulative additional impacts have the potential to increase the existing watershed impervious area by less than 3 percent. "Relatively minor effect" was not defined with a numeric threshold in Appendix F of the March 2011 Final HMP.

The sensitivity analysis prepared for the urban infill exemption examined synthetic unit watersheds with 40, 50, and 60 percent imperviousness. The extent of the spread in the results of the 40, 50, and 60-percent models demonstrated that unchecked development within urbanized watershed would have a noticeable effect on the peak flows and flow durations observed within the receiving waters. While watersheds 70% impervious and above were not modeled, unchecked development within these "highly impervious / highly urbanized watersheds" may also have a noticeable effect on the peak flows and flow durations observed within the receiving waters.

Since the adoption of the March 2011 Final HMP, a study titled, "Channel Enlargement in Semiarid Suburbanizing Watersheds: A Southern California Case Study," prepared by R.J. Hawley and B.P. Bledsoe, was published in Journal of Hydrology 496 (2013). The study presented a numeric threshold at which channel enlargement could be expected. In the study, "the threshold corresponding to the presence/absence of headcutting varied based on substrate type, and was roughly quantified as a sediment-transport ratio greater than ~1.20 in systems with a median grain size > 16 mm, and Lr ~1.05 when d50 < 16 mm." Sediment-transport ratio or Lr is the ratio of the cumulative excess shear stress over all flows capable of transporting the channel-bed material from post-development to pre-development condition. This is also known as "effective work index" or "erosion potential."

Using thresholds of 1.20 for systems with a median grain size > 16 mm, and 1.05 for systems with a median grain size < 16 mm, Geosyntec Consultants prepared a study in support of the Ventura County Hydromodification Control Plan (Ventura County HCP) to evaluate thresholds for additional impervious cover, from existing conditions (at the time of the HCP effective date) to build-out conditions, for the area tributary to a susceptible receiving water below which the risk of hydromodification impacts is considered negligible for that channel. The study is titled, "Basis for Designating Negligible Risk Based on Cumulative Future Buildout," and is presented in Appendix D of the Ventura County HCP (Final Draft dated September 2013). A copy of Appendix D of the Ventura County HCP (Final Draft dated September 2013) is provided in Attachment B.1.3. The following are the results of the study, presented as a function of a susceptible channel's tributary area (A) and median grain size (D50):

- If A > 1 square mile and D50 < 16 mm, then the threshold of additional imperviousness is evaluated using a nomograph that is based on empirical flow duration equations (Hawley and Bledsoe, 2011), empirical channel geometry relationships (Coleman et al, 2005 and County of San Diego, 2009), and Erosion Potential analyses. The results range from 0.46% to 1.00% additional imperviousness, depending on watershed size and mean annual precipitation (MAP).

- If A < 1 square mile and D50 < 16 mm, then the threshold of additional imperviousness is 0.44%.
- If D50 > 16 mm, then the threshold of additional imperviousness is 1.65%.

The thresholds of additional imperviousness presented in the Ventura County HCP (ranging from 0.44% to 1.65%) are lower than the 3% allowable limit presented in the San Diego County Final HMP dated March 2011.

4.1.3.4. Recommendation

Based on evaluation of the exemptions presented in the March 2011 Final HMP and comparison with more recent research prepared for the Ventura County HCP, resurrection of the highly impervious / highly urbanized and urban infill exemptions from the March 2011 Final HMP is not recommended. The research prepared in support of the Ventura County HCP determined lower thresholds of additional impervious area (ranging from 0.44% to 1.65%) than the limit presented in the San Diego County Final HMP dated March 2011 (3%).

4.1.4. Tidally Influenced Lagoons

4.1.4.1. History

The March 2011 Final HMP, approved by the SDRWQCB under the 2007 MS4 Permit, provided a potential exemption from hydromodification management requirements for projects discharging runoff directly to a tidally-influenced lagoon. To qualify for the potential exemption, additional analysis would be required to assess the effects of the freshwater / saltwater balance and the resultant effects on lagoon-system biology. This assessment, which would be required by other permitting processes such as the Army Corps of Engineers, California Department of Fish and Game, etc., must be provided by a certified biologist or other specialist as approved by the governing municipality. Additionally, project discharges must include an energy dissipation system (riprap, etc.) designed to mitigate 100-year outlet velocities based upon a free outfall condition.

4.1.4.2. Status under 2013 Regional MS4 Permit

The Regional MS4 Permit language discussing exemptions from hydromodification management does not specifically include the terminology that was used in the Final HMP including, "tidally influenced lagoons" or "tidally influenced areas." The Permit does indicate that exemptions from hydromodification management may be granted for discharges from existing underground storm drains and concrete lined conveyance channels to "enclosed embayments" (lagoons). However, other drainage systems not meeting the above definition may be identified by Copermittees as appropriate for an exemption in the optional WMAA incorporated into the WQIP.

4.1.4.3. Recommendation

Engineered conveyance systems discharging to lagoons that are stabilized with materials other than concrete, such as riprap, turf reinforcement mat, or vegetation, including rehabilitated stream systems, and/or existing natural stream systems that appear stable based on visual inspection may be studied using the exemption methodology presented in Attachment E. Systems evaluated using this methodology and that meet the criteria presented below, may be recommended as exempt systems in the optional WMAA incorporated into the WQIP. However, any future proposed HMP exemptions would need to be approved through the WQIP Update process (Regional MS4 Permit Section F.2.c.).

The following are additional requirements and criteria for the qualifying for potential exemption:

- To qualify for exemption, the studied conveyance system must discharge to an exempt system (i.e., an exempt water body, an exempt river reach, or an existing storm drain system or concrete-lined channel that extends all the way to an exempt water body or exempt river reach). In other words, the studied conveyance system cannot discharge to a non-exempt channel segment prior to discharge to the exempt system.
- Channel cross section(s) must be selected to represent the condition where the greatest shear stress is expected in the channel(s)

5. Conclusions

5.1. Watershed Management Area Characterization

The WMA Characterization data was developed using available regional data to further understand the macro-scale watershed characteristics and processes in the San Diego permit region. The Regional MS4 Permit allows for flexibility in complying with land development requirements when using the information developed in the WMAA to improve water quality planning and implementation associated with land development. This dataset will assist with identifying the opportunities and constraints for projects and management decisions based on a watershed-scale (rather than piecemeal project identification without context within the watershed) and provides Copermittees the ability to exercise the option to create an alternative compliance program that offers the opportunity to develop watershed-specific alternatives to universal onsite structural BMP implementation. The characterization data includes:

Characterization Data	Utilization Potential
Dominant Hydrologic Process: • Overland flow • Infiltration • Interflow	• Identify areas for enhanced infiltration or collection of storm water for treatment • Implement management measures that correspond to pre-development conditions – promotes long-term channel stability and health • Increases understanding of the natural functioning of the watershed and what has been (or is at risk of being) altered by urbanization.
Stream Characterization: • Reach type • Bed material • Bank material • Hydrographic category • Channel infrastructure	• Preliminary dataset that can be used to conduct stream power evaluations • Identify channel systems for preservation or restoration • Identification of appropriate space for channel processes to occur (e.g., flood plain connectivity) • Insight to sensitivity of receiving stream reach • Indicates the features within channels that affect water and sediment movement through the watershed

Characterization Data	Utilization Potential
Land Use: • Existing • Future	• Foresight (identifies relative risks, opportunities, or constraints) in comparing future to existing land uses, i.e., areas that may be more/less vulnerable to adverse impacts to changes in storm water runoff associated with development • Encourage infill development
Potential Critical Coarse Sediment Yield Areas	• Preservation of areas or function that contributes critical sediment within the watershed to stream armoring/stability • Assist with identifying potentially susceptible stream reaches that require uninterrupted coarse sediment supplies to remain stable • Dual goal of open space conservation

Regarding the identification of the potential critical coarse sediment yield areas in the Regional WMAA using readily available regional datasets, it is anticipated that when more precise estimates for potential critical coarse sediment yield areas are required for a particular site or subarea that this regional study will be augmented with site-specific analysis. Development projects must avoid critical sediment yield areas or implement measures that allow critical coarse sediment to be discharged to receiving waters, such that there is no net impact to the receiving water to meet the requirements of the Regional MS4 permit. As such, projects should consult the Model BMP Design Manual and/or jurisdiction specific BMP Design manual for options to meet the Regional MS4 permit requirements. It is anticipated that the data will not be static but will be enhanced over time through future studies or field assessments that will refine what is currently a macro-level data set.

5.2. Template for Candidate Project List

It is anticipated the Copermittees that elect to develop alternative compliance programs will conduct a separate exercise to nominate potential candidate projects for inclusion into the WQIPs using the template developed for this project.

5.3. Hydromodification Management Exemptions

Attachment B.2 presents hydromodification management applicability/exemption mapping. The mapping includes receiving waters that are exempt based on the Regional MS4 Permit or recommended exempt based on studies.

Receiving waters that are **exempt** based on the Regional MS4 Permit include:

- The Pacific Ocean
- San Diego Bay
- Mission Bay
- Lakes and Reservoirs
- Existing underground storm drains or concrete-lined channels draining directly to bays or the ocean

Receiving waters or conveyance systems that are recommended exempt based on studies that were prepared as part of the Regional WMAA or prepared by others and provided for this purpose include:

- Otay River from Outfall at San Diego Bay to Interstate 805
- San Diego River from Pacific Ocean to confluence with San Vicente Creek
- San Dieguito River from upstream edge of the railroad crossing to Lake Hodges Dam
- San Luis Rey River from Pacific Ocean to upstream river limit of Basin Plan subwatershed 903.1 upstream of Bonsall and near Interstate 15
- Sweetwater River from San Diego Bay to Sweetwater Reservoir Dam
- Forrester Creek stabilized reach from the confluence with the San Diego River to Prospect Avenue

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San Diego County Regional Watershed Management Area Analysis ATTACHMENTS

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October 2015

Prepared for:
San Diego County Copermittees

Prepared by:

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ATTACHMENT A

WATERSHED MANAGEMENT AREA CHARACTERIZATION

ATTACHMENT A.1

DOMINANT HYDROLOGICAL PROCESS

A.1 Dominant Hydrological Process

Table A.1.1: Runoff Coefficients versus Land Use, Hydrologic Soil Group (A, B, C, D), and Slope Range

	A			B			C			D		
Land Use	0–2%	2–6%	6%+	0–2%	2–6%	6%+	0–2%	2–6%	6%+	0–2%	2–6%	6%+
Cultivated land	0.08[a]	0.13	0.16	0.11	0.15	0.21	0.14	0.19	0.26	0.18	0.23	0.31
	0.14[b]	0.18	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Pasture	0.12	0.20	0.30	0.18	0.28	0.37	0.24	0.34	0.44	0.30	0.40	0.50
	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Meadow	0.10	0.16	0.25	0.14	0.22	0.30	0.20	0.28	0.36	0.24	0.30	0.40
	0.14	0.22	0.30	0.20	0.28	0.37	0.26	0.35	0.44	0.30	0.40	0.50
Forest	0.05	0.08	0.11	0.08	0.11	0.14	0.10	0.13	0.16	0.12	0.16	0.20
	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Residential lot size 1/8 acre	0.25	0.28	0.31	0.27	0.30	0.35	0.30	0.33	0.38	0.33	0.36	0.42
	0.33	0.37	0.40	0.35	0.39	0.44	0.38	0.42	0.49	0.41	0.45	0.54
Residential lot size 1/4 acre	0.22	0.26	0.29	0.24	0.29	0.33	0.27	0.31	0.36	0.30	0.34	0.40
	0.30	0.34	0.37	0.33	0.37	0.42	0.36	0.40	0.47	0.38	0.42	0.52
Residential lot size 1/3 acre	0.19	0.23	0.26	0.22	0.26	0.30	0.25	0.29	0.34	0.28	0.32	0.39
	0.28	0.32	0.35	0.30	0.35	0.39	0.33	0.38	0.45	0.36	0.40	0.50
Residential lot size 1/2 acre	0.16	0.20	0.24	0.19	0.23	0.28	0.22	0.27	0.32	0.26	0.30	0.37
	0.25	0.29	0.32	0.28	0.32	0.36	0.31	0.35	0.42	0.34	0.38	0.48
Residential lot size 1 acre	0.14	0.19	0.22	0.17	0.21	0.26	0.20	0.25	0.31	0.24	0.29	0.35
	0.22	0.26	0.29	0.24	0.28	0.34	0.28	0.32	0.40	0.31	0.35	0.46
Industrial	0.67	0.68	0.68	0.68	0.68	0.69	0.68	0.69	0.69	0.69	0.69	0.70
	0.85	0.85	0.86	0.85	0.86	0.86	0.86	0.86	0.87	0.86	0.86	0.88
Commercial	0.71	0.71	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.89	0.89	0.90
Streets	0.70	0.71	0.72	0.71	0.72	0.74	0.72	0.73	0.76	0.73	0.75	0.78
	0.76	0.77	0.79	0.80	0.82	0.84	0.84	0.85	0.89	0.89	0.91	0.95
Open space	0.05	0.10	0.14	0.08	0.13	0.19	0.12	0.17	0.24	0.16	0.21	0.28
	0.11	0.16	0.20	0.14	0.19	0.26	0.18	0.23	0.32	0.22	0.27	0.39
Parking	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97

[a] Runoff coefficients for storm recurrence intervals less than 25 years.

[b] Runoff coefficients for storm recurrence intervals of 25 years or longer.

Source: Table 7-9 in *Hydrologic Analysis and Design* (McCuen, 2005)

Table A.1.2: Land Cover Grouping

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
1	42000 Valley and Foothill Grassland	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Agricultural/Grass
2	42100 Native Grassland		Agricultural/Grass
3	42110 Valley Needlegrass Grassland		Agricultural/Grass
4	42120 Valley Sacaton Grassland		Agricultural/Grass

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
5	42200 Non-Native Grassland	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Agricultural/Grass
6	42300 Wildflower Field		Agriculture/Grass
7	42400 Foothill/Mountain Perennial Grassland		Agriculture/Grass
8	42470 Transmontane Dropseed Grassland		Agriculture/Grass
9	45000 Meadow and Seep		Agriculture/Grass
10	45100 Montane Meadow		Agriculture/Grass
11	45110 Wet Montane Meadow		Agriculture/Grass
12	45120 Dry Montane Meadows		Agriculture/Grass
13	45300 Alkali Meadows and Seeps		Agriculture/Grass
14	45320 Alkali Seep		Agriculture/Grass
15	45400 Freshwater Seep		Agriculture/Grass
16	46000 Alkali Playa Community		Agriculture/Grass
17	46100 Badlands/Mudhill Forbs		Agriculture/Grass
18	Non-Native Grassland		Agriculture/Grass
19	18000 General Agriculture	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Agriculture/Grass
20	18100 Orchards and Vineyards		Agriculture/Grass
21	18200 Intensive Agriculture		Agriculture/Grass
22	18200 Intensive Agriculture - Dairies, Nurseries, Chicken Ranches		Agriculture/Grass
23	18300 Extensive Agriculture - Field/Pasture, Row Crops		Agriculture/Grass
24	18310 Field/Pasture		Agriculture/Grass
25	18310 Pasture		Agriculture/Grass
26	18320 Row Crops		Agriculture/Grass
27	12000 Urban/Developed		Developed
28	12000 Urban/Develpoed		Developed
29	81100 Mixed Evergreen Forest	Forest	Forest
30	81300 Oak Forest		Forest
31	81310 Coast Live Oak Forest		Forest
32	81320 Canyon Live Oak Forest		Forest
33	81340 Black Oak Forest		Forest
34	83140 Torrey Pine Forest		Forest
35	83230 Southern Interior Cypress Forest		Forest
36	84000 Lower Montane Coniferous Forest		Forest
37	84100 Coast Range, Klamath and Peninsular Coniferous Forest		Forest

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
38	84140 Coulter Pine Forest	Forest	Forest
39	84150 Bigcone Spruce (Bigcone Douglas Fir)-Canyon Oak Forest		Forest
40	84230 Sierran Mixed Coniferous Forest		Forest
41	84500 Mixed Oak/Coniferous/Bigcone/Coulter		Forest
42	85100 Jeffrey Pine Forest		Forest
43	11100 Eucalyptus Woodland	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Forest
44	60000 RIPARIAN AND BOTTOMLAND HABITAT	Riparian and Bottomland Habitat	Forest
45	61000 Riparian Forests		Forest
46	61300 Southern Riparian Forest		Forest
47	61310 Southern Coast Live Oak Riparian Forest		Forest
48	61320 Southern Arroyo Willow Riparian Forest		Forest
49	61330 Southern Cottonwood-willow Riparian Forest		Forest
50	61510 White Alder Riparian Forest		Forest
51	61810 Sonoran Cottonwood-willow Riparian Forest		Forest
52	61820 Mesquite Bosque		Forest
53	62000 Riparian Woodlands		Forest
54	62200 Desert Dry Wash Woodland		Forest
55	62300 Desert Fan Palm Oasis Woodland		Forest
56	62400 Southern Sycamore-alder Riparian Woodland		Forest
57	70000 WOODLAND	Woodland	Forest
58	71000 Cismontane Woodland		Forest
59	71100 Oak Woodland		Forest
60	71120 Black Oak Woodland		Forest
61	71160 Coast Live Oak Woodland		Forest
62	71161 Open Coast Live Oak Woodland		Forest
63	71162 Dense Coast Live Oak Woodland		Forest
64	71162 Dense Coast Love Oak Woodland		Forest

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
65	71180 Engelmann Oak Woodland	Woodland	Forest
66	71181 Open Engelmann Oak Woodland		Forest
67	71182 Dense Engelmann Oak Woodland		Forest
68	72300 Peninsular Pinon and Juniper Woodlands		Forest
69	72310 Peninsular Pinon Woodland		Forest
70	72320 Peninsular Juniper Woodland and Scrub		Forest
71	75100 Elephant Tree Woodland		Forest
72	77000 Mixed Oak Woodland		Forest
73	78000 Undifferentiated Open Woodland		Forest
74	79000 Undifferentiated Dense Woodland		Forest
75	Engelmann Oak Woodland		Forest
76	52120 Southern Coastal Salt Marsh	Bog and Marsh	Other
77	52300 Alkali Marsh		Other
78	52310 Cismontane Alkali Marsh		Other
79	52400 Freshwater Marsh		Other
80	52410 Coastal and Valley Freshwater Marsh		Other
81	52420 Transmontane Freshwater Marsh		Other
82	52440 Emergent Wetland		Other
83	44000 Vernal Pool	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Other
84	44320 San Diego Mesa Vernal Pool		Other
85	44322 San Diego Mesa Claypan Vernal Pool (southern mesas)		Other
86	13100 Open Water	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Other
87	13110 Marine		Other
88	13111 Subtidal		Other
89	13112 Intertidal		Other
90	13121 Deep Bay		Other
91	13122 Intermediate Bay		Other
92	13123 Shallow Bay		Other
93	13130 Estuarine		Other
94	13131 Subtidal		Other
95	13133 Brackishwater		Other

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
96	13140 Freshwater	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Other
97	13200 Non-Vegetated Channel, Floodway, Lakeshore Fringe		Other
98	13300 Saltpan/Mudflats		Other
99	13400 Beach		Other
100	21230 Southern Foredunes	Dune Community	Scrub/Shrub
101	22100 Active Desert Dunes		Scrub/Shrub
102	22300 Stabilized and Partially-Stabilized Desert Sand Field		Scrub/Shrub
103	24000 Stabilized Alkaline Dunes		Scrub/Shrub
104	29000 ACACIA SCRUB		Scrub/Shrub
105	63000 Riparian Scrubs	Riparian and Bottomland Habitat	Scrub/Shrub
106	63300 Southern Riparian Scrub		Scrub/Shrub
107	63310 Mule Fat Scrub		Scrub/Shrub
108	63310 Mulefat Scrub		Scrub/Shrub
109	63320 Southern Willow Scrub		Scrub/Shrub
110	63321 Arundo donnax Dominant/Southern Willow Scrub		Scrub/Shrub
111	63330 Southern Riparian Scrub		Scrub/Shrub
112	63400 Great Valley Scrub		Scrub/Shrub
113	63410 Great Valley Willow Scrub		Scrub/Shrub
114	63800 Colorado Riparian Scrub		Scrub/Shrub
115	63810 Tamarisk Scrub		Scrub/Shrub
116	63820 Arrowweed Scrub		Scrub/Shrub
117	31200 Southern Coastal Bluff Scrub	Scrub and Chaparral	Scrub/Shrub
118	32000 Coastal Scrub		Scrub/Shrub
119	32400 Maritime Succulent Scrub		Scrub/Shrub
120	32500 Diegan Coastal Sage Scrub		Scrub/Shrub
121	32510 Coastal form		Scrub/Shrub
122	32520 Inland form (> 1,000 ft. elevation)		Scrub/Shrub
123	32700 Riversidian Sage Scrub		Scrub/Shrub
124	32710 Riversidian Upland Sage Scrub		Scrub/Shrub
125	32720 Alluvial Fan Scrub		Scrub/Shrub
126	33000 Sonoran Desert Scrub		Scrub/Shrub
127	33100 Sonoran Creosote Bush Scrub		Scrub/Shrub
128	33200 Sonoran Desert Mixed Scrub		Scrub/Shrub
129	33210 Sonoran Mixed Woody Scrub		Scrub/Shrub

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
130	33220 Sonoran Mixed Woody and Succulent Scrub	Scrub and Chaparral	Scrub/Shrub
131	33230 Sonoran Wash Scrub		Scrub/Shrub
132	33300 Colorado Desert Wash Scrub		Scrub/Shrub
133	33600 Encelia Scrub		Scrub/Shrub
134	34000 Mojavean Desert Scrub		Scrub/Shrub
135	34300 Blackbush Scrub		Scrub/Shrub
136	35000 Great Basin Scrub		Scrub/Shrub
137	35200 Sagebrush Scrub		Scrub/Shrub
138	35210 Big Sagebrush Scrub		Scrub/Shrub
139	35210 Sagebrush Scrub		Scrub/Shrub
140	36110 Desert Saltbush Scrub		Scrub/Shrub
141	36120 Desert Sink Scrub		Scrub/Shrub
142	37000 Chaparral		Scrub/Shrub
143	37120 Southern Mixed Chaparral		Scrub/Shrub
144	37120 Southern Mixed Chapparal		Scrub/Shrub
145	37121 Granitic Southern Mixed Chaparral		Scrub/Shrub
146	37121 Southern Mixed Chaparral		Scrub/Shrub
147	37122 Mafic Southern Mixed Chaparral		Scrub/Shrub
148	37130 Northern Mixed Chaparral		Scrub/Shrub
149	37131 Granitic Northern Mixed Chaparral		Scrub/Shrub
150	37132 Mafic Northern Mixed Chaparral		Scrub/Shrub
151	37200 Chamise Chaparral		Scrub/Shrub
152	37210 Granitic Chamise Chaparral		Scrub/Shrub
153	37220 Mafic Chamise Chaparral		Scrub/Shrub
154	37300 Red Shank Chaparral		Scrub/Shrub
155	37400 Semi-Desert Chaparral		Scrub/Shrub
156	37500 Montane Chaparral		Scrub/Shrub
157	37510 Mixed Montane Chaparral		Scrub/Shrub
158	37520 Montane Manzanita Chaparral		Scrub/Shrub
159	37530 Montane Ceanothus Chaparral		Scrub/Shrub
160	37540 Montane Scrub Oak Chaparral		Scrub/Shrub
161	37800 Upper Sonoran Ceanothus Chaparral		Scrub/Shrub
162	37830 Ceanothus crassifolius Chaparral		Scrub/Shrub
163	37900 Scrub Oak Chaparral		Scrub/Shrub
164	37A00 Interior Live Oak Chaparral		Scrub/Shrub

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
165	37C30 Southern Maritime Chaparral	Scrub and Chaparral	Scrub/Shrub
166	37G00 Coastal Sage-Chaparral Scrub		Scrub/Shrub
167	37K00 Flat-topped Buckwheat		Scrub/Shrub
168	39000 Upper Sonoran Subshrub Scrub		Scrub/Shrub
169	Diegan Coastal Sage Scrub		Scrub/Shrub
170	Granitic Northern Mixed Chaparral		Scrub/Shrub
171	Southern Mixed Chaparral		Scrub/Shrub
172	11000 Non-Native Vegetation	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Unknown
173	11000 Non-Native VegetionVegetation		Unknown
174	11200 Disturbed Wetland		Unknown
175	11300 Disturbed Habitat		Unknown
176	13000 Unvegetated Habitat		Unknown
177	Disturbed Habitat		Unknown

Table A.1.3: Related Land Cover and Land Use Categories

Land Cover per San Diego County	Land Use per Table A.1.1
Agriculture/Grass	Meadow
Forest	Forest
Scrub/Shrub	Average (Meadow, Forest)
Unknown/Other	Meadow

Table A.1.4: Applicable Hydrologic Response Unit Calculations

Land Cover	Soil	Gradient	Runoff Coeff.	ET Coeff.	Infiltration Coeff.	Runoff/ Infiltration Ratio	Hydrologic Process Designation
Agriculture/Grass	A	0-2%	0.10	0.60	0.30	0.33	I
Agriculture/Grass	A	2-6%	0.16	0.60	0.24	0.67	U
Agriculture/Grass	A	6-10%	0.25	0.60	0.15	1.67	O
Agriculture/Grass	B	0-2%	0.14	0.60	0.26	0.54	I
Agriculture/Grass	B	2-6%	0.22	0.60	0.18	1.22	U
Agriculture/Grass	B	6-10%	0.30	0.60	0.10	3.00	O
Agriculture/Grass	C	0-2%	0.20	0.60	0.20	1.00	U
Agriculture/Grass	C	2-6%	0.28	0.60	0.12	2.33	O
Agriculture/Grass	C	6-10%	0.36	0.60	0.04	9.00	O
Agriculture/Grass	D	0-2%	0.24	0.60	0.16	1.50	U
Agriculture/Grass	D	2-6%	0.30	0.60	0.10	3.00	O
Agriculture/Grass	D	6-10%	0.40	0.60	0.00	infinite	O

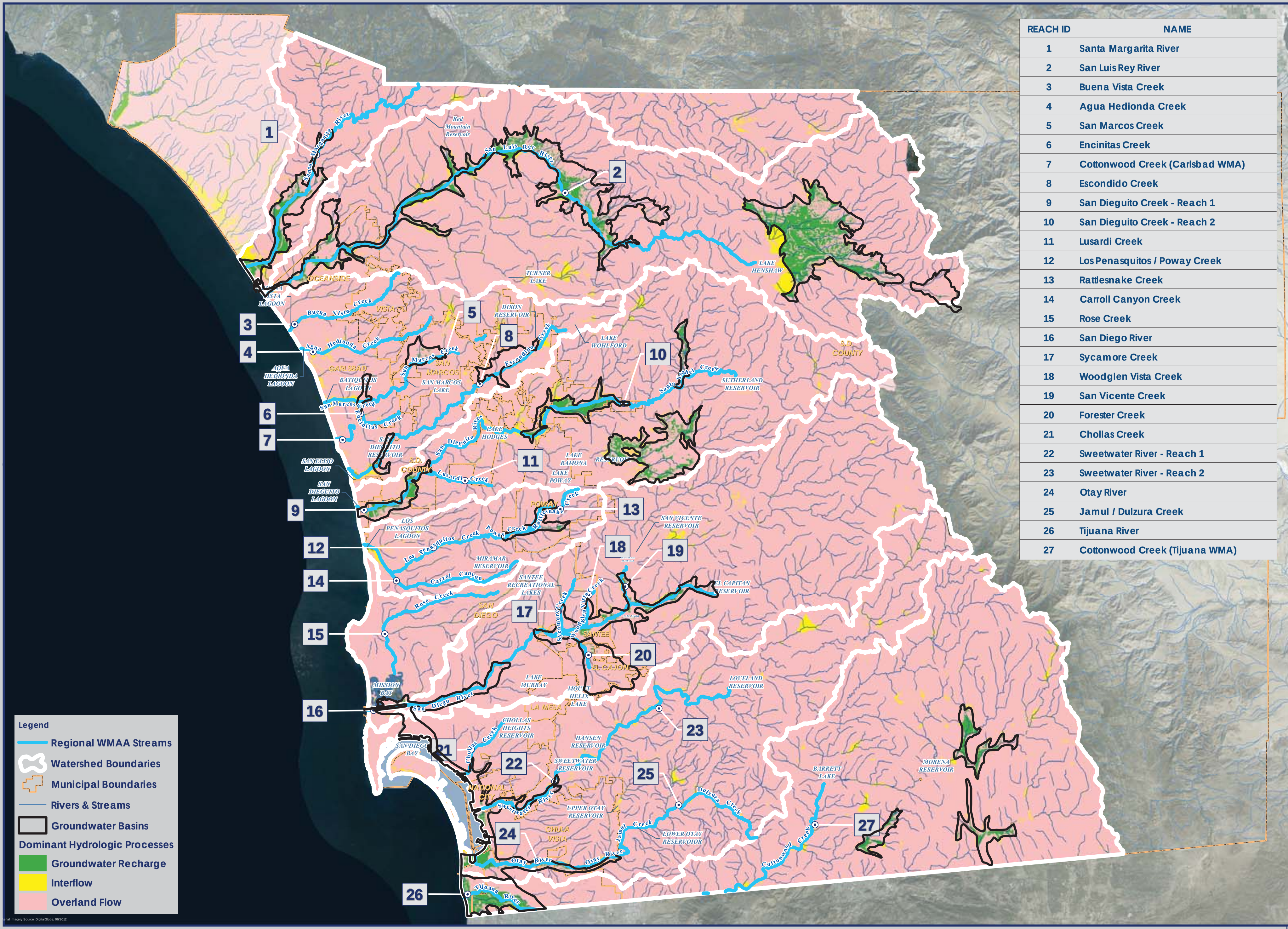
Land Cover	Soil	Gradient	Runoff Coeff.	ET Coeff.	Infiltration Coeff.	Runoff/ Infiltration Ratio	Hydrologic Process Designation
Forest	A	0-2%	0.05	0.80	0.15	0.33	I
Forest	A	2-6%	0.08	0.80	0.12	0.67	U
Forest	A	6-10%	0.11	0.80	0.09	1.22	U
Forest	B	0-2%	0.08	0.80	0.12	0.67	U
Forest	B	2-6%	0.11	0.80	0.09	1.22	U
Forest	B	6-10%	0.14	0.80	0.06	2.33	O
Forest	C	0-2%	0.10	0.80	0.10	1.00	U
Forest	C	2-6%	0.13	0.80	0.07	1.86	O
Forest	C	6-10%	0.16	0.80	0.04	4.00	O
Forest	D	0-2%	0.12	0.80	0.08	1.50	U
Forest	D	2-6%	0.16	0.80	0.04	4.00	O
Forest	D	6-10%	0.20	0.80	0.00	infinite	O
Scrub/Shrub	A	0-2%	0.08	0.70	0.23	0.33	I
Scrub/Shrub	A	2-6%	0.12	0.70	0.18	0.67	U
Scrub/Shrub	A	6-10%	0.18	0.70	0.12	1.50	U
Scrub/Shrub	B	0-2%	0.11	0.70	0.19	0.58	I
Scrub/Shrub	B	2-6%	0.17	0.70	0.14	1.22	U
Scrub/Shrub	B	6-10%	0.22	0.70	0.08	2.75	O
Scrub/Shrub	C	0-2%	0.15	0.70	0.15	1.00	U
Scrub/Shrub	C	2-6%	0.21	0.70	0.10	2.16	O
Scrub/Shrub	C	6-10%	0.26	0.70	0.04	6.50	O
Scrub/Shrub	D	0-2%	0.19	0.70	0.12	1.50	U
Scrub/Shrub	D	2-6%	0.23	0.70	0.07	3.29	O
Scrub/Shrub	D	6-10%	0.30	0.70	0.00	infinite	O

Hydrologic Process Designation: I = Interflow; O = Overland Flow; U = Uncertain

Table A.1.5: Hydrologic Response Unit Designations

Land Cover	Slope	Soil Type				
		A	B	C	D	Other (fill/water)
Agriculture/ Grass/Unknown/ Other	0-2%	I	I	U	U	U
	2-6%	U	U	O	O	U
	6-10%	O	O	O	O	O
	>10%	O	O	O	O	O
Developed	0-2%	O	O	O	O	O
	2-6%	O	O	O	O	O
	6-10%	O	O	O	O	O
	>10%	O	O	O	O	O
Forest	0-2%	I	U	U	U	U
	2-6%	U	U	O	O	U
	6-10%	U	O	O	O	U
	>10%	O	O	O	O	O
Scrub/Shrub	0-2%	I	I	U	U	U
	2-6%	U	U	O	O	U
	6-10%	U	O	O	O	U
	>10%	O	O	O	O	O

Hydrologic Process Designation: I = Interflow; O = Overland Flow; U = Uncertain



REACH ID	NAME
1	Santa Margarita River
2	San Luis Rey River
3	Buena Vista Creek
4	Agua Hedionda Creek
5	San Marcos Creek
6	Encinitas Creek
7	Cottonwood Creek (Carlsbad WMA)
8	Escondido Creek
9	San Dieguito Creek - Reach 1
10	San Dieguito Creek - Reach 2
11	Lusardi Creek
12	Los Penasquitos / Poway Creek
13	Rattlesnake Creek
14	Carroll Canyon Creek
15	Rose Creek
16	San Diego River
17	Sycamore Creek
18	Woodglen Vista Creek
19	San Vicente Creek
20	Forester Creek
21	Chollas Creek
22	Sweetwater River - Reach 1
23	Sweetwater River - Reach 2
24	Otay River
25	Jamul / Dulzura Creek
26	Tijuana River
27	Cottonwood Creek (Tijuana WMA)

Dominant Hydrologic Processes

Regional San Diego County Watersheds

Exhibit Date: Sept. 8, 2014

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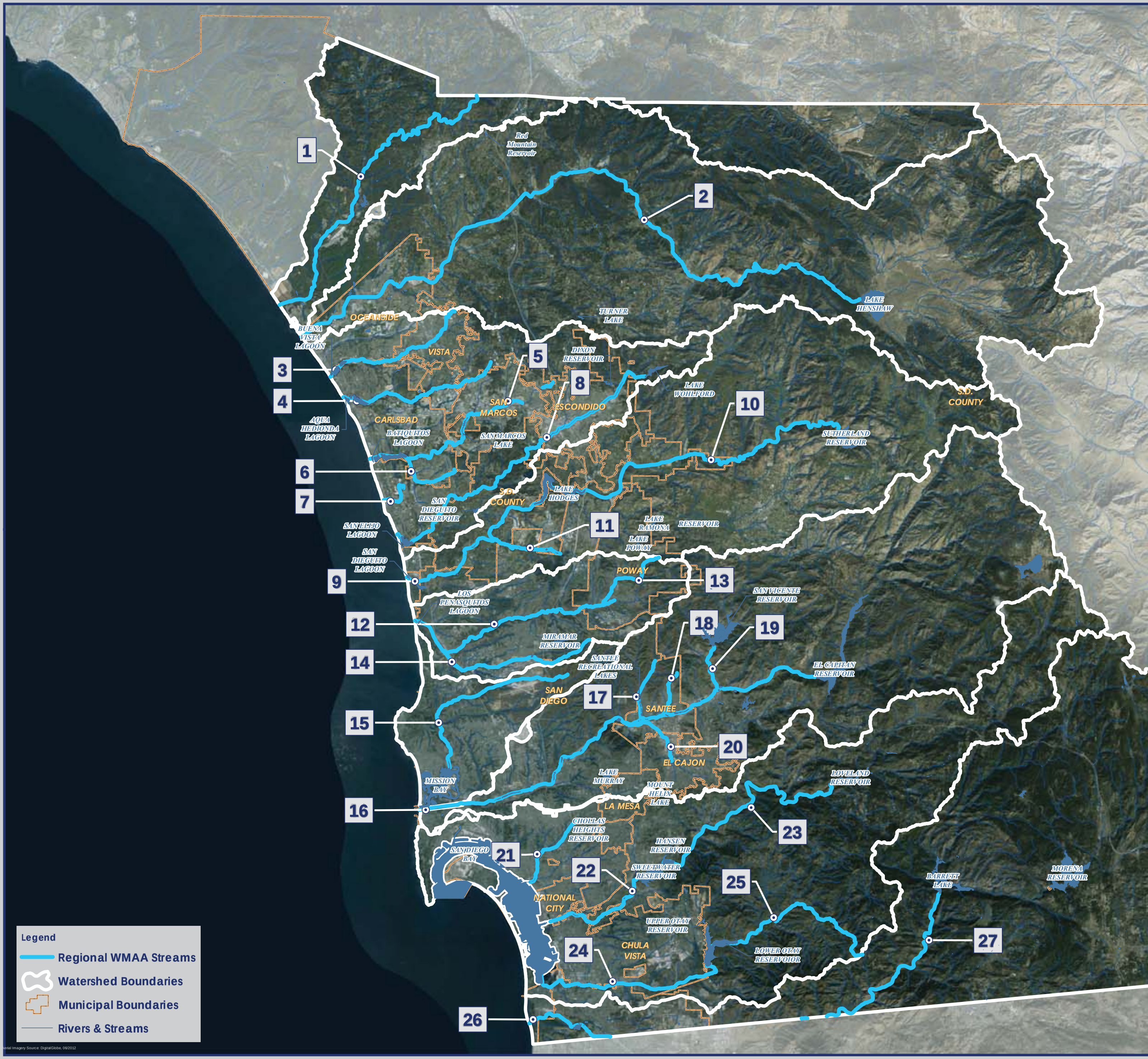
RICK Engineering Company

ATTACHMENT A.2

STREAM CHARACTERIZATION



REACH ID	NAME
1	Santa Margarita River
2	San Luis Rey River
3	Buena Vista Creek
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5	San Marcos Creek
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14	Carroll Canyon Creek
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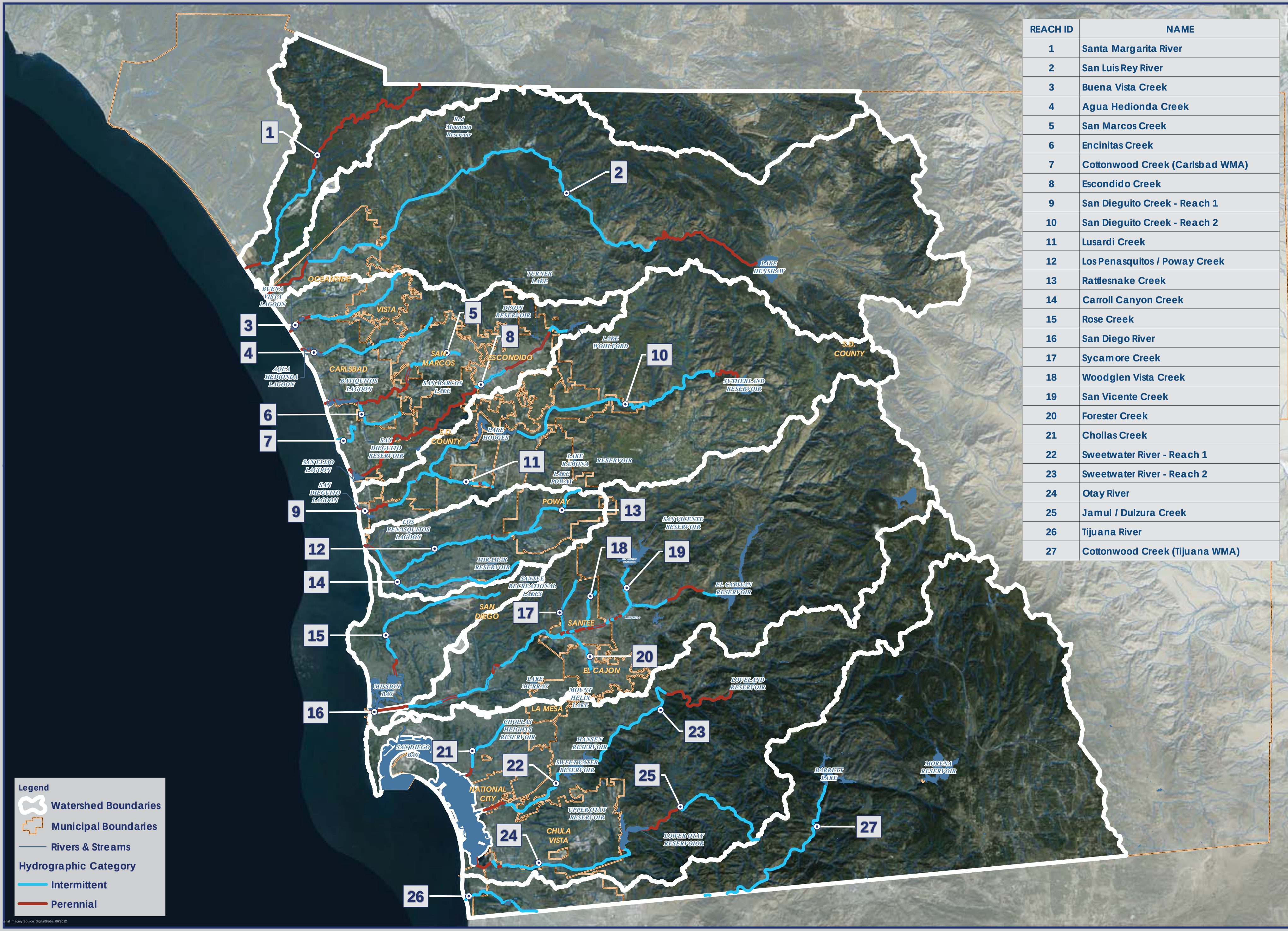
18	Woodglen Vista Creek
19	San Vicente Creek
20	Forester Creek
21	Chollas Creek
22	Sweetwater River - Reach 1
23	Sweetwater River - Reach 2
24	Otay River
25	Jamul / Dulzura Creek
26	Tijuana River
27	Cottonwood Creek (Tijuana WMA)

Watershed Management Area Streams
Regional San Diego County Watersheds

Exhibit Date: Sept. 8, 2014



REACH ID	NAME
1	Santa Margarita River
2	San Luis Rey River
3	Buena Vista Creek
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5	San Marcos Creek
6	Encinitas Creek
7	Cottonwood Creek (Carlsbad WMA)
8	Escondido Creek
9	San Dieguito Creek - Reach 1
10	San Dieguito Creek - Reach 2
11	Lusardi Creek
12	Los Penasquitos / Poway Creek
13	Rattlesnake Creek
14	Carroll Canyon Creek
15	Rose Creek
16	San Diego River
17	Sycamore Creek
18	Woodglen Vista Creek
19	San Vicente Creek
20	Forester Creek
21	Chollas Creek
22	Sweetwater River - Reach 1
23	Sweetwater River - Reach 2
24	Otay River
25	Jamul / Dulzura Creek
26	Tijuana River
27	Cottonwood Creek (Tijuana WMA)

Legend
- Watershed Boundaries
- Municipal Boundaries
- Rivers & Streams

Hydrographic Category
- Intermittent
- Perennial

Watershed Management Area Streams by Hydrographic Category

Regional San Diego County Watersheds

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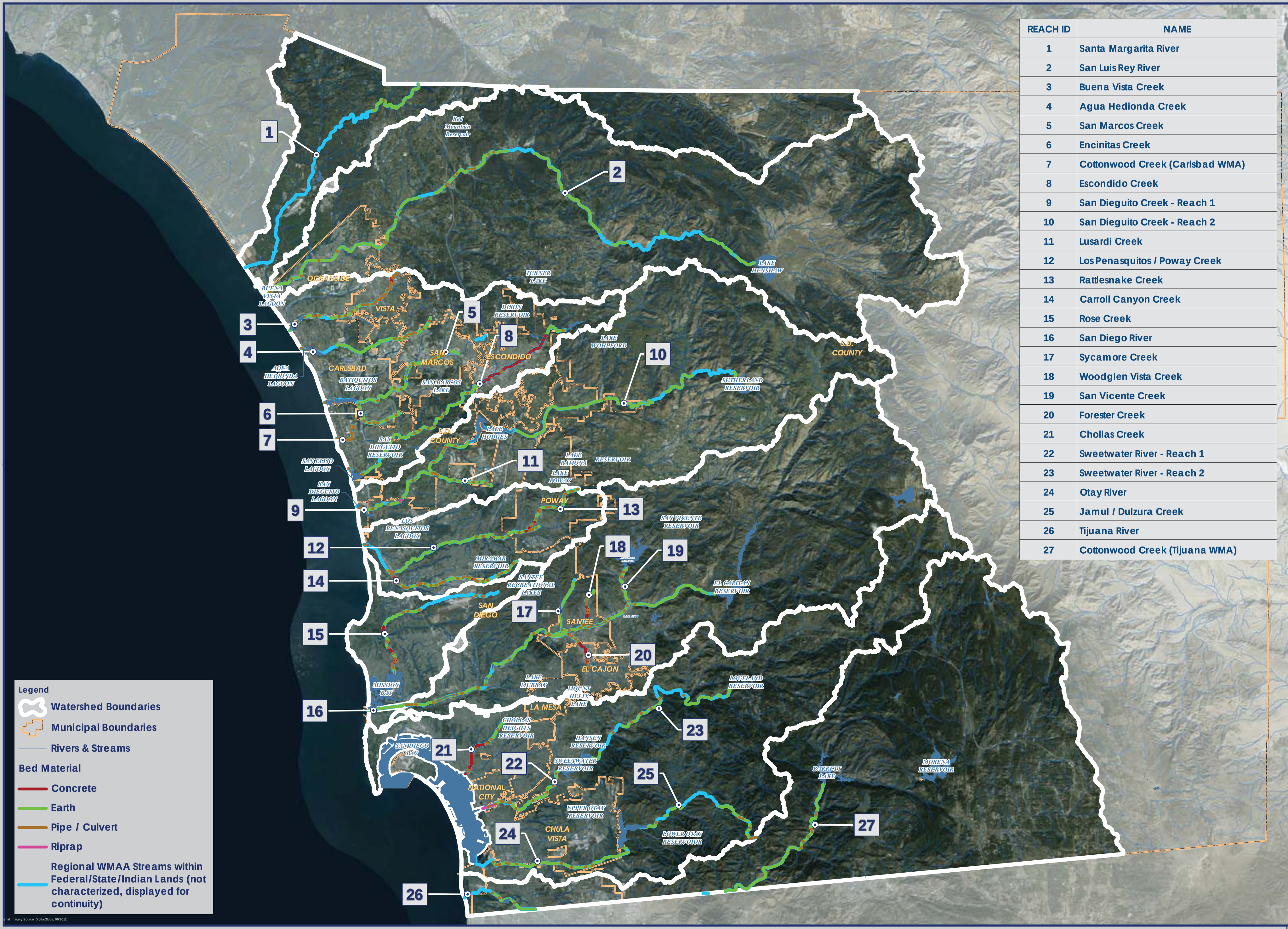

REACH ID	NAME
1	Santa Margarita River
2	San Luis Rey River
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10	San Dieguito Creek - Reach 2
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12	Los Penasquitos / Poway Creek
13	Rattlesnake Creek
14	Carroll Canyon Creek
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17	Sycamore Creek
18	Woodglen Vista Creek
19	San Vicente Creek
20	Forester Creek
21	Chollas Creek
22	Sweetwater River - Reach 1
23	Sweetwater River - Reach 2
24	Otay River
25	Jamul / Dulzura Creek
26	Tijuana River
27	Cottonwood Creek (Tijuana WMA)

Watershed Management Area Streams by Bed Material

Regional San Diego County Watersheds

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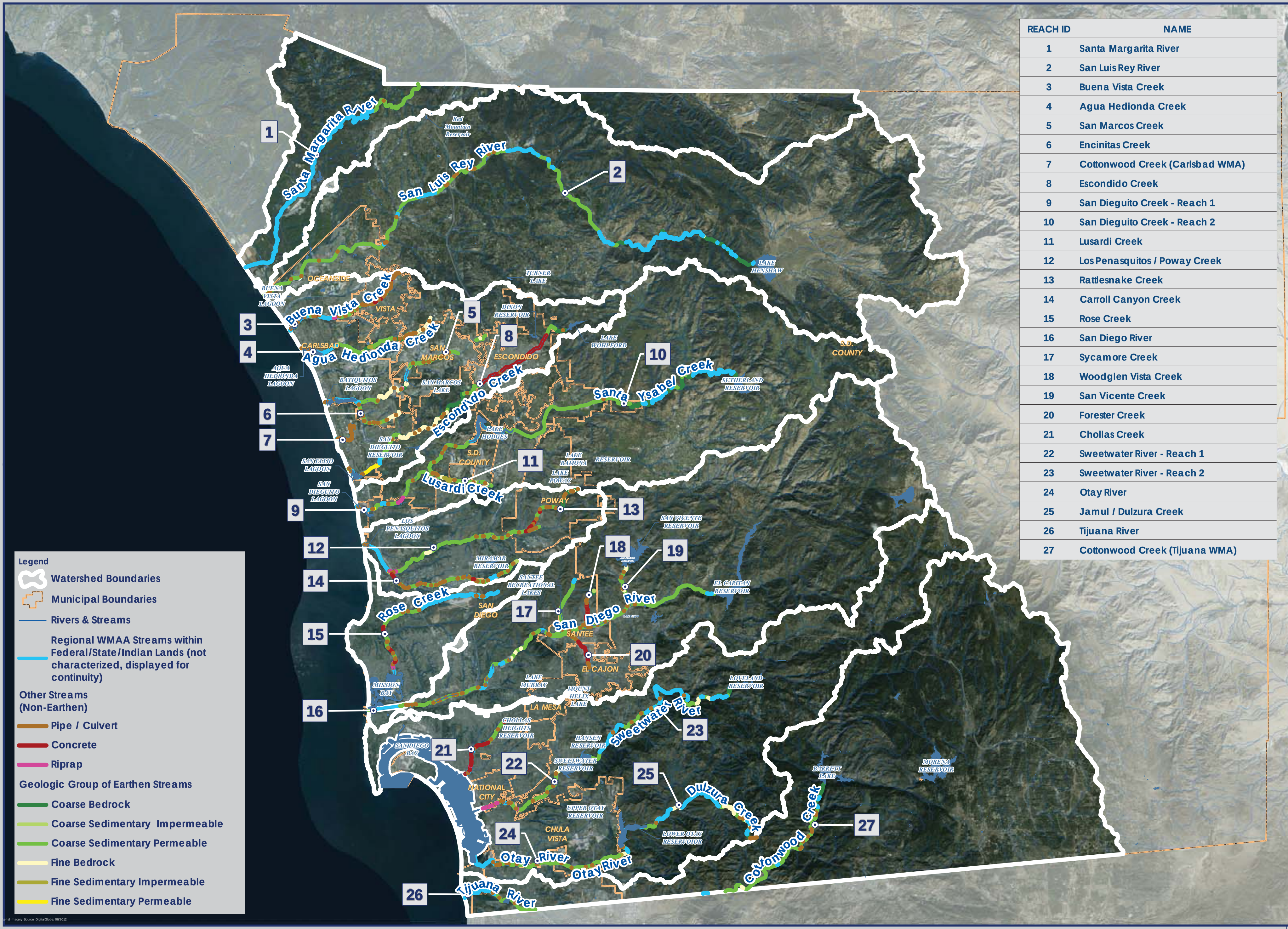

REACH ID	NAME
1	Santa Margarita River
2	San Luis Rey River
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5	San Marcos Creek
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Watershed Management Area Streams by Geologic Group

Regional San Diego County Watersheds

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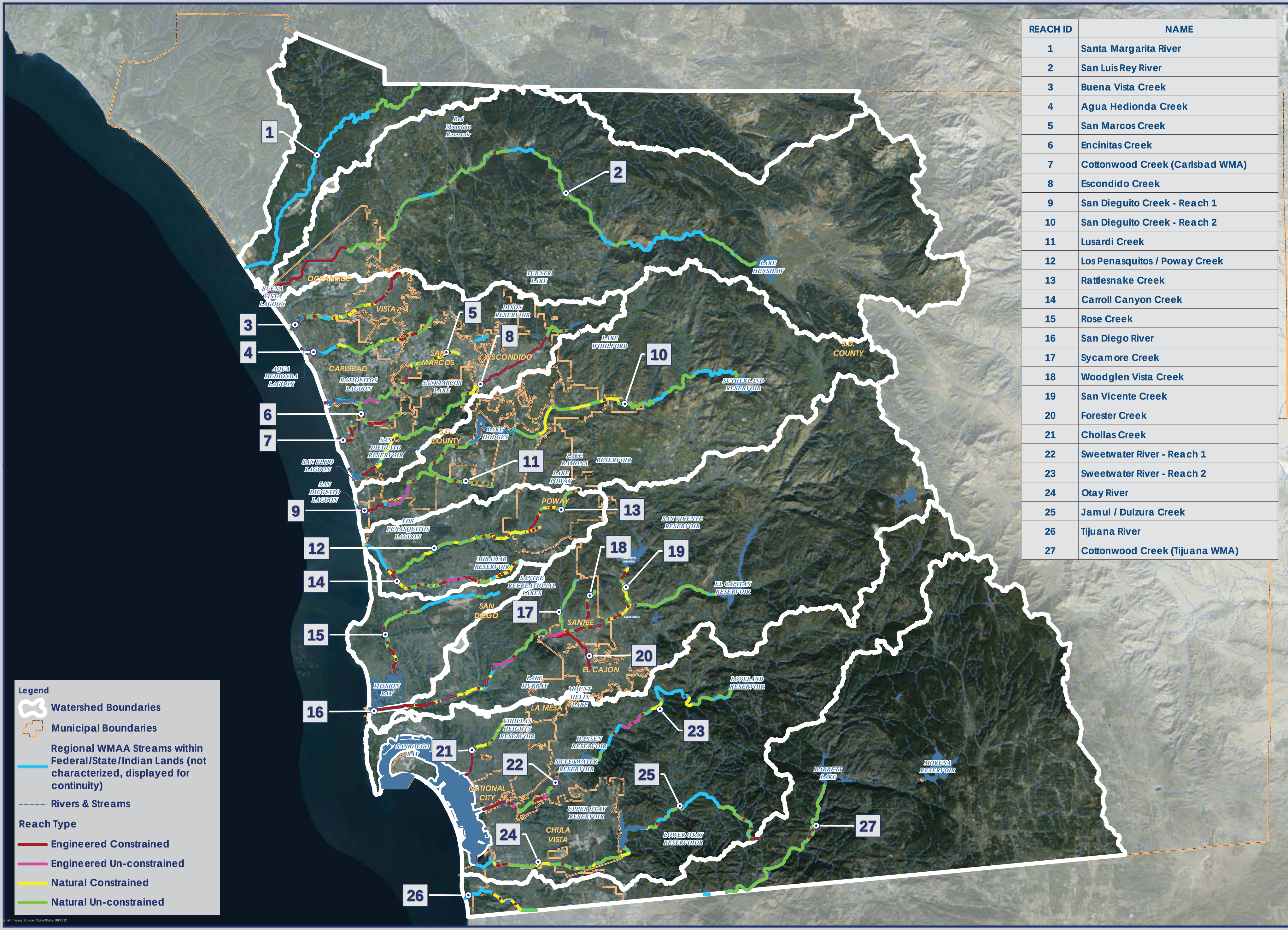

REACH ID	NAME
1	Santa Margarita River
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Watershed Management Area Streams by Reach Type

Regional San Diego County Watersheds

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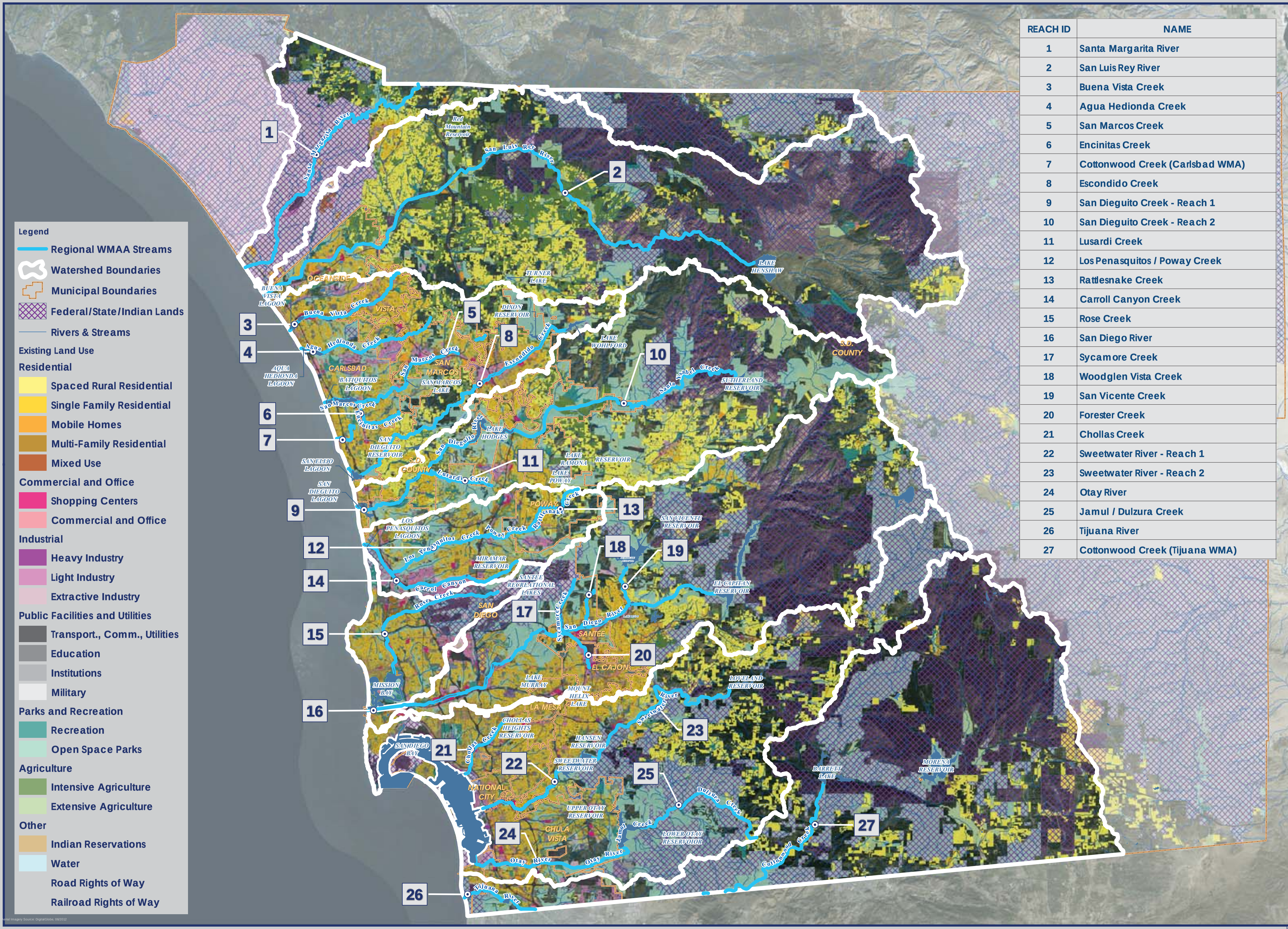
ATTACHMENT A.3

LAND USES



REACH ID	NAME
1	Santa Margarita River
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Existing Land Use

Regional San Diego County Watersheds

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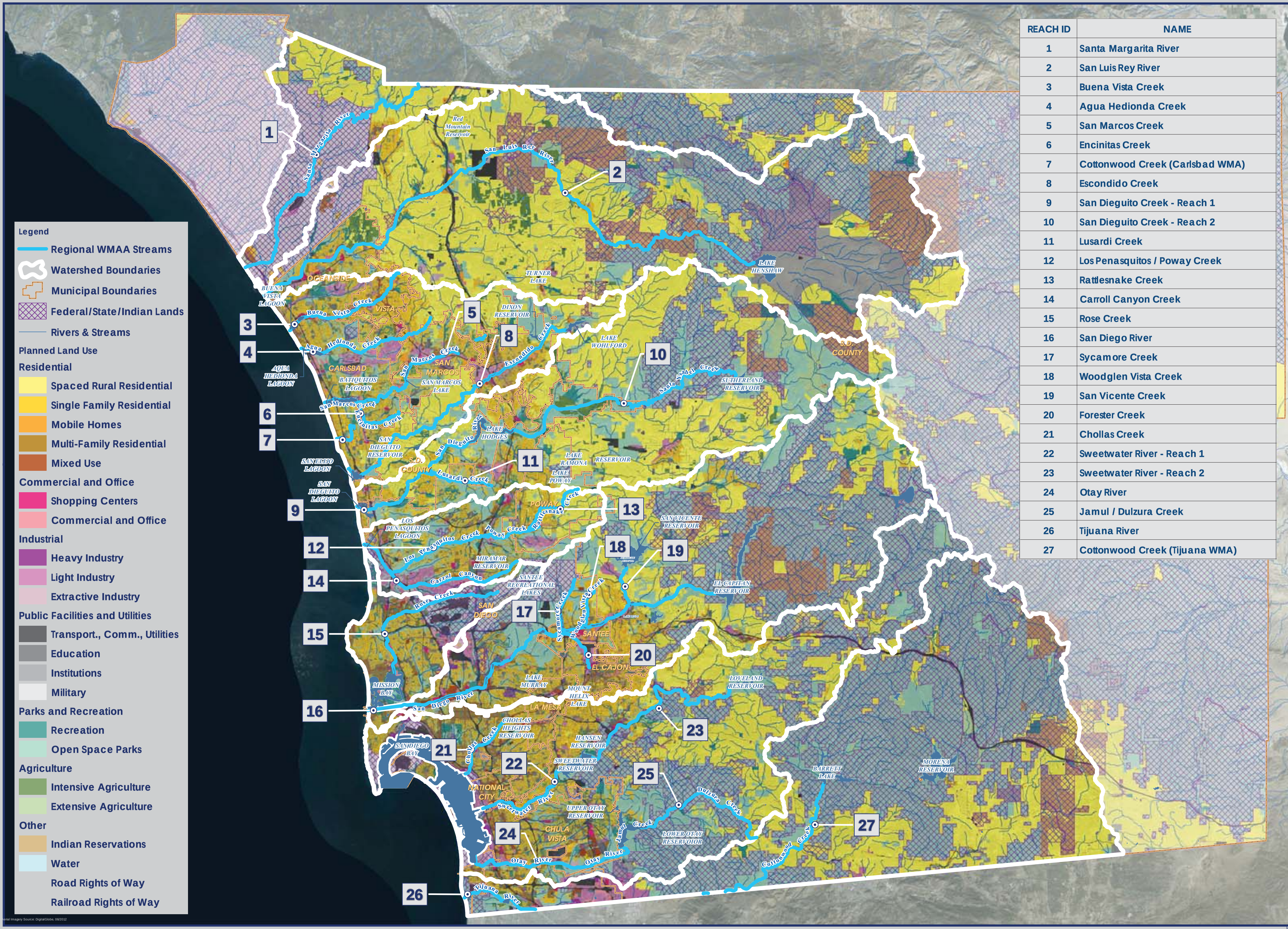

REACH ID	NAME
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26	Tijuana River
27	Cottonwood Creek (Tijuana WMA)

Planned Land Use

Regional San Diego County Watersheds

Exhibit Date: Sept. 8, 2014

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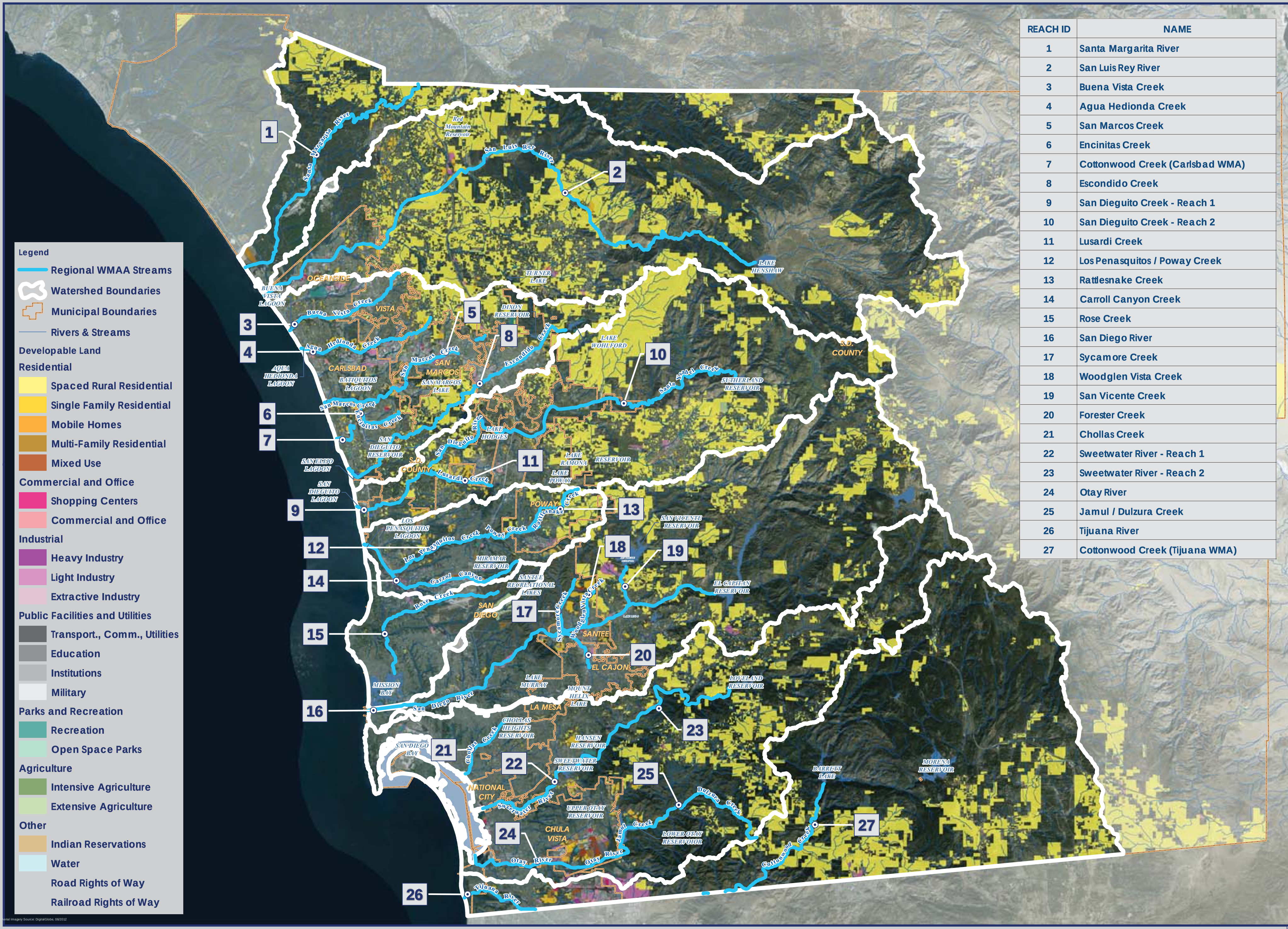

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Legend

- Regional WMAA Streams
- Watershed Boundaries
- Municipal Boundaries
- Rivers & Streams

Developable Land

Residential
- Spaced Rural Residential
- Single Family Residential
- Mobile Homes
- Multi-Family Residential
- Mixed Use

Commercial and Office
- Shopping Centers
- Commercial and Office

Industrial
- Heavy Industry
- Light Industry
- Extractive Industry

Public Facilities and Utilities
- Transport., Comm., Utilities
- Education
- Institutions
- Military

Parks and Recreation
- Recreation
- Open Space Parks

Agriculture
- Intensive Agriculture
- Extensive Agriculture

Other
- Indian Reservations
- Water
- Road Rights of Way
- Railroad Rights of Way

Aerial Imagery Source: DigitalGlobe, 06/2012

Developable Land
Regional San Diego County Watersheds

Exhibit Date: Sept. 8, 2014

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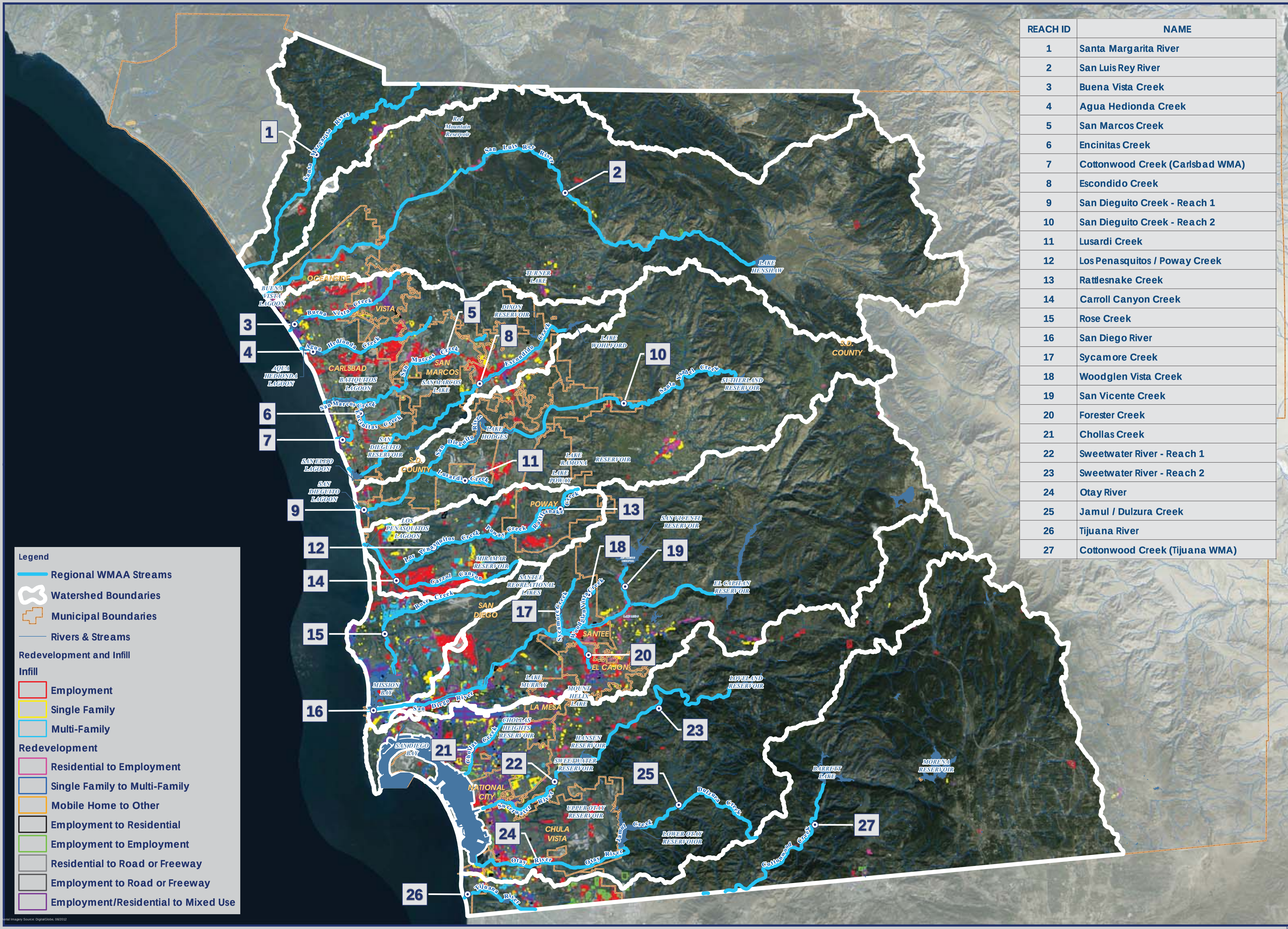

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27	Cottonwood Creek (Tijuana WMA)

Redevelopment and Infill Areas

Regional San Diego County Watersheds

Exhibit Date: Sept. 8, 2014

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ATTACHMENT A.4

POTENTIAL COARSE SEDIMENT YIELD AREAS

A.4.1 Geology Grouping

Geologic grouping was based on the mapped geologic unit as determined by published geologic mapping information. The following describes the methodology utilized to determine bedrock or sedimentary characteristics, anticipated grain size, and suitability for infiltration. A complete list of the various geologic maps used in this evaluation is listed in Chapter 6.

Due to the various mapped scales of the published data and differing mapped unit names, the geologic units were initially compiled into similar categories where possible. For example, the Lindavista Formation is mapped as unit Ql on geologic maps at a scale of 1:24,000 but correlates to the same unit Qvop8 on geologic maps at a scale of 1:100,000. Following the compilation of geologic unit names, the units were differentiated between crystalline bedrock and sedimentary formations based on geologic characterization and material behavior. The Point Loma Formation for example, is a Cretaceous-age sandstone, but it was classified as a "coarse bedrock" unit due to its indurated and resistant nature.

For each site location, the predominant geologic units were then described as "coarse" or "fine" based on typical weathering characteristics of the bedrock units, or primary grain size of the sedimentary units. For example, granodiorite or tonalite crystalline rock typically weathers to a coarse material such as a silty sand and therefore was classified as "coarse," compared to a gabbro which generally weathers to a sandy clay and was characterized as "fine." Sedimentary formations can be more variable, such as the Mission Valley Formation. In this case, the Mission Valley Formation was characterized as "coarse" since the unit is predominantly comprised of sandstone even if it does contain localities of siltstone and claystone within the unit.

To further characterize the sedimentary formations, these units were evaluated for suitability of infiltration. Since no field investigations were performed for this evaluation to determine permeability, the differentiation between impermeable and permeable were based on the age of the geologic unit with the assumption that relatively younger sedimentary units of Pleistocene-age or younger (<1.6 mya) would be more susceptible to surface water infiltration. Geology grouping of different map units is presented in Table A.4.1

Table A.4.1 Geologic grouping for different map units

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
gr-m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
grMz	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Jcr	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Jhc	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Jsp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ka	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kbm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kbp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcc	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcm	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kdl	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgbf	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgdf	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgh	San Diego 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm1	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm2	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm3	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm4	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgr	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgu	San Diego 30' x 60'	Coarse	Bedrock	Impermeable	CB
Khg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ki	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kis	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kjd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
KJem	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
KJld	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kjv	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
Klb	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klh	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Km	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmgp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kpa	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kpv	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kqbd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Krm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Krr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kt	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ktr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kvc	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwsr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Mzd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzq	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzs	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
sch	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Kp	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ql	El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
QTf	El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Ec	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
K	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
Kccg	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Kcs	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Kl	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Ku	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
Qvof	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop8a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop9a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmsc	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmss	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tp	San Diego & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tpm	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsc	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tscu	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsd	San Diego & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsdcg	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsdss	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsm	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tso	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tst	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tt	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tta	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmv	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsi	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa11	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa12	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa13	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoc	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop1	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop10	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop10a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop11	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
Qvop11a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop12	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop13	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop2	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop3	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop4	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop5	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop6	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop7	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop8	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop9	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsa	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qof	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof1	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof2	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Q	Jennings; CA	Coarse	Sedimentary	Permeable	CSP
Qa	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qd	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qf	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qmb	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qw	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyf	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qt	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa1-2	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa2-6	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa5	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa6	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa7	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
Qoc	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop1	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qc	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qu	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop2-4	San Diego 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop3	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop4	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop6	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop7	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qya	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyc	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Mzu	San Diego & Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
gb	Jennings; CA	Fine	Bedrock	Impermeable	FB
JTRm	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kat	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kc	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgb	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
KJvs	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kmv	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Ksp	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kvsp	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kwmt	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Qv	Jennings; CA	Fine	Bedrock	Impermeable	FB
Tba	San Diego 30' x 60'	Fine	Bedrock	Impermeable	FB
Tda	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Tv	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Tvsr	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgdfg	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Ta	San Diego 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tcs	Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Td	San Diego & Oceanside	Fine	Sedimentary	Impermeable	FSI

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
	30' x 60'				
Td+Tf	San Diego 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Qls	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tm	Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tf	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tfr	El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
To	San Diego & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Qpe	San Diego & Oceanside 30' x 60'	Fine	Sedimentary	Permeable	FSP
Mexico	San Diego 30' x 60'	NA	NA	Permeable	Other
Kuo	San Diego 30' x 60'	NA (Offshore)	NA	Permeable	Other
Teo	San Diego & Oceanside 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
Tmo	Oceanside 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
Qmo	San Diego 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
QTso	San Diego 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
af	San Diego & Oceanside 30' x 60'	Variable, dependent on source material	Sedimentary		Other

A.4.2 Quantitative Analysis

Soil loss estimates for each Geomorphic Landscape Unit were estimated using the Revised Universal Soil Loss Equation (RUSLE; Renard et al. 1997) listed below:

$$A = R \times K \times LS \times C \times P$$

Where

A = estimated average soil loss in tons/acre/year

R = rainfall-runoff erosivity factor

K = soil erodibility factor

LS = slope length and steepness factor

C = cover-management factor

P = support practice factor; assumed 1 for this analysis

Regional datasets used to estimate the inputs required to estimate the soil loss from each GLU are listed in table below:

Dataset	Source	Download year	Description
RUSLE – R Factor	SWRCB	2014	Regional R factor map was downloaded from ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_R_Factor/
RUSLE – K Factor	SWRCB	2014	Regional K factor map was downloaded from ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_K_Factor/
RUSLE – LS Factor	SWRCB	2014	Regional LS factor map was downloaded from ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_LS_Factor/
RUSLE – C Factor	USEPA	2014	Regional C factor map was downloaded from http://www.epa.gov/esd/land-sci/emap_west_browser/pages/wemap_mm_sl_rusle_c_qt.htm#mapnav

GIS analysis was used to calculate the area weighted estimate of R, K, LS and C factors using the regional datasets listed in the table above. For the developed land cover the C factor was then adjusted to 0 from the regional estimate to account for management actions implemented on developed sites (e.g. impervious surfaces). Soil loss estimates ranged from 0 to 15.2 tons/acre/year.

For evaluating the degree of relative risk to a stream solely arising from changes in sediment and/or water delivery SCCWRP Technical Report 605, 2010 states:

> *"The challenge in implementing this step is that presently we have insufficient basis to defensibly identify either low-risk or high-risk conditions using these metrics. For example, channels that are close to a threshold for geomorphic change may display significant morphological changes under nothing more than natural year-to-year variability in flow or sediment load.*

- *Acknowledging this caveat, we nonetheless anticipate that changes of less than 10% in either driver are unlikely to instigate, on their own, significant channel changes. This value is a conservative estimate of the year-to-year variability in either discharge or sediment flux that can be accommodated by a channel system in a state of dynamic equilibrium. It does not "guarantee," however, that channel change may not occur—either in response to yet modest alterations in water or sediment delivery, or because of other urbanization impacts (e.g., point discharge of runoff or the trapping of the upstream sediment flux; see Booth 1990) that are not represented with this analysis.*
- *In contrast, recognizing a condition of undisputed "high risk" must await broader collection of regionally relevant data. We note that >60% reductions in predicted sediment production have resulted in both minimal (McGonigle) and dramatic (Agua Hedionda) channel changes, indicating that "more data" may never provide absolute guidance. At present, we suggest using predicted watershed changes of 50% or more in either runoff (as indexed by change in impervious area) or sediment production as provisional criteria for requiring a more detailed evaluation of both the drivers and the resisting factors for channel change, regardless of other screening-level assessments. Clearly, however, only more experience with the application of such "thresholds," and the actual channel conditions that accompany them, will provide a defensible basis for setting numeric standards."*

The following criterion was developed using the suggestions listed above and then used to assign relative sediment production rating to each GLU:

- Low: Soil Loss < 5.6 tons/acre/year [GLUs that have a soil loss of 0 to 5.6 tons/acre/year produces around 10% of the total coarse sediment soil loss from the study area]
- Medium: 5.6 tons/acre/year < Soil Loss < 8.4 tons/acre/year
- High: > 8.4 tons/acre/year [GLUs that have a soil loss greater than 8.4 tons/acre/year produces around 42% of the total coarse sediment soil loss from the study area]

Results from the quantitative analysis are summarized in Table A.4.2.

Table A.4.2 Relative Sediment Production for different Geomorphic Landscape Units

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CB-Agricultural/Grass-1	52883	0.20	4.67	0.14	50	6.5	Medium	No
CB-Agricultural/Grass-2	40633	0.21	5.19	0.14	56	8.3	Medium	No
CB-Agricultural/Grass-3	32617	0.22	6.04	0.14	57	10.6	High	Yes
CB-Agricultural/Grass-4	11066	0.23	7.38	0.14	57	13.5	High	Yes
CB-Developed-1	39746	0.22	3.77	0	49	0	Low	No
CB-Developed-2	32614	0.22	4.28	0	50	0	Low	No
CB-Developed-3	15841	0.22	4.86	0	49	0	Low	No
CB-Developed-4	1805	0.22	5.63	0	48	0	Low	No
CB-Forest-1	32231	0.20	6.38	0.14	39	6.8	Medium	No
CB-Forest-2	38507	0.20	7.20	0.13	45	8.8	High	Yes
CB-Forest-3	55303	0.20	8.14	0.13	48	10.6	High	Yes
CB-Forest-4	38217	0.20	9.95	0.14	50	13.6	High	Yes
CB-Other-1	1036	0.20	5.52	0.13	45	6.5	Medium	No
CB-Other-2	317	0.20	6.46	0.13	45	7.9	Medium	No
CB-Other-3	296	0.20	6.96	0.14	43	8.3	Medium	No
CB-Other-4	111	0.21	6.84	0.14	41	8.2	Medium	No
CB-Scrub/Shrub-1	88135	0.20	5.66	0.14	33	5.3	Low	No
CB-Scrub/Shrub-2	143694	0.20	6.51	0.14	37	6.8	Medium	No
CB-Scrub/Shrub-3	246703	0.21	7.33	0.14	41	8.4	Medium	No
CB-Scrub/Shrub-4	191150	0.21	8.28	0.14	42	9.8	High	Yes
CB-Unknown-1	1727	0.21	5.32	0.13	44	6.3	Medium	No
CB-Unknown-2	1935	0.21	5.95	0.13	44	7.1	Medium	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CB-Unknown-3	1539	0.22	6.21	0.13	44	7.7	Medium	No
CB-Unknown-4	278	0.22	6.61	0.13	44	8.4	High	Yes
CSI-Agricultural/Grass-1	14609	0.34	2.72	0.14	39	4.8	Low	No
CSI-Agricultural/Grass-2	9059	0.37	3.61	0.14	47	8.7	High	Yes
CSI-Agricultural/Grass-3	10096	0.38	3.99	0.14	47	9.8	High	Yes
CSI-Agricultural/Grass-4	2498	0.37	4.33	0.14	47	10.5	High	Yes
CSI-Developed-1	82371	0.28	2.51	0	39	0	Low	No
CSI-Developed-2	22570	0.30	2.66	0	41	0	Low	No
CSI-Developed-3	13675	0.30	2.89	0	40	0	Low	No
CSI-Developed-4	3064	0.27	3.20	0	39	0	Low	No
CSI-Forest-1	449	0.27	4.26	0.13	43	6.6	Medium	No
CSI-Forest-2	611	0.25	5.11	0.13	44	7.5	Medium	No
CSI-Forest-3	716	0.29	4.43	0.13	44	7.4	Medium	No
CSI-Forest-4	348	0.30	4.49	0.13	43	7.6	Medium	No
CSI-Other-1	319	0.31	2.50	0.13	32	3.2	Low	No
CSI-Other-2	83	0.27	3.01	0.13	39	4.3	Low	No
CSI-Other-3	45	0.28	3.03	0.13	39	4.5	Low	No
CSI-Other-4	13	0.24	4.01	0.14	39	5.2	Low	No
CSI-Scrub/Shrub-1	9051	0.26	3.53	0.13	39	4.7	Low	No
CSI-Scrub/Shrub-2	10802	0.27	4.36	0.13	41	6.3	Medium	No
CSI-Scrub/Shrub-3	28220	0.26	4.82	0.13	41	6.7	Medium	No
CSI-Scrub/Shrub-4	20510	0.26	5.52	0.13	41	7.8	Medium	No
CSI-Unknown-1	5292	0.28	2.38	0.13	36	3.1	Low	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CSI-Unknown-2	2074	0.29	2.98	0.13	40	4.5	Low	No
CSI-Unknown-3	2171	0.27	3.04	0.13	39	4.2	Low	No
CSI-Unknown-4	676	0.26	3.04	0.13	38	3.8	Low	No
CSP-Agricultural/Grass-1	59327	0.22	3.01	0.14	44	4.0	Low	No
CSP-Agricultural/Grass-2	8426	0.23	3.81	0.14	42	5.2	Low	No
CSP-Agricultural/Grass-3	2377	0.24	4.05	0.14	41	5.6	Low	No
CSP-Agricultural/Grass-4	291	0.22	6.28	0.14	52	10.1	High	Yes
CSP-Developed-1	85283	0.27	2.10	0	42	0	Low	No
CSP-Developed-2	7513	0.26	2.77	0	42	0	Low	No
CSP-Developed-3	2317	0.27	2.70	0	40	0	Low	No
CSP-Developed-4	272	0.27	2.76	0	38	0	Low	No
CSP-Forest-1	14738	0.22	4.52	0.14	44	6.0	Medium	No
CSP-Forest-2	3737	0.22	5.99	0.14	45	8.2	Medium	No
CSP-Forest-3	1858	0.21	6.42	0.14	45	8.5	High	Yes
CSP-Forest-4	484	0.21	7.62	0.14	48	10.2	High	Yes
CSP-Other-1	7404	0.23	2.61	0.14	39	3.2	Low	No
CSP-Other-2	343	0.24	3.68	0.13	40	4.8	Low	No
CSP-Other-3	126	0.24	3.76	0.13	40	4.9	Low	No
CSP-Other-4	17	0.24	4.19	0.13	39	5.3	Low	No
CSP-Scrub/Shrub-1	22583	0.23	3.75	0.14	41	4.8	Low	No
CSP-Scrub/Shrub-2	8938	0.24	5.63	0.14	40	7.1	Medium	No
CSP-Scrub/Shrub-3	7186	0.23	6.15	0.13	39	7.5	Medium	No
CSP-Scrub/Shrub-4	2609	0.22	7.16	0.14	43	9.3	High	Yes

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CSP-Unknown-1	6186	0.25	2.63	0.13	40	3.4	Low	No
CSP-Unknown-2	744	0.27	3.49	0.13	39	4.8	Low	No
CSP-Unknown-3	350	0.28	3.32	0.13	38	4.5	Low	No
CSP-Unknown-4	78	0.28	3.26	0.13	40	4.5	Low	No
FB-Agricultural/Grass-1	6103	0.25	5.49	0.14	49	9.2	High	No
FB-Agricultural/Grass-2	7205	0.25	5.87	0.14	51	10.1	High	No
FB-Agricultural/Grass-3	6730	0.24	6.43	0.14	53	11.3	High	No
FB-Agricultural/Grass-4	2586	0.22	8.62	0.14	57	15.2	High	No
FB-Developed-1	10116	0.28	3.94	0	46	0	Low	No
FB-Developed-2	9075	0.28	4.41	0	45	0	Low	No
FB-Developed-3	5499	0.27	4.72	0	44	0	Low	No
FB-Developed-4	785	0.27	5.08	0	43	0	Low	No
FB-Forest-1	3780	0.21	7.24	0.13	39	8.0	Medium	No
FB-Forest-2	7059	0.21	7.53	0.13	43	8.8	High	No
FB-Forest-3	13753	0.22	8.02	0.13	43	9.7	High	No
FB-Forest-4	8899	0.26	9.63	0.13	35	11.5	High	No
FB-Other-1	172	0.26	5.72	0.13	44	8.6	High	No
FB-Other-2	75	0.26	5.97	0.13	38	7.7	Medium	No
FB-Other-3	76	0.28	6.27	0.13	34	7.6	Medium	No
FB-Other-4	36	0.31	6.70	0.13	33	8.6	High	No
FB-Scrub/Shrub-1	10297	0.24	6.94	0.14	36	8.3	Medium	No
FB-Scrub/Shrub-2	25150	0.25	7.24	0.14	38	9.0	High	No
FB-Scrub/Shrub-3	70895	0.25	7.89	0.13	38	10.0	High	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
FB-Scrub/Shrub-4	70679	0.26	9.05	0.14	39	12.1	High	No
FB-Unknown-1	654	0.30	5.33	0.13	37	7.6	Medium	No
FB-Unknown-2	829	0.29	5.26	0.13	40	7.9	Medium	No
FB-Unknown-3	1062	0.29	5.54	0.13	39	8.2	Medium	No
FB-Unknown-4	299	0.28	6.02	0.13	38	8.4	High	No
FSI-Agricultural/Grass-1	8462	0.32	3.91	0.13	24	3.9	Low	No
FSI-Agricultural/Grass-2	4979	0.33	4.29	0.13	31	5.7	Medium	No
FSI-Agricultural/Grass-3	4808	0.34	4.26	0.13	34	6.3	Medium	No
FSI-Agricultural/Grass-4	1055	0.35	4.11	0.13	36	6.7	Medium	No
FSI-Developed-1	9953	0.29	3.09	0	34	0	Low	No
FSI-Developed-2	4972	0.31	3.22	0	37	0	Low	No
FSI-Developed-3	3350	0.29	3.30	0	36	0	Low	No
FSI-Developed-4	763	0.28	3.31	0	37	0	Low	No
FSI-Forest-1	186	0.33	4.62	0.13	37	7.2	Medium	No
FSI-Forest-2	217	0.35	4.47	0.13	39	7.9	Medium	No
FSI-Forest-3	262	0.37	4.71	0.13	40	9.2	High	No
FSI-Forest-4	111	0.36	4.73	0.13	40	9.2	High	No
FSI-Other-1	266	0.31	3.11	0.13	24	2.9	Low	No
FSI-Other-2	81	0.30	3.29	0.13	25	3.1	Low	No
FSI-Other-3	56	0.31	3.04	0.13	27	3.2	Low	No
FSI-Other-4	15	0.29	3.57	0.13	33	4.4	Low	No
FSI-Scrub/Shrub-1	2241	0.27	4.46	0.13	29	4.5	Low	No
FSI-Scrub/Shrub-2	3911	0.28	4.96	0.13	31	5.7	Medium	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
FSI-Scrub/Shrub-3	7590	0.29	5.05	0.13	34	6.3	Medium	No
FSI-Scrub/Shrub-4	3502	0.30	5.14	0.13	37	7.5	Medium	No
FSI-Unknown-1	1117	0.29	2.83	0.13	27	3.0	Low	No
FSI-Unknown-2	780	0.30	3.44	0.13	32	4.3	Low	No
FSI-Unknown-3	855	0.29	3.41	0.13	31	4.0	Low	No
FSI-Unknown-4	285	0.28	3.21	0.13	32	3.7	Low	No
FSP-Agricultural/Grass-1	13	0.22	2.22	0.13	40	2.5	Low	No
FSP-Agricultural/Grass-2	3	0.22	2.59	0.13	40	3.0	Low	No
FSP-Agricultural/Grass-3	2	0.22	2.69	0.13	40	3.2	Low	No
FSP-Agricultural/Grass-4	0	0.20	2.94	0.12	40	2.9	Low	No
FSP-Developed-1	180	0.26	2.85	0	40	0	Low	No
FSP-Developed-2	13	0.25	2.69	0	40	0	Low	No
FSP-Developed-3	8	0.21	2.25	0	40	0	Low	No
FSP-Developed-4	0	0.21	2.29	0	40	0	Low	No
FSP-Forest-1	8	0.22	2.29	0.14	40	2.9	Low	No
FSP-Forest-2	5	0.20	2.22	0.14	40	2.5	Low	No
FSP-Forest-3	0	0.20	2.22	0.14	40	2.5	Low	No
FSP-Other-1	1307	0.20	2.38	0.14	40	2.7	Low	No
FSP-Other-2	34	0.21	2.36	0.14	40	2.7	Low	No
FSP-Other-3	8	0.22	2.56	0.13	40	3.0	Low	No
FSP-Other-4	0	0.43	4.35	0.12	40	9.3	High	No
FSP-Scrub/Shrub-1	147	0.23	2.68	0.14	40	3.3	Low	No
FSP-Scrub/Shrub-2	18	0.23	2.55	0.14	40	3.3	Low	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
FSP-Scrub/Shrub-3	4	0.20	2.23	0.14	40	2.6	Low	No
FSP-Scrub/Shrub-4	0	0.20	1.70	0.12	40	1.7	Low	No
FSP-Unknown-1	40	0.20	1.87	0.13	40	1.9	Low	No
FSP-Unknown-2	5	0.20	1.99	0.12	40	2.0	Low	No
FSP-Unknown-3	1	0.20	2.39	0.12	40	2.4	Low	No
O-Agricultural/Grass-1	2433	0.20	2.93	0.14	34	2.8	Low	No
O-Agricultural/Grass-2	112	0.21	3.44	0.14	32	3.2	Low	No
O-Agricultural/Grass-3	30	0.23	3.89	0.13	32	3.8	Low	No
O-Agricultural/Grass-4	1	0.26	6.47	0.13	37	7.9	Medium	No
O-Developed-1	8327	0.27	1.37	0	39	0	Low	No
O-Developed-2	474	0.25	2.12	0	40	0	Low	No
O-Developed-3	157	0.26	3.07	0	41	0	Low	No
O-Developed-4	26	0.24	3.89	0	41	0	Low	No
O-Forest-1	235	0.22	6.15	0.13	43	7.6	Medium	No
O-Forest-2	67	0.21	5.07	0.13	45	6.6	Medium	No
O-Forest-3	45	0.21	5.43	0.13	47	7.3	Medium	No
O-Forest-4	20	0.20	5.95	0.13	59	9.0	High	No
O-Other-1	9362	0.25	3.86	0.13	36	4.3	Low	No
O-Other-2	344	0.24	3.32	0.13	35	3.5	Low	No
O-Other-3	120	0.23	4.86	0.13	35	5.0	Low	No
O-Other-4	37	0.22	5.64	0.13	39	6.6	Medium	No
O-Scrub/Shrub-1	688	0.22	4.83	0.13	40	5.7	Medium	No
O-Scrub/Shrub-2	224	0.22	5.80	0.13	36	6.3	Medium	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
O-Scrub/Shrub-3	209	0.22	6.47	0.13	41	7.5	Medium	No
O-Scrub/Shrub-4	96	0.22	6.62	0.13	44	8.2	Medium	No
O-Unknown-1	1236	0.28	1.60	0.12	26	1.5	Low	No
O-Unknown-2	62	0.27	1.48	0.13	36	1.8	Low	No
O-Unknown-3	15	0.29	3.52	0.13	38	4.9	Low	No
O-Unknown-4	7	0.34	3.87	0.12	40	6.6	Medium	No

GLU Nomenclature: Geology – Land Cover – Slope Category

Geology Categories:

CB Coarse Bedrock

CSI Coarse Sedimentary Impermeable

CSP Coarse Sedimentary Permeable

FB Fine Bedrock

FSI Fine Sedimentary Impermeable

FSP Fine Sedimentary Permeable

O Other

Slope Categories:

1 0%-10%

2 10% - 20%

3 20% - 40%

4 > 40%

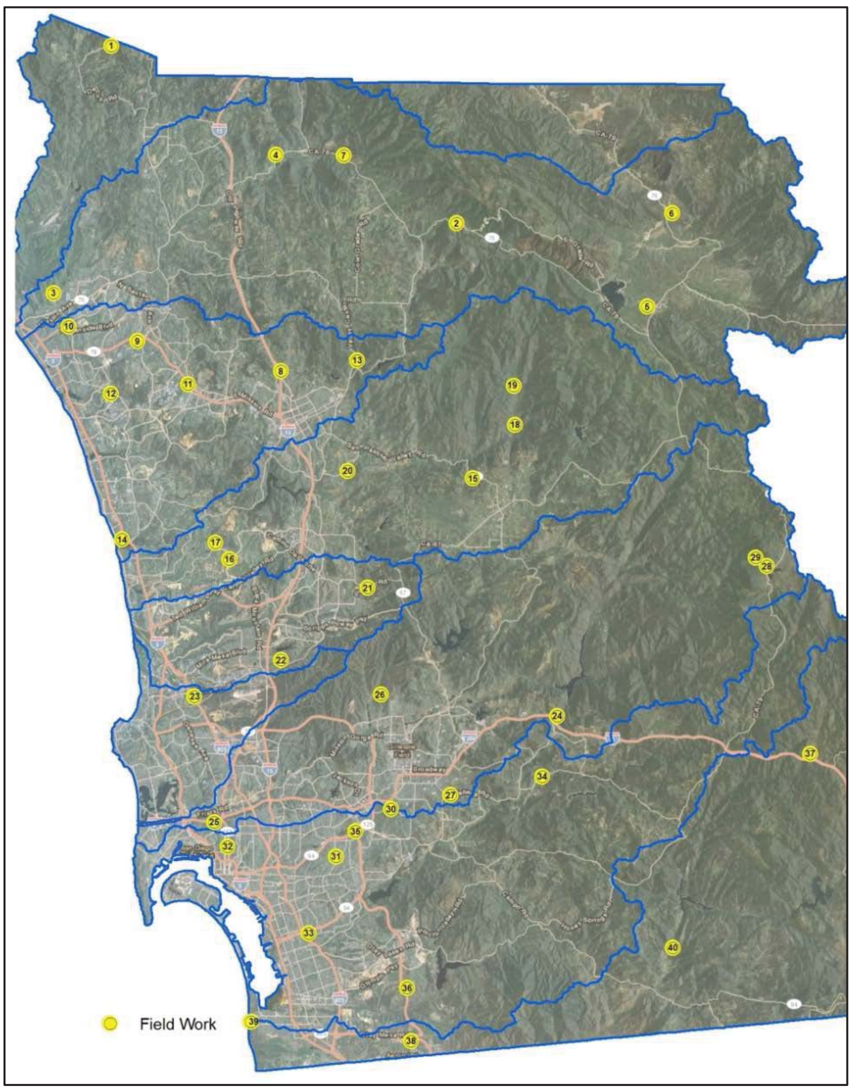
A4.3 Field Assessment

Site Selection:

Forty locations were selected from the study region for field assessment. Sites were selected such that they are accessible by existing road network based on review of satellite imagery and are uniformly distributed considering the following criteria:

- Geologic grouping
- Land cover
- Slope category
- WMA
- Jurisdiction

Yellow circles in the figure below shows the 40 locations for which field assessment was performed.



Pre-Field Activities

Prior to conducting field activities, the consultant team reviewed available published geologic information at each site location and prepared satellite imagery of each site using Google Earth™. Pre-field activities consisted of evaluating site access at each location using aerial imagery and logistics were coordinated based on regional site location to maximize field efficiency.

Site Reconnaissance

Site reconnaissance was performed at forty locations between 22 January and 7 February 2014 by a team of geologists. The reconnaissance consisted of:

- Visual soil classification,
- Assessing existing vegetative cover (0-100%),
- Qualitative assignment of existing sediment production (low, medium, and high) [based on existing vegetative cover],
- Qualitative assignment of potential sediment production (low, medium, and high)[assuming there is 0% vegetative cover], and
- Identifying existing erosional features.

Descriptions and visual classifications of the surficial materials were based on the Unified Soil Classification System (USCS). Underlying geologic units were confirmed where exposed formations were observed within the individual site limits.

SITE AND GEOLOGIC CONDTIONS

Our knowledge of the site conditions has been developed from a review of available geologic literature, previous geologic and geotechnical investigations by the consultant team in the study region, professional experience, site reconnaissance, and field investigations performed for this study.

Surface Conditions

Site locations were sited in open space with the exception of sites ID-27, -30, and -31 which were situated within developed areas with paved streets and sidewalks. The surface conditions at the site locations were characterized by sloping terrain varying from relatively flat (< 5%) to very steep slopes (> 40%). At the time of our reconnaissance the natural hillsides along the areas of interest were covered by varying degrees of moderate to dense growth scrub brush, low grasses, and scattered trees.

Existing erosional and geomorphic features at each site location were identified where possible. The observed erosional features included notable drainages, rilling, scour, and sediment accumulation. Observed geomorphic features included areas of minor slope instability and surficial slumping. Several sources of ground disturbance were identified during the site reconnaissance included active grading operations and bioturbation.

An evaluation of the existing and potential sediment production for each site was determined based on surface conditions. Sediment production was assigned as “high, medium, or low” based on the existing conditions and consultant team’s professional experience.

Surficial Deposits

Surficial deposits, including topsoil, alluvium, colluvium, slopewash, and residual soils are present in portions of the study area within the natural drainages and mantling the slope areas. The composition and grain size of these materials are variable depending on the age, parent sources, and mode of deposition.

Geologic Conditions

Our knowledge of the subsurface conditions at the site locations is based on a review of available published geologic information, professional experience, site reconnaissance, previous explorations and geotechnical investigations performed by the consultant team in the study region.

Field Assessment Photo Log

Field Visit ID-1

GLU: CB-Scrub/Shrub-4

View: Looking southwest

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 90%

Field Visit ID-2

GLU: CB-Forest-4

View: Looking north

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 95%

Field Visit ID-3

GLU: CSI-Agricultural/ Grass-3

View: Looking southwest

Existing sediment production: Low to Med

Potential sediment production:

Med to High

Existing veg. cover:

95-100%

Field Visit ID-4

GLU: CSI-Scrub/Shrub-2

View: Looking north

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 70%

Field Visit ID-5

GLU: CSP-Agricultural/ Grass-1

View: Looking southwest

Existing sediment production: Low to Med

Potential sediment production: Med

Existing veg. cover: 90%

Field Visit ID-6

GLU: CSP-Agricultural/ Grass-3

View: Looking east

Existing sediment production: Low to Med

Potential sediment production:

Low to Med

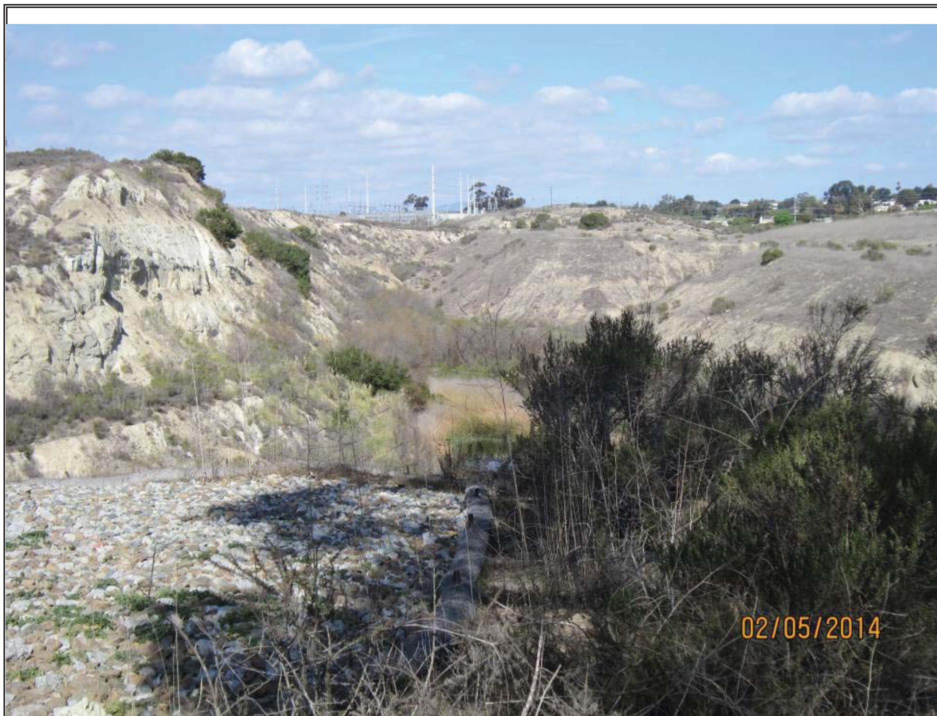
Existing veg. cover:
Southeast slope ~50%

Northeast slope ~70%

	**Field Visit ID-7** **GLU: CSP-Forest-3** View: Looking east Existing sediment production: Med to High Potential sediment production: High Existing veg. cover: 75-80%

	**Field Visit ID-8** **GLU: CB-Scrub/Shrub-3** View: Looking southeast Existing sediment production: Low to Med Potential sediment production: Med to High Existing veg. cover: 90-95%

	**Field Visit ID-9** **GLU: CB-Agricultural/ Grass-2** View: Looking northwest Existing sediment production: Low to Med Potential sediment production: Med Existing veg. cover: 70%

	**Field Visit ID-10** **GLU: CSI-Unknown-2** View: Looking north Existing sediment production: Med to High Potential sediment production: High Existing veg. cover: 75%

Field Visit ID-11

GLU: CSI-Agricultural/ Grass-2

View: Looking east

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 85%

Field Visit ID-12

GLU: CSP-Unknown-2

View: Looking southwest

Existing sediment production: Low

Potential sediment production:

Low to Med

Existing veg. cover: 50%

Field Visit ID-13

GLU: CSP-Scrub/Shrub-2

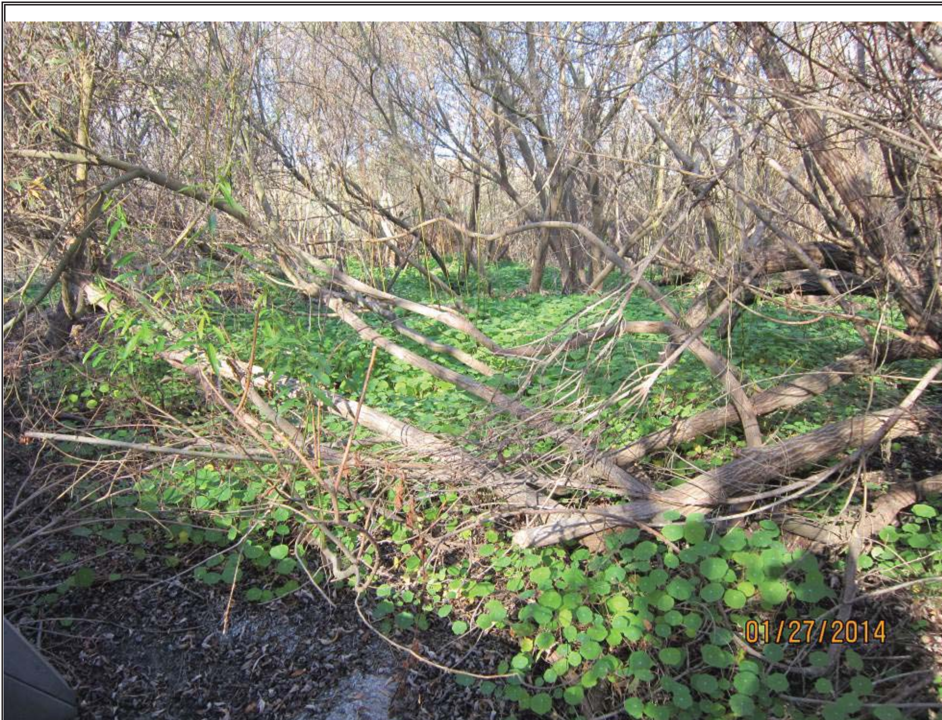
View: Looking southeast

Existing sediment production: Med

Potential sediment production:

Med to High

Existing veg. cover: 80-85%



Field Visit ID-14

GLU: FSP-Scrub/Shrub-1

View: Looking northeast

Existing sediment production: Low

Potential sediment production:

Low to Med

Existing veg. cover:

95-100%

	**Field Visit ID-15** **GLU: CB-Agricultural/ Grass-4** View: Looking west Existing sediment production: Med Potential sediment production: High Existing veg. cover: 95% .
	**Field Visit ID-16** **GLU: CB-Agricultural/ Grass-3** View: Looking south Existing sediment production: High* Potential sediment production: High Existing veg. cover: 90-95% * Area was burned in 2014 fires after the field assessment so existing sediment production was adjusted to High (based on potential sediment production) from Medium

	**Field Visit ID-17** **GLU: CSI-Scrub/Shrub-4** View: Looking west Existing sediment production: Med Potential sediment production: High Existing veg. cover: 95%

	**Field Visit ID-18** **GLU: CSP-Forest-1** View: Looking southwest Existing sediment production: Low to Med Potential sediment production: Med Existing veg. cover: 80%

Field Visit ID-19

GLU: CSP-Scrub/Shrub-3

View: Looking southwest

Existing sediment production: Low to Med

Potential sediment production:

Med to High

Existing veg. cover: 60%

Field Visit ID-20

GLU: CSP-Unknown-1

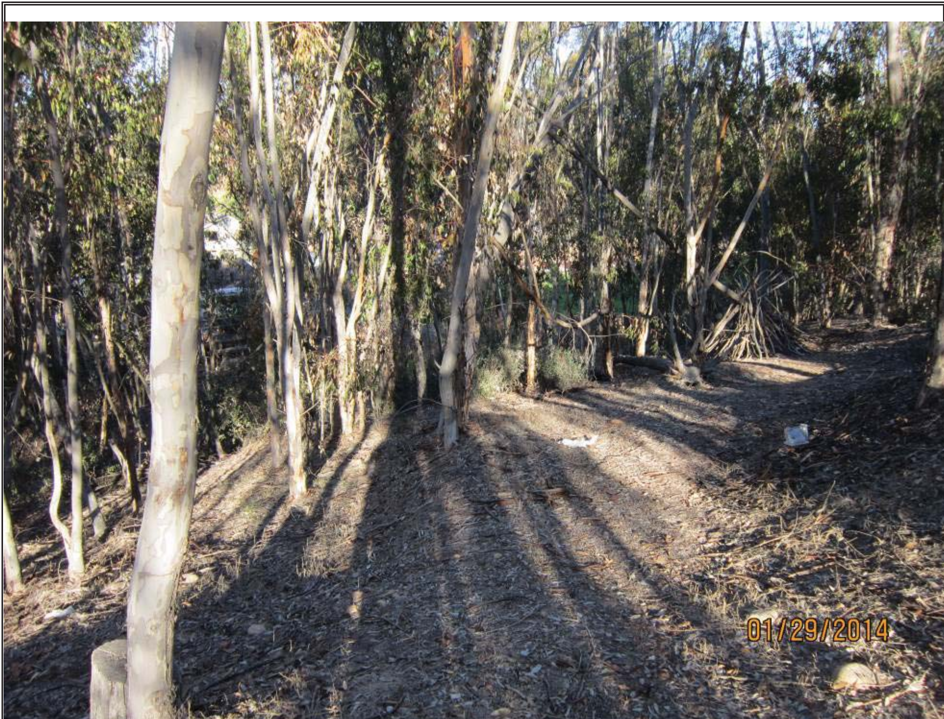
View: Looking southeast

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 95%

	**Field Visit ID-21** **GLU: CB-Unknown-3** View: Looking northwest Existing sediment production: Low to Med Potential sediment production: Med to High Existing veg. cover: 50-60%

	**Field Visit ID-22** **GLU: CSI-Forest-3** View: Looking east Existing sediment production: Low Potential sediment production: Med Existing veg. cover: 60%

Field Visit ID-23

GLU: CSI-Scrub/Shrub-1

View: Looking north

Existing sediment production: Low

Potential sediment production: Low

Existing veg. cover: 80%

Field Visit ID-24

GLU: CB-Unknown-4

View: Looking northeast

Existing sediment production: Low to Med

Potential sediment production: High

Existing veg. cover: 80%

Field Visit ID-25

GLU: CSI-Agricultural/ Grass-4

View: Looking east

Existing sediment production: Low

Potential sediment production: Med-High

Existing veg. cover: 95%

Field Visit ID-26

GLU: CSI-Scrub/Shrub-3

View: Looking east

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 100%

.

	**Field Visit ID-27** **GLU: CSP-Developed-2** View: Looking north Existing sediment production: Low Potential sediment production: Low Existing veg. cover: 30-35% .
	**Field Visit ID-28** **GLU: CSP-Agricultural/ Grass-2** View: Looking north Existing sediment production: Low Potential sediment production: Med Existing veg. cover: 90-95% .

Field Visit ID-29

GLU: FB-Forest-3

View: Looking northwest

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 80-85%

Field Visit ID-30

GLU: CB-Developed-4

View: Looking northeast

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 70%

.

Field Visit ID-31

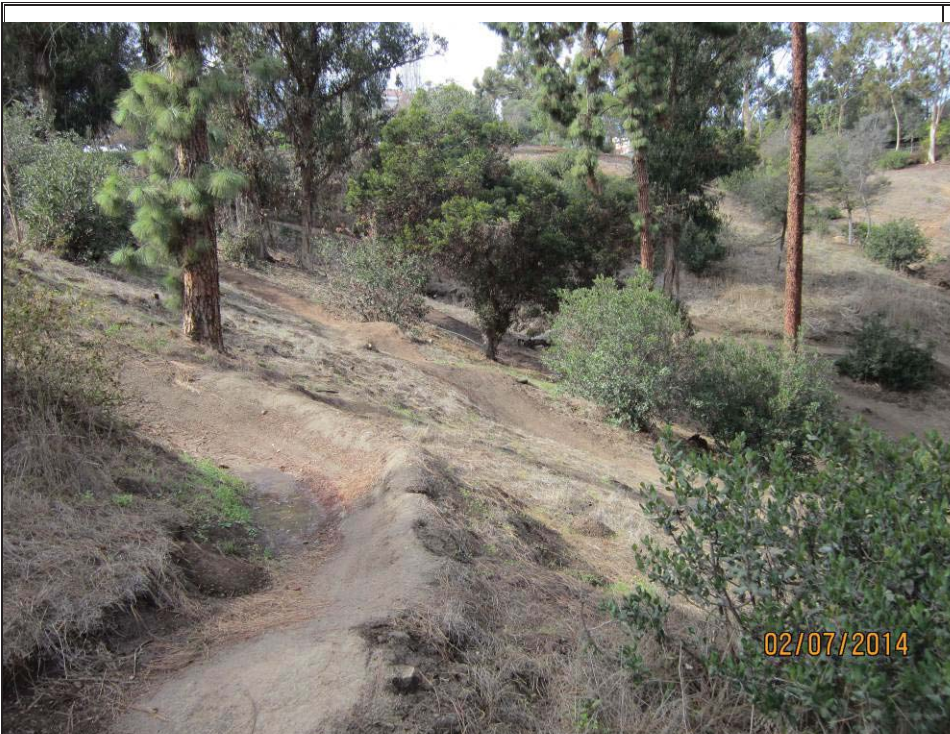
GLU: CSI-Developed-3

View: Looking north

Existing sediment production: Low

Potential sediment production: Low

Existing veg. cover: 30-35%



Field Visit ID-32

GLU: CSI-Unknown-3

View: Looking west

Existing sediment production: Low to Med

Potential sediment production: Med

Existing veg. cover: 70-75%

Field Visit ID-33

GLU: CSP-Scrub/Shrub-1

View: Looking northeast

Existing sediment production: Low to Med

Potential sediment production:

Med to High

Existing veg. cover: 70%

Field Visit ID-34

GLU: CSP-Developed-2

View: Looking south

Existing sediment production: Low

Potential sediment production: Low

Existing veg. cover: 95%

	**Field Visit ID-35** **GLU: FB-Scrub/Shrub-3** View: Looking northeast Existing sediment production: Low Potential sediment production: Med Existing veg. cover: 90-95%

	**Field Visit ID-36** **GLU: FSI-Agricultural/ Grass-2** View: Looking northeast Existing sediment production: Low Potential sediment production: Med Existing veg. cover: 95%

Field Visit ID-37

GLU: CB-Forest-3

View: Looking southeast

Existing sediment production: Med-High

Potential sediment production: High

Existing veg. cover: 75-80%

Field Visit ID-38

GLU: CSI-Agricultural/ Grass-1

View: Looking northeast

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 85%

Field Visit ID-39

GLU: CSP-Developed-1

View: Looking west

Existing sediment production: Low

Potential sediment production: Low

Existing veg. cover: 30-35%

Field Visit ID-40

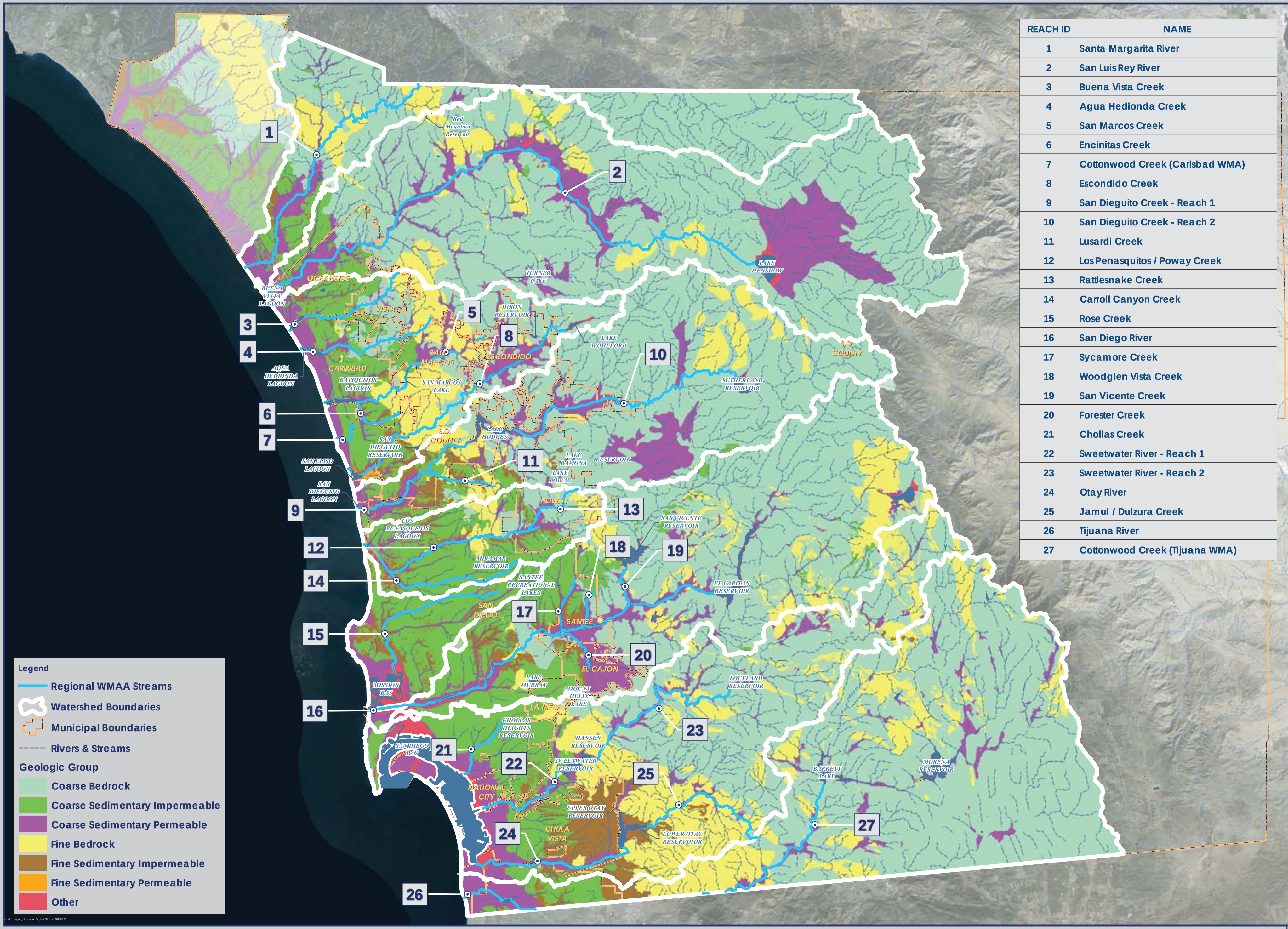
GLU: CSP-Scrub/Shrub-4

View: Looking south

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 90-95%



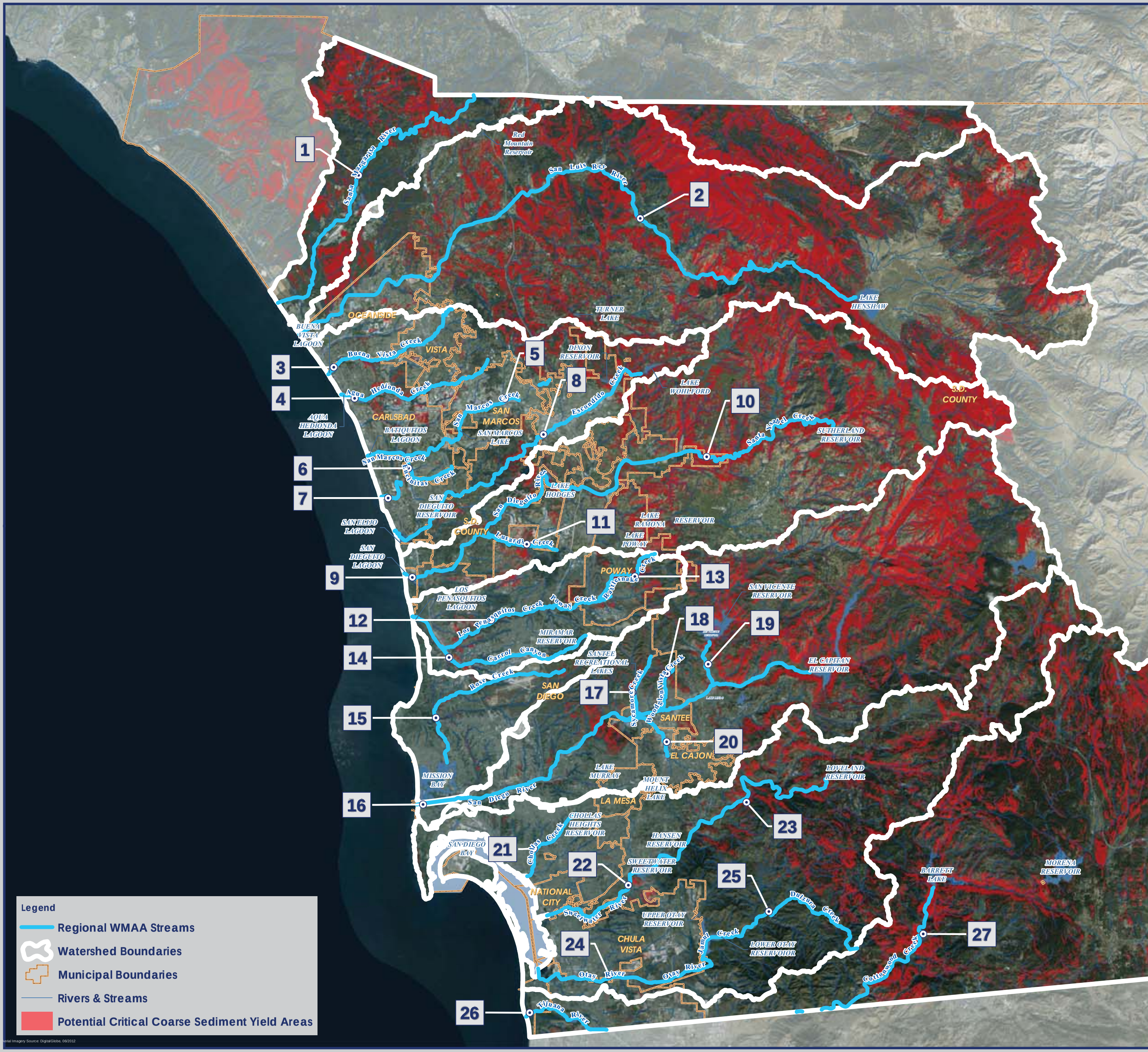
REACH ID	NAME
1	Santa Margarita River
2	San Luis Rey River
3	Buena Vista Creek
4	Agua Hedionda Creek
5	San Marcos Creek
6	Encinitas Creek
7	Cottonwood Creek (Carlsbad WMA)
8	Escondido Creek
9	San Dieguito Creek - Reach 1
10	San Dieguito Creek - Reach 2
11	Lusardi Creek
12	Los Penasquitos / Poway Creek
13	Rattlesnake Creek
14	Carroll Canyon Creek
15	Rose Creek
16	San Diego River
17	Sycamore Creek
18	Woodglen Vista Creek
19	San Vicente Creek
20	Forester Creek
21	Chollas Creek
22	Sweetwater River - Reach 1
23	Sweetwater River - Reach 2
24	Otay River
25	Jamul / Dulzura Creek
26	Tijuana River
27	Cottonwood Creek (Tijuana WMA)

Geologic Groups

Regional San Diego County Watersheds

Exhibit Date: Sept. 8, 2014

Geosyntec consultants
RICK ENGINEERING COMPANY



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19	San Vicente Creek
20	Forester Creek
21	Chollas Creek
22	Sweetwater River - Reach 1
23	Sweetwater River - Reach 2
24	Otay River
25	Jamul / Dulzura Creek
26	Tijuana River
27	Cottonwood Creek (Tijuana WMA)

Potential Critical Coarse Sediment Yield Areas

Regional San Diego County Watersheds

Exhibit Date: Sept. 8, 2014

Geosyntec consultants
RICK ENGINEERING COMPANY

ATTACHMENT A.5

PHYSICAL STRUCTURES

A.5 Physical Structures

The desktop-level analysis to identify existing physical structures within the nine watershed management areas within the San Diego region utilized the following GIS data sources:

- ESRI ArcMap, Google Earth, and Google Maps products
- Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) Flood Profiles and FEMA Flood Insurance Rate Map (FIRM)
- National Flood Hazard Layer (NFHL)
- Municipal master drainage plans (as provided)
- San Diego Geographic Information Source (SanGIS) Municipal Boundaries and Hydrologic Basins
- United States Geological Survey (USGS) National Hydrography Dataset (NHD) California data
- Stream data generated as indicated in Section 2.2

The following documents the process used to identify the physical structures along the reaches and the resulting GIS data:

- The process began by importing the data sources indicated above into a single ArcMap document that served as a master map file from which all further analysis proceeded.
- The data were screened and selected for inclusion as appropriate to the project scope.
- Point features were placed along river reach line segments to coincide with visually identified structures, utilizing different feature symbols according to the type of infrastructure.
- In the case of levees, the point was placed at the downstream-most end of the FEMA NFHL Shapefile. All point features generated in this task appear in the GIS shapefile.
- Municipal boundaries intersecting river reaches were identified to identify the applicable municipal drainage plan data.
- Point feature attributes and associated information for Physical Structures GIS shapefile is indicated in Table A.5.1 below.

Table A.5.1: Structure Identification Point Feature Attribute Development and Information

Attribute	Description
Struct_ID	The Structure ID field provides a six-digit identification number based upon the structure's specific location within a watershed. The first three digits in the code reflect the structure's Hydrologic Unit (HU) Basin number (ranging between 902-911 for Region 9, as defined in the Water Quality Control Plan for the San Diego Basin). The subsequent three digits reflect the structure's location along the reach, ascending along the channel from the headwaters to tailwaters (ranging between 001-999, beginning at the confluence and increasing in the upstream direction).

Attribute	Description
WMA	The Watershed Management Area field provides the name of the watershed in which the structure exists. The WMA corresponds with the HU identified in the first three digits in the Struct_ID (e.g., 911, Tijuana Watershed).
Channel_ID	The Channel ID field provides the name of the channel in which the structure exists.
Struct_Typ	The Structure Type field classifies known structures as one of the following types:, Bridge, Culvert, Dam, Energy Dissipater, Flood Management Basin, Flood Wall, Grade Control, Levee, Pipeline, Weir.
Struct_Dtl	The Structure Detail field provides known quantitative information for multi-section culverts.
Struct_Mtl	The Structure Material field provides known qualitative information for structure material composition.
Struct_Shp	The Structure Shape field provides known geometric information for culvert shapes, and is classified as one of the following types: Arch, Box, Pipe.
Jurisd_ID	The Jurisdiction ID field, when applicable, provides the known separate structure identification number developed and utilized by the jurisdiction or entity responsible for creating and distributing the coinciding structure Shapefile data used for this analysis. This number was copied from the coinciding external Shapefile data attribute field best representing a unique jurisdiction or entity-based identification number (external Shapefile data received from regional WMAA data call; for jurisdictional information, see "Other" attribute field). Coinciding external Shapefile data was used to determine various structure attributes.
Plan_ID	The Plan ID field, when applicable, provides the known structure plan number corresponding with the Jurisdiction ID. This number was copied from the coinciding external Shapefile data attribute field best representing a unique plan number received from the regional WMAA data call (external Shapefile data received from regional WMAA data call; for jurisdictional information, see "Other" field). Coinciding external Shapefile data was used to determine various structure attributes.
Diameter	The Diameter field, when applicable, provides the known diameter (in US feet) for culverts.
Length	The Length field, when applicable, provides the known length (in US feet) for select structure types. When lengths were determined using FEMA FIS Flood Profiles, the scaled horizontal distances along the indicated roadway or channel slope were used.
Width	The Width field, when applicable, provides the known width (in US feet) for select structure types.
Height	The Height field, when applicable, provides the known height (in US feet) for select structure types. When heights were determined using FEMA FIS Flood Profiles, the scaled vertical distances from channel bed to indicated roadway bottom were used.
US_Invert	The Upstream Invert field, when applicable, provides the known upstream invert elevation (in US feet) for select structure types.
DS_Invert	The Downstream Invert field, when applicable, provides the known downstream invert elevation (in US feet) for select structure types.

Attribute	Description
RD_EL_NAVD	The Roadway Elevation (NAVD) field, when applicable, provides the known roadway elevation (in US feet, NAVD) for select structure types. When roadway elevations were determined using FEMA FIS Flood Profiles, the horizontal projection onto the vertical grid scales were used.
Loc_Descr	The Location Description field, when applicable, provides information for structures crossing a known roadway. In nearly all cases, Google Earth imagery was used to determine the roadway name.
Other	The Other field is used to convey any information not present within the preceding fields. Typically, "other" information includes jurisdictional, plan, and supplemental dimensions for a given structure.

Example Structure Identification

The following example demonstrates the structure identification process for a discrete structure (ID 907029) along the San Diego River. The San Diego River is located in the San Diego River watershed (WMA 907). Scanning the river from lower to higher reached, a new point feature was placed at the road crossing over the San Diego River as indicated in Figure A.5.1. Select attributes of this particular structure were available from the FEMA NFHL as displayed in the highlighted boxes in Figure A.5.1. Additional attributes such as the culvert height, length, roadway elevation, and name were also determined from the FIS Flood Profile as indicated in Figure A.5.2. Satellite imagery (e.g., Google) was used to verify the existence of structure. In this case, the most current Google Map data indicated that the culvert still exists and that the roadway name has been changed to Qualcomm Way. When structures could not be verified with satellite imagery, the structure identification was based solely upon the information provided or readily available and was not physically verified in the field. Figure A.5.3 displays an example of imagery used to identify structures.

Figure A.5.1: Typical ArcMap Window

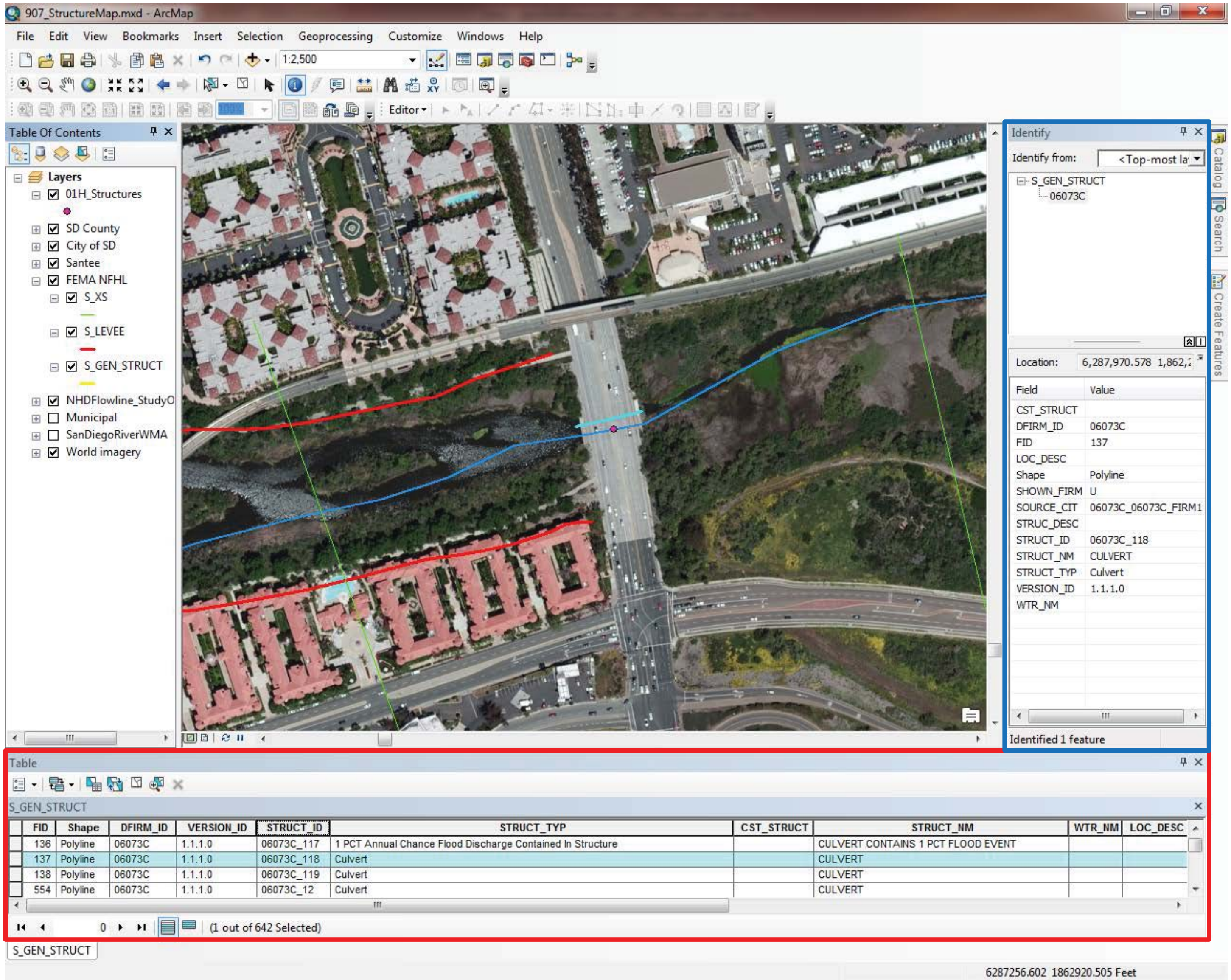
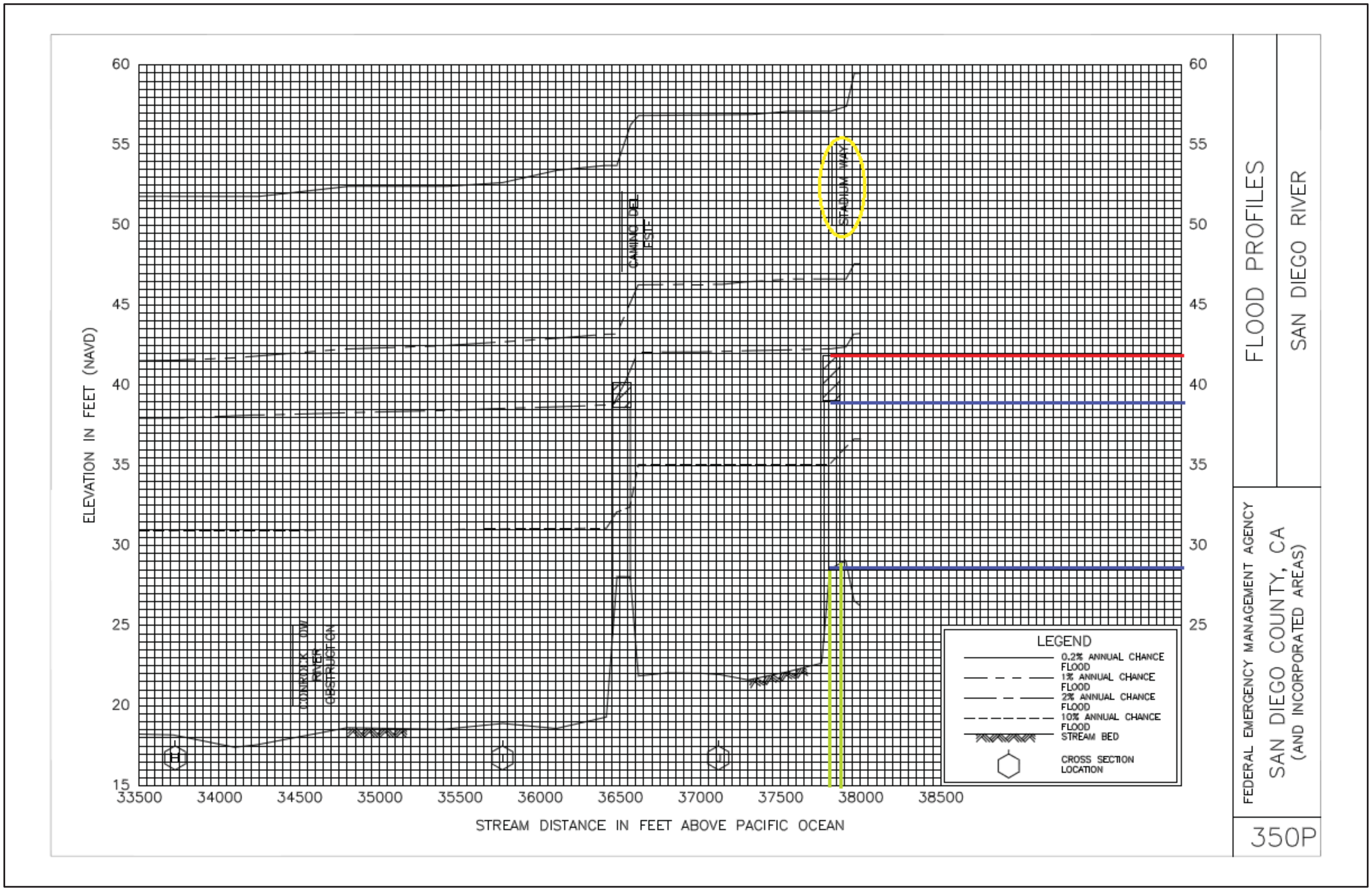


Figure A.5.2: Typical FEMA FIS Flood Profile



Legend: roadway elevation (red), roadway name (yellow), culvert height (blue), culvert width (green)

Figure A.5.3: Google Map Imagery for Structure Identification

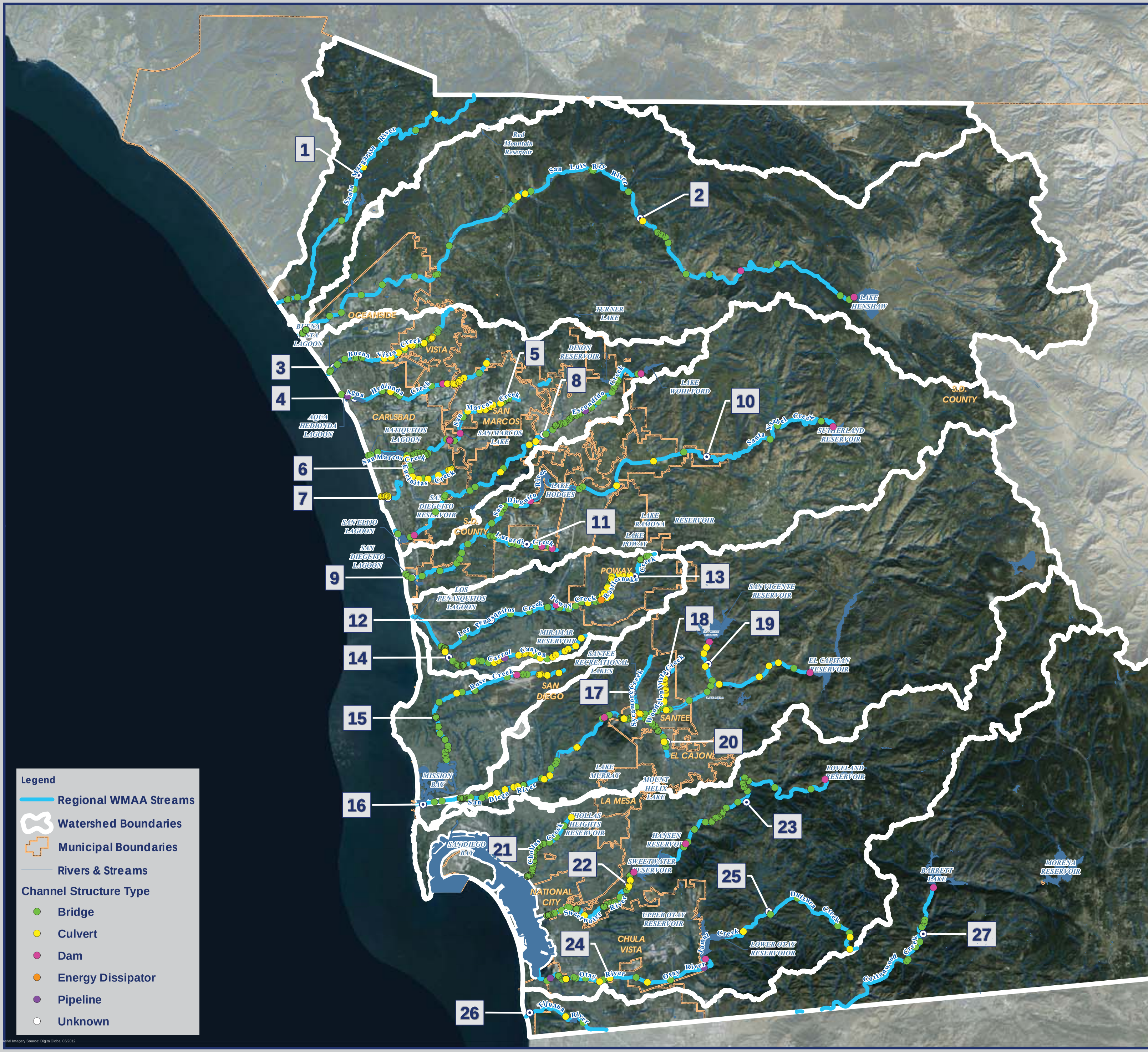
The following bridge structure dimensional attributes were included in the point feature attributes:

- length 110 feet
- height 10 feet
- roadway elevation 41.9 feet

The attribute table associated with the identified structure included in the GIS shapefile is indicated in Table A.5.2.

Table A.5.2: Structure 907029 Attribute Table

Attribute	Description
Struct_ID	907029
WMA	San Diego
Channel_ID	San Diego River
Struct_Typ	Culvert
Struct_Dtl	
Struct_Mtl	
Struct_Shp	
Jurisd_ID	06073C_118
Plan_ID	06073C_06073C_FIRM1
Diameter	0
Length	110
Width	0
Height	10
US_Invert	0
DS_Invert	0
RD_EL_NAVD	41.9
Loc_Descr	Qualcomm Way
Other	Info from FEMA NFHL shapefile data/FIS FP V.9-350P



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25	Jamul / Dulzura Creek
26	Tijuana River
27	Cottonwood Creek (Tijuana WMA)

Watershed Management Area Streams with Channel Structures

Regional San Diego County Watersheds

Exhibit Date: Sept. 8, 2014

Geosyntec consultants · RICK Engineering Company

ATTACHMENT B

HYDROMODIFICATION MANAGEMENT APPLICABILITY/EXEMPTIONS

ATTACHMENT B.1

ADDITIONAL ANALYSIS FOR HYDROMODIFICATION MANAGEMENT EXEMPTIONS

ATTACHMENT B.1.1
EXEMPT RIVER REACHES

B.1.1 Exempt River Reaches

B.1.1.1 Approach for Exempt River Reach Analysis

The approach selected in this cumulative hydromodification impacts study accounts for: (1) hydrology, (2) channel geometry, (3) bed and bank material, and (4) sediment supply. The selected approach compares long-term changes in sediment transport capacity, or in-stream work, and sediment supply for the existing and future development conditions. The ratio of future/existing condition transport capacity, or work, is termed Erosion Potential (Ep). The ratio of future/existing condition bed sediment supply is termed Sediment Supply Potential (Sp). To calculate Ep, the hydrology, channel geometry, and bed/bank materials are characterized for the existing and future conditions. To calculate Sp, the sediment supply factor is characterized for the existing and future conditions.

The findings in this study propose exemption for a given river reach if the analysis satisfies the following criteria:

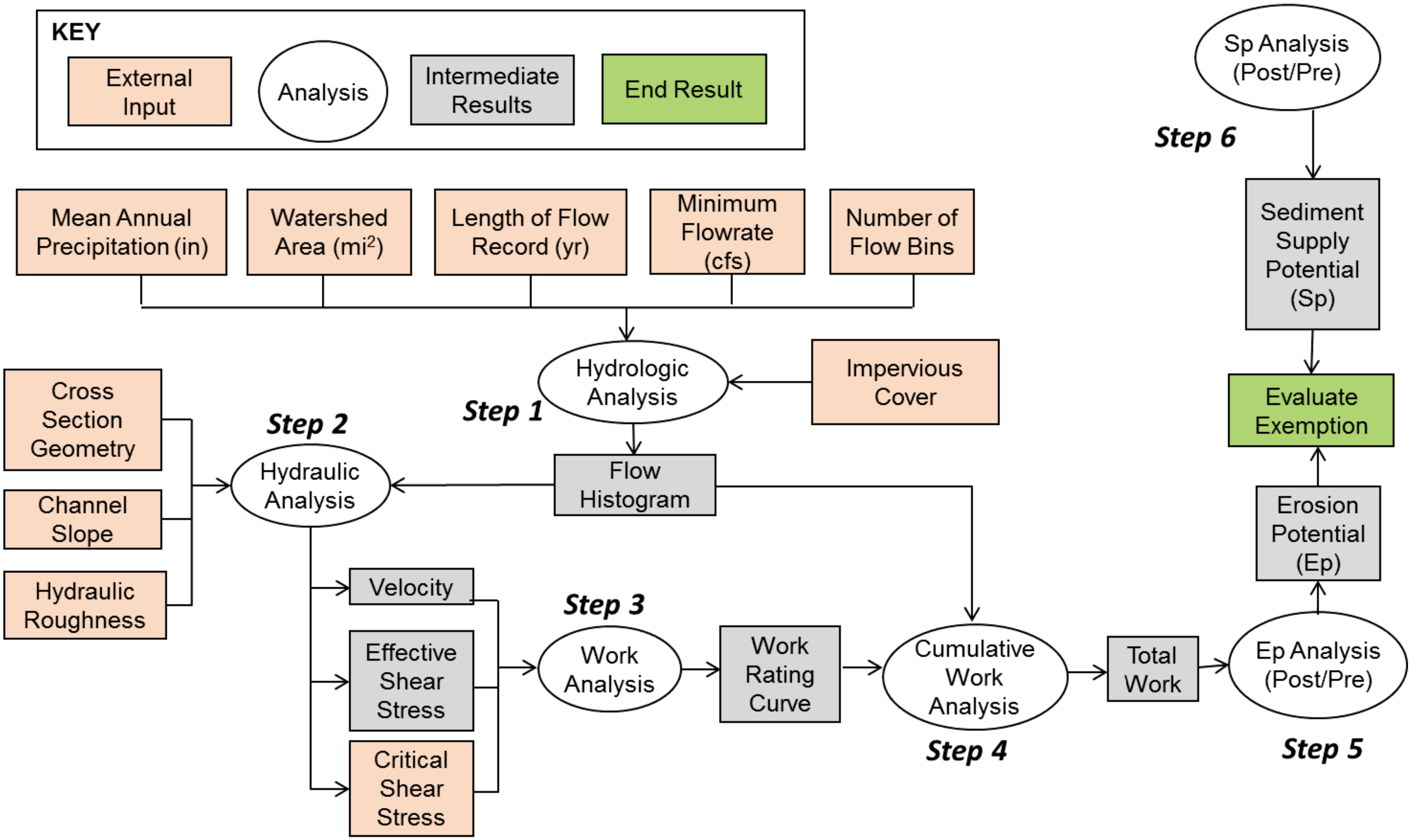
- Ep < 1.05 when d50 < 16 mm or Ep < 1.20 when d50 > 16 mm, and;
- Sp > 0.90

The following bullet points provide basis for the criteria listed above:

- For Ep
  - According to the Journal of Hydrology article titled Channel Enlargement in Semiarid Suburbanizing Watersheds: A Southern California Case Study (Hawley and Bledsoe, 2013): "*The threshold corresponding to the presence/absence of headcutting varied based on substrate type, and was roughly quantified as a sediment-transport ratio greater than ~1.20 in systems with a median grain size > 16mm, and [Ep] ~ 1.05 when d_{50} < 16 mm*"
- For Sp
  - Soar and Thorne (2001) indicate that a greater than 10% reduction in sediment supply can have potentially significant effects on stream stability.
  - SCCWRP Technical Report 605, 2010 states that changes of less than 10% in either driver (Water delivery and sediment are the drivers in this report) are unlikely to instigate, on their own, significant channel changes.

The flow chart summarizing the analysis procedure is presented below.

Flowchart for Exempt River Reach Analysis



B.1.1.2 Selection of Inputs for Exempt River Reach Analysis

The following steps were implemented for each river reach:

- Step 1 – Hydrologic Analysis:
    - Due to limited flow data, a flow duration equation developed for Southern California (Hawley and Bledsoe, 2011) was used to estimate existing and future flow histograms for each watershed.
    - The change in impervious cover between existing and future development conditions was estimated using the developable land use layer from Section 2.3.
    - A desktop-level GIS exercise was performed to manually assign land use classifications if the parcel in the developable land use layer directly discharges into the analyzed reach. Results are summarized in Section B.1.13.
    - Assumptions for percent imperviousness for each land use type were based on the information provided in the San Diego County Imperviousness Study (County of San Diego, 2010).
    - The table below presents the input parameters used to construct flow histograms, as well as the estimated channel slope at the critical cross section.

Exempt River Reach	Area (sq. miles)	Mean Annual Precipitation (in)	Length of Daily Flow Record (Years)	Channel Slope (ft/ft)
San Diego River	173	14.5	30	0.0012
Otay River – West of Interstate 805	46	12	30	0.0026
San Dieguito River	45	14	30	0.0012
San Luis Rey River	353	20	30	0.0019
Sweetwater River	72	12	30	0.0033

- Step 2 – Hydraulic Analysis: The reach type classification from Section 2.2 was used to identify the critical cross section along the reach for Ep analysis. A critical flow rate of $0.5Q_2$ was assigned to estimate the critical shear stress for the analyzed cross section. Flow rates below $0.5Q_2$ were assumed to perform no work on the reach.
- Step 3 – Work Analysis: The simplified effective work equation shown below is used to calculate the work done for each flow bin.

  $$W = (\tau - \tau_c)^{1.5} V$$

  Where

  W = Work (dimensionless)
  τ = effective Shear Stress [lb/ft^2]
  τ_c = Critical Shear Stress [lb/ft^2]
  V = Flow Velocity [ft/s]
- Step 4 – Cumulative Work Analysis: Cumulative work is a measure of the long-term total work or sediment transport capacity performed at a given stream location. Cumulative work incorporates both discharge magnitude and flow duration distributions for the full range of simulated flow rates. Cumulative work is calculated by multiplying work and

duration for each bin. Total work is calculated through summation of work from all flow bins.

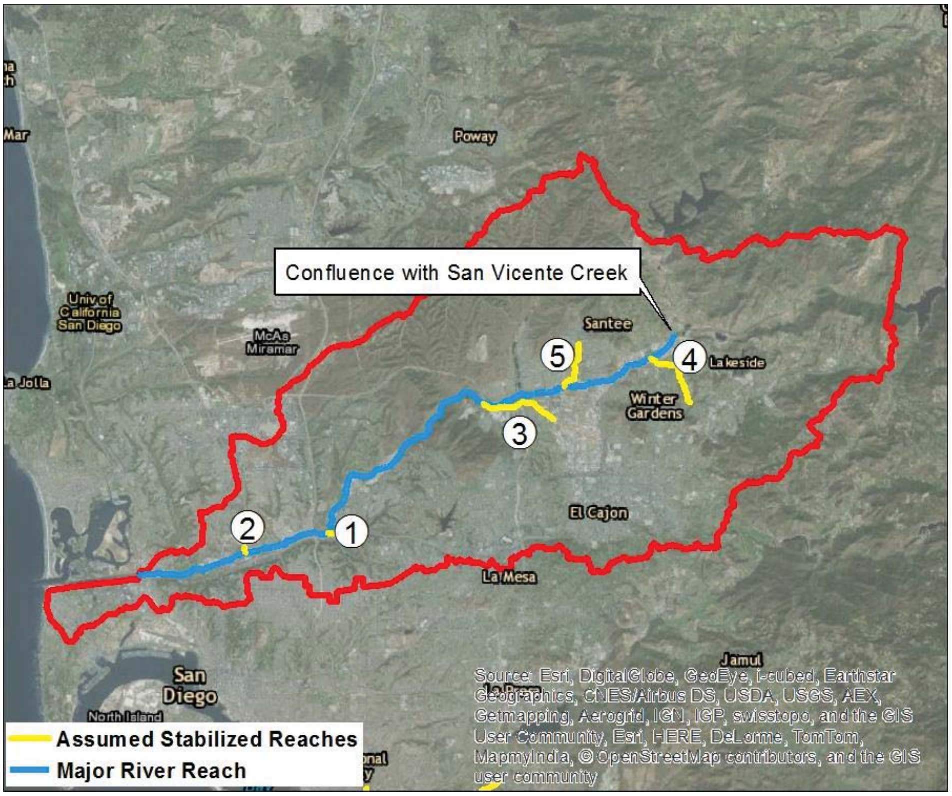
- Step 5 – Ep Analysis: Ep is calculated by dividing the total work of the future condition by that of the existing condition. The existing river reaches analyzed appear relatively stable and have not experienced excessive geomorphic instability due to the alteration of the drainage areas. Given the stable condition of the existing channels, the existing condition was used as the baseline condition instead of natural. Results from the Ep analysis are presented in Section B.1.1.3.
- Step 6 – Sp Analysis: Coarse Sediment Supply Potential for each watershed was estimated using the quantitative results from Section 2.4. First, the watershed coarse sediment soil loss was estimated for all GLUs producing coarse sediment. Then, the future-condition coarse sediment soil loss was estimated by subtracting the approximate exempt parcel soil loss from the existing soil loss. Sp is ultimately calculated by dividing the future coarse sediment soil loss by the existing coarse sediment soil loss. Results from Sp analysis are presented in Section B.1.1.3.

Steps 1 to 5 were performed in Excel and Steps 1 and 6 were executed in GIS. Ep estimates for the exempt river reaches are included in this attachment.

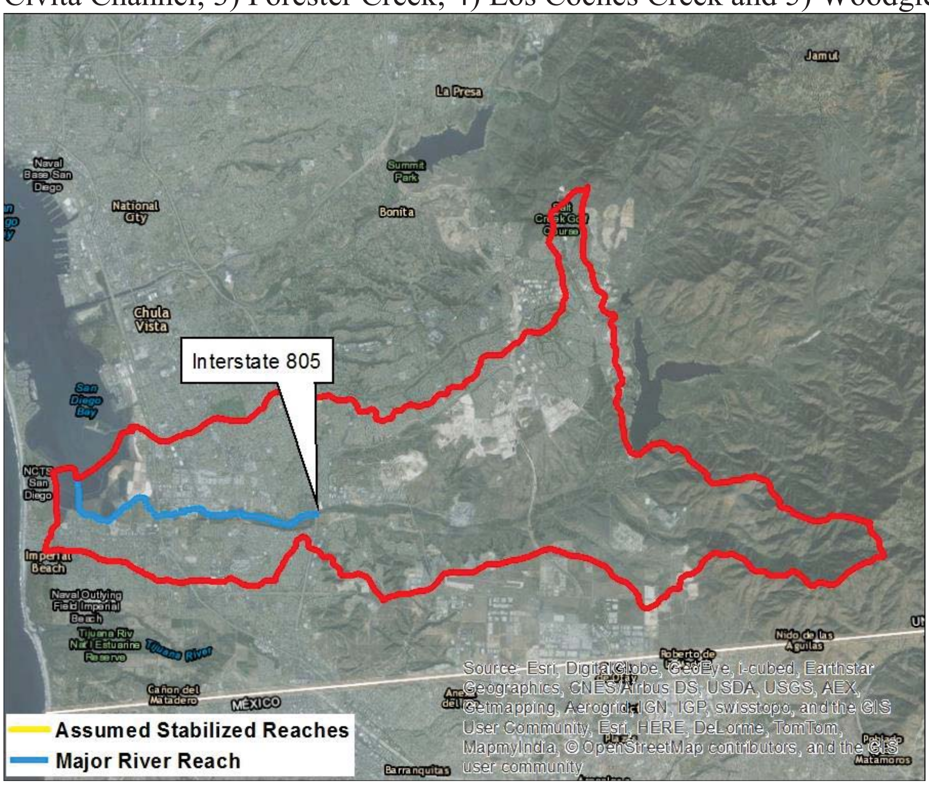
Exempt river reach extents are shown in the figures below. Figures also indicate the tributaries assumed to be stable for performing the erosion potential analysis as a conservative approach to approximate potential HMP exempt flows that may enter the river reach being analyzed.

For a PDP draining to one of the assumed stable tributaries shown in the following exempt reach figures, the PDP applicant shall verify and document that the assumed stable tributary is a stabilized conveyance system by using the methodology presented in section 4.1.2 prior to claiming exemption from hydromodification management requirements.

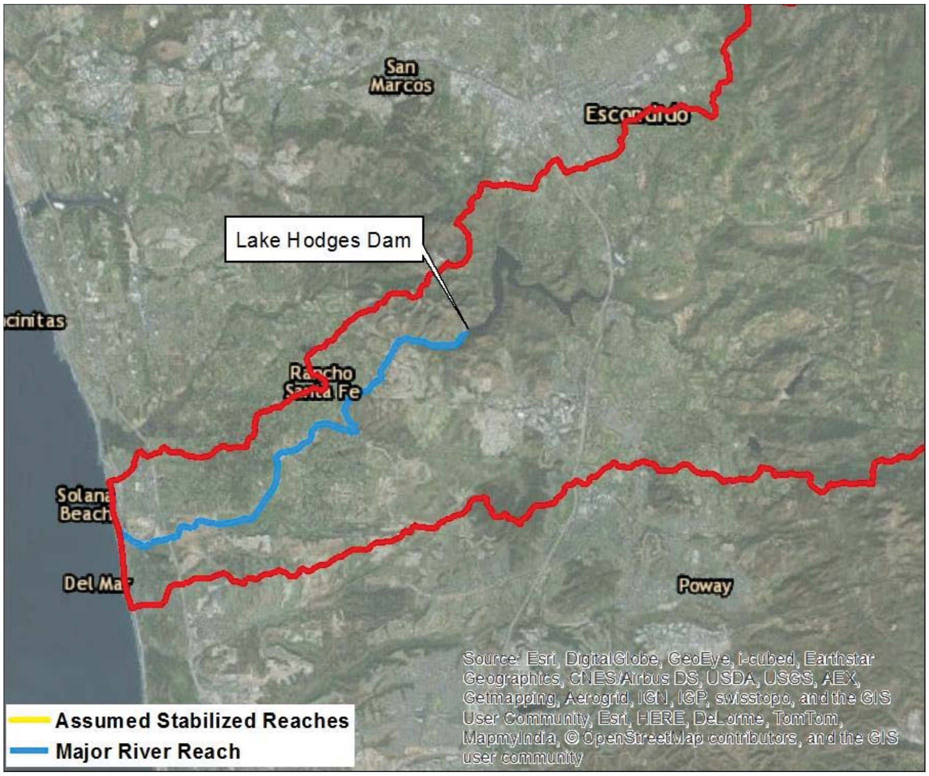
For a PDP draining to a tributary not shown in the figures below to be considered for exemption, a stability analysis using the section 4.1.2 methodology is to be conducted for the given tributary. If the stability analysis determines the tributary is stable, then the exempt river reach analysis indicated in section 4.1.1 shall be performed by adding the additional stabilized tributary to the current list of tributaries shown in the figures below to confirm that the reach satisfies the Ep and Sp criteria.



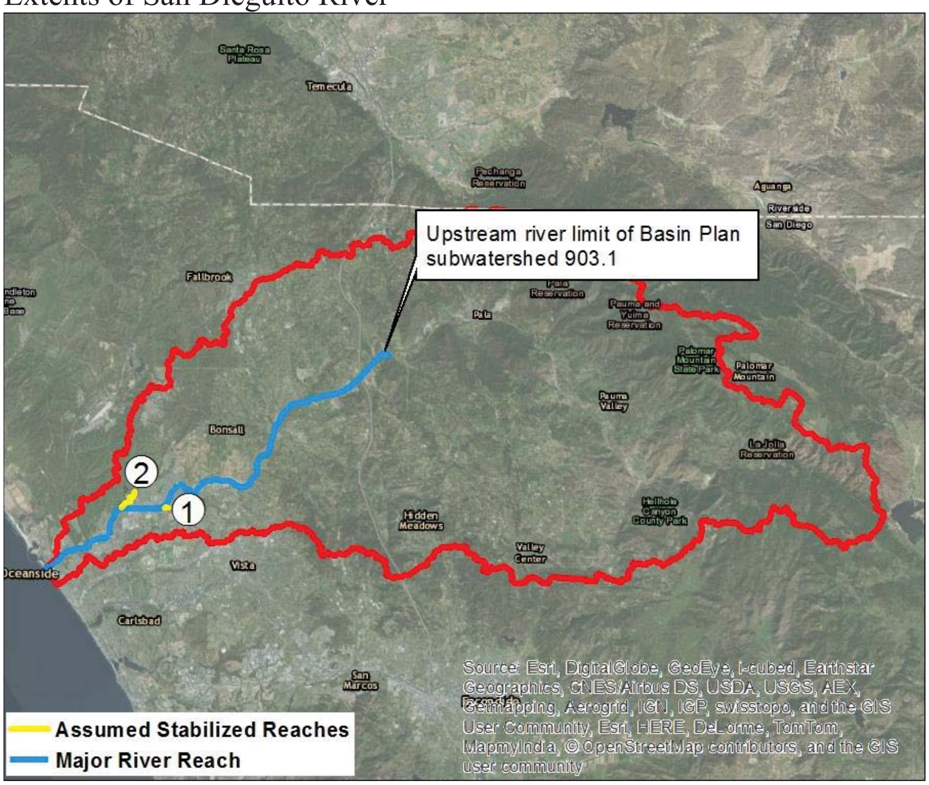
Extents of San Diego River and extents of assumed Stabilized Reaches: 1) Alvarado Creek; 2) Civita Channel; 3) Forester Creek; 4) Los Coches Creek and 5) Woodglen Vista Creek



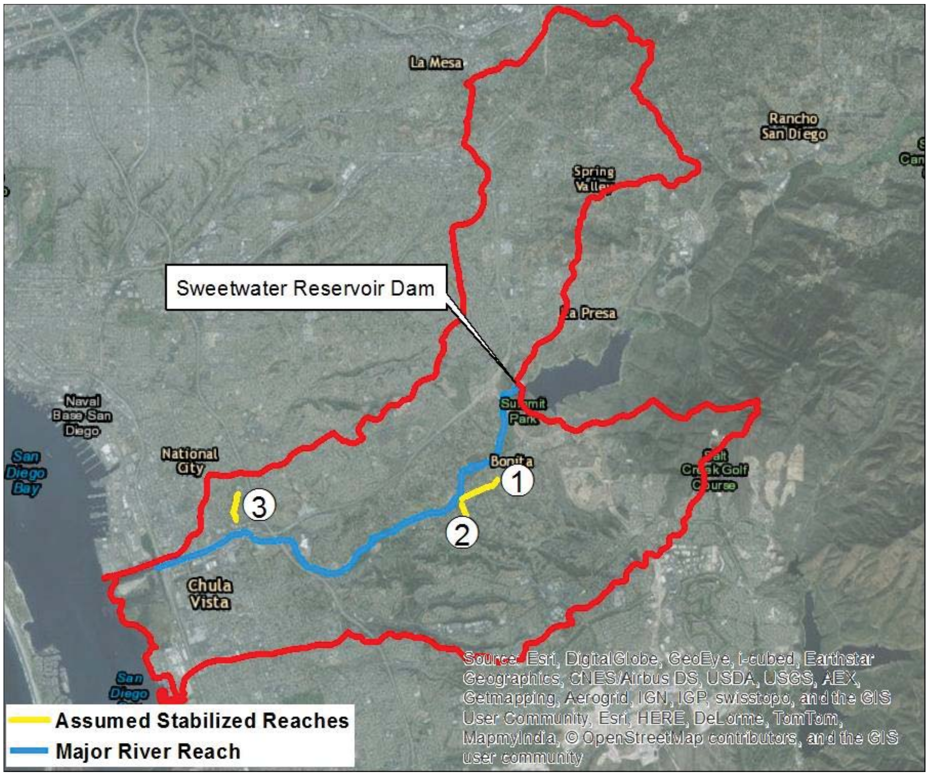
Extents of Otay River



Extents of San Dieguito River



Extents of San Luis Rey River and extents of assumed Stabilized Reaches: 1) Frazee Road Channel and 2) Pilgrim Creek



Extents of Sweetwater River and extents of assumed Stabilized Reaches: 1) Sunnyside Channel; 2) Long Canyon Channel; and 3) National City Gold Course Channel

The table below presents the summary of the developable land in each of the five watersheds with the exempt river reach and the estimated developable area that will be exempted from hydromodification management area requirements if the exempt river reach exemption is reinstated. This area will still be subject to the pollutant control requirements from the regional MS4 permit.

Exempt River Reach	Developable Land		
	Total (acres)	Area exempt (acres)	Exempt (%)
Otay River – West of Interstate 805	4,310	68	2%
San Diego River	13,667	1,196	9%
San Dieguito River	4,653	1,054	23%
San Luis Rey River	77,418	4,223	5%
Sweetwater River	1,332	255	19%

B.1.1.3 Results from Exempt River Reach Analysis

Results from Erosion potential analysis are presented below:

Exempt River Reach	Area (acres)	Impervious Area (acres) [%]			Ep (Post/Pre) [Criteria<1.05]
		Pre	Post	Increase	
Otay River – West of Interstate 805	29,571	9,428[31.8]	9,473[32.0]	45[0.2]	1.01
San Diego River	111,006	32,106[28.9]	32,777[29.5]	671 [0.6]	1.03
San Dieguito River	28,701	6,008[20.9]	6,042[21.0]	34[0.1]	1.01
San Luis Rey River	225,768	26,216[11.6]	26,803[11.9]	587[0.3]	1.01
Sweetwater River	26,596	10,566[39.7]	10,663[40.1]	97[0.4]	1.03

Results from coarse sediment supply potential analysis are presented below:

Exempt River Reach	Soil Loss (tons/yr.)			Sp (Post/Pre) [Criteria>0.90]
	Pre	Exempt Parcels	Post [Pre – Exempt Parcels]	
Otay River – West of Interstate 805	24,402	38	24,364	1.00
San Diego River	354,619	2,575	352,044	0.99
San Dieguito River	53,549	3,582	49,967	0.93
San Luis Rey River	1,503,964	27,072	1,476,892	0.98
Sweetwater River	16,672	601	16,071	0.96

Based on the results from the analysis it is recommended that exemption be reinstated for Otay River west of Interstate 805, San Diego River, San Dieguito River, San Luis Rey River and Sweetwater River.

Erosion Potential Analysis for Otay River - West of I805

Erosion Potential (Ep)	1.01

Channel Slope	0.0026	ft/ft
Estimated Q_2	133	cfs
$0.5Q_2$	66.5	cfs
Critical Shear	0.135	lb/sq. ft
γ	62.4	lb/ft^3

			Existing Condition	**Future Condition**
Tributary Area	*A*	sq mi	46	46
Mean Annual Precip	*MAP*	in/yr	12.0	12.0
Length of Daily Flow Record	*Yr*	yr	30	30
Imperviousness	*Impav*	mi^2/mi^2	0.3188	0.3203
Maximum Flow of Record	*Qmax*	cfs	1236.9	1236.9
Minimum Flow of Record	*Qmin*	cfs	0.01	0.01
10-year peak flow	*Q10*	cfs	3405.1	3405.1
Coefficient of DDF	*day1*	days & cfs	14796.19	15110.20
Exponent of DDF	*day2*	days & cfs	-0.91	-0.91
Number of Bins	N_B	--	25	25
Bin Size	$H_{B\text{-}log}$	--	0.489	0.489

Bin Number	Lower Bound of Bin Number	Upper Bound of Bin Number	Flow	Hydraulic Radius	Flow Velocity	Shear Stress	Work	Duration	Cumulative Work	Duration	Cumulative Work
B	$B_{lwr\text{-}log\,(cfs)}$	$B_{upr\text{-}log\,(cfs)}$	*Q (cfs)*	*R (ft)*	*v (ft/s)*	τ (psf)	*W*		*W*duration*		*W*duration*
1	0.006	0.010	0.01	0.03	0.18	0.005	0.000	1169806	0.00	1205056	0.00
2	0.010	0.016	0.01	0.03	0.18	0.005	0.000	751154	0.00	773107	0.00
3	0.016	0.027	0.02	0.04	0.22	0.006	0.000	482330	0.00	495989	0.00
4	0.027	0.043	0.03	0.05	0.24	0.008	0.000	309713	0.00	318204	0.00
5	0.043	0.071	0.06	0.06	0.29	0.010	0.000	198872	0.00	204144	0.00
6	0.071	0.115	0.09	0.07	0.32	0.011	0.000	127699	0.00	130970	0.00
7	0.115	0.188	0.15	0.08	0.36	0.013	0.000	81998	0.00	84024	0.00
8	0.188	0.306	0.25	0.10	0.41	0.016	0.000	52653	0.00	53906	0.00
9	0.306	0.498	0.40	0.12	0.46	0.019	0.000	33809	0.00	34583	0.00
10	0.498	0.812	0.66	0.14	0.52	0.023	0.000	21709	0.00	22187	0.00
11	0.812	1.324	1.07	0.17	0.59	0.028	0.000	13940	0.00	14234	0.00
12	1.324	2.158	1.74	0.21	0.66	0.034	0.000	8951	0.00	9132	0.00
13	2.158	3.517	2.84	0.25	0.75	0.041	0.000	5748	0.00	5859	0.00
14	3.517	5.733	4.62	0.30	0.85	0.049	0.000	3691	0.00	3759	0.00
15	5.733	9.344	7.54	0.36	0.96	0.058	0.000	2370	0.00	2411	0.00
16	9.344	15.230	12.29	0.43	1.08	0.070	0.000	1522	0.00	1547	0.00
17	15.230	24.825	20.03	0.52	1.22	0.084	0.000	977	0.00	992	0.00
18	24.825	40.465	32.64	0.62	1.38	0.101	0.000	627	0.00	637	0.00
19	40.465	65.956	53.21	0.75	1.56	0.122	0.000	403	0.00	409	0.00
20	65.956	107.507	86.73	0.94	1.82	0.153	0.004	259	1.12	262	1.14
21	107.507	175.233	141.37	1.18	2.11	0.191	0.029	166	4.74	168	4.80
22	175.233	285.626	230.43	1.46	2.44	0.237	0.080	107	8.50	108	8.60
23	285.626	465.563	375.59	1.80	2.81	0.292	0.175	68	12.02	69	12.14
24	465.563	758.856	612.21	2.15	3.16	0.349	0.313	44	13.77	44	13.90
25	758.856	1236.916	997.89	2.57	3.56	0.417	0.534	28	15.08	28	15.21

Erosion Potential Analysis for San Diego River

Erosion Potential (Ep)	1.03

Channel Slope	0.0012	ft/ft
Estimated Q_2	436	cfs
$0.5Q_2$	218	cfs
Critical Shear	0.109	lb/sq. ft
γ	62.4	lb/ft^3

			Existing Condition	**Future Condition**
Tributary Area	*A*	sq mi	173	173
Mean Annual Precip	*MAP*	in/yr	14.5	14.5
Length of Daily Flow Record	*Yr*	yr	30	30
Imperviousness	*Impav*	mi^2/mi^2	0.2892	0.2953
Maximum Flow of Record	*Qmax*	cfs	6336.8	6336.8
Minimum Flow of Record	*Qmin*	cfs	0.01	0.01
10-year peak flow	*Q10*	cfs	12411.4	12411.4
Coefficient of DDF	*day1*	days & cfs	48535.40	52754.33
Exponent of DDF	*day2*	days & cfs	-0.88	-0.88
Number of Bins	N_B	--	25	25
Bin Size	$H_{B\text{-}log}$	--	0.557	0.557

Bin Number	Lower Bound of Bin Number	Upper Bound of Bin Number	Flow	Hydraulic Radius	Flow Velocity	Shear Stress	Work	Duration	Cumulative Work	Duration	Cumulative Work
B	$B_{lwr\text{-}log\ (cfs)}$	$B_{upr\text{-}log\ (cfs)}$	*Q (cfs)*	*R (ft)*	*v (ft/s)*	τ (psf)	*W*		*W*duration*		*W*duration*
1	0.006	0.010	0.01	0.00	0.02	0.000	0.000	3404271	0.00	3830691	0.00
2	0.010	0.017	0.01	0.00	0.02	0.000	0.000	2089074	0.00	2341409	0.00
3	0.017	0.030	0.02	0.00	0.03	0.000	0.000	1281986	0.00	1431125	0.00
4	0.030	0.053	0.04	0.01	0.04	0.001	0.000	786707	0.00	874737	0.00
5	0.053	0.093	0.07	0.01	0.05	0.001	0.000	482773	0.00	534660	0.00
6	0.093	0.162	0.13	0.01	0.07	0.001	0.000	296259	0.00	326797	0.00
7	0.162	0.282	0.22	0.02	0.08	0.001	0.000	181803	0.00	199746	0.00
8	0.282	0.492	0.39	0.02	0.10	0.001	0.000	111566	0.00	122090	0.00
9	0.492	0.859	0.68	0.03	0.13	0.002	0.000	68464	0.00	74624	0.00
10	0.859	1.499	1.18	0.04	0.16	0.003	0.000	42014	0.00	45612	0.00
11	1.499	2.615	2.06	0.06	0.20	0.004	0.000	25782	0.00	27879	0.00
12	2.615	4.562	3.59	0.09	0.25	0.007	0.000	15822	0.00	17040	0.00
13	4.562	7.960	6.26	0.12	0.31	0.009	0.000	9709	0.00	10415	0.00
14	7.960	13.889	10.92	0.17	0.39	0.013	0.000	5958	0.00	6366	0.00
15	13.889	24.234	19.06	0.23	0.49	0.017	0.000	3656	0.00	3891	0.00
16	24.234	42.283	33.26	0.33	0.61	0.025	0.000	2244	0.00	2378	0.00
17	42.283	73.776	58.03	0.45	0.76	0.034	0.000	1377	0.00	1454	0.00
18	73.776	128.724	101.25	0.63	0.94	0.047	0.000	845	0.00	889	0.00
19	128.724	224.597	176.66	0.87	1.17	0.065	0.000	519	0.00	543	0.00
20	224.597	391.875	308.24	1.20	1.45	0.090	0.000	318	0.00	332	0.00
21	391.875	683.742	537.81	1.65	1.80	0.124	0.003	195	0.60	203	0.62
22	683.742	1192.991	938.37	2.25	2.21	0.168	0.032	120	3.81	124	3.94
23	1192.991	2081.525	1637.26	3.00	2.68	0.225	0.105	74	7.72	76	7.96
24	2081.525	3631.836	2856.68	3.80	3.13	0.285	0.230	45	10.36	46	10.64
25	3631.836	6336.812	4984.32	4.06	3.28	0.304	0.282	28	7.80	28	7.98

Erosion Potential Analysis for San Dieguito River

Erosion Potential (Ep)	1.01

Channel Slope	0.0012	ft/ft
Estimated Q_2	156	cfs
$0.5Q_2$	78	cfs
Critical Shear	0.044	lb/sq. ft
γ	62.4	lb/ft^3

			Existing Condition	**Future Condition**
Tributary Area	*A*	sq mi	45	45
Mean Annual Precip	*MAP*	in/yr	14.0	14.0
Length of Daily Flow Record	*Yr*	yr	30	30
Imperviousness	*Impav*	mi^2/mi^2	0.209	0.211
Maximum Flow of Record	*Qmax*	cfs	1583.0	1583.0
Minimum Flow of Record	*Qmin*	cfs	0.01	0.01
10-year peak flow	*Q10*	cfs	3734.4	3734.4
Coefficient of DDF	*day1*	days & cfs	5669.51	5762.95
Exponent of DDF	*day2*	days & cfs	-0.84	-0.84
Number of Bins	N_B	--	25	25
Bin Size	$H_{B\text{-}log}$	--	0.499	0.499

Bin Number	Lower Bound of Bin Number	Upper Bound of Bin Number	Flow	Hydraulic Radius	Flow Velocity	Shear Stress	Work	Duration	Cumulative Work	Duration	Cumulative Work
B	$B_{lwr\text{-}log\,(cfs)}$	$B_{upr\text{-}log\,(cfs)}$	*Q (cfs)*	*R (ft)*	*v (ft/s)*	τ (psf)	*W*		*W*duration*		*W*duration*
1	0.006	0.010	0.01	0.01	0.07	0.001	0.000	322675	0.00	330221	0.00
2	0.010	0.016	0.01	0.01	0.07	0.001	0.000	212448	0.00	217264	0.00
3	0.016	0.027	0.02	0.02	0.09	0.001	0.000	139875	0.00	142946	0.00
4	0.027	0.045	0.04	0.01	0.10	0.001	0.000	92093	0.00	94049	0.00
5	0.045	0.074	0.06	0.03	0.11	0.002	0.000	60634	0.00	61878	0.00
6	0.074	0.121	0.10	0.03	0.13	0.002	0.000	39921	0.00	40712	0.00
7	0.121	0.199	0.16	0.04	0.14	0.003	0.000	26284	0.00	26786	0.00
8	0.199	0.328	0.26	0.05	0.16	0.004	0.000	17305	0.00	17623	0.00
9	0.328	0.541	0.43	0.05	0.19	0.004	0.000	11394	0.00	11595	0.00
10	0.541	0.891	0.72	0.07	0.21	0.005	0.000	7502	0.00	7629	0.00
11	0.891	1.467	1.18	0.08	0.25	0.006	0.000	4939	0.00	5019	0.00
12	1.467	2.416	1.94	0.11	0.29	0.008	0.000	3252	0.00	3302	0.00
13	2.416	3.979	3.20	0.13	0.34	0.010	0.000	2141	0.00	2173	0.00
14	3.979	6.552	5.27	0.17	0.40	0.013	0.000	1410	0.00	1430	0.00
15	6.552	10.790	8.67	0.21	0.46	0.016	0.000	928	0.00	941	0.00
16	10.790	17.769	14.28	0.26	0.53	0.019	0.000	611	0.00	619	0.00
17	17.769	29.263	23.52	0.34	0.62	0.025	0.000	402	0.00	407	0.00
18	29.263	48.191	38.73	0.43	0.73	0.032	0.000	265	0.00	268	0.00
19	48.191	79.361	63.78	0.54	0.85	0.040	0.000	174	0.00	176	0.00
20	79.361	130.694	105.03	0.68	1.00	0.051	0.001	115	0.06	116	0.06
21	130.694	215.228	172.96	0.86	1.16	0.064	0.003	76	0.25	76	0.25
22	215.228	354.441	284.83	1.08	1.35	0.081	0.009	50	0.47	50	0.48
23	354.441	583.699	469.07	1.34	1.57	0.100	0.021	33	0.68	33	0.69
24	583.699	961.245	772.47	1.65	1.80	0.124	0.040	22	0.87	22	0.87
25	961.245	1582.993	1272.12	1.98	2.03	0.148	0.068	14	0.97	14	0.97

Erosion Potential Analysis for San Luis Rey River

Erosion Potential (Ep)	1.01

Channel Slope	0.0019	ft/ft
Estimated Q_2	1225	cfs
$0.5Q_2$	612.5	cfs
Critical Shear	0.077	lb/sq. ft
γ	62.4	lb/ft^3

			Existing Condition	Future Condition
Tributary Area	*A*	sq mi	353	353
Mean Annual Precip	*MAP*	in/yr	20.0	20.0
Length of Daily Flow Record	*Yr*	yr	30	30
Imperviousness	*Impav*	mi^2/mi^2	0.1161	0.1187
Maximum Flow of Record	*Qmax*	cfs	22579.2	22579.2
Minimum Flow of Record	*Qmin*	cfs	0.01	0.01
10-year peak flow	*Q10*	cfs	29414.3	29414.3
Coefficient of DDF	*day1*	days & cfs	23720.72	24587.28
Exponent of DDF	*day2*	days & cfs	-0.76	-0.76
Number of Bins	N_B	--	25	25
Bin Size	$H_{B\text{-}log}$	--	0.610	0.610

Bin Number	Lower Bound of Bin Number	Upper Bound of Bin Number	Flow	Hydraulic Radius	Flow Velocity	Shear Stress	Work	Duration	Cumulative Work	Duration	Cumulative Work
B	$B_{lwr\text{-}log\,(cfs)}$	$B_{upr\text{-}log\,(cfs)}$	*Q (cfs)*	*R (ft)*	*v (ft/s)*	τ (psf)	*W*		*W*duration*		*W*duration*
1	0.01	0.01	0.01	0.00	0.02	0.000	0.000	955692	0.00	1005555	0.00
2	0.01	0.02	0.01	0.00	0.02	0.000	0.000	601390	0.00	631581	0.00
3	0.02	0.03	0.03	0.00	0.03	0.000	0.000	378438	0.00	396691	0.00
4	0.03	0.06	0.05	0.00	0.03	0.000	0.000	238140	0.00	249158	0.00
5	0.06	0.11	0.09	0.00	0.04	0.000	0.000	149855	0.00	156494	0.00
6	0.11	0.21	0.16	0.01	0.05	0.001	0.000	94299	0.00	98293	0.00
7	0.21	0.39	0.30	0.01	0.07	0.001	0.000	59340	0.00	61737	0.00
8	0.39	0.71	0.55	0.01	0.08	0.001	0.000	37341	0.00	38776	0.00
9	0.71	1.31	1.0	0.02	0.11	0.002	0.000	23498	0.00	24355	0.00
10	1.3	2.4	1.9	0.02	0.14	0.002	0.000	14786	0.00	15297	0.00
11	2.4	4.4	3.4	0.03	0.17	0.004	0.000	9305	0.00	9608	0.00
12	4.4	8.2	6.3	0.05	0.22	0.006	0.000	5855	0.00	6035	0.00
13	8.2	15.0	11.6	0.07	0.27	0.008	0.000	3684	0.00	3790	0.00
14	15.0	27.6	21.3	0.10	0.35	0.012	0.000	2319	0.00	2381	0.00
15	27.6	50.9	39.2	0.14	0.44	0.017	0.000	1459	0.00	1495	0.00
16	50.9	93.6	72.2	0.20	0.55	0.024	0.000	918	0.00	939	0.00
17	93.6	172.1	132.8	0.28	0.70	0.033	0.000	578	0.00	590	0.00
18	172.1	316.6	244.4	0.40	0.87	0.047	0.000	364	0.00	371	0.00
19	316.6	582.5	449.6	0.55	1.09	0.065	0.000	229	0.00	233	0.00
20	582.5	1071.6	827.0	0.76	1.35	0.090	0.002	144	0.29	146	0.29
21	1071.6	1971.3	1521.4	1.07	1.69	0.127	0.019	91	1.70	92	1.72
22	1971.3	3626.6	2798.9	1.50	2.12	0.178	0.068	57	3.87	58	3.91
23	3626.6	6671.6	5149.1	2.09	2.65	0.248	0.187	36	6.71	36	6.77
24	6671.6	12273.5	9472.6	2.92	3.31	0.346	0.462	23	10.43	23	10.51
25	12273.5	22579.2	17426.3	4.06	4.12	0.481	1.059	14	15.04	14	15.13

Erosion Potential Analysis for Sweetwater River

Erosion Potential (Ep)	1.025

Channel Slope	0.0033	ft/ft
Estimated Q_2	110	cfs
$0.5Q_2$	55	cfs
Critical Shear	0.136	lb/sq. ft
γ	62.4	lb/ft^3

			Existing Condition	**Future Condition**
Tributary Area	*A*	sq mi	42	42
Mean Annual Precip	*MAP*	in/yr	12.0	12.0
Length of Daily Flow Record	*Yr*	yr	30	30
Imperviousness	*Impav*	mi^2/mi^2	0.397	0.401
Maximum Flow of Record	*Qmax*	cfs	1114.9	1114.9
Minimum Flow of Record	*Qmin*	cfs	0.01	0.01
10-year peak flow	*Q10*	cfs	3105.6	3105.6
Coefficient of DDF	*day1*	days & cfs	40664.46	42754.73
Exponent of DDF	*day2*	days & cfs	-1.01	-1.01
Number of Bins	N_B	--	25	25
Bin Size	$H_{B\text{-}log}$	--	0.484	0.484

Bin Number	Lower Bound of Bin Number	Upper Bound of Bin Number	Flow	Hydraulic Radius	Flow Velocity	Shear Stress	Work	Duration	Cumulative Work	Duration	Cumulative Work
B	$B_{lwr\text{-}log\,(cfs)}$	$B_{upr\text{-}log\,(cfs)}$	*Q (cfs)*	*R (ft)*	*v (ft/s)*	τ (psf)	*W*		*W*duration*		*W*duration*
1	0.006	0.010	0.01	0.03	0.18	0.006	0.000	5155264	0.00	5533785	0.00
2	0.010	0.016	0.01	0.03	0.18	0.006	0.000	3168799	0.00	3394387	0.00
3	0.016	0.026	0.02	0.03	0.22	0.006	0.000	1947774	0.00	2082094	0.00
4	0.026	0.043	0.03	0.04	0.24	0.008	0.000	1197243	0.00	1277143	0.00
5	0.043	0.069	0.06	0.05	0.29	0.010	0.000	735912	0.00	783391	0.00
6	0.069	0.113	0.09	0.06	0.32	0.012	0.000	452345	0.00	480527	0.00
7	0.113	0.183	0.15	0.07	0.36	0.014	0.000	278044	0.00	294752	0.00
8	0.183	0.297	0.24	0.08	0.40	0.016	0.000	170906	0.00	180799	0.00
9	0.297	0.481	0.39	0.10	0.46	0.021	0.000	105051	0.00	110901	0.00
10	0.481	0.781	0.63	0.12	0.51	0.025	0.000	64572	0.00	68026	0.00
11	0.781	1.268	1.02	0.14	0.58	0.029	0.000	39691	0.00	41727	0.00
12	1.268	2.057	1.66	0.17	0.66	0.035	0.000	24397	0.00	25595	0.00
13	2.057	3.339	2.70	0.20	0.74	0.041	0.000	14996	0.00	15700	0.00
14	3.339	5.419	4.38	0.24	0.83	0.049	0.000	9218	0.00	9630	0.00
15	5.419	8.795	7.11	0.29	0.94	0.060	0.000	5666	0.00	5907	0.00
16	8.795	14.273	11.53	0.35	1.06	0.072	0.000	3483	0.00	3623	0.00
17	14.273	23.165	18.72	0.42	1.20	0.086	0.000	2141	0.00	2223	0.00
18	23.165	37.595	30.38	0.51	1.36	0.105	0.000	1316	0.00	1363	0.00
19	37.595	61.014	49.30	0.63	1.57	0.130	0.000	809	0.00	836	0.00
20	61.014	99.022	80.02	0.78	1.81	0.161	0.007	497	3.50	513	3.61
21	99.022	160.707	129.86	0.70	1.67	0.144	0.001	306	0.38	315	0.39
22	160.707	260.818	210.76	0.71	1.69	0.146	0.002	188	0.33	193	0.34
23	260.818	423.291	342.05	0.81	1.85	0.167	0.010	115	1.16	118	1.19
24	423.291	686.974	555.13	1.04	2.19	0.214	0.048	71	3.40	73	3.48
25	686.974	1114.916	900.95	1.35	2.61	0.278	0.140	44	6.10	45	6.23

ATTACHMENT B.1.2

SUPPORT MATERIALS FOR ANALYSIS OF FORESTER CREEK AS A STABILIZED CONVEYANCE SYSTEM

Forester Creek Erosion Potential Analysis for Cross Section 1300 Located Downstream of Mission Gorge Road

			Existing Condition	Future Condition
Tributary Area	*A*	sq mi	23.36	23.36
Mean Annual Precip	*MAP*	in/yr	14	14
Length of Daily Flow Record	*Yr*	yr	30	30
Imperviousness	*Impav*	mi^2/mi^2	0.4634	0.4792
Maximum Flow of Record	*Qmax*	cfs	836.0	836.0
Minimum Flow of Record	*Qmin*	cfs	0.01	0.01
10-year peak flow	*Q10*	cfs	2120.2	2120.2
Coefficient of DDF	*day1*	days & cfs	121556.06	151171.59
Exponent of DDF	*day2*	days & cfs	-1.17	-1.19
Number of Bins	N_B	--	25	25
Bin Size	$H_{B\text{-}log}$	--	0.472	0.472

γ	62.4	lb/ft^3
Critical Shear	2.100	lb/sq. ft
Channel Slope	0.0060	ft/ft

Critical Shear Flow Rate	2150	cfs	Approximate flow rate that would achieve critical shear stress for this channel cross section
Critical Shear Flow Depth	6.3	ft	Approximate flow depth that would achieve critical shear stress for this channel cross section

Bin Number	Lower Bound of Bin Number	Upper Bound of Bin Number	Flow	Flow Depth	Flow Area	Wetted Perimeter	Hydraulic Radius	Flow Velocity	Channel Slope	Shear Stress	Work	Existing Condition Duration	Existing Condition Duration	Existing Condition Cumulative Work	Future Condition Duration	Future Condition Duration	Future Condition Cumulative Work
B	$B_{lwr\text{-}log}$	$B_{upr\text{-}log}$	*Q*	*D*	*A*	*P*	*R*	*v*	*ft/ft*	τ	*W*	*days*	*years*	*W*days*	*days*	*years*	*W*days*
--	cfs	cfs	cfs	ft	sq ft	ft	ft	ft/s	ft/ft	psf	--	days	years	--	days	years	--
1	0.006	0.010	0.008	0.00	0.30	84.01	0.00	0.03	0.006	0.000	0.000	34249940.4	93771.2	0.00	46609552.7	127610.0	0.00
2	0.010	0.016	0.013	0.00	0.40	84.02	0.00	0.03	0.006	0.000	0.000	19693227.1	53917.1	0.00	26564034.2	72728.4	0.00
3	0.016	0.026	0.021	0.01	0.53	84.03	0.01	0.04	0.006	0.004	0.000	11323324.6	31001.6	0.00	15139555.5	41449.8	0.00
4	0.026	0.041	0.033	0.01	0.70	84.03	0.01	0.05	0.006	0.004	0.000	6510750.1	17825.5	0.00	8628438.7	23623.4	0.00
5	0.041	0.066	0.054	0.01	0.94	84.05	0.01	0.06	0.006	0.004	0.000	3743588.4	10249.4	0.00	4917578.7	13463.6	0.00
6	0.066	0.106	0.086	0.01	1.24	84.06	0.01	0.07	0.006	0.004	0.000	2152509.9	5893.3	0.00	2802660.0	7673.3	0.00
7	0.106	0.170	0.138	0.02	1.65	84.08	0.02	0.08	0.006	0.007	0.000	1237662.5	3388.5	0.00	1597311.1	4373.2	0.00
8	0.170	0.273	0.221	0.03	2.19	84.11	0.03	0.10	0.006	0.011	0.000	711638.3	1948.4	0.00	910350.4	2492.4	0.00
9	0.273	0.437	0.355	0.03	2.91	84.14	0.03	0.12	0.006	0.011	0.000	409181.9	1120.3	0.00	518833.1	1420.5	0.00
10	0.437	0.701	0.569	0.05	3.86	84.19	0.05	0.15	0.006	0.019	0.000	235273.7	644.1	0.00	295696.9	809.6	0.00
11	0.701	1.124	0.913	0.06	5.13	84.25	0.06	0.18	0.006	0.022	0.000	135279.0	370.4	0.00	168525.6	461.4	0.00
12	1.124	1.803	1.464	0.08	6.81	84.33	0.08	0.22	0.006	0.030	0.000	77783.5	213.0	0.00	96047.3	263.0	0.00
13	1.803	2.891	2.347	0.11	9.04	84.43	0.11	0.26	0.006	0.041	0.000	44724.4	122.4	0.00	54739.9	149.9	0.00
14	2.891	4.636	3.764	0.14	12.01	84.58	0.14	0.31	0.006	0.052	0.000	25715.9	70.4	0.00	31197.7	85.4	0.00
15	4.636	7.435	6.036	0.19	15.96	84.76	0.19	0.38	0.006	0.071	0.000	14786.3	40.5	0.00	17780.4	48.7	0.00
16	7.435	11.922	9.679	0.25	21.22	85.01	0.25	0.46	0.006	0.094	0.000	8501.9	23.3	0.00	10133.5	27.7	0.00
17	11.922	19.119	15.520	0.33	28.21	85.35	0.33	0.55	0.006	0.124	0.000	4888.5	13.4	0.00	5775.4	15.8	0.00
18	19.119	30.658	24.888	0.44	37.53	85.79	0.44	0.66	0.006	0.165	0.000	2810.8	7.7	0.00	3291.5	9.0	0.00
19	30.658	49.163	39.911	0.59	49.95	86.37	0.58	0.80	0.006	0.217	0.000	1616.2	4.4	0.00	1875.9	5.1	0.00
20	49.163	78.837	64.000	0.78	66.55	87.15	0.76	0.96	0.006	0.285	0.000	929.3	2.5	0.00	1069.1	2.9	0.00
21	78.837	126.421	102.629	1.03	88.77	88.18	1.01	1.16	0.006	0.378	0.000	534.3	1.5	0.00	609.3	1.7	0.00
22	126.421	202.726	164.574	1.37	118.57	89.54	1.32	1.39	0.006	0.494	0.000	307.2	0.8	0.00	347.3	1.0	0.00
23	202.726	325.088	263.907	1.82	158.67	91.35	1.74	1.66	0.006	0.651	0.000	176.7	0.5	0.00	197.9	0.5	0.00
24	325.088	521.305	423.196	2.41	212.84	93.74	2.27	1.99	0.006	0.850	0.000	101.6	0.3	0.00	112.8	0.3	0.00
25	521.305	835.955	678.630	3.20	286.33	96.91	2.95	2.37	0.006	1.104	0.000	58.4	0.2	0.00	64.3	0.2	0.00
														0.000000			0.000000

Ep #DIV/0!

(No work occurs in existing or future condition for the range of geomorphically significant flows)

Calculations shown below are for reference only - the flow rates are higher than the range of geomorphically significant flows:

Maximum Flow of Record			836.0	3.62	326.77	98.61	3.31	2.56	0.006	1.239	0.000
10-year peak flow			2120.2	6.27	595.18	109.31	5.44	3.56	0.006	2.037	0.000

Critical Shear Flow Rate			2150.0	6.32	600.64	109.52	5.48	3.58	0.006	2.052	0.000

Forester Creek Erosion Potential Analysis for Cross Section 2475 Located between Mission Gorge Road and State Route 52

			Existing Condition	Future Condition
Tributary Area	*A*	sq mi	23.36	23.36
Mean Annual Precip	*MAP*	in/yr	14	14
Length of Daily Flow Record	*Yr*	yr	30	30
Imperviousness	*Impav*	mi^2/mi^2	0.4634	0.4792
Maximum Flow of Record	*Qmax*	cfs	836.0	836.0
Minimum Flow of Record	*Qmin*	cfs	0.01	0.01
10-year peak flow	*Q10*	cfs	2120.2	2120.2
Coefficient of DDF	*day1*	days & cfs	121556.06	151171.59
Exponent of DDF	*day2*	days & cfs	-1.17	-1.19
Number of Bins	N_B	--	25	25
Bin Size	$H_{B\text{-}log}$	--	0.472	0.472

γ	62.4	lb/ft^3
Critical Shear	2.100	lb/sq. ft
Channel Slope	0.0030	ft/ft

Critical Shear Flow Rate	9400	cfs	Approximate flow rate that would achieve critical shear stress for this channel cross section
Critical Shear Flow Depth	12.92	ft	Approximate flow depth that would achieve critical shear stress for this channel cross section

Bin Number	Lower Bound of Bin Number	Upper Bound of Bin Number	Flow	Flow Depth	Flow Area	Wetted Perimeter	Hydraulic Radius	Flow Velocity	Channel Slope	Shear Stress	Work	Existing Condition Duration	Existing Condition Duration	Existing Condition Cumulative Work	Future Condition Duration	Future Condition Duration	Future Condition Cumulative Work
B	$B_{lwr\text{-}log}$	$B_{upr\text{-}log}$	*Q*	*D*	*A*	*P*	*R*	*v*	*ft/ft*	τ	*W*	*days*	*years*	*W*days*	*days*	*years*	*W*days*
--	cfs	cfs	cfs	ft	sq ft	ft	ft	ft/s	ft/ft	psf	--	days	years	--	days	years	--
1	0.006	0.010	0.008	0.00	0.47	155.01	0.00	0.02	0.003	0.000	0.000	34249940.4	93771.2	0.00	46609552.7	127610.0	0.00
2	0.010	0.016	0.013	0.00	0.63	155.02	0.00	0.02	0.003	0.000	0.000	19693227.1	53917.1	0.00	26564034.2	72728.4	0.00
3	0.016	0.026	0.021	0.01	0.84	155.02	0.01	0.03	0.003	0.002	0.000	11323324.6	31001.6	0.00	15139555.5	41449.8	0.00
4	0.026	0.041	0.033	0.01	1.10	155.03	0.01	0.03	0.003	0.002	0.000	6510750.1	17825.5	0.00	8628438.7	23623.4	0.00
5	0.041	0.066	0.054	0.01	1.48	155.04	0.01	0.04	0.003	0.002	0.000	3743588.4	10249.4	0.00	4917578.7	13463.6	0.00
6	0.066	0.106	0.086	0.01	1.95	155.06	0.01	0.04	0.003	0.002	0.000	2152509.9	5893.3	0.00	2802660.0	7673.3	0.00
7	0.106	0.170	0.138	0.02	2.59	155.07	0.02	0.05	0.003	0.004	0.000	1237662.5	3388.5	0.00	1597311.1	4373.2	0.00
8	0.170	0.273	0.221	0.02	3.44	155.10	0.02	0.06	0.003	0.004	0.000	711638.3	1948.4	0.00	910350.4	2492.4	0.00
9	0.273	0.437	0.355	0.03	4.57	155.13	0.03	0.08	0.003	0.006	0.000	409181.9	1120.3	0.00	518833.1	1420.5	0.00
10	0.437	0.701	0.569	0.04	6.07	155.17	0.04	0.09	0.003	0.007	0.000	235273.7	644.1	0.00	295696.9	809.6	0.00
11	0.701	1.124	0.913	0.05	8.06	155.23	0.05	0.11	0.003	0.009	0.000	135279.0	370.4	0.00	168525.6	461.4	0.00
12	1.124	1.803	1.464	0.07	10.70	155.31	0.07	0.14	0.003	0.013	0.000	77783.5	213.0	0.00	96047.3	263.0	0.00
13	1.803	2.891	2.347	0.09	14.21	155.41	0.09	0.17	0.003	0.017	0.000	44724.4	122.4	0.00	54739.9	149.9	0.00
14	2.891	4.636	3.764	0.12	18.87	155.54	0.12	0.20	0.003	0.022	0.000	25715.9	70.4	0.00	31197.7	85.4	0.00
15	4.636	7.435	6.036	0.16	25.06	155.72	0.16	0.24	0.003	0.030	0.000	14786.3	40.5	0.00	17780.4	48.7	0.00
16	7.435	11.922	9.679	0.21	33.29	155.96	0.21	0.29	0.003	0.039	0.000	8501.9	23.3	0.00	10133.5	27.7	0.00
17	11.922	19.119	15.520	0.28	44.23	156.27	0.28	0.35	0.003	0.052	0.000	4888.5	13.4	0.00	5775.4	15.8	0.00
18	19.119	30.658	24.888	0.38	58.79	156.69	0.38	0.42	0.003	0.071	0.000	2810.8	7.7	0.00	3291.5	9.0	0.00
19	30.658	49.163	39.911	0.50	78.15	157.24	0.50	0.51	0.003	0.094	0.000	1616.2	4.4	0.00	1875.9	5.1	0.00
20	49.163	78.837	64.000	0.66	103.94	157.97	0.66	0.62	0.003	0.124	0.000	929.3	2.5	0.00	1069.1	2.9	0.00
21	78.837	126.421	102.629	0.88	138.32	158.95	0.87	0.74	0.003	0.163	0.000	534.3	1.5	0.00	609.3	1.7	0.00
22	126.421	202.726	164.574	1.17	184.24	160.24	1.15	0.89	0.003	0.215	0.000	307.2	0.8	0.00	347.3	1.0	0.00
23	202.726	325.088	263.907	1.55	245.63	161.95	1.52	1.07	0.003	0.285	0.000	176.7	0.5	0.00	197.9	0.5	0.00
24	325.088	521.305	423.196	2.06	327.91	164.22	2.00	1.29	0.003	0.374	0.000	101.6	0.3	0.00	112.8	0.3	0.00
25	521.305	835.955	678.630	2.73	438.50	167.22	2.62	1.55	0.003	0.490	0.000	58.4	0.2	0.00	64.3	0.2	0.00
														0.000000			0.000000

Ep #DIV/0!

(No work occurs in existing or future condition for the range of geomorphically significant flows)

Calculations shown below are for reference only - the flow rates are higher than the range of geomorphically significant flows:

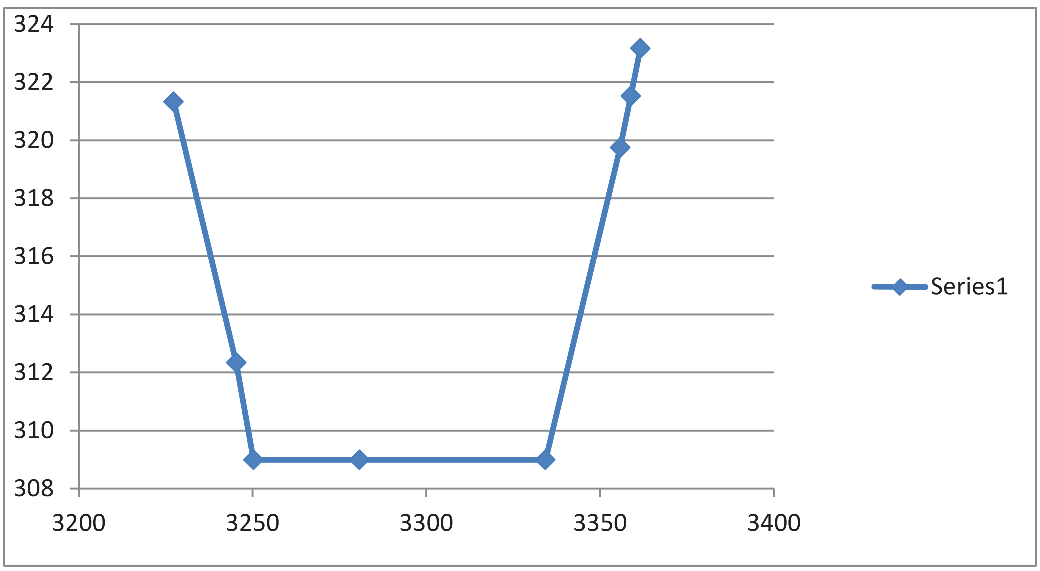
Maximum Flow of Record			836.0	3.09	498.85	168.84	2.95	1.68	0.003	0.552	0.000
10-year peak flow			2120.2	5.39	892.72	179.08	4.98	2.37	0.003	0.932	0.000

Critical Shear Flow Rate			9400.0	12.92	2337.34	212.80	10.98	4.02	0.003	2.055	0.000

CHANNEL GEOMETRY FOR FORESTER CREEK SECTION 1300
DOWNSTREAM OF MISSION GORGE ROAD

RS = 1300

STATION (FT)	ELEVATION (FT)
3227.329	321.325
3245.341	312.336
3250.328	308.99
3280.84	308.99
3334.35	308.99
3355.84	319.751
3358.858	321.522
3361.621	323.163



DEPTH = 321.325 - 308.99
12.335 (12 FEET)

TOP = 3358.858 - 3227.329
131.529 (132 FEET)

BOTTOM = 3334.35 - 3250.328
84.022 (84 FEET)

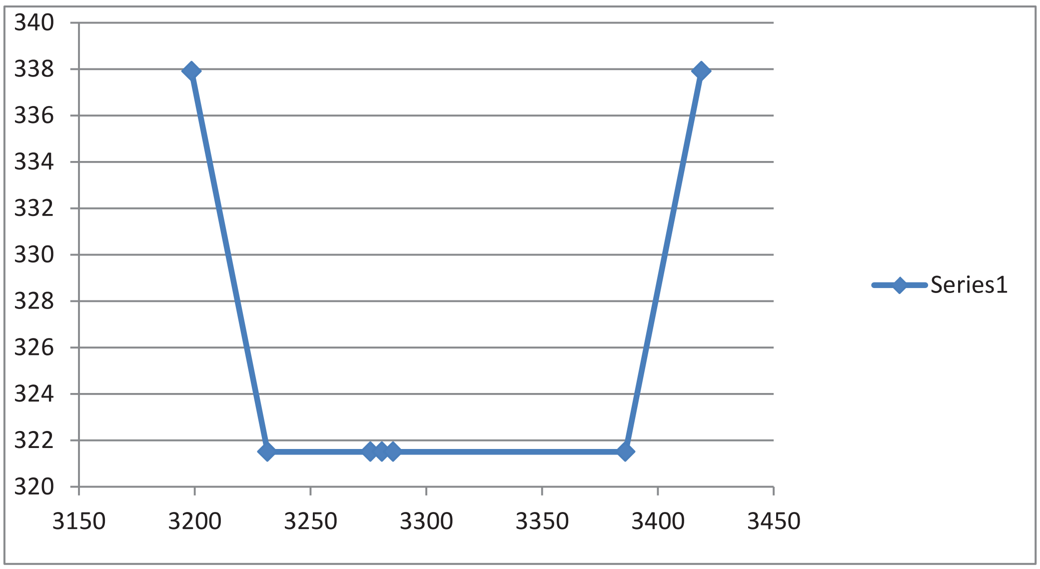
Z1 = (3250.328 - 3245.321) / (312.336 - 308.99)
1.5

Z2 = (3355.84 - 3334.35) / (319.751 - 308.99)
2.0

CHANNEL GEOMETRY FOR FORESTER CREEK SECTION 2475
BETWEEN MISSION GORGE ROAD AND STATE ROUTE 52

RS = 2475

STATION (FT)	ELEVATION (FT)
3198.688	337.913
3231.463	321.509
3275.919	321.509
3280.84	321.509
3285.761	321.509
3385.991	321.509
3418.799	337.913



DEPTH = 337.913 - 321.509
16.404 (16 FEET)

TOP = 3418.799 - 3198.688
220.111 (220 FEET)

BOTTOM = 3385.991 - 3231.463
154.528 (155 FEET)

Z1 = (3418.799 - 3385.991) / (337.913 - 321.509)
2.0

Z2 = (3231.463 - 3198.688) / (337.913 - 321.509)
2.0

Impervious Area Calculations for Forester Creek Watershed

Existing Condition

Existing Land Use

FREQUENCY	lu	landuse	Acres	% Impervious	A_Imp
81	1000	Spaced Rural Residential	754.48	0.10	75.45
	1100	Single Family Residential	0	0.42	0.00
1039	1110	Single Family Detached	5821.90	0.42	2445.20
353	1120	Single Family Multiple-Units	227.58	0.42	95.58
149	1190	Single Family Residential Without Units	45.72	0.42	19.20
297	1200	Multi-Family Residential	844.76	0.74	625.13
12	1290	Multi-Family Residential Without Units	1.44	0.74	1.06
40	1300	Mobile Home Park	399.85	0.74	295.89
25	1409	Other Group Quarters Facility	42.06	0.47	19.77
20	1501	Hotel/Motel (Low-Rise)	27.71	0.50	13.86
1	2001	Heavy Industry	20.29	0.80	16.23
52	2101	Industrial Park	587.62	0.82	481.85
15	2103	Light Industry - General	108.35	0.84	91.02
8	2104	Warehousing	16.18	0.84	13.59
15	2105	Public Storage	26.97	0.84	22.65
1	2301	Junkyard/Dump/Landfill	0.83	0.62	0.51
1	4103	General Aviation Airport	390.90	0.45	175.90
5	4111	Rail Station/Transit Center	6.62	0.77	5.10
8	4112	Freeway	365.74	0.58	212.13
44	4113	Communications and Utilities	38.39	0.40	15.35
11	4114	Parking Lot - Surface	3.28	0.75	2.46
1	4115	Parking Lot - Structure	1.30	0.61	0.79
1	4116	Park and Ride Lot	0.88	0.87	0.77
18	4117	Railroad Right of Way	25.88	0.52	13.46
58	4118	Road Right of Way	1907.10	0.60	1144.26
5	4119	Other Transportation	33.72	0.55	18.54
1	5002	Regional Shopping Center	73.97	0.94	69.53
4	5003	Community Shopping Center	37.14	0.83	30.83
17	5004	Neighborhood Shopping Center	110.81	0.85	94.19
21	5006	Automobile Dealership	58.88	0.89	52.40
193	5007	Arterial Commercial	260.86	0.83	216.52
37	5008	Service Station	18.68	0.94	17.56
42	5009	Other Retail Trade and Strip Commercial	74.30	0.80	59.44
	6001	Office (High-Rise)	0	0.61	0.00
38	6002	Office (Low-Rise)	44.03	0.65	28.62
2	6003	Government Office/Civic Center	16.31	0.80	13.05
2	6101	Cemetery	12.41	0.44	5.46
49	6102	Religious Facility	105.29	0.48	50.54
1	6103	Library	1.44	0.57	0.82
2	6104	Post Office	4.70	0.78	3.66
11	6105	Fire/Police Station	30.20	0.63	19.02
11	6109	Other Public Services	18.60	0.56	10.42
1	6502	Hospital - General	12.28	0.74	9.09
24	6509	Other Health Care	44.38	0.68	30.18
1	6701	Military Use	4.70	0.62	2.92
2	6802	Other University or College	34.53	0.54	18.64
4	6804	Senior High School	130.06	0.56	72.83
4	6805	Junior High School or Middle School	62.55	0.55	34.40
18	6806	Elementary School	163.06	0.56	91.31
1	6807	School District Office	13.59	0.72	9.78
5	6809	Other School	7.39	0.51	3.77
3	7210	Other Recreation - High	14.52	0.34	4.94
13	7601	Park - Active	83.80	0.14	11.73
42	7603	Open Space Park or Preserve	894.01	0.06	53.64
90	7606	Landscape Open Space	49.08	0.42	20.61
9	7607	Residential Recreation	10.06	0.42	4.22
	7609	Undevelopable Natural Area	0	0.06	0.00
	9700	Mixed Use	0	0.74	0.00
3	8001	Orchard or Vineyard	7.72	0.03	0.23
1	8002	Intensive Agriculture	2.09	0.12	0.25
1	8003	Field Crops	2.12	0.09	0.19
323	9101	Vacant and Undeveloped Land	806.75	0.08	64.54
23	9501	Residential Under Construction	37.51	0.42	15.76
1	9506	Road Under Construction	0.31	0.60	0.18
1	9507	Freeway Under Construction	0.79	0.58	0.46
			14948.47		6927.50
		square miles:	23.36		10.82
					46.34%

Impervious Area Calculations for Forester Creek Watershed

Future Condition

Planned Land Use

FREQUENCY	plu	plannedlu	Acres	% Impervious	A_Imp
45	1000	Spaced Rural Residential	1139.00	0.10	113.90
237	1100	Single Family Residential	391.50	0.42	164.43
996	1110	Single Family Detached	5691.47	0.42	2390.42
272	1120	Single Family Multiple-Units	200.38	0.42	84.16
161	1190	Single Family Residential Without Units	28.38	0.42	11.92
320	1200	Multi-Family Residential	975.71	0.74	722.02
15	1290	Multi-Family Residential Without Units	6.62	0.74	4.90
33	1300	Mobile Home Park	370.34	0.74	274.05
26	1409	Other Group Quarters Facility	42.48	0.47	19.97
12	1501	Hotel/Motel (Low-Rise)	20.38	0.50	10.19
1	2001	Heavy Industry	20.29	0.80	16.23
52	2101	Industrial Park	613.06	0.82	502.71
20	2103	Light Industry - General	143.05	0.84	120.16
8	2104	Warehousing	18.92	0.84	15.89
13	2105	Public Storage	24.52	0.84	20.59
	2301	Junkyard/Dump/Landfill	0	0.62	0.00
2	4103	General Aviation Airport	331.86	0.45	149.34
4	4111	Rail Station/Transit Center	6.91	0.77	5.32
11	4112	Freeway	366.71	0.58	212.69
46	4113	Communications and Utilities	38.92	0.40	15.57
	4114	Parking Lot - Surface	0	0.75	0.00
	4115	Parking Lot - Structure	0	0.61	0.00
1	4116	Park and Ride Lot	0.88	0.87	0.77
17	4117	Railroad Right of Way	34.97	0.52	18.19
58	4118	Road Right of Way	1919.19	0.60	1151.52
6	4119	Other Transportation	32.96	0.55	18.13
1	5002	Regional Shopping Center	73.97	0.94	69.53
4	5003	Community Shopping Center	38.33	0.83	31.82
21	5004	Neighborhood Shopping Center	110.59	0.85	94.00
12	5006	Automobile Dealership	39.76	0.89	35.39
134	5007	Arterial Commercial	202.24	0.83	167.86
34	5008	Service Station	17.73	0.94	16.67
74	5009	Other Retail Trade and Strip Commercial	95.29	0.80	76.23
11	6001	Office (High-Rise)	37.42	0.61	22.83
35	6002	Office (Low-Rise)	52.57	0.65	34.17
2	6003	Government Office/Civic Center	16.31	0.80	13.05
2	6101	Cemetery	12.42	0.44	5.46
42	6102	Religious Facility	97.91	0.48	47.00
1	6103	Library	1.44	0.57	0.82
2	6104	Post Office	4.70	0.78	3.66
11	6105	Fire/Police Station	28.83	0.63	18.16
12	6109	Other Public Services	20.95	0.56	11.73
1	6502	Hospital - General	12.28	0.74	9.09
22	6509	Other Health Care	45.84	0.68	31.17
1	6701	Military Use	4.70	0.62	2.92
2	6802	Other University or College	34.53	0.54	18.64
4	6804	Senior High School	130.09	0.56	72.85
4	6805	Junior High School or Middle School	62.60	0.55	34.43
19	6806	Elementary School	171.68	0.56	96.14
1	6807	School District Office	4.98	0.72	3.59
6	6809	Other School	11.02	0.51	5.62
2	7210	Other Recreation - High	11.59	0.34	3.94
23	7601	Park - Active	89.56	0.14	12.54
41	7603	Open Space Park or Preserve	866.19	0.06	51.97
90	7606	Landscape Open Space	55.58	0.42	23.34
10	7607	Residential Recreation	9.77	0.42	4.10
21	7609	Undevelopable Natural Area	34.38	0.06	2.06
77	9700	Mixed Use	134.73	0.74	99.70
	8001	Orchard or Vineyard	0	0.03	0.00
	8002	Intensive Agriculture	0	0.12	0.00
	8003	Field Crops	0	0.09	0.00
	9101	Vacant and Undeveloped Land	0	0.08	0.00
	9501	Residential Under Construction	0	0.42	0.00
	9506	Road Under Construction	0	0.60	0.00
	9507	Freeway Under Construction	0	0.58	0.00
			14948.47		7163.55
		square miles:	23.36		11.19
					47.92%

ATTACHMENT B.1.3

EXCERPT OF VENTURA COUNTY HCP (FINAL DRAFT DATED SEPTEMBER 2013): APPENDIX D, BASIS FOR DESIGNATING NEGLIGIBLE RISK BASED ON CUMULATIVE FUTURE BUILDOUT

APPENDIX D

Basis for Designating Negligible Risk Based on Cumulative Future Buildout

APPENDIX D

BASIS FOR DESIGNATING NEGLIGIBLE RISK BASED ON CUMULATIVE FUTURE BUILDOUT

1. BACKGROUND

Hydromodification impacts are typically most severe just downstream of development and tend to decrease if more undeveloped watershed area contributes to the channel in the downstream direction. Analyses were performed to evaluate thresholds for additional impervious cover, from existing conditions (at the time of the HCP effective date) to buildout conditions, for the area tributary to a susceptible receiving water below which the risk of hydromodification impacts is considered negligible for that channel.

The following results are provided as a function of a susceptible channel's tributary area (A) and median grain size (D_{50}):

- If A $\geq$ 1 square mile and $D_{50} \leq$ 16 mm, then the threshold of additional imperviousness is evaluated using the nomograph in Figure 3-12.

  Figure 3-12 is based on empirical flow duration equations (Hawley and Bledsoe, 2011), empirical channel geometry relationships (Coleman et al, 2005 and County of San Diego, 2009), and Erosion Potential analyses (see HCP Section 6.3 for a discussion on the Erosion Potential analysis method). The results range from 0.46% to 1.00% additional imperviousness, depending on watershed size and mean annual precipitation (MAP).

- If A < 1 square mile and $D_{50} \leq$ 16 mm, then the threshold of additional imperviousness is 0.44%. (See Section 6.2 below.)
- If $D_{50} \geq$ 16 mm, then the threshold of additional imperviousness is 1.65%. (See Section 6.2 below.)

The analyses used to establish these thresholds are described below.

2. HYDROLOGIC ANALYSIS

2.1 Identify the Typical Range of Rainfall Conditions

For the purposes of this analysis, the typical range of mean annual precipitation (MAP) is assumed to be 14 inches to 18 inches per year because most of the developed regions within Ventura County fall within this range on the isohyetal map (Figure 2-5) and this range is consistent with Ventura County's long-term precipitation gage records

(VCWPD 2007). It is anticipated that future development will impact the most miles of susceptible channel in the Calleguas Watershed within and downstream of the Cities of Thousand Oaks, Simi Valley, and Moorpark. The long-term precipitation records in these areas are all within the 14 inch to 18 inch range and thus these two MAPs were used in this analysis.

Table D-1. Long-Term Precipitation Gage Records in Ventura County

Precipitation Gage ID	Period of Record	Mean Annual Precipitation (inches)
Camarillo #219	1965-2006	13.45
Port Hueneme #17	1891-2006	13.62
Moorpark #141	1949-2006	14.45
Ventura #66	1873-2006	14.71
Simi Valley #154	1948-2006	14.89
Thousand Oaks #128	1943 -2006	15.6
Santa Paula #245	1961-2006	17.35
Piru #36	1927-2006	17.39
Fillmore #199	1959-2006	18.44
Ojai #30	1906-2006	21.32

2.2 Identify the Range of Watershed Areas

The range of typical watershed areas used in the sensitivity analysis were established based on an inventory of a subset of natural drainage channels that have significant urban development in their tributary areas. While there are a few susceptible drainage channels with watershed areas over 100 square miles or less than 1 square mile, most of the susceptible channels downstream of development are lower order with watershed areas ranging from about 2 to 10 square miles. Seven categories of watershed area (1-, 2-, 5-, 10-, 20-, 50-, and 100-square miles) were used in this analysis.

2.3 Identify Length of Daily Flow Record

A 30-year length of daily flow record was assumed in this analysis. During preliminary runs it was found that the threshold of additional impervious cover was not sensitive to changes in the assumed length of daily flow record.

2.4 Calculate Necessary Peak Flow Inputs (Q_2, Q_5, Q_{10})

Empirical peak flow equations used to estimate the 2-, 5-, and 10-year recurrence interval flows (Hawley and Bledsoe, 2011). The general form of the equation is:

$$Q_i = e^{(Incpt)} * A^{a} * P^{p} * e^{(impmax*Impmax)}$$

Where:

Q_i	=	the instantaneous peak flow at return interval i years (cfs)
Incpt	=	the vertical axis intercept of the log-transformed linear regression model
A	=	total drainage area (mi^2)
P	=	average annual precipitation (in)
Impmax	=	the maximum spatial extent of the total impervious area during the gage record as a fraction of the total drainage area (mi^2/mi^2)

a, p, and impmax = regression parameters specific to each return period

Table D-2 provides the regression parameters for each return period of interest.

Table D-2. Regression parameters for the 2-, 5-, and 10-year peak flows

Return Period (yrs)	Incpt (-)	a (mi^2)	p (in)	Impmax (-)
2	-0.644	0.667	1.29	8.61
5	2.137	0.838	0.773	3.23
10	2.90	0.868	0.767	0

Table D-3 presents the resulting flowrates for each combination of tributary area and mean annual precipitation analyzed (14 total) assuming no imperviousness.

Table D-3. Peak Flow (Q_2, Q_5, Q_{10}) Results

Tributary Area	Mean Annual Precipitation	Q2	Q5	Q10
A	MAP			
sq mi	in/yr	cfs	cfs	cfs
1	14	15.8	65.2	138
2	14	25.1	116	251
5	14	46.2	251	556
10	14	73.4	449	1015
20	14	117	802	1853
50	14	215	1729	4104
100	14	341	3091	7491
1	18	21.9	79.1	167
2	18	34.7	141	304
5	18	63.9	305	674
10	18	102	545	1231
20	18	161	974	2247
50	18	297	2100	4977
100	18	472	3753	9083

2.5 Calculate Inputs for Long-Term Cumulative Durations (Q_{max}, Q_{min}, day1, day2, N_B, $H_{B\text{-}log}$)

In order to represent the mean daily flows with cumulative duration curves, logarithmic histogram bins were created to represent flow frequencies without any discontinuities following the Hawley and Bledsoe (2011) methodology. The bin size of the logarithmically-spaced histogram bins ($H_{B\text{-}log}$) is represented as follows:

$$H_{B\text{-}log} = \{\ln(Q_{max})-\ln(Q_{min})\}/(N_B-1)$$

Where:

Q_{max}	=	the maximum flow of record (cfs)
Q_{min}	=	the minimum flow of record (cfs)
N_B	=	the number of bins

The minimum flow (Q_{min}) was set equal to 0.01 cfs, which represents the lowest non-zero mean daily flow reported at any gage used in the Hawley and Bledsoe (2011) analysis. The number of bins (N_B) was set at 25 to provide a balance between using small enough bin sizes for adequate resolution and ensuring that the flow-record data would be capable of populating each of the bins. The maximum flow of record (Q_{max}) is equivalent to the maximum mean 24-hour flow and is estimated using the following equation:

$$Q_{max}=e^{(-2.24)}*A^{0.979}*P^{1.79}*Yr^{0.341}$$

Where:

A	=	total drainage area (mi^2)
P	=	average annual precipitation (in)
Yr	=	the length of the mean daily flow record (30 years)

Q_{max} is also the scaling factor for the duration density function (DDF), or conditional probability density function, used to predict the cumulative durations of the binned geomorphically-effective flows. A power function is used to represent the duration in days, with the following form:

$$days = day1*Q^{day2}$$

The parameter 'day1' represents the magnitude of the power function calibrated in 'days' and 'cfs' and is estimated using the following relationship:

$$day1 = e^{(-12.9)}*A^{0.676}*P^{3.71}*Yr^{1.85}*e^{(13.8*Impav)}$$

Where:

A	=	total drainage area (mi^2)

P	=	average annual precipitation (in)
Yr	=	the length of the mean daily flow record (30 years)
Impav	=	the average spatial extent of the total impervious area expressed as a fraction of the total drainage area (mi^2/mi^2)

The parameter 'day2' represents the shape of the power function and is calibrated in 'days' and 'cfs' through the following relationship:

$$day2 = -1.60+0.166*\ln(Q_{10})-0.138*\ln(day1)+0.129*\ln(Yr)+0.720*Impav$$

Where:

Q_{10}	=	the instantaneous 10-year peak flow
Yr	=	the length of the mean daily flow record (30 years)
Impav	=	the average spatial extent of the total impervious area expressed as a fraction of the total drainage area (mi^2/mi^2)

2.6 Calculate Long-Term Cumulative Durations for Each Flow Bin (B, $B_{lwr-log}$, $B_{upr-log}$, Q, days)

Using the bin size estimated above (H_{B-log}), the lower and upper bounds of each logarithmically-spaced bin (B) can be calculated as follows:

$$B_{lwr-log} = e^{\{\ln(Qmin)+(B-2)*HB-log\}}$$

$$B_{upr-log} = e^{\{\ln(Qmin)+(B-1)*HB-log\}}$$

The average flow within each of the bins was used in the power function to calculate the cumulative duration for the histogram.

$$Q = (B_{lwr-log}+B_{upr-log})/2$$

$$days = day1*Q^{day2}$$

3. HYDRAULIC ANALYSIS

3.1 Identify a Range of Typical Receiving Channel Geometry Dimensions

An empirical relationship developed by Coleman et al (2005), modified by Stein (County of San Diego, 2009) was used to express channel dimensions (width, depth, and, to a lesser extent, gradient) as a function of dominant discharge (Q_{bf}, in cfs). The Stein and Coleman relationship was used because it: (1) produced more consistent and conservative results than the Hey-Thorne (1986) relationship; (2) resulted in Qcrit results within the range of values suggested for implementation in the San Diego HMP (0.1Q2, 0.3Q2, 0.5Q2); (3) was general in that it did not require an assumption of D50; and (4) is applicable to the most sensitive sand bedded channels, which the Parker (2007) relationship is not. The geometry relationships are as follows:

$$\text{Width (ft)} = 0.6012 * Q_{bf}^{0.6875}$$

$$\text{Depth (ft)} = 0.3854 * Q_{bf}^{0.3652}$$

Q_{bf}, assumed to be approximately the 5-year peak discharge (Q_5), was estimated using the empirical equation from Hawley and Bledsoe (2011) provided in Section 2.4 of this Appendix. This equation calculates Q_5 (cfs) as a function of watershed area (sq. mi.), mean annual precipitation (MAP, in/yr), and percent impervious cover (%) based on empirical observations of USGS gages.

Manning's equation was used to iteratively find the slope for each channel dimension, such that the wetted cross sectional area at bankfull conveys the Q_5. Manning's equation is expressed as:

$$Q = \frac{1.49 A R^{0.67} S^{0.5}}{n}$$

Where:

Q	=	Flowrate (cfs)
A	=	Cross Section Flow Area (ft^2)
R	=	Hydraulic Radius (ft) = A / P
P	=	Wetted Perimeter (ft)
S	=	Energy Gradient Assumed Equal to Longitudinal Slope (ft/ft)
n	=	Manning Roughness (unitless)

The hydraulic analysis assumed a Manning Roughness value (n) of 0.035 for the main channel, corresponding to a non-vegetated, straight channel with no riffles and pools. This reflects the small, ephemeral receiving channels which are prevalent in Southern California. A relatively low 'n' value was used at the request of the San Diego Regional Water Board in the development of the San Diego HMP. A Manning's roughness of

0.07 was used for the over bank floodplain with an assumed side slope of 10 to 1 (Horizontal:Vertical). The overbank parameters were not as sensitive of parameters as longitudinal slope and channel geometry for the purpose of this analysis, therefore a range was not evaluated.

The receiving channel geometry dimensions used for hydraulic analysis of each model scenario are presented in Table D-4.

Table D-4. Receiving Channel Geometry Dimensions

Tributary Area	Mean Annual Precipitation	Longitudinal Slope	Bankfull Width	Bankfull Depth
A	*MAP*	*S*	*W*	*D*
sq mi	in/yr	%	ft	ft
1	14	0.45	10.6	1.8
2	14	0.30	15.8	2.2
5	14	0.18	26.8	2.9
10	14	0.12	40.0	3.6
20	14	0.08	59.7	4.4
50	14	0.05	101.2	5.9
100	14	0.04	150.8	7.3
1	18	0.40	12.1	1.9
2	18	0.27	18.1	2.4
5	18	0.16	30.7	3.1
10	18	0.11	45.7	3.8
20	18	0.07	68.2	4.8
50	18	0.05	115.6	6.3
100	18	0.03	172.4	7.8

3.2 Calculate Effective Shear Stress and Velocity for Each Flow Bin

The flow velocity was calculated after iterating for the slope to achieve $Q=Q_5$ as:

$$V = Q/A$$

Where:

V = Flow Velocity (ft/s)

Q = Flowrate (cfs)

A	=	Cross Section Flow Area (ft^2)

Average boundary shear stress was calculated as:

$$\tau = \gamma R S$$

Where:

τ	=	Effective Shear Stress (lb/ft^2)
γ	=	Unit Weight of Water (lb/ft^3)
R	=	Hydraulic Radius (ft)
S	=	Longitudinal slope (ft/ft)

4. WORK ANALYSIS

4.1 Identify Critical Flowrate (10%Q_2)

The regional default critical flowrate of 10% Q_2, per Appendix E, was used for this analysis. Flow rates below this value were assumed to perform no work on the channel.

4.2 Calculate Work for Each Flow Bin

The simplified effective work equation used is specified in the Ventura County MS4 Permit (LARWQCB, 2010) and is expressed as:

$$W = (\tau - \tau_c)^{1.5} V$$

Where:

W	=	Work [dimensionless];
τ	=	Effective Shear Stress [lb/ft^2];
τ_c	=	Critical Shear Stress [lb/ft^2];
V	=	Flow Velocity [ft/s]

If the effective shear stress for a given flow bin is less than the critical shear stress, then the effective work is equal to zero.

5. CUMULATIVE WORK ANALYSIS

Cumulative work is a measure of the long-term total work or sediment transport capacity performed at a creek location. It incorporates the distribution of both discharge magnitude and duration for the full range of flowrates simulated. To calculate cumulative work, first the work and duration associated with each flow bin is multiplied. Then the cumulative work for all flow bins is summed to obtain total work. This analysis can be expressed as:

$$W_t = \sum_{i=1}^{n} W_i \, \Delta t_i$$

Where:

W_t	=	Total Work [unitless]
W_i	=	Work per flow bin [unitless]
Δt	=	Duration per flow bin [days]
n	=	number of flow bins

6. EROSION POTENTIAL ANALYSIS

Ep is calculated by simply dividing the total work of the post-project condition by that of the pre-project condition. Ep is expressed as:

$$E_p = W_{t,post} / W_{t,pre}$$

Where:

E_p	=	Erosion Potential [unitless]
$W_{t,post}$	=	Total Work associated with the post-project condition [unitless]
$W_{t,pre}$	=	Total Work associated with the pre-project condition [unitless]

6.1 Iterate % Impervious Cover to Meet the Hydromodification Management Standard (Ep < 1.05)

Considering that the Hydromodification Management Standard for Ventura County aims to "maintain the Ep in-stream at a value of 1.0", it is assumed that an Ep value less than 5% of the target value meets the Management Standard (i.e., an Ep value of 1.04 rounds to 1.0). Additional basis for the use of a +/- 5% allowance on Ep is supported in Section 6.3.7 in the HCP. An iterative process was used to determine the percentage of impervious cover that meets the hydromodification management standard (Ep < 1.05). The percent imperviousness is an input for the DDF power function coefficient and exponent (day1 and day2, respectively) and modifies the duration of flows within each of the logarithmically-spaced flow bin. The new durations (days) for each flow bin are multiplied by the work per flow bin (W_i) and summed across all bins to arrive at a new value for total work associated with the post-project condition ($W_{t,post}$) and Erosion Potential (Ep). Percent impervious cover is subsequently adjusted until an E_p of 1.05 is converged upon.

In preliminary runs it was evaluated that the threshold additional impervious cover associated with Ep equal to 1.05 was not highly sensitive to the baseline pre-development (or existing condition) imperviousness. For example, an increase in imperviousness from 0% to 1% resulted in the same Ep as an increase from 10% to 11%. The resulting thresholds of additional imperviousness from existing (at the time of the HCP effective date) to buildout conditions are provided below in Table D-5 and in Figure 3-12. The results provided used an existing imperviousness of 0%.

Table D-5: Threshold Additional Imperviousness Results

Tributary Area	Mean Annual Precipitation	Threshold Additional Imperviousness	Pre-Project Total Cumulative Work	Post-Project Total Cumulative Work	Erosion Potential
A	*MAP*	*Impav*	*Wt, pre*	*Wt, post*	*Ep*
sq mi	in/yr	%	--	--	--
1	14	0.46	1.67	1.75	1.05
2	14	0.50	1.52	1.59	1.05
5	14	0.56	1.45	1.52	1.05
10	14	0.61	1.48	1.55	1.05
20	14	0.68	1.59	1.67	1.05
50	14	0.80	1.89	1.98	1.05
100	14	0.92	2.27	2.39	1.05
1	18	0.48	2.69	2.82	1.05
2	18	0.52	2.44	2.57	1.05
5	18	0.59	2.12	2.23	1.05
10	18	0.65	2.07	2.17	1.05
20	18	0.72	2.12	2.23	1.05
50	18	0.85	2.25	2.36	1.05
100	18	1.00	2.54	2.67	1.05

6.2 Thresholds of Additional Imperviousness Based on Hawley and Bledsoe (2013)

For susceptible channels with a tributary area less than one square mile, the threshold of additional imperviousness below which the risk of hydromodification impacts is considered negligible for that channel is 0.44%. This result is based on equating two of the channel enlargement equations listed in Hawley and Bledsoe (2013) and solving for an Ep of 1.05. The two enlargement functions are:

$$Ar = 1.18*Ep^{0.998}$$

and

$$Ar = 1.18*e^{(11.0*Imp)}$$

Where:

Ar = Enlargement expressed as the relative magnitude

Ep = Sediment-transport capacity load ratio between 25-yr post-developed and pre-developed DDF simulations

Imp = Total impervious area as a fraction of total drainage area

The following equation expresses Imp as a function of Ep:

$$Imp = (0.998/11) * \ln(Ep)$$

Assuming Ep is equal to 1.05, the resulting Imp is 0.44%.

For susceptible channels with a median grain size (D_{50}) greater than 16 mm, a +/- 20% allowance on Ep is supported in Section 6.3.7 in the HCP. Assuming an Ep of 1.20 and using the equation above, the threshold additional imperviousness, below which the risk of hydromodification impacts is considered negligible for that channel, is 1.65%.

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ATTACHMENT B.1.4

TEXT AND HMP EXEMPTION EXHIBITS EXCERPTED FROM: "HYDROMODIFICATION EXEMPTION ANALYSES FOR SELECT CARLSBAD WATERSHEDS," PREPARED BY CHANG CONSULTANTS, DATED SEPTEMBER 17, 2015

HYDROMODIFICATION EXEMPTION ANALYSES FOR SELECT CARLSBAD WATERSHEDS

September 17, 2015

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TABLE OF CONTENTS

Executive Summary i
Introduction 1
Outlet Conditions 3
Discharge to Lagoons 5
Hydrologic and Hydraulic Analyses 7
Conclusion 10
Figures 12

APPENDICES (on CD in map pocket)

A. Dokken Engineering's HEC-RAS Analyses

B. 10-Year Rational Method Analyses

MAP POCKET

Study Area Exhibit
HMP Exemption Exhibit
CD Containing As-Built Plans

City of Carlsbad
Report accepted by:

____

Jason Geldert, City Engineer   Date
PE# 63912   Exp 9/30/16

EXECUTIVE SUMMARY

In accordance with Order No. R9-2013-0001, issued by the California Regional Water Quality Control Board (Municipal Permit), projects that are subject to Priority Development Project requirements must incorporate: 1) Treatment control best management practices, and 2) Flow-control requirements to address potential hydromodification impacts to downstream natural (non-hardened) channels.

However, certain improved/hardened drainage systems are not impacted by channel erosion. For these cases, the Municipal Permit includes provisions where a local agency may provide exemptions from hydromodification:

> *Each Copermittee has the discretion to exempt a Priority Development Project from hydromodification management BMP performance requirements of Provisions E.3.c.(2) where the project discharges water runoff to:*
>
> *(i) Existing underground storm drains discharging directly to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean.*
>
> *ii) Conveyance channels whose bed and bank are concrete lined all the way from the point of discharge to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean;*

Having development/redevelopment projects explore HMP exemption criteria could require an individual project proponent to undertake significant engineering analyses and evaluation of downstream drainage facilities and conditions within a watershed area. Consequently, the City of Carlsbad's Land Development Engineering Division commissioned this hydromodification exemption study.

This report focuses on certain watershed areas tributary to the Agua Hedionda Lagoon, Batiquitos Lagoon, and Buena Vista Lagoon. All three Lagoons are located within the Carlsbad Watershed area and are considered enclosed embayments per the Municipal Permit.

The study limits focus on select areas draining to the lagoons that are highly-developed and are served by improved existing paved streets that collect and convey runoff via reinforced concrete pipes (hardened systems) that are not subject to erosion potential. For each storm drain network discharging to the lagoon, the discharge locations were evaluated to ensure they qualify as a 'direct discharge'. To qualify as a direct discharge, field visits were performed at each outlet location to verify properly sized energy dissipation and, by a review of record drawings, that the discharge locations are below the 100-year flood elevation of the lagoon (consistent with Watershed Management Area Analysis (WMAA) for the San Diego River). Pictures of the outlet locations are at the end of this study.

The HMP Exemption Exhibit in the map pocket at the back of this report includes the limits of the study areas. For those projects located within a hatched area, they are considered exempt from hydromodification requirements either under current conditions or with some future improvements. In accordance with the Municipal Permit, projects that are exempt from hydromodification must still satisfy all other applicable storm water standards (i.e.: site design, source control measures, treatment control best management practices, low impact development, etc.).

Although several watershed areas were evaluated, not all drainage areas qualified for exemption from hydromodifcation requirements. These reasons why they did not qualify will be explained further in the study and are, therefore, not included as exempt areas in the HMP Exemption Exhibit.

INTRODUCTION

In accordance with the Municipal Permit, development and redevelopment projects are subject to either: 1) Standard Stormwater or 2) Priority Development Project (PDP) requirements, which are more rigorous. The City's "Storm Water Standards Questionnaire E-34" (see Figure 11) is used to determine whether a project must meet Standard Stormwater or PDP requirements. The questionnaire, using criteria from the Municipal Permit, provides specific thresholds under which these new development/redevelopment projects trigger PDP requirements.

Among other things, projects subject to PDP requirements must include treatment control best management practices (BMPs) and are required to incorporate hydromodification BMPs. Hydromodification provides requirements to control post-development storm water runoff rates, velocities, and durations in order to maintain or reduce pre-development downstream erosion, sediment pollutant generation, and protect beneficial uses and stream habitat.

For this study, a focus was made to look at the three lagoons within the city (Buena Vista, Agua Hedionda, and Batiquitos Lagoon) and explore applicable HMP exemptions. This study assesses the lagoons and seven (7) major drainage areas contributing to the lagoons to determine whether they meet hydromodification exemption criteria. The seven major drainage areas are tributary to one of the seven following storm drain outlets into Buena Vista, Agua Hedionda, or Batiquitos Lagoon (see the Study Area Exhibits and HMP Exemption Exhibit in the map pocket):

Buena Vista Lagoon

- 48" and 66" outlets on the east side of Carlsbad Boulevard into the south side of the lagoon
- 48" outlet on the west side of Interstate 5 into the south side of the lagoon
- 66" outlet on the west side of Jefferson Street into the south side of the lagoon

Agua Hedionda Lagoon

- 18" outlet on the west end of Date Avenue into the north side of the lagoon
- 84" outlet on the east side of the railroad tracks into the north side of the lagoon
- 60" outlet near the south end of Marina Drive into the north side of the lagoon

Batiquitos Lagoon

- 84" outlet on the east side of Carlsbad Boulevard into the north side of the lagoon

With the exception of one area, the studied tributary areas do not include natural (non-hardened) channels directly to a lagoon. Each of these major drainage areas is served by a network of improved (hardened) public drainage facilities that outlet into a lagoon. The majority of the public facilities are underground storm drain systems or paved streets. Some facilities are also lined (concrete, gunite, etc.) drainage ditches or swales. Provided runoff from the study area discharges into a non-erodible drainage network that is continuous with a direct discharge to a lagoon, it is potentially eligible for a hydromodification exemption. Based on record drawing research and field reconnaissance, the Study Area Exhibits identify the improved (hardened) drainage networks. The exhibits demonstrate that each major drainage area, except the 48" outlet towards Buena Vista Lagoon on the west side of Interstate 5, contains a continuously improved non-erodible network that serves the drainage area; therefore MS4's draining directly into the lagoons are not subject to potential impacts from hydromodification. The discharge points must be below the 100-year water surface elevations in the lagoon (consistent with Watershed Management Area Analysis (WMAA) for the San Diego River).

Areas Draining to Buena Vista Lagoon

Using rational method analyses from the 2003 County *Hydrology Manual* and as-built (record drawing) research, the existing storm drain network collecting run-off for all of the Buena Vista Lagoon drainage areas (Major Drainage Basins 100, 200, and 300 as shown on the Study Area Exhibits) analyzed in this report have been shown to be adequate to convey the Q_{10} runoff, which is the upper range for hydromodification as described the Municipal Permit. Each outlet structure was observed to ensure they include adequate energy dissipation to address erosion potential. For details of how these each of these criteria where satisfied, refer to the Appendices of this study. The select areas draining to the Buena Vista Lagoon from Major Drainage Basins 100 and 300, which are determined to be exempt from HMP are shown in the HMP Exemption Exhibit.

Although Major Drainage Basin 200 includes an improved non-erosive (hardened) storm drain system, the existing 48" outlet is not directly adjacent to the waters edge of Buena Vista Lagoon; therefore, does not qualify as a direct discharge to an exempt water body. In order for Major Drainage Basin 200 to qualify for an exemption a non-erodible drainage facility capable of conveying at least the 10-year flow will need to be constructed from the existing 48" outlet to the 100-year floodplain in the receiving lagoon.

Areas Draining to Agua Hedionda Lagoon and Batiquitos Lagoon

Certain drainage areas that drain to these lagoons were selected (Major Drainage Basin 400, 500, 600, and 700 as shown on the Study Area Exhibits). The existing storm drain network for each drainage area was also evaluated against their ability to carry the Q10. As provided in the Technical Appendices, the storm drain system for each drainage areas has the capacity to carry the Q10. The outlet for each storm drain system was also observed to ensure they include adequate energy dissipation to address erosion potential. For details of how these each of these criteria where satisfied, refer to the Appendices of this study. Based on these findings, the select areas draining to Agua Hedionda Lagoon and Batiquitos Lagoon are shall be considered exempt from HMP. These exempt areas are shown in the HMP Exemption Exhibit.

There are two isolated areas within Major Drainage Basin 600 that direct storm runoff over the natural ground surface west of the railroad tracks. Without further analysis using erosion potential (or equivalent), the naturally-lined swales are not considered exempt from hydromodification. Therefore, these areas were excluded from the exemption area in HMP Exemption Exhibit and from further analysis.

OUTLET CONDITIONS

Since the storm drain networks considered in this report are continuously non-erodible to one of the three lagoons (except from Major Drainage Basin 200 and a portion of 600), the energy dissipation to be studied are at the lagoon outlets. As-built drawings were reviewed and a site visit was performed to determine the conditions at each outlet. The following describes the findings for each outlet. In addition, the Lagoon Assessment section contained next in this report confirms that each outlet is below the 100-year water surface elevation. This effort confirms the storm drain network (MS4's) qualifies as a 'direct discharge' to an exempt water body.

Buena Vista Lagoon 48" and 66" Outlets

These are adjacent reinforced concrete pipe outlets that discharge into the south edge of Buena Vista Lagoon immediately east of the merge of State Street and Carlsbad Boulevard. During the site visit, the lagoon water level was at the invert of the 48" outlet and just above the invert of the 66" outlet (see Figure 1 after this report text). Riprap energy dissipation was not observed below the outlets nor was there evidence of erosion below the outlets (see Figure 2).

Drawing No. 215-9 shows that the invert elevation of the 66" reinforced concrete pipe outlet is at 6.0 feet NGVD 29 (the reference drawings are included on the compact disc in the map pocket). The 48" outlet is shown on Drawing 153-9, but the plan does not identify the vertical datum. Based on the site visit, the 48" outlet invert is approximately 6 inches higher than the 66" outlet invert. Buena Vista Lagoon contains a weir structure near the Pacific Ocean that controls the water surface in the lagoon. A field survey by Algert Engineering revealed that the top of the weir structure is at 7.6 feet NAVD 88 or 5.5 feet NGVD 29. Therefore, the water level in the lagoon will be within at least 6 to 12 inches of the outlets. During most periods, the water level should be higher than 5.5 feet due to natural sand build-up above the weir crest caused by littoral processes as well as backwater in the lagoon. Since ponded water is an effective energy dissipater, the 48" and 66" outlets contain proper energy dissipation. This is further evidenced by the absence of erosion below the outlets even though they have been in place since at least the mid-1980's.

Buena Vista Lagoon 48" Outlet

This 48" reinforced concrete pipe is a Caltrans facility whose outlet discharges towards, but not directly into, the south edge of Buena Vista Lagoon immediately west of Interstate 5. The as-built plans (Document No. 40002483) show that the outlet is at elevation 22.0 feet and was designed with "rock slope protection." During the site visit, riprap was observed below the 48" outlet (see Figure 3). The typical riprap diameter was over 12 inches, which is consistent with the sizing proposed on the design plans. Tall grasses obscured some of the riprap, but the grass indicates that the energy dissipation is effective. However, since this outlet is not a 'direct' discharge to the lagoon (see Lagoon Assessment section), no further analysis is provided.

Buena Vista Lagoon 66" Outlet

This 66" reinforced concrete pipe discharges into the south edge of Buena Vista Lagoon immediately west of Jefferson Street. The as-built plans (Drawing No. 182-10) show that the outlet invert is at elevation 5.3 feet NGVD 29 and contains ¼-ton riprap. The outlet invert was just below the lagoon water level (see Figure 4) during the site visit, which is consistent with the weir-controlled lagoon water level. Riprap was not observed at the outlet during the site visit due to the difficulty in accessing the outlet through the dense vegetation. However, the fact that the water level will be at or above the outlet invert indicates that this outlet has appropriate energy dissipation.

Agua Hedionda Lagoon 18" Outlet

This 18" corrugated metal pipe discharges onto a riprap-lined revetment protecting the northeast bank of Agua Hedionda Lagoon immediately west of the intersection of Date Avenue with Garfield Street (see Figure 5). Storm runoff flows a short distance down the revetment and into the lagoon. As-built plans (Drawing No. 133-3) show that the outlet invert is at elevation 5.36 feet and that energy dissipation has been designed below the outlet. In addition, the tributary drainage area covers approximately 5.2 acres, so the pipe flows will be relatively small.

Agua Hedionda Lagoon 84" Outlet

This 84" reinforced concrete pipe discharges into the north edge of Agua Hedionda Lagoon just east of the railroad tracks. The engineering plans (Drawing No. 360-5) were as-built in 2006, so this is a relatively recent system. The plans show that the storm drain system and its grouted riprap energy dissipater were designed for the 100-year storm flow in accordance with current engineering criteria. A site visit confirmed that the grouted riprap energy dissipater exists and is in substantial conformance with the plans (see Figure 6).

Agua Hedionda Lagoon 60" Outlet

This 60" reinforced concrete pipe discharges directly into the north edge of Agua Hedionda Lagoon just west of Marina Drive. The as-built plans (Drawing No. 152-3) show that the outlet invert elevation is -1.75 feet NGVD 29. This elevation is lower than mean sea level, so the lagoon water level will serve as appropriate energy dissipation for the outflow. A site visit confirmed that the invert is lower than the lagoon water level (see Figure 8).

Batiquitos Lagoon 84" Outlet

This 84" reinforced concrete pipe discharges into the north edge of Batiquitos Lagoon just east of Carlsbad Boulevard and west of the railroad tracks. The as-built drawings (Drawing No. 337-9) show that the storm drain system and its energy dissipater (1-ton riprap and concrete sill) were designed for the 100-year storm flow in accordance with current engineering criteria. A site visit confirmed that the energy dissipater exists in substantial conformance with the plans (see Figure 9).

Summary

For those outlets that qualify as direct discharges, the above information confirms that proper energy dissipation currently exists at each of the storm drain outlet locations for the drainage areas. The dissipation is provided by either riprap or the water level in a lagoon.

DISCHARGE TO LAGOONS

The October 3, 2014, *San Diego River Watershed Management Area Analysis*, states that "to qualify for the potential [hydromodification] exemption, the outlet elevation must be between the river bottom elevation and the 100-year floodplain elevation and properly designed energy dissipation must be provided." Proper energy dissipation was verified in the prior section. This section discusses the 100-year floodplain elevations. Research was performed to determine the 100-year water surface elevations in each of the three lagoons. FEMA provides 100-year floodplain information for many waterbodies. FEMA defines a 100-year floodplain for the lagoons, but does not provide the necessary water surface elevations. However, Dokken Engineering (Dokken) performed detailed HEC-RAS hydraulic analyses of each lagoon as part of their December 2008, *Interstate 5 North Coast Floodplain Studies,* for Caltrans. Relevant excerpts from the Dokken studies are included in the Appendices. Table 1 summarizes the outlet elevations of each discharge point from the as-built drawings (discussed in the prior section) and the associated 100-year floodplain elevation from the Dokken studies. The as-built drawings are either identified as being on NGVD 29 datum or were prepared prior to 1988, so by default should be on NGVD 29. On the other hand, the Dokken studies are on NAVD 88 datum. Corpscon is provided by the US Army Corps of Engineers for coordinate conversions, and shows that 2.2 feet is added to the NGVD 29 elevations to convert to NAVD 88 elevations.

Major Drainage Basin	Description	Outlet Elevation, feet[1]	Lagoon 100-Year Water Surface Elevation, feet[2]
100	Buena Vista Lagoon 48" and 66" Outlets	6.00	13.93
200	Buena Vista Lagoon 48" Outlet	22.00	13.89
300	Buena Vista Lagoon 66" Outlet	5.30	15.75
400	Agua Hedionda Lagoon 60" Outlet	-1.75	12.33
500	Agua Hedionda Lagoon 18" Outlet	5.36	11.68
600	Agua Hedionda Lagoon 84" Outlet	7.95	12.21
700	Batiquitos Lagoon 84" Outlet	6.27	8.90

[1]Elevations are on NGVD 29 (add 2.2 feet to convert to NAVD 88)
[2]Elevations are on NAVD 88

Table 1. Summary of Storm Drain Outlet Elevations and Lagoon Elevations

Table 1 shows that all of the storm drain outlets (with the conversion applied) except at Major Drainage Basin 200 are below the 100-year water surface elevation in the associated lagoon. Therefore, the hydromodification exemption requirement to have the outlet elevation below the 100-year floodplain elevation is met except at Major Drainage Basin 200.

Summary

The four drainage areas (Major Drainage Basins 400, 500, 600, 700) tributary to the Agua Hedionda Lagoon and Batiquitos Lagoon are served by an improved (non-erosive) street and underground storm drains system and have capacity to convey the 10-year rain event condition. The storm drain outlets for these drainage areas to the lagoon are considered direct discharges. Therefore, these areas are considered exempt from hydromodification.

The easterly and westerly drainage areas (Major Dainage Basins 100 and 300) tributary to and outletting directly into Buena Vista Lagoon are served by an improved (non-erosive) street and underground storm drains system and have capacity to convey the 10-year rain event condition. The storm drain outlets for these drainage areas to the lagoon are considered direct discharges. Therefore, these areas are also considered exempt from hydromodification.

The westerly drainage areas (Major Drainage Basin 200) tributary to and outletting adjacent to the Buena Vista Lagoon west of Interstate 15 is served by an improved (non-erosive) street and underground storm drains system and have capacity to convey the 10-year rain event condition. However, this outlet is not considered a direct discharge. In order to create a direct discharge, drainage improvements will need to be constructed that are capable of conveying the 10-year flow to the lagoon. The new outlet must have proper energy dissipation and extend below the 100-year water surface elevation. If such improvements are constructed in the future, this area can be considered as exempt from hydromodification.

HYDROLOGIC AND HYDRAULIC ANALYSES

As mentioned in the Introduction, hydromodification applies to flows up to the 10-year event. Consequently, the drainage network (storm drain pipes, streets, etc.) within each major drainage area are required to convey the 10-year flow in order to qualify for an exemption. All of the available as-built plans for the public storm drain systems in the seven major drainage areas were obtained and reviewed. Several of the more recent as-built plans list 10- or 100-year flow rates in the pipes and/or hydraulic grade lines on the storm drain profiles. These systems have been identified on the Study Area Exhibits and further analyses were not required since the systems have been designed to convey the 10-year or greater flow rates. Therefore, development within these areas is exempt from HMP.

Hydrologic and hydraulic analyses have been performed for the remaining systems whose plans do not contain the flow or hydraulic grade line data. The hydrologic analyses were performed to determine the ultimate condition 10-year flow rates. The County of San Diego's 2003 *Hydrology Manual* rational method procedure was used for the 10-year hydrologic analyses. The rational method input parameters are summarized below and the supporting data is included in Appendix B:

- Precipitation: The 10-year, 6- and 24-hour precipitation values are 1.7 and 3.1 inches, respectively, for the drainage areas tributary to Buena Vista and Agua Hedionda Lagoon. The 10-year, 6- and 24-hour precipitation values are 1.7 and 2.9 inches, respectively, for the drainage areas tributary to Batiquitos Lagoon.

- Drainage subbasin: The drainage subbasins were delineated from the City's 2005 2-foot contour interval topographic mapping, the City's GIS storm drain network, available as-built plans, and a site investigation. See the Study Area Exhibits in the map pocket for the major and subbasin boundaries, rational method node numbers, and subbasin areas.

- Hydrologic soil groups: The hydrologic soil groups were determined from the *San Diego County Soils Interpretation Study* maps for Encinitas and Rancho Santa Fe. The soil group in the study area is primarily A with some pockets of C and D.

- Runoff coefficients: The runoff coefficients were assigned based on the underlying land uses and soil groups. The land uses range from undisturbed areas to commercial/industrial development. The land uses were determined from a 2009 aerial photograph from the City and 2010 Google Earth aerials as well as a site investigation. For undeveloped areas that could be subject to development, a developed condition was assumed. Therefore, the hydrologic analyses essentially model a fully built-out condition. This approach is similar to what would be done for a storm water master plan.

- Flow lengths and elevations: The flow lengths and elevations were obtained from the topographic mapping and engineering plans.

The 10-year rational method analyses were performed using CivilDesign's San Diego County Rational Hydrology Program and the results are included in Appendix B. Separate analyses were performed for the major drainage areas and are labeled as follows:

Buena Vista Lagoon

- Major Basin 100 is tributary to the 48" and 66" outlet on the east side of Carlsbad Boulevard
- Major Basin 200 is tributary to the 48" outlet on the west side of Interstate 5
- Major Basin 300 is tributary to the 66" outlet on the west side of Jefferson Street

Agua Hedionda Lagoon

- Major Basin 400 is tributary to the 60" outlet at the south end of Marina Drive
- Major Basin 500 is tributary to the 18" outlet at the west end of Date Avenue
- Analyses were not performed for the 84" outlet on the east side of the railroad tracks because flow rates and hydraulic grade lines were provided on the majority of the as-built plans.

Batiquitos Lagoon

- Analyses were not performed for the 84" outlet on the east side of Carlsbad Boulevard because flow rates and hydraulic grade lines were provided on the majority of the as-built plans.

The CivilDesign rational method analyses include pipeflow routines for modeling flow in circular pipes. The upstream and downstream invert elevations and pipe length are entered in the model for each storm drain segment. The program then determines the required normal depth pipe size based on the calculated 10-year flow rate, longitudinal slope, and roughness coefficient. The pipeflow routines were used to assess the adequacy of the existing pipes. Invert elevations were selected so that the longitudinal slope from the as-built plans was accurately modeled in the analyses. The longitudinal slope of each storm drain segment was determined from a review of all relevant as-built plans. Some storm drain segments contain varying or multiple slopes. In this case, the flattest slope was used because it will result in the most conservative sizing. A few segments were missing elevations on the as-built plans. For these segments, the average street slope was used. The pipe size from the hydraulic analyses were then compared to the size from the as-built plans to identify pipes with adequate capacity and those with deficiencies.

Since the rational method program determines the minimum required pipe size to convey the 10-year flow in each specific segment, it is possible that program will show the required size increasing or decreasing in adjacent segments of the overall storm drain system. For instance, if the same flow rate is conveyed in two adjacent segments, but the downstream segment has a steeper longitudinal slope, the results can show that the downstream pipe is smaller. Engineering design criteria typically does not allow subsequent segments in a storm drain system to be smaller. However, since the rational method results are merely used as a comparison with the sizes from the as-built plans, any usual telescoping effects are not relevant.

The pipes have been categorized based on their capacity and identified on the Study Area Exhibits per their category. The first category represents pipes in which the as-built plans contain flow rate or hydraulic grade line information indicating that the pipes can convey the 10-year runoff. As mentioned above, analyses were not specifically performed for these systems since detailed information is contained on the as-built plans. The second category represents pipes in which the rational method analyses show that the existing size can convey the 10-year flow rate. The third category represents pipes in which the rational method analyses show that the existing pipes need to be upsized by at most one pipe size (6 inches) to convey the 10-year flow. The fourth category represents pipes in which the rational method analyses show that the existing pipes need to be upsized by more than one pipe size to convey the 10-year flow.

The first and second categories represent no major deficiencies in capacity. The third category indicates that the existing pipe is slightly undersized. However, if pressure flow and street capacity are considered, these systems will be capable of conveying the 10-year flows since the additional flow associated with an at most 6 inch increase in pipe size can be conveyed under pressure or within the adjacent street. This was confirmed by comparing the 10-year flow rates with a street flow capacity chart. For a given pipe segment, the street flow capacity chart indicated that the associated street can convey the required flow. Therefore, the drainage systems within the first three categories have capacity for the 10-year flow.

Existing pipes under the fourth category require additional review to determine whether the 10-year flow can be conveyed. Additional review resulted in the following assessment of the storm drain systems within the fourth category.

Major Basin 100

There are four storm drain segments in Major Basin 100 that fall within the fourth category. The segments are between rational method nodes 105 to 109, 135 to 136, 137 to 138, and 138 to 141. The following assesses the pipe and street capacity of each of these four segments.

The existing pipe from nodes 105 to 109 has an 18" diameter with a normal depth capacity of approximately 10 cubic feet per second (cfs). However, the rational method results show that the 10-year flow rate is 37 cfs, and the pipe size needed to convey 37 cfs varies from 30" to 33". The corridor along the street between these nodes has capacity for the additional 27 cfs (37 – 10 = 27 cfs) needed beyond the pipe capacity. Therefore, the combined pipe and street in this area can convey the 10-year flow.

A similar assessment is made for the other three segments. The existing pipe from nodes 135 to 136 is a 24" reinforced concrete pipe (RCP), while the analyses show that a 33" RCP is needed. The existing pipe from nodes 137 to 138 is a 36" RCP while the analyses show that a 45" RCP is needed. The existing pipe from nodes 138 to 141 is a 12" RCP while the analyses show that a 30" RCP is needed. For each of these deficient segments, the associated streets can handle the additional capacity needs. In addition, the adjacent upstream and downstream pipe segments are not deficient. Therefore, the overall drainage systems along these nodes can convey the 10-year flow.

Major Basin 300

There are two storm drain segments in Major Basin 300 that fall within the fourth category. The segments are between rational method nodes 309 to 316 and nodes 340 to 343. The existing pipes from nodes 309 to 316 are 24" RCPs, while the required pipe varies from 36" to 39". The existing pipes from nodes 340 to 343 are 66" RCPs, while the required size varies from 78" to 81". For both of these areas, the associated streets can handle the additional capacity needs, so these areas can convey the 10-year flow.

Major Basin 400

There are two storm drain segments in Major Basin 400 that fall within the fourth category. The segments are between rational method nodes 408 to 409 and 418 to 420. The existing pipe between nodes 408 and 409 is an 18" RCP, while a 30" RCP is needed. This pipe crosses a sump in the street. The excess stormwater will pond in the street until it drains through the 18" RCP. Therefore, the 10-year flow will be detained in this area. In addition, there are no natural streams in the vicinity that would be subject to HMP requirements.

The existing pipe between nodes 418 and 420 is a 60" RCP that outlets into Agua Hedionda Lagoon, while the analyses show that a 72" RCP is required. However, a 60" bypass structure near the upper end of this segment can divert a portion of the runoff to a second outlet that discharges to a cove connecting to Agua Hedionda Lagoon. The as-built plans (Drawing No. 152-3) show that the bypass is controlled by stop logs. If the bypass is open, then the pipe capacity below the bypass will be sufficient for the 10-year flow. The City of Carlsbad's Utilities Operations staff has a "Weir Wall Removal Procedure," so the stop logs will be removed during high flow events to ensure 10-year flow capacity. Therefore, this area conveys the 10-year runoff to Agua Hedionda Lagoon.

CONCLUSION

The City of Carlsbad's final HMP outlines conditions under which a Priority Development Project can be exempt from hydromodification requirements. The purpose of this study is to explore HMP exemptions based on the January 2011 Carlsbad SUSMP and Order No. R9-2013-0001 adopted by the Regional Water Quality Control Board. In particular, this study examines the criteria necessary for HMP exemptions for 1) enclosed embayments (lagoons) and 2) stabilized conveyances to exempt systems.

These analyses have been performed for seven major drainage areas selected by the City of Carlsbad and are summarized below based on the two primary criteria that were investigated. Additional criteria must be met in addition to the primary criteria to achieve an exemption. The additional criteria is also summarized below.

Stabilized Conveyances with Energy Dissipation

The hydrologic and hydraulic analyses show that the 10-year flow is conveyed by the underground storm drain alone in most areas, and the combination of the underground storm drain and improved public streets in the remaining areas. In addition, each storm drain outlet into a lagoon has proper energy dissipation. Therefore, each study area contains an underground storm drain or conveyance channel that discharges directly to an enclosed conveyance.

Lagoon Floodplains

A comparison of as-built drawings with a recent detailed HEC-RAS analysis of each lagoon confirmed that each outlet is below the 100-year floodplain except in Major Drainage Basin 200. Each outlet is also at or above the associated lagoon floor. Therefore, each outlet except in Major Drainage Basin 200 meets the floodplain criteria for a hydromodification exemption. Major Drainage Basin 200 can meet the criteria if its non-erodible drainage system is extended to the lagoon.

Future Projects

Based on the findings in this report, future projects within one of the studied drainage areas (except Major Drainage Basin 200) qualify for an exemption if their storm runoff is directed to a public drainage facility included in this report without being conveyed over a natural drainage course.

However, future projects in certain locations within the study area will be required to perform additional analyses prior to receiving a hydromodification exemption. These exceptions are outlined below.

The major drainage area tributary to the 84” outlet into Agua Hedionda Lagoon is bisected along its westerly side by the existing railroad tracks. Storm runoff from two areas west of the tracks will be directed to naturally-lined swales near the tracks. Since naturally-lined swales prevent a hydromodification exemption, development west of the tracks may need to replace a natural swale with a non-erodible conveyance. It will be the responsibility for a future development project west of the tracks to assess this situation in detail and propose a solution, as needed. The HMP Exemption Exhibit delineates the two non-exempt areas for reference. Hydrologic analyses have not been performed for these two areas.

AGUA HEDIONDA CREEK DRAINAGE AREAS

GRAPHIC SCALE
300 0 300 600
1 INCH = 300 FEET

LEGEND:

- MAJOR DRAINAGE BASIN BOUNDARY
- MINOR DRAINAGE BASIN BOUNDARY (SUBBASIN)
- OVERLAND FLOW PATH
- 3.62 AC DRAINAGE BASIN AREA
- 10 RATIONAL METHOD NODE NUMBER
- EXISTING CATCH BASIN OR INLET
- EXISTING DRAINAGE DITCH OR SWALE
- MINOR EXISTING STORM DRAIN PIPE OR LATERAL
- AS-BUILT PLANS SHOWING 10-YEAR OR HIGHER FLOW CONTAINED IN EXISTING PIPE
- NORMAL DEPTH ANALYSIS SHOWING 10-YEAR FLOW CONTAINED IN EXISTING PIPE
- NORMAL DEPTH ANALYSIS SHOWING EXISTING PIPE INCREASED BY ONE PIPE SIZE (6") TO CONTAIN 10-YEAR FLOW (SEE TABLE FOR DETAILS)
- NORMAL DEPTH ANALYSIS SHOWING EXISTING PIPE INCREASED BY MORE THAN ONE PIPE SIZE TO CONTAIN 10-YEAR FLOW (SEE TABLE FOR DETAILS)
- STORM DRAIN DISCHARGES INTO NATURAL CHANNEL SO PROPOSED DEVELOPMENT WITHIN DRAINAGE AREA MUST PROVIDE PROJECT-SPECIFIC ASSESSMENT TO DETERMINE IF AN EXEMPTION IS POSSIBLE.
- OUTLET INTO LAGOON
- (A) PIPE SEGMENT IDENTIFIER (SEE TABLE FOR DETAILS)

PIPE SEGMENT	AS-BUILT DRAWING NO.	EXISTING FACILITY AND MINIMUM SLOPE	10-YEAR FLOW, CFS	10-YEAR FLOW CONTAINED IN PIPE UNDER PRESSURE	EXCESS 10-YEAR FLOW CONTAINED IN STREET	EXCESS 10-YEAR FLOW ENTERS ADJACENT LAGOON
A	287-2	18" RCP AT 0.5%	13	Y		
B	220-8	18" RCP (UNKNOWN SLOPE)	37		Y	
C	462-6	18" RCP AT 0.5%	13	Y		
D	137-3A	12" RCP AT 0.24%	18		Y	
E	133-9	36" RCP AT 0.76%	91		Y	
F	146-8	24" RCP AT 0.43%	57		Y	
G	CALTRANS CONTRACT 11-039724	30" RCP (UNKNOWN SLOPE)	32	Y		
H	182-10, 304-2	66" RCP AT 0.28%	293		Y	
I	166-8, 189-6, 206-2	36" RCP AT 1.60% TO 48" RCP AT 2.27%	118 TO 265	Y		
J	141-3	24" RCP AT 1.03% TO 27" RCP AT 2.30%	56 TO 104		Y	
K	146-3	18" RCP AT 1.52%	19	Y		
L	125-4	18" RCP AT 1.23%	16	Y		
M	158-6	18" RCP AT 1.00%	34		Y	
N	158-6	24" RCP AT 1.00%	39	Y		
O	167-4	24" RCP AT 2.00%	39	Y		
P	167-4	21" RCP AT 10.00% TO 24" RCP AT 2.00%	36	Y		
Q	167-5	42" RCP AT 1.00%	117	Y		
R	152-3	60" RCP AT 0.4%	263			Y

NOTE:
THE STORM DRAIN SEGMENTS IN THIS TABLE ARE ONES IN WHICH THE HYDRAULIC ANALYSES SHOW INSUFFICIENT NORMAL DEPTH CAPACITY TO CONVEY THE 10-YEAR FLOW (YELLOW AND RED LINES ON THE LEGEND). THIS TABLE INDICATES IF THE SEGMENTS HAVE CAPACITY TO CONVEY THE 10-YEAR FLOW UNDER PRESSURE. FOR SYSTEMS THAT CANNOT CONVEY THE 10-YEAR FLOW UNDER PRESSURE, THE TABLE INDICATES IF THE EXCESS FLOW CAN BE CONVEYED IN THE STREET OR WILL DIRECTLY ENTER AN ADJACENT LAGOON. ALL OF THE SEGMENTS MEET ONE OF THESE CRITERIA AND, HENCE, SATISFIES THE HYDROMODIFICATION EXEMPTION REQUIREMENT FOR CONVEYING THE 10-YEAR FLOW.

THE DRAINAGE AREAS ENCOMPASSING SEGMENTS A THROUGH L ARE ON STUDY AREA EXHIBIT SHEET 2. THE DRAINAGE AREAS ENCOMPASSING SEGMENTS M THORUGH R ARE ON STUDY AREA EXHIBIT SHEET 1.

STUDY AREA EXHIBIT

HYDROMODIFICATION EXEMPTION

BUENA VISTA CREEK DRAINAGE AREAS

PIPE SEGMENT	AS-BUILT DRAWING NO.	EXISTING FACILITY AND MINIMUM SLOPE	10-YEAR FLOW, CFS	10-YEAR FLOW CONTAINED IN PIPE UNDER PRESSURE	EXCESS 10-YEAR FLOW CONTAINED IN STREET	EXCESS 10-YEAR FLOW ENTERS ADJACENT LAGOON
A	287-2	18" RCP AT 0.5%	13	Y		
B	220-8	18" RCP (UNKNOWN SLOPE)	37		Y	
C	462-6	18" RCP AT 0.5%	13	Y		
D	137-3A	12" RCP AT 0.24%	18		Y	
E	133-9	36" RCP AT 0.76%	91		Y	
F	146-8	24" RCP AT 0.43%	57		Y	
G	CALTRANS CONTRACT 11-039724	30" RCP (UNKNOWN SLOPE)	32	Y		
H	182-10, 304-2	66" RCP AT 0.28%	293		Y	
I	166-8, 189-6, 206-2	36" RCP AT 1.60% TO 48" RCP AT 2.27%	116 TO 265	Y		
J	141-3	24" RCP AT 1.03% TO 27" RCP AT 2.30%	56 TO 104		Y	
K	146-3	18" RCP AT 1.52%	19	Y		
L	125-4	18" RCP AT 1.23%	16	Y		
M	158-6	18" RCP AT 1.00%	34		Y	
N	158-6	24" RCP AT 1.00%	39	Y		
O	167-4	24" RCP AT 2.00%	39	Y		
P	167-4	21" RCP AT 10.00% TO 24" RCP AT 2.00%	36	Y		
Q	167-5	42" RCP AT 1.00%	117	Y		
R	152-3	60" RCP AT 0.4%	263			Y

NOTE:
THE STORM DRAIN SEGMENTS IN THIS TABLE ARE ONES IN WHICH THE HYDRAULIC ANALYSES SHOW INSUFFICIENT NORMAL DEPTH CAPACITY TO CONVEY THE 10–YEAR FLOW (YELLOW AND RED LINES ON THE LEGEND). THIS TABLE INDICATES IF THE SEGMENTS HAVE CAPACITY TO CONVEY THE 10–YEAR FLOW UNDER PRESSURE. FOR SYSTEMS THAT CANNOT CONVEY THE 10–YEAR FLOW UNDER PRESSURE, THE TABLE INDICATES IF THE EXCESS FLOW CAN BE CONVEYED IN THE STREET OR WILL DIRECTLY ENTER AN ADJACENT LAGOON. ALL OF THE SEGMENTS MEET ONE OF THESE CRITERIA AND, HENCE, SATISFIES THE HYDROMODIFICATION EXEMPTION REQUIREMENT FOR CONVEYING THE 10–YEAR FLOW.

THE DRAINAGE AREAS ENCOMPASSING SEGMENTS A THROUGH L ARE ON STUDY AREA EXHIBIT SHEET 2. THE DRAINAGE AREAS ENCOMPASSING SEGMENTS M THORUGH R ARE ON STUDY AREA EXHIBIT SHEET 1.

LEGEND:
- MAJOR DRAINAGE BASIN BOUNDARY
- MINOR DRAINAGE BASIN BOUNDARY (SUBBASIN)
- OVERLAND FLOW PATH
- 3.62 AC DRAINAGE BASIN AREA
- 10 RATIONAL METHOD NODE NUMBER
- EXISTING CATCH BASIN OR INLET
- EXISTING DRAINAGE DITCH OR SWALE
- MINOR EXISTING STORM DRAIN PIPE OR LATERAL
- AS–BUILT PLANS SHOWING 10–YEAR OR HIGHER FLOW CONTAINED IN EXISTING PIPE
- NORMAL DEPTH ANALYSIS SHOWING 10–YEAR FLOW CONTAINED IN EXISTING PIPE
- NORMAL DEPTH ANALYSIS SHOWING EXISTING PIPE INCREASED BY ONE PIPE SIZE (6") TO CONTAIN 10–YEAR FLOW (SEE TABLE FOR DETAILS)
- NORMAL DEPTH ANALYSIS SHOWING EXISTING PIPE INCREASED BY MORE THAN ONE PIPE SIZE TO CONTAIN 10–YEAR FLOW (SEE TABLE FOR DETAILS)
- OUTLET INTO LAGOON
- (A) PIPE SEGMENT (SEE TABLE FOR DETAILS)

BATIQUITOS CREEK DRAINAGE AREAS

STUDY AREA EXHIBIT

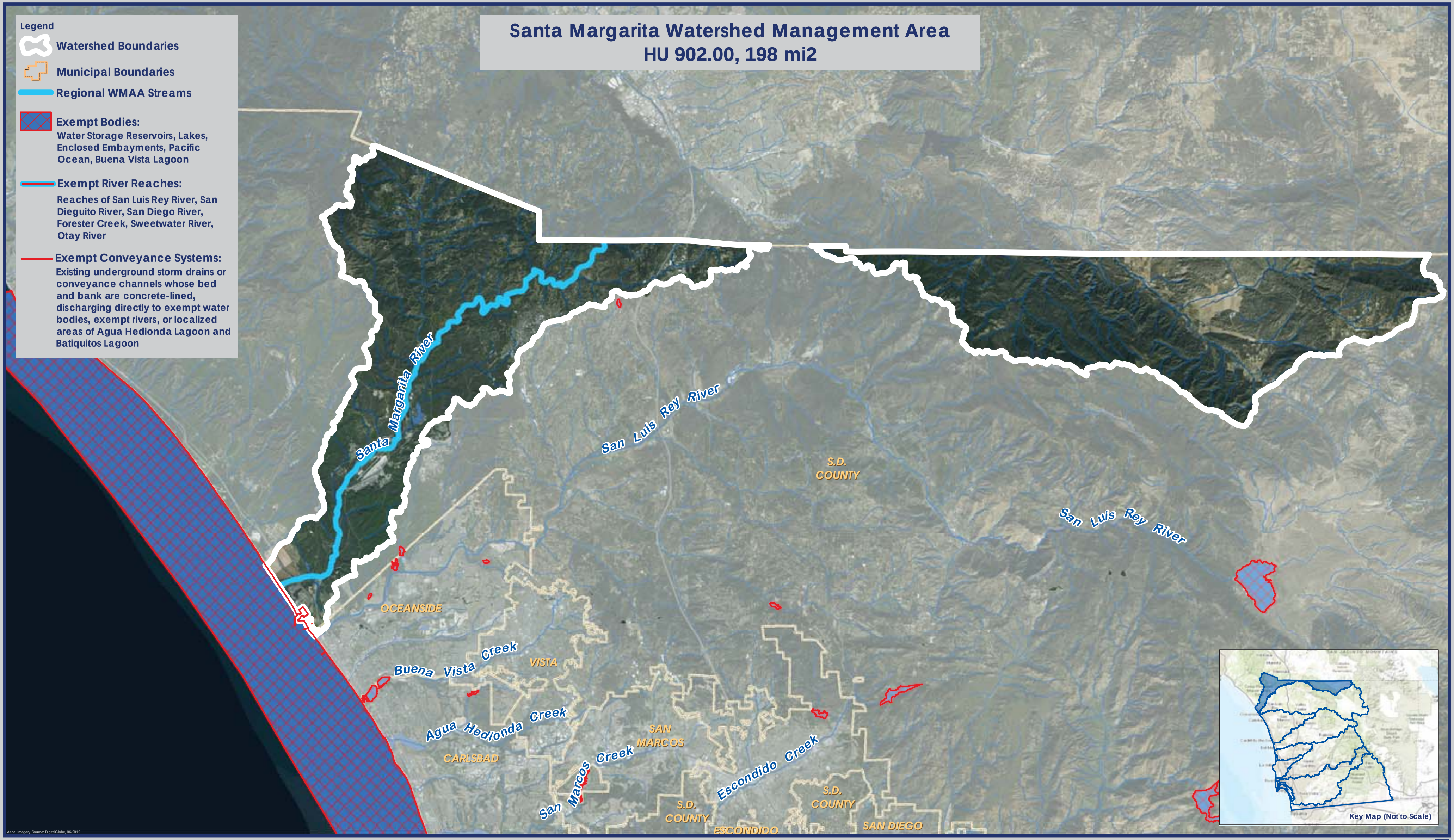
HYDROMODIFICATION EXEMPTION

SHEET 2 OF 2

HMP EXEMPTION EXHIBIT

ATTACHMENT B.2

HYDROMODIFICATION MANAGEMENT EXEMPTION MAPS

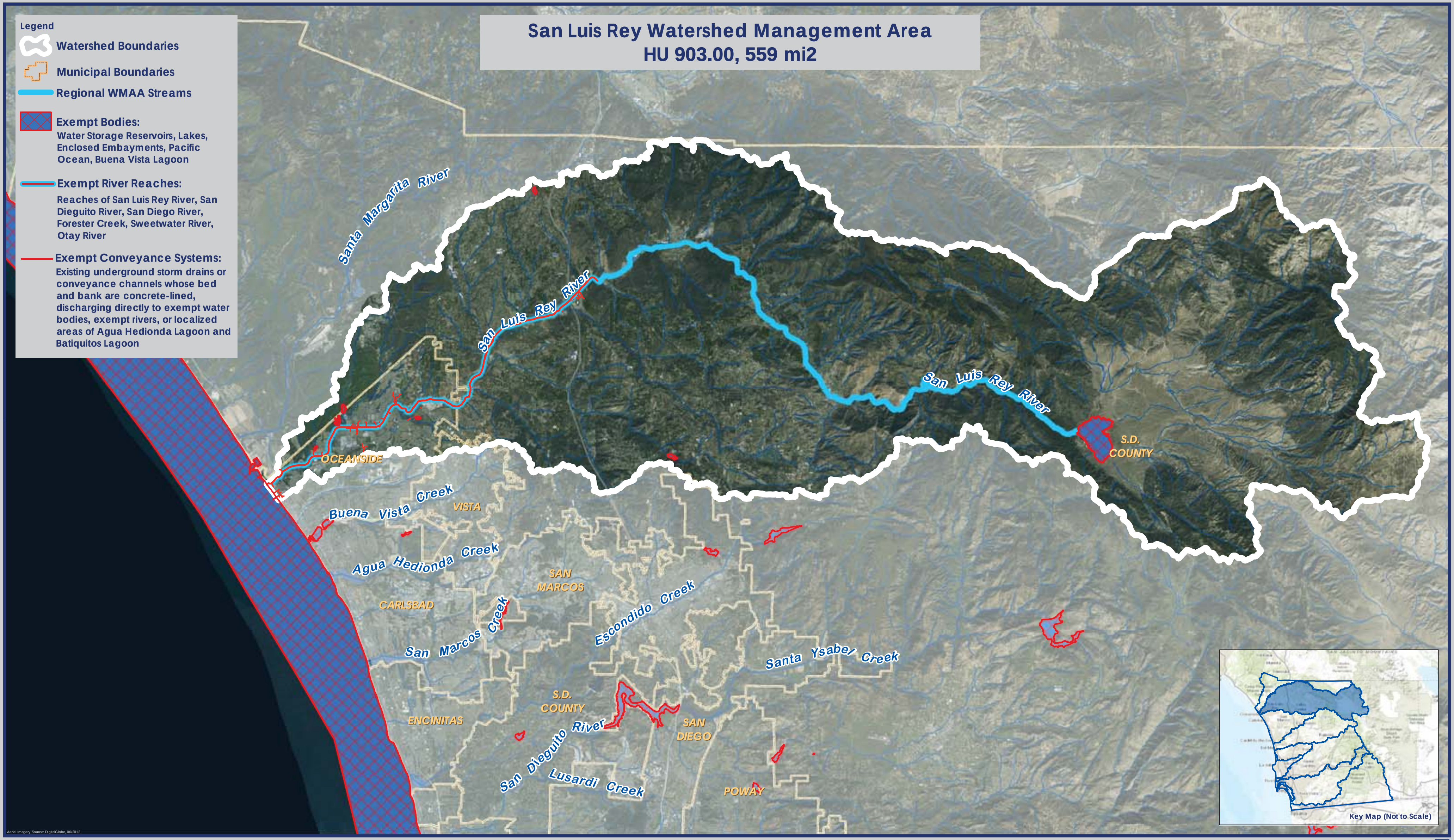


Receiving Waters and Conveyance Systems Exempt from Hydromodification Management Requirements

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK ENGINEERING COMPANY

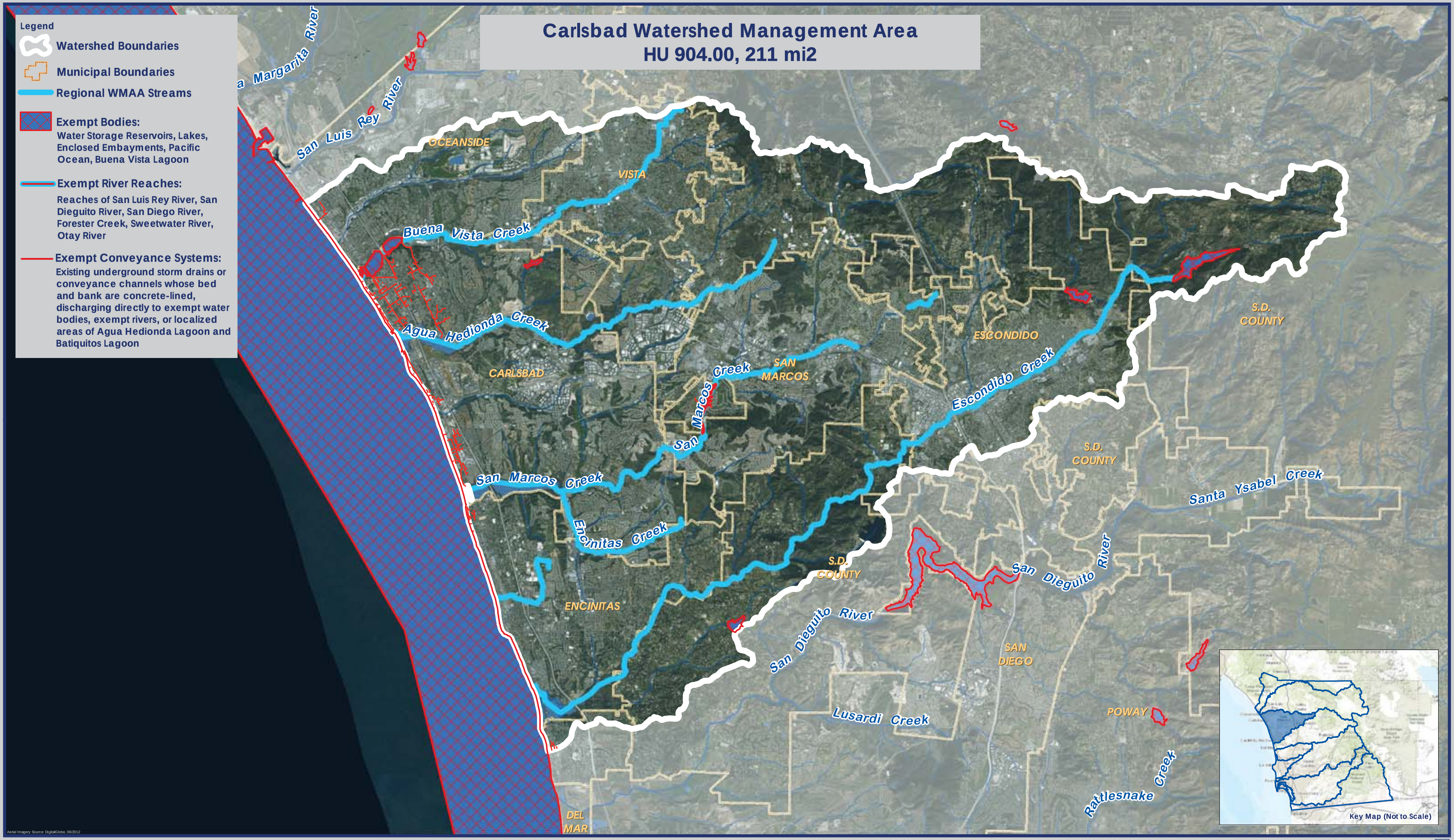


Receiving Waters and Conveyance Systems Exempt from Hydromodification Management Requirements

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK ENGINEERING COMPANY

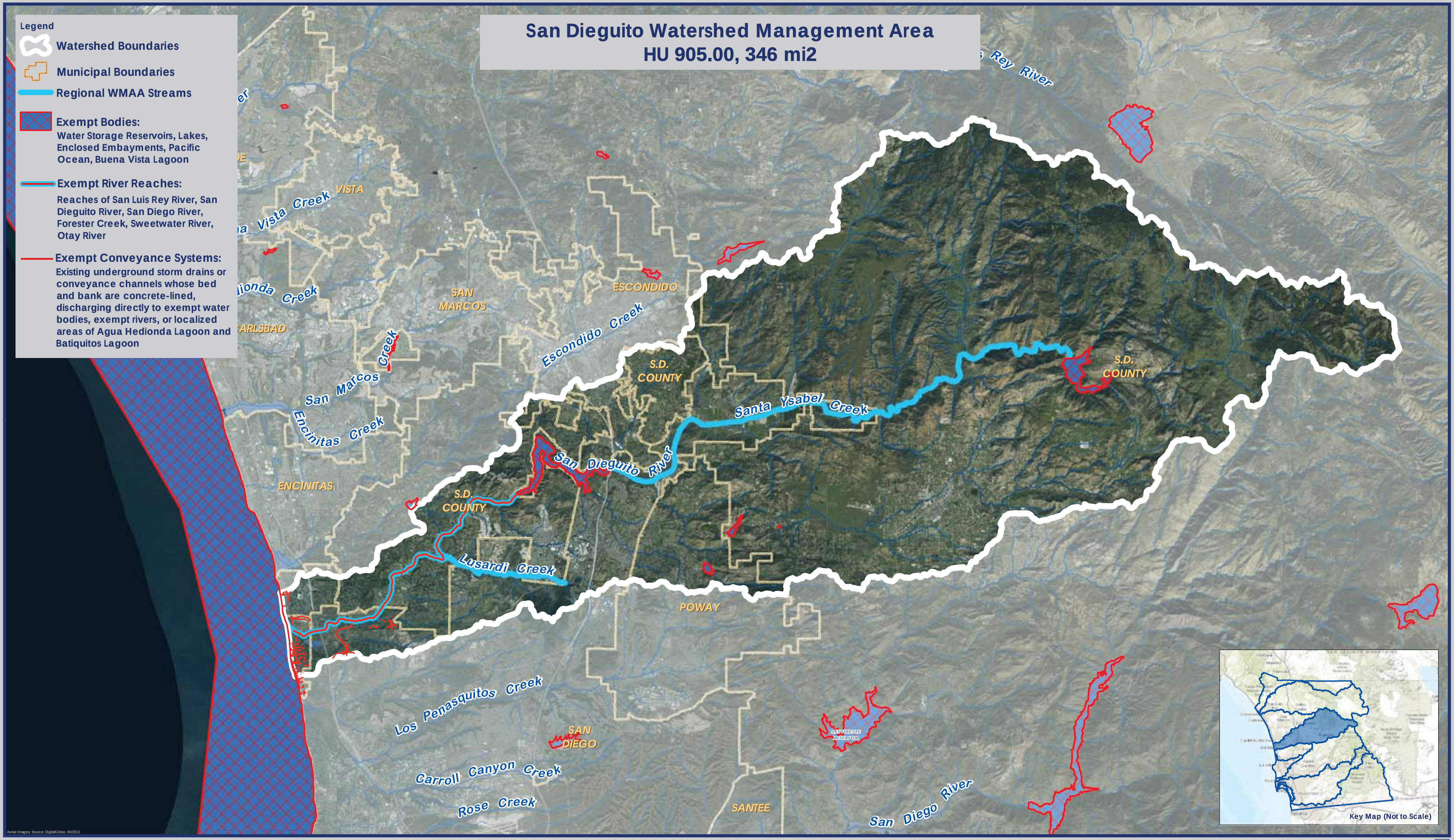


Receiving Waters and Conveyance Systems Exempt from Hydromodification Management Requirements

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK ENGINEERING COMPANY

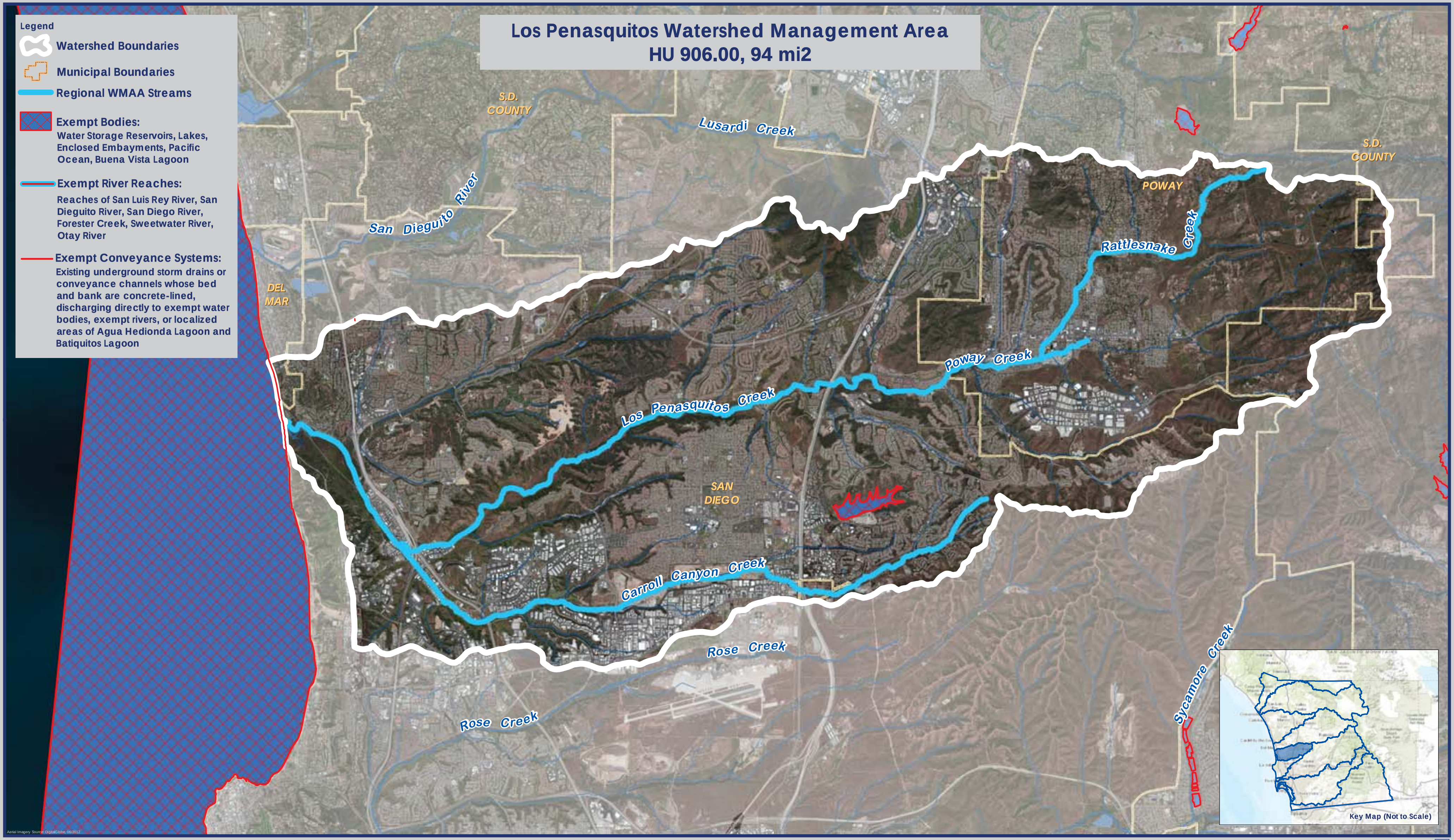


Receiving Waters and Conveyance Systems Exempt from Hydromodification Management Requirements

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK Engineering Company

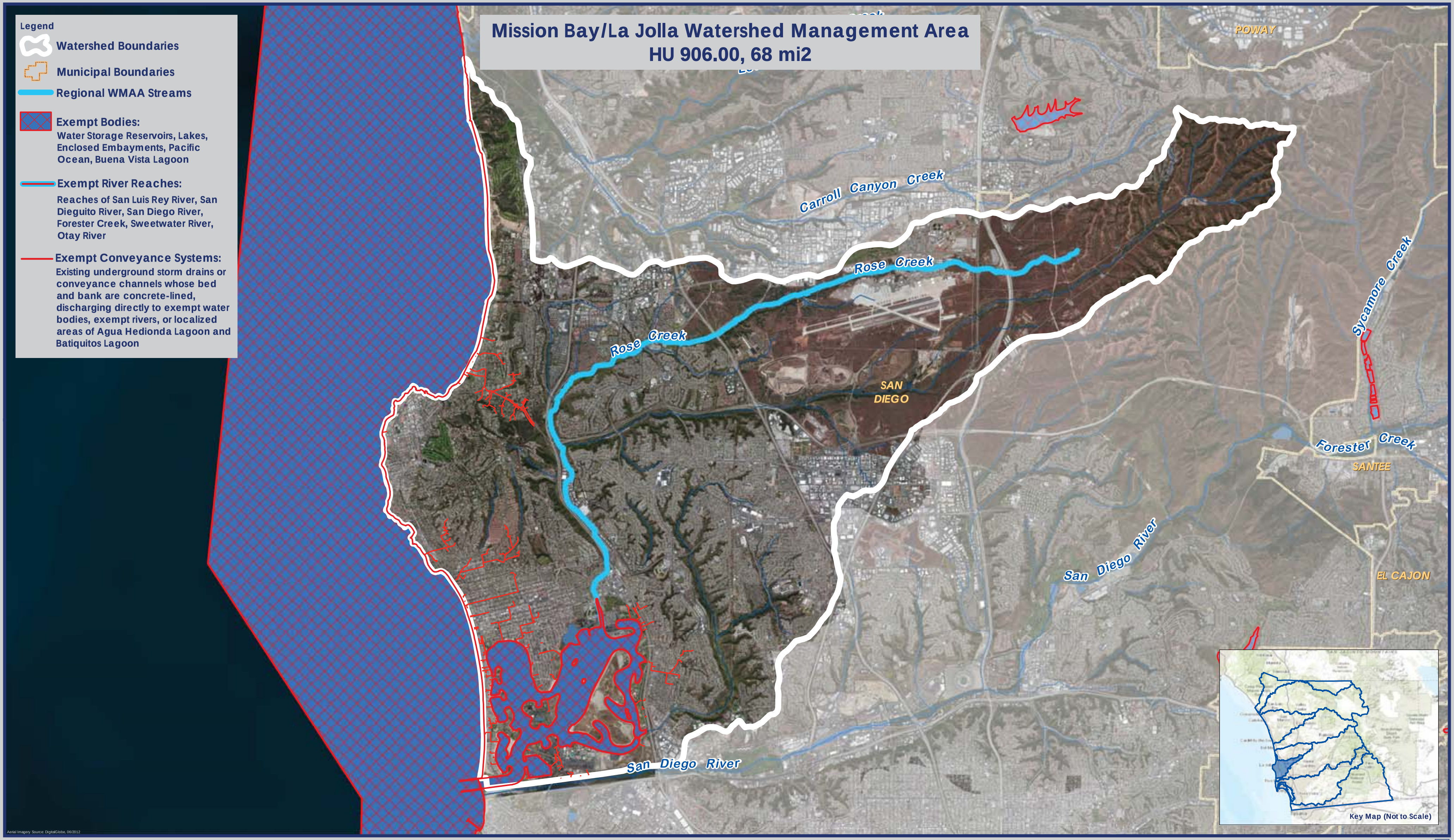


Receiving Waters and Conveyance Systems Exempt from Hydromodification Management Requirements

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK ENGINEERING COMPANY

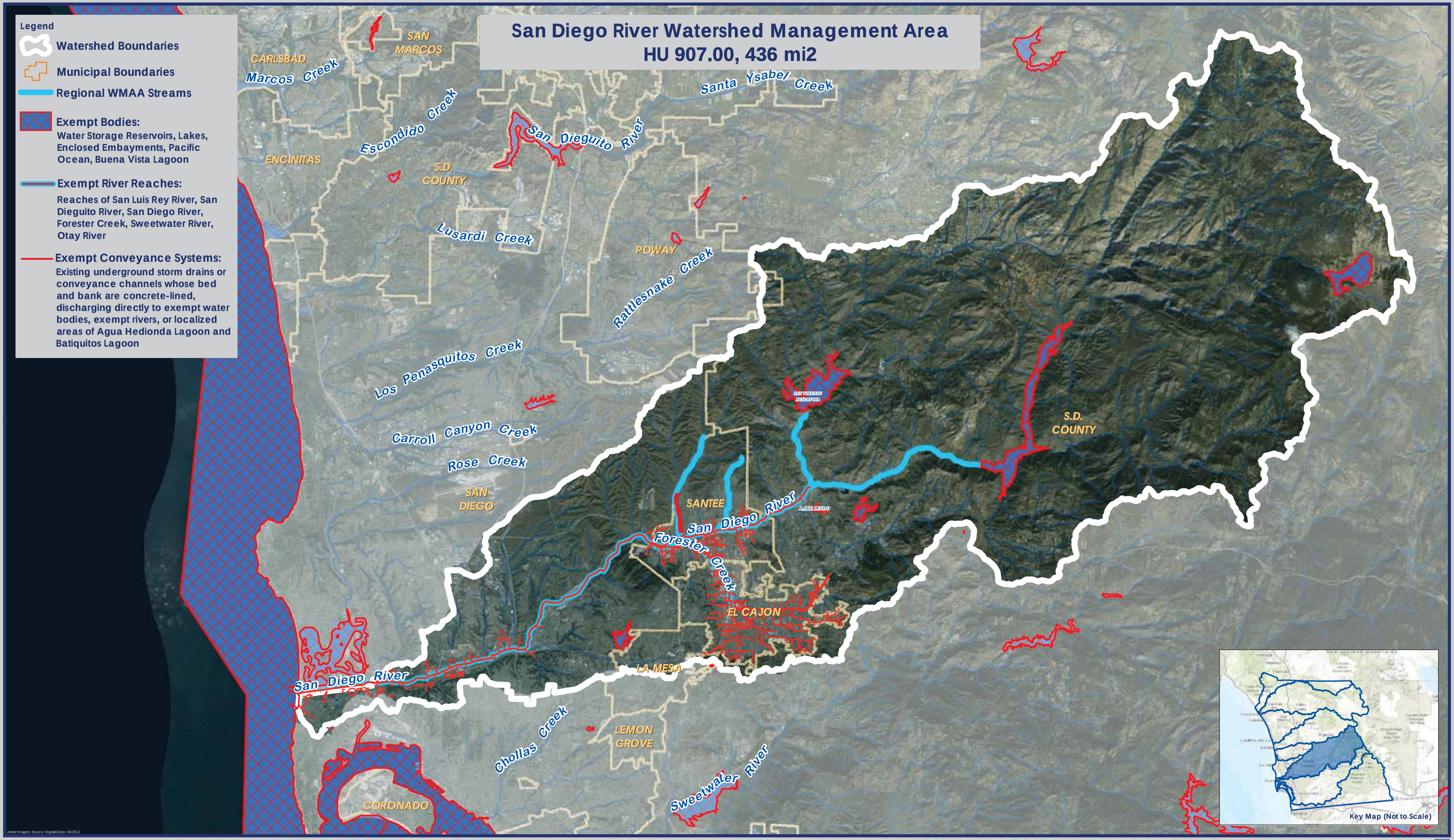


Receiving Waters and Conveyance Systems Exempt from Hydromodification Management Requirements

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

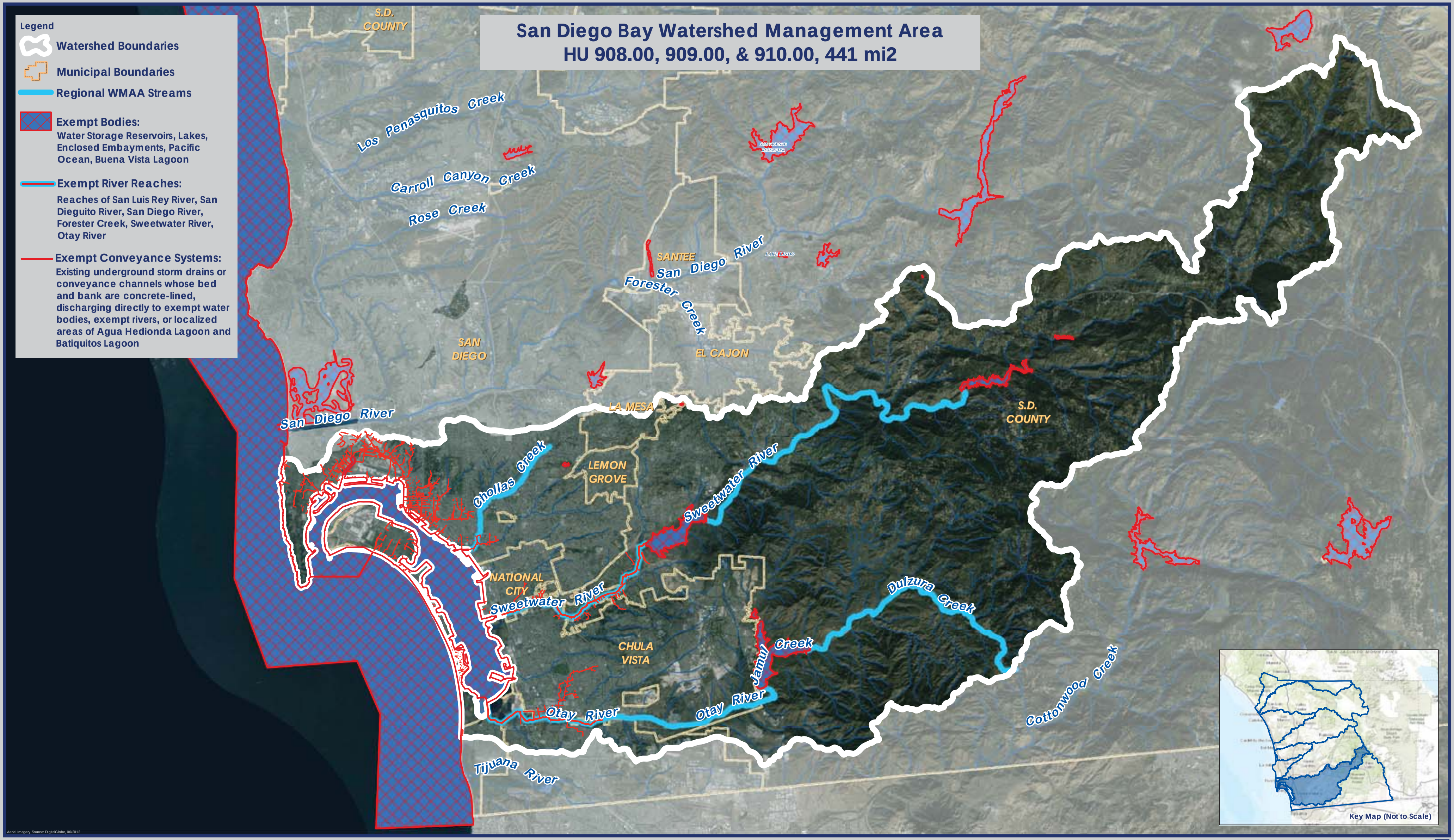
RICK ENGINEERING COMPANY



Receiving Waters and Conveyance Systems Exempt from Hydromodification Management Requirements

Exhibit Date: Sept. 8, 2014

San Diego Bay Watershed Management Area
HU 908.00, 909.00, & 910.00, 441 mi2

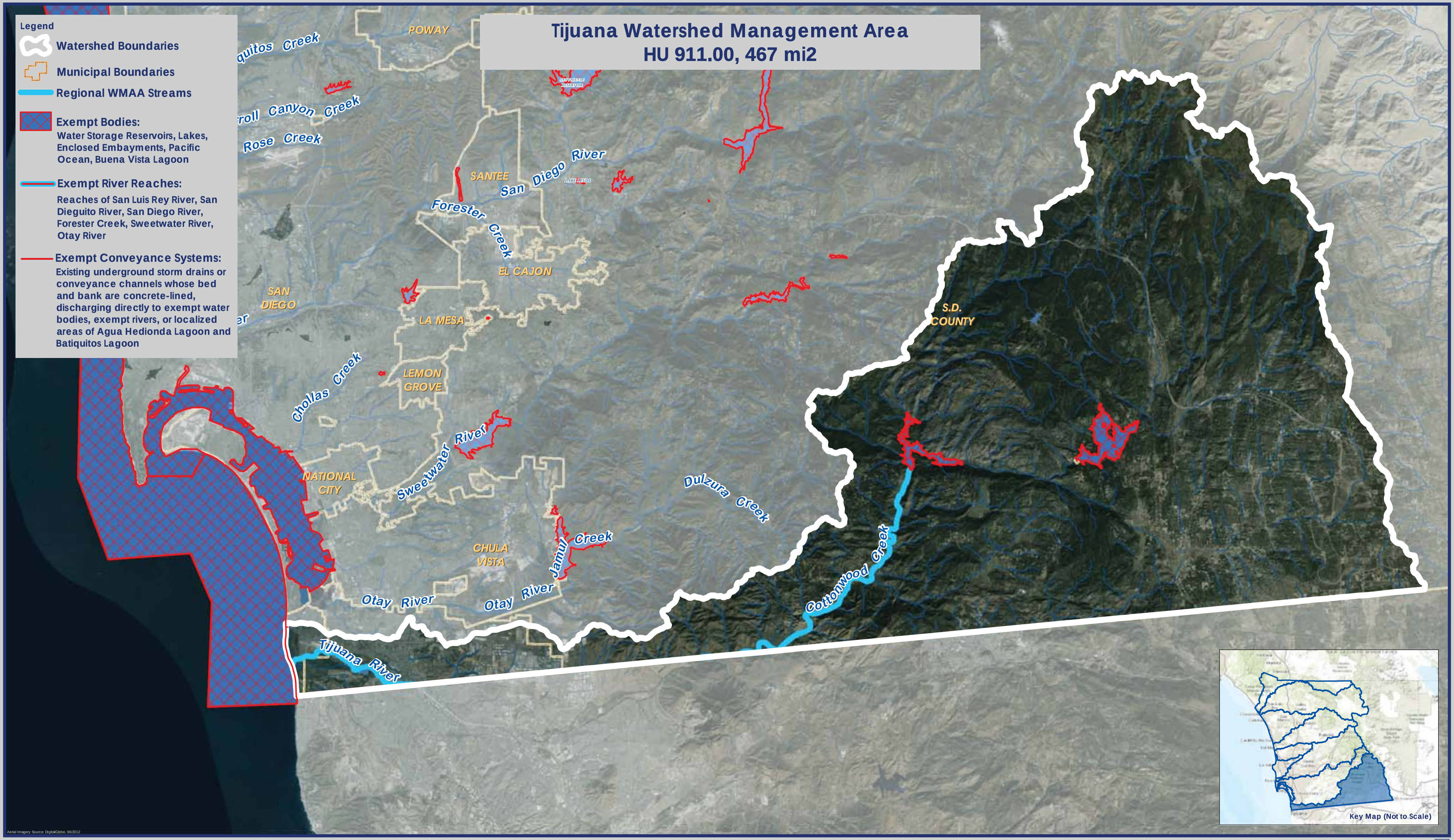


Receiving Waters and Conveyance Systems Exempt from Hydromodification Management Requirements

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK ENGINEERING COMPANY



Receiving Waters and Conveyance Systems Exempt from Hydromodification Management Requirements

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK ENGINEERING COMPANY

ATTACHMENT C
ELECTRONIC FILES

Electronic Folder titled "Attachment _C_ElectronicData_Regional.zip" Contents:

1. ArcMap 10.0 and 10.1 map files created for purpose of viewing Regional WMAA data
   - Regional_WMAA_Data_2014_0908_v10.mxd (
   - Regional_WMAA_Data_2014_0908_v101.mxd (
2. ESRI Geodatabase titled "Regional_WMAA_Data_2014_0908_v10.gdb" containing the following data:
   - WatershedBoundaries
     - Watershed_Boundaries
   - HydrologicProcesses
     - HRUAnalysis
   - Streams – description of existing streams in the watershed
     - SD_Regional_WMAA_Streams (streams selected for detailed analysis)
     - SD_NHD_Streams (portion of NHD dataset included for reference)
   - LandUsePlanning
     - SanGIS_ExistingLandUse
     - SanGIS_PlannedLandUse
     - SanGIS_DevelopableLands
     - SanGIS_RedevelopmentandInfill
     - SanGIS_MunicipalBoundaries
     - Federal_State_Indian_Lands
     - SanGIS_MHPA_SD
     - SanGIS_MSCP_CN
     - SanGIS_MSCP_EAST_DRAFT_CN
     - SanGIS_Draft_North_County_MSCP_Version_8_Categories
   - PotentialCoarseSedimentYield
     - GLUAnalysis
     - PotentialCoarseSedimentYieldAreas
     - MacroLevelPotentialCriticalAreas
     - PotentialCriticalCoarseSedimentYieldAreas
   - ChannelStructures
     - ChannelStructures
   - HydromodExemptions
     - Exempt_Systems
     - Exempt_Bodies
   - Floodplains: included for reference
     - FEMA_NFHL
   - Baselayers: included for reference
     - SanGIS_Lakes
     - link to ESRI World Imagery (internet connection is required to access ESRI World Imagery basemap)

3. Regional_WMAA_Data_2014_0908.kmz**,** KMZ file containing the following data:
    - WatershedBoundaries
    - Streams
        - SD Regional WMAA Streams (streams selected for detailed analysis)
        - SD NHD Streams (portion of NHD dataset included for reference)
    - LandUsePlanning
        - Municipal Boundaries
        - Federal/State/Indian Lands
    - ChannelStructures
    - HydromodExemptions
        - Exempt_Systems
        - Exempt_Bodies
    - Floodplains: included for reference
        - FEMA Floodplain

Notes:

- Open a map file (with extension .mxd) using ArcMap to view the data.
- All data contained in the geodatabase is loaded into the map.
- Some data such as Hydrologic Processes and Coarse Sediment are best viewed at a large scale. Zoom the map to an area of interest to review this data.

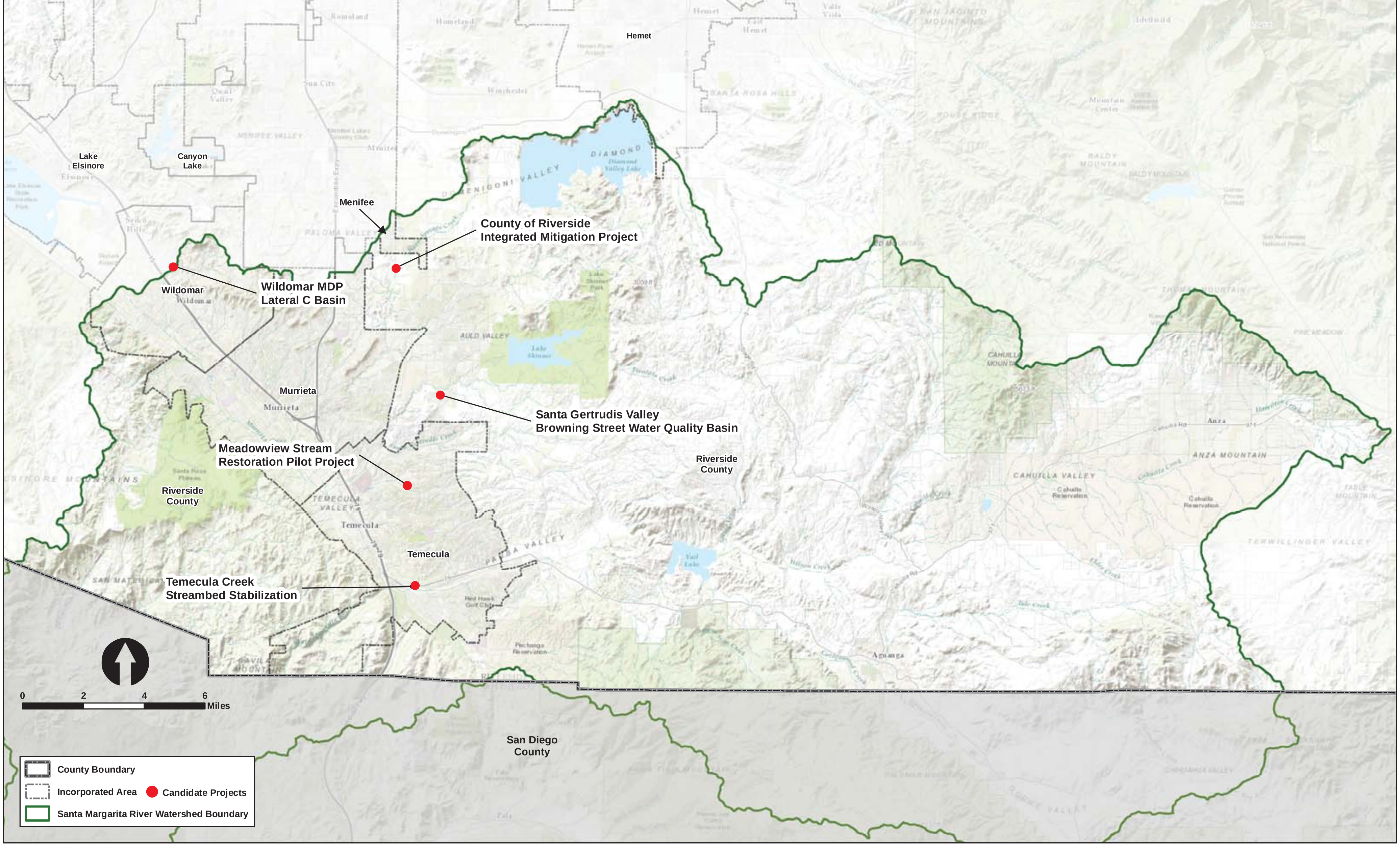
ATTACHMENT D
REGIONAL MS4 PERMIT CROSSWALK

Table below provides a linkage between the Regional MS4 Permit requirements for WMAA and this report.

Regional MS4 Permit Provision	Regional WMAA Report
B.3.b.(4)(a)	Chapter 2; Section 5.1; Attachment A and Attachment C
B.3.b.(4)(a)(i)	Section 2.1; Attachment A.1 and Attachment C
B.3.b.(4)(a)(ii)	Section 2.2; Attachment A.2 and Attachment C
B.3.b.(4)(a)(iii)	Section 2.3; Attachment A.3 and Attachment C
B.3.b.(4)(a)(iv)	Section 2.4; Attachment A.4 and Attachment C
B.3.b.(4)(a)(v)	Section 2.5; Attachment A.5 and Attachment C
B.3.b.(4)(b)	Chapter 3 and Section 5.2
B.3.b.(4)(c)	Chapter 4; Section 5.3; Attachment B and Attachment C

Attachment J. Candidate Projects for the Upper SMR Subwatershed

Candidate Projects for the Upper SMR Subwatershed



Attachment K. Riverside County Flood Control Interim Criteria

INTERIM CRITERIA FOR SIZING INCREASED RUNOFF DETENTION FACILITIES

* The entire area of proposed development will be routed through a detention facility(s) to mitigate increased runoff. All basins must have positive drainage; dead storage basins shall not be acceptable.

* Storms to be studied will include the 1-hour, 3-hour, 6-hour and 24-hour duration events for the 2-year, 5-year and 10-year return frequencies. Detention basin(s) and outlet(s) sizing will ensure that none of these storm events have a higher peak discharge in the "after" condition than in the "before" condition.

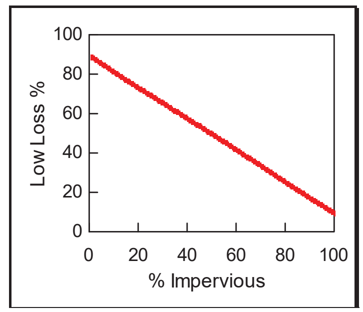
* For the 2-year and 5-year events the loss rate will be determined using an AMC I condition. For the 10-year event AMC II will be used. Constant loss rates shall be used for the 1-hour, 3-hour and 6-hour events. A variable loss rate shall be used for the 24-hour events.

* Low Loss rates will be determined using the following:

  - Undeveloped Condition --> *Low Loss = 90%*

  - Developed Condition --> *Low Loss = .9 - (.8 x % impervious)*

  - Basin Site --> *Low Loss = 10%*



* Where possible and feasible the on-site flows should be mitigated before combining with off-site flows to minimize the size of the detention facility required. If it is necessary to combine off-site and on-site flows into a detention facility two separate conditions should be evaluated for each duration/return period/before-after development combination studied; the first for the total tributary area (off-site plus on-site), and the second for the area to be developed alone (on-site). It must be clearly demonstrated that there is no increase in peak flow rates under either condition (total tributary area or on-site alone), for each of the return period/duration combinations required to be evaluated. A single plot showing the pre-developed, post-developed and routed hydrograghs for each storm considered, shall be included with the submittal of the hydrology study.

* No outlet pipe(s) will be less than 18" in diameter. Where necessary an orifice plate may be used to restrict outflow rates. Appropriate trash racks shall be provided for all outlets less than 48 inches in diameter.

* The basin(s) and outlet structure(s) must be capable of passing the 100-year storm without damage to the facility.

* Mitigation basins should be designed for joint use and be incorporated into open space or park areas. Side slopes should be no steeper than 4:1 and depths should be minimized where public access is uncontrolled.

* A viable maintenance mechanism, acceptable to both the County and the District, should be provided for detention facilities. Generally, this would mean a CSA, landscape district, parks agency or commercial property owners association. Residential homeowners associations would generally not be acceptable.

pcdoc/59946
DW:FJP 5-30-95

Attachment L. Santa Margarita Watershed Impervious Area Summary Table

Copermittee Impervious Area Summary Tables

Current

SCAG code	County		Hemet		Menifee		Murrieta		Temecula		Wildomar	
	ISC	Area	ISC	Area	ISC	Area	ISC	Area	ISC	Area	ISC	Area
1100	0.10	5324085.59		0		0	0.15	554047		0	0.42	9755.55
1110	0.18	155266002.3		0	0.3	2343782.049	0.41	32982102.71	0.36	279916827.2	0.33	92945883.25
1111	0.42	62904902.69		0		0	0.46	181518865.5	0.51	4565845.088		0
1112	0.17	1370932.95		0		0	0.4	30023817.89	0.19	8061398.63		0
1120	0.08	1852031.703		0		0	0.69	4238424.102	0.65	3310519.854	0.43	2290459.7
1122	0.19	1724856		0		0	0.46	1878455.17	0.61	2291268.681	0.37	445834.36
1123	0.69	1124374.58		0		0	0.71	6457666.531	0.67	14769752.76	0.69	836826
1124		0		0		0	0.71	1125317.93		0		0
1130	0.14	19295044.93		0	0.17	12243305.62	0.5	1322824.49		0	0.34	49068065.69
1131	0.42	8035540.83		0		0	0.45	7846292.992	0.02	1707278.4		0
1132	0.07	1046248.56		0		0	0.47	217805.17		0		0
1150	0.13	764248756		0		0	0.32	44347787.12	0.11	5592924	0.07	950480
1200	0.51	0	0.51	0	0.51	0	0.51	5775114.342	0.51	1240698.26	0.51	0
1210	0.29	7887880.7	0.29	0	0.29	444850	0.29	4499984.491	0.29	4925423.375	0.29	564512.232
1211	0.57	348212.41	0.57	0	0.57	0	0.57	1351678.017	0.57	2779638.85	0.57	0
1220	0.47	2954216.788	0.47	0	0.47	0	0.47	999453.45	0.47	8611803.54	0.47	546178.14
1221	0.72	0	0.72	0	0.72	0	0.72	0	0.72	2323360.8	0.72	0
1222	0.68	1182013.507	0.68	0	0.68	0	0.68	10190385.36	0.68	27021737.2	0.68	2199114.37
1223	0.50	1363605.25	0.50	0	0.50	0	0.50	9086816.83	0.50	991857.7	0.50	0
1230	0.10	8501.82	0.10	0	0.10	0	0.10	0	0.10	607345.2	0.10	0
1231	0.44	528134.27	0.44	0	0.44	0	0.44	2082729.6	0.44	2214019.5	0.44	0
1232	0.25	201710.38	0.25	0	0.25	0	0.25	1340415.5	0.25	0	0.25	0
1233	0.31	935703	0.31	0	0.31	0	0.31	82775.5	0.31	1516937	0.31	0
1240	0.22	0	0.22	315866	0.22	0	0.22	1500470.17	0.22	276486.2	0.22	2583217.3
1241	0.46	2248238	0.46	0	0.46	0	0.46	938480.3	0.46	1082359	0.46	0
1242	0.43	230777	0.43	0	0.43	0	0.43	389063	0.43	59539.9	0.43	0
1243	0.38	121932.4	0.38	0	0.38	0	0.38	290473.6	0.38	343914.3	0.38	0
1244	0.29	232407.36	0.29	0	0.29	0	0.29	756904	0.29	1156618.99	0.29	1080517.4
1245	0.31	564684	0.31	0	0.31	0	0.31	1857536.6	0.31	4362402.7	0.31	1195953
1246	0.27	887018.92	0.27	0	0.27	0	0.27	791607.99	0.27	1678293.2	0.27	0
1247	0.52	0	0.52	0	0.52	0	0.52	0	0.52	223807.3	0.52	0
1252	0.37	277529.21	0.37	0	0.37	0	0.37	669696.6	0.37	0	0.37	0
1253	0.16	1192381.8	0.16	0	0.16	0	0.16	93637.9	0.16	0	0.16	0
1260	0.27	580447.6	0.27	0	0.27	0	0.27	222160.4	0.27	5113989.2	0.27	2702718.2
1261	0.42	0	0.42	0	0.42	0	0.42	281658.5	0.42	241750.01	0.42	0
1262	0.41	2569393.475	0.41	0	0.41	0	0.41	5229471.79	0.41	4948552.58	0.41	0
1263	0.39	905954	0.39	0	0.39	0	0.39	1660395	0.39	5138099	0.39	340297
1264	0.41	1997955	0.41	0	0.41	0	0.41	6651659.98	0.41	7266500	0.41	0
1265	0.40	0	0.40	0	0.40	0	0.40	1800586.038	0.40	551728	0.40	0

Copermittee Impervious Area Summary Tables

Current

	County		Hemet		Menifee		Murrieta		Temecula		Wildomar	
1271	0.20	0	0.20	0	0.20	0	0.20	0	0.20	0	0.20	334961
1310	0.53	826661.36	0.53	0	0.53	0	0.53	94192.1	0.53	2293449.89	0.53	127376
1311	0.44	13110750.09	0.44	0	0.44	0	0.44	5902111.12	0.44	17394732.52	0.44	1032227.6
1320	0.06	1595986.08	0.06	0	0.06	0	0.06	221668.2	0.06	0	0.06	0
1321	0.01	863813	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0
1323	0.11	2202592.78	0.11	0	0.11	0	0.11	1083122.9	0.11	0	0.11	0
1331	0.02	4971748.6	0.02	0	0.02	0	0.02	201034.5	0.02	0	0.02	0
1340	0.47	361053.5	0.47	0	0.47	0	0.47	0	0.47	2582769.7	0.47	685021
1400	0.64	0	0.64	0	0.64	0	0.64	0	0.64	232665.6	0.64	0
1410	0.52	0	0.52	0	0.52	0	0.52	0	0.52	3708674.911	0.52	0
1411	0.22	9697112	0.22	0	0.22	113902	0.22	3258724.3	0.22	0	0.22	60420.4
1413	0.46	0	0.46	0	0.46	0	0.46	46845.261	0.46	0	0.46	0
1415	0.07	209544	0.07	0	0.07	0	0.07	115379.5	0.07	0	0.07	0
1416	0.05	403420	0.05	0	0.05	0	0.05	12106.25	0.05	0	0.05	0
1420	0.14	55592.2	0.14	0	0.14	0	0.14	199754	0.14	94059.3	0.14	0
1430	0.63	0	0.63	0	0.63	0	0.63	0	0.63	502976	0.63	0
1431	0.42	513956.86	0.42	0	0.42	0	0.42	270625.9	0.42	405413.92	0.42	933962.151
1432	0.00	1375949	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
1433	0.37	0	0.37	0	0.37	0	0.37	2601277	0.37	3852531	0.37	0
1434	0.11	18547209.7	0.11	265393.6	0.11	0	0.11	2316777	0.11	400336.1	0.11	75419.8
1435	0.09	254225	0.09	0	0.09	0	0.09	0	0.09	0	0.09	0
1436	0.10	5666122	0.10	0	0.10	0	0.10	90737.6	0.10	2688789.98	0.10	0
1437	0.11	9977400.2	0.11	0	0.11	0	0.11	8930927.32	0.11	24514968.72	0.11	67750.4
1440	0.32	349517.2	0.32	0	0.32	0	0.32	598872.6	0.32	0	0.32	0
1500	0.67	310135.498	0.67	0	0.67	0	0.67	4852115.51	0.67	8671358.23	0.67	0
1600	0.21	0	0.21	0	0.21	0	0.21	0	0.21	97076.5	0.21	0
1700	0.23	54874025.34	0.23	0	0.23	98438.75	0.23	11230696.68	0.23	200034.48	0.23	338973.31
1800	0.16	0	0.16	0	0.16	0	0.16	4280901.49	0.16	45494839.51	0.16	0
1810	0.07	10812633.89	0.07	0	0.07	0	0.07	21947173.34	0.07	31892516.63	0.07	0
1820	0.18	2422076.669	0.18	0	0.18	0	0.18	7114176.99	0.18	13741915.82	0.18	85333.3
1830	0.00	1600590652	0.00	0	0.00	0	0.00	157539.2	0.00	4315720	0.00	2062800
1840	0.09	112192	0.09	0	0.09	0	0.09	428666	0.09	278718.7	0.09	0
1850	0.00	0	0.00	0	0.00	0	0.00	0	0.00	201798742.2	0.00	0
1880	0.03	27636808.29	0.03	0	0.03	0	0.03	1165767.1	0.03	3580.92	0.03	0
2000	0.03	4833575.98	0.03	0	0.03	10278648.4	0.03	0	0.03	0	0.03	7551491.868
2100	0.04	84193.4	0.04	0	0.04	0	0.04	0	0.04	1138871.8	0.04	0
2110	0.01	148602240.7	0.01	0	0.01	0	0.01	6816384.97	0.01	0	0.01	0
2120	0.03	414470503.7	0.03	0	0.03	0	0.03	24679753.95	0.03	0	0.03	0
2200	0.01	580541862.5	0.01	0	0.01	0	0.01	7892189.146	0.01	0	0.01	10958432

Copermittee Impervious Area Summary Tables

Current

	County		Hemet		Menifee		Murrieta		Temecula		Wildomar	
2300	0.02	27879310.15	0.02	0	0.02	0	0.02	4200642.7	0.02	0	0.02	0
2400	0.02	4719608.9	0.02	0	0.02	0	0.02	1276898	0.02	0	0.02	1787546.9
2500	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	477684.1
2600	0.02	38503359.54	0.02	0	0.02	0	0.02	3776665.3	0.02	0	0.02	39219231
2700	0.03	119504503.6	0.03	0	0.03	0	0.03	17155897.64	0.03	0	0.03	0
3000	0.02	14830.8	0.02	17331334.64	0.02	4389933	0.02	18750337.62	0.02	27814738.78	0.02	123785423.1
3100	0.01	7032468978	0.01	0	0.01	0	0.01	248934900.3	0.01	73002509.6	0.01	53667862.16
3200	0.01	2957047.1	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0
3300	0.03	26061215	0.03	0	0.03	0	0.03	30785.55	0.03	26684210.46	0.03	0
4000	0.26	0	0.26	0	0.26	0	0.26	0	0.26	623656.6	0.26	0
4100	0.01	283526671	0.01	0	0.01	0	0.01	6811655	0.01	0	0.01	0
5555	0.00	895485516.2	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
9999	0.11	207753.73	0.11	0	0.11	0	0.11	330894.13	0.11	0	0.11	432831
11111	0.26	350715504	0.26	191026	0.26	2909890	0.26	129396200	0.26	137162000	0.26	37989900
1300	0.24											
ISC: Weighted Avg	3%	12,747,729,324	3%	18,103,620	12%	32,822,750	24%	918,230,958	22%	1,036,484,534	16%	439,434,459
Area: Total												

Global Avg Imperviousness: Existing		6%	
	Total area (ft2)	15192805645.882	348778.8257
	Total (mi2)	544.936	

Copermittee Impervious Area Summary Tables

Future

SCAG code	County ISC	County Area	Hemet ISC	Hemet Area	Menifee ISC	Menifee Area	Murrieta ISC	Murrieta Area	Temecula ISC	Temecula Area	Wildomar ISC	Wildomar Area
1110	0.20	24483476			0.44	3333584.493	0.47	270186186.7	0.07	17614058.02	0.20	1016040
1110	0.20	2219294							0.31	21521320.52	0.69	4177322
1110	0.27	8938925.5							0.46	215461920.4	0.27	23037297
1110	0.42	302391583.1									0.35	57222142.6
1110	0.42	59438476.1									0.42	107094508.8
1110	0.61	505685									0.52	9225942.3
1110	0.69	4648768									0.73	910167
1110											0.61	504692
1120							0.71	26971348.85	0.69	15170200		
1130									0.59	28454400.02		
1140												
1150	0.07	2719550392			0.20	15604445.8	0.15	134479713.5	0.16	109336013.9	0.07	106605175.8
1150	0.12	3098201381			0.07	550388.41					0.12	8621340
1150	0.20	544597636.2			0.35	35854.1					0.27	2803090
1150	0.27	11881689			0.12	10373860.3					0.20	48485550
1150	0.35	2549321.8										
1210	0.29	19832301.4	0.29		0.29		0.29	57771764.38	0.29	14770100	0.29	13879757
1200	0.51	0	0.51		0.51		0.51	53565995.86	0.51	0	0.51	0
1220	0.47	34819590.93	0.47		0.47		0.47	0	0.47	37434879.62	0.47	23851906
1221	0.72	0	0.72		0.72		0.72	0	0.72	3807510	0.72	0
1230	0.10	27341778	0.10		0.10		0.10	31203188.91	0.10	7407065.978	0.10	0
1233	0.31	0	0.31		0.31		0.31	0	0.31	0	0.31	0
1240	0.22	86117403.36	0.22		0.22		0.22	46177119.57	0.22	65600569.89	0.22	3098969
1250	0.00	0	0.00		0.00		0.00	0	0.00	0	0.00	0
1260	0.27	0	0.27		0.27		0.27	0	0.27	0	0.27	0
1265	0.40	0	0.40		0.40		0.40	0	0.40	0	0.40	0
1270	0.00	0	0.00		0.00		0.00	0	0.00	0	0.00	0
1300	0.24	0	0.24		0.24		0.24	8110904.88	0.24	46827323.1	0.24	0
1310	0.53	27629786.6	0.53		0.53		0.53	0	0.53	0	0.53	5102242.6
1311	0.44	0	0.44		0.44		0.44	0	0.44	0	0.44	0
1320	0.06	0	0.06		0.06		0.06	0	0.06	0	0.06	0
1321	0.01	0	0.01		0.01		0.01	0	0.01	0	0.01	0
1340	0.47	0	0.47		0.47		0.47	0	0.47	0	0.47	0
1410	0.52	6677010	0.52		0.52		0.52	22157774.8	0.52	11090277.28	0.52	7351550
1420	0.14	0	0.14		0.14		0.14	0	0.14	0	0.14	0
1430	0.63	0	0.63		0.63		0.63	0	0.63	0	0.63	0
1500	0.67	12846522	0.67		0.67		0.67	1860187.439	0.67	0	0.67	4860273
1600	0.21	0	0.21		0.21		0.21	0	0.21	0	0.21	0
1810	0.07	0	0.07		0.07		0.07	0	0.07	0	0.07	0

Copermittee Impervious Area Summary Tables

Future

SCAG code	County ISC	County Area	Hemet ISC	Hemet Area	Menifee ISC	Menifee Area	Murrieta ISC	Murrieta Area	Temecula ISC	Temecula Area	Wildomar ISC	Wildomar Area
1820	0.18	107668279.4	0.18		0.18		0.18	146017713.8	0.18	304263064.4	0.18	11186880.3
1830	0.00	0	0.00		0.00		0.00	0	0.00	0	0.00	0
1840	0.09	0	0.09		0.09		0.09	0	0.09	0	0.09	0
1850	0.00	2572489960	0.00		0.00		0.00	0	0.00	0	0.00	527110
1860	0.00	0	0.00		0.00		0.00	0	0.00	0	0.00	0
1870	0.00	0	0.00		0.00		0.00	0	0.00	0	0.00	0
1880	0.03	1329889911	0.03	18041200	0.03		0.03	0	0.03	0	0.03	0
1900	0.00	0	0.00		0.00		0.00	0	0.00	0	0.00	0
3000	0.02	0	0.02		0.02		0.02	0	0.02	0	0.02	0
2000	0.03	564200528	0.03		0.03		0.03	0	0.03	0	0.03	0
4000	0.26	279987483.6	0.26		0.26		0.26	0	0.26	0	0.26	0
7777	0.00	0	0.00		0.00		0.00	0	0.00	0	0.00	0
8888	0.00	0	0.00		0.00		0.00	0	0.00	0	0.00	0
9999	0.11	0	0.11		0.11		0.11	0	0.11	0	0.11	0
5555	0.00	898384576	0.00		0.00		0.00	0	0.00	6431870	0.00	0
11111	0.26	0	0.26		0.26	2919360	0.26	119832000	0.26	131293000	0.26	0
ISC: Weighted Avg / Area: Total	8%	12,747,291,758	3%	18,041,200	20%	32,817,493	32%	918,333,899	29%	1,036,483,573	29%	439,561,955
Difference to existing (ft2)		-437566		-62420		-5257		102941		-961		127496

Global Avg Imperviousness: Future	12%
Total area (ft2)	1.5E+10
Total (mi2)	544.926