# TECHNICAL MEMORANDUM:

# Analysis of PCCSYAs for Newland Sierra

Prepared For:

Fuscoe Engineering

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# TECHNICAL MEMORANDUM: ANALYSIS OF PCCSYAs FOR NEWLAND SIERRA

## 1. SUMMARY

The purpose of this Technical Memo is to demonstrate that the Newland Sierra Project generates a No Net Impact in the Critical Coarse Sediment Yield (CCSY) for 10 unnamed tributaries and sub-tributaries emanating from the large contributing area of the project. The tributaries and their corresponding POCs and receiving creeks are as follows: (a) five tributaries with 6 POCs (10, 13A + 13B, 16, 19, and 20) draining towards the east to the South Fork of Moosa Canyon Creek; (b) four tributaries with 5 POCs (21, 25A + 25B, 26 and 27) draining to Twin Oaks Valley Creek, and (c) one tributary with 3 POCs (29A + 29B + 29C) draining to the South Fork of Gopher Canyon Creek. The methodology explained in Appendix H (reference [1]) of the County of San Diego BMP Design Manual (updated by the Critical Coarse Sediment Technical Advisory Committee on March 2016, from which the City of San Diego, The County of San Diego, Technical Experts and representatives of the Water Quality Control Board were present, see Appendix 1) will be used to conclude that the Potential Critical Coarse Sediment Yield Areas (PCCSYAs) within the Newland Sierra Project are not significant and can be removed from Critical Designation, and their removal will not impact negatively the three receiving streams.

## 2. METHODOLOGY TO IDENTIFY CCSYAs

### 2.1 Identification of CCSYAs

The Watershed Management Area Analysis (WMAA) PCCSYA Map prepared by the County of San Diego (commonly known as the Rash Map where PCCSYA are depicted in red) is used in the memo to identify PCCSYA in the project. Figure 1, prepared by Fuscoe Engineering, displays the WMAA areas identified for the project (in light purple). Further refinement options will be applied to determine if the PCCSYA identified areas become CCSYAs or Non-CCSYAs.

### 2.2 First Preliminary Analysis: Allowable 5% Encroachment into WMAA Areas

Table 1 displays the PCCSYAs draining to each of the 14 POCs to be analyzed in this report. From the review of Table 1, it is clear than the drainage areas of the following nine POCs are encroaching 5% or less into the WMAA Map: POCs 10, 13A, 16, 21, 25B, 27, 29A, 29B and 29C. Therefore, those POCs can be removed from further consideration, as ***95% or more of the PCCSYAs contributing to these POCs are being preserved and/or by-passed downstream to the receiving POC***. The remaining five (5) POCs will require further analysis: POCs 13B, 19, 20, 25A and 26.

**Table 1.** Encroachment into WMAA Areas

| Basin | Total Area (acre) | PCCSYA (acre) | Impacted area (acre) | Percentage (%) |
|---|---|---|---|---|
| 10 | 439.82 | 162.42 | 8.10 | 5.0% |
| 13A | 35.99 | 12.72 | 0.50 | 3.9% |
| 13B | 82.26 | 40.45 | 11.99 | 29.6% |
| 16 | 27.75 | 16.05 | 0.80 | 5.0% |
| 19 | 70.63 | 20.48 | 15.66 | 76.5% |
| 20 | 10.62 | 0.01 | 0.01 | 100.0% |
| 21 | 29.74 | 3.67 | 0.13 | 3.5% |
| 25A | 391.37 | 142.14 | 23.18 | 16.3% |
| 25B | 170.53 | 62.38 | 0.86 | 1.4% |
| 26 | 142.12 | 11.59 | 6.49 | 56.0% |
| 27 | 45.16 | 11.00 | 0.53 | 4.8% |
| 29A | 54.63 | 7.88 | 0.16 | 2.0% |
| 29B | 16.30 | 8.37 | 0.32 | 3.8% |
| 29C | 40.28 | 25.72 | 1.29 | 5.0% |

### 2.3 Second Preliminary Analysis: De Minimis PCCSYAs

In accordance to Section H.3.3 of the BMP Manual, all areas that (a) are not significant contributors of bed sediment yield due to their small size and (b) are considered as not practicable to by-pass to the downstream water of the state, can be excluded from the analysis as those areas are below the minimum significant threshold of applicability of protection (i.e. are De Minimis PCCSYAs).

The PCCSYA from POC-20 is only 0.01 acre (25 times smaller than the De Minimis Area) and it appears to be a legacy area from a GIS Methodology applied at a macro-scale to determine PCCSYAs in the WMAA Map for the entire County of San Diego. Consequently, POC-20 is excluded from further analysis. The remaining 4 POCs will be analyzed in this report: POCs 13B, 19, 25A and 26.

### 2.4 Refinement Options

#### *2.4.1 Depositional Analysis*

If it can be demonstrated that the potential source of coarse sediment is deposited into the existing system prior to reaching the first downstream unlined water of the state, then PCCSYA can be removed from further considerations. Depositional systems may include natural sinks, existing structural BMPs, existing hardened MS4 systems or other existing similar features that produce a peak velocity from the discrete 2-year, 24 hour runoff event of less than 3 ft/s in the system being analyzed. It is clear for the location of the remaining PCCSYAs that a deposition of coarse sediments before reaching the first erodible upstream tributaries is not feasible, as the PCCSYA drain directly into the creek. Therefore, this refinement option is considered unnecessary for this project.

An additional consideration can be made in regards to POCs 13B and 19: there is sufficient slope to ensure transport of critical coarse sediment adjacent to the pipe discharge (on each branch upstream of POC 13B, and at the discharge of the pipe upstream of POC-19), but downstream of both POCs (and after the flow is piped underneath HWY 15) the potential for coarse sediment transport is reduced downstream. The reson for this is that] once the water reaches the South Fork Moosa Canyon Creek (alongside HWY 15) this creek eventually confluences with Moosa Canyon Creek (coming from Old Castle Road) to increase the contributing area of Moosa Canyon Creek, which then discharges into an artificial lake with recreational uses at the All Seasons R.V. Park, just north of the confluence of Gopher Canyon Road and Old Hwy 395, between Old Hwy 395 and HWY 15. This lake is approximately 800 ft long by 200 ft wide, and reduction of coarse sediment is beneficial for its recreational uses, as (a) removal of sediments extends the useful life of the lake and (b) coarse sediment cannot escape downstream as the coarse sediment will quickly settle in the lake. Therefore, any protection of the coarse sediment yield is irrelevant for the portion of the Moosa Canyon Creek downstream of the dam impounding the lake all the way to San Luis Rey River.

The argument related to the depositional analysis of the runoff from POCs 13B and 19 (and in extension to the runoff from POCs 10, 13A, and 20) will not be used by the project to re-assess PCCSYAs, because it could be argued that the little portion of the overall coarse sediment removed from those points could be necessary in the stream network from the tail of the lake upstream to the respective discharge points. However, this discussion is included in this study to add perspective of the relatively minor relevance of this coarse sediment geomorphic utility downstream, which in turn suggest (a) a less stringent view for the remaining POCs draining to Moosa Canyon Creek (13B and 19) and (b) another aspect to reduce even more the importance of the 0.01 acre of PCCSYAs draining to POC-20. In other words, from the remaining POCs to analyze, the relative importance of POCs 25A + 26 is higher than that of POCs 13B + 19, as the runoff from the former is not impounded about three miles downstream as the runoff from the later. Nevertheless, depositional analysis will not be used to exclude POCs 13B and 19 from further considerations.

### *2.4.2 Threshold Channel Analysis*

A threshold channel is a stream channel in which channel boundary material has no significant movement during the design flow. If there is no movement of bed load in the stream channel, then it is not anticipated that reductions in sediment supply will be detrimental to stream stability because the channel bed consists of the parent material and not coarse sediment supplied from upstream. In such a situation, changes in sediment supply are not considered a geomorphic condition of concern.

An approximate threshold channel analysis was performed for the remaining POCs: 13B, 19, 25A and 26. The following are the assumptions and results:

- Upstream and Downstream analyses extend identically as the downstream and upstream analyses prepared by Chang in two different reports (Hydromodification Screening for Newland Sierra, January 14, 2015 (reference [2]) which analyzed 6 POCs, and Hydromodification Screening for Newland Sierra, July 8, 2016 (reference [3]) which analyzed other 4 POCs; see maps in Appendix 2). Therefore, measurements, results, and/or assumptions made in both of Chang's studies will be useful for analyses in this report.
- For calculations of Specific Stream Power $Q_{10}$, slope S and channel width w are needed. S and w will be obtained from [2], [3], while $Q_{10}$ will be obtained following the methodology of the updated Appendix H (see Appendix 1 of this study).
- For $Q_{10}$ calculations, the post-development percentage of impervious area draining to the channel is needed to determine the Adjustment Factor AF from Figure H.7-2 (See Appendix 1). The following conservatively large and realistic values of impervious percentage are used per BMP: POC-13B: 30%; POC-19: 60%; POC-25A: 30% (later reviewed in the SWMM model to be 26.5%), and POC-26: 60%. Those values determine conservative values of AF per POC: POC-13B: AF=1.23; POC-19: AF=1.31; POC-25A: AF=1.23; POC-26: AF=1.31. Those AF values are used to ensure that the conclusions of the Threshold Channel Analysis are valid regardless of the impervious percentage (see Table 2).
- As a susceptibility analysis of the results as a function of AF, additional calculations where made with the largest possible value of AF per POC (see Table 2). Notice that AF changes little with high changes of AF, and therefore, the results remain the same even with 90% value of imperviousness on the portion developed on each POC (which determines 60%, 33%, 88%, 82% and 60% of imperviousness on POCs 13B reach 2, 13B reach 3, 19, 26 and 25A respectively).
- For the calculation of an overall $d_{50}$ value, the values obtained in 2015 Chang's study will be applied here for POC 25-A (see reference [2] and Table 2 for results).
- The different values of $d_{50}$ will be used in the equation of Figure H.7-1 to determine if the channel is a threshold channel or an alluvial channel, as the 10-year Specific Stream Power ω will be known at each POC. In other words, if $\omega > 16.7 \cdot d_{50}^{0.75}$ then the channel is a threshold channel and PCCSYAs become CCSYAs.
- For those instances where $d_{50}$ cannot be determined (POCs 13B, 19 and 26), a theoretical $d_{50}$ that satisfies the braided equilibrium condition will be obtained. The value of $d_{50}$ will be calculated according to $d_{50} = (\omega/16.7)^{4/3}$. This value will be compared to the corresponding equivalent value estimated indirectly by the author based on a Geotechnical Letter prepared by Leighton and Associates, Inc. (Appendix 2) dated 6/10/16, revised 10/5/16, where it is explained that the permissible shear stress will be in excess of 10 pounds, and therefore the equivalent $d_{50}$ should be at least 24" according to Fischenich.

Table 2 shows the results of the Threshold Channel Calculation based on information collected in [2] and [3], and methodology detailed in final version of Appendix H (see Appendix 1). From the result of the calculations, it is clear that POCs 13B, 19 and 26 drain to Threshold Channels (as the minimum $d_{50}$ required is much less than 610 mm) while POC 25A is located in an Alluvial Channel. Also, it is clear that the results show little sensitivity to AF.

**Table 2.** Threshold Channel Calculations: Results with average AF and Maximum AF.

| POC | Reach | Slope, S | Width, W (m) | Area, A ($mi^2$) | P, (in) | AF(1) | $Q_{10}$ (cfs)(2) | $Q_{10}$ ($m^3/s$) | SSP ($W/m^2$)(3) | $d_{50}$ (mm)(6) | ω-BE ($W/m^2$)(4) | ω-BE > SSP(5)? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **13B** | 2 | 0.1250 | 1.5 | 0.0446 | 14.6 | 1.23 | 11.8 | 0.33 | 272.9 | ***41.5*** | 272.9 | YES |
| **13B** | 3 | 0.3604 | 3.0 | 0.0213 | 14.6 | 1.23 | 6.2 | 0.18 | 206.8 | ***28.7*** | 206.8 | YES |
| **19** | 1 | 0.1047 | 1.2 | 0.1187 | 14.6 | 1.31 | 29.4 | 0.83 | 713.1 | ***149.2*** | 713.1 | YES |
| **26** | 4 | 0.0584 | 2.4 | 0.2376 | 14.6 | 1.31 | 53.8 | 1.52 | 363.7 | ***60.8*** | 363.7 | YES |
| **25A** | 3 | 0.0202 | 6.1 | 0.7626 | 14.6 | 1.23 | 139.4 | 3.95 | 128.2 | 11.0 | 100.9 | **NO** |
| **POC** | **Reach** | **Slope, S** | **Width, W (m)** | **Area, A ($mi^2$)** | **P, (in)** | **AF(1)** | **$Q_{10}$ (cfs)(2)** | **$Q_{10}$ ($m^3/s$)** | **SSP ($W/m^2$)(3)** | **$d_{50}$ (mm)(6)** | **ω-BE ($W/m^2$)(4)** | **ω-BE > SSP(5)?** |
| **13B** | 2 | 0.1250 | 1.5 | 0.0446 | 14.6 | 1.31 | 12.6 | 0.36 | 290.6 | ***45.1*** | 290.6 | YES |
| **13B** | 3 | 0.3604 | 3.0 | 0.0213 | 14.6 | 1.24 | 6.2 | 0.18 | 208.5 | ***29.0*** | 208.5 | YES |
| **19** | 1 | 0.1047 | 1.2 | 0.1187 | 14.6 | 1.36 | 30.5 | 0.86 | 740.3 | ***156.9*** | 740.3 | YES |
| **26** | 4 | 0.0584 | 2.4 | 0.2376 | 14.6 | 1.35 | 55.5 | 1.57 | 374.9 | ***63.3*** | 374.9 | YES |
| **25A** | 3 | 0.0202 | 6.1 | 0.7626 | 14.6 | 1.21 | 148.4 | 4.20 | 136.5 | 11.0 | 100.9 | **NO** |

(1): Adjustment Factor (AF) taken from Figure H.7-2 (See Appendix 1) with a conservative imperviousness approach for development conditions.
(2): Q (cfs) obtained with equation H.7-4 : $\mathbf{Q_{10} = AF \cdot 18.2 \cdot A^{0.87} \cdot P^{0.77}}$
(3): SSP (Specific Stream Power, Watt/$m^2$): Obtained with equation H.7-1 : $\mathbf{SSP = \Upsilon \cdot Q_{10} \cdot S/W}$ (International Units)
(4): ω-BE (Braided equilibrium Specific Power, Watt/$m^2$): Obtained with equation in Figure H.7-1 : $\mathbf{\omega\text{-}BE = 16.7 \cdot d_{50}^{0.75}}$ ($d_{50}$ = mm)
(5) : If ω-BE > SSP then ($d_{50}$ , SSP) plots below the braided equilibrium line in Figure H.7-1, and therefore the channel is a threshold channel (see **Appendix 1**).
(6) : Bold diameters are theoretical, and represent minimum diameter required to satisfy braided equilibrium. Equivalent diameter = 610 mm.

### 2.4.2.1 *Considerations about Threshold Channel, Geology and Shear Stress*

POC 13B, 19 and 26 provide a difficult challenge because a simple threshold channel method cannot be used as a $d_{50}$ representative of the channel conditions cannot be measured (the channels are not granular: they are a mix of outcrops of hard rock, boulders and entrenched vegetation). As a consequence, the author decided to refer to Appendix H definition: *"The key factor for determining whether a channel is a threshold channel is the composition of its bed material. Larger bed sediment consisting primarily of cobbles and boulders are typically immobile, unless the channel is a large river with sufficient discharge to regularly transport such grain sizes as bed load. As a rule-of-thumb, channels with bed material that can withstand a 10-year peak discharge without incipient motion are considered threshold channels and not live-bed alluvial channels. Threshold channel beds typically consist of cobbles, boulders, bedrock, or very dense vegetation (e.g., a thicket)".*

It is clear from the December 2016 Leighton and Associated, Inc. letter included in the appendices that the typical structure of a threshold channel is satisfied by the observations in the field as the channels are composed of thick vegetation, boulders and bedrock.

Also, in the same Threshold Channel section Appendix H states*:*

*"For a project to be exempt from coarse sediment supply requirements, the applicant must submit the following for approval by the County:*

*• Photographic documentation and grain size analysis used to determine the $d_{50}$ of the bed material; and*

*• Calculations that show that the receiving water of concern meets the specific stream power criteria defined below* ***or a finding from a geomorphologist*** *that the stream channel has existing grade control structures that protect the stream channel from hydromodification impacts".*

The first requirement is satisfied by (a) aerial photographic evidence now included in Appendix 2, (b) photographic records of a site visit performed on December 2016 also included, with the corresponding Exhibit indicating the location were the photos were taken and (c) determination of an equivalent $d_{50}$ as explained in section 2.4.2.2. The determination of $d_{50}$ on the opinion of the author of this study is irrelevant as the findings from a geomorphologist supersede a precise determination of $d_{50}$, because there is no explanation in Appendix H of how to relate $d_{50}$ with the findings from a geomorphologist (in other words, $d_{50}$ is only useful for the stream power criteria of the second bullet point above, but the existence of grade controls that protect the stream channel from hydromodification impacts as determined by a geomorphologist is unrelated with an specific value of $d_{50}$). Consequently, the discussion of $d_{50}$ will only serve to complete the submittal requirements as shown in page H-37 of Appendix H. It should be pointed out that the opinion of Leighton and Associates (also in the December 2016 Geology Letter located in Appendix 2) satisfies the requirement of "findings from a geomorphologist".

#### *2.4.2.2 <u>$d_{50}$ Equivalent and Jet Testing Discussion</u>*

According to the geology letter included in Appendix 2, the channel system for POC 13B, 19 and 26 is mainly composed of granite bedrock exposed, outcrops of very hard igneous rocks, and dense canopies of native brush, and there is a lack of observable sediment within the subject drainages that make impossible the determination of a $d_{50}$, simply because the channels are non-granular.

For non-granular channels, it has been clearly understood in the Technical literature that critical shear stress (the initial value of shear stress that starts erosion) is unrelated to the size of the soil particles. For example, in cohesive materials (channels in clayed soils) cohesion forces of electric nature are more important than gravitational forces associated with particle size. In vegetated channels, the root system of the plants keeps the soil in place and provides a resistance to erosion much larger than the equivalent resistance of the naked soil without vegetation. In channels excavated on rock, very high velocities are required to generate sufficient shear stress to break the rock surface in contact with the water and generate erosion. Appendix H recognizes this issue (page H-50) and the use of in-situ jet test, reference tables, or empirical relationships is suggested, without specifying what references can be valid and what references are not. However, 2 references are cited as valid: ASCE No. 77 (1992) and Fischenich (2001).

A brief discussion and criticism of in-situ jet test is included in this paragraph, as a response to a County comment: in-situ jet test is a test that requires heavy machinery, pumps, significant amount of water and calibrated instrumentation to be performed. Such equipment is unpractical in the field, especially to transport to channels were access on foot is extremely difficult and were water is not present to do the test. A cistern truck delivering water would be necessary in Southern California Climate, and such water delivery would cause additional problems and would be considered an illegal discharge (or would require a special permit). For this reason, the author of this study believes that in-situ jet test is a completely unpractical technicality impossible in Southern California except in very large creeks (see, among others, https://naldc.nal.usda.gov/download/10012/PDF).


Continuing with the non-granular channel discussion, from previous experience of the author of this study, and based upon studies approved in the region (even studies directly approved by the SDRWQCB, such as the River District in the City of San Marcos) the Fischenich Table has been used as a linkage between vegetated channels and a $d_{50}$ equivalent: the procedure consist on determine the critical shear stress for a given vegetation characteristics and knowing this value, calculate an equivalent $d_{50}$ which means the determination of what would be the $d_{50}$ size that will have the same shear stress resistance than a specified vegetated channel.

In regards to the vegetation encountered on the site visit, it was dense, stable and in many cases impassable, so a conservative value of the permissible shear stress should be between 1.7 to 2.5 lb/ft$^2$ (good quality long native grass to food quality hardwood tree planting), and an average value of 2.0 lb/ft$^2$ is assumed. Noticing that the relationship between $d_{50}$ (inches) and the critical shear stress $\tau_c$ (lb/ft$^2$) in the Fischenich table is $\tau_c = 0.422 \cdot d_{50}$ (or $d_{50} = 2.38 \cdot \tau_c$) we can conclude that $d_{50} \approx 4.8''$ for the vegetation portion. In regards to the hard rock portion, Fischenich Table does not display values of velocities or permissible shear stress for rock lined channels. The only reference the author is aware of is Table 8-4, Reference [6] (National Engineering Handbook, USDA 2007, Chapter 8, Threshold Channel Design) were velocities of 20 ft/s are suggested as maximum velocities for good rocks (igneous and hard metamorphic, as present on the field). This velocity will translate into a shear stress of about 12.5 lb/ft$^2$, which in turn would correspond to an approximate $d_{50} = 30''$ using the linear relationship described. Such large value of $d_{50}$ is not surprising, considering that the type of rock existing on site is the rock material used in quarry operations to produce rocks for rip-rap.

As summary $d_{50}$ = 4.8" (vegetation portion of the channels) and $d_{50}$ = 30" (hard rock portion of the channels). Those values denote the significant erosion resistance that the materials in the field have, and give additional credibility to the expert opinion of the Leighton letter in Appendix 2.

#### *2.4.2.3 Specific Stream Power (SSP) Criteria*

As a consequence of the updated sections 2.4.2.1 and 2.4.2.2, this section is no longer needed. However, calculations in Table 3 are included in light gray to avoid breaking the continuity of the table enumeration and avoid changing reference to comments. Please be aware that results displayed in Table 3 are irrelevant now to define channels as Threshold Channels.

**Table 3.** Detail Depth, Shear Stress, and SSP Calculations

Large "n" scenario

| POC | Reach | Slope | W (ft) | z:1 | $Q_{10,max}$ | h (ft) | n | $Q_M$ (cfs) | $R_H$ (ft) | $\tau$ (lb/ft$^2$) | v (ft/s) | A (sq-ft) | P (ft) | F | $\tau_B$ (lb/ft$^2$) | $v_B$ (ft/s) | SSP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13B | 2 | 0.1250 | 4.921 | 2 | 12.55 | 0.545 | 0.080 | 12.55 | 0.445 | 3.47 | 3.8 | 3.28 | 7.36 | 0.99 | 4.3 | 4.7 | 290.5 |
| 13B | 3 | 0.3604 | 9.843 | 2 | 6.25 | 0.178 | 0.080 | 6.25 | 0.171 | 3.85 | 3.4 | 1.82 | 10.64 | 1.46 | 4.0 | 3.6 | 208.4 |
| 19 | 1 | 0.1047 | 3.937 | 1.5 | 30.54 | 0.883 | 0.055 | 30.54 | 0.652 | 4.26 | 6.6 | 4.64 | 7.12 | 1.38 | 5.8 | 8.8 | 740.0 |
| 26 | 4 | 0.0584 | 7.874 | 2 | 55.46 | 0.999 | 0.055 | 55.46 | 0.799 | 2.91 | 5.6 | 9.86 | 12.34 | 1.09 | 3.6 | 7.0 | 374.7 |

Small "n" scenario

| POC | Reach | Slope | W (ft) | z:1 | $Q_{10,max}$ | h (ft) | n | $Q_M$ (cfs) | $R_H$ (ft) | $\tau$ (lb/ft$^2$) | v (ft/s) | A (sq-ft) | P (ft) | F | $\tau_B$ (lb/ft$^2$) | $v_B$ (ft/s) | SSP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13B | 2 | 0.1250 | 4.921 | 2 | 12.555 | 0.416 | 0.050 | 12.55 | 0.353 | 2.75 | 5.2 | 2.39 | 6.78 | 1.53 | 3.2 | 6.1 | 290.5 |
| 13B | 3 | 0.3604 | 9.843 | 2 | 6.248 | 0.135 | 0.050 | 6.25 | 0.130 | 2.93 | 4.6 | 1.36 | 10.44 | 2.23 | 3.0 | 4.7 | 208.4 |
| 19 | 1 | 0.1047 | 3.937 | 1.5 | 30.545 | 0.684 | 0.035 | 30.54 | 0.530 | 3.46 | 9.0 | 3.39 | 6.40 | 2.11 | 4.5 | 11.3 | 740.0 |
| 26 | 4 | 0.0584 | 7.874 | 2 | 55.455 | 0.772 | 0.035 | 55.45 | 0.642 | 2.34 | 7.6 | 7.27 | 11.32 | 1.65 | 2.8 | 9.1 | 374.7 |

Critical Flow Scenario (F = 1)

| POC | Reach | Slope | W (ft) | z:1 | $Q_{10,max}$ | h (ft) | T (ft) | $Q^2/g-A^3/T$ | $R_H$ (ft) | $\tau$ (lb/ft$^2$) | v (ft/s) | A (sq-ft) | P (ft) | F | $\tau_B$ (lb/ft$^2$) | $v_B$ (ft/s) | SSP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13B | 2 | 0.1250 | 4.921 | 2 | 12.55 | 0.543 | 7.09 | 0.00 | 0.444 | 3.46 | 3.8 | 3.26 | 7.35 | 1.000 | 4.2 | 4.7 | 290.5 |
| 13B | 3 | 0.3604 | 9.843 | 2 | 6.25 | 0.228 | 10.76 | 0.00 | 0.217 | 4.87 | 2.7 | 2.35 | 10.86 | 1.000 | 5.1 | 2.8 | 208.4 |
| 19 | 1 | 0.1047 | 3.937 | 1.5 | 30.54 | 1.068 | 7.14 | 0.00 | 0.760 | 4.96 | 5.2 | 5.91 | 7.79 | 1.000 | 7.0 | 7.3 | 740.0 |
| 26 | 4 | 0.0584 | 7.874 | 2 | 55.46 | 1.051 | 12.08 | 0.00 | 0.834 | 3.04 | 5.3 | 10.49 | 12.58 | 1.000 | 3.8 | 6.7 | 374.7 |

#### *2.4.2.4 Conclusions of Threshold Channel Analysis*

As a conclusion of this section, the reaches on POC 13B, 19 and 26 are Threshold Channels, under different approaches analyzed. Threshold channel analysis eliminates the contributing area of 3 POCs as PCCSYAs and transforms those areas in Non-CCSYAs: 13B, 19 and 26. Only the contributing area of POC 25A is not eliminated from further analysis.

#### *2.4.3 Coarse Sediment Source Area Verification*

A sieve analysis has not been performed for the remaining area POC-25A. Therefore, this optional analysis is not included. In other words, potential exclusion of POC-25A contingent upon the results of the Sieve Analysis is not considered necessary as simple inspection of the soils in the area denote a relatively significant presence of coarse sediments.

#### *2.4.4 Verification of Geomorphic Landscape Units (GLUs)*

GLU analysis was performed for the contributing area of POC 25A and a verification of the slope, land use and geology of the area confirms that GLU analysis will not remove PCCSYA areas. Therefore, all PCCSYAs draining to POC 25-A are in fact CCSYAs, and a no net impact demonstration is needed for this portion of the project.

### 2.5. Conclusion of the Refinement Options

After a refinement analysis a PCCSYA has two options: it is either a Critical Coarse Sediment Yield Area (CCSYA) or it becomes a Non Critical Coarse Sediment Yield Area (Non-CCSYA). Only one of the refinement options needs to produce a positive result for PCCSYA to become a Non-CCSYA. If no positive result occurs, then PCCSYA becomes CCSYA. As at least one refinement option shown in Table 3 produces a positive result for all POCs except 25A, then all areas of Figure 1 are considered Non-CCSYA (except for POC-25A) and no protection of those Non-CCSYAs (avoidance or no net impact demonstration) is required. Further analysis is required only for CCSYAs draining to POC-25A.

**Table 4.** Refinement Options Results

| Basin | Is PCCSYA a CCSYA or a Non-CCSYA? | Refinement Option used | Basin | Is PCCSYA a CCSYA or a Non-CCSYA? | Refinement Option used |
|---|---|---|---|---|---|
| 10 | Non-CCSYA | <5% encroachment | 25A | CCSYA | **None. No Net Impact needed.** |
| 13A | Non-CCSYA | <5% encroachment | 25B | Non-CCSYA | <5% encroachment |
| 13B | Non-CCSYA | Threshold channel | 26 | Non-CCSYA | Threshold channel |
| 16 | Non-CCSYA | <5% encroachment | 27 | Non-CCSYA | <5% encroachment |
| 19 | Non-CCSYA | Threshold channel | 29A | Non-CCSYA | <5% encroachment |
| 20 | Non-CCSYA | De Minimis | 29B | Non-CCSYA | <5% encroachment |
| 21 | Non-CCSYA | <5% encroachment | 29C | Non-CCSYA | <5% encroachment |

Note: All basins encroaching < 5% do contain CCSYAs that are effectively identified, avoided and by-passed if they are upstream, or simply identified and avoided if they are downstream of the proposed development.

## 3. AVOIDANCE AND BYPASS

The project cannot avoid the totality of the CCSYAs included within the boundary of POC-25A as many of those areas are located in places planned for development. Therefore, Avoidance and By-Pass will be used to the maximum extent practicable to protect as many as possible CCSYAs draining to POC-25A: as a matter of fact, all undisturbed natural areas (including CCSYAs embedded into them) will by-pass downstream basins, per section H.3.11 of the BMP Manual. As by-pass by itself is insufficient, please refer to the No Net Impact Section where it is demonstrated that enough protection/flow control is achieved to conclude that No Net Impact occurs at POC-25A. Finally, it must be noticed that avoidance and by-pass is also included in POCs where PCCSYAs < 5%: 13A, 16, 21, 25B, 27, 29A, 29B and 29C. Basically the remaining 95%+ of PCCSYAs are downstream and protected or in few cases, a portion of the PCCSYAs is upstream and by-passed to the POC.

### 3.1 General Hydraulic Considerations of By-Pass Velocities

Let the San Diego Standard Type A drainage ditch be used to by-pass natural flows. This is a concrete triangular channel, with lateral slope 1.25:1, n = 0.013, and geometry defined according to the following equations: flow area A = 1.25·$h^2$, wetted perimeter P = 3.2016·h and hydraulic radius R = 0.3904·h, with h being the depth of the flow. Let a velocity v of 3 ft/s be defined as the minimum acceptable velocity for a 2 year peak flow $Q_2$. The use of the Manning's equation establishes:

$$v = \frac{1.486}{n}\sqrt{s}\cdot R^{2/3};\;\; hence\;\; 3 = \frac{1.486}{0.013}\sqrt{s}(0.3904\cdot h)^{2/3}\; equivalent\; to:\;\; h = \frac{0.01089}{s^{3/4}}$$

Similarly, using Manning's equation for peak flow $Q_2$ :

$$Q_2 = \frac{1.486\sqrt{s}\cdot 0.3904^{2/3}\cdot 1.25\cdot h^{8/3}}{n}\;; then\; Q_2 = \frac{1.486\sqrt{s}\cdot 0.3904^{2/3}\cdot 1.25\cdot 0.01089^{8/3}}{0.013\cdot s^2}\; which\; is\; s = \frac{0.00583}{{Q_2}^{2/3}}$$

The design equation to guarantee a minimum of 3 ft/s velocity, under Type A concrete brow-ditch is:

**$s \geq \frac{0.00583}{Q_2^{2/3}}$ for $Q_2$ > 0.15 cfs, and s ≥ 2% for $Q_2$ < 0.15 cfs (3.1)**

At this point the precise peak flows draining to the ditches have not being established because the precise design of the ditches will occur in final engineering. The project will guarantee compliance with equation (3.1) or compliance with Table in section H.3.1 for those cases where an 18" pipe is used as a by-pass conveyance system.

## 4. DEMONSTRATE NO NET IMPACT

The purpose of Chapter 4 of this study is to demonstrate that the portion of the Newland Sierra Project draining to POC-25A will generate No Net Impact in the Critical Sediment Yield to the aforementioned POC. No net impact will be achieved by equilibrating two different components: (a) the discharges of the sediment producing areas will be diverted as recommended in this analysis to adjust the Sediment Production $S_P$ as close as possible to the original conditions and (b) the discharges of the developed areas will be adjusted by designing BMPs such that the work exercised by the discharged flows (the Erosion Potential $E_P$) is as close as possible to the pre-development work. By working simultaneously on those to factors ($S_P$ and $E_P$), the project will achieve compliance as any reduction in the dimensionless Sediment Production Coefficient $S_P$ will be compensated by similar reduction in the Erosion Potential Coefficient $E_P$ so that no overall net impact downstream is achieved ($S_P/E_P < 1.1$).

### 4.1 Verification of Geomorphic Landscape Units (GLUs)

As an initial step, GLU areas will be mapped to determine the original critical coarse sediment yield of the CCSYAs draining to POC-25A. Appendix 3 shows the GIS results of the property combined with a Geology Map. It is clear from this analysis that (a) there are 2 geologic types occurring in the analyzed Area per the simplified classification of Section H.6.1 of Appendix H (Coarse Bedrock CB and Coarse Sedimentary Permeable CPS) of which CB is the dominant geology; (b) the land use of the analyzed area (associated mainly with existing vegetation) can be of 3 types: Scrubs and Shrubs, Forest and Agricultural + grasses, per order of importance; and (c) the influence of the slope is different depending on the geology and land use. Therefore, a slope analysis is needed to determine the amount of area of those categories.

A slope analysis is also included in Appendix 3 (for both pre-development and post-development conditions). The result of the slope analysis combined with the geology and the land use, determines 10 types of area producing Critical Coarse Sediment in Pre-development conditions, and only 4 types of area producing Critical Coarse Sediment (as the other 6 types are covered by developed lands). Area Types and magnitude can be seen in Table 4.

Cut and fill sloped areas are also analyzed (see corresponding graphic in Appendix 3), as those are the only developed areas allowed to be included in sediment production calculations of post-development conditions as long as they do not drain to any BMPs and do not include impervious areas. There will be 4 types of slope areas considered: cut and fill slopes in CB geology, and cut and fill slopes in CSP geology. Land-use of the cut and fill slopes is assumed to be a combination of grasses-forest land-use as a landscape land use is not included in section H.6.1 of Appendix H. It should be pointed out that the land use of the slopes cannot be considered developed, as per the Regional WMAA Attachment provided by the County of San Diego (and included in Appendix 1) developed land use is assumed a sediment production of 0 (which defeats the purpose of including slopes in the analysis of sediment-producing areas in post-development condition). Consequently an average land use of grass-forest was considered as representative of the potential sediment production of the landscape that will be occurring in many of the cut and fill slopes.

**Table 5.** GLU Units, Pre and Post-Development (with Corresponding Areas)

| GLU: Pre-Development | Area (ac) | GLU: Post-Dev., Preserved | Area (ac) |
|---|---|---|---|
| CB-Agri/Grass-3 | 0.11 | CB-Agri/Grass-3 | 0.11 |
| CB-Agri/Grass-4 | 0.13 | CB-Agri/Grass-4 | 0.13 |
| CB-Forest-2 | 3.08 | CB-Forest-2 | 0.73 |
| CB-Forest-3 | 0.04 | CB-Scrub/Shrub-4 | 142.87 |
| CB-Forest-4 | 0.18 | **GLU: Post-Dev., Slopes** | **Area (ac)** |
| CB-Scrub/Shrub-4 | 184.87 | CB- Cut slope (P=0.5) | 22.70 |
| CSP-Agri/Grass-4 | 0.01 | CB- Fill slope (P=0.25) | 13.47 |
| CSP-Forest-3 | 0.04 | CSP- Cut slope (P=0.5) | 0.00 |
| CSP-Forest-4 | 0.24 | CSP- Fill slope (P=0.25) | 0.67 |
| CSP-Scrub/Shrub-4 | 0.47 | | |

## 4.2 $S_P$ Calculation

For the determination of $S_P$ (Sediment Supply Potential) the sediment yield in pre and post-development conditions is needed. The following procedure was followed (please see $S_P$ detailed calculations in Appendix 4):

- In both pre and post-development conditions, the areas at each slope range (determined with the slope analysis) were obtained. This area was multiplied by the sediment yield depending on the slope, according to the information provided by the County included in Appendix 3 (Table A.4.2 from the Regional WMAA Analysis, reference [4])
- Only sediment yield from critical areas was considered (those areas classified in Table 4). Therefore, the total area considered is smaller than the total area contributing to POC-25A.
- The sediment yield from natural areas has been reduced from 1852 ton/yr to 1410 ton/yr.
- In post-development conditions, additional coarse sediment producing areas were considered from the slopes of the development. Sediment yield factors were corrected from Table A.4.2 to account for a change in P factor (P is a support practice factor, assumed 0.5 for fill slopes and 0.25 for cut slopes, per Appendix H; it can also be seen as a safety factor).
- The sediment yield of the post-development slopes is 201 ton/yr; therefore, the total post-development sediment yield based on RUSLE is 1611 ton/yr. As a consequence, $SY_{RUSLE}$ can be determined as $SY_{RUSLE}$ = 1611/1852 = 0.826.
- Sediment yield also must include channel analysis. Per the NHDPlus Channel Map included in Appendix 3, it has been estimated that approximately 6,800 ft of NHDPlus channels exists in pre-

development conditions, and those will become only about 1,400 ft of NHDPlus channels in post-development conditions. Consequently, $SY_{NHD} = 0.206$.

- Following the recommendations of Appendix H, a weighed factor of 0.3 is applied to waters that are part of the NHDPlus data set and 0.7 for the RUSLE data. Consequently, the following equation is used: $S_P = 0.7 \cdot SY_{RUSLE} + 0.3 \cdot SY_{NHD}$ .
- Finally, the overall $S_P$ is 0.671 (See Appendix 4).

### 4.3 $E_P$ and $E_P/S_P$ Calculation

To calculate $E_P$, REC follows the procedure explained in Appendix H, Section H.8.1.2, Standard $E_P$ Method. The following is the procedure used here:

- Scaling factors are not necessary in this study, as the area of the watershed and the area of the portion of the project being analyzed are the same (in other words, 100% of the area draining to POC-25A is included as part of the project area).
- Hydraulic analysis follows a combination of Manning's equation and shear stress calculation, starting with the given peak flow Q, and the geometry of the channel per Chang's study (bottom width 3 ft, lateral slope z is 2.125:1, slope S is 0.0202, and Manning's coefficient assumed as 0.035)
- The sequence of the hydraulic calculation is as follows: a given Q (cfs) and a given geometry determine a given depth of flow h (Ft) per Manning's equation (1); the geometry of the channel determines an area A ($ft^2$) per (2), a hydraulic radius R (ft) per (3), an average velocity V (ft/s) per (4), a shear stress $\tau$ ($lb/ft^2$) per (5) and a dimensionless work W per (6). Results are displayed in Appendix 5.

$$Q = \frac{1.486\sqrt{s}}{n}\frac{(B \cdot h + z \cdot h^2)^{5/3}}{\left(B + 2h\sqrt{1+z^2}\right)^{2/3}} \qquad (1)$$

$$A = B \cdot h + z \cdot h^2 \qquad (2)$$

$$R = \frac{A}{B + 2h\sqrt{1+z^2}} \qquad (3)$$

$$V = {Q}/{A} \qquad (4)$$

$$\tau = \gamma \cdot R \cdot S \qquad (5)$$

$$W = V \cdot \sqrt{(\tau - \tau_c)^3} \qquad (6)$$

- The results of a continuous simulation model prepared for POC-25A using SWMM (see reference [5], prepared by REC) are used here in the calculations displayed in Appendix 5: the 2-year peak flow $Q_2$ (obtained with SWMM) is used to define the lower threshold as 50% of $Q_2$ because the receiving channel has low susceptibility per Chang's study.
- All flows larger than 50% of $Q_2$ in the continuous simulation (with one-hour duration) are gathered from the continuous simulation results both in pre-development and post-

development conditions. This option was preferred over working with bins because the amount of peaks was not very large and the precision of doing the calculations with the exact values instead of using the average values for each bin is worth the extra effort. There are 243 peaks to be analyzed in pre-development conditions and 199 in post-development conditions, which correspond with almost the same amount of calculations than if 100 bins per the SWMM results are used (see Appendix 5).

- According to the results of Appendix 5, the summation of the dimensionless work factors (that defines the total dimensionless work variables $\Sigma W_{PRE}$ and $\Sigma W_{POST}$ in pre-development and post-development conditions is used to obtain $E_P = \Sigma W_{POST} / \Sigma W_{PRE} = 183.82/268.23 = 0.685$.
- From the previous section, $S_P = 0.671$. Therefore, **$E_P/S_P = 1.022 < 1.1$**
- No net impact is achieved by proving that $E_P/S_P < 1.1$, according to Appendix H. Notice that the results of reference [5] demonstrate flow control beyond the minimum necessary by hydromodification considerations alone (demonstrated by the separation of the pre and post development Flow Duration Curves FDCs) so that $E_P$ could be reduced to levels compatible with No Net Impact conditions.

#### *4.3.1 Calculation of Critical Shear Stress ($\tau_C$ for Q = 50% of $Q_2$)*

As an example of shear stress calculation, the critical shear stress is calculated as follows:

- 50% of $Q_2$ is assigned as the flow that produces critical shear stress. Therefore, $Q = 0.5 \cdot 162.84 = 81.42$ cfs
- From Chang (2015), bottom width W = 3 ft, lateral slope assuming symmetrical trapezoidal section is z =2.125, longitudinal channel slope is 0.0202, and Manning's coefficient is assumed equal to 0.035. The application of the Manning's equation determines a depth of 1.841 ft.
- The hydraulic radius R is determined with the area and wetted perimeter per equations (2), (3), and (4). R = 1.092 ft (at the flow that produces critical depth)
- The critical shear stress results from equation (5) as $\tau_C = 1.377$ lb/ft$^2$.

A similar procedure is used for all flows to determine the shear stress τ as a function of the peak flow Q, so that the work W can be calculated for each flow using equation (6).

### 4.4 Conclusion of Section 4.

This study has demonstrated that the proposed HMP BMPs provided for the portion of Newland Sierra draining to POC-25A in addition to the protection of the remaining natural area and the diversion of the runoff from the slope areas shown in Appendix 3 are sufficient to meet the No Net Impact Criteria defined as $E_P/S_P \leq 1.1$.

## 5 CONCLUSIONS OF THE STUDY

The Newland Sierra project avoids any impact into CCSYAs with the following measures: (a) by encroaching into less than 5% of the WMAA Areas draining into 9 POCs (POCs 10, 13A, 16, 21, 26, 27, 29A, 29B, 29C) and by-passing and protecting the remaining WMAA areas in those POCs; (b) by removing a PCCSYA 25 times smaller than the De Minimis Area (POC-20), (c) by proving that the sediment would be discharging into Threshold Channels that do not need such sediment (POCs 13B, 19 and 25B); and (d) by demonstrating No Net Impact via Continuous Simulation and $E_P/S_P$ analysis in the remaining POC (POC-25A).

## 6 LIST OF APPENDICES

Appendix 1:

- Relevant Information from Appendix H
- Relevant Information from Regional WMAA CCSYA Quantitative Analysis

Appendix 2:

- Relevant Maps of Hydromodification Screening Reports (References [2] and [3])
- General Satellite Exhibit with Location of Site-Visit Photos of Contributing Areas to POCs 13B, 19 and 26; Dec. 2016)
- Photographic Records of December 2016 Site Visit
- Aerial Photography of the Location of POC-19, POC-13B and POC-26
- New Updated Letter by Geologist (Leighton and Associates Inc. Dated 12/15/16 that Supersedes previous Geology Letter Dated 6/10/16 and Revised 10/5/16)

Appendix 3:

- Pre and Post-Development Slope Analysis Maps (Fuscoe, August 2016)
- Pre and Post-Development GLU Areas (Fuscoe, October 2016)
- Fill and Cut Slope Map (Fuscoe, October 2016)
- NHD-Plus Channel Map (Fuscoe, October 2016)
- New Avoidance/Bypass Exhibits, (Fuscoe, December 2016)

Appendix 4: $S_P$ Calculations.

Appendix 5: $E_P$ Calculations. Summary of Results.

Appendix 6:

- Response to Comments, First Round
- Response of Comments Identified on 10/21/2016, Second Round

# 7 REFERENCES


[1] County of San Diego BMP Design Manual. Appendices. February 2016 – Appendix H.

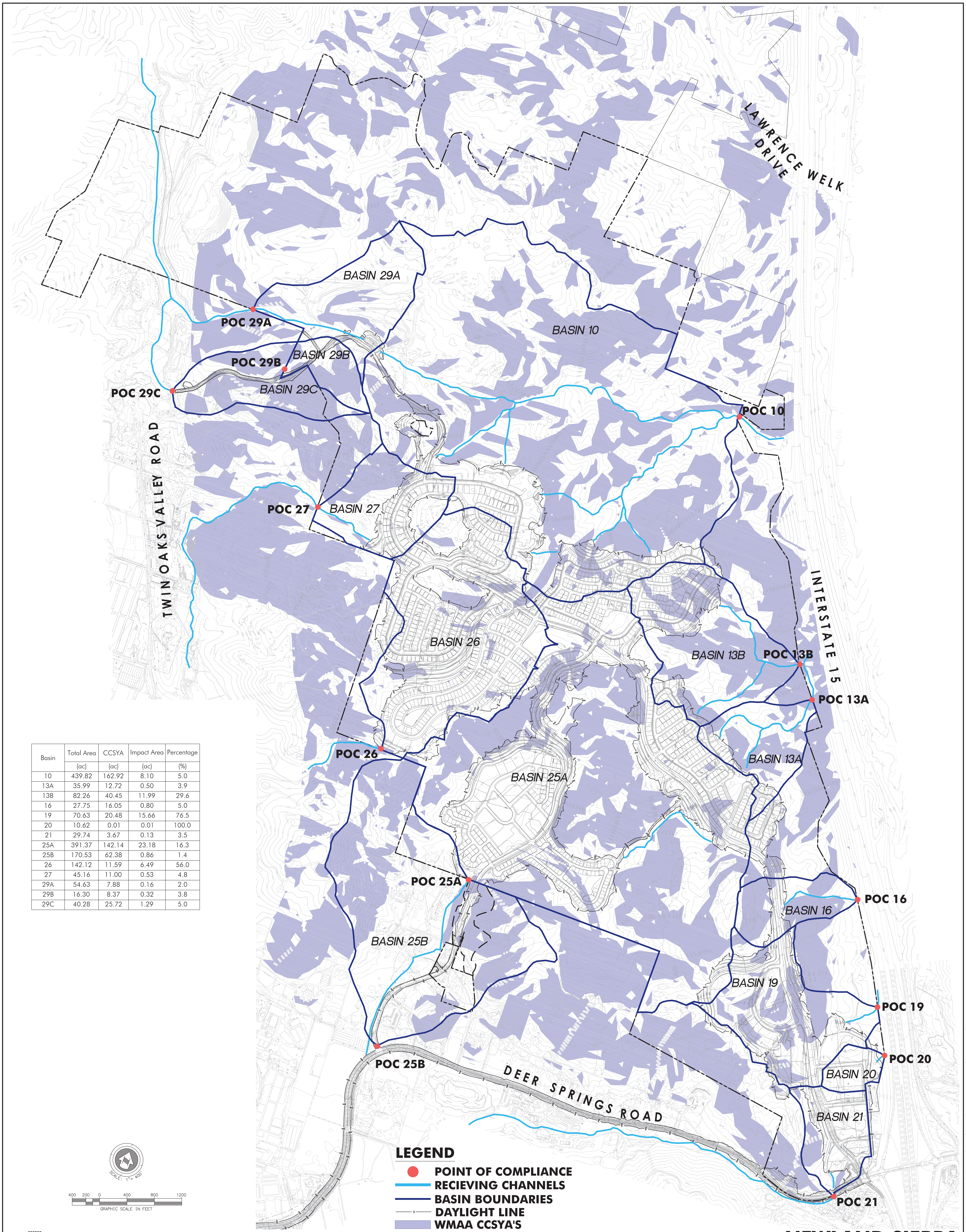
[2] Chang Consultants: "Hydromodification Screening for Newland Sierra", January 14, 2015

[3] Chang Consultants: "Hydromodification Screening for Newland Sierra", July 8, 2016

[4] Regional WMAA Excerpt of CCSYA Quantitative Analysis. Provided by San Diego County.

[5] REC Consultants: "Technical Memorandum: SWMM Modeling for Hydromodification Compliance of Newland Sierra", August 18, 2016

[6] Part 654 Stream Restoration Design, National Engineering Handbook (USDA 2007). Chapter 8, Threshold Channel Design.




| Basin | Total Area | CCSYA | Impact Area | Percentage |
|---|---|---|---|---|
| | (ac) | (ac) | (ac) | (%) |
| 10 | 439.82 | 162.92 | 8.10 | 5.0 |
| 13A | 35.99 | 12.72 | 0.50 | 3.9 |
| 13B | 82.26 | 40.45 | 11.99 | 29.6 |
| 16 | 27.75 | 16.05 | 0.80 | 5.0 |
| 19 | 70.63 | 20.48 | 15.66 | 76.5 |
| 20 | 10.62 | 0.01 | 0.01 | 100.0 |
| 21 | 29.74 | 3.67 | 0.13 | 3.5 |
| 25A | 391.37 | 142.14 | 23.18 | 16.3 |
| 25B | 170.53 | 62.38 | 0.86 | 1.4 |
| 26 | 142.12 | 11.59 | 6.49 | 56.0 |
| 27 | 45.16 | 11.00 | 0.53 | 4.8 |
| 29A | 54.63 | 7.88 | 0.16 | 2.0 |
| 29B | 16.30 | 8.37 | 0.32 | 3.8 |
| 29C | 40.28 | 25.72 | 1.29 | 5.0 |

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Figure 1

**NEWLAND SIERRA**
**CRITICAL COARSE SEDIMENT YIELD IMPACT EXHIBIT**
**JULY 2016**

Appendix 1:

- Relevant Information from Appendix H
- Relevant Information from Regional WMAA CCSYA Quantitative Analysis

# Appendix H

# Guidance for Investigating Potential Critical Coarse Sediment Yield Areas

February 26, 2016

# H.3 Step 3: Bypass Onsite and Upstream CCSYAs

Another key element of preserving the stability of receiving waters is to maintain current bed sediment supply characteristics through effective bypass of onsite and upstream sediment sources. Upstream bed sediment sources may include overland flow from CCSYAs and/or concentrated channel flows. Applicants must ensure both onsite and upstream sources of bed sediment are effectively bypassed through their project. If onsite and/or upstream CCSYAs are not effectively bypassed per the criteria below, applicant must demonstrate no net impact to the receiving water per the guidance presented in Appendix H.4.

## H.3.1 Bypass CCSYAs from Hillslopes

Both onsite and upstream hillslopes mapped as CCSYAs must be effectively bypassed through and/or around the proposed project site.

- Proposed hardened drainage systems (e.g. storm drains, drainage ditches) that convey the bed sediment from the hillslopes to the downstream waters of the state should maintain a peak velocity from the discrete 2-year, 24-hour runoff event greater than three feet per second.
    - When drainage ditches are proposed for bypass, this velocity may be achieved by designing to the minimum dimensions listed in the San Diego Regional Standard drawing D-75.
    - When an 18" concrete storm drain is proposed for bypass, this velocity may typically be achieved by maintaining a storm drain slope of ≥0.5%. In instances where 2 year, 24-hour peak flow rates associated with the storm drain are less than 1.1 cfs, applicants may refer to the table below for minimum slopes needed to maintain three feet per second. Applicants may interpolate the values from the table below, or may elect to perform more detailed cleansing velocity calculations presented in Appendix H.7.1.

| 2-Year, 24-Hour Peak Flow (cfs) | Minimum Slope for 18" Concrete Storm Drain |
|---|---|
| <0.25 | n/a, this PCCSYA is considered de-minimis |
| 0.25 | 2.0% |
| 0.50 | 1.0% |
| 1.10 | 0.5% |

- Storm water runoff that contains the bed sediment from CCSYAs must not be routed through detention basins or other facilities with restricted outlets that will trap sediment. Bypass systems shall be designed as necessary so that the bed material is conveyed to the downstream receiving water. Structural BMPs (including most flow-thru BMPs) are likely to trap sediment.
- For scenarios where a BMP must be constructed to treat offsite drainage area and there are CCSYAs outside of the project footprint, it may be feasible to achieve mitigation by construction of an outlet structure that can convey the bed load to the downstream receiving water and clear water through a bypass structure to a BMP.
- Proposed crossings (culverts, driveways, etc.) should not impede the transport of upstream critical coarse sediment. Crossings should be designed to avoid headwater conditions that would result in the trapping/settling of sediment.

### H.3.2 Bypass CCSYAs from Channels

Projects that effectively avoid and bypass CCSYAs mapped in Step 1 of this guidance are not required to take specific action to ensure bypass of channel flows. This guidance does not set forth channel bypass criteria for this scenario because it recognizes that existing regulator mechanisms (such as 401 certifications, site design requirements, etc) are generally sufficient to preserve the sediment transport functions of onsite channels.

However, projects that do not effectively avoid and bypass the CCSYAs mapped in Step 1, will be required to specifically account for bypass of channel flows as part of the demonstration of no net impact outlined in Appendix H.4.

### H.3.3 De Minimis Upstream CCSYA

Applicants have an option to exclude de minimis upstream CCSYAs. De minimis upstream CCSYAs consist of coarse hillslope areas that are not significant contributors of bed sediment yield due to their small size, and are considered by the owner and County as not practicable to bypass to the downstream waters of the state. In limited scenarios where all of the criteria below are satisfied, de minimis upstream CCSYAs may be omitted from consideration.

- De minimis upstream CCSYA is not disturbed through the proposed project activities.
- De minimis upstream CCSYA is not part of an upstream drainage contributing more than 0.31 total acres to the project site.
- Multiple de minimis upstream CCSYAs cannot be adjacent to each other and hydraulically connected.
- The SWQMP must document the reason why each de minimis upstream CCSYA could not be bypassed to the downstream waters of the state.

The 0.31-acre (13,500 square feet) de minimis threshold was established using 0.25 cfs as the cut off peak flow for the 2-year, 24-hour event, rational method equation and the following assumptions:

- C = 0.225 (average runoff coefficient (C) for soil type A and B);
- Average 6-hour, 2-year storm depth = 1.5 inches;
- Time of concentration = 6 minutes; and
- 2-year peak intensity = 3.51 in/hr. (based on procedures from the County Hydrology Manual).

The strategies for sediment bypass do not mitigate for the reduction of CCSYA that have been replaced by development onsite but can only mitigate scenarios where development hinders movement of bed sediment through the project footprint. When preservation of existing channels and/or implementation of sediment bypass measures is not feasible and/or not implemented, the applicant must demonstrate no net impact to the receiving water via the guidance presented in Appendix H.4.

### H.6.1 Site-Specific GLU Analysis

In order to perform a site-specific GLU analysis the applicant must first delineate the project boundary and any areas draining through the project boundary. The applicant must then determine appropriate slopes, geology, and land cover categories for this area as identified below.

There are four slope categories in the GLU analysis. Category numbers shown (1 to 4) were assigned for the purpose of GIS processing.

- 0% to 10% (1)
- 10% to 20% (2)
- 20% to 40% (3)
- >40% (4)

There are seven geology categories in the GLU analysis:

- Coarse bedrock (CB)
- Coarse sedimentary impermeable (CSI)
- Coarse sedimentary permeable (CSP)
- Fine bedrock (FB)
- Fine sedimentary impermeable (FSI)
- Fine sedimentary permeable (FSP)
- Other (O)

There are six land cover categories in the GLU analysis:

- Agriculture/grass
- Forest
- Developed
- Scrub/shrub
- Other
- Unknown

Project site slopes shall be classified into the categories based on project-level topography. Project site geology may be determined from geologic maps (may be the same as regional-level information) or classified in the field by a qualified geologist. Table H.6-1 provides information to classify geologic map units into each geology category. Project site land cover shall be determined from

| Map Unit | Map Name | Anticipated Grain size of Weathered Material | Bedrock or Sedimentary | Impermeable / Permeable | Geology Grouping |
|---|---|---|---|---|---|
| | Oceanside 30' x 60' | | | | |
| **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 |
| **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 |

| Map Unit | Map Name | Anticipated Grain size of Weathered Material | Bedrock or Sedimentary | Impermeable / Permeable | Geology Grouping |
|---|---|---|---|---|---|
| **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 |
| **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 & | Fine | Sedimentary | Impermeable | FSI |

| Map Unit | Map Name | Anticipated Grain size of Weathered Material | Bedrock or Sedimentary | Impermeable / Permeable | Geology Grouping |
|---|---|---|---|---|---|
| | Oceanside 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 |

**TableH.6-2: Land Cover Grouping for SanGIS Ecology-Vegetation Data Set**

| 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 |
| **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 |

| Id | SanGIS Legend | SanGIS Grouping | Land Cover Grouping |
|---|---|---|---|
| **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/Develpped | | 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 |
| **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 |

| Id | SanGIS Legend | SanGIS Grouping | Land Cover Grouping |
|---|---|---|---|
| 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 |
| 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 |

| Id | SanGIS Legend | SanGIS Grouping | Land Cover Grouping |
|---|---|---|---|
| 94 | 13131 Subtidal | | Other |
| 95 | 13133 Brackishwater | | Other |
| 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 |
| 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 |

| Id | SanGIS Legend | SanGIS Grouping | Land Cover Grouping |
|---|---|---|---|
| 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 |
| 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 H.6-3: Potential Critical Coarse Sediment Yield Areas**

| GLU | Geology | Land Cover | Slope (%) |
|---|---|---|---|
| **CB-Agricultural/Grass-3** | Coarse Bedrock | Agricultural/Grass | 20% - 40% |
| **CB-Agricultural/Grass-4** | Coarse Bedrock | Agricultural/Grass | >40% |
| **CB-Forest-2** | Coarse Bedrock | Forest | 10 – 20% |
| **CB-Forest-3** | Coarse Bedrock | Forest | 20% - 40% |
| **CB-Forest-4** | Coarse Bedrock | Forest | >40% |
| **CB-Scrub/Shrub-4** | Coarse Bedrock | Scrub/Shrub | >40% |
| **CB-Unknown-4** | Coarse Bedrock | Unknown | >40% |
| **CSI-Agricultural/Grass-2** | Coarse Sedimentary Impermeable | Agricultural/Grass | 10 – 20% |
| **CSI-Agricultural/Grass-3** | Coarse Sedimentary Impermeable | Agricultural/Grass | 20% - 40% |
| **CSI-Agricultural/Grass-4** | Coarse Sedimentary Impermeable | Agricultural/Grass | >40% |
| **CSP-Agricultural/Grass-4** | Coarse Sedimentary Permeable | Agricultural/Grass | >40% |
| **CSP-Forest-3** | Coarse Sedimentary Permeable | Forest | 20% - 40% |
| **CSP-Forest-4** | Coarse Sedimentary Permeable | Forest | >40% |
| **CSP-Scrub/Shrub-4** | Coarse Sedimentary Permeable | Scrub/Shrub | >40% |

# H.7 PCCSYAs: Refinement Options

If an applicant has identified onsite and/or upstream PCCSYAs and elects to perform additional optional analyses to refine the PCCSYA designation, the guidance presented below should be followed. Protection of critical coarse sediment yield areas is a necessary element of hydromodification management because coarse sediment supply is as much an issue for causing erosive conditions to receiving streams as are accelerated flows. However, not all downstream systems warrant preservation of coarse sediment supply nor all source areas need to be protected. The following guidance shall be used to refine PCCSYA designations:

- Depositional Analysis (Appendix H.7.1)
- Threshold Channel Analysis (Appendix H.7.2)
- Coarse Sediment Source Area Verification (Appendix H.7.3)

## H.7.1 Depositional Analysis

Areas identified as PCCSYAs may be removed from consideration if it is demonstrated that these sources are deposited into existing systems prior to reaching the first downstream unlined water of the state. Systems resulting in deposition may include existing natural sinks, existing structural BMPs, existing hardened MS4 systems, or other existing similar features. Applicants electing to perform depositional analysis to refine PCCSYA mapping must meet the following criteria to qualify for exemption from CCSYA designation:

- The existing hardened MS4 system that is being analyzed should be upstream of the first downstream unlined waters of the state; and
- The peak velocity from the discrete 2-year, 24-hour runoff event for the existing hardened MS4 system that is being analyzed is less than three feet per second.

The three feet per second criteria is consistent with the recommended minimum velocity for storm and sanitary sewers in ASCE Manual of Engineering Practice No. 37 (ASCE, 1970).

In limited scenarios, applicant may have the option to establish site specific minimum self-cleansing velocity using Equation H.7-1 or other appropriate equations instead of using the default three feet per second criteria. This site specific analysis must be documented in the SWQMP and the County has the discretion to request additional analysis prior to approving a site specific minimum self-cleansing velocity. If an applicant chooses to establish a site specific minimum self-cleansing velocity for refinement, then the applicant must design any new bypass hardened conveyance systems proposed by the project to meet the site specific criteria.

**Equation H.7-1: Minimum Self Cleansing Velocity**

$$V = \frac{1.486}{n} R^{1/6}\left[B\left(s_g - 1\right)D_g\right]^{1/2}$$

Where:

V = minimum self-cleansing velocity (ft/sec)
R = hydraulic radius (ft)
n = Manning's roughness coefficient (unitless)
B = constant equal to 0.04 for clean granular particles (unitless)
$s_g$ = specific gravity of sediment particle (unitless): **Use 2.65**
$D_g$ = sediment particle diameter (inches): **Use 0.20 in**

## H.7.2 Threshold Channel Analysis

A threshold channel is a stream channel in which channel boundary material has no significant movement during the design flow. If there is no movement of bed load in the stream channel, then it is not anticipated that reductions in sediment supply will be detrimental to stream stability because the channel bed consists of the parent material and not coarse sediment supplied from upstream. In such a situation, changes in sediment supply are not considered a geomorphic condition of concern. SCCWRP Technical Report 562 (2008) states the following in regards to sand vs. gravel bed behavior/threshold vs. live-bed contrasts:

> "Sand and gravel systems are quite varied in their transport of sediment and their sensitivity to sediment supply. On the former, sand-bed channels typically have live beds, which transport sediment continuously even at relatively low flows. Conversely, gravel/cobble-bed channels generally transport the bulk of their bed sediment load more episodically, requiring higher flow events for bed mobility (i.e., threshold behavior)."

> "Sand-bed streams without vertical control are much more sensitive to perturbations in flow and sediment regimes than coarse-grain (gravel/cobble) threshold channels. This has clear implications in their respective management regarding hydromodification (i.e., sand systems being relatively more susceptible than coarser systems). This also has direct implications for the issue of sediment trapping by storm water practices in watersheds draining to sand-bed streams, as well as general loss of sediment supply following the conversion from undeveloped sparsely-vegetated to developed well-vegetated via irrigation."

The following provides guidance for evaluating whether a stream channel is a threshold channel or not. This determination is important because while accounting for changes in bed sediment supply is appropriate for quantifying geomorphic impacts in non-threshold stream channels, it is not considered appropriate for threshold channels. The domain of analysis for this evaluation shall be the same as that used to evaluate susceptibility, per SCCWRP Technical Report 606, Field Manual for Assessing Channel Susceptibility (2010). This domain is defined by the following upstream and downstream boundaries:

- From the point of compliance proceed downstream until reaching one of the following:
    - At least one reach downstream of the first grade-control point (preferably second downstream grade control location);
    - Tidal backwater/lentic (still water) waterbody;
    - Equal order tributary (Strahler 1952);
    - A 2-fold increase in drainage area.

  OR demonstrate sufficient flow attenuation through existing hydrologic modeling.

- From the point of compliance proceed upstream for 20 channel top widths OR to the first grade control in good condition, whichever comes first.

Applicant must complete Worksheet H.7-1 to document selection of the domain of analysis. If the entire domain of analysis is classified as a threshold channel, then the PDP can be exempt from the MS4 Permit requirement for sediment supply. The following definitions from the Natural Resources Conservation Service's (NRCS) National Engineering Handbook Part 654 - Stream Restoration Design (2007) are helpful in understanding what a threshold channel is.

- **Alluvial Channel**: Streams and channels that have bed and banks formed of material transported by the stream. There is an exchange of material between the inflowing sediment load and the bed and banks of an alluvial channel (NRCS, 2007).
- **Threshold Channel**: A channel in which channel boundary material has no significant movement during the design flow (NRCS, 2007).

The key factor for determining whether a channel is a threshold channel is the composition of its bed material. Larger bed sediment consisting primarily of cobbles and boulders are typically immobile, unless the channel is a large river with sufficient discharge to regularly transport such grain sizes as bed load. As a rule-of-thumb, channels with bed material that can withstand a 10-year peak discharge without incipient motion are considered threshold channels and not live-bed alluvial channels. Threshold channel beds typically consist of cobbles, boulders, bedrock, or very dense vegetation (e.g., a thicket). Threshold channels also includes channels that have existing grade control structures that protect the stream channels from hydromodification impacts.

For a project to be exempt from coarse sediment supply requirements, the applicant must submit the following for approval by the County:

- Photographic documentation and grain size analysis used to determine the $d_{50}$ of the bed material; and

- Calculations that show that the receiving water of concern meets the specific stream power criteria defined below <u>or</u> a finding from a geomorphologist that the stream channel has existing grade control structures that protect the stream channel from hydromodification impacts.

## Specific Stream Power

Specific (i.e., unit) stream power is the rate at which the energy of flowing water is expended on the bed and banks of a channel (refer to Equation H.7-2). SCCWRP studies have found that locating channels on a plot of Specific Stream Power at $Q_{10}$ (as calculated by the Hawley et al. method optimized for Southern California watersheds – Figure H.7-2) versus median channel grain size is a good predictor of channel stability. The $Q_{10}$ equation from SCCWRP TR 606 is presented as Equation H.7-3.

**Equation H.7-2: Calculation of Specific Stream Power**

$$Specific\ Stream\ Power = \frac{Total\ Stream\ Power}{Channel\ Width} = \frac{\gamma QS}{w}$$

Where:

$\gamma$: Specific Weight of Water (9810 $N/m^3$)
Q: Flow Rate (dominant discharge in many cases, $m^3/sec$)
S: Slope of Channel
w: Channel Width (meters)

**Equation H.7-3: Calculation of $Q_{10}$ using the Hawley et al. method**

$$Q_{10cfs} = 18.2 * A^{0.87} * P^{0.77}$$

Where:

$Q_{10cfs}$: 10 year Flow Rate in cubic feet per second
A: Drainage Area in sq. miles
P: Mean Annual Precipitation in inches

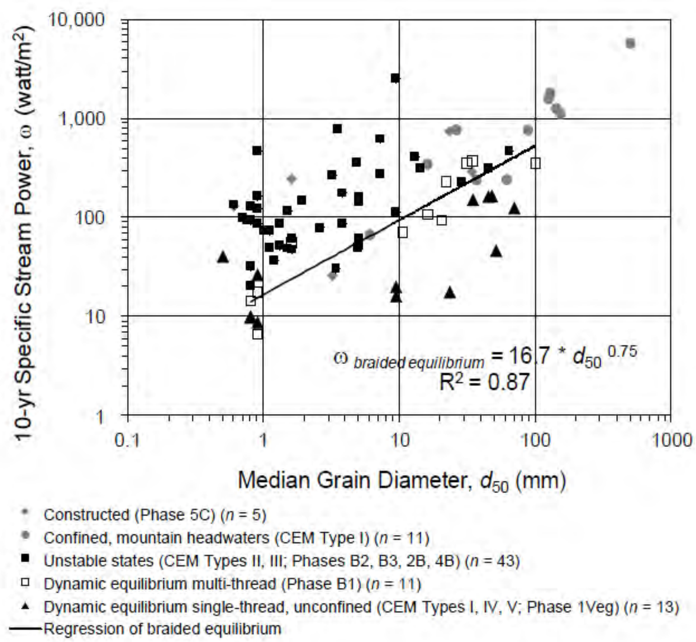


**Figure H.7-1: Threshold of stream instability based on specific stream power and channel sediment diameter**

Since the SCCWRP TR 606 $Q_{10}$ (Equation H.7-3) does not explicitly consider watershed imperviousness, adjustment factors (AF) shown in Figure H.7-2 were developed using the following Equation H.7-4 for $Q_{10}$ from SCCWRP TR 654 to account for imperviousness while estimating $Q_{10}$.

**Equation H.7-4: Calculation of $Q_{10}$ using equation from SCCWRP TR 654**

$$Q_{10} = e^{3.61} * A^{0.865} * DD^{0.804} * P_{224}^{0.778} * IMP^{0.096}$$

Where:

$Q_{10}$: 10 year Flow Rate
A: Drainage Area in sq. miles
DD: Drainage Density
$P_{224}$: 2-Year 24-Hour Precipitation in inches
IMP: Watershed Imperviousness

Adjustment factors were developed as part of this methodology by changing the watershed imperviousness in Equation H.7-4 and keeping the remaining terms constant. Adjustment factor for imperviousness of 3.6% was set to 1; since it is the mean imperviousness of the dataset used to develop the stability curve in Figure H.7-1. Updated $Q_{10}$ equation with adjustment factor is presented as Equation H.7-5 below:

**Equation H.7-5: Calculation of $Q_{10}$ with Adjustment Factor for Watershed Imperviousness**

$Q_{10cfs} = AF * 18.2 * A^{0.87} * P^{0.77}$

Where:

$Q_{10cfs}$: 10 year Flow Rate in cubic feet per second
AF: Adjustment Factor
A: Drainage Area in sq. miles
P: Mean Annual Precipitation in inches

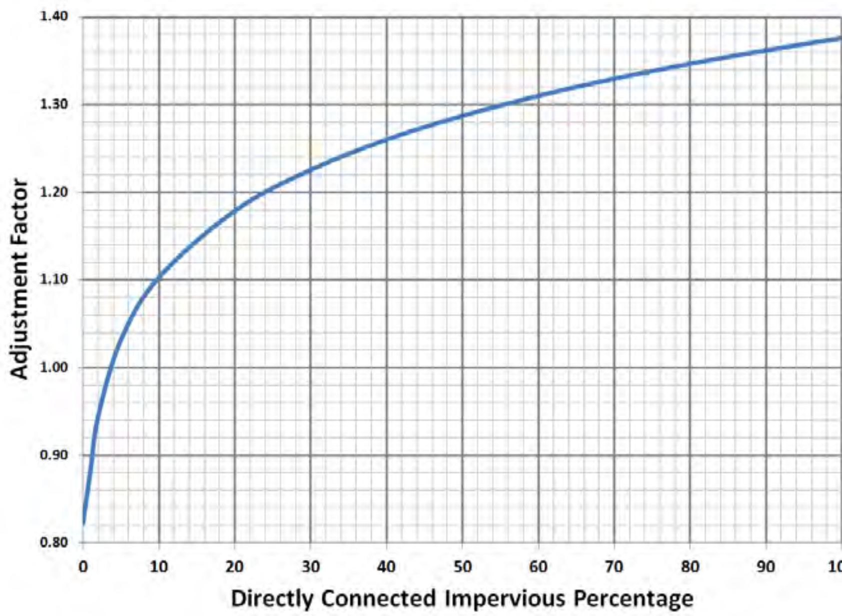


**Figure H.7-2: Adjustment factor to account for imperviousness while estimating $Q_{10}$**

Steps for evaluating the specific stream power criteria are presented below:

- **Step 1**: Calculate the specific stream power for the receiving water. Use Equation H.7-2, H.7-5 and Figure H.7-2. Directly connected imperviousness shall be estimated using guidance provided in the Water Quality Equivalency guidance document.
- **Step 2**: Determine the $d_{50}$ of representative cross section within the domain of analysis.
- **Step 3**: Use results from Step 1 and Step 2; and Figure H.7-1 to determine if the receiving water meets the specific stream power criteria. Receiving water shall be considered meeting the specific stream power criteria when the point plotted based on results from Step 1 and Step 2 is below the solid line in Figure H.7-1.

### H.7.3 Coarse Sediment Source Area Verification

When it has been determined that PCCSYAs are present, and it has been determined that downstream systems require protection, additional analysis may be performed that may refine the extents of actual CCSYAs to be protected onsite. The following analysis shall be performed to determine if the mapped PCCSYAs are a significant source of bed sediment supply to the receiving water, based on the coarse sediment proportion of the soil onsite

- Obtain a grain size distribution per ASTM D422 for the project's PCCSYA that is being evaluated.
- Identify whether the source material is a coarse grained or fine grained soil. Coarse grained is defined as over 50% by weight coarse than no. 200 sieve (i.e., $d_{50}$ > 0.074 mm).
- By performing this analysis, the applicant can exclude PCCSYAs that are determined to be fine grained (i.e., $d_{50}$ < 0.074 mm). Fine grained soils are not considered significant sources of bed sediment supply.
- Applicant shall include the following information in the SWQMP when this refinement option is performed:
    - Map with locations on where the grain size distribution analysis was performed;
    - Photographic documentation; and
    - Grain size distribution.
- Additional grain size distribution analysis may be requested at specific locations by the County prior to approval of this refinement.

Areas that are not expected to be a significant source of bed sediment supply (i.e. fine grained soils) to the receiving stream do not require protection and are not considered CCSYAs.
If it is determined that the PCCSYAs are producing sediment that is critical to receiving streams, or if the optional additional analysis presented above has not been performed, the project must provide management measures for protection of critical coarse sediment yield (refer to Appendix H.2, H.3 and H.4).

# H.8 Calculation Methodology for Ep and Sp

One method for quantifying hydromodification impacts to stream channels, which takes into account changes in the four factors in Lane's relationship (i.e., hydrology, channel geometry, bed and bank material, and sediment supply), is to compare long-term changes in sediment transport capacity, or in-stream work, to bed sediment supply. For the purposes of demonstrating no net impact within the MS4-permitted region of the County of San Diego, Erosion Potential (Ep) is defined as the ratio of post-project/pre-development (natural) long-term transport capacity or work. To calculate Ep, the hydrology, channel geometry, and bed/bank material factors mentioned above need to be characterized for both land use scenarios. Sediment Supply Potential (Sp) is defined as the ratio of post-project/pre-project (existing) long-term bed sediment supply. While evaluating changes in discharge and sediment supply is done primarily as a desktop analysis, geomorphic field assessment is often necessary to characterize channel geometry and bed/bank material, and to ground truth assumptions for the desktop analyses. This appendix provides methodologies for the following:

- Calculation of Ep, and
- Calculation of Sp.

## H.8.1 Calculation of Ep

Erosion Potential (Ep) is defined as the ratio of post-project/pre-development (natural) long-term transport capacity or work. To calculate Ep, the hydrology, channel geometry, and bed/bank material factors mentioned above need to be characterized for both land use scenarios. Traditionally, Ep is calculated based on a watershed-scale analysis (using future built out conditions) of the area tributary to a given receiving channel of concern at the point of compliance. However, watershed-scale continuous hydrologic modeling might not be feasible for small projects, with this understanding specific simplification steps for project-scale modeling are provided in this appendix. The applicant shall perform Ep calculations using one of the following methods, as applicable:

- **Simplified Ep Method**: Applicable when the default low flow threshold of $0.1Q_2$ is used and no changes to the receiving water are proposed. Refer to Appendix H.8.1.1.
- **Standard Ep Method**: Applicable for all scenarios. Refer to Appendix H.8.1.2.

### H.8.1.1 Simplified Ep Method

The simplified method is based on the relationships developed by Parra (2016) between the flow duration curve in the pre-development and post-project conditions and the standard simplified work equation. These relationships were developed using standard hydraulic equations and approximations that are applicable for channels of any lateral slope and the following geometrical cross sections: (a) wide rectangular sections; (b) relatively wide parabolic sections, and (c) triangular sections. The simplified Ep method is only applicable when the default low flow threshold of $0.1Q_2$ has been selected by the applicant for flow duration control and no changes to the receiving water geometry are proposed. Applicants shall follow Steps 1 through 3 to calculate Ep using the simplified methodology:

1. Perform continuous hydrologic simulation for the pre-development and post-project condition following guidelines in Appendix G. Generate flow bins and flow duration tables for the range of flows from $0.1Q_2$ to $Q_{10}$.
2. Calculate the total work in the pre-development and the post-project condition using Equation H.8.1

$$W_t = \sum_{j=1}^{n} \Delta t_j . \left(Q^{3m/2} - (0.1Q_2)^{3m/2}\right)^{1.5} Q^m$$

Equation H.8.1

Where:

$W_t$ = Total Work [dimensionless]

$\Delta t_j$ = Duration per flow bin

Q = Flow Rates estimated in STEP 1 [cfs] for a typical bin "j". Usually, in Flow Duration Curve (FDC) analyses, the number of bins is 100, so j = 1 to n (with n= 100). However, the number of bins can be as small as 20 (n = 20).

$Q_2$ = Pre-development 2-year peak flow [cfs]

m = exponent based on the function of the receiving channels geometry.

- For narrow creek where the top width is 7 times or less the corresponding depth, m = 1/4.
- For intermediate creeks, where the top width is more than 7 times but less than 25 times the depth, m = 4/13.
- For wide creeks, where the top width is more than 25 times the depth, m = 2/5.

3. Ep is calculated by dividing the total work of the post-project condition by that of the pre-development (natural) condition. Ep is expressed as:

$E_p = W_{t,post} / W_{t,pre}$ Equation H.8.2

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-development condition [unitless]

### H.8.1.2 Standard Ep Method

While using the standard method, Ep calculation must be performed using the receiving water information from the point of compliance. Suggested steps for performing an Ep analysis are shown in the Figure H.8-1 below. This appendix describes each analysis step shown in Figure H.8-1, including the inputs and outputs of each step.

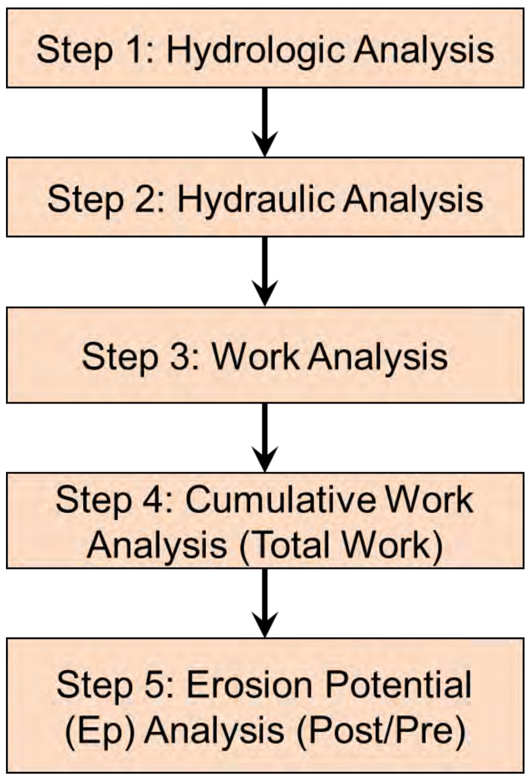


**Figure H.8-1 Erosion Potential Flow Chart**

## STEP 1: CONTINUOUS HYDROLOGIC ANALYSIS

Hydrologic models are applied to simulate the hydrologic response of the watershed under pre-development and post-project conditions for a continuous period of record. Modeling software appropriate for this type of simulation includes USEPA's Storm Water Management Model (SWMM), Hydrological Simulation Program – Fortran (HSPF) developed by the USGS and USEPA, USACE's Hydrologic Modeling System (HEC-HMS), and the San Diego Hydrology Model (SDHM) developed by Clear Creek Solutions, Inc. SDHM uses an HSPF computational engine, long-term precipitation data, and is a visually-oriented interactive tool for automated modeling and facility sizing.

Input parameters for these continuous simulations are hourly precipitation data for a long-term (>30 years) record, sub-catchment delineation, impervious cover, soil type, vegetative cover, terrain steepness, lag time or flow path length, and monthly evapotranspiration rate. The primary output is a simulated discharge record associated with the receiving channel of concern. Flow routing through drainage conveyances is necessary for continuous hydrologic analysis at the watershed scale. Appendix G provides guidance for developing continuous simulation models.

Traditionally, a hydrograph (Figure H.8-2) is the primary means for graphically comparing discharge records; however, a hydrograph is not ideal because long-term flow records span several decades.

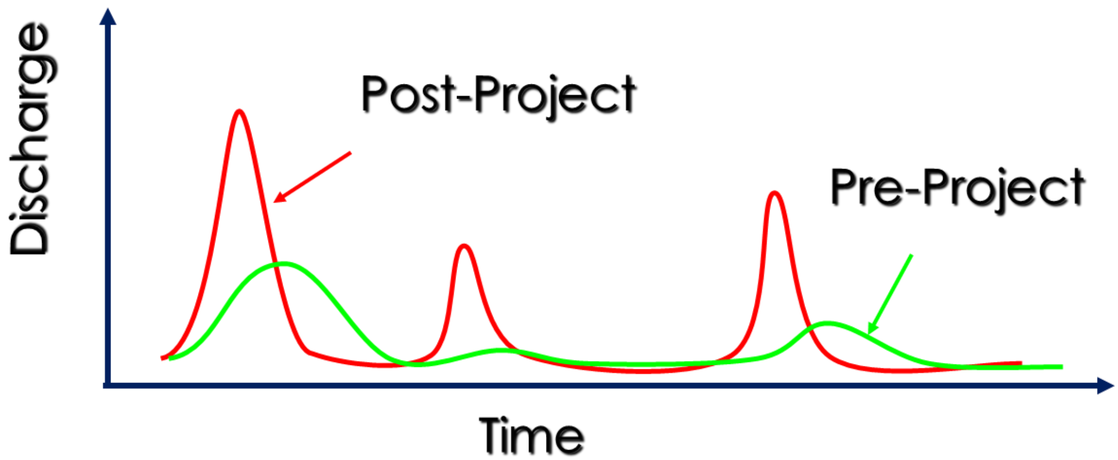


**Figure H.8-2 Example Hydrograph Comparison**

Instead, a more effective means for comparing long-term continuous discharge records is to create a flow histogram, which differentiates the simulated flowrates into distinct "flow bins" so that the duration of flow for each bin can be tabulated. One method for establishing the distribution of flow bins is to increment the flow bins according to increments of flow stage using a hydraulic analysis, such as the normal depth equation. In this way, the hydraulic analysis step (Step 2) can be considered an input to the continuous hydrologic analysis step. While there is no established rule of thumb for how many flow bins are necessary, it is suggested that no less than 20 be used for an Ep analysis. An example of a flow histogram is provided on Figure H.8-3.

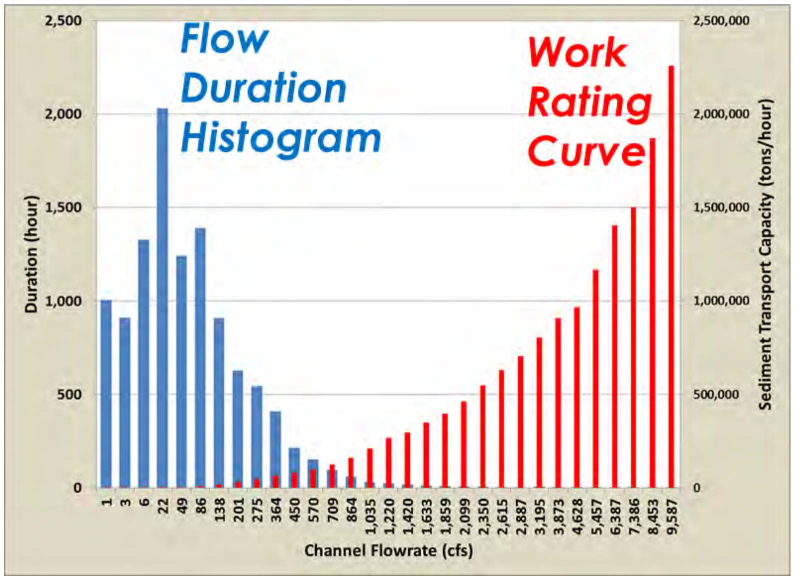


**Figure H.8-3 Example Flow Duration Histogram**

Flow duration curves are another commonly used method for graphically interpreting long-term flow records. A flow duration curve is simply a plot of flowrate (y-axis) versus the cumulative duration, or percentage of time, that a flowrate is equaled or exceeded in the simulation record (x-axis). Figure H.8-4 provides an example flow duration curve comparison.

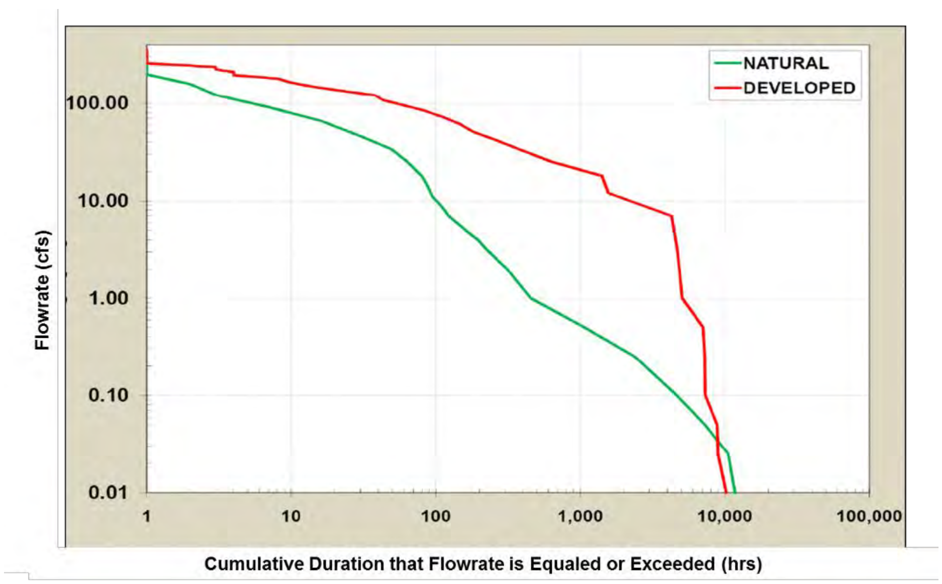


**Figure H.8-4 Example Flow Duration Curve**

## <u>Scaling Factor for Project-Scale Modeling</u>

Project-scale flow rates derived from continuous hydrologic simulation can be scaled using the ratio of the pre-development 2-year peak discharge for the watershed and project catchment (i.e., $Q_2$ watershed / $Q_2$ project catchment) so that hydraulic and effective work calculations can be

## STEP 2: HYDRAULIC ANALYSIS

Hydraulic parameters, such as stage, effective shear stress, and flow velocity, are computed for each designated flow bin using channel geometry and roughness data. Hydraulic calculations can be as simple as using the normal flow equation and obtaining results for the central channel or as complicated as using hydraulic models which account for backwater effects, such as HEC-RAS.

Using the formula for unit tractive force (Chow 1959), effective shear stress is expressed using equation H.8.4

$$\tau = \gamma RS \qquad \text{Equation H.8.4}$$

Where:

$\tau$ = Effective Shear Stress [lb/ft$^2$]

$\gamma$ = Unit Weight of Water [62.4 lb/ft$^3$]

R= Hydraulic Radius [ft]

S = Energy Gradient Assumed Equal to Longitudinal Slope [ft/ft].

Normal depth can be estimated using Manning's equation (Equation H.8.5). Several sources provide lists of roughness coefficients for use in hydraulic analysis (Chow, 1959).

$$Q = \frac{1.49AR^{0.67}S^{0.5}}{n} \ or \ V = \frac{1.49R^{0.67}S^{0.5}}{n} \qquad \text{Equation H.8.5}$$

Where

Q = Peak Flowrate [cfs]

V = Average Flow Velocity [ft/s]

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 [unit less]

Channel geometry inputs should be characterized by surveying cross-sections and longitudinal profiles of the active channel at strategic locations. Methods of collecting topographic survey data can range from traditional survey techniques (auto level, cloth tape, and survey rod), to conducting a detailed ground-based LiDAR survey.

## STEP 3: WORK ANALYSIS

Hydraulic results for each flow bin along with the critical bed/bank material strength parameters are input into a work or sediment transport function in order to produce a work or transport rating curve. An example of such a rating curve is provided on Figure H.8-3. The work equations can range from simplistic indices, material-specific sediment transport equations, or more complex functions based on site-calibrated sediment transport rating curves.

- **Simplistic indices:** An acceptable equation for effective work, as stated in the Los Angeles Regional MS4 Permit (LARWQCB, 2012) is expressed using equation H.8.6:

  $$W = (\tau - \tau_c)^{1.5} V \quad \text{Equation H.8.6}$$

  Where:

  W = Work [dimensionless];

  $\tau$ = Effective Shear Stress [lb/ft$^2$];

  $\tau_c$ = Critical Shear Stress [lb/ft$^2$];

  V = Mid-Channel Flow Velocity [ft/s]

- **Material-specific sediment transport equations**: Material specific sediment transport equations are allowed to estimate the sediment transport capacity in the post-project and pre-development condition.
- **Site-calibrated sediment transport curves**: Applicants may have an option to use site-calibrated sediment transport curves. In the future these may be available based on monitoring efforts being performed to support the County of San Diego's Hydromodification Management Plan.

The critical shear stress to be used in equation H.8.6 must be estimated using one of the following:

- Shear stress corresponding to the critical flow rate or low flow threshold (Qc). Qc is the flowrate that results in incipient motion of bed or bank material, whichever is least resistant. Qc is expressed as a fraction of the pre-development 2-year peak flow. The allowable low flow threshold Qc can be estimated as 10%, 30%, or 50% of the pre-development 2-year peak flow ($0.1Q_2$, $0.3Q_2$, or $0.5Q_2$) depending on the receiving stream susceptibility to erosion, per SCCWRP Technical Report 606, Field Manual for Assessing Channel Susceptibility (SCCWRP, 2010). If a channel susceptibility assessment is not performed, then the conservative default is a Qc equal to $0.1Q_2$.
- Bed and bank material can also be characterized through a geomorphic field assessment. For each stream location analyzed, a measure of critical shear stress can be obtained for the weakest bed or bank material prevalent in the channel. For non-cohesive material, a Wolman pebble count or sieve analysis can be used to obtain a grain size distribution, which can be converted to a critical shear stress using empirical relationships or published reference tables.

For cohesive material, an in-situ jet test or reference tables are used. For banks reinforced with vegetation, reference tables are generally used. Appropriate references for critical shear stress values are provided in ASCE No.77 (1992) and Fischenich (2001). To account for the effects of vegetation density and channel irregularities, the applied shear stress can be partitioned into channel form and bed/bank roughness components. SCCWRP Technical Report 667 also has guidance for estimating critical shear stress.

## STEP 4: 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 flow rates simulated. The cumulative work analysis must be performed up to the maximum geomorphically significant flow of $Q_{10}$. To calculate cumulative work, first multiply the work (from STEP 3) and duration associated with each flow bin (from STEP 1). Then, the total work is obtained by summing the cumulative for all flow binds ($Q_c$ to $Q_{10}$). This analysis can be expressed as:

$$W_t = \sum_{i=1}^{n} W_i \, \Delta t_i$$ Equation H.8.7

Where:

$W_t$ = Total Work [dimensionless]

$W_i$ = Work per flow bin [dimensionless]

$\Delta t$ = Duration per flow bin [hours]

n = number of flow bins

The distribution of cumulative work, also referred to as a work curve (or work histogram), is helpful in understanding which flow rates are performing the most work on the channel of interest. An example work curve is provided in Figure H.8-5.

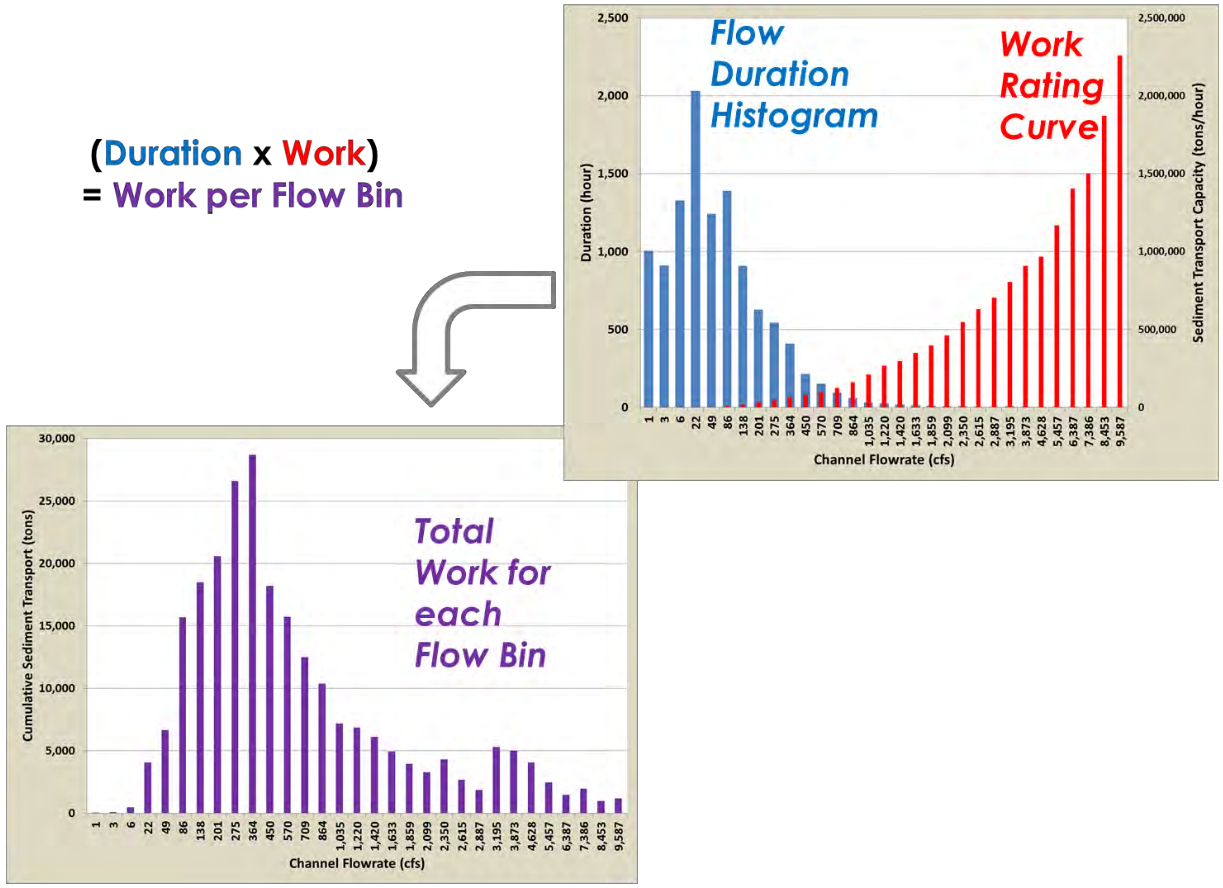


**Figure H.8-5 Example Work Curve**

## STEP 5: EROSION POTENTIAL ANALYSIS

Ep is calculated by simply dividing the total work of the post-project condition by that of the pre-development (natural) condition. Ep is expressed as:

$$E_p = W_{t,post} / W_{t,pre} \qquad \text{Equation H.8.8}$$

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-development condition [unitless]

As applicable, the applicant must use Worksheet H.8.1-1 and H.8.1-2 to document the Ep calculations for each point of compliance.

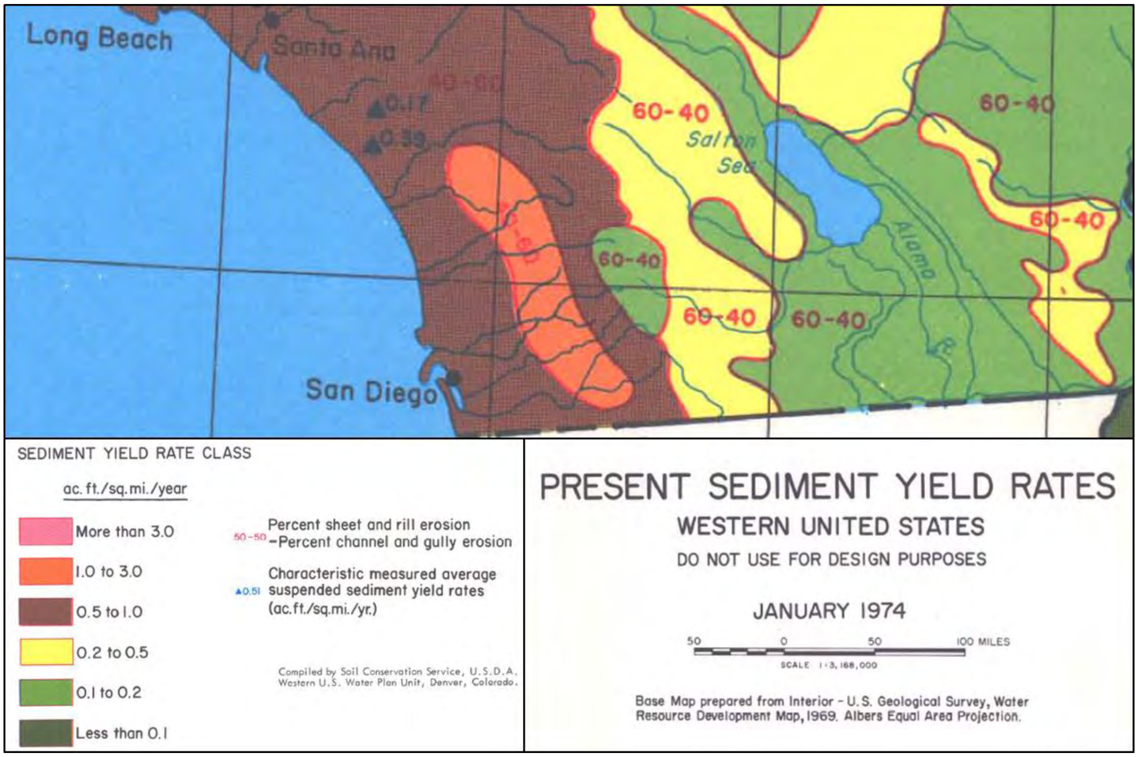


**Figure H.8-6 Regional Sediment Yield Map**

According to a regional sediment yield map of the Western US (USDA, 1974), hillslope processes (sheet and rill erosion) account for approximately 40% of the sediment yield in the San Diego County region, while channel processes (in-stream and gully erosion) account for approximately 60% of the sediment yield. Figure H.8-7 shows the different erosion processes. Provision E.3.a.(3)(a) of the MS4 Permit requires, "maintenance or restoration of natural storage reservoirs and drainage corridors (including topographic depressions, areas of permeable soils, natural swales, and ephemeral and intermittent streams)", effectively making maintenance or restoration of channels and gullies within a project site a site design requirement.

### H.8.2 Calculation of Sp

While there are many categories of erosion processes (e.g., landslides, debris flows, gullies, tree throw, animal burrows, sheetwash erosion, wind erosion, dry ravel, bank erosion), in this evaluation processes will be simplified to sediment production from hillslopes and channels. Under ideal circumstances, the total bed sediment supply rate (tons/year) would be calculated for both the post-project built-out condition and pre-project condition using a watershed-scale Geomorphic Landscape Unit (GLU) and Geomorphic Channel Unit (GCU) approach which:

(1) identifies different sources of sediment supply based on categories of terrain slope, geology, land cover, and stream order;
(2) estimates the base erosion rate of those sources (GLUs and GCUs);
(3) approximates the sediment delivery ratio (SDR) to the receiving channel;
(4) evaluates the coarse bed-load fraction of the sources; and
(5) integrates these considerations into a bed-load yield rate for both the existing condition and proposed built-out condition.

However, calculation of sediment yield rates for each GLU (tons/mi$^2$-yr) and GCU (tons/mi-yr) using the available science is inherently inexact and requires extensive field calibration. Additionally, performing the geospatial calculations necessary for such a comprehensive GLU and GCU analysis may not be straightforward for some project applicants. Since the objective is to determine the fraction of reduction in bed sediment supply in the post-project condition compared to the pre-project condition, but not to determine the bed sediment yield in physical units (tons/year/acre, for example) the following simplifications are allowed. These simplifications take into consideration the regional sediment yield map shown in Figure H.8.6.

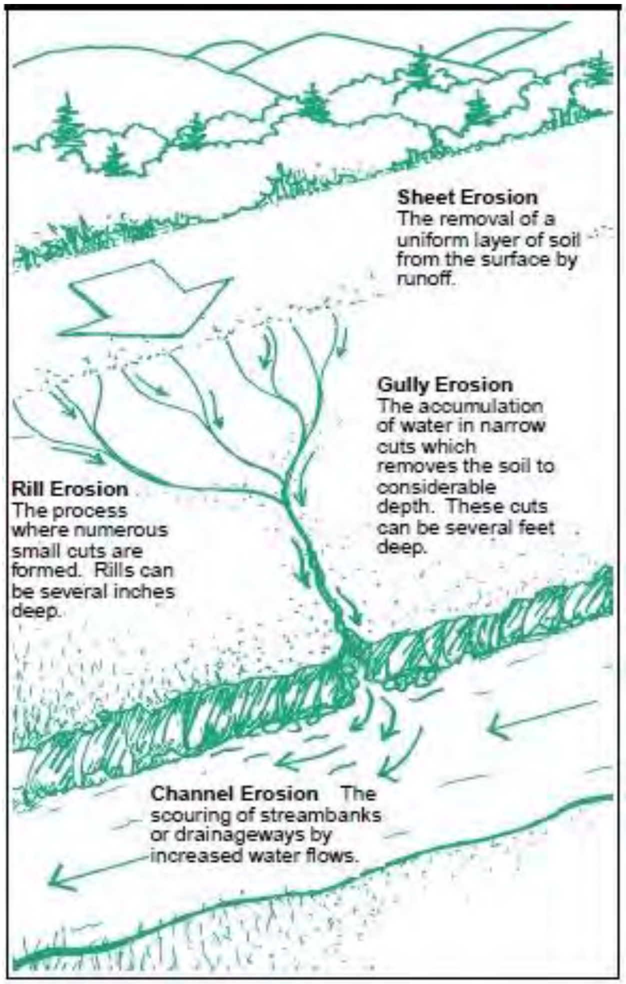


**Figure H.8-7 Different Erosion Processes that Contribute Sediment**

Source: http://www.fairfaxcounty.gov/nvswcd/youyourland/soil.htm

Sediment yield from hillslope processes (sheet and rill erosion) can be estimated using the Revised Universal Soil Loss Equation (RUSLE) and a sediment delivery ratio. For channel processes, the best available regional datasets are the USGS National Hydrography Dataset (NHD) and the NHDPlus dataset from USEPA and USGS (http://www.horizon-systems.com/nhdplus/). Both these datasets may not include the lowest order channels or gullies in the stream network, which can contribute a considerable amount of sediment produced from channel processes. Since the lower order channels and gullies originate and are mostly on the hillslopes, it is assumed for the Sp analysis that the sediment yield from lower order channels and gullies is proportional to the sediment yield from hill slopes. Based on feedback received during the TAC meetings (Appendix H.5.1) the following distribution is proposed for the calculation of Sp:

- 70% of bed sediment yield ratio from RUSLE analysis (assumed to account for sediment yield from hillslope processes (sheet and rill erosion) and channels and gullies not part of the NHDPlus dataset); and

- 30% of bed sediment yield ratio from channels in the NHDPlus dataset.

**Note:**

- If an applicant elects to map the waters of the state, the Sp distribution shall be revised to
  - 40% of bed sediment yield ratio from RUSLE analysis;
  - 30% of bed sediment yield ratio from waters of the state that are not part of NHDPlus dataset; and
  - 30% of bed sediment yield ratio from channels in the NHDPlus dataset.

## SCALE OF ANALYSIS

The project applicant shall perform the Sp analysis at point (or points) where runoff leaves the project site[25]. The steps for performing an Sp analysis are shown in Figure H.8-8 and described below.

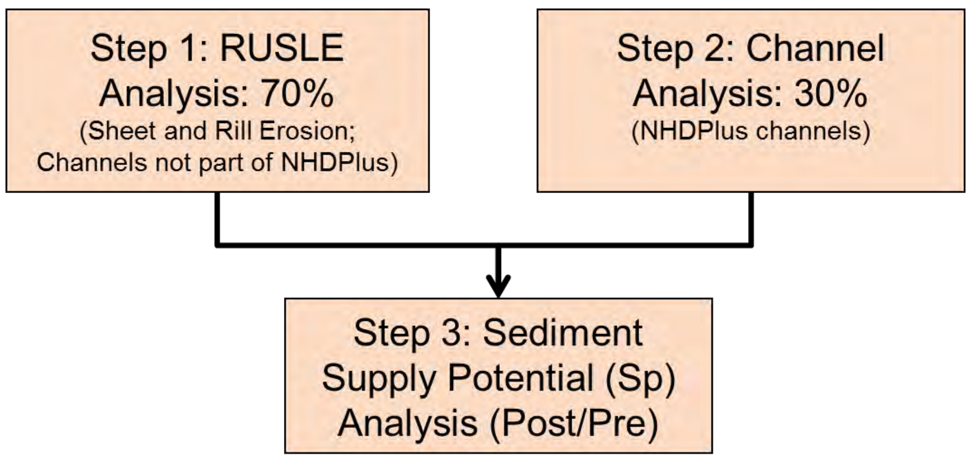


**Figure H.8-8 Sediment Supply Potential Flow Chart**

## STEP 1: RUSLE ANALYSIS

RUSLE analysis is assumed to account for sediment yield from hillslope processes (sheet and rill erosion) and channels and gullies not part of the NHDPlus dataset. The change in bed sediment yield in the post-project condition compared to the pre-project condition using the RUSLE analysis must be estimated using equation H.8.9. This equation is a modified form of the standard RUSLE equation. Only hillslopes that are anticipated to generate coarse sediment must be used in this

[25] In limited scenarios, the County has the discretion allow for a watershed-scale Sp analysis to be performed at the point of compliance it the future built-out conditions of the watershed are used in the analysis.

analysis. Since Sp is a dimensionless index the terms that are relatively constant in the pre and post project condition, such as rainfall factor, have been removed.

$$SY_{RUSLE} = \frac{Post\text{−}Project \sum\{A \times K \times LS \times C \times P\}}{Pre\text{−}Project \sum\{A \times K \times LS \times C\}}$$ Equation H.8.9

Where:

A = Hillslope Area (acres)

K = Soil erodibility factor, this value can be obtained from regional K factor map from SWRCB or web soil survey or site-specific grain size analysis

LS = Slope length and steepness factor, this value can be obtained from the regional LS factor map from SWRCB or site-specific determination using look up tables based on slope and horizontal slope length from USDA Agriculture Handbook Number 703 (Renard et al., 1997) or other relevant sources

C= Cover management factor, use regional C factor map from USEPA or site-specific information; this is the reciprocal of the amount of surface cover on soil, whether it be vegetation, temporary mulch or other material. It is roughly the percentage of exposed soil, i.e., 95 percent cover yields a "C" value of 0.05. Use C=0 for areas where management actions are implemented (e.g. impervious areas)

P = Practice factor, only included in post-project condition. This term is added to account for sediment yield from engineered slopes. Practice factor of 0.25 shall be used for fill slopes and a practice factor of 0.50 shall be used for cut slopes. Use a practice factor of 1 for undisturbed areas.

The applicant may be allowed to receive credit for bed sediment yield from engineered slopes on the project perimeter directly discharging to conveyance systems if <u>all</u> of the following criteria are met:

- The engineered slopes consist of coarse bed material. This is confirmed by performing grain size distribution per ASTM D422 for the engineered slope and verifying that the $d_{50}$ is greater than no. 200 sieve (0.074 mm).
- Cover factor in the post project condition shall not be greater than the cover factor used in the pre project condition for the same area.
- A maximum practice factor of 0.25 may applied to proposed fill slopes. A maximum practice factor of 0.50 may be applied to proposed cut slopes.
- A statement from the geotechnical engineer is included in the SWQMP certifying that the engineered slope will be stable even after accounting for bed sediment generation and the anticipated soil loss during the planned lifetime of the engineered slope is acceptable.

Additional analysis and/or documentation may be requested by the County prior to approval of the credit for bed sediment yield from engineered slopes.

performed at the point of compliance with a larger tributary watershed. This scaling translates the runoff from the project catchment to its contribution to erosivity in the down gradient receiving channel, without the need for a complex watershed-scale continuous hydrologic model.

Applicant can estimate the scaling factor using Equation H.8.3. The scaling factor equation was developed using the 2-year peak flow rate empirical equation from Hawley and Bledsoe (2011) and removing the terms (average annual precipitation and imperviousness (pre-development condition as required by the MS4 Permit) that are constant.

$$Scaling\ Factor = \left(\frac{A_{watershed}}{A_{project}}\right)^{0.667}$$ Equation H.8.3

Where:

$A_{watershed}$ = total watershed drainage area at the point of compliance($mi^2$)

$A_{project}$ = total project drainage area ($mi^2$)

## STEP 2: CHANNEL ANALYSIS

If an NHDPlus mapped channel exists within the project property boundary, applicants must consider the sediment production from this existing channel system. The change is bed sediment yield in the post-project condition compared to the pre-project condition from channels in the NHDPlus dataset must be estimated using equation H.8.10 ($SY_{NHD}$). This equation is based on screening-level GIS calculations of stream length that will be contributing sediment in the post-project condition in the watershed tributary to the point of compliance.

$$SY_{NHD} = \frac{L_{post}}{L_{pre}} \qquad \text{Equation H.8.10}$$

Where:

$L_{post}$ = Length of NHDplus streams in the watershed contributing to bed sediment supply in the post-project condition [miles]

$L_{pre}$ = Length of NHDplus streams in the watershed contributing to bed sediment supply in the pre-project existing condition [miles]

## STEP 3: SEDIMENT SUPPLY POTENTIAL ANALYSIS

Sediment Supply Potential (Sp) is defined as the ratio of post-project/pre-project (existing) long-term bed sediment supply. Sp must be calculated using equation H.8.11 presented below:

$$S_p = 0.7 \times SY_{RUSLE} + 0.3 \times SY_{NHD} \qquad \text{Equation H.8.11}$$

Where:

$S_p$ = Sediment Supply Potential [unitless]

$SY_{RUSLE}$ = Change in bed sediment yield from hillslopes and lower order channels and gullies not part of NHDPlus dataset [unitless]

$SY_{NHD}$ = Change in bed sediment yield from channels in NHDPlus dataset [unitless]

When estimating Sp the following additional conditions apply:

- Projects that do not have onsite NHDPlus channels shall omit consideration of $SY_{NHD}$ and weighting factors depicted in Equation H.8.11. This simply results in Sp = $SY_{RUSLE.}$
- It must be assumed that the sediment yield from an area that drains to a structural BMP is zero. Consideration of sediment yield from an area draining to the structural BMP may be allowed if sediment bypass measures are implemented upstream of the structural BMP. However, additional analysis may be requested by the County to substantiate the sediment yield estimates proposed by the applicant from implementing sediment bypass measures.
- For scenarios where an upstream coarse sediment yield area drains through the project footprint and the project footprint cuts off conveyance of bed sediment generated upstream

of the project footprint to the point of compliance, (e.g., via debris basins) the contribution from the upstream area shall be assumed to be zero.

As applicable, the applicant must use Worksheet H.8.2-1 to document the Sp calculations for each point of compliance.

### 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%

## Appendix 2:

- Relevant Maps of Hydromodification Screening Reports (References [2] and [3]).
- General Satellite Exhibit with Location of Site-Visit Photos of Contributing Areas to POCs 13B, 19 and 26; Dec. 2016)
- Photographic Records of December 2016 Site Visit
- Aerial Photography of the Location of POC-13B, POC-19 and POC-26
- New Updated Letter by Geologist (Leighton & Associates Inc. Dated 12/15/16 that Supersedes previous Geology Letter Dated 6/10/16 and Revised 10/5/16)