Appendix I.3 – Attachment 3: Rancho Mission Viejo Runoff Management Plan. 2013. Chapter 15: Rancho Mission Viejo Hydromodification Management Plan

15 Hydromodification Management Plan (HMP)

15.1 Introduction

15.1.1 Objective

The objective of this Rancho Mission Viejo Ranch Plan Planned Communities Hydromodification Management Plan (RMV HMP) is to describe the control measures that will be used to manage increases in runoff volumes, discharge rates, and durations (i.e., hydromodification impacts) from the development of the Ranch Plan Planned Communities within Planning Areas 2 through 5. The control measures for Planning Area 1 are described in the PA-1 ROMP, which is included as an appendix to this ROMP.

The focus of this HMP is controlling long-term general scour (i.e., hydromodification control) as opposed to short-term, local scour (i.e., flood control). Flood control and hydromodification control are inherently different in their objectives as well as methods of analysis. The objective of flood control is to prevent flood inundation of property from high magnitude and rare storm events (e.g., the 100-year event). The objective of hydromodification management is to prevent excessive long-term erosion and deposition in natural channels from a range of channel flows that are typically much lower than flood design flow rates (e.g., from 10% of the 2-year storm to the 10-year storm event).

While hydrologic analyses for flood control, such as those contained in the Orange County Hydrology Manual, are based on evaluating the magnitude of one or a few large discrete events (on the order of hours to days), hydromodification analysis focuses on continuous simulations (spanning over several decades) which take into account both flow magnitude and duration. Because hydromodification analysis looks at both magnitude and duration of the long-term flow record, the large but rare events that are crucial to flood control can be relatively insignificant when considering sediment transport and changes in channel form. In fact, geomorphic research has found that for most stream channels, the most important range of flows from the perspective of affecting channel form are the relatively frequent flows that are contained primarily within the active channel and not the rare, high magnitude flows which exceed the rate of flow that can be contained in the normally wetted perimeter of the channel.

Flows which create high enough shear stresses to initiate sediment transport within the channel and which occur frequently enough to have influence over long-term stream morphology are considered “geomorphically-significant” flows. To provide perspective on the timescales of interest, a peak storm event may result in a bed scour hole, which slowly fills in with sediment over days to months after the event takes place. But if the time scale considered for stream stability is on the order of several decades, that scour hole may be a negligible perturbation on the overall record of channel form.

15.1.2 Regulatory Requirements

This RMV HMP establishes a hydromodification control performance standard for the Ranch Plan Planned Communities in compliance with:

- The hydromodification provisions of the South Orange County MS4 Permit (Provision F.1.h of Order R9-2009-0002; SDRWQCB, 2009);
- The South Orange County Hydromodification Management Plan (SOC HMP) (County of Orange, 2011); and
- The Ranch Plan EIR Mitigation and Monitoring Measures developed as conditions of approval of the EIR by the County Board of Supervisors (County of Orange, 2006).

15.1.3 Supporting Documents

Extensive baseline studies and modeling efforts have been conducted to characterize geologic, hydrologic, and geomorphic conditions in the San Juan Creek watershed; how development within the Ranch Plan Planned Communities could affect these conditions; and to assess mitigation measures that

address hydromodification impacts. The documents listed below provided a basis for the development of this HMP:

- Extensive field and literature review work was conducted prior to the development of the Ranch Plan EIR, including the *Baseline Geomorphic and Hydrologic Conditions Report* (PCR Services Corporation, 2002).
- The connection between geomorphic conditions and sensitive species habitat was addressed in the *Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species* (PCR and Dudek & Associates, 2002).
- Natural resources were inventoried, which led to the development of the *Watershed and Sub-basin Planning Principles Report* by a working group with representatives from the resource agencies (Natural Community Conservation Planning Act/Special Area Management Plan Working Group, 2003).
- Balance Hydrologics (2005) addressed sediment supply and transport processes within the San Juan Creek Watershed and how those processes might be altered with development. This report included mapping of hydrologic soil groups (HSGs) and provided estimates of sub-basin sediment yield and in-channel sediment transport. The report also discussed the important role of episodic events, such as fires and infrequent hydrologic events, in re-establishing or resetting the geomorphic baseline.
- The Ranch Plan EIR and the Conceptual Water Quality Management Plan (WQMP) (Geosyntec Consultants, 2004) included site design, source control, and combined flow duration and water quality facilities to mitigate the effects of the Ranch Plan development on water quality and hydromodification.
- Following approval of the Ranch Plan EIR, an extensive and detailed hydrologic, hydraulic, and sediment transport and delivery modeling study was conducted by PACE Engineering (2010) that included detailed information on channel morphology and bed and bank particle size characteristics.

15.1.4 Report Organization

The organization of this document is consistent with the organization of the SOC HMP and includes sections addressing:

- Requirements and Standards (Section 15.2),
- Hydromodification Sediment Standards (Section 15.3), and
- HMP Monitoring and Effectiveness (Section 15.4).

15.2 Requirements and Standards

15.2.1 HMP Criteria

RMV falls under Tier 1 in the South OC HMP (development over 100 acres), which allows RMV to pursue a regional approach for hydromodification. The HMP Criteria in the SOC HMP and this RMV HMP are designed to address increases in runoff discharge rates and duration as well as decreases in bed sediment supply resulting from project development. The SOC HMP criteria are stated as follows:

- All Priority Development Projects (PDPs) must use continuous simulation to ensure that post-project runoff flow rates and durations for the PDP shall not exceed pre-development, naturally occurring, runoff flow rates and durations by more than 10% for flow rates from 10% of the 2-year runoff event up to the 10-year runoff event.
- In addition, the PDP must compensate for the loss of sediment supply due to the development.

The HMP Criteria contained in this RMV HMP include the following:

- Hydrologic Criteria:

- If only Out-of-Channel measures (i.e., hydrologic source control measures, on-site management controls, and regional controls located upstream of receiving waters) are used to manage hydromodification, then those measures shall be selected and applied using continuous simulation (per Section 15.2.1.1 below) to ensure that post-project runoff flow rates and durations at the project discharge point[1] shall not exceed pre-development, naturally occurring, runoff flow rates and durations by more than 10%,[2] for the range of geomorphically significant flows (per Section 15.2.1.2 below).
- If In-Channel (i.e., in-stream) measures are used in addition to Out-of-Channel measures to manage hydromodification in side tributary channels[3], then such measures shall be selected and applied using continuous simulation and sediment transport modeling to maintain the Erosion Potential[4] (Ep) ratio to within 10% of the target value from the project discharge point to a downstream receiving water that is exempt from this HMP. The target Ep will be adjusted to account for changes in bed sediment supply.

- Sediment Supply Criteria:

  - All project development shall manage for long-term bed sediment supply reductions to the receiving channel of the project using the methods described in Section 15.3.

15.2.1.1 Continuous Simulation

Continuous simulation to demonstrate compliance with the HMP Criteria shall be completed in one of the following ways:

- South Orange County Hydrology Model (SOCHM): The SOC HMP includes a continuous simulation modeling tool for PDPs. The tool, the South Orange County Hydrology Model (SOCHM), is an Hydrologic Simulation Program FORTRAN (HSPF) model based on the San Diego Hydrology Model which allows PDPs to design and size facilities to meet the HMP criteria. The analysis is facilitated through an interactive user interface. Details on how to use the model are provided in Appendix C of the SOC HMP (County of Orange, 2011).

- USEPA Storm Water Management Model (SWMM): Continuous hydrologic simulations to estimate combined control facility sizing were performed using SWMM as part of the Conceptual WQMP (Geosyntec, 2004). The input parameters used in the SWMM modeling were calibrated to available local streamflow measurements including dry weather base flows, indirect wet weather peak discharge estimates, and continuous stream flow hydrographs. Using SWMM with these calibrated parameters is an acceptable method for performing continuous hydrologic simulation.

Flow Frequency Analysis Using Partial Duration Series

In order to establish the flow range of interest for flow duration control, the 2-year (Q_2) and 10-year (Q_{10}) return period discharges for the pre-project condition must be calculated at the points of compliance. This should be done by constructing a partial-duration series from the pre-project (natural) condition continuous simulation output as follows:

- The entire runoff time series generated by the pre-project hydrologic simulation is divided into a set of discrete events. Flow events should be considered separate based on a 24-hour interval

[1] If portions of the project discharge to different receiving channels, then a separate flow duration control analysis is needed for each associated outfall and tributary area.
[2] This matching under the hydrologic HMP criteria is also termed "flow duration control". To demonstrate that flow duration control is achieved, a graphical comparison can be made of the baseline (pre-project) flow duration curve to that of the proposed condition. An example flow duration curve comparison is provided in Figure 15-11.
[3] In-Stream measures will not be used in mainstem tributary channels (e.g., Chiquita, Gobernadora, and Verdugo) or San Juan Creek because they have not been permitted by the natural resource agencies.
[4] Ep is the ratio of total long-term sediment transport capacity in the proposed condition versus the baseline (natural) condition.

between peaks for flow-frequency analysis, consistent with the revised SOC HMP and methods used in SOCHM.

- The peak flows from each discrete event are ranked and the return intervals are computed using the Weibull plotting method to establish the Q_2 and Q_{10}, consistent with the revised SOC HMP and methods used in SOCHM. The low flow threshold is a ratio of the computed Q_2 (e.g., $0.1Q_2$).

This partial duration series analysis is automatically performed in SOCHM and can be performed using SWMM.

15.2.1.2 Range of Geomorphically Significant Flows

High Flow Threshold

The pre-development (natural) 10-year peak flowrate (Q_{10}) is considered to be an appropriate high flow threshold for the Ranch Plan Planned Communities for the following reasons:

- According to the report *Hydromodification Assessment and Management in California,* commissioned and sponsored by the California State Water Resources Control Board, "in large storms with return intervals of 10 or more years, the influence of urbanization is considered less pronounced" (SCCWRP, 2012).
- Less frequent, larger magnitude flows are less strongly affected by urbanization because during such infrequent storm events, the ground rapidly becomes saturated, and acts (for purposes of runoff generation) in a similar manner as impervious surfaces (County of Orange, 2011).
- Flows above the 10-year return period cause relatively little cumulative erosion in receiving waters due to their low recurrence (County of San Diego, 2009).
- The eight (8) HMPs developed to date in California (Alameda County, Contra Costa County, Fairfield Suisun Urban Runoff Management Program, Sacramento County, San Diego County, San Mateo County, Santa Clara County, and South Orange County) have all adopted the 10-year peak flowrate (Q_{10}) as the upper flow threshold.

Low Flow Threshold

<u>Low Flow Threshold – Regional Planning</u>

For regional planning purposes associated with the ROMP, 10% of the pre-development 2-year peak flowrate ($0.1Q_2$) is considered to be an appropriate low flow threshold for RMV. This assumption is supported by a planning-level critical flow sensitivity analysis, consistent with the methodology used by PWA in Appendix A of the *San Diego HMP* (County of San Diego, 2009). This sensitivity analysis was performed as follows:

Step 1: Identify the Typical Range of Rainfall Conditions for the HMP Area

Mean annual precipitation is 15" to 18" per year, as shown by the California Department of Water Resources precipitation isohyetal lines on Figure 15-1 of this report.

Step 2: Identify the Range of Typical Watershed Areas Likely to be Developed

The sub-basins used in the sensitivity analysis were established in the *RMV Sediment Yield Technical Memorandum* (PWA, 2004). For planning purposes, the main tributary channels of Chiquita, Gobernadora, and Verdugo were used. Sub-basins analyzed include Chiquita 8 (4.7 sq. mi.), Chiquita 31 (4.6 sq. mi.), Gobernadora 63 (3.4 sq. mi.), and Verdugo 9 (4.8 sq. mi.).

Step 3: Identify a Range of Typical Receiving Channel Dimensions for Each Watershed Area

An empirical relationship developed by Coleman et al (2005), modified by Stein (County of San Diego, 2009) was used to express channel dimensions (width, depth, and, to a lesser extent, gradient) as a

function of dominant discharge (Q_{bf}, in cfs). The Stein and Coleman relationship was used because it: (1) produced more consistent and conservative results than the Hey-Thorne (1986) and Parker et al (2007) relationships: (2) resulted in Qcrit results within the range of values suggested for implementation in the SD HMP (0.1Q2, 0.3Q2, 0.5Q2): and (3) was general in that it did not require an assumption of D50. The geometry relationships are as follows:

$$\text{Width (ft)} = 0.6012 * Q_{bf}^{0.6875}$$
$$\text{Depth (ft)} = 0.3854 * Q_{bf}^{0.3652}$$

Q_{bf}, assumed to be approximately the 5-year peak discharge (Q_5), was estimated using the USGS regional regression for undeveloped watersheds in the South Coast region (Waananen and Crippen, 1977). This equation calculates Q_5 (cfs) as a function of watershed area (sq. mi.) and mean annual precipitation (MAP, in/yr), based on empirical observations of USGS gages. The relationship is:

$$Q_5 = 0.4 * \text{Watershed Area}^{0.77} * \text{MAP}^{1.69}$$

Manning's equation was used to iteratively find the slope for each channel dimension, such that the wetted cross sectional area at bankfull conveys the Q_5. Manning's equation is expressed as:

$$Q = \frac{1.49 A R^{0.67} S^{0.5}}{n}$$

Where:

Q = Flowrate (cfs)
A = Cross Section Flow Area (ft^2)
R = Hydraulic Radius (ft) = A / P
P = Wetted Perimeter (ft)
S = Energy Gradient Assumed Equal to Longitudinal Slope (ft/ft)
n = Manning Roughness (unitless)

The sensitivity analysis assumed a Manning Roughness value of 0.035, corresponding to a non-vegetated, straight channel with no riffles and pools. This reflects the small, ephemeral receiving channels which are prevalent in Southern California. A relatively low 'n' value was used at the request of the San Diego Regional Water Board in the development of the San Diego HMP.

Step 4: Identify a Range of Typical Channel Materials for Receiving Channels

The Chiquita and Gobernadora channels (along with several smaller tributaries of the central San Juan sub-basin) are predominantly sand-bedded, with little or no gravel or cobble content in the bed material (Balance, 2005). Because of the small sediment size and corresponding lack of armoring, significant amounts of sediment are transported even at relatively low-flows. A sand-bedded channel is the most typical channel type within the Ranch Plan Planned Communities area. The range of critical shear stress assumed to initiate mobilization of a sand-bed is between 0.025 lb/ft^2 and 0.05 lb/ft^2. While 0.025 lb/ft^2 is the value assumed by PWA in the San Diego HMP sensitivity analysis (County of San Diego, 2009), 0.05 lb/ft^2 is the recommended value of permissible shear stress per ASCE Manual No. 77 (1992) for sand-bedded channels containing a low content of fine sediment in the water. This range of values does not account for the effects of vegetation density on banks and channel irregularities, which would effectively increase the critical shear stress.

The channels within the upper Verdugo sub-watershed within or adjacent to RMV are predominately gravel-cobble bedded streams with coarse sand (Balance, 2005). The coarser sediment within these streams is a direct reflection of the geologic terrain within the upper portions of the sub-watershed, predominately composed of granitic and other crystalline metavolcanic rocks. Because of the larger bed-sediment size and bed structure within these channels, the bed is mobilized much less frequently than in purely sand-bedded streams. While the critical shear stress associated with a medium gravel-bed is

approximately 0.12 lb/ft^2, the values assumed for a sand-bed were also used in this sensitivity analysis for Verdugo as a conservative estimate.

Step 5: Identify the Flow Rate at Which Boundary Shear Stress Exceeds Critical Shear Stress for the Channel and Material

Using Manning's equation for the established channel cross section, roughness, and gradient (from Step 3), the flow depth was iterated until the average boundary shear stress equaled the critical value (from Step 4). Average boundary shear stress was calculated as:

$$\tau = \gamma R S$$

Where:

τ = Effective Shear Stress (lb/ft^2)
γ = Unit Weight of Water (lb/ft^3)
R = Hydraulic Radius (ft)
S = Longitudinal slope (ft/ft)

The resulting flowrate from this iterative process is Q_{crit}, or the flow rate at which boundary shear stress equals critical shear stress.

Step 6: Express the Flow Rate as a Function of Q_2

The 2-year peak discharge (Q_2) was calculated for each channel condition using the following USGS regional regression for the South Coast region (Waananen and Crippen, 1977):

$$Q_2 = 0.14 * \text{Watershed Area}^{0.72} * \text{MAP}^{1.62}$$

By dividing the calculated Q_{crit} (Step 5) by Q_2, the low flow threshold was calculated for each channel. The results are provided in Table 15-1 below.

Step 7: Group Critical Flowrates by Channel Material

The low-flow threshold for sand-bedded channels is approximately 5% Q_2 to 15% Q_2. For regional planning purposes (i.e., for preliminary sizing of hydromodification control facilities in the ROMP), 10% Q_2 will be assumed. This value is consistent with the minimum low-flow threshold of other HMPs in California, including the SOC HMP. Although gravel-bedded portions of the Verdugo channel will have a greater low-flow threshold (~69% Q_2), 10% Q_2 will be used throughout the project until a stream-specific analysis is conducted.

Table 15-1: Regional Critical Flow Analysis Results

	Trib Area	Mean Annual Precip	5-year Flowrate	2-year Flowrate	Critical Flowrate	Low-Flow Threshold	Bankfull Width	Bankfull Depth
	A	*MAP*	Q_5	Q_2	Q_{crit}	Q_{crit}/Q_2	*W*	*D*
Drainage ID	sq mi	in/yr	cfs	cfs	cfs	% of Q_2	ft	ft
τ_{crit} = 0.025 lb/ft^2, sand bed (low end)								
Chiquita 8	4.66	15	127	34	1.5	**4%**	16.8	2.3
Chiquita 31	4.58	15	125	34	1.4	**4%**	16.7	2.2
Gobernadora 63	3.40	15	100	27	1.0	**4%**	14.2	2.1
Verdugo 9	4.80	15	130	35	1.5	**4%**	17.1	2.3

Drainage ID	Trib Area *A* sq mi	Mean Annual Precip *MAP* in/yr	5-year Flowrate Q_5 cfs	2-year Flowrate Q_2 cfs	Critical Flowrate Q_{crit} cfs	Low-Flow Threshold Q_{crit}/Q_2 % of Q_2	Bankfull Width *W* ft	Bankfull Depth *D* ft
Chiquita 8	4.66	18	173	46	2.3	**5%**	20.8	2.5
Chiquita 31	4.58	18	171	45	2.3	**5%**	20.6	2.5
Gobernadora 63	3.40	18	136	36	1.6	**4%**	17.6	2.3
Verdugo 9	4.80	18	177	47	2.5	**5%**	21.1	2.6
τ_{crit} = 0.05 lb/ft^2, sand bed (high end)								
Chiquita 8	4.66	15	127	34	4.7	**14%**	16.8	2.3
Chiquita 31	4.58	15	125	34	4.6	**14%**	16.7	2.2
Gobernadora 63	3.40	15	100	27	3.3	**12%**	14.2	2.1
Verdugo 9	4.80	15	130	35	4.9	**14%**	17.1	2.3
Chiquita 8	4.66	18	173	46	7.5	**16%**	20.8	2.5
Chiquita 31	4.58	18	171	45	7.4	**16%**	20.6	2.5
Gobernadora 63	3.40	18	136	36	5.2	**14%**	17.6	2.3
Verdugo 9	4.80	18	177	47	7.8	**17%**	21.1	2.6
τ_{crit} = 0.12 lb/ft^2, gravel								
Verdugo 9	4.80	15	130	35	22.2	**64%**	17.1	2.3
Verdugo 9	4.80	18	177	47	34.8	**74%**	21.1	2.6

<u>Low Flow Threshold – Channel Specific</u>

The initial assumption of a low-flow threshold of 10% Q_2 will be revisited based on future channel specific investigations conducted for individual Planning Areas. A channel specific investigation requires both a hydrologic and geomorphic evaluation of the receiving channel downstream of the project outfall, as outlined below.

Hydrologic Evaluation of Q_2

The hydrologic evaluation requires calculating the pre-project 2-year peak flow (Q_2) at the channel sections of interest. In computing Q_2, the original condition of the watershed tributary to the stream, before development, shall be considered. This provides a means of apportioning the critical flow in a channel to individual projects that discharge to that channel, such that cumulative discharges do not exceed the critical flow (Q_{crit}) in the stream of concern. The Q_2 can be computed using a standard engineering method for calculating the peak flow for a 2-year return period storm event (e.g., per Orange County Hydrology Manual or USGS regional regression). It is preferred that Q_2 be estimated based on a flow gage record in the receiving stream or a continuous hydrologic model, if available. Partial duration series analysis, per Section 15.2.1.1, should be utilized to evaluate Q_2 if continuous flow data is available.

Geomorphic Evaluation

The geomorphic evaluation requires surveying the cross section and longitudinal profile geometry of the active channel, estimating the hydraulic roughness of the channel, and evaluating the critical shear stress (pounds per square foot) of the most sensitive bed and bank material. Using normal-flow hydraulics or a

one-dimensional hydraulic model (i.e., HEC-RAS) for the central portion, or active bed, of the channel, Q_{crit} can be evaluated as the discharge needed to generate the critical shear stress. To account for the effects of vegetation density and channel irregularities, a method for partitioning the applied shear stress into form and bed/bank roughness components can be performed as well.

Normalizing Q_{crit}

For management purposes and ease of implementation, the Q_{crit} is normalized by dividing it by the Q_2 so that Q_{crit} can be expressed as a fraction of Q_2. This will allow for the determination of the low-flow threshold from a specific project area.

15.2.2 HMP Applicability Requirements

A HMP Decision Flowchart is provided for the Ranch Plan Planned Communities in Figure 15-2. Each decision node of Figure 15-2 is described below.

- Node 1 – All development in RMV is a PDP.
- Node 2 – Properly designed energy dissipation systems are required for all project outfalls to unlined channels. Such systems should be designed in accordance with the Orange County Local Drainage Manual (1996) to ensure downstream channel protection from concentrated outfalls.
- Node 3 – Potential exemptions from hydromodification requirements may be granted for projects discharging runoff directly to an exempt receiving water. The SOC HMP identifies San Juan Creek as exempt from hydromodification requirements. Exempt receiving waters for RMV are further discussed in Section 15.2.3 below.
- Node 4 – For projects discharging runoff directly to a hardened conveyance or rehabilitated conveyance system that extends to exempt receiving waters detailed in Node 3, potential exemptions from hydromodification criteria may be granted. Such hardened or rehabilitated systems could include existing storm drain systems, existing concrete conveyance channels, or stable engineered unlined conveyance channels that are not receiving waters. To qualify for this exemption, the existing hardened or rehabilitated conveyance system must continue uninterrupted to the exempt system.
- Node 5 - The project proponent must demonstrate that the hardened or rehabilitated conveyance system has the capacity to convey the 10-year ultimate condition flow through the conveyance system without significant channel erosion. The 10-year flow should be calculated based upon single-event hydrologic criteria as detailed in the Orange County Hydrology Manual (1986).

15.2.3 HMP Exemptions

The SOC HMP includes an exemption for large river reaches. As stated in the plan, the effects of cumulative watershed impacts are minimal in stream reaches of large depositional rivers. These large rivers typically have very wide floodplain areas when in the natural condition or are stabilized when in the engineered condition, and are of low gradient. A flow duration curve analysis that was performed for the San Diego HMP demonstrated that the effect of cumulative watershed impacts are minimal in those reaches for which the contributing drainage area exceeds 100 square miles and with a 100-year design flow in excess of 20,000 cfs (County of San Diego, 2009). Development projects that discharge either directly or via a conveyance system designed to convey the 10-year ultimate condition into such large river streams are hence exempt from the SOC HMP requirements, provided that properly sized energy dissipation is implemented at the outfall location and the discharge occurs within the 10-year floodplain (or other location approved by the County) and does not create local scour. On this basis, the SOC HMP identifies San Juan Creek as exempt from hydromodification requirements from the outfall to Pacific Ocean to Casper Park Road (upstream of the Ranch Plan boundary).

Similarly, the Conceptual WQMP (Geosyntec, 2004) established that, although the tributaries to San Juan Creek are susceptible to hydromodification impacts, the mainstem of San Juan Creek is not susceptible to hydromodification impacts from direct discharges from the planned Ranch Plan development. As stated in the Conceptual WQMP, San Juan Creek, given its watershed and channel characteristics, is

considered to be able to accept additional flows without causing erosion. This conclusion was based on the watershed/sub-watershed-based hydrologic and fluvial geomorphologic studies and planning principles used to develop the Ranch Plan (Geosyntec, 2012). The resiliency of San Juan Creek is described by Balance Hydrologics (2005) as follows:

> "The intrinsic resilience of these larger channels [San Juan Creek and lower Gabino channels] – which have a very similar channel form as that reflected in 1938 aerial photographs or 1947 topographic maps (PCR, 2002) – is coupled with the proportionately smaller project-related discharges to minimize hungry-water effects on these two channels. In addition, these larger watersheds are inherently more dynamic systems than the side canyons, and better able to modulate the effects of any slight downstream erosion that may occur."

Specific sections and text from the EIR (County of Orange, 2006) and Conceptual WQMP (Geosyntec, 2004) that documents the large river exemption are identified below:

- Mitigation Measure 4.5-6 and Conceptual WQMP section 3.4.1 (pg. 65,66) state that "San Juan Creek or Lower Cristianitos Creek, have characteristics that allow them to handle additional flows without causing damage to the stream channel."

- The Conceptual WQMP section 4.2.3 (pg.99) states that, "Where flow duration control is not necessary, as in Catchment 18, that discharges directly to San Juan Creek, an extended detention (ED) water quality basin has been provided."

- Tables 4-7 and 4-11 in the Conceptual WQMP identify facilities (Chiquita-18 and Gob-1) which require water quality treatment only. The tables state that, "No flow control assumed to be required as discharge directed to San Juan Creek."

Of the twenty one (21) outfalls[5] associated with Planning Areas 2 through 5 identified in the ROMP, twelve (12) outfalls are exempt from the HMP Criteria because they discharge directly to San Juan Creek or are routed through continuous hardened conveyances which discharge to San Juan Creek. These include Outfalls 5, 7, 10, 12, 13, 15, 17, 20 to 22, 24, and 25[6] (shown on Figure 15-1). Basins at these outfalls will be designed and sized for water quality control. The position and design of these outfalls will be addressed as part of the local hydrology studies.

Direct discharges within the 10-year floodplain of San Juan Creek may require the following additional permits:

- CEQA/NEPA review
- California Department of Fish and Game – 1602 Streambed Alteration Agreement
- US Fish and Wildlife Service – Authorization Under the Endangered Species Act
- US Army Corps of Engineers – Nationwide 404 Permit
- Regional Water Quality Control board – 401 Water Quality Certification
- Local Grading Permit

15.2.4 HMP Alternative Compliance

All development in the Ranch Plan Planned Communities will meet the RMV HMP Criteria using hydromodification management measures implemented within the RMV boundary, as shown on Figure 15-1. Alternative methods for HMP compliance, including off-site mitigation and jurisdictional mitigation banking, as described in Sections 4.4.1 and 4.4.2 of the SOC HMP, will not likely be used for the Ranch

[5] There are 27 total permitted outfalls. Outfalls 6, 8, 11, 14, 16, and 23 are not used at this time. If used in the future, the HMP Criteria would apply to Outfall 8, but Outfalls 6, 11, 14, 16, and 23 would be exempt.
[6] Outfalls 24, and 25 will be conveyed via pipe to San Juan Creek.

Plan Planned Communities. Nonetheless, considerations for implementing off-site mitigation and jurisdictional mitigation banking options are briefly discussed below.

15.2.4.1 Off-Site Mitigation

From the perspective of the SOC HMP, off-site mitigation applies to regional detention/retention facilities and in-stream restoration that are outside of the project boundary, because the typical frame of reference for a PDP is one that is small relative to its watershed. However, because RMV has a boundary which encompasses large planning areas and many receiving streams, on-site mitigation measures at RMV include hydrologic source control measures, on-site (parcel or project-based) management controls, and regional controls located upstream of receiving waters. Thus, what the SOC HMP refers to as "on-site", the RMV HMP calls "distributed", and what the SOC HMP refers to as "off-site" the RMV HMP calls "regional." The RMV HMP also considers distributed and regional management measures to be classified as "out-of-channel," whereas in-stream restoration is termed "in-channel." Due to the special nature of the Ranch Plan Planned Communities projects, there is not expected to be any "off-site" mitigation (i.e., outside of the RMV boundary).

15.2.4.2 Jurisdictional Mitigation Banking

As described in the SOC HMP, each Copermittee has the option to develop a jurisdictional HMP mitigation bank which will develop regional HMP mitigation projects where PDPs can buy HMP mitigation credits if it is determined that implementing on-site hydromodification controls is infeasible (County of Orange, 2011). A regional HMP mitigation bank is not a viable HMP alternative compliance option for RMV, although one could consider the planned hydromodification control regional facilities listed in the ROMP to serve as an HMP mitigation bank for the projects tributary to each applicable outfall within the Ranch Plan Planned Community identified on Figure 15-1.

15.2.5 Tiered Requirements

The Ranch Plan Planned Community is considered a Tier 1 PDP per the SOC HMP, meaning that it is composed of development projects in a common initial or phased development plan that exceeds 100 acres (County of Orange, 2011).

Pursuant to MS4 Permit item F.1.d.(11), implementation of regional control systems for hydromodification may be considered. Overall, either of the following approaches may be pursued by Tier 1 projects:

- Meet the HMP Criteria identified in Section 15.2.1 by mitigating flow and duration through on-site hydrologic control measures and addressing sediment loss through on-site management controls.
- Implement regional control systems in lieu of on-site management controls, consistent with the language in permit item F.1.d.(11).

15.2.6 Hydrologic Management Measures

PDPs are encouraged to use the full suite of hydrologic management measures (HMMs) available to meet the hydrologic HMP Criteria identified in Section 15.2.1. The intent of the HMP is not to specify the types of HMMs that must be used but rather identify the criteria that RMV will apply to select management measures to meet the HMP Criteria. The following sections provide a discussion of HMMs available to meet the hydrologic HMP Criteria in Section 15.2.1. These options are summarized in terms of structural versus non-structural measures.

15.2.6.1 Non-Structural HMMs

The following non-structural HMMs provide hydrologic source control for the Ranch Plan Planned Community. These HMMs were considered in the development of the land use plan for the project.

Minimization of Impervious Areas / Preservation of Open Spaces

Project design to minimize impervious areas reduces the increase in runoff volumes and rates that need to be managed. Undeveloped areas with un-compacted soils also provide opportunities for infiltration of

impervious area runoff, and help to preserve the pre-development water budget (consisting of infiltration, evapotranspiration, percolation, subsurface flows, groundwater recharge, and surface runoff). Areas that are outside of the planning area boundaries will be conserved as natural open space, unless otherwise permitted in the future (e.g., for purposes of conveyance of flows to the 10 year floodplain).

Prioritize Soils for Development and Infiltration

Development within the Ranch Plan Planned Community is located preferentially on existing poorly infiltrating soils, leaving soils with good infiltration rates as areas for flow and volume management and groundwater recharge. If development is to occur on well infiltrating soils, then incorporation of on-site infiltration facilities will help compensate for the loss if infiltration associated with the development.

Establish Riparian Buffer Zones

Established riparian buffer zones, where no development is allowed, prevents direct impacts to riparian habitat in multiple ways. Benefits of riparian buffer zones include: helping to stabilize channel geometry and retain bed and bank materials that otherwise can contribute to increased erosion; sustainably supporting habitat for flora and fauna that existed prior to development; maintaining the degree of native wood and leaf debris input into the creek system; filtering stormwater runoff before it enters the receiving stream; and maintaining the hydrologic connectivity between channels and floodplains. Finally, if runoff can be routed through the buffer, it can provide attenuation and infiltration to reduce the volume of runoff entering the channel. Extensive riparian buffer zones have been provided along San Juan Creek and the tributaries within the Ranch Plan Planned Community as a result of the Southern Natural Community Conservation Plan/Habitat Conservation Plan (Southern NCCP/HCP) and Special Area Management Plan (SAMP) planning process.

15.2.6.2 Structural HMMs

Structural HMMs are classified in the RMV HMP as distributed, regional, or in-channel. Distributed HMMs are smaller-scale facilities that receive runoff from a parcel, a portion of one parcel, or several neighboring parcels. Regional HMMs are larger-scale facilities that receive runoff from multiple parcels and are located adjacent to an outfall. In-channel HMMs receive runoff from the entire watershed tributary to it. Figure 15-3 illustrates these three (3) types of HMMs.

Distributed Volume and Flow Management

A variety of volume/flow management structural measures are available that utilize the following two (2) basic principles:

- Detain runoff and release it in a controlled way that either mimics pre-development in-stream sediment transport capacity, mimics flow durations, or reduces flow durations to account for a reduction in sediment supply.
- Manage excess runoff volumes through one (1) or more of the following pathways: infiltration, evapotranspiration, storage and use, discharge at a rate below the critical low-flowrate, or discharge downstream to a stream that has constructed channel and is not susceptible to erosion.

Distributed facilities are smaller-scale facilities, typically treating runoff from less than ten (10) acres. These types of facilities typically include LID BMPs as defined in the Model WQMP and Technical Guidance Document, but may also include hydromodification control detention-type facilities such as underground vaults and pipes. LID BMPs, typically be sized to achieve the LID performance standard, may be enlarged to accommodate hydromodification control. Distributed facilities are most feasible where the land use is lower density.

Regional Detention / Retention Basins

Regional detention/retention basins, or ponds, are large scale stormwater management facilities that are designed to detain or infiltrate runoff from multiple parcels or project areas. These basins are typically shallow with flat, vegetated bottoms. Regional basins can be constructed by either excavating a depression or building a berm to create above ground storage, such that runoff can drain into the basin by gravity. Runoff is stored in the basin as well as in the pore spaces of the surface soils. Pre-treatment BMPs such as swales, filter strips, and sedimentation forebays minimize fine sediment loading to the basins, thereby reducing maintenance frequencies.

Regional basins for hydromodification management incorporate outlet structures designed for flow duration control. These basins can also be designed to support flood control and LID objectives in addition to hydromodification. If underlying soils are not suitable for infiltration, the basin may be designed for flow detention only, with alternative practices to manage increased volumes, such as storage and use, discharge at a rate below the critical rate for adverse impacts, or discharge to a non-susceptible water body, as well as to meet the LID objectives.

To the maximum extent possible, regional basins should be designed to receive flows from developed areas only. This facilitates design optimization as well as avoiding intercepting coarse sediments from open spaces that should ideally be passed through to the stream channel. Reductions in coarse sediment loads contribute to channel instability, as discussed in Section 15.3.

In-Channel Stabilization

Hydromodification management can also be achieved by in-channel measures, including drop structures, grade control structures, bed and bank reinforcement, increased channel sinuosity, and increased channel width. The objectives of these in-channel controls is to reduce or maintain the overall erosion potential (Ep) of the stream by modifying the receiving channel hydraulic properties and bed/bank material resistance without fully controlling runoff. Per the MS4 Permit, in-stream structural measures are only an option where the stream which receives runoff from the project is already impacted by erosive flows and shows evidence of excessive sediment, erosion, deposition, or is a hardened channel.

In-channel stabilization outside of the Planning Area boundaries would have to be permitted by the resource agencies on a case-by-case basis. In addition to meeting the HMP requirements, in-channel stabilization outside of the Planning Area boundary may require the following permits:

- CEQA/NEPA review
- California Department of Fish and Game – 1602 Streambed Alteration Agreement
- US Fish and Wildlife Service – Authorization Under the Endangered Species Act
- US Army Corps of Engineers – Nationwide 404 Permit
- Regional Water Quality Control board – 401 Water Quality Certification
- Local Grading Permit

<u>Drop Structures</u>

Drop structures are designed to reduce the channel slope, thereby reducing the shear stresses generated by stream flows. These controls can be incorporated as natural appearing rock structures with a step-pool design which allows drop energy to be dissipated in the pools while providing a reduced longitudinal slope between structures.

<u>Grade Control Structures</u>

Grade control structures are designed to maintain the existing channel slope while allowing for minor amounts of local scour. These control measures are often buried and entail a narrow trench across the width of the stream backfilled with concrete or similar material, as well as the creation of a “plunge pool” feature on the downstream side of the sill by placing boulders and vegetation. A grade control option provides a reduced footprint and impact compared to drop structures, which are designed to alter the channel slope.

Bed and Bank Reinforcement

Channel reinforcement serves to increase bed and bank resistance to stream flows. A number of vegetated approaches are increasingly utilized. Such approaches include large woody debris, live crib walls, vegetated mechanically stabilized earth, live siltation, live brushlayering, willow posts and poles, live staking, live fascine, rootwad revetment, live brush mattresses, and vegetated reinforcement mats. These technologies provide erosion control that stabilizes bed and bank surfaces and allows for re-establishment of native plants, which serves to further increase channel stability.

Channel Sinuosity

Increasing channel sinuosity (ratio of channel distance between two (2) points to straight line distance) can serve to reduce the channel slope, thereby reducing the shear stresses generated by stream flows. However, forcing a channel to be too sinuous is likely to lead to subsequent channel avulsion to a straighter course. Channel sinuosity needs to be supported by a geomorphic basis of design that shows the proposed form and gradient to be appropriate for the valley slope and sediment and water regime. This may take the form of reference reaches in similar watersheds that have supported the proposed morphology over a significant period of time, or comparison between the proposed form and typical literature values (San Diego County, 2009).

Channel Widening

Increasing the width-to-depth ratio of a stream's cross section is meant to spread flows out over a wider cross section with lower depths, thereby reducing shear stress for a given flow rate. This approach can be a useful mitigation strategy in incised creeks to bring them back to equilibrium conditions once vertical incision has ceased. As with sinuosity, it is important to develop a robust geomorphic basis of design that shows the increase in width-to-depth ratio to be sustainable (San Diego County, 2009).

15.2.6.3 Selection and Design of HMMs

Selection and design of HMMs is an iterative process that has been developed as part of the SOCHM. The SOCHM has a comprehensive menu of hydrologic site design measures and hydrologic management measures that can be selected for implementation. The design parameters for these hydrologic measures have been incorporated into the SOCHM and can be modified based on site constraints. Selection and design of HMMs is therefore addressed in the SOCHM. Currently SOCHM is not programmed to take into account sediment supply reduction, as described in Section 15.3.

As mentioned in Section 15.2.1.1, SWMM is another viable continuous hydrologic simulation method to demonstrate compliance with the hydrologic HMP Criteria and size HMMs. Guidance for performing a flow duration control analysis without SOCHM is provided in Appendix A. Guidance for performing erosion potential (Ep) analysis is provided in Appendix B.

Pretreatment is required for HMMs in order to reduce the sediment load entering the facility and maintain the infiltration rate of the facility. Pretreatment refers to design features that provide settling of particles before runoff reaches a management practive: easing the long-term maintenance burden. Pretreatment is particularly important for HMMs, which infiltrate runoff. To ensure that pretreatment mechanisms are effective, designers should incorporate sediment reduction practices. Sediment reduction BMPs may include vegetated swales, vegetated filter strips, sedimentation forebays, sedimentation manholes and hydrodynamic separation devices, or similar BMPs.

15.2.6.4 Inspection and Maintenance of HMMs

Maintenance for HMMs is critical to ensure their optimal operation. PDPs are conditioned to provide verification of inspections and maintenance operations as defined in Section 7.II-4.0 of the Model WQMP. The list of such inspection and maintenance operations is included in the ROMP and shall be included in the future Ranch Plan Planned Community WQMPs. Maintenance activities shall ensure that the systems

are properly controlling flow rates and durations to ensure the HMP criteria are being met and inspections shall document the maintenance activities performed and that the hydrologic control measure is functioning properly.

15.3 Hydromodification Sediment Standards

15.3.1 Sediment Supply Management

The purpose of this section is to discuss measures that can help maintain the pre-development delivery of bed material to receiving streams following urbanization. The general approach to ensure maintenance of the pre-project bed sediment supply includes the following:

- Determine whether the site is a significant source of bed material to the receiving stream.
- Avoid significant bed material supply areas in the site design.
- Pass through sediments from undeveloped open spaces to the receiving channel.
- Replace significant bed material supply areas that are eliminated through urbanization.
- An alternative compliance option includes providing additional mitigation in-site runoff to compensate for the reduction of bed material.

15.3.2 Bed Sediment Supply Evaluation

The first non-exempt channel downstream of a project discharge point, or outfall, will serve as the upstream limit of the "receiving" channel for the project. Generally, hydromodification and sediment supply effects are expected to decrease as more undeveloped area contributes to the receiving channel in the downstream direction, thus limiting the downstream extent of impact. Receiving streams of interest which are downgradient of the nine (9) outfalls for which the HMP Criteria apply are shown on Figure 15-1. Of these nine (9) outfalls, two (2) discharge directly to mainstem tributary channels (i.e. Chiquita, Gobernadora, or Verdugo Creek) (Outfalls 1 and 19), six (6) discharge to side tributaries of those mainstem channels (Outfalls 2, 3, 4, 9, 18, and 27) and one (1) discharges to a side tributary into San Juan Creek (Outfall 26). Reductions in sediment supply are anticipated to be greatest for those outfalls discharging to side tributary channels because the ratio of proposed development area to total drainage area is largest in these small channels[7]. The bed sediment supply evaluation methodology applies only to side tributary channels.

The end result of the methodology presented below is to designate the receiving channel's potential for adverse response due to bed-load reduction as High, Medium, or Low. This designation relates directly to how Sediment Management Measures (SMMs) are to be selected (see Section 15.3.3 below). The following steps shall be performed for the drainage area tributary to the receiving channel to evaluate whether the development significantly reduces bed material[8]:

1. Identify sediment supply sources.
2. Estimate the base erosion rate of sources.
3. Approximate the sediment delivery ratio of sources.
4. Evaluate the bed-load proportion of sources.
5. Calculate the bed-load yield rate of sources.
6. Identify sources to be eliminated after development.
7. Calculate the total pre- and post-development bed-load yield.
8. Compare the total pre- and post-development bed-load yield.
9. Designate receiving stream's potential for adverse response (High, Medium, or Low).

[7] Those outfalls which are shown to discharge to side tributaries can discharge further downstream directly to a mainstem tributary channel if such a discharge is permitted by the appropriate resource agencies, similar to Section 15.2.3.
[8] The bed sediment supply evaluation is conducted for all areas (developed and undeveloped) tributary to the receiving channel, not only the tributary area to the outfall.

15.3.2.1 Step 1: Identify Sediment Supply Sources

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), for the purposes of the RMV HMP, these will be simplified to sediment production from ***hillslopes*** and ***channels***. Past hydromodification studies related to sediment supply have focused primarily on hillslope processes and not channel processes. In-channel erosion, however, is a concentrated source of bed sediment supply and this resource should be accounted for in project planning.

The domain of analysis for identifying sediment supply sources is the sub-watershed or catchment tributary to the receiving channel. There will be large undeveloped areas retained after project development and these areas, as well as their channels, should be included in this analysis as they are important sources of bed sediment.

Hillslopes

Areas where hillslope erosion processes are similar have been mapped previously for the San Juan Creek watershed by Balance Hydrologics as part of the *Baseline Geomorphic and Hydrologic Conditions Report* (PCR, 2002). This map (see Figure 15-4) is similar to those described in *SCCWRP Technical Report 605* (2010a), which documents a process to predict likely effects of hydromodification based on potential change in sediment discharge. The methodology described in *Technical Report 605* is a GIS-based catchment analysis which distinguishes Geomorphic Landscape Units (GLUs) based on geology types, hillslope gradient, and land cover. Grain size distributions associated with the surficial soil of each GLU within the receiving stream tributary area will be quantified with available sieve analysis results. If existing data is not available, new sediment samples will be obtained where development is proposed using the surface and subsurface bulk sample technique (USACE, 2007).

Channels

Examination of banks along a variety of stream orders discloses the distribution and types of bank erosion processes and usually reveals the factors that control their distribution (Reid, 1996). Sources of bank erosion and bed incision will be identified during a geomorphic field assessment of a subset of channels and aerial photograph review of all channels tributary to a receiving channel. Channels with similar bed and bank erosion processes will be distinguished into Geomorphic Channel Units (GCUs). Distinguishing GCUs will involve locating and mapping erodible banks and bar deposits of a subset of channels[9] and then extrapolating the field findings to similar channels in the drainage area of interest. Stream order is one appropriate basis for categorizing GCUs. Field work will be prioritized to channels within the development boundary. As part of the field assessment the following activities will be conducted:

- Vertical and lateral channel susceptibility to erosion will be assessed according to *SCCWRP Technical Report 606* (2010b). This procedure includes assessing the receiving channel and a subset of the upgradient lower order channels for bank stability, degree of incision, and bed and bank material gradation[10].
- Bank Erosion Hazard Index (BEHI)[11] and Near-Bank Stress (NBS) ratings (Rosgen, 2006) will be assigned based on the vertical and lateral channel susceptibility assessment.
- An estimation will be made as to whether the receiving stream is transport or supply limited.

[9] Erosion of alluvial sediment within the channel will be characterized in the field, but it does not traditionally count as sediment production unless the eroding deposits are relics of earlier conditions (Reid, 1996). Large areas of alluvial sediment should be delineated as a unique GLU.

[10] For bed and bank material gradations, samples will be taken using the surface and subsurface bulk sample technique (USACE, 2007). Where available, existing grain size distributions should be utilized.

[11] Included within the BEHI methodology is an assessment of vegetation's role in bank stability. Factors used to assess vegetation's influence on bank stability are, ratio of root depth to overall bank height, weighted root density, and percent surface protection. Other factors used in the BEHI methodology are bank angle, and ratio of overall bank height to bankfull height.

15.3.2.2 Step 2: Estimate the Base Erosion Rate of Sources

While erosion rates of the hillslopes and channels tributary to the receiving stream will be estimated independently, per the methods below, relative contributions of each will serve as a quality check on these estimates. According to a regional sediment yield map of the Western US (USDA, 1974), hillslope processes account for approximately 40% of sediment production in the RMV region, while channel processes account for approximately 60%. Previous studies on sediment yield rates (tons/mi^2-yr) in the San Juan Creek Watershed are summarized in Table 15-2. Calculations by Taylor (1981) are believed to provide a reasonable range for RMV and are summarized in Table 15-3 for major sub-watersheds tributary to San Juan Creek. A breakdown of area and length of the GLUs and GCUs situated within these sub-watersheds will allow an iterative adjustment of erosion rates (tons/mi^2-yr and tons/mi-yr) until the estimates are comparable with the results.

Hillslopes

To compare relative differences in erosion rates the following factors should be compared for each GLU:

- soil erodibility (K),
- topographic relief (slope gradient),
- vegetative cover, and
- lithology

Once base erosion rates are defined for each GLU (tons/mi^2-yr) they can be multiplied by the acreage tributary to its downstream receiving channel, resulting in total sediment production (tons/yr) associated with hillslope erosion.

Channels

Based on the vertical/lateral channel susceptibility observations, a sediment-load rate category for each GCU (tons/mi-yr) will be created to predict bank erosion and bed incision material contributions. When applied to channel lengths of similar order, the total sediment production (tons/yr) associated with channel erosion can be estimated.

Table 15-2: Published Annual Sediment Yield Estimates in the San Juan Creek Watershed

Rate (tons/mi^2-yr)	Author	Comments
1,500 to 6,000	Taylor	Highest in mountainous areas, lower in foothills.
1,230	Kroll & Porterfield	Based on measurements taken during 1967-1968. Rating curve applied to gauging record.
1,700 to 3,400	Soil Conservation Service	Western US Regional Map

Table 15-3: Estimated Sediment Attributes by Sub-Watershed

Basin Parameter	Source of Data	Chiquita Watershed			Gobernadora	Verdugo	Central San Juan	
		Upper	Lower	Total			Lower	Upper
Drainage Area (sq mi)	Baseline Report (PCR, PWA, BH, 2002)	4.57	4.64	9.21	3.39	4.79	4.59	7.41
Sediment Transport Limited By	Baseline Report (PCR, PWA, BH, 2002)	supply	supply	supply	supply	transport	supply	supply
Estimated Average Annual Sediment Yield (tons/sq mi)	Baseline Report (PCR, PWA, BH, 2002)	3060	3060	3060	2918	3131	2500	3000
Estimated Sediment Delivery Ratio from 1938	photointerpretation (BH, unknown)	0.15	0.20	0.17	0.10	0.45	0.15	0.25
Estimated Proportion of Sediment Yield as Bedload	Baseline Report (PCR, PWA, BH, 2002)	0.10	0.05	0.08	0.05	0.50	0.25	0.25
Estimated Bedload Yield (tons/ sq mi)	Sediment Yield * Delivery Ratio * Proportion	46	31	42	15	704	94	188
Percentage of Long-Term Sediment Yield Delivered by Episodic Events	Geomorphologic Factors Report (BH, 2005)	>40%	40%	>40%	>40%	>40%	20%	30%

15.3.2.3 Step 3: Approximate the Sediment Delivery Ratio of Sources

Not all erosion that takes place is delivered directly to the receiving stream because of sediment deposition on the landscape between the source and the receiving stream.

Hillslopes

Balance Hydrologics (2005) estimated the sediment delivery ratio to major tributary channels of San Juan Creek, provided in Table 15-3. It is anticipated that the sediment delivery ratio to upgradient side tributary channels is greater than or equal to the delivery ratio estimated for points summarized in Table 15-3. This is due to the fact that sediment deposition occurs upgradient of the calculation points shown in Table 15-3. Estimates of sediment delivery ratio for the side canyons can be refined using a sediment yield model such as GeoWEPP[12], if needed in future WQMP preparation.

Channels

The sediment delivery ratio for channel erosion in side tributary channels shall be assumed to be 1.0, unless there is clear evidence otherwise, because bank erosion and bed incision are considered direct inputs to the reach channel system.

15.3.2.4 Step 4: Evaluate the Bedload Proportion of Sources

Not all sediment source material delivered to the receiving channel contributes to its bed-load. The proportion of the source material finer than the receiving stream's bed material is assumed to contribute to suspended wash-load, while the proportion of the source material that is coarser than the bed material is assumed to deposit prior to reaching the receiving stream. Utilizing a geotechnical and sieve analysis of the bulk sediment samples collected, the grain size distribution of the receiving stream bed material shall be compared to that of the source material to evaluate the bed-load proportion of both hillslope and channel sediment sources.

Hillslopes

The sieve analysis for each bulk sample taken should report the grain size distribution in accordance with ASTM D 422, and provide a Unified Soil Classification System (USCS) designation (e.g., SW and ML). An example of a particle size distribution chart that should be produced is provided in Figure 15-5. The grain diameters associated with the coarsest 90, 50, and 10% (by weight) of the material (D90, D50, and D10) shall be reported as well[13]. To evaluate the bed-load proportion of hillslope sediment sources, the range of receiving channel bed grain sizes will be highlighted on the grain size distribution plot for the hillslope bulk samples. The percentage of hillslope material that is within the bed-load range will be considered the bed-load proportion. A similar comparison should be done for the grain sizes ranging between D90 and D10, to reduce the tail effects at the upper and lower ends of the distribution plots. The calculated bed-load proportions can be compared to those provided on Table 15-3 for the mainstem tributary channels. Based on the results, a bed-load proportion will be selected for each GLU.

Channels

The sieve analysis and comparison of grain size distribution described for hillside sources shall be done for bank erosion and bed incision source material. Based on the results, a bed-load proportion will be assigned to each type of bank erosion and bed incision sediment source (GCU).

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[12] GeoWEPP is a geo-spatial interface for the Water Erosion Prediction Project, which is a continuous simulation, process-based model produced by the US Department of Agriculture (USDA) to estimate sediment yield of agricultural, rangeland, and forested landscapes (LESAM 2008). The key inputs to GeoWEPP are topography, soil type, land cover, and precipitation.

[13] Although the most commonly used grain sizes for geomorphic analysis are the D84, D50, and D16, Reporting of D90 and D10 are considered common for geotechnical analyses. If necessary the D84 and D16 can be determined directly from the grain size distribution chart.

15.3.2.5 Step 5: Calculate the Bed-load Yield Rate of Sources

The total bed-load yield will be calculated by summing that of the hillslope and channel sources. The method of calculating the pre- and post-development bed-load yields for each contributing source is described below.

Hillslopes

The bed-load yield rate (tons/mi^2-yr) for each GLU shall be calculated by multiplying the base erosion rate (Step 2), sediment delivery ratio (Step 3), and bed-load proportion (Step 4). Where appropriate, multiple GLUs can be grouped together into classifications of bed-load potential (i.e., Primary, Moderate, or Insignificant) so that one (1) yield rate is assigned to all GLUs in this group. Such a classification has been created for the San Juan watershed by Balance Hydrologics (2005) to identify beach material sources. A map of these groupings is provided on Figure 15-6 and the logic tree used to create the classifications is on Figure 15-7. It is anticipated that this same classification of GLUs will be used for the Ranch Plan Planned Communities because the bed material in the receiving streams is generally consistent with the coarse-grained sand important to beach sand supply.

Channels

The bed-load yield rate (tons/mi-yr) for each GCU is calculated by multiplying the base erosion rate (Step 2), sediment delivery ratio (Step 3), and bed-load proportion (Step 4) associated with each GCU tributary to the receiving stream. Where appropriate, multiple GCUs can be grouped together into classifications of bed-load potential (i.e. Primary, Moderate, or Insignificant) so that one (1) yield rate is assigned to all GCUs in this group.

15.3.2.6 Step 6: Identify Sources to be Eliminated After Development

Sediment generated from proposed development and areas tributary to future sediment sinks (including HMMs) are removed in the post-development condition. This will result in an overall reduction in long-term bedload supply due to urbanization. GLUs and GCUs tributary to the receiving stream that will be eliminated after development should be identified.

15.3.2.7 Step 7: Calculate the Total Pre- and Post-Development Bed-load Yield

The total bed-load yield will be calculated by summing the contributions from hillslope and channel sources.

Hillslopes

The total bed-load yield (tons/yr) associated with hillslopes tributary to the receiving stream shall be calculated by multiplying the GLU bed-load yield rate (Step 5) by its respective GLU area. The total pre-development bed-load yield is then calculated by summing the bed-load yield for all GLUs tributary to the receiving stream. The total post-development bed-load yield is calculated by summing the bed-load yield of all tributary GLUs not eliminated by urbanization (Step 6).

Channels

The total bed-load yield (tons/yr) associated with channels tributary to the receiving stream shall be calculated by multiplying the GCU bed-load yield rate (Step 5) by its respective GCU length. The total pre-development bed-load yield is then calculated by summing the bed-load yield for all GCUs tributary to the receiving stream. The total post-development bed-load yield is calculated by summing the bed--load yield of all tributary GCUs not eliminated by urbanization (Step 6).

15.3.2.8 Step 8: Compare the Total Pre- and Post-Development Bed-load Yield

Sediment supply potential (Sp) is the ratio of total bed-load yield in the post-development conditions to that in the pre-development condition (post-development/pre-development). Sp shall be calculated for each receiving channel.

15.3.2.9 Step 9: Designate Receiving Stream's Potential for Adverse Response (High, Medium, or Low)

Based on the Sp results, the receiving stream shall be designated into one (1) of the following categories for potential of adverse response due to bed-load supply reduction. The threshold values below can be modified at the individual planning area level as appropriate based on a geomorphic analysis of whether the receiving channel is supply or transport limited[14]:

- High: Sp < 0.5 (bed sediment supply reduction is greater than 50%)
- Medium: 0.5 $\leq$ Sp < 0.9 (bed sediment supply reduction is between 10% and 50%)
- Low: 0.9 $\leq$ Sp $\leq$ 1.0 (bed sediment supply reduction is less than 10%)

Justification for the bed sediment supply loss thresholds are provided below.

High to Medium Threshold (Sp = 0.5):

Fifty percent bed sediment supply reduction is assumed to be a critical threshold value for the channels within the Ranch Plan Planned Community because at that level of reduction, a typical transport limited stream is at risk of becoming supply limited. This assumption is justified by the following statement in the RMV *Baseline Geomorphic and Hydrologic Conditions* report (PCR, 2002):

> For all methods, calculated sediment yields that attempt to quantify the amount of material available for stream transport exceed estimates and measurements of transported sediment-loads by more than a factor of 2. This may accurately reflect the condition of watersheds in an arid environment, where far more material is weathered and eroded than can typically be conveyed to and transported by local stream systems.

Altering a stream such that it transitions from being transport limited to supply limited can result in severe hydromodification impacts in the form of channel adjustment, particularly for sand bedded streams. A local example of such steam instability is Gobernadora Creek, which has experienced reductions in bed sediment supply as well as increases in runoff due to the upstream Coto de Caza development. Gobernadora Creek has responded to hydromodification through channel avulsion (Figure 15-8) and incision (Figure 15-9) (Balance, 2006).

Medium to Low Threshold (Sp = 0.9):

Soar and Thorne (2001) indicate that a greater than 10% reduction in sediment supply can have potentially significant effects on stream stability. On this basis, the 10% value is used as a quantitative significance threshold. It should be noted that sediment transport and supply measurements and calculations are inherently inexact. Discrepancies of up to 10% should not be a source of concern (PCR, 2002). With this in mind, both the hydrologic and sediment supply HMP criteria allow for a 10% variance without assumed negative impact.

15.3.3 Sediment Management Measures

Similar to hydrologic management measures (HMMs), sediment management measures (SMMs) include both non-structural and structural controls. A receiving stream designated as having "Low" potential for adverse impact due to bed-load supply reduction does not require any additional SMMs. Receiving streams designated as "Medium" and "High" require additional SMMs until its designation changes to "Low". SMMs for the Ranch Plan Planned Community are listed below in their order of preference. A decision flowchart for selecting SMMs based on designation (i.e., High, Medium, and Low) is provided on Figure 15-10.

[14] Receiving channels that are transport limited may be better able to buffer changes in bed material as compared to those that are supply limited. The degree to which a channel is transport limited, or the ratio of bed sediment supply to bed transport capacity, should factor into an adjusted Sp threshold.

15.3.3.1 Non-Structural SMMs

Avoid Significant Bed Material Supply Sources in Site Design

The most effective approach to ensuring stability of receiving streams is to avoid changes in bed sediment supply by avoiding development on areas (GLUs) and channels (GCUs) that are a significant contributor of bed material load. Where possible, development within a project should be located preferentially outside of natural channels and on existing soils that have a low potential to contribute bed material to the receiving stream. The map provided in Figure 15-6 should be used to help apply this measure. In large part, the Ranch Plan has adopted this measure by concentrating development on ridges. According to Balance Hydrologics (2005):

> Urban areas have generally been set back from the alluvial valley floor areas adjacent to major streams, and urban development within smaller side-canyons has been severely restricted, such that the stream corridors' natural values and physical integrity have been protected. One such value is that the main chronic supply sources of coarse sediment will remain intact.

Pass Through Sediments from Open Spaces

Where possible, drainage pathways for open spaces upstream of developments should be designed to pass coarse bed sediments from natural areas (GLUs) and channels (GCUs) to the receiving stream. Maintaining natural bed sediment supplies to streams helps to reduce the potential for excess erosion. Additional analysis or maintenance protocols may be required to ensure downstream flood protection.

15.3.3.2 Structural SMMs

Replace Significant Bed Material Sources that are Eliminated

If, after implementing non-structural SMMs, it is not feasible to obtain a potential for adverse response of "Low", then bed sediment shall be added to the receiving stream by placing coarse sediment just downgradient of the outfall's energy dissipation system. The caliber of this sediment shall be of the same grain size distribution as the receiving stream, and it shall not contain a significant amount of fine sediment associated with the suspended wash-load. The annual replenishment of this supplemented bed sediment, in tons, shall be equal to the estimated annual bed-load deficit caused by project development, as calculated in the bed sediment supply evaluation (Section 15.3.2.7)[15]. This rate of replenishment can be modified after two (2) years as part of the adaptive management and monitoring plan. Prior to project construction, the stockpile should initially be stocked with two (2) times the annual bed-load deficit in the event that the first wet season has higher than normal precipitation and runoff. Added bed sediment material should be placed such that it can be readily transported by fluvial forces exiting the energy dissipation system.

It is anticipated that natural bed sediment deposited in RMV's regional flood control basins will be utilized as source material for the replacement of bed material. Prior to placing this material at an outfall, it must undergo a sieve treatment to mimic the grain size distribution of the receiving stream of interest and remove fine particles.

Additional Mitigation in Site Runoff

An alternative compliance option includes providing additional mitigation in site runoff to compensate for the reduction of bed material. This SMM would require increasing flow attenuation by adding storage volume in structural HMMs beyond the level needed to meet the hydrologic HMP Criteria. The alternative modeling approach must include the following for the pre- and post-development conditions relative to the

[15] As a means of comparison, Table 15-3 provides an estimate of bedload yield rate for channels analyzed by Balance Hydrologics (2005). Replacement rates would only be a fraction of the bedload rates provided in Table 15-3 since only a small portion of the sub-watershed will be developed, much of which will not disturb existing channel sources.

receiving stream (County of Orange, 2011): (1) continuous hydrologic simulation of the tributary area; (2) a sediment transport model; and (3) a bed sediment supply evaluation. Because a sediment transport model is required, per the SOC HMP, simply reducing the flow duration curve by a given proportion does not meet the modeling requirements. Instead an Ep management objective, similar to the HMP Criteria (Section 15.2.1), shall be the basis for design. The Ep management objective is:

> *Hydromodification management measures will be selected and applied to maintain the Erosion Potential (Ep) ratio to within 10% of the target value in the receiving channel*[16]*. The target Ep will be adjusted to account for changes in bed sediment supply.*

Ep is the ratio of total sediment transported in the proposed condition versus the baseline (natural) condition (post-development/pre-development). Because the basic factors affecting sediment transport capacity are channel geometry, bed material, and runoff, and it is a management objective for channel form to remain constant, only changes in runoff (quantified using continuous hydrologic simulation) can affect Ep. Changes in sediment supply are accounted for by deviating the target Ep from 1.0 in proportion to the change in bed sediment supply (post-development/pre-development), expressed as Sp (see Section 15.3.2.8). This represents the best current understanding of how to quantitatively account for sediment supply changes without replacing bed sediment sources (Palhegyi and Rathfelder, 2007). For example, if there is a 30% reduction in bed-load due to proposed urbanization, then Sp equals 0.7 and the target Ep becomes 0.7 +/-10%. To meet this target Ep, detention storage must be added until the post-development flow duration curve is lowered such that the long-term sediment transport capacity becomes 63% to 77% of the baseline condition.

Meeting the Ep management objective is not considered feasible if the bed sediment supply reduction gets above 50% (Sp < 0.5). Thus, if the receiving channel has a “High” designation, the alternative compliance option may need to include in-channel stabilization (Section 15.2.6.2) to meet the Ep management objective between the receiving channel and San Juan Creek or one of its mainstem tributary channels (i.e. Chiquita, Gobernadora, or Verdugo Creek). In-stream stabilization is also an option for receiving streams designated as “Medium”.

15.4 HMP Monitoring and Effectiveness

The goals of the SOC HMP and Bioassessment Monitoring and Effectiveness Program is to provide data to evaluate the effectiveness of the proposed mitigation (to support pre-development stream stability and biological diversity) and to feed into an adaptive management plan that would enhance mitigation as needed and would re-evaluate the monitoring plan to better address the goals of the monitoring program. Consistent with the SOC HMP, the RMV HMP monitoring plan is organized into the following two (2) elements:

- Stream channel survey and geomorphic assessment, and
- Adaptive management.

15.4.1 Stream Channel Survey and Geomorphic Assessment

The scope of the monitoring follows the Ranch Plan EIR mitigation measure requirements, which in turn are based on previous recommendations regarding HMP monitoring (Balance Hydrologics, 2005). The stream channel survey and geomorphic assessment described below is consistent with the County-approved RMV PA-1 Development Area Stream Monitoring Plan (PACE, 2006).

15.4.1.1 Stream Walks

A geomorphologist, with California registration as geologist or engineer, familiar with flood conveyance and hydrologic and stream bed conditions required to meet habitat needs of sensitive species will walk critical reaches of named channels each year in late April following the wet season. The stream walker

[16] If only out-of-channel HMMs are implemented, the Ep management objective only applies to the receiving channel, which is the most upgradient natural channel segment. If in-channel HMMs are implemented, the Ep management objective must be met all the way down to an exempt receiving water (i.e. San Juan Creek).

will note bed conditions, measure high water marks, note new sources of sediment or bank instability, compile information needed to estimate channel roughness coefficient, and assess whether bed or bank vegetation is suitable to meet conveyance and habitat objectives. Stream walks will be conducted in years 1, 2, 3, 4, 5 and 10 following substantial grading in the planning area tributary to the outfalls, and during any year with the first 10 years when the 6-hour rainfall intensities exceed the 5-year recurrence intensities at a nearby pre-selected recording rainfall gauge. The stream walker will similarly canvas the lower 2 miles of Bell Canyon and the upper Chiquita watershed north of Oso Parkway, two (2) stream segments with largely intact and formally preserved watersheds, which can serve as control or reference reaches for comparison purposes. Geo-referenced photographs showing key sites or problems will be taken. The individual will prepare an annual report by May 20 of the relevant year(s) specifying maintenance or repair measures needed to maintain suitable sediment transport and bed conditions.

15.4.1.2 Major Stream Cross Section Surveys

Monumented cross sections will be established and surveyed on[17]:

- Lower Narrow Creek
- Chiquita Creek (four (4) locations)
- Gobernadora Creek (four (4) locations)
- Bell Creek (two (2) locations)

The station locations will be selected based on information gained from the stream walks and other data collected as part of this monitoring program. Priority will be given to stations just downstream of where runoff from project development enters the mainstem tributary channel, either via a side tributary or an outfall.

Additional monitoring sections will also be provided on San Juan Creek and all monitoring locations will first be approved by the County of Orange before implementation. Stations will be surveyed to the nearest 0.05 feet vertical, and include notations of bed materials encountered and a qualitative description of vegetation, and other observations conforming to geomorphic conventions, such as the International Hydrologic Vigil Network standards.

The initial surveys will be conducted prior to grading, with resurveys during years 1, 3, 5 and 10 following initial grading. Re-surveys will also be conducted during years when 6-hour average rainfall intensities exceed the 5-year recurrence intensities at a nearby pre-selected recording rainfall gauge. The longitudinal slope at each survey control section will be obtained based on survey points extending 200 feet upstream and downstream of the cross section, and measured within the thalweg. Results will be analyzed by the stream walker, and included in the related report, recommending maintenance and restorative measures. The report will be submitted by May 20 following the survey years, to allow design and implementation (where needed) prior to the next winter.

15.4.1.3 Periodic Aerial Photography

Aerial photographs of the entire project area will be taken during May or June following project approval, and during each subsequent May or June of years ending in “5” or “0”, until the project has been completed as defined by the County of Orange. Resolution of the photographs will be sufficient to prepare 200’ scale maps with 2’ contours. Contour maps will be prepared for the San Juan Creek channel from the Verdugo Canyon confluence to 0.5 miles downstream of Antonio Parkway showing the topography of the bed and the banks to elevations 15 feet above the adjoining bed.

Light Detection and Ranging (LIDAR) or other techniques can be substituted for conventional photogrammatic methods. A qualified geomorphologist shall review the aerial photographs of the entire project area, identifying new upland sources of sediment, event-related or land-use disturbance, or evidence of channel change and instability. The geomorphologist will assess discontinuities in sediment

[17] Cross sections will be coordinated consistent with the PA-1 monitoring plan. Upper Chiquita and Bell Creek serve as reference conditions.

transport throughout the project area, and will present an assessment of changes, if any, in the San Juan Creek corridor. Results will be presented in a report to be prepared by May 20 of each year, including recommendations for maintenance, repair and other actions.

15.4.1.4 Evaluation of Changes Downstream of Ponds and Basins

This section of the monitoring plan addresses channels downstream of basins and the associated non-exempt outfalls.

- Outfalls 1 and 19 directly discharge into Chiquita and Verdugo Creek, respectively.
- Outfalls 2, 3, 4, 9, 18, 27 discharge to a side tributary to Chiquita, Gobernadora, or Verdugo, and Outfall 26 discharges to a side tributary to San Juan Creek.

Longitudinal profiles and channel or drainage-way cross sections will be established downstream of basins or ponds with capacities exceeding 1 acre-foot, or which create a 4' elevation change in the energy grade line. Resurveys will occur whenever the stream walker and/or the geomorphologist reviewing the aerial photos identify actual or incipient incision or erosion. Resurveys will be completed prior to July 1 when and where the need is identified in the May 20 report discussed above.

15.4.1.5 Evaluation of Changes in Geomorphic Conditions Associated with Direct Discharges to San Juan Creek

Exempt outfalls are outfalls that discharge directly to San Juan Creek. These include Outfalls 5, 7, 10, 12, 13, 15, 17, and 20 to 25. Given the intermittent nature of flood conditions in San Juan Creek, these outfalls are expected to be situated above the creek's water surface elevation and outside of the water's edge for most of the year. Thus, there will be an un-inundated riparian area between the outfalls and the main stream course. Some temporary, limited rill and gully erosion in these areas is expected due to concentrated runoff flowing by gravity from the outfalls to the main stream course in San Juan Creek. However, historical aerial photographs (Balance, 2005) provide evidence that this erosion within the floodplain will be washed out by high magnitude resetting events and will not impact the long-term stream morphology of San Juan Creek.

The primary geomorphic concern with direct discharges to San Juan Creek would be if localized channelization in the floodplain would erode the base elevation of San Juan Creek at the confluence and create a knickpoint that could unzip upstream. Although this occurrence is unlikely, the floodplain corridors near each San Juan Creek outfall will be monitored as part of the monitoring and adaptive management program. This monitoring will be included in the periodic aerial photography and stream walk monitoring measures. If it is found that erosion in the floodplain buffer, caused by outfall runoff, is affecting the long-term average thalweg elevation in San Juan Creek resulting in propagation of head cuts up San Juan Creek, then this will trigger management actions to stabilize the corridor. Management actions on the floodplain may include enhancement of the outfall energy dissipation systems or other types of in-channel stabilization measures.

15.4.2 Adaptive Management Program

Adaptive Management is a process by which information collected as part of the monitoring program is regularly assessed to determine if the HMP is effective in protecting the geomorphic and biological integrity of receiving streams. Based on this assessment, corrective actions may be taken to improve the HMP, such as how the hydromodification control facilities are designed, constructed, and/or are being operated and maintained. The process will also evaluate the monitoring program and modify it as needed to improve the overall effectiveness and efficiency of the HMP.

The adaptive management plan entails the following elements:

- *HMP Facility Inspection and Performance Monitoring***.** Routine inspection and monitoring of the HMP system components is required to establish that they are being properly maintained and are functioning as intended.

- *Hydrologic Monitoring*. Routine monitoring of the general hydrologic conditions is needed to ascertain if there are changes in the hydrologic regime and subsequent change to stream stability and geomorphology.
- *HMP Review and Evaluation*. Annual review of the inspection and monitoring data will be conducted to determine if there is a need for corrective action, to evaluate impacts due to changes in watershed conditions on the hydrologic regime or BMP performance, and in general to evaluate if the HMP is effective in meeting the planning objectives.
- *Corrective Measures*. Corrective measures will be undertaken for specific problems or conditions of concern identified in the review and evaluation. Depending on the nature of the problem, corrective measures could involve modification of the BMP design, construction, operation, or maintenance and/or implementation of additional control measures. The effectiveness of the corrective measures will themselves be evaluated through continued inspection and monitoring. Thus, the management approach is adaptive to specific problems or conditions as they arise and are identified through ongoing inspection, monitoring, documentation, and evaluation.
- *Documentation and Reporting*. Documentation of all operation, maintenance, inspection, and monitoring activities will establish a continuous record of the condition of HMP facilities and the geomorphic integrity of the stream system. All records will be available to the public and regulatory and resource agencies.

The following sections expand on each of the adaptive management elements.

15.4.2.1 HMP System Facility Inspection and Performance Monitoring

The scope of the inspection and monitoring program is described above. The data and information from the monitoring plan will be compiled and assessed annually as part of the adaptive management process. The assessment will include revising the scope of the monitoring effort where appropriate based on issues identified in the field, or as needed to clarify corrective actions.

15.4.2.2 Hydrologic Monitoring

Hydrologic monitoring will be performed to determine if there are changes in the hydrologic regime and associated changes in stream stability and geomorphology. Visual observation of direct and indirect indicators will be used where practical. Hydrologic monitoring will include:

- *Groundwater levels* – Groundwater levels will be monitored quarterly at existing monitoring wells in the Cañada Gobernadora sub-basin, and at additional monitoring wells to be located in consultation with the management entity responsible for long-term adaptive management of protected habitat areas.
- *Base flows* – Dry weather base flows will be spot checked quarterly in sensitive areas through direct or estimated measurements.
- *Peak Discharges* – Stormwater peak flows will be estimated through stage measurements or measurements of high water marks. Stream channels will be surveyed annually for visual signs of down cutting or aggradation.

15.4.2.3 HMP Review and Evaluation

Annual review of the inspection and monitoring data will be conducted to: (1) evaluate if the structural BMPs are maintained and functioning properly; (2) identify hydrologic issues of concern; (3) evaluate whether the BMPs are functioning as intended in terms of hydromodification controls; and (4) identify appropriate adjustments to the monitoring plan. Table 15-4 lists general criteria that should be used in the annual review and evaluation. Additional criteria will likely be needed to address specific and unique circumstances as they arise.

15.4.2.4 Corrective Measures

BMP modifications and corrective measures will be undertaken to improve performance and remedy any problems that are identified. Selected actions and remedies will be unique to each situation, and in general should be based on a sound understanding of the possible causes and evaluation of alternatives.

Table 15-4 identifies potential actions and corrective measures that may be considered. Significant changes to the HMP proposed as a result of the Adaptive Management Program will be submitted to Orange County for review and approval.

Table 15-4: Criteria for Review and Evaluation of Monitoring and Inspection Data and Potential Actions and Corrective Measures

Evaluation Topics and Triggers	Potential Actions & Corrective Measures
BMP Status and Sizing	
BMP Maintenance: Are structural BMPs properly maintained?	• Correct maintenance practices and increase management oversight.
BMP Sizing: Are structural BMPs sufficient to address hydrologic conditions of concern? Are there any unforeseen or unique changes in the watershed conditions that could potentially increase sediment-loads or runoff?	• Review and implement BMPs to address anticipated sediment loads or runoff. • Continue and possibly increase watershed and BMP monitoring. • Implement additional source control and/or structural BMPs.
HMP Facility Effectiveness	
Hydromodification Control Basins: Are the HMP basins and downstream mitigation operating as intended in terms of protecting stream beneficial uses including geomorphic and biological integrity?	• Review O&M history of the facility to determine if poor performance is related to inadequate maintenance. • Review monitoring information on sediment accumulation and removals, and influent TSS levels (if available) to evaluate if influent sediment-levels are excessive. • Review hydrologic monitoring to determine if there are unique or temporary watershed conditions that could lead to excessive sediment-loads (e.g. construction activities, fires). • Potential corrective measures include: – Review and implement erosion control BMPs to reduce sediment loads. – Continue and possibly increase BMP monitoring. – Evaluate the facility design and modify if necessary.

Evaluation Topics and Triggers	Potential Actions & Corrective Measures
HMP Facility Infiltration: Are the infiltration basins functioning properly (i.e., are observed percolation rates equivalent to or in excess of the design rate)?	• Evaluate possible causes of poor performance: – Determine if there is sufficient groundwater capacity. – Verify that the flow duration controls (orifices) are designed and functioning properly. – Verify that there is adequate pre-treatment of sediments and that there is no clogging are crusting in infiltration basins. – Review O&M history of the facility to determine if poor performance is related to inadequate maintenance. • Potential corrective measures include: – Modify flow duration controls (orifices) in the FD/WQ basin. – Correct maintenance deficiencies. – Evaluate and modify the design of the infiltration basin. – If groundwater capacity is insufficient, evaluate and implement alternative measures for recycling, infiltration, or diversion of excess flows.
Hydrologic Conditions	
Elevated Groundwater: Are observed groundwater levels chronically elevated in comparison with pre-development levels? Are maximum groundwater levels maintained 10' below bottom of basins?	• Look for additional opportunities to increase recycling, and/or ET of runoff. • Look for alternative or additional areas suitable for infiltration. • Divert excess flows to less-sensitive sub-basins or channels (e.g., San Juan Creek).
Elevated Base Flows: Are base flow discharges or seasonal duration chronically elevated in comparison with pre-development levels? Are changes in base flows having an undesirable effect on stream stabilization or riparian vegetation?	• Review adequacy and maintenance of existing dry-weather source control measures. Correct deficiencies as necessary, and look for ways to improve performance of existing source controls. • Look for additional opportunities to reduce dry-weather flows, such as methods to increase ET and recycling. • Divert excess flows to less-sensitive sub-basins or channels (e.g., San Juan Creek).
Local and General Long-term Scour. Are flows resulting in excessive local or general long-term channel down cutting?	• Review adequacy and maintenance of existing hydrologic source control measures. Correct deficiencies as necessary, and look for ways to improve performance of existing HMMs. • Potentially conduct continuous hydrologic monitoring of inflows, outflows, and stage of structural HMMs if channel incision or instability is observed downstream. • Look for additional opportunities for non-structural and structural HMMs. • Consider in-channel improvements to stabilize local scour, only if necessary.

15.4.2.5 Documentation and Reporting

An annual summary of all O&M and monitoring activities will be prepared. The summary report shall include:

- BMP construction and maintenance activities, including maintenance logs.
- All monitoring information, including watershed, hydrologic, and BMP performance monitoring data.
- Findings of the annual evaluation and response, if any.

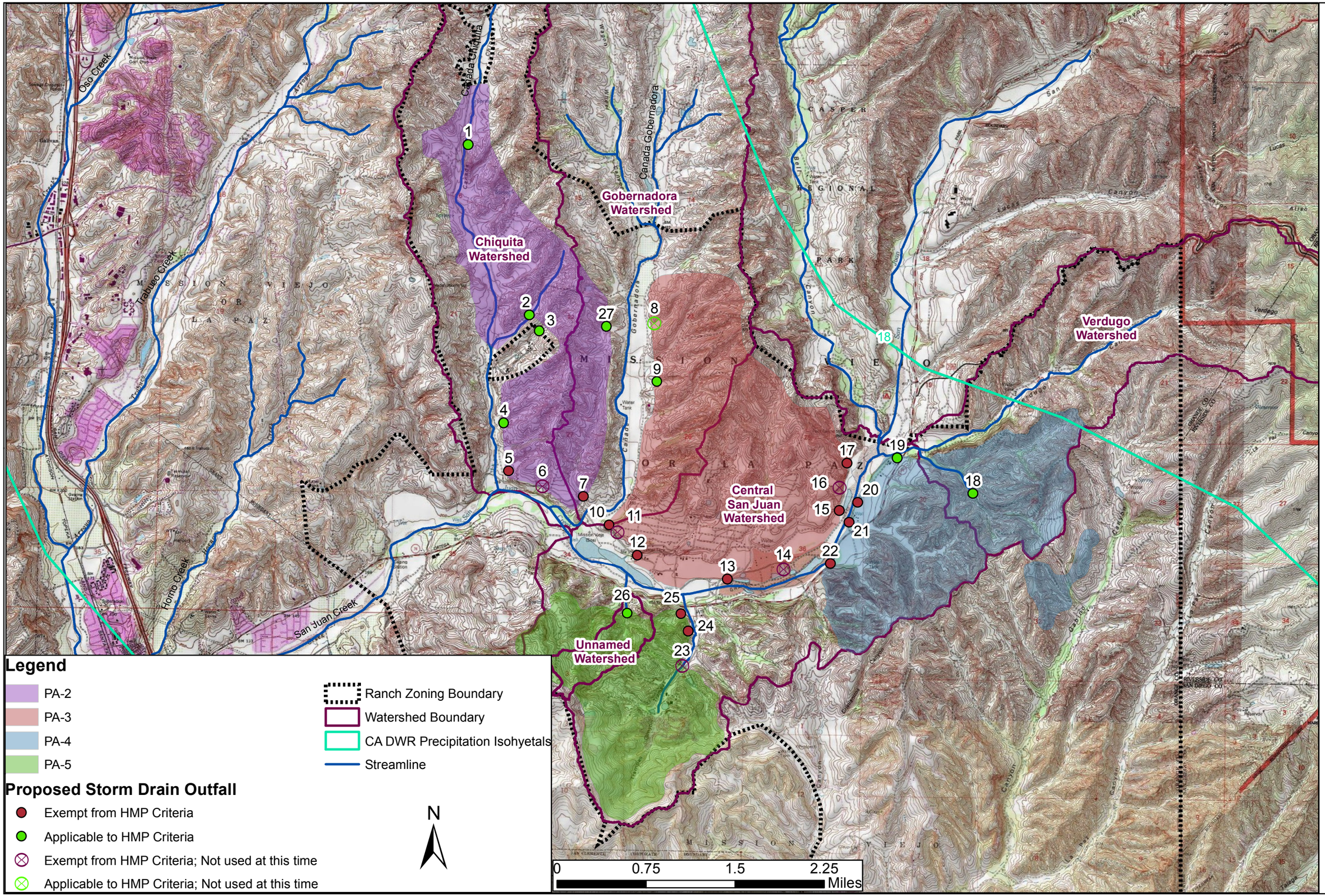

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Figure 15-1
HMP Applicability by Outfall

Rancho Mission Viejo
ROMP

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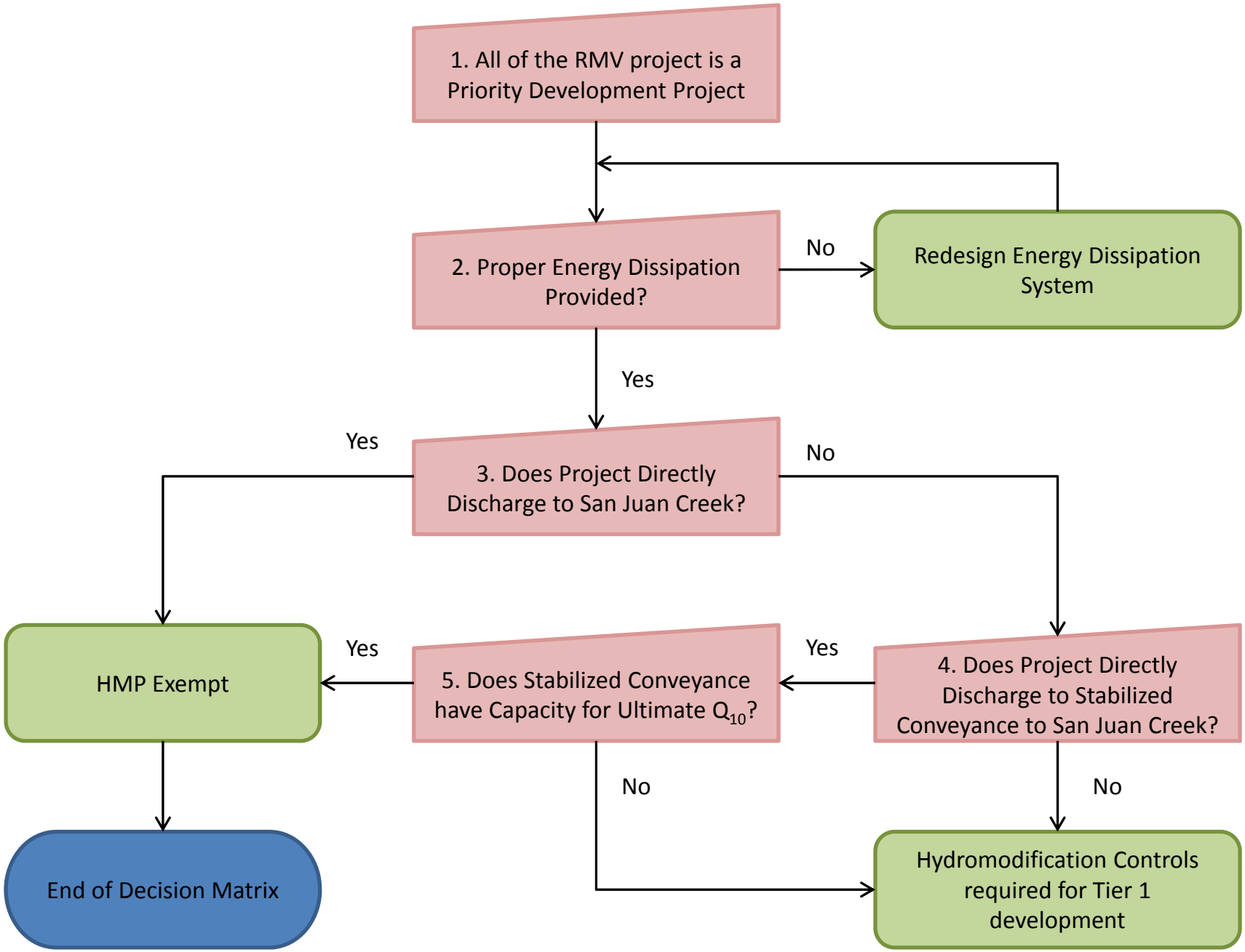

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Figure 15-2
HMP Applicability Flowchart

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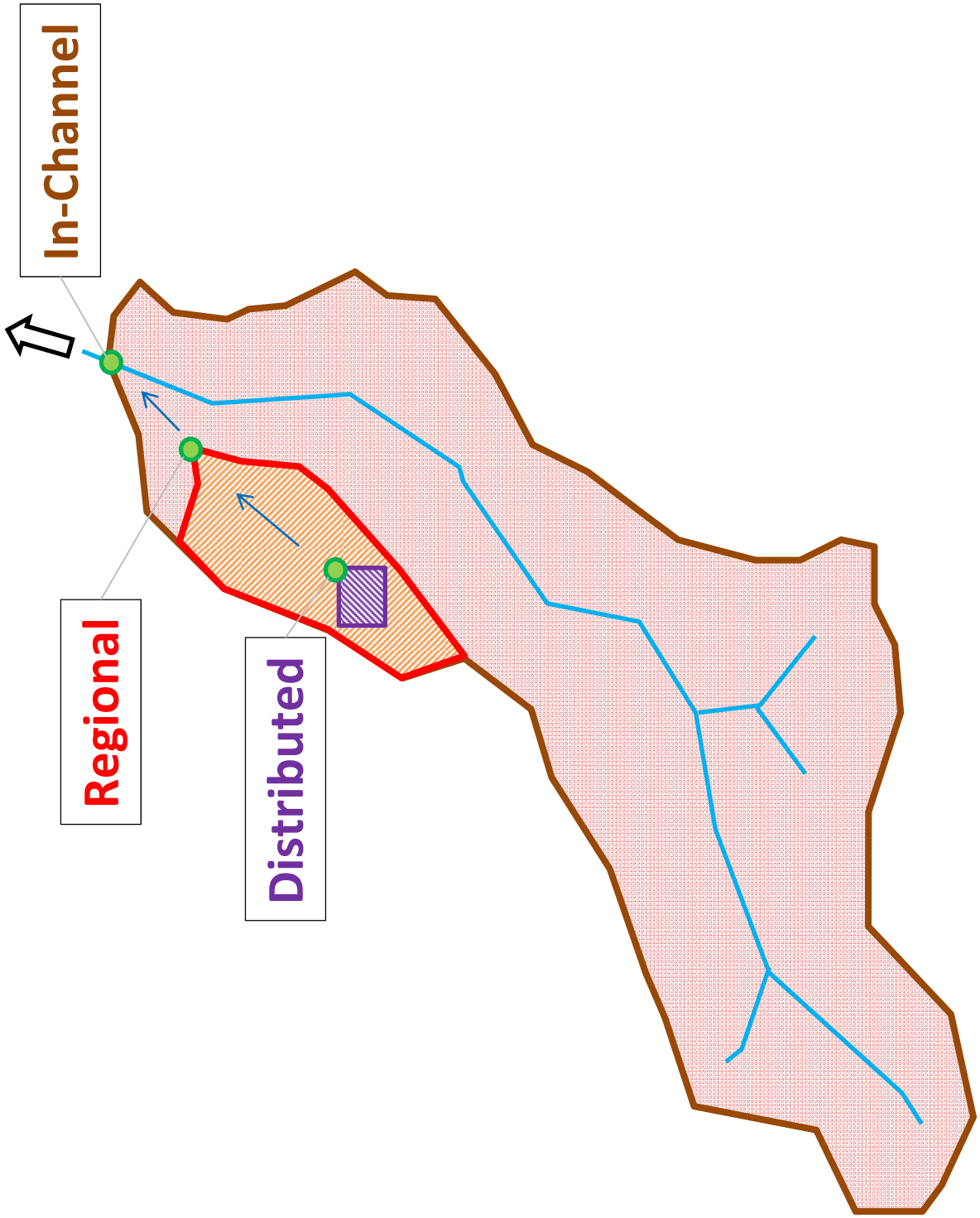

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Figure 15-3
Geographic Scales of Structural Hydrologic Management Measures

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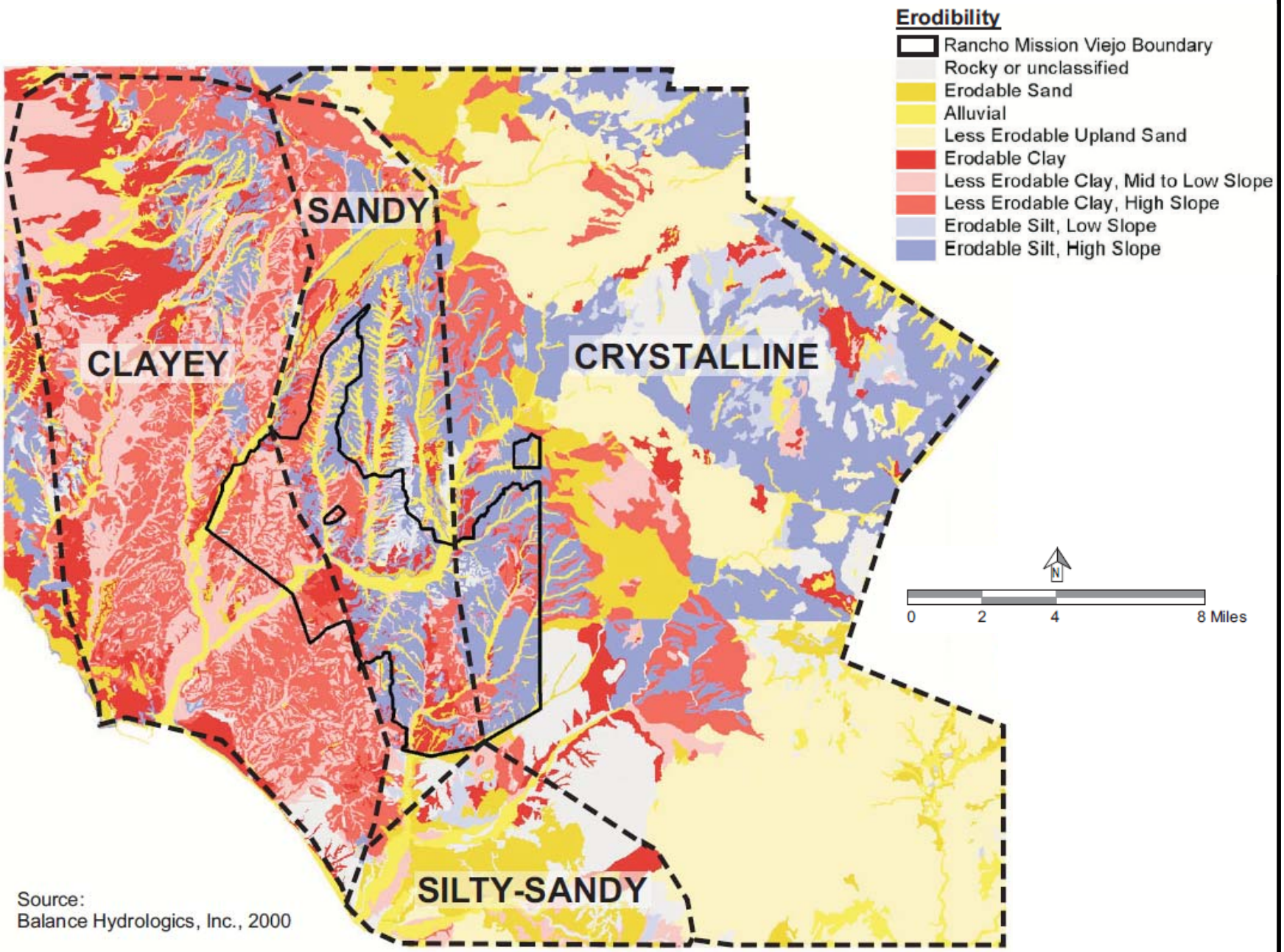

Source:
Balance Hydrologics, Inc., 2000

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Figure 15-4
Landscape Scale Terrains and Shallow Substrate Erodibility

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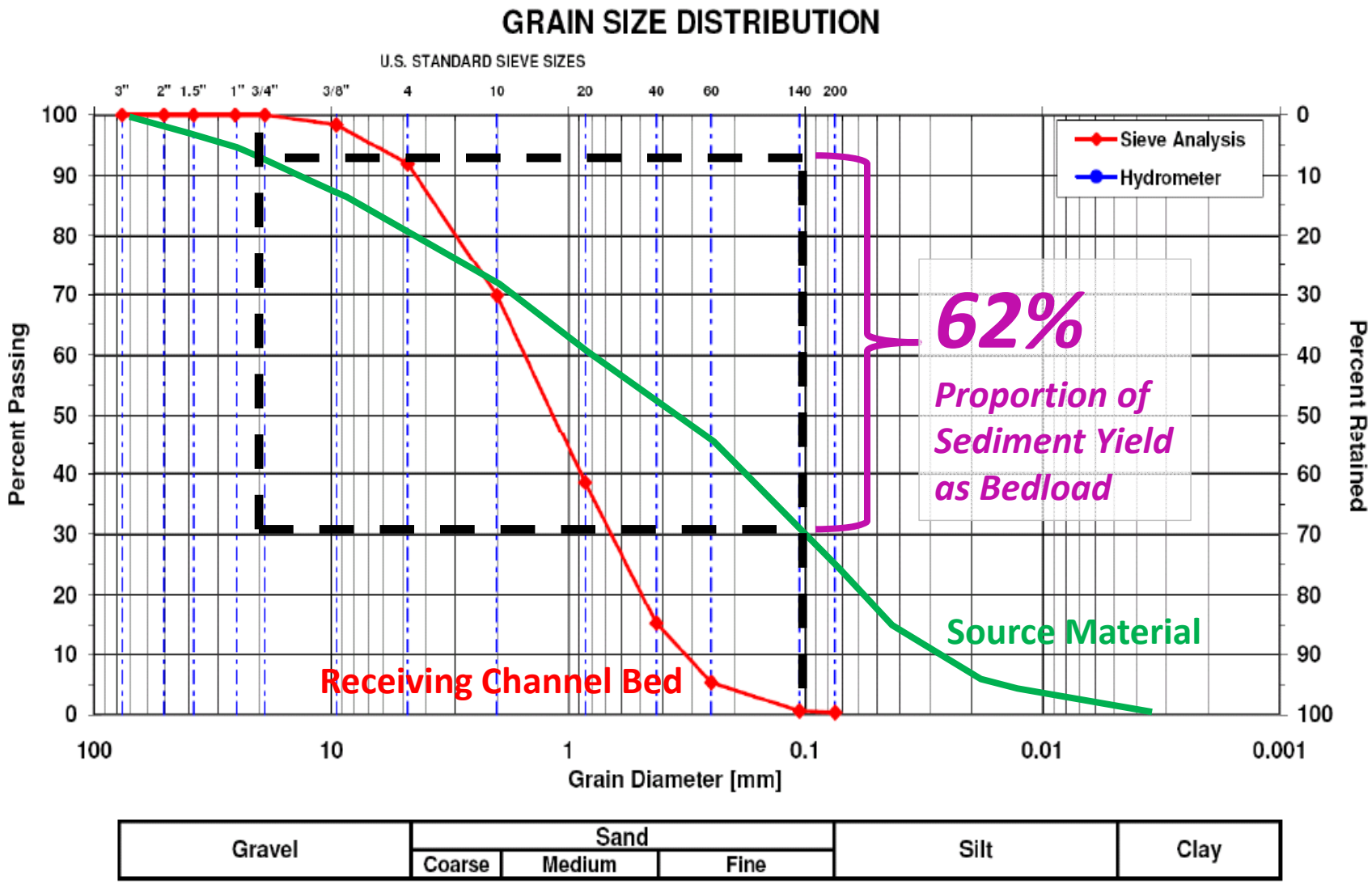

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Figure 15-5
Example Grain Size Distribution Comparison

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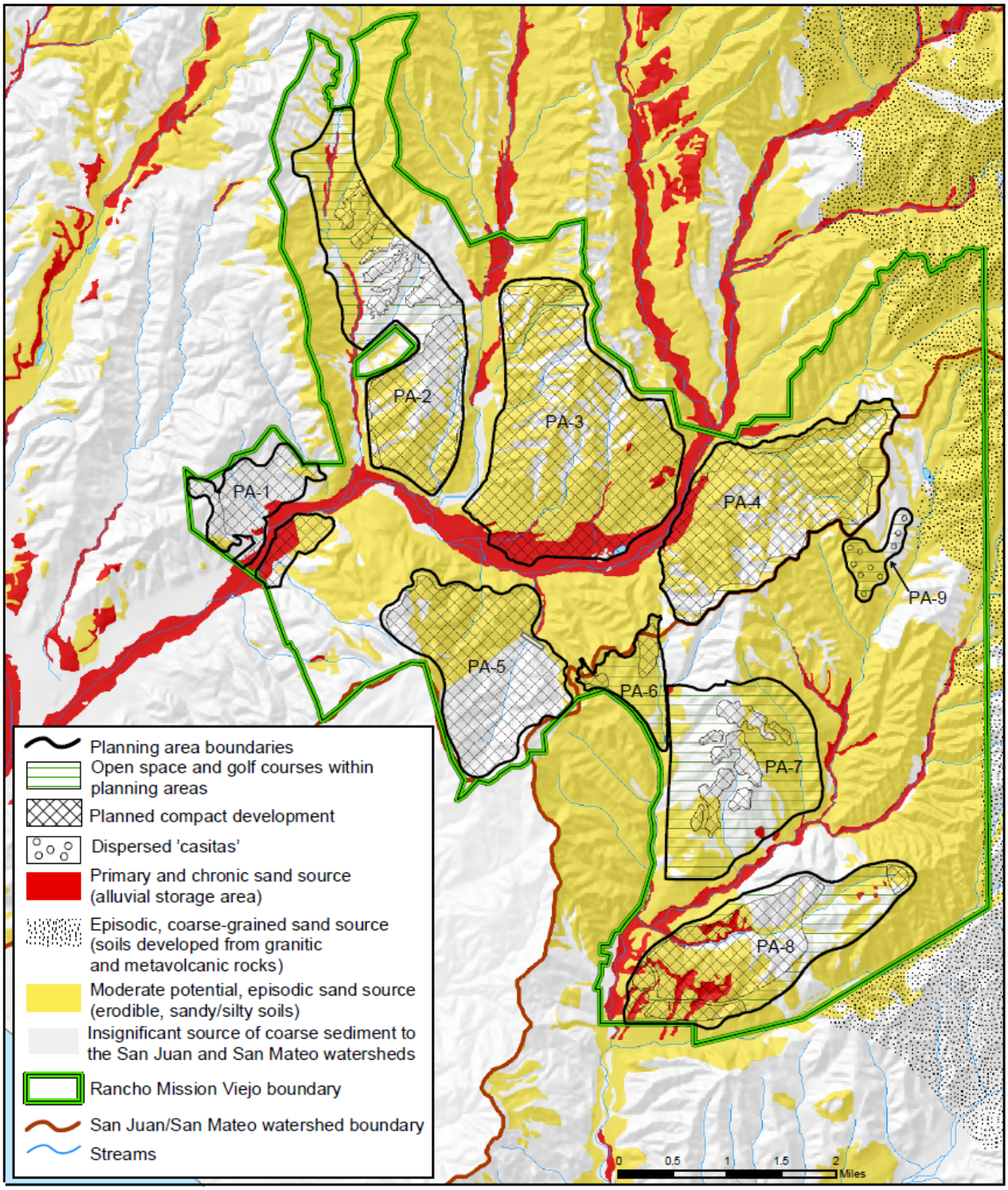

NOTE: Planning Areas 6 through 9 no longer apply to RMV
Source: Balance Hydrologics, Inc., 2005

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Figure 15-6
Coarse Sediment Material Sources

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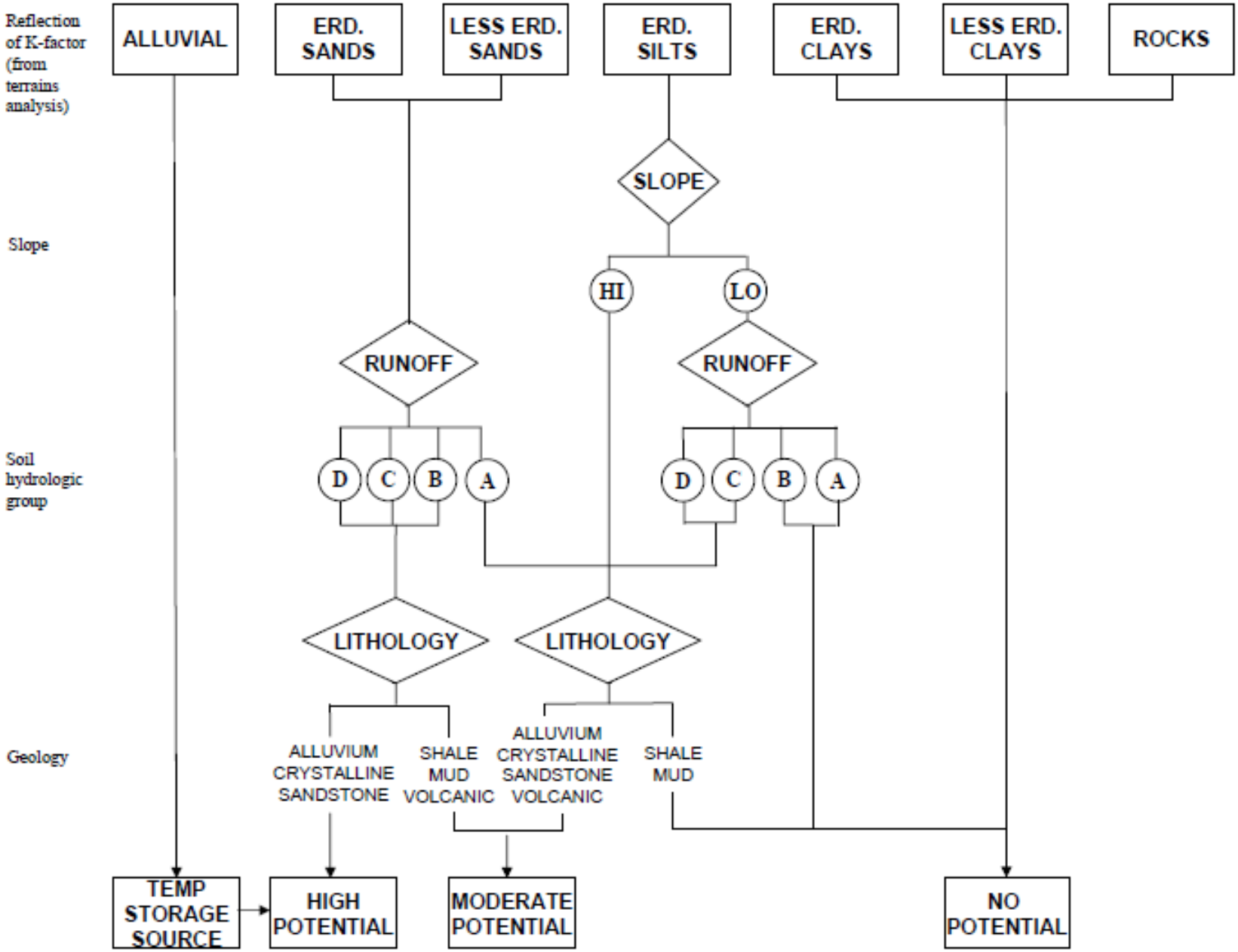
Figure 15-7
Schematic of Method Used to Identify Potential Sources of Sand



Source: Balance Hydrologics, Inc., 2005

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Source: Balance Hydrologics, Inc., 2006

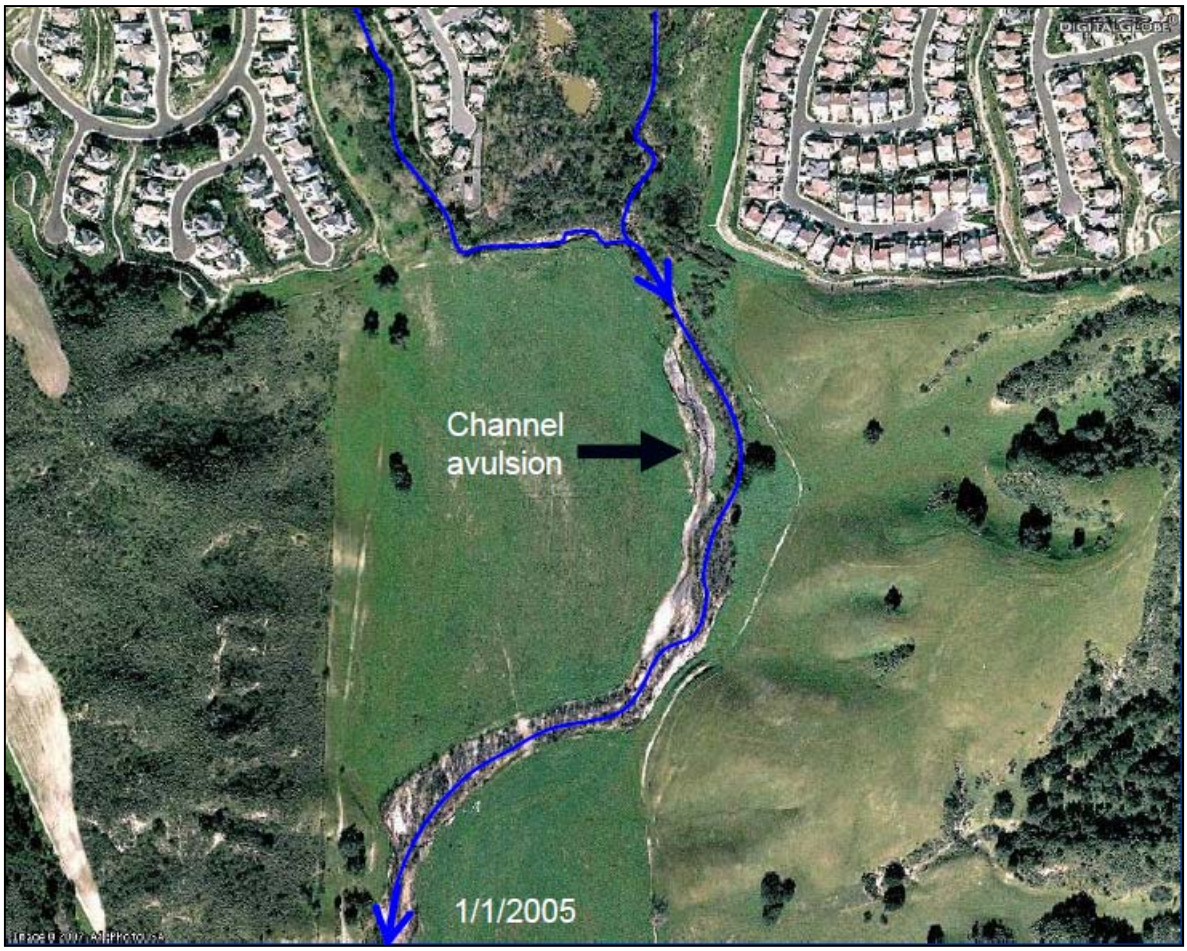

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Figure 15-8
Channel Avulsion in Gobernadora Creek

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Source: Balance Hydrologics, Inc., 2006

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Figure 15-9
Channel Incision in Gobernadora Creek

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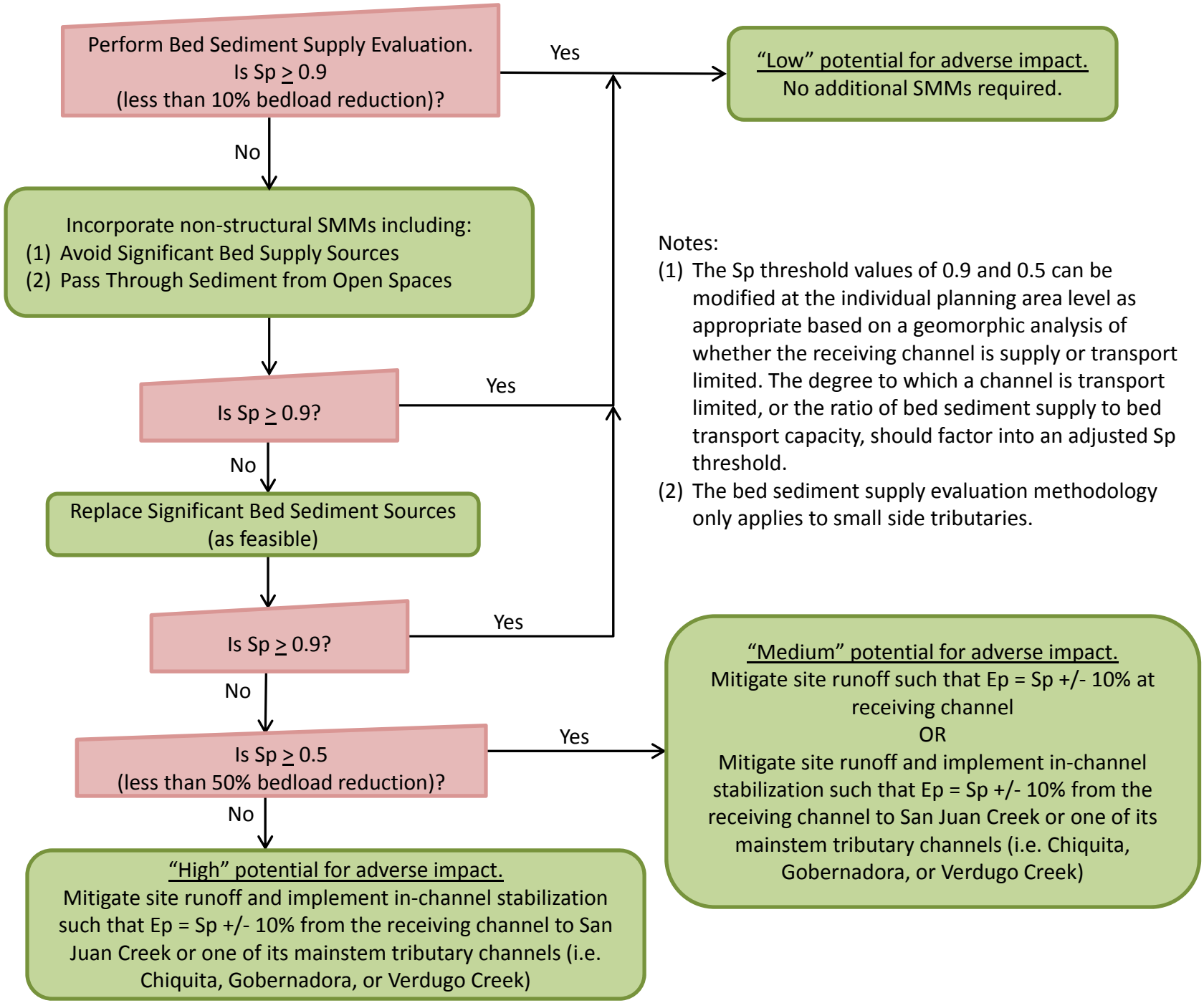

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Figure 15-10
Sediment Management Measure
Decision Flowchart

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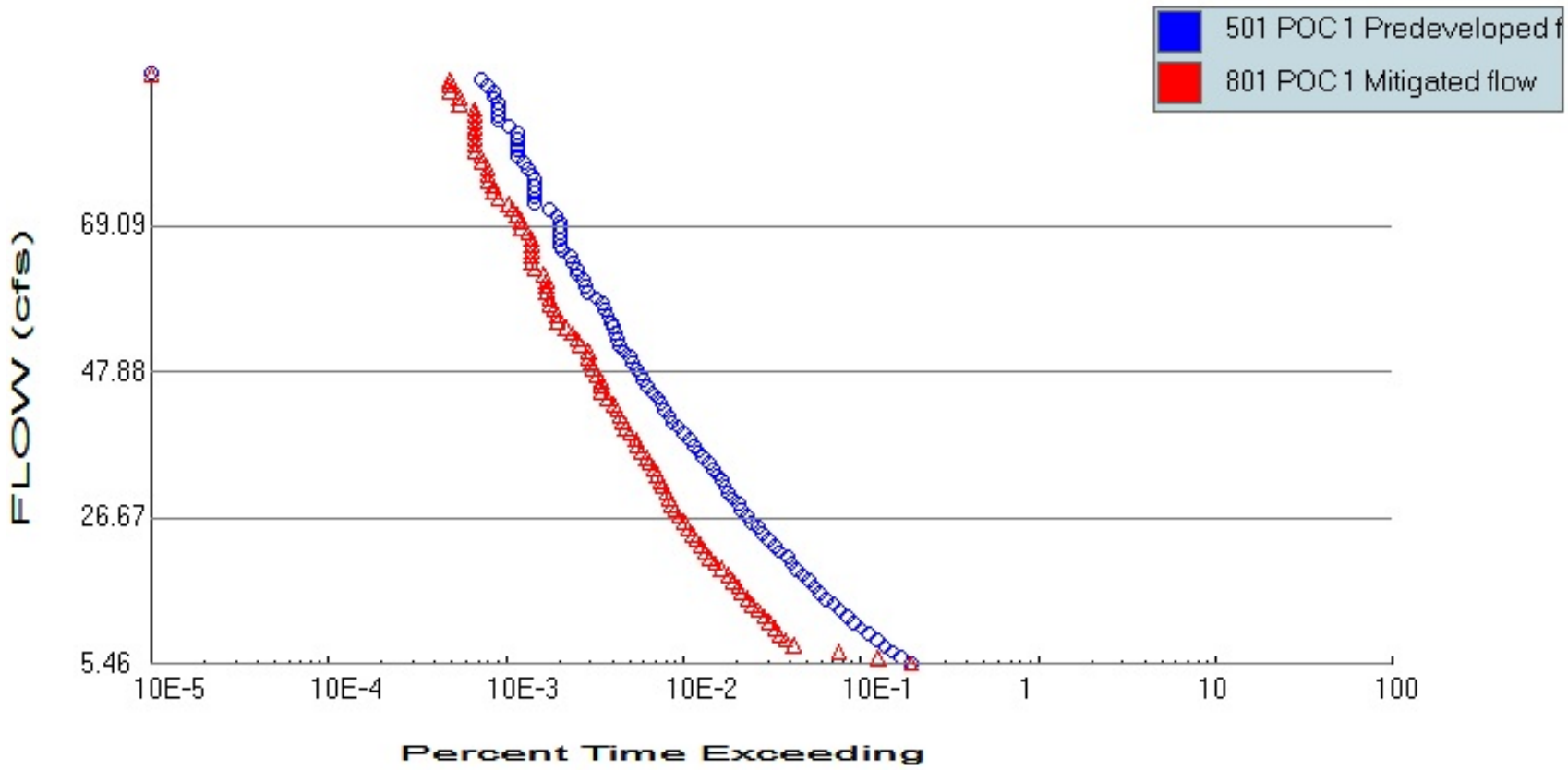
Figure 15-11
Example Flow Duration Curve Comparison



Outfall 19

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