DRAFT

HYDROMODIFICATION MANAGEMENT PLAN

EVALUATION PROGRAM

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SANTA ANA REGION of RIVERSIDE COUNTY

May 29, 2014

Contents

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Introduction

The Santa Ana Region (SAR) Hydromodification Management Plan (HMP) Evaluation Program is established to assess the effectiveness of efforts to manage increases in runoff volumes and discharge rates from new development or significant redevelopment projects through the implementation of the SAR HMP. The overall goal of the HMP Evaluation Program is to ensure that the natural geomorphologic processes in the channel systems are maintained as development occurs.

This HMP Evaluation Program defines a protocol as required by Provision XII.B.5.b. of the 2010 SAR MS4 Permit that will be implemented by the Permittees to evaluate potential impacts to those channel segments deemed most susceptible to hydromodification.

> *"The HMP will identify sites to be monitored, include an assessment methodology, and required follow-up actions based on monitoring results. Where applicable, monitoring sites may be used to evaluate the effectiveness of BMPs in preventing or reducing impacts from Hydromodification."*

Periodic monitoring and analysis of factors representative of the benthic health and geomorphic state of these channels may demonstrate the long-term viability of the criteria outlined in the SAR HMP. As required by legislative mandate, several receiving waters within the urbanized areas of the SAR have been channelized and/or otherwise improved to adequately protect life and property within existing and future communities.[1] One key consideration of the HMP Evaluation Program is to distinguish hydromodification impacts, if any, that are caused by new development or significant redevelopment projects, that are created by upstream dams or retarding systems, agricultural developments, significant storm events or other stressors within the SAR.

The HMP Evaluation Program will operate on the basis of adaptive management principles. Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. The HMP Evaluation Program may be updated as new information on the state of science of hydromodification or improved monitoring methods such as remote sensing imagery become available, or as adequate monitoring locations are identified. As identified in Section 4.2, a minimum period of five years of observations will be necessary to draw initial conclusions on the program, upon which, the Permittees may consider revising the HMP Evaluation Program accordingly.

Throughout the duration of the HMP Evaluation Program, the Permittees may apply the following adaptive management principles:

- Assess the objectives of the HMP Evaluation Program.
- Identify adequate monitoring locations and key parameters for monitoring.
- Evaluate on an annual basis the geomorphic state of the channel and the change in physical indicator metrics, if any. An evolution may be correlated to the range of geomorphically-significant flows, specific events, or other identified stressors.
- Incorporate new and/or additional information from new studies and/or optimized monitoring methods such as remote sensing imagery.

[1] Chapter 1122, Statutes of 1945, Act 6642 of State Legislature Creating the Riverside County Flood Control and Water Conservation District

- After a minimum of five years, re-evaluate HMP effectiveness based on monitoring data and optimize the HMP Evaluation Program.

The HMP Evaluation Program identifies a location to monitor alterations to natural geomorphologic processes associated with a new development project. Additional monitoring locations may be selected by the Permittees to:

- Account for both temporal and spatial variability of natural geomorphologic processes as identified in Section 2.2; and

- Assess the effectiveness of the efforts to manage increases in runoff volumes and discharge rates associated with new development or significant redevelopment projects through the implementation of the SAR HMP.

The findings of the monitoring plan may guide refinements to improve the Hydrologic Conditions of Concern (HCOC) standards.

1 Watershed History and Historical Hydromodification Impacts

The intent of this section is to describe qualitatively the existence of historical stressors to the natural geomorphologic processes occurring within the SAR. In addition, a technical memorandum, entitled "Causes of Degradation and Aggradation in the SAR of Riverside County", was developed as part of the SAR HMP (Appendix B). The technical memorandum identifies evidences of degradation based on geologic, land cover, and topographic considerations, as well as historical aerial photographs of channel segments. The findings of the technical memorandum are summarized per subwatershed in Section 2.2 of the SAR HMP.

Santa Ana River Watershed

The Santa Ana River Watershed is located in southern California, south and east of the city of Los Angeles. The Santa Ana River Watershed includes much of Orange County, the northwestern corner of Riverside County, the southwestern corner of San Bernardino County, and a small portion of Los Angeles County. The Santa Ana River Watershed is bound on the south by the Santa Margarita Watershed, on the east by the Whitewater Watershed and on the northwest by the San Gabriel River Watershed. The area of the Santa Ana River Watershed is approximately 2,650 square miles. The headwaters of the Santa Ana River are in the San Bernardino Mountains with its major tributary being the San Jacinto River, originating in the San Jacinto Mountains. The Santa Ana River traverses through Prado Dam before cutting through the Santa Ana Mountains and flowing to the Orange Coastal Plain. Eventually, the river discharges to the ocean in the City of Huntington Beach.

Santa Ana Region

The SAR is that portion of the Santa Ana River Watershed within Riverside County and is the area addressed by this HMP Evaluation Program. The SAR extends over more than 63 miles from east to west, and over more than 29 miles from north to south. The SAR lies between the Santa Ana Mountains and the San Bernardino Mountains; the topography of the SAR varies highly with altitudes ranging from 415 feet to 8,200 feet. The San Jacinto River is a tributary of the Santa Ana River within Riverside County. Runoff from the 768-square mile San Jacinto River Watershed is regulated by Railroad Canyon Dam and natural storage in Lake Elsinore. This Watershed contributes flow into the Santa Ana River only as a result of unusual high intensity storm events that result in overflow from Lake Elsinore. The San Jacinto River flows through Canyon Lake, Lake Elsinore, and Temescal Creek to confluence with the Santa Ana River in the city of Corona.

Surface drainage from the remainder of the SAR, including the cities of Jurupa Valley, Eastvale, and Riverside, drain through local systems to Reach 3 of the Santa Ana River.

1.1 Lakes, Water Reservoirs, and Basins

The SAR includes basins, two natural lakes and several man-made reservoirs, some of which may have modified the hydrologic and sediment supply regimes of the natural channels within the SAR. The natural lakes are Lake Elsinore and Mystic Lake; the man-made reservoirs are Prado Dam, Lake Mathews, Canyon Lake, Diamond Valley Lake, Lake Hemet, and Lake Perris. These man-made reservoirs do not include the smaller regional watershed protection facilities that may warrant evaluation of their inherent contributions in mitigating potential HCOCs during project planning.

Basins

There are many retention, detention, debris, and infiltration basins located within the SAR that may affect geomorphologic processes. Although they are structurally similar facilities, they serve different purposes. Basins may include an excavated area and an outlet structure to provide an impoundment. Retention basins are typically used to manage stormwater runoff to prevent flooding, downstream erosion, and improve water quality in an adjacent river, stream or lake. Detention basins are typically installed to protect against flooding and downstream erosion by storing or "detaining" runoff for a limited period. Debris basins are designed to prevent debris flows (rocks, boulders, trees, sediment, etc.) from reaching channels where the material may compromise flow conveyance and result in flooding of agricultural or urban development. An infiltration basin is typically an impoundment designed to infiltrate runoff to recharge groundwater basins. Infiltration basins have been demonstrated to have high pollutant removal efficiency.

Natural Lakes

The natural lakes located within the SAR are Mystic Lake and Lake Elsinore. Mystic Lake is a 200-acre ephemeral lake in the San Jacinto Valley that lies within the outlet area of the San Jacinto River. Lake Elsinore is the largest natural freshwater lake in southern California. When high intensity storm events occur, overflow from Lake Elsinore drains into Temescal Wash.

Man-Made Reservoirs and Flood Control Improvements

Prado Lake is a flood control dam that was built in 1941 by the U.S. Army Corps of Engineers (USACE) downstream of the SAR to provide flood protection to the communities in Orange County. The 25,800 acre-feet dam is also operated to provide water conservation capacity. The USACE also constructed levees along the Santa Ana River to protect adjacent and downstream communities.

Bautista Basin is located at the headwaters of Bautista Creek southwest of the city of Hemet in the San Jacinto River Watershed. Bautista Basin was constructed by the USACE to regulate flow and control sedimentation. Accumulated sediment is removed by sand and gravel operations located in the basin. Outflow from the basin is conveyed to Bautista Channel and on to the San Jacinto River. Downstream communities are protected by levees constructed along Bautista Creek (earthen levee faced with ungrouted stone revetment) and the San Jacinto River (Segments 1a and 1b of earthen levee faced with grouted stone revetment) by the USACE and local entities.

Lake Hemet was formed in 1895 following the completion of the 135-foot high arched masonry structure. Lake Hemet is located at 4,340 feet above sea level in the San Jacinto Mountains and has a storage capacity of 14,000 acre-feet. Lake Hemet captures runoff from the upper reaches of the San Jacinto River and is operated based on water supply and recreational activities purposes, not flood control.

Lake Mathews is a 182,000 acre-feet reservoir that commenced to supply water in 1941. Lake Mathews receives water supply from the State Water Project and the Colorado Aqueduct, and captures the natural stormwater flows from Cajalco Creek. A series of water quality wetlands and basins, as well as sediment basins are located on Cajalco Creek. Lake Mathews and the water quality wetlands and basins are operated by the Metropolitan Water District solely on the considerations of water supply, not for flood control purposes. Releases from Lake Mathews would only occur if the water elevation was to reach the spillway crest.

Canyon Lake, also referenced as Railroad Canyon Reservoir, was constructed in 1928 and has a total capacity of 11,600 acre-feet. Canyon Lake receives runoff from the 749-square mile San Jacinto River Watershed. Canyon Lake creates a sump for bed material that has been transported along the San Jacinto River. The Elsinore Valley Municipal Water District operates the lake based on water supply considerations and maintains a minimum lake elevation of 1,372 feet for the benefits of residents of the Lake Elsinore/Canyon Lake area. In addition, the Canyon Lake Property Owners Association leases surface rights for water recreation and regulates residential development around the edge of the lake.

Diamond Valley Lake is a man-made water supply reservoir located near Hemet and is one of the largest reservoirs in southern California. The Metropolitan Water District began construction of the project in 1995 and first started filling the lake by way of the Colorado River Aqueduct in 1999. Diamond Valley Lake was created by construction of three earth fill dams, two located on either side of the valley and one on the north rim. Diamond Valley Lake provides storage for 800,000 acre-feet of water and is not a flood control facility.

Lake Perris is another man-made water supply reservoir that was completed in 1973 in the mountain-rimmed valley between Moreno Valley and the city of Perris. Lake Perris is supplied from imported State Water Project water and the storage capacity of the reservoir is of 131,400 acre-feet and is not a flood control facility.

The storage capacity of Prado Dam, Lake Elsinore, Mystic Lake, Bautista Basin, Lake Hemet, Lake Mathews, Canyon Lake, Diamond Valley Lake, and Lake Perris provide a reduction of peak flow rates and durations during storm events. The potential increases in flood flows resulting from upstream development are offset, if not fully absorbed, by the storage effect of the reservoirs (Phillip Williams & Associates, 2004). However, the presence of these lakes and reservoirs in the SAR affects the geomorphologic equilibrium and the health of riparian communities by:

- Decreasing the amount of runoff released after frequent storm events.
- Altering the supply of coarse-grained sediment from high yield areas to the downstream channels. The presence of coarse-grained sediments is essential in maintaining the natural highly dynamic geomorphic processes in the SAR.

1.2 Urbanization in the SAR

The land uses in the SAR are primarily undeveloped with only approximately 30% in residential, commercial, and industrial. In 2008, agriculture accounted for 10% of the land uses within the SAR. Historically, the SAR has seen significant agricultural development and remains a strong component of the County's economy[1] (2020 General Plan, Riverside County). As of September 2013, the SAR is home to approximately 1.6 million individuals[2], and current projections indicate a 70% increase by 2035[3]. Projections for housing demand are proportional to the projected increase in population, and urbanization has, over the past few decades, been rising rapidly to meet the demand. Over the last approximately 18 years, Permittees have mitigated increases in runoff from new development during the planning process and have minimized downstream impacts.

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[1] County of Riverside General Plan, Vision Statement for Year 2020. Website: http://planning.rctlma.org/ZoningInformation/GeneralPlan.aspx

[2] State of California, Dept. of Finance, E-1 Population Estimates, and RCIT's Riverside County Progress Report

[3] 2010 Projections of Population. Riverside County Center for Demographic Research.

1.3 Floodplain Management

Runoff from urbanization is managed by the Riverside County Flood Control and Water Conservation District (District), the principal Permittee, in collaboration with the Co-Permittees. The District reviewed technical literature including the "Effects of Increased Urbanization from the 1970's to the 1990's on storm-runoff characteristics in Perris Valley, CA" and the "Engineering Workshop on Peak reduction for Drainage and Flood Control Projects" when developing the criteria for managing increased runoff. A number of technical issues were explored in some detail, including a review of the models used to evaluate development-related increases in runoff, and a review of the effectiveness of the various detention/retention schemes commonly proposed as management measures. During the planning and design phase of all new development and significant redevelopment projects, Permittees require users to demonstrate that the project's associated runoff volume and peak discharge will not significantly increase for selected storm return frequencies. Demonstration is achieved as one of the required elements of an approved project-specific water quality management plan (WQMP).

The Permittees participate in the National Flood Insurance Program, which provides flood insurance to participating communities. The Permittees successively implement and enforce a floodplain management ordinance to regulate development in mapped flood hazard areas. Consistent with the requirements of the National Flood Insurance Program, the District has adopted the 100-year return frequency storm event as the minimum standard for the protection of all habitable structures. Flood protection facilities, including storm drains and detention and retention facilities within the SAR, are designed to provide this level of protection. In addition, onsite drainage facilities are required to convey the 10-year storm while habitable structures are protected from the 100-year flood by the inclusion of factors of safety and freeboard. Projects that do not meet or exceed these requirements do not receive a grading permit until the requirements are met.

The Permittees collectively maintain MS4 facilities to ensure that adequate level of protection is provided for their communities. Projects may be considered by the District to reduce historical flooding hazards in specific communities in order to minimize threats to life, property, and the environment. Improvement projects may also include the rehabilitation or restoration of channel segments that have been impacted by hydromodification.

1.4 Future Infrastructure and Project Prioritization

The Permittees are responsible for the maintenance of MS4s and other drainage facilities within the SAR. The District was established by the Legislature to ensure that the major drainage infrastructure is properly functioning to convey the design discharge and protect the communities of Riverside County. The District, as part of its annual budget process, holds public budget hearings for the purpose of receiving flood control project requests. The process is described, as follows:

- Public hearings are held in a centrally located public place in each of the District's seven tax zones. Each zone has three Flood Control Commissioners who are zone residents. These Commissioners are appointed by the Board of Supervisors.
- Any individual, or representative of any business, organization, or government entity, may make a request for a flood control project by appearing at the budget hearing for the appropriate zone, or by submitting a written request to the District. Support for currently budgeted projects may also be offered. Written project requests should include the location and nature of the problem and the degree of damage (i.e., are residences or businesses actually flooded, etc.).

- After the public hearing, District staff prepares cost estimates of all newly requested projects, as well as ongoing projects, and then prioritizes them on the basis of public need, necessity, and available funds. A draft budget is then prepared by District staff and is presented to the Commissioners at a second public meeting (Work Session). At the Work Session, the Commissioners review the draft budget with District staff and make adjustments as they deem appropriate before making a recommendation for approval. The Work Session is a public meeting and there is opportunity for public comment.
- In June of each year, a final draft proposed budget, approved by the District Commissioners, is forwarded to the District's Board of Supervisors for final approval.

2 Technical Concepts

Hydromodication monitoring measures aim at identifying a potential response of channel segments to an altered flow regime, if any, or other physical and watershed constraints. Response from a channel segment may be assessed through the monitoring of two types of field indicators: a morphologic assessment of channel geometry and an evaluation of the channel physical indicators in an identified segment as a deviation from natural geomorphological processes. This section provides a technical justification to using both field indicators.

2.1 HMP Monitoring Measures

Temporal Evolution of Channel Morphology

Evaluation of instream conditions may provide insight on the effects caused by urbanization, and in turn may be used to predict possible future degradation resulting from expanded development. The most direct method to assess changes instream, due to scour or deposition, is to physically measure the pre-project and post-project cross sections, and determine if the channel is aggrading or degrading (incising and/or widening) over time. This may be accomplished by conducting geomorphic assessments and measurements of channel geometry of segments upstream and downstream of a planned development before and after construction. However, channel aggradation and degradation must be considered in the context of natural geomorphologic processes in the SAR. As an alternative to physical measurements, comparison of current and historical photos, aerial photogrammetry acquired from remote sensing techniques, and site inspection for signs of channel degradation can provide important supporting evidence.

Instream Physical Indicators

As an option, a selection of physical indicator metrics may be investigated concurrently with channel morphology observations. Changes in the canopy cover, riparian vegetation, instream indicator complexity, and human influence may provide an indication of exposure over time and responses to cumulative stressors where taken in consideration of natural geomorphic processes. The Surface Water Ambient Monitoring Program has established physical indicator assessment procedures that may be considered to ephemeral or intermittent channel segments, as identified by Ode et al. (2007)[4]. Applicable terrestrial procedures have been derived from the physical indicator assessment methods developed by Kaufmann et al. (1994), which are currently used as the standard method of stream indicator collection by the U.S. Environmental Protection Agency (USEPA) in its Environmental Monitoring and Assessment Program (EMAP) (USEPA, 1999).

For the purposes of the HMP, instream morphologic assessment may be accomplished using advanced remote imagery techniques where available. Potential physical indicator metrics that will be considered for the HMP Evaluation Program include the following:

- Substrate composition - Changes in substrate size distributions are often indicative of catchment and streamside disturbances that may alter rates of hill slope erosion or mobilize sediment, observations that may be conducted from remote imagery.

[4] Final Report on Bioassessment in Nonperennial Streams. Southern California Coastal Water Research Project. Technical Report 695. June 2012.

- Riparian vegetation - Typically riparian canopy over a channel does not exist in the SAR. Where canopy does exist it is important not only for its role in moderating stream temperatures through shading, but also as an indicator of conditions that control bank stability and the potential for inputs of coarse and fine particulate organic material (USEPA, 1999). Observations of the presence of canopy or the loss of canopy should be considered. Types, density, and coverage of the canopy should be classified into three categories (groundcover, lower canopy, and upper canopy) based on the remote imagery or field assessment observations within the defined riparian zone.
- Instream indicator complexity for aquatic fauna – The instream indicator complexity consists of identifying and quantifying the presence of typical channel features that provide good information about the general condition and complexity of the channel. Channel features that may be evaluated for the purposes of the HMP Evaluation Program include boulders, woody debris, undercut banks, overhanging vegetation, live tree roots, and artificial structures.
- Human influence – Field evaluations should identify the presence and proximity of significant types of human activities in the stream riparian area, including land use, infrastructure, and other influences.

2.2 Temporal and Spatial Variability of Hydromodification Monitoring Locations

An investigation of the potential causes of channel degradation in all major subwatersheds of the SAR was performed as part of the SAR HMP. The investigation included both the examination of historical and current aerial photographs and the development of a GIS-based study using three factors to create geomorphic landscape units including geology types, land cover, and hill slope gradient[5]. A brief summary of the findings of the investigations is provided per subwatershed, as follows:

- The upper San Jacinto River subwatershed outlets at its confluence with Bautista Creek and has observed limited development (5.9%) since 1972. The majority of the upper, steeper reaches have remained in a natural condition, which would be beneficial to replenish the downstream channels with coarse grained sediments. However, the presence of Lake Hemet has partially reduced this supply to downstream reaches.
- The middle and lower San Jacinto River subwatersheds are located downstream of the confluence with Bautista Creek and drain successively to Canyon Lake and Lake Elsinore. Debris and detention basins have been constructed downstream of the upper reaches that are concentrated near the San Jacinto Mountains, the Lakeview Mountains, and the Santa Ana Mountains surrounding Lake Elsinore. The debris and detention basins have reduced the supply of coarse grained sediment from making it to the downstream channel reaches. In addition, the significant change in impervious area due to watershed development has increased the frequency and rate of flow in the channel.
- Agriculture and grasslands have historically been dominant land uses within the Temescal Wash subwatershed. Historical aerial photographs depict a significant urbanization within the floodplain over the 1952-2013 period. The aerial photographs notably show the impacts of increasing imperviousness on the natural hydrologic response of the subwatershed and on the geomorphology of Temescal Wash.
- The SAR portion of the San Timoteo Creek subwatershed originates in the San Bernardino Mountains and drains to Cherry Valley. Agricultural runoff and effluent from publicly-owned

[5] Draft Technical Memorandum - Causes of Degradation and Aggradation in the Santa Ana Region of Riverside County. SAR HMP Appendix B. November 2013.

treatment works activities occur year-round to San Timoteo Creek and create a perennial flow condition. Historical aerials show that dense vegetation has stabilized the geomorphology of the creek under altered hydrologic and sediment regimes.

Temporal Variability

The single most important factor affecting the temporal variability inherent to measuring channel aggradation and degradation is variable inter-annual rainfall frequency and intensity. Droughts in the SAR can last years. Historical precipitation records since year 1895 at Prado Dam have recorded a minimum of 4.6 inches for the 2006-2007 water year[6]. In addition to droughts, the SAR also experiences anomalously high storm frequencies and intensities. During El Niño years, frequencies and intensities resulted in sudden naturally occurring geomorphic changes. Rainfall intensity also varies intra-annually. Accordingly, findings from the HMP Evaluation Program will be derived only over time. Trends may require many years to identify. Physical indicator metrics may be a correlating variable to geomorphic changes in channels. As identified in Section 2.1, physical indicator metrics should be evaluated on an individual basis that reflects the flow conditions (perennial, intermittent, or ephemeral) of the evaluated channel segment.

Spatial Variability

A change in elevation in the SAR translates into significant geographic variation of the average annual rainfall, which equals approximately 10 inches and 28 inches in Riverside and in Idyllwild, respectively. The selection of a monitoring location should encompass, to the maximum extent practicable, these geographic variations of natural (stated above) and anthropogenic stressors such as urbanization. Specifically, the measurement of physical indicator metrics and the evaluation of measurements of channel geometry is important to document the range of natural watershed conditions and stream stability of channel segments and to identify if hydromodification associated with new development or significant redevelopment has occurred. Other important factors that reflect channel responses to hydromodification include channel grade, watershed area, and channel sinuosity. In addition to channel and watershed features, location within the watershed is an important consideration. Monitoring locations should ideally:

- Be located in the headwaters or upper portion of representative subwatersheds within the SAR;
- Be located just downstream (or within the domain of influence as defined in Appendix A of the SAR HMP) of a new development or significant redevelopment project of sufficient size, so that hydromodification effects of the project can be isolated to the maximum extent practicable; and
- Not be influenced by other confounding variables including dam operation, non-MS4 runoff, runoff retention basins, Caltrans runoff, or agricultural development and operation.

Specifically, channel segments that are located downstream of controlled release points, or within segments of large rivers, are not ideal locations for the investigations.

Upper reaches in representative SAR subwatersheds may provide more definitive measures of HMP effectiveness if they can more directly correlate effects to specific new development or significant redevelopment projects. Upper reaches within the SAR may include the San Jacinto Mountains, the Lakeview Mountains, and the Santa Ana Mountains surrounding Lake Elsinore.

[6] Preliminary Studies of Flow of Santa Ana River at Prado Dam – Indices of Precipitation and Runoff and Base Periods. Bookman and Edmonston. March 1966

Middle subwatershed and lower subwatershed sites would be influenced by confounding variables (such as mass wasting or other existing development projects) in the subwatershed. Mass wasting or slope failure occurs on channel banks subject to weathering, increased water content, changes in vegetation cover, and overloading. Therefore, middle and lower subwatershed monitoring sites would require much more time to assess overall program effectiveness, if achievable.

The concept of providing hydromodification effectiveness measurements in the watershed headwaters is supported by Southern California Coastal Water Research Project (SCCWRP). Research has shown that hydromodification effects of a development project may become muted with increasing distance from the project site (defined by SCCWRP as the Domain of Effect).

3 Approaches Selected to Assess HMP Effectiveness

The philosophy of the HMP Evaluation Program is to identify adequate monitoring locations in the SAR to evaluate HMP implementation and effectiveness. The selection of adequate monitoring locations shall be consistent with the siting criteria defined in Section 2.2. This will provide the most efficient alternative for the Permittees and will ensure that the requirements of the MS4 permit are met.

Measurements of channel geometry may include remote sensing techniques, where appropriate, upon improvement of the physical limits of remote sensing equipment. Currently, remote sensing techniques, such as airborne Light Detection and Ranging (LIDAR), offer a vertical accuracy of 0.5 foot under optimal conditions. Optimal conditions may be compromised by vegetative conditions, slope, and land cover[7]. Conversely, measurements of channel geometry require at least 20 elevation measurements at significant breaks of slope that occur across the channel. The terrace and the floodplain may be included in the measurement of channel geometry, based on the characteristics of the site[8].

3.1 Assessment Principles

The HMP Evaluation Program will extend for a period of five years. A period of five years is necessary to implement the hydromodification monitoring locations and/or initiate the acquisition of remote sensing imagery, analyze the data, and account for spatial and temporal variability of the conditions in the SAR. Implementation of the HMP Evaluation Program will be discussed in the SAR annual monitoring reports. HMP monitoring data will be submitted to the Santa Ana Regional Board at the end of the evaluation period, tentatively in Fall 2019.

An examination of the riparian physical indicator may be accomplished by assessing geomorphologic changes of the channels. Locations of perennial, intermittent, or ephemeral flow should be monitored annually using the channel geometry measurement methods described in Section 2.1.

The following approaches are recommended for HMP Evaluation Program:

Complete a measurement of channel geometry at each of the selected locations annually. The channel geometry measurements consist of collecting topographic and bathymetric measurements along each cross section to characterize morphology and longitudinal slope of the channel segment. Surveys may be performed by field measurements, aerial and ground-based photogrammetry, laser scanning, or an alternatively acceptable surveying technique that meets all requirements of Section 3. Where feasible, aerial photogrammetry can specifically be used to evaluate floodplain width, planform changes, channel migration, and floodplain obstructions or constrictions (SCCWRP, 2013). Four parameters will be surveyed: the floodprone width, the bankfull width, the bankfull depth, and the longitudinal slope. Each surveyed channel segment will be subsequently classified per the simplified Rosgen system of channel classification (Rosgen, 1996). **Figure 1** shows the different types of channels per Rosgen channel classification (Rosgen, 1996).

[7] Lidar Base Specification Version 1.0. United States Geological Survey. 2012
[8] Maintenance and Monitoring. National Engineering Handbook Part 65. United States Department of Agriculture. August 2007

Figure 1: Simplified Rosgen Channel Classification

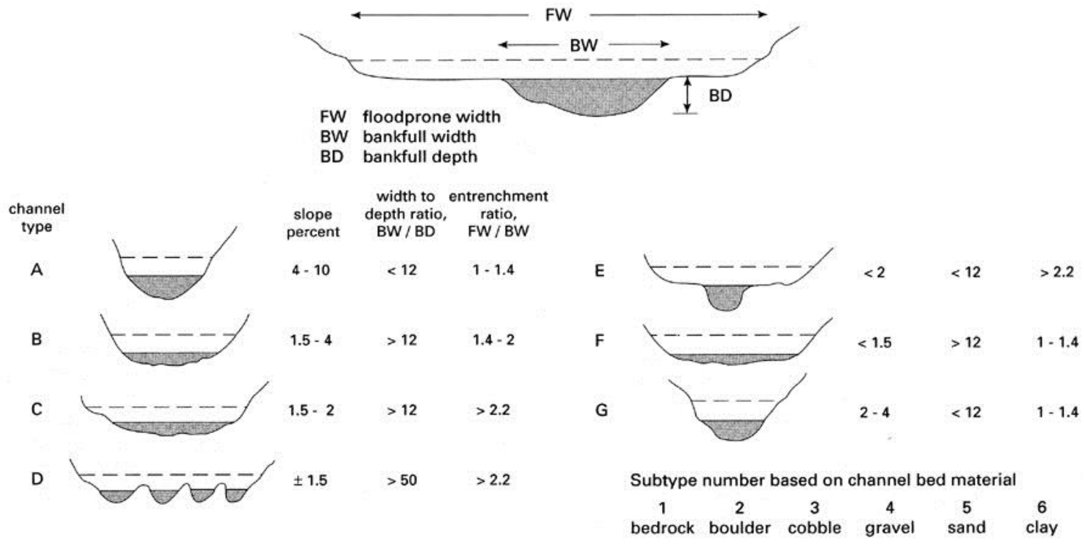
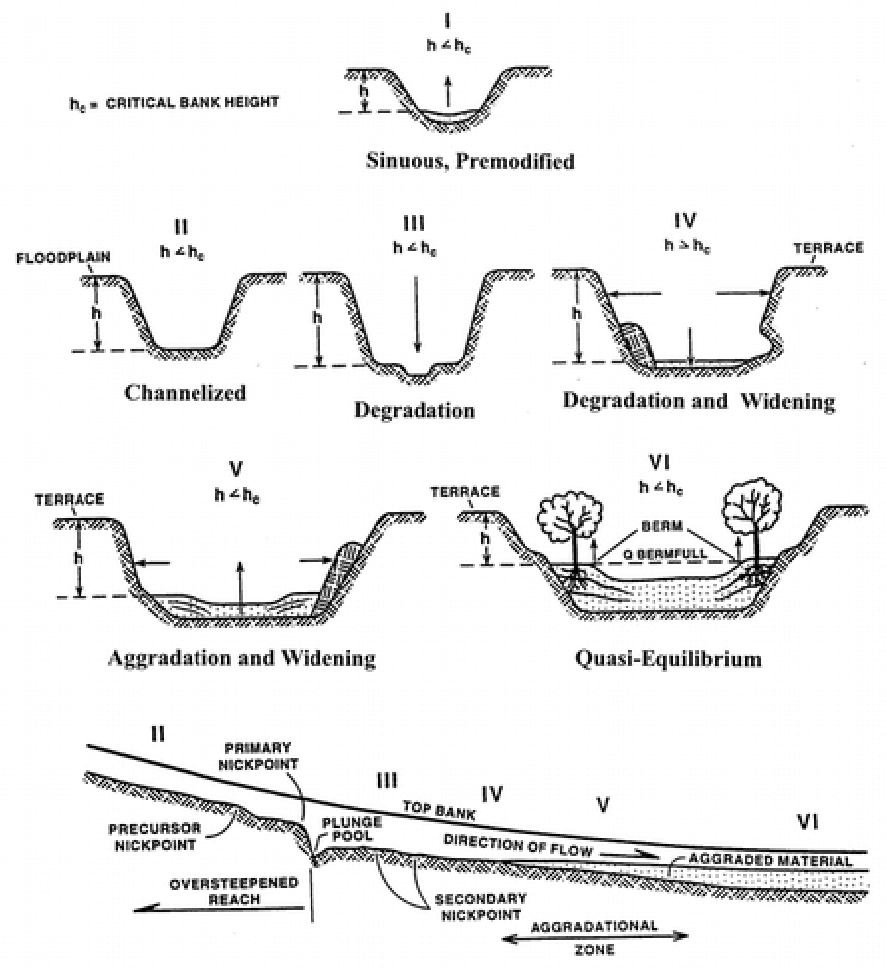


Figure 1.12 The Rosgen system of channel classification.

(Rosgen, 1996)

The temporal evolution in geomorphology, if any, of the surveyed channel segment will be compared to the six-stage Channel Evolution Model defined by Simon (Simon et al., 1992), as well as the previous year cross section data, to correlate any potential impacts of urbanization to this change of channel geomorphology. **Figure 2** illustrates the six-stage sequence of incised channel evolution (Simon et al., 1992). A channel segment will be considered stable over time if features of the channel segment (such as dimension, pattern, and profile) are maintained, and the channel system neither aggrades nor degrades.

Figure 2: Six-Stage Channel Evolution Model



(Simon et al, 1992)

3.2 Selection of Monitoring Locations

The selection of monitoring locations should follow the following criteria:

- Monitoring upper reaches of representative subwatersheds within the SAR: upper subwatershed monitoring (channel surveys) is recommended to eliminate confounding lower watershed variables that would skew the analysis and minimize the potential for reaching meaningful conclusions. The influence of upstream dams and existing urbanized areas should particularly be minimized;
- Monitoring locations should be located just downstream (or within the domain of influence as defined in Appendix A of the SAR HMP) of a new development or significant redevelopment project of sufficient size, so that hydromodification effects of the project can be isolated to the maximum extent practicable; and
- Monitoring locations should not be influenced by other confounding variables including dam operation, non-MS4 runoff, runoff retention basins, Caltrans runoff, or agricultural development and operation.

- Monitoring locations should be in a portion of the study area downstream of minimal existing development.

Consistent with Permit Provision XII.B.5.b., the Permittees have investigated the SAR for potential monitoring sites and have identified one that meets the siting criteria set forth. Other opportunities will be identified as future new development or significant redevelopment projects are evaluated by the Permittees for project approval. The new development or significant redevelopment approval process includes the evaluation of potential impacts to the receiving waters and the mitigation alternatives to be implemented; hence, will facilitate the identification of adequate monitoring locations.

3.3 Proposed Monitoring Location – The Villages of Lakeview

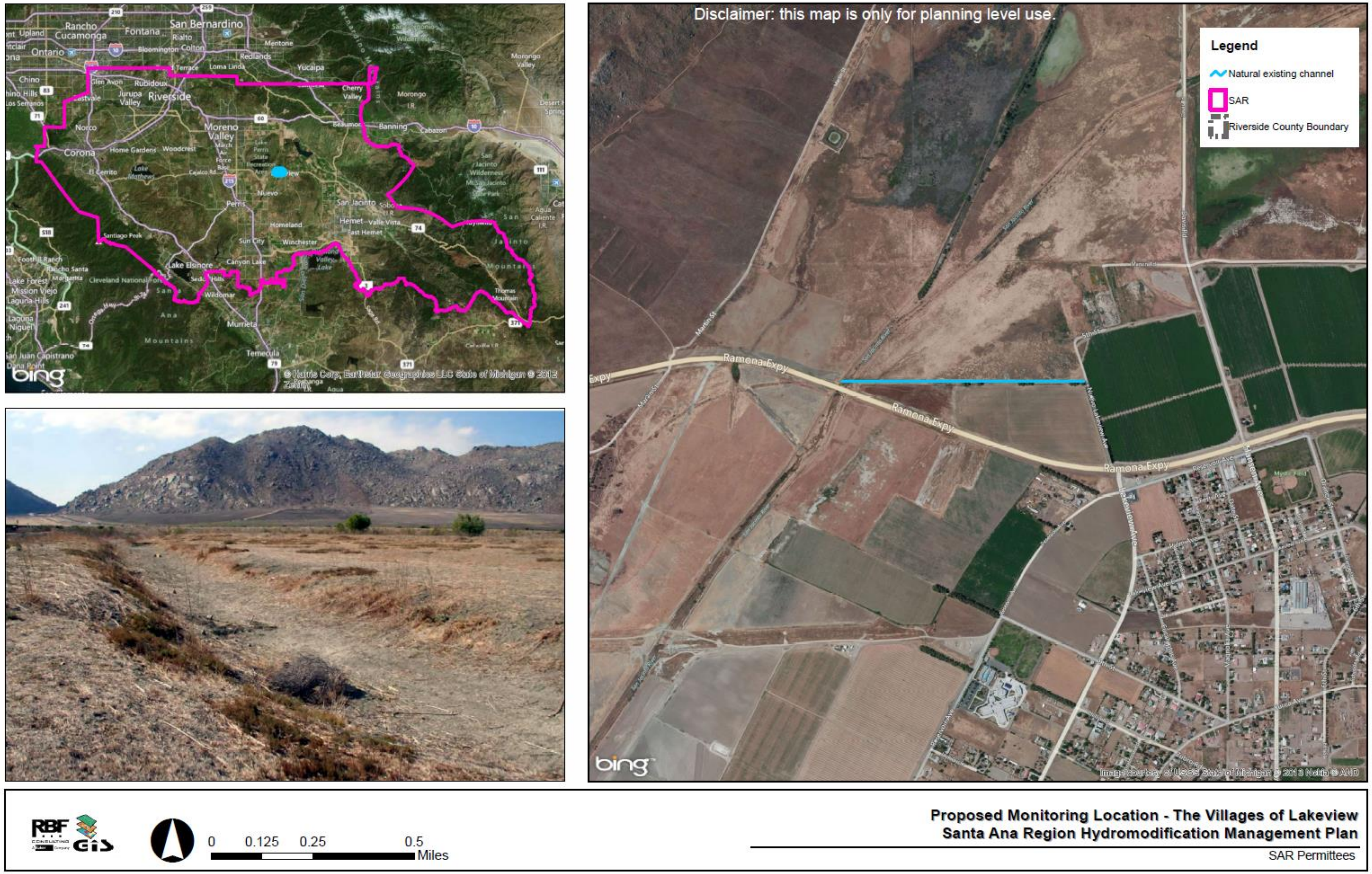
The Villages of Lakeview is a future 2,800 acre residential development to be located in the Lakeview/Nuevo area of Riverside County along the Ramona Expressway. Current land uses at the site consist of active and fallow agricultural land and open space. In addition, a 115-acre horse ranch and a 100-acre chicken ranch currently occupy portions of the project area.

The project site is located in the San Jacinto River watershed in Riverside County and is bounded by Marvin Road in the north, Princess Ann Road in the east, Contour Avenue (farther south), and San Jacinto River (northwestern corner) and Hansen Road in the west, south of Ramona Expressway. Geotechnical investigations over the project site have characterized the subsurface geology as alluvial deposits derived from the San Jacinto River and eroded sediment from the Lakeview Mountains (Leighton and Associates, Inc.). Near surface conditions are dominated by silty sand over most of the project area and local fine grained deposits may be associated with ephemeral tributaries to the San Jacinto River that descend from the Lakeview Mountains.

The specific plan for The Villages of Lakeview project identifies that stormwater will be delivered from the southeast part of the project site to the northern edge at Ramona Expressway. Flows will be split by high flow bypass structures that will divert water quality design flow rates to a water quality basin. Flows from the water quality basin will merge with flows from a channel and be conveyed into an existing onsite channel and subsequently to the San Jacinto River.

It is recommended that the initial monitoring location be established on the existing onsite channel before the confluence with the San Jacinto River. The existing onsite channel has an approximately trapezoidal cross section with roughly 2:1 sideslopes and 20-foot bottom width at a very mild slope (< 0.5%) and is made of very fine grained alluvial material. The monitoring location will be able to evaluate the effectiveness of the upstream water quality basin and other controls on both the geomorphology and the physical indicator of the natural channel. It appears that the monitoring location is within the Nuevo Development Corporation property adjacent to state property. The location and access rights are currently being evaluated. **Figure 3** identifies the location of the proposed monitoring site.

Figure 3 - Initial Monitoring Location



4 HMP Effectiveness Evaluation

The effectiveness of the HMP is to be evaluated into two main elements:

- BMP Inspections and Maintenance; and
- Performance Protocol

4.1 BMP Inspections and Maintenance

One key component of the implementation of the HMP is to ensure that the hydrologic control measures that are identified in Section 3 of the SAR HMP perform effectively. New development and significant redevelopment projects are conditioned to verify inspections and maintenance operations as defined in Chapter 5 of the SARWQMP Guidance Document. The list of such inspections and maintenance operations will be included in the project-specific WQMP submitted by the user. Regular maintenance activities ensure the long-term performance of the hydrologic control measures at mitigating both volumes and times of concentration.

4.2 Performance Protocol

As defined in Section 3, channel geometry measurements are to be performed using pertinent surveying techniques, including cross sectional survey or, if applicable, remote sensing techniques. The selected monitoring location in the SAR will be assessed to determine if they exceed natural geomorphologic processes. If significant aggradation or degradation of the evaluated channel segment is detected, a hydrologic analysis will be performed and assessed to determine if it exceeds natural processes. A significant aggradation or degradation of the channel segment will be deemed by the analyst as a rapid change of the morphology of the channel (cross section) that follows Simon's Channel Evolution Model.

The hydrologic analysis, if applicable, shall determine if the significant aggradation or degradation of the monitored channel segment is associated to storm events with a return frequency lower than two years or if it was caused by flows associated with relatively unusual storm events or by other variables identified by the analyst. A significant difference in expected and observed flows and volumes would automatically trigger a performance protocol.

The performance protocol consists of investigating the tributary area of the affected channel segment to identify the potential source(s) for the aggradation or degradation of the channel and/or the morphology of the channel segment. The analyst may investigate the following potential sources:

- If the channel aggradation or degradation was caused by flows associated with relatively unusual storm events (more unusual than the 2-year storm event), the extensive hydrologic analysis may terminate and no further investigation is needed;
- If the channel aggradation or degradation was caused by other unexpected stressors identified by the analyst, their impact to the flow and sediment supply regimes through the evaluated stream segment should be documented; and
- Hydrologic control measures of one or several new development or significant redevelopment projects may be examined to see how they are performing. In this case, performance may be examined by evaluating any drastic changes in channel conditions. A drastic change in the channel conditions may be identified as the progression of the evaluated channel segment from

one level of the Channel Evolution Model defined in Section 3.1 to another. Rehabilitation of the channel segment may be required depending on the risk and project priority.

It is expected that initial conclusions regarding the effectiveness of the HMP will be drawn after a minimum of five years of observations.

5 Summary and Conclusions

The HMP Evaluation Program, scheduled for initial implementation by the Permittees over a five-year period, will include the following specific activities:

Baseline Monitoring Plan:

- Establishment of the objectives of the HMP Evaluation Program;
- Identification of representative monitoring locations that meet the siting criteria identified in Section 2.2;
- Evaluation of historical data at representative monitoring locations, if available;
- Perform a morphologic assessment of channel geometry and an evaluation of the channel physical indicator of channel segments, if applicable, per the methods identified in Section 2.2 and Section 3;
- If applicable, perform a hydrologic analysis following the performance protocol in Section 4.2;
- Discussion of the HMP implementation in the annual reports (2015–2019); and
- HMP Evaluation Program Summary (submitted in 2019 Annual Report)

The approach of the HMP Evaluation Program is conceptualized and summarized in **Figure 4**.

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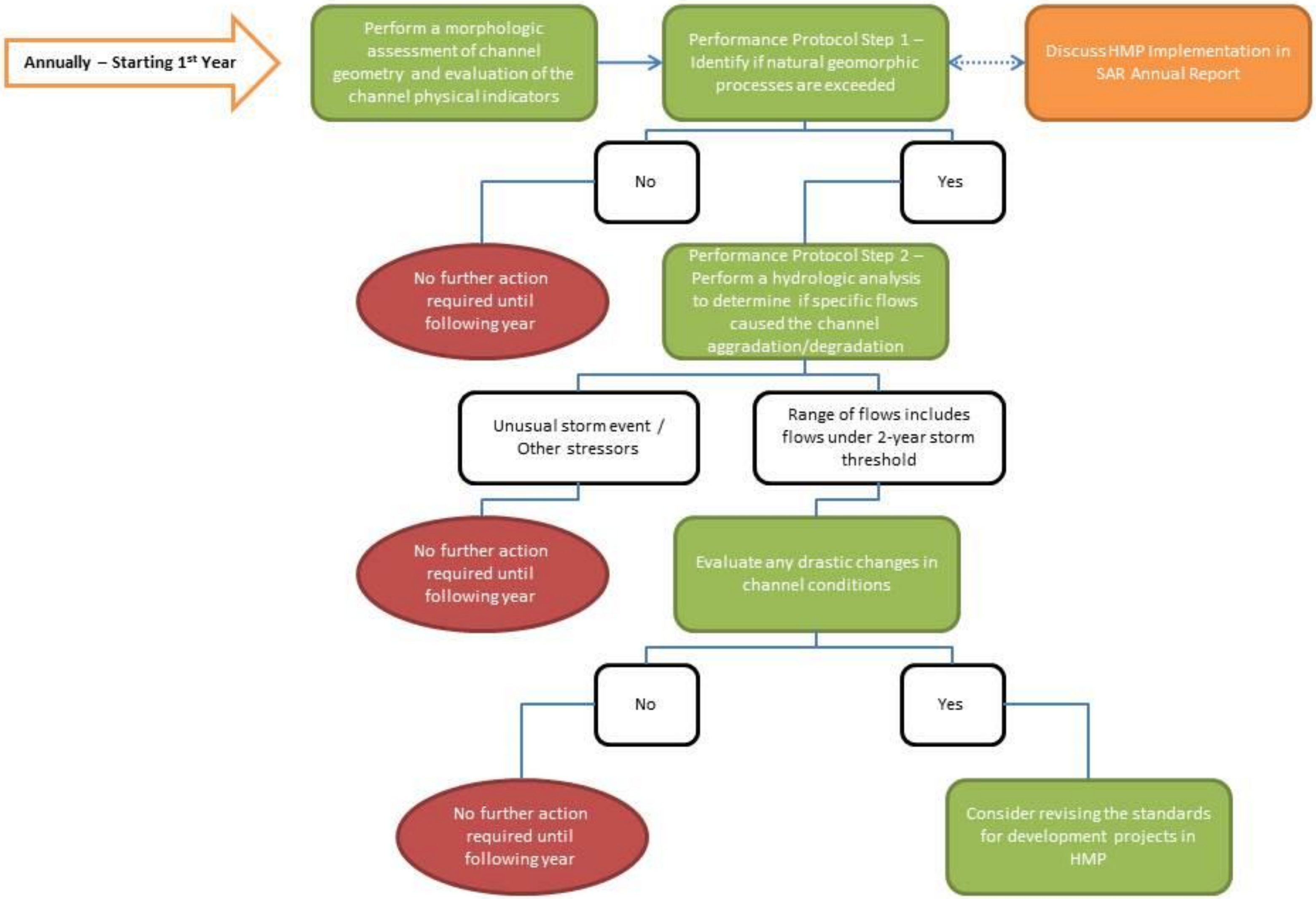
Figure 4: HMP Evaluation Program Schemati



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