Appendix

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ALTERNATIVE COMPLIANCE PROGRAM GUIDELINES AND DEVELOPMENT

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FINAL

ALTERNATIVE COMPLIANCE PROGRAM GUIDELINES AND DEVELOPMENT

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Acronyms and Abbreviations

ACP	Alternative Compliance Program
ASCI	Algal Stream Condition Index
BMP	best management practice
CEQA	California Environmental Quality Act
City	City of Chula Vista's
CSCI	California Stream Condition Index
CRAM	California Rapid Assessment Methodology
CWA	Clean Water Act
DCV	design capture volume
ILF	in-lieu fee structure
MEP	maximum extent practicable
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NSMP	Natural Systems Management Practices
PDP	Priority Development Project
Plan	City's 2005 General Plan
Porter-Cologne Act	Porter-Cologne Water Quality Act
PDP	Priority Development Project
Program	Alternative Compliance In-Lieu Fee Program
RWQCB	Regional Water Quality Control Board
SUSMP	Standard Urban Stormwater Program
SWAMP	Surface Water Ambient Monitoring Program
WMA	Watershed Management Area
WMAA	Watershed Management Area Analysis
WQE	Water Quality Equivalency
WQE Guidance	Water Quality Equivalency Guidance Document: Region 9
WQIP	Water Quality Improvement Plan

Executive Summary

The purpose of this document is to provide guidance on use of the City of Chula Vista's Alternative Compliance In-Lieu Fee Program (Program), which proposes the use of stream rehabilitation Natural Systems Management Practices (NSMP) as the mechanism for alternative compliance. The overall goal of this Program is to provide alternative mechanisms to meet stormwater compliance criteria while providing a greater water quality benefit and improved habitat within the City of Chula Vista's (City) watersheds.

The San Diego Regional Municipal Separate Storm Sewer System (MS4) Permit allows for a Priority Development Project (PDP) to participate in an Alternative Compliance Program (ACP) as an offsite alternative to meet the onsite structural best management practice (BMP) performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) of the Regional MS4 Permit while also meeting regional and watershed goals that are not met through onsite compliance. Participation in an ACP is allowed so long as the offsite alternative will have a greater overall water quality benefit than fully complying with the performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) onsite. An ACP can be used as an option for compliance so long as flow-thru treatment control BMPs sized and designed in accordance with Permit Provisions E.3.c.(1)(a)(ii)[a]-[c] are also implemented on the development site.

Alternative compliance can be achieved through the use of structural BMPs or NSMPs. Structural BMPs are physical structures or features that are designed to collect, treat, infiltrate, and/or convey stormwater. Examples include retention ponds, rain gardens, constructed wetlands, and pervious pavement (RWQCB, 2018: ES-2). The City obtained SB 2 grant funding to develop an ACP for NSMPs to provide alternative compliance and treatment options for stormwater consistent with the Regional MS4 Permit. NSMPs are stormwater management practices implemented to restore and/or preserve predevelopment watershed functions in lieu of onsite direct pollutant removal and hydromodification flow control treatment BMPs (RWQCB, 2018: xv).

This document was developed to provide guidance on use of the City's Program utilizing stream rehabilitation NSMP projects as an offsite alternative compliance mechanism. Participants in the City's program will follow the regulations outlined in the Regional MS4 Permit and other supporting regulatory guidance approved for use within the City's jurisdiction. The two main benefits for participation in this Program are greater water quality benefit to the watershed compared to onsite implementation of BMPs and enhanced flexibility of developing property within the City's jurisdiction. Additionally, this Program supports watershed and regional level goals beyond what can be achieved through onsite compliance as described in Provision E.3.c.(1)(a) by improving the water quality of a larger quantity of water than onsite treatment, improving local resiliency to climate change, and facilitating implementation of watershed-scale natural system solutions that improve watershed functions, amongst other watershed-level benefits.

Chapter 1
Program Purpose and Authority

1.1 Purpose

The purpose of the Program described in this document is to provide offsite pollution control treatment opportunities using NSMPs, specifically stream rehabilitation techniques, as allowed by provision E.3.c.(3), as an alternative to the onsite structural BMP performance standards set in Provisions E.3.c.(1) and E.3.c.(2)(a) of the San Diego Regional Municipal Separate Storm Sewer System (MS4) Permit (Order R9-2013-0001, as amended) and the *City of Chula Vista BMP Design Manual*. The Program is funded by a California Department of Housing and Community Development SB 2 Planning Grant that provides funding and technical assistance to local governments to help prepare, adopt, and implement plans and process improvements that streamline housing approvals and accelerate housing production. By doing so, the grant's goal is to increase the availability of affordable housing within California. The City's Program will increase project onsite buildable acreage which will help the City meet its housing and community development goals. The Program will also allow PDPs to meet Regional MS4 Permit requirements for stormwater pollutant control and hydromodification management through providing a mechanism for the creation and approval of stormwater credits.

Participation in the Program is allowed so long as the offsite alternative will have a greater overall water quality benefit than fully complying with the performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) onsite and flow-thru treatment control BMPs sized and designed in accordance with Permit Provisions E.3.c.(1)(a)(ii)[a]-[c] are implemented on the development site.

This document provides information on the authorities supporting the Program, identifies what a project is and gives context for NSMP projects, provides background and guidance for use regarding the Water Quality Equivalency developed for stream rehabilitation NSMPs for this Program, and provides guidance for use of the Program. The two main benefits for participation in this Program are greater water quality benefit to the watershed compared to onsite implementation of BMPs and enhanced flexibility of developing property within the City's jurisdiction. Authority

The guidelines and requirements in this document are designed to address the requirements in San Diego Region Municipal Permit, National Pollutant Discharge Elimination System (NPDES) Order No. CAS0109266, as modified by Order Nos. R9-2015-0001 and R9-2015-0100, Sections E.3.c.(3), as authorized under Section 402 of federal Clean Water Act and implementing regulations (Code of Federal Regulations, Title 40, Part 122) adopted by the United States Environmental Protection Agency, and Chapter 5.5, Division 7 of the California Water Code. Section 402(p)(3)(B)(iii) of the Clean Water Act requires that discharges from MS4s reduce the discharge of pollutants to the maximum extent practicable (MEP). To determine the MEP, a municipality may consider the effectiveness, cost, regulatory compliance, public acceptability, and feasibility of implementation (Regional MS4 Permit Attachment C).

Additional guidelines include the Chula Vista BMP Design Manual (City of Chula Vista 2021), San Diego Bay Watershed Management Area Water Quality Improvement Plan (WQIP) (San Diego Bay Responsible Parties 2016), San Diego Regional Water Quality Equivalency Guidance Document (Regional WQE Guidance) (RWQCB 2018), and San Diego Bay Watershed Management Area Analysis (WMAA).

1.2 Watershed and City-Wide Benefits Analysis

Provision E.3.c.(3) of the Regional MS4 Permit allows PDPs to participate in this Program if participation will result in a greater overall water quality and ecosystem benefits to the Watershed Management Area than fully complying with performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) onsite. This program supports watershed and regional level goals that are not accomplished through onsite compliance as described in Provision E.3.c.(1)(a) and provides an additional option for PDPs to achieve MEP.

The water quality of the larger watershed is impacted by water generated on older developments built prior to the current treatment requirements. When a PDP utilizes onsite treatment BMPs, the maximum amount of water that can be treated by those BMPs is limited by the amount of stormwater generated by the PDP. ACP projects implemented through this Program have the potential to increase the pollutant treatment function of the stream through stream rehabilitation NSMPs, allowing the Program to improve overall water quality within the system. To demonstrate greater overall water quality benefits, an ACP will consider pollutant control and hydromodification flow control separately. As defined in the Regional WQE Guidance: "Greater overall water quality benefit is demonstrated when Stormwater Pollutant Control Benefits are greater than or equal to Stormwater Pollutant Control Impacts, AND Hydromodification Flow Control Benefits are greater than or equal to Hydromodification Flow Control Impacts" (RWQCB 2018). The implementation of stream rehabilitation NSMPs through this Program will result in a greater water quality benefit to the watershed, and overall benefit to the City by:

a. Requiring each PDP participating in the Program to demonstrate that they are providing greater water quality benefits than they would through the onsite BMP performance requirements of Provision E.3.c.(1)(a). Greater overall water quality benefit for stormwater pollutant control is established by demonstrating that the earned volume from a NSMP is greater than the earned volume from an onsite BMP (See Appendix C, Section "NSMP WQE Equation Development"). The natural system project must also provide greater water quality benefits within the Watershed Management Area than fully complying with onsite BMP performance requirements (Provision E.3.c.(3)(b)(i)).

b. Improving the water quality of a larger quantity of water than onsite treatment. When a PDP utilizes onsite treatment control best management practices (BMPs), the maximum amount of water that can be treated by those BMPs is the amount of stormwater flow generated by the PDP not already addressed through source control or site design BMPs. Natural system projects implemented through this Program not only address the individual project's runoff, but also have the potential to improve the water quality of the larger watershed that is impacted by runoff generated from older developments that were built prior to the current treatment requirements. PDPs participating in this Program will be required to implement flow-thru treatment control BMPs to treat onsite runoff in accordance with Provisions E.3.c.(1)(a)(ii)[a]-[c].

c. Facilitating implementation of watershed-scale natural system solutions that improve watershed functions not met through project level onsite compliance described in Provision E.3.c.(1)(a). The Regional WQE Guidance states that greater overall watershed benefit is achieved when stream rehabilitation measures are designed to mitigate both future and legacy hydromodification impacts associated with development that occurs within the watershed (RWQCB 2018). PDPs can demonstrate greater overall watershed benefit by calculating hydromodification flow control equivalency for stream rehabilitation with existing methodologies in Section 3.6 of the Regional WQE Guidance Document.

d. Allowing developers to maximize the developable space within a PDP and support the City's housing and community development goals. Implementation of onsite BMPs necessarily utilizes space within the PDP site that could be used to increase the density of development within the PDP site. The City has identified housing and community development goals in the 2021-2029 Housing Element of the General Plan and the 2020-2024 Five-Year Consolidated Plan for its HUD entitlement programs. While the Program is not restricted to PDPs that will supply additional housing, it would help the City to meet its identified housing density goals, and the housing needs in the region. Maximizing of the use of developable space at participating PDP locations by allowing pollutant control and hydromodification treatment to be implemented at an offsite ACP will have the potential to reduce the total number of PDP sites to meet these goals, allowing some areas to remain undeveloped.

e. Stream rehabilitation improves local resiliency to climate change. Healthy riparian areas are naturally resilient, provide thermal refugia for wildlife, and provide both habitat linkages as well as connectivity between aquatic and terrestrial habitats, which are all factors that can support resiliency to climate change in the ecosystem (Seavy et. al. 2009).

Based on the criteria listed above, the City has elected to allow PDPs to participate in this Program as an alternative mechanism to achieve MEP, when coupled with implementing low-impact development, onsite flow-through treatment, and source control, as appropriate. Per provisions E.3.c.(1)(a)(ii)[a]-[c] within the permit, onsite flow thru treatment is required by the PDP. The two main benefits for participation in this Program are greater water quality benefit to the watershed compared to onsite implementation of BMPs and enhanced flexibility of developing property within the City's jurisdiction while concurrently incentivizing improvements to water quality in locations that otherwise may not see improvements in the near term.

1.2.1 Citywide Watershed Baseline

In the calculation of earned volume by an ACP, the applicant must characterize the ACP tributary land uses and relative pollutant concentrations. This process is needed because ACPs may offset PDP impacts from anywhere within the same hydrologic area within the watershed management area (WMA). The Regional WQE Guidance contains existing methodologies in Section 2-2 and Appendix D of the guidance document to identify land uses and pollutants of concern in the San Diego River Watershed (San Diego Hydrologic Unit 907.00) (RWCQB 2018). Applicants proposing an NSMP ACP must utilize the existing methodology in the Regional WQE Guidance to establish a baseline of watershed conditions. The ACP will also conduct pre- and post-project condition surveys to document the improvement in condition and support that the planned benefits to the watershed are in place. The information provided below is specific to the Citywide Watershed and the various functions that NSMPs provide for greater overall watershed benefit.

Chula Vista is located within the San Diego Bay Watershed Management Area and contains portions of the Sweetwater and Otay Hydrologic Units. The Otay Hydrologic Unit encompasses nearly 98, 500 acres and is further broken down into the Coronado, Otay Valley, and Dulzura hydrologic areas, or sub-watersheds. Nearly 68% of the Otay Hydrologic Unit is composed of undeveloped and open space land. Land uses vary within the hydrologic areas, with 52% of the Coronado Hydrologic Area comprising of 52% military, the Otay Valley Hydrologic Area having dominant land uses of 47% open space and undeveloped land and 16% residential, and the Dulzura Hydrologic Unit being comprised of 83% open space and undeveloped land use and 18% residential (Project Clean Water 2022). Figure 1-1 and Table 1-1 provide context for existing land use in Otay watershed within the City limits. The entirety of the Sweetwater Hydrologic Unit encompasses over 145,000 acres and can be further broken down into three sub-watersheds: the Lower, Middle, and Upper Sweetwater Hydrologic Areas. More than half of the watershed is comprised of undeveloped land and open space, with much of the more densely populated areas, including the City of Chula Vista, existing in the Lower Sweetwater Hydrologic Area. Residential areas and transportation land uses make up 44% and 18%, respectively, of hydrologic area land use. Figure 1-2 and Table 1-1 provide context for existing land use in Sweetwater watershed within the City limits.

Table 1-1. Land Use Acreages for Existing (2022) and Future (2050) Conditions within Otay Sub-Watershed and Sweetwater Sub-Watershed

	Land Use Acreage			
Land Use[1]	Otay Existing	Otay Future[2]	Sweetwater Existing	Sweetwater Future[2]
Agriculture	0	0	7	0
Commercial	742	746	1,305	1,146
Education	673	1,053	746	738
Industrial	405	616	405	677
Multi-Family Residential	867	1,734	781	1,247
Orchard[1]	0	0	0	0
Rural Residential	11	1	19	15
Single Family Residential	3,704	4,040	5,034	4,875
Transportation	2,409	2,379	3,086	3,006
Vacant / Open Space	7,797	6,039	3,897	3,675
Water	0	0	1,453	1,355
Total	**16,608**	**16,608**	**16,734**	**16,734**

[1] The land use classes presented here are the same as those presented in the 2018 WQE Table 2-2. Not all land use types are present in each sub-watershed.
[2] Future land use acreages are based on current projections and are subject to change.

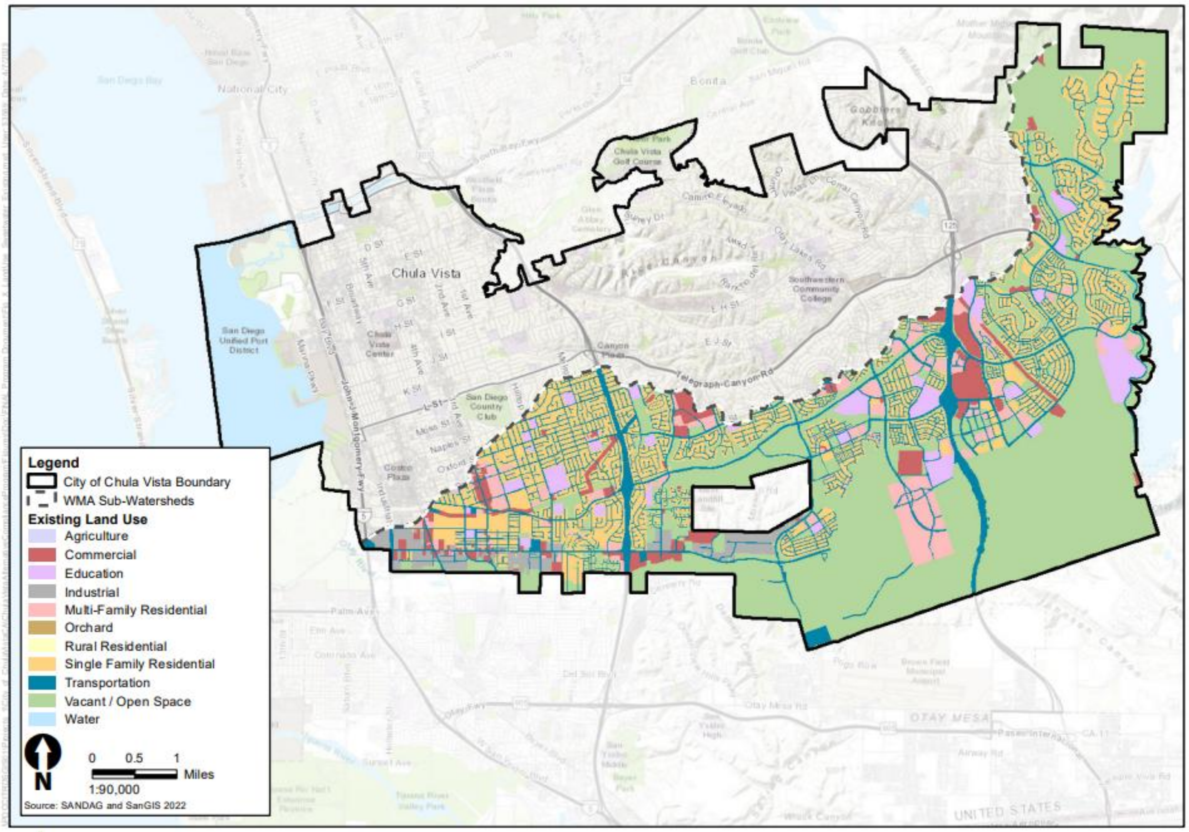


Figure 1-1. Existing Land Use in Otay Watershed within the City Limits

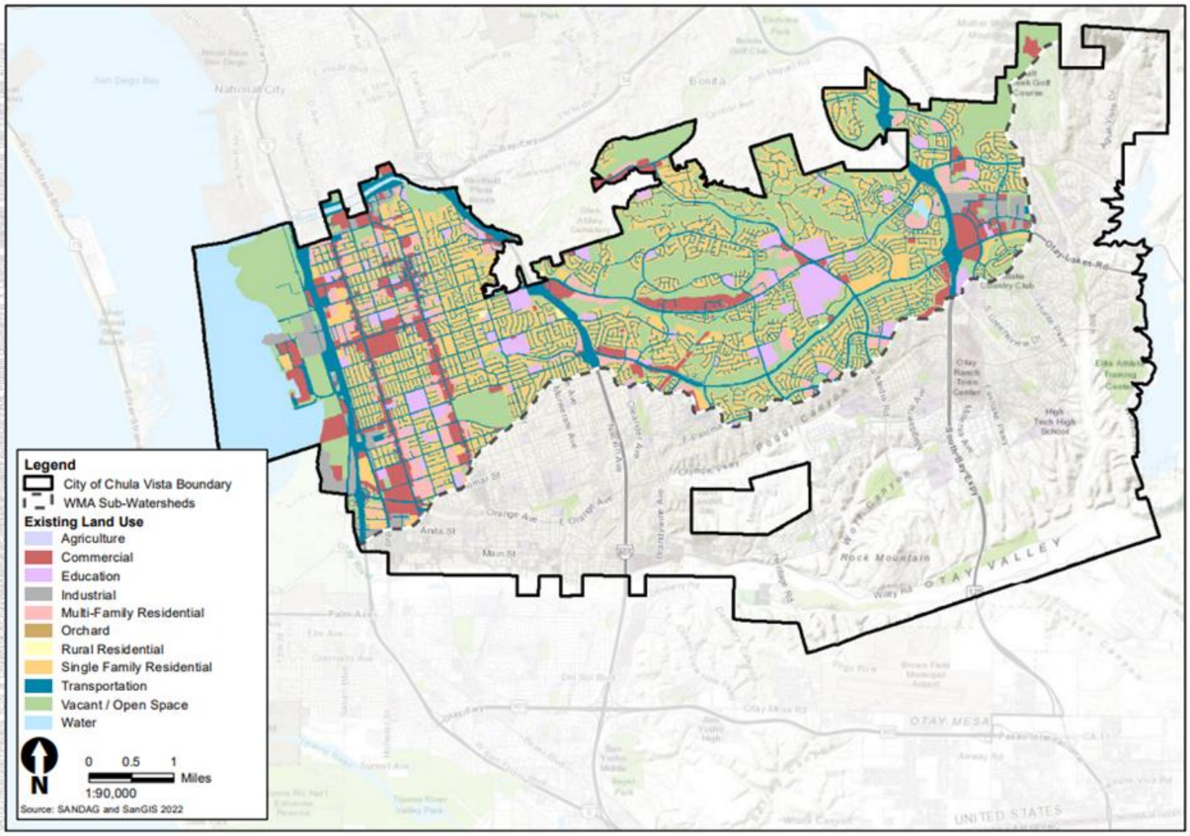


Figure 1-2. Existing Land Use in Sweetwater Watershed within the City Limits

This Program proposes to provide greater water quality and watershed benefits to the City of Chula Vista through stream rehabilitation NSMPs. Stream rehabilitation NSMPs can restore or enhance riverine functions that provide a variety of benefits for water quality, in addition to co-benefits for ecological, economic, and community interests. Floodplain connectivity can attenuate flood flows, maintain hyporheic exchange, provide high flow refugia, store sediment, and reduce erosive forces. Dynamism in the floodplain creates habitat diversity and variability, supporting different life stages of vegetation and wildlife, enhancing species composition and diversity. A naturally stabilized reach may have higher capacity to recover from a significant disturbance because it can return to the natural size, shape, or position imposed on it prior to disturbance.

Well-vegetated riparian areas can increase infiltration, filter pollutants, provide sources of food, migration corridors, shading to reduce water temperature, and nutrient cycling. Hydrogeomorphic and vegetative complexity provided by NSMPs on a watershed-scale can improve post-wildlife resiliency by minimizing the impacts of disturbance regimes (fire extent, floods, debris flows). NSMPs can provide better recreational spaces than traditional BMPs and create opportunities to incorporate traditional ecological knowledge and nature education with local communities.

These water quality benefits include waters generated on older developments that were not required to provide pollutant control or hydromodification treatment. This can lead to an overall improvement of water quality in the watershed. The Regional MS4 Permit currently requires that all development provide pollutant control and hydromodification treatment for all water generated from the project, however, this was not a requirement prior to 2013. Figure 1-3 shows the areas within the City developed before 2013 ("developed"), after 2013 ("stormwater PDP sites"), and that remain undeveloped. Table 1-2 provides the proportion of the City within each of these areas. This program assumes that the areas developed prior to 2013 do not include treatment control and that those areas contain little to no treatment. The Program will not change the nature of the development within the City, but the program will be able to document locations of ACPs implemented and may use that to show areas that are receiving greater watershed benefits within the City.

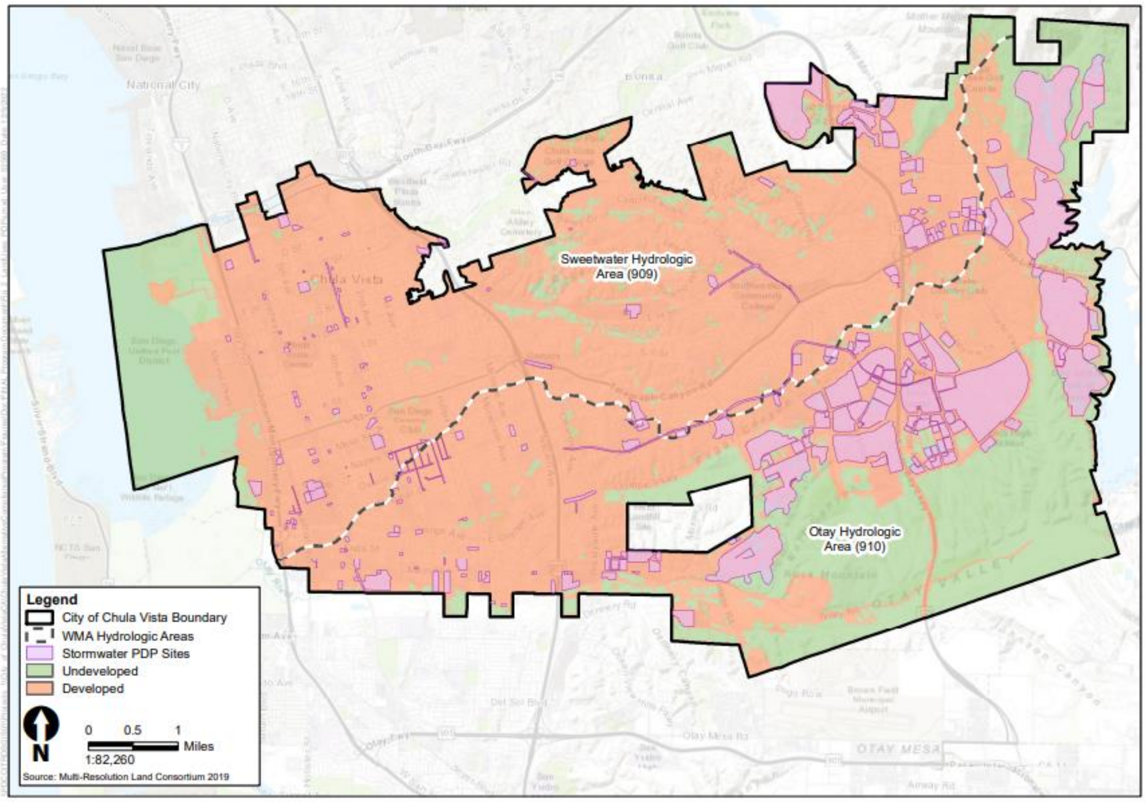


Figure 1-3. Spatial extent of developed areas within the City of Chula Vista, with and without stormwater treatment

The extent of development for the City was extracted from the National Land Cover Database and clipped to the City boundary (Figure 1-3) (Multi-Resolution Land Characteristics Consortium 2019). The location of stormwater PDP sites were obtained from the City's open GIS database (City of Chula Vista, last updated May 20, 2022). Please note that the PDP data from the GIS database is a snapshot in time and can change. A small portion of the stormwater PDP sites also include some 2007 Permit Standard Urban Stormwater Program (SUSMP) sites with partial treatment. The percent of hydrologic area for a given land use were calculated with the total area of the hydrologic area within the City boundary (Table 1-1). The hydrologic areas within the City are sub-watersheds of the San Diego Bay Watershed Management Area. Figure 1-3 shows the portions of the City developed pre and post- 2013 San Diego Region MS4 permit. The 2013 Regional MS4 Permit requires pollutant and hydromodification treatment of all stormwater effluent from development and redevelopment projects that meet PDP criteria. The pre-2013 development projects may have incorporated partial treatment, not to the extent that projects under the current 2013 Regional MS4 Permit are required to implement. ACP projects implemented under this Program will provide stormwater pollutant and volume control benefits that will include flows generated from developments built prior to 2013. It is important to note the vast potential of ACP NSMP projects, as they will treat a much larger area than the traditional onsite PDP compliance pathway.

Table 1-2. Percent of hydrologic area for a given development type

	Portion of Development within The Hydrologic Area	
	Sweetwater Hydrologic Area (909) 16,735 acres	Otay Hydrologic Area (910) 16,608 acres
Undeveloped	2,678 (16%)	5,979 (36%)
Developed	13,327 (79.6%)	7,393 (45%)
Stormwater PDPs	730 (4.4%)	3,236 (19%)
Number of PDPs	139	173

*Note that the percent of hydrologic area is based on the total area within the City of Chula Vista boundary.

The Series 14 Regional Growth Forecast land use data from San Diego Association of Governments (SANDAG) was used to develop the expected buildout conditions for 2050. The Series 14 Regional Growth Forecast includes analysis and assumptions about how local plans (General, etc.) and policies from the 18 incorporated cities and unincorporated County may evolve over time in response to the region’s continuing growth. Additionally, the local jurisdictions provided detailed feedback on the projections to provide a realistic forecast to 2050 (SANDAG, 2023). Figure 1-4 shows future land use for Otay watershed and Figure 1-5 shows future land use for Sweetwater watershed.

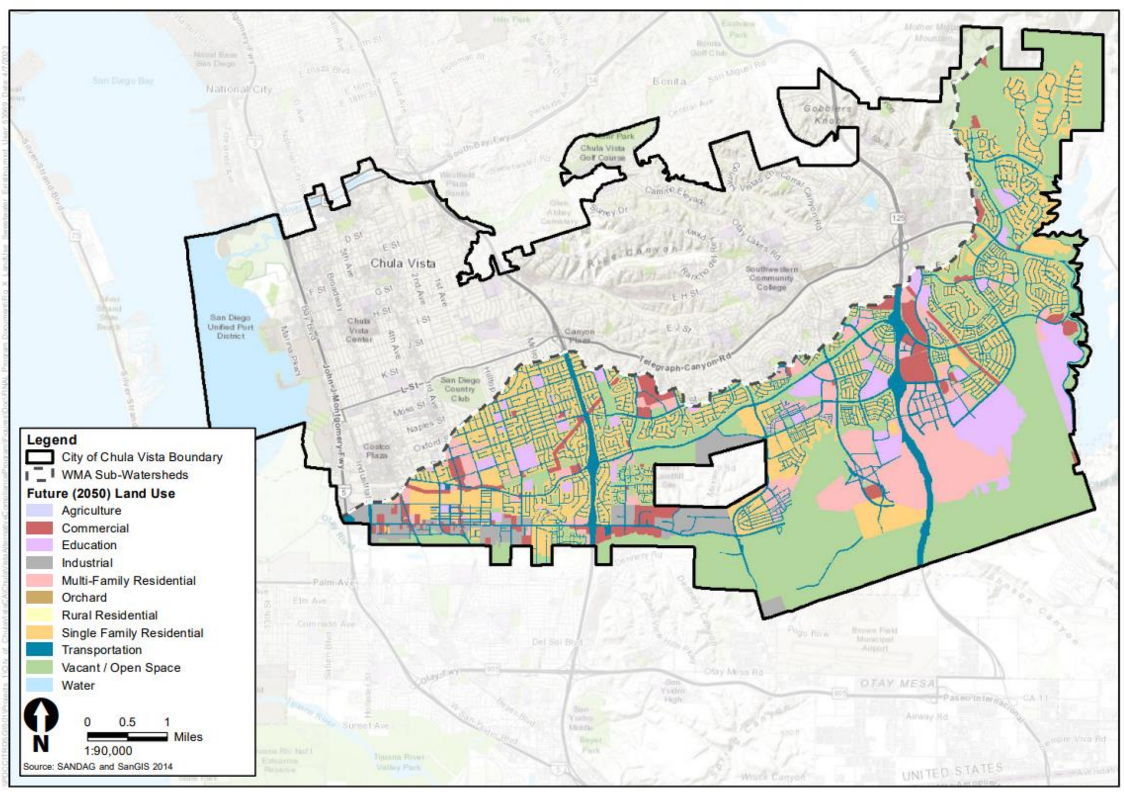


Figure 1-4. Future Land Use in Otay Watershed within the City Limits

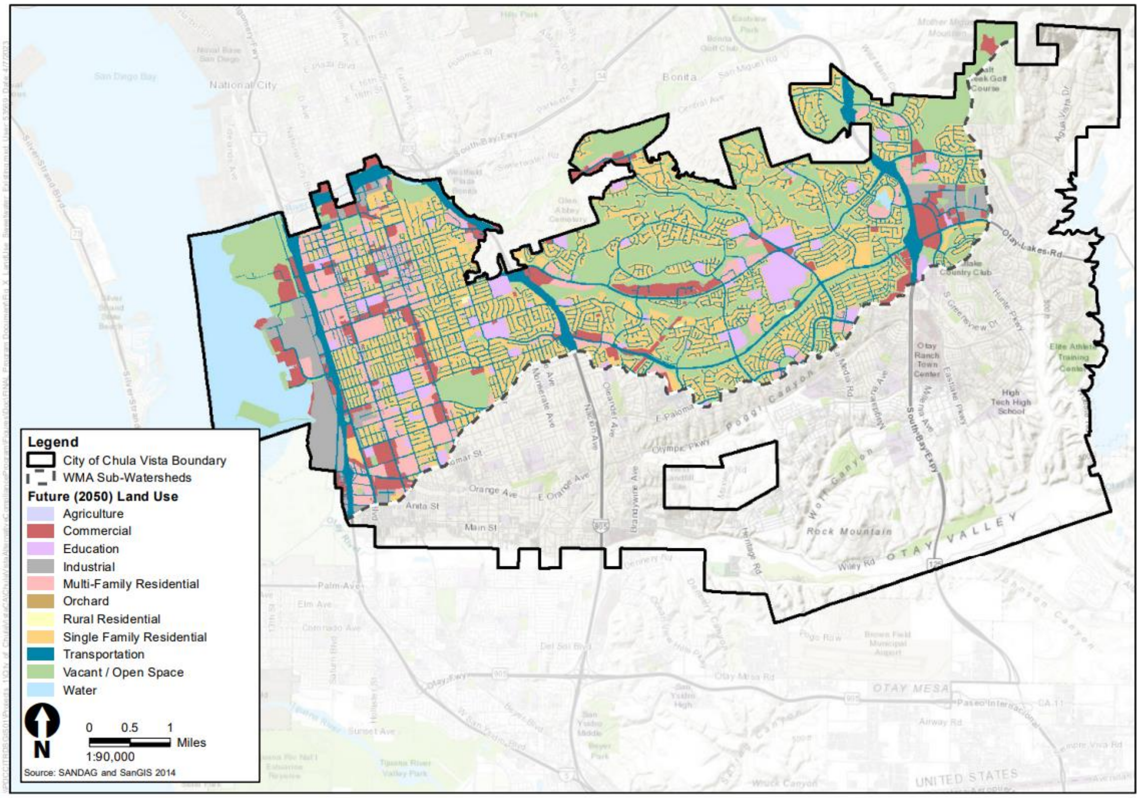


Figure 1-5. Future Land Use in Sweetwater Watershed within the City Limits

As of January 1, 2018, the City provided a total of 83,493 housing units (SANDAG 2019). The City's 2005 General Plan (Plan) provides expected build out acreages and land within its jurisdiction by the year 2030. A projected total of 124,958 dwelling units will be provided by 2030. All new development will be required to comply with the MS4 permit requirements, of which PDPs must meet on-site treatment BMPs requirements under the baseline condition. Alternative compliance has the potential to increase the overall density of dwelling units (dwelling units per acre) while potentially increasing the area of land in open space or water land uses. Additionally, stream rehabilitation NSMPs will improve the riparian habitat within the City, which will be documented by each ACP project. While there are additional benefits expected from these projects, such as climate change resiliency as described above, these benefits will be evident in response to climate related events, and will be documented when observed.

Chapter 2
NSMP Alternative Compliance

As discussed in Chapter 1, this document was developed to provide Guidance for use of the City's In-Lieu Fee Program implementing stream rehabilitation NSMP projects to provide pollutant removal credits to PDP applicants as an offsite alternative to onsite treatment BMPs. This Chapter provides a general overview of alternative compliance and alternative compliance project options allowed in the Regional MS4 permit and within the City's jurisdiction. Alternative compliance can be achieved through the use of structural BMPs or NSMP projects, so long as the correct methodologies are used to determine pollutant removal and hydromodification credit values. The Regional WQE Guidance provides methodologies to calculate pollutant removal values for structural BMPs and hydromodification values for structural BMPs and NSMPs. However, it does not provide methodologies to determine pollutant removal values for NSMPs. The Program discussed in this document solely addresses the development and use of alternative compliance project credits provided by stream rehabilitation NSMPs. In support of this Program, the City developed a City specific WQE framework for NSMPs, including an equation to calculate the WQE credits generated by NSMPs (Appendix B). The Regional WQE Guidance also provides methodologies to determine overall greater water quality benefit through use of an ACP.

2.1 Alternative Compliance Project

An alternative compliance project is defined by the *Water Quality Equivalency Guidance Document: Region 9* (WQE Guidance; RWQCB 2018) as a project implemented to provide a greater overall water quality benefit to the WMA and offset stormwater pollutant control impacts and impacts associated with PDP. Greater overall water quality benefit is defined in the San Diego Region Municipal Permit as a condition in which the quantifiable water quality benefits from an alternative compliance project are greater than the quantifiable water quality impacts from a PDP, where benefits and impacts for stormwater pollutant control and hydromodification flow control must be considered individually (RWQCB 2018:xii–xiv). Alternative compliance projects could be implemented using either structural BMPs or NSMPs so long as the proper methodologies for credit determination are applied. This Program addresses how to implement stream rehabilitation NSMPs to provide ACP credits.

An ACP project may also provide credits to offset hydromodification flow control impacts associated with PDPs per the WQE Guidance Document for Region 9, this is discussed further in Section 3.3. Table 2-1 illustrates the availability of Stormwater Pollutant Control Benefits and Hydromodification Flow Control Benefits currently available. All benefits listed as "Available" or "Limited Availability" are included in the Regional WQE Guidance as an existing methodology. In the development of this ACP for Natural Systems, the City has focused on developing a City-specific methodology for the Stream Rehabilitation NSMP category, which is highlighted in dark blue for emphasis.

Table 2-1. WQE Availability for Alternative Compliance Programs

ACP Category		Stormwater Pollutant Control Benefits: Pollutant Reduction – Retention	Pollutant Reduction – Biofiltration	Pollutant Reduction – Flow-Thru	Volume Reduction	Hydromod Flow Control Benefits
BMP	Retrofit	Available	Available	Limited Availability	Available	Available
BMP	Regional	Available	Available	Limited Availability	Available	Available
BMP	Water Supply	Available	Available	Limited Availability	Available	Available
NSMP	Land Restoration	Not Available	Not Available	Not Available	Available	Available
NSMP	Land Preservation	Not Available	Not Available	Not Available	Limited Availability	Available
NSMP	Stream Rehabilitation	Developed for Chula Vista ACP Program			Limited Availability	Available

2.2 Determining Greater Water Quality Benefit

The Regional WQE Guidance provides step by step guidelines to determine if an offsite alternative compliance project will provide a greater overall water quality benefit. First, the treatment required of and provided by the PDP must be characterized to define the remaining Deficit of Stormwater Pollutant Control Volume. Second, the treatment provided by the ACP is characterized to define the Earned Stormwater Pollutant Control Volume. Finally, if the volume from Step 2 is greater than the volume from Step 1, then the Permit standard for pollutant control has been met. These steps are detailed in the following sections of the Regional WQE Guidance: Sections 2.2 Step 1: PDP Stormwater Pollutant Control Impact, 2.3.2 Option B: Alternative Compliance Project Stormwater Pollutant Control Benefits for NSMPs, and 2.4 Determination of Stormwater Participants of the City's Program must use the listed sections to determine that overall greater water quality benefit is being provided. The Regional WQE Guidance does not, however, provide methods to determine pollutant removal WQE calculation for stream rehabilitation projects. For Step 2, PDPs choosing to participate in the City's Program shall use the Water Quality Equivalency (WQE) framework developed for NSMPs for the City of Chula Vista (Appendix B) to determine the water quality benefit and credit equivalency of the project and support use of an NSMP to provide MEP.

2.3 Natural Systems Management Practices

NSMPs are defined by the San Diego Regional Water Quality Control Board (RWQCB) as "[s]tormwater management practices implemented to restore and/or preserve predevelopment watershed functions in lieu of providing direct pollutant removal and hydromodification flow control. NSMPs may include structural or engineered elements, but these elements do not expressly provide stormwater pollutant removal. NSMPs include: Land Restoration, Land Preservation, and Stream Rehabilitation projects" (RWQCB 2018:xv). Land Preservation NSMPs "permanently preserve undeveloped land in its current state. In limited scenarios, Land Preservation may provide quantifiable stormwater pollutant control and hydromodification flow control benefits by preventing increases in stormwater runoff volumes and pollutant concentrations associated with the future built out condition of a tributary" (RWQCB 2018:xv). Land Restoration NSMPs "restore currently developed land back to a stabilized pre-development condition. Land restoration practices are similar to Retrofit BMPs that provide reductions in impervious surfaces, but require appropriate stabilization techniques" (RWQCB 2018:xv).

Projects designed as part of the City's ACP are limited to Stream Rehabilitation projects as they are likely to provide greater water quality benefit than either land restoration or land preservation NSMPs, as discussed in the *Technical Memorandum on Alternative Compliance Program: Water Quality Equivalency Using Natural System Management Practices* (Appendix A). Stream Rehabilitation is defined as remedial measures or activities for the purpose of improving or restoring the beneficial uses of streams, channels, or river systems. Techniques may vary from in-stream restoration techniques to in-line stormwater management practices installed in the system corridor or upland areas, or a combination of in-stream and out-of-stream techniques. Rehabilitation techniques may include but are not limited to the following: riparian zone restoration, constructed wetlands, channel modifications that improve habitat and stability, and daylighting of drainage systems (RWQCB 2018:xvi).

2.4 Alternative Compliance Project Options

Provision E.3.c.(3) of the Regional MS4 Permit allows PDPs and Copermittees to enter into voluntary agreements that authorize the use of an ACP in lieu of the onsite structural BMP performance requirements so long as a greater overall water quality benefit than complying with Provisions E.3.c.(1) and E.3.c.(2)(a) onsite would be achieved. Alternative compliance projects can be implemented in several different ways, which are described below and can be found in Provisions E.3.c.(3)(b)– E.3.c.(3)(e) of the Regional MS4 Permit. If a PDP participates in an ACP, they are required by both the Regional MS4 Permit and the City of Chula Vista's BMP Design Manual to, at a minimum, provide onsite flow-thru treatment control BMPs sized and designed in accordance with Permit Provisions E.3.c.(1)(a)(ii)[a]-[c], as well as implement low impact development and source control BMPs. The City BMP Design Manual allows for applicant implemented alternative compliance projects that may utilize either structural BMPs or NSMPs. The City will be submitting an update to the City BMP Design Manual to include this Program as part of the January 2023 WQIP Annual Report. The following subsections provide an overview of the alternative compliance project options allowed in the Regional MS4 Permit. This guidance document was developed to provide guidance on the City's In-Lieu Fee Program for NSMPs; Chapters 3 and 4 provide specific guidance to use of the Program.

2.4.1 Watershed Management Area Analysis Candidate Projects

The Regional MS4 Permit provides guidelines that allow PDP applicants to fund, contribute funds to, or implement a candidate project identified by the Copermittees in the Watershed Management Area Analysis (WMAA) included in the WQIP so long as requirements of Provisions E.3.c.(3)(b)(i)–(viii) of the Regional MS4 Permit are met. PDPs that will implement a WMAA NSMP candidate project should utilize the Water Quality Equivalency (WQE) framework developed for NSMPs for the City of Chula Vista (Appendix B) to determine the water quality benefit and credit equivalency of the project and support use of an NSMP to provide MEP.

2.4.2 Applicant Proposed

The Regional MS4 Permit provides guidelines that allow PDP applicants to fund, contribute funds to, or implement an alternative compliance project not identified by the WMAA included in the WQIP so long as requirements of Provisions E.3.c.(3)(b)(i)–(viii) of the Regional MS4 Permit are met. Any applicant proposing an ACP project under this provision will need to document to the City that each of these requirements has been met prior to City approval of the ACP project.

This is currently allowed by the City's BMP Design Manual. Under this option, the applicant is fully responsible for the alternative compliance project design, construction, operation, and long-term maintenance (in perpetuity, see Section 4.1.5). Applicant-proposed alternative compliance projects using NSMPs are required to utilize the WQE Framework developed for NSMPs for the City of Chula Vista (Appendix C) to demonstrate that a proposed alternative compliance project results in a greater overall water quality benefit.

2.4.3 In-Lieu Fee Structure

The Regional MS4 permit states that a Copermittee may choose to allow a PDP applicant to fund or partially fund a candidate or alternative compliance project through the development of an in-lieu fee structure (ILF), as is the City's intent and purpose of this document. Through development of the City's Program, the City will receive funds from PDP applicants to fund identified NSMP projects within the City's jurisdiction. ACP projects may include projects identified in the WMAA or other City proposed stream rehabilitation projects that would provide water quality benefits. Any NSMP proposed project should utilize the WQE framework developed for NSMPs for the City of Chula Vista (Appendix B) to determine the water quality benefit and credit equivalency of the project. The City may implement an ILF project themselves, or through a public-private partnership. Implementation is discussed further in Section 4.1.

2.4.4 Water Quality Credit System

The Regional MS4 permit states that a Copermittee may develop and implement an alternative compliance water quality credit system option. Under this system, alternative compliance projects could be implemented independently of a PDP and generate credits for PDP applicants to use in lieu of onsite BMP compliance. Such a system would need to clearly exhibit that it will not allow discharges from PDPs to cause or contribute to a net impact over and above the impact caused by projects meeting the onsite structural BMP performance requirements. Any water quality credit system program that a Copermittee chooses to implement is required to be submitted to the San Diego RWQCB Executive Officer for review and acceptance as part of the WQIP. The City is not proposing a water quality credit trading system at this time. If the city chooses to develop a water quality credit system, they will submit the proposed system with the WQIP Annual Report by January 31 of the year of submittal.

Chapter 3
Stream Rehabilitation NSMP Credit Determination

3.1 Pollutant Removal Treatment Credit Water Quality Equivalency Framework for NSMPs

In March 2019 the RWQCB accepted the WQE Guidance submitted by the County of San Diego on behalf of the Regional MS4 Copermittees (RWQCB 2018). This update outlines standards and guidelines for Copermittees to design and implement offsite alternative compliance projects to meet water quality requirements as defined in the Regional MS4 Permit. The WQE Guidance provides detailed instructions, equations, and examples for pollutant reduction, volume reduction, and hydromodification flow control for structural BMPs. The WQE Guidance also provides detailed instructions, equations, and examples for calculating the hydromodification flow control benefits of Land Preservation, Land Restoration, and Stream Rehabilitation NSMPs. At the time of the approval of the updated WQE Guidance, however, calculations had not yet been determined for NSMP pollutant reduction benefits (retention, biofiltration, or flow-thru) and only limited applications had been developed for volume reduction.

In support of this Program, the City developed a City specific WQE framework for NSMPs, specifically stream rehabilitation NSMPs, including an equation to calculate the WQE credits generated by NSMPs. Existing WQE credit methodologies for structural BMPs were the foundation for NSMP pollutant reduction benefit equation development. The calculation of earned stormwater control volume for NSMPs is based on three processes: (1) runoff retention, (2) sediment stabilization, and (3) vegetation biofiltration. Figure 3-1 below provides a visual representation of these processes in a proposed project. The overall uplift in ecological benefits for a restored system is represented by a multiplier in the equation that increases credit volume. The capture volume and pollutant removal efficiency provided by these three processes can be consistently calculated based on the existing conditions and proposed design. The NSMP must be sized and designed to remove pollutants in stormwater discharge to the MEP. The earned volume from the NSMP must be greater than the earned volume from an onsite BMP in order to comply with requirements for greater overall water quality benefits. Figure 3-2 below demonstrates the potential earned credit area for an NSMP.

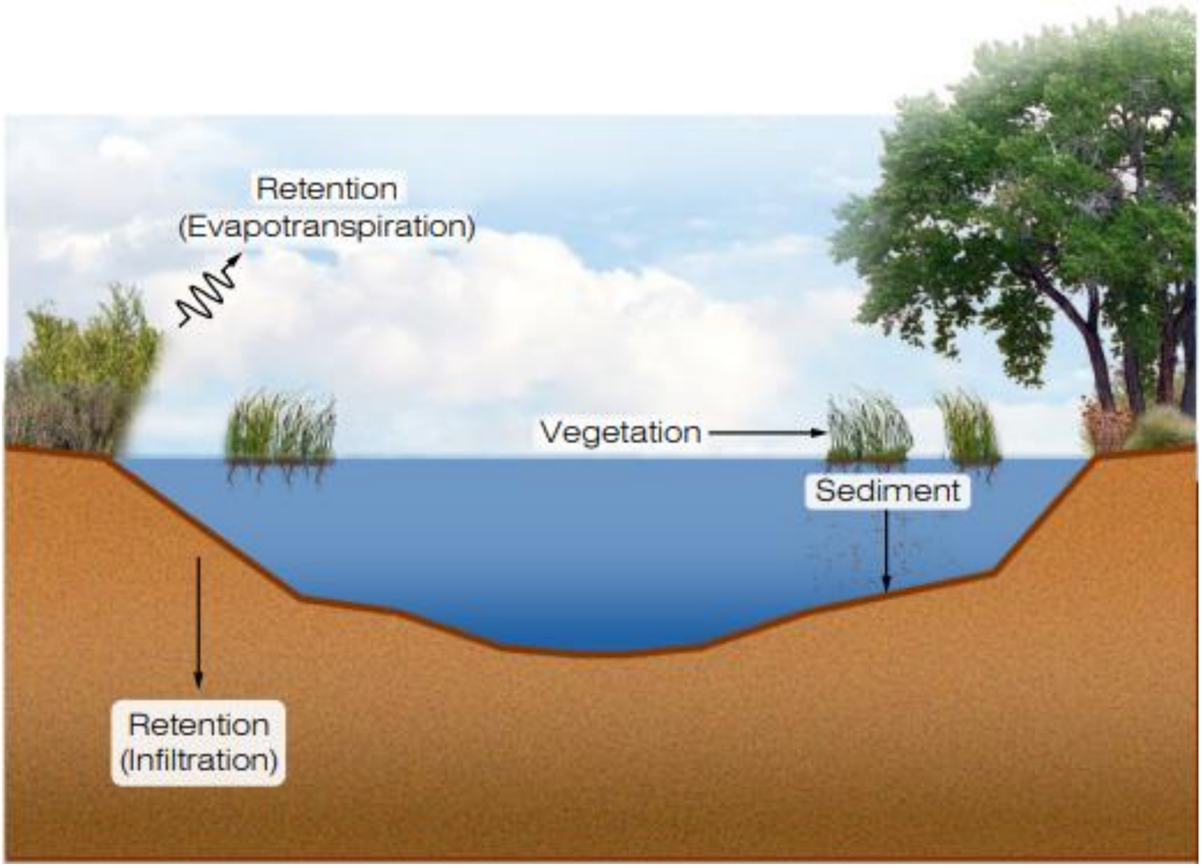


Figure 3-1. Provides an illustration of processes represented in the WQE framework for NSMPs

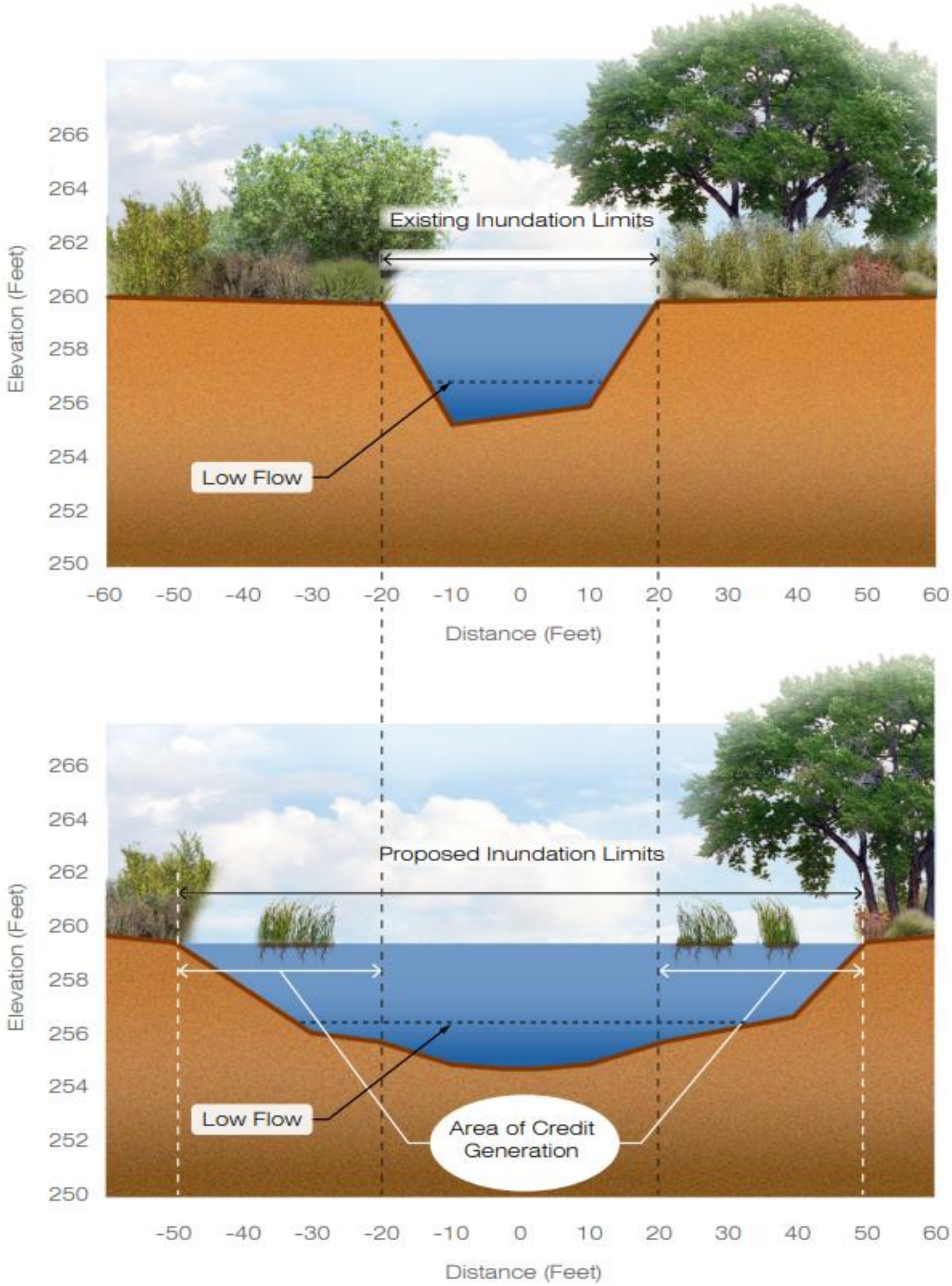


Figure 3-2 The figure demonstrates the pre- and post- restoration conditions for an example NSMP project

The City submitted this WQE credit methodology to the RWQCB for approval in January of 2023. Methods for use of the WQE equation can be found in Appendix B of this document. A detailed description of the equation development and support, including examples for calculating the pollutant control benefits of Stream Rehabilitation NSMPs can be found in Appendix C of this document and in Appendix B.6 of the City's BMP Design Manual. A worksheet to document credit usage and greater water quality benefit by a PDP in the Storm Water Quality Management Plan is included as Appendix D.

3.2 Add-On Pollutant Removal Credits

An ACP project may establish additional pollutant removal credits through the preservation of buffer, preservation and restoration of buffer or by completing bioassessment surveys as described below. The total credits created by an ACP project may not exceed 100% of the total design capture volume (DCV) under any circumstance.

3.2.1 Buffer Credits

Additional credits may be generated by preserving and restoring the upland buffer around the stream rehabilitation project. Buffer can be defined as the habitat immediately adjacent to the inundation area that is in a natural or semi-natural state, currently not dedicated to anthropogenic uses that would severely detract from the project's ability to entrap contaminants, has the ability to discourage forays into the project area by people and non-native predators, or otherwise protects the project from stress and disturbance. Buffers provide many ecological benefits including, but not limited to, entrapping contaminants before they enter a waterway, preventing erosion, and providing wildlife connectivity. Certain landcover types and uses are more compatible with upland buffer and do not detract from buffer functions. Table 3-1 provides examples of buffer types, compatible land uses that do not detract from buffer function, and high impact land covers that are not considered buffer.

The buffer must be between 15 and 820 feet (5 and 250 meters) wide laterally from the edge of the inundation area (85th percentile storm event). The width of the buffer is determined by width of contiguous appropriate buffer land covers.

Buffer credits provided will be an additional percentage based on the total amount of credits generated by the ACP project as determined by applying the WQE to the project design. To qualify for buffer credits, the area preserved must be placed under a perpetual conservation easement as defined in California Civil Code Section 815. Additionally, the preserved buffer area must meet the width requirements stated above, and must be present and preserved along at least 50% of the ACP project length. The ACP project and buffer area may (and in most cases will) be placed under one conservation easement. The easement must restrict development and surface mineral extraction rights, and include the natural character of the land as the conservation value preserved by the easement.

To qualify for buffer credits by restoring the buffer area, the area must meet the standard for buffer preservation above, and the condition of the habitat must be demonstrably improved. The success criteria for buffer improvement can be determined by the project, however an example of demonstrating improvement would be increasing the buffer condition metric in the post-implementation California Rapid Assessment Method (CRAM) survey. Improvements can include restoration of non-buffer land uses to buffer land uses, or improvements of the buffer condition such as removal of nonnative species or reduction of impacts from human uses. Improvement of buffer condition will need to be included in the success criteria for the ACP project.

Table 3-1. Appropriate Buffer Landcovers

Examples of Buffer Land Covers	Land uses Compatible with Buffer Function	High Impact Land Uses Not Included as Buffer
• Natural upland habitats • Nature or wildland parks • Rangeland and pastures • Swales and ditches	• At-grade bike and foot trails with light traffic • Horse trails • Railroads (with infrequent use: <2 trains/day) • Infrequently used roads that are not hazardous to wildlife such as low traffic rural roads, forestry roads, private roads, or otherwise gate-controlled roads • Vegetated levees	• Commercial developments • Fences that interfere with wildlife movement (i.e., unbroken chain-link fences or food safety fences that prevent the movement of most or all sizes of native wildlife) • Intensive agriculture (row crops, orchards, and vineyards) • Golf courses • Paved roads (2 lanes or larger) • Active railroads (>2 trains/day) • Lawns • Parking lots • Horse paddocks, feedlots, turkey ranches, etc. • Residential areas • Sound walls • Sports fields • Urbanized parks with active recreation • Pedestrian bike trails with heavy traffic

Source: CWMW 2013.

Table 3-2 identifies the additional buffer credits multiplier that an ACP may include. The Credit Multiplier increases with increased buffer width as areas with wider buffers typically provide higher habitat value, better water quality, and other valuable ecosystem functions.

Table 3-2. Add-On Buffer Credit Multipliers

Type of Buffer Add-on	Buffer Width	Buffer Credit Multiplier
None	N/A	0
Preservation	15–410 feet (5–125 meters)	0.01
	410–820 feet (125–250 meters)	0.02
Restoration	15–410 feet (5–125 meters)	0.04
	410–820 feet (125–250 meters)	0.05

3.2.2 Bioassessment Survey Credits

An ACP project can generate additional credits by demonstrating stable or improving ecological condition through equal or higher bioassessment scores. Bioassessment surveys would be conducted before the implementation of the ACP project and at least once during the success monitoring period. Bioassessment surveys will include physical habitat transect data and biotic community sampling of both benthic macroinvertebrates and algae, which must be identified at a sufficient taxonomic resolution to calculate the California Stream Condition Index (CSCI) and Algal Stream Condition Index (ASCI), following the current Surface Water Ambient Monitoring Program (SWAMP) *Standard*

Operating Procedures for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat (California Water Boards 2016). Credits will be released for each survey year where CSCI scores are improving or are greater than 0.79. If the CSCI for a project improves from below 0.79 pre-project to above 0.79 for at least 2 surveys, then the full bioassessment add-on credit multiplier will be applied. Table 3-3 identifies the add-on buffer credits multiplier that an ACP may include.

Table 3-3. Bioassessment Survey Add-on Credit Multiplier

Number of Years of Bioassessment Surveys[1]	Bioassessment Credit Multiplier[2]
0[3]	0
2	0.025
3	0.03
4	0.035
5	0.04

1 Project must complete pre-project bioassessment surveys and at least 1 year of post-implementation bioassessment surveys to obtain add-on credits. Surveys are recommended in alternating years as changes to the biotic community resulting from restoration are not expected to be observable at one-year intervals.

2 Credit multipliers listed represent the total multiplier allowed based on the number of years of surveys showing improvements in scores completed. An improvement in CSCI must be demonstrated for any Bioassessment Add-on credits to be released.

3 Year 0 data must be collected prior to implementation of the NSMP.

3.2.3 Add-On Credit Calculations

Add-on credits will be calculated separately for buffer and bioassessment survey credits. Each calculation will be completed by multiplying the appropriate credit multiplier by V_e (credit value earned) calculated from the WQE developed for stream rehabilitation NSMPs for use by the City to determine the number of each type of add-on credits. The add-on credits will then be added to the outcome of the V_e of the ACP project to determine the total credits that the project will generate. The total credits created by an ACP project may not exceed 100% of total DCV under any circumstance.

Total Credits = V_e + (V_e * Buffer Credit Multiplier) + (V_e * Bioassessment Credit Multiplier)

3.3 Hydromodification Credits

Stream rehabilitation projects implemented through this program have the potential to provide quantifiable hydromodification management flow control benefits that can be used to fulfill the requirements for PDPs set forth in Section E.3.c.(2) of the Regional MS4 Permit. Section 3 of the WQE Guidance provides water quality equivalency calculation guidance for hydromodification control. Projects developed under the City's ILF Program will use the methods outlined in Section 3.5.2 Regional WQE Guidance for independent alternative compliance projects. Additionally, section 3.7 provides guidance for partial hydromodification management flow control credit generation. In the case that a project may use or provide partial hydromodification control compliance, Method 3: project-specific modeling approach outlined in section 3.7.1.3 would be utilized. The Problem Statement presented in Section 5.6 of the 2018 WQE provides an example of the process used to determine HMP credits from a stream rehabilitation project.

An alternative compliance project implemented within the City of Chula Vista's jurisdiction can choose to follow the WQE Guidance and provide offsite hydromodification compliance. There are, however, specific limitations on locations of alternative compliance projects in relation to the PDP impact. An overview of this guidance can be found in Chapter 4.3 of the Regional WQE Guidance. The Regional MS4 Permit does not allow for hydromodification credit generation for critical coarse sediment. Greater overall watershed benefit is achieved when stream rehabilitation is designed to mitigate both future and legacy hydromodification impacts associated with development that occurs within the watershed (RWQCB 2018).

Chapter 4
Program Implementation

The Regional MS4 Permit allows the Copermittees and PDP developer to enter into a voluntary agreement to utilize alternative compliance as an offsite alternative to meet the onsite structural BMP performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) while also meeting regional and watershed goals that are not met through onsite compliance. Participation in an ACP is allowed so long as the offsite alternative will have a greater overall water quality benefit than fully complying with the performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) onsite and flow-thru treatment control BMPs sized and designed in accordance with Permit Provisions E.3.c.(1)(a)(ii)[a]-[c] are also implemented on the development site. Provision E.3.c.(3)(d) of the Regional MS4 Permit allows Copermittees to develop an in-lieu fee structure to serve as an alternative compliance mechanism. The City intends to implement an in-lieu fee structure to allow PDP applicants to fund or partially fund candidate projects identified by the City that will provide pollutant removal and/or hydromodification control benefits that offset PDP impacts.

4.1 In-Lieu Fee

The City's intention is to develop and administer an In-Lieu Fee Program to provide financial and spatial relief to PDP applicants within the City's jurisdiction. The WQE Guidance defines an in-lieu fee structure as "[a]n optional program that may be implemented by Copermittees individually or with other entities to allow a project proponent to fund or partially fund one or more alternative compliance projects in-lieu of fully complying with the onsite pollutant reduction or hydromodification management requirements of Order No. R9-2013-0001. In-lieu fee structures must be sufficient to ensure the proper design, development, construction, operation, and maintenance of alternative compliance projects. In-lieu fees must be transferred to the Copermittee (for public projects) or an escrow account (for private projects) prior to the construction of a PDP." The City intends to create a program incompliance with Provision E.3.c.(3)(d) of the Regional MS4 Permit. The Program will comply with the conditions set forth in Provision E.3.c.(b)(i)-(viii). In doing so, the Program will ensure:

- Purchasing credits through the City's Program would provide a greater overall water quality benefit for the PDP than fully complying with the performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) onsite;
- The in-lieu fee structure described in Provision E.3.c.(3)(c) will be followed;
- If the PDP applicant chooses to fully or partially fund a candidate project, The City will ensure that the funds to be obtained from the PDP applicant are sufficient to mitigate for impacts caused by not fully implementing structural BMPs onsite, pursuant to the performance requirements described in Provisions E.3.c.(1) and E.3.c.(2)(a);
- If the PDP applicant chooses to implement a candidate project, the City will ensure that pollutant control and/or hydromodification management within the candidate project are sufficient to mitigate for impacts caused by not implementing structural BMPs fully onsite, pursuant to the performance requirements described in Provisions E.3.c.(1) and E.3.c.(2)(a);

- The voluntary agreement to fund, partially fund, or implement a candidate project must include reliable sources of funding for operation and maintenance of the candidate project;
- Design of the alternative compliance project will be conducted under an appropriately qualified engineer, geologist, architect, landscape architect, or other professional licenses where applicable.
- The candidate project will be constructed as soon as possible and no later than 4 years after the certificate of occupancy is granted for the first PDP that contributed funds toward the construction of the candidate project unless a longer period of time is authorized by the San Diego RWQCB Executive Officer.
- Temporal mitigation will be required for pollutant loads and altered flows that are discharged from a PDP in the case that the candidate project is constructed after the PDP is constructed. The required temporal mitigation will be determined on a case by case basis and is discussed further in Section 4.2.

4.1.1 City Implementation

City-developed alternative compliance projects utilizing ILF would be planned, designed, permitted, implemented, and maintained in perpetuity by the City. The City may use contractors to implement any portion of the project, however, responsibility for project success and long-term maintenance will remain with the City. All credits produced through City implemented projects would be available for use by the City or available for sale to the development community in-lieu of onsite BMP compliance with provisions E.3.c. Funds for the sale of an ILF credit will be transferred to the City, or into an escrow account established for the ILF project, prior to the construction of the PDP. Funds collected from the sale of any credits will be calculated to include all planning, development, implementation, and long-term costs associated with the ACP project. The City will hold the funds in an endowment, or other account established by the City solely for use by the ACP program.

4.1.2 Public-Private Partnership

The City may utilize public-private partnerships to implement ACP projects. Any project implemented through a public-private partnership will be developed in accordance with a project specific agreement between the City and the private entity that identifies the party responsible for each ACP project component as well as the allotment of credits and funding. The City will include oversight for any ACP project component implemented by the private entity. The City will retain all responsibilities that they have discretionary authority over such as design approval, meeting success criteria, credit release approval, and use of credits by a PDP.

Funding for the ACP project as provided by either the City, private developer, or from previous credit sales will be calculated to be sufficient to fund all costs associated with the planning, development, implementation, and long-term costs associated with the ACP project. Funds associated with long-term management and maintenance will be held in an endowment or other account established by the City solely for use by the ACP program. The partnership agreement will determine the number of credits that will be allotted to each partner, and when those credits will be available. The credit allocation will be commensurate with the level of effort and funding provided by each partner for the life of the ACP project All credits developed through a public-private partnership will be considered as part of the ILF program and will be available for transfer to a third party by either the City or the private partner. Any credit transfer will be overseen by the City and will require City approval for use of credits by the PDP purchasing credits.

The City anticipates that most ACP projects implemented through public-private partnerships will be constructed on City owned lands, however they may be constructed on lands outside of City ownership. In either scenario, the land will be placed under a perpetual site protection mechanism such as an open space easement (California Government Code Section 51050-51065) or conservation easement (California Civil Code Section 815-816) to preserve the conservation values provided by the ACP Project. Any such easement will be in favor of the City.

4.1.3 City Roles and Functions

The City will be responsible for program management, which includes project design and permitting, construction, monitoring, maintenance and management, and credit sales and tracking. The City will set a fee amount per credit that will be sufficient to cover the costs of project implementation. The City will develop and implement a process for collecting and managing these fees to utilize them from project development and design. By utilizing the In-Lieu Fee Program, responsibility for MS4 compliance will be transferred from the PDP applicant to the City.

4.1.4 Forms and Certifications

The City will maintain and administer a number of forms and certifications in association with the Program. These forms and certifications will be developed by City staff and utilized by PDP applicants participating in the Program. Documentation to support PDP eligibility to use the ILF must include:

For Pollutant Removal Credits

a. Demonstrate that the use of the ACP will have a greater overall water quality benefit than fully complying with the performance requirements of Provisions E.3.c.(1) onsite (use Priority Development Project Credit Usage Worksheet found in Appendix D)

b. Documentation that the PDP has implemented on-site flow through BMPs that are sized and designed in accordance with provisions E.3.c.(1)(a)(ii)[a]-[c] of the Regional MS4 Permit; and

c. For PDPs that use proprietary BMPs to meet onsite flow through pollutant control requirements, documentation must be submitted that demonstrates the proprietary BMP(s):

    i. Are sized and designed in accordance with provisions E.3.c.(1)(a)(ii)[a]-[c] of the Regional MS4 Permit;

    ii. Have met all the Washington State Department of Ecology TAPE9 certification tested design and sizing approval requirements for the primary project pollutants treated by proprietary BMP; and

For Hydromodification Credits

a. Demonstrate the offsite alternative will have a greater overall water quality benefit than fully complying with the performance requirements of Provisions E.3.c.(1) onsite

b. Documentation that PDPs approved for generating or using the ILF Program have mitigated for the post-project runoff conditions not fully managed onsite.

4.1.5 Process

PDP projects and alternative compliance projects in the ILF Program have a process by which they are implemented, from initial conceptual design through to construction. Figure 4-1 provides an overview of the Program process for a PDP to implement a WMAA Candidate Project or Applicant Proposed ACP project.

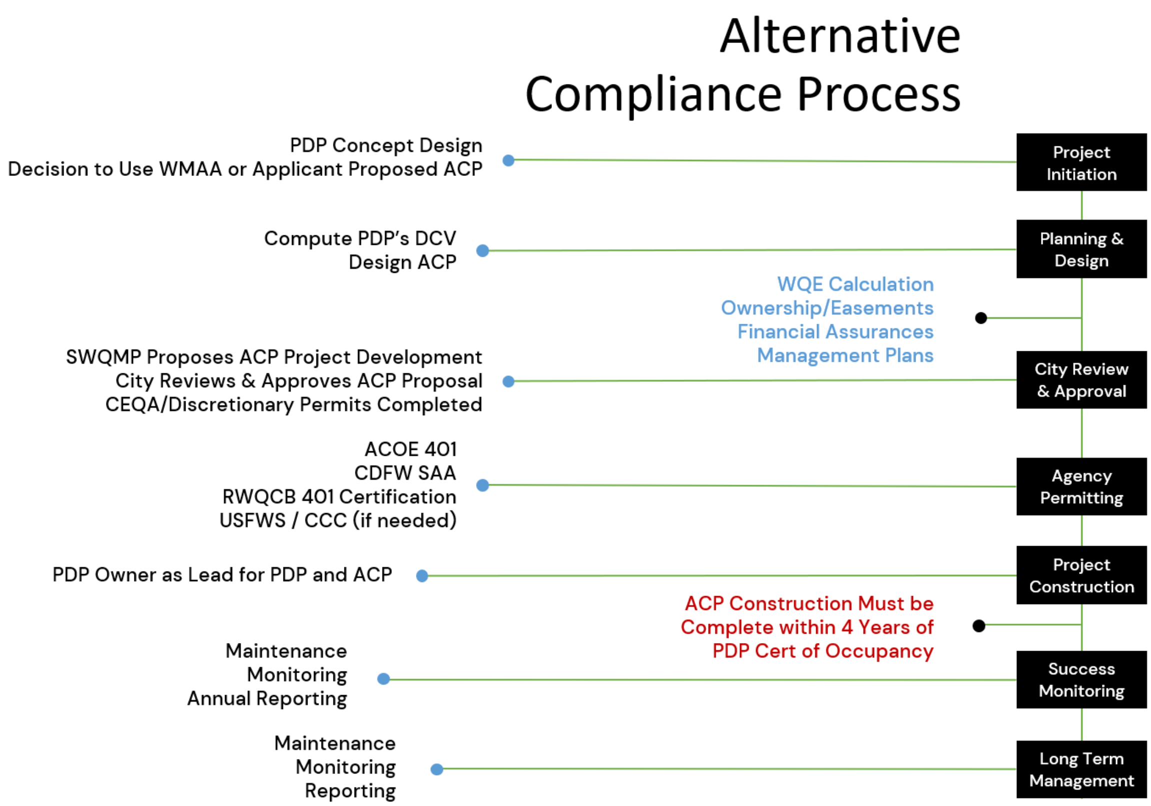
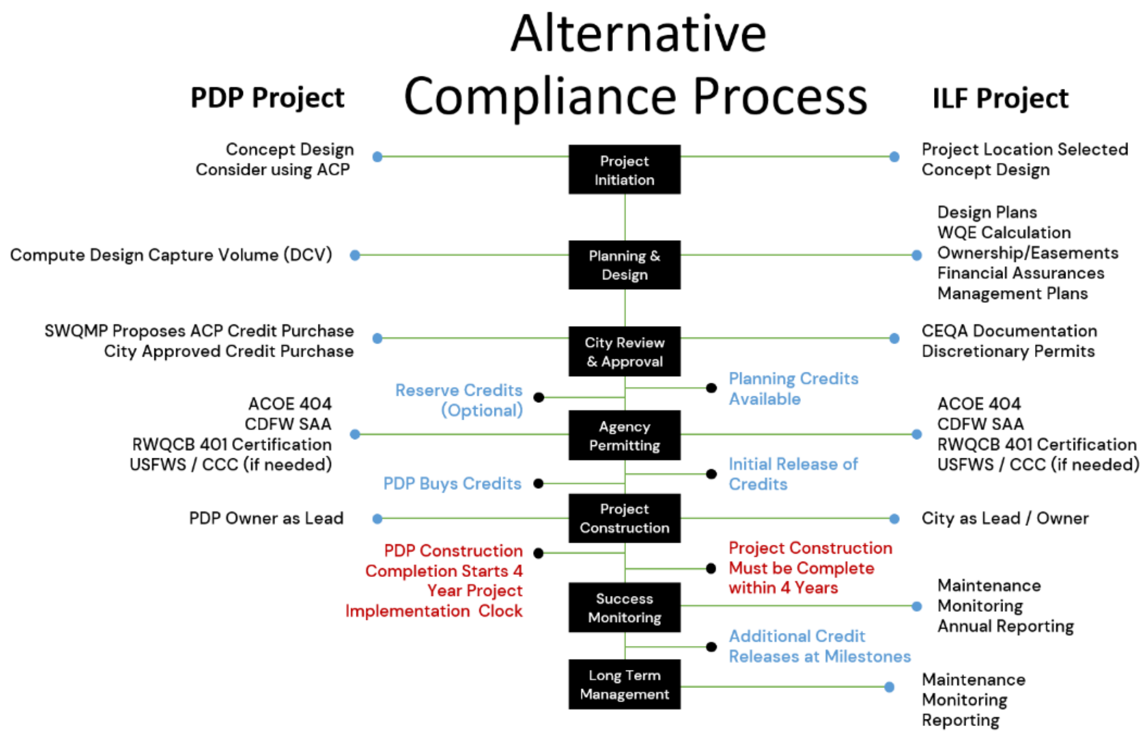


Figure 4-1. Overview of the Program Using WMAA or Applicant Proposed ACP Project

Figure 4-2 provides an overview of the Program process and explores the relationship that a PDP and an ILF project have within the Program. PDP and ILF project stages would not necessarily be synchronized. This chart illustrates the process for each independently (on the outside columns of information) and the key relationships between them (on the inside columns of information).



ACOE = U.S. Army Corps of Engineers; CCC= California Coastal Commission; CDFW = California Department of Fish and Wildlife; CEQA= California Environmental Quality Act; SWQMP = Stormwater Quality Management Plan; USFWS = U.S. Fish and Wildlife Service

Figure 4-2. Overview of the Program Process Using ILF Option

The following text provides detail on the various steps in the process outlined in Figure 4-2. These steps are specific to alternative compliance projects constructed under the ILF Program and are therefore discussed as ILF projects. The requirements for the PDP project and an ILF project in each step will differ. However, if the PDP chooses to utilize the ILF program to comply with the Regional MS4 permit requirements, certain alignments within the project timelines are necessary and are discussed below.

Project Initiation

During project initiation of the ILF project, a strategic location will be chosen based on project objectives and constraints using the conceptual design, and the design will utilize NSMP principles.

During the PDP's project initiation, it may choose to use the ACP to meet its Regional MS4 permit compliance requirements for pollutant control, hydromodification, or both.

Planning and Design

As the ILF project continues through planning and design, multiple steps and processes will be completed. These include completion of design plans, using the WQE equation designed for the NSMPs within the City's jurisdiction to calculate provided pollutant removal credits and the WQE guidance for hydromodification to determine provided hydromodification credits, and establishment of property ownership and easements, financial assurances, and project management plans.

When a PDP opts to use the ACP to meet its Regional MS4 Permit compliance for pollutant control credits, design of the PDP would include onsite flow-through treatment, as required under E.3.c.(1)(a)(ii)[a]-[c] of the Regional MS4 Permit. The ACP must be sized and designed to remove pollutants from stormwater to the MEP as defined by the Regional MS4 Permit. If the PDP opts to use the ACP to meet its Regional MS4 Permit compliance for hydromodification credits, it will address any critical coarse sediment concerns in the siting and design process. As part of the PDP development process, it will calculate the design capture volume (DCV) of the PDP in support of the SWQMP. Once a PDP has calculated its onsite DCV it will use the NSMP Pollutant Control WQE developed for the Program to determine its credit needs to meet compliance standards. Hydromodification credit needs will be determined according to the methods in the Region 9 WQE Guidance.

City Review and Approval

When planning and design of the ILF project are at an appropriate stage, the City will begin the CEQA process and apply for appropriate discretionary permits. Once CEQA is completed and the City approves the project, planning credits will be available for purchase to the development community.

The PDP can propose ILF credit purchase to meet its Regional MS4 Permit requirements during the City's review and approval of the project. If the City approves the credit purchase proposal, the PDP has the option to reserve credits.

Agency Permitting

Prior to ILF project or PDP construction, appropriate agency permits will be submitted. These may include, but are not limited to, the Army Corps of Engineers Section 404 Permit, California Department of Fish and Wildlife Lake and Stream Bed Alteration Agreement, and RWQCB 401 Water Quality Certification. The initial release of credits from the ILF project will occur once the project has been permitted. At this time, the PDP may officially purchase ACP credits.

Project Construction

The City and PDP developer will have full ownership over construction of their projects, respectively.

To comply with Regional MS4 permit requirements, the ILF project must be fully constructed within four years of the first issued certificate of occupancy from a PDP that purchased credits.

Success Monitoring

Success criteria for the ILF will be set during the planning phase of the project. Once the project is implemented, maintenance and monitoring will be conducted to ensure success criteria are met. Results from monitoring efforts will be reported annually. It is anticipated that success criteria will be a condition of the 401 Water Quality Certification required for the ACP project, and reporting on the results of success criteria monitoring will be provided to the Regional Board under that program, however, all monitoring actions and any credit releases based on documented success will be reported to the Regional Board in the WQIP annual report. Additional credit releases will occur as the project matures and meets predetermined milestones. This phase includes short term maintenance, monitoring, and reporting up to 5 years after construction is completed, or until final success criteria are met for two consecutive years.

Long Term Management

An ILF project will be maintained in perpetuity and the project area will be protected through a perpetual site protection mechanism, such as an open space easement, conservation easement, or restrictive covenant that is recorded onto the deed and conveys with the property. As such, a long-term maintenance plan will be developed during the planning process for the project. Maintenance, monitoring, and annual reporting to the City will be required. The Regional MS4 Permit requires the City to verify that projects are "adequately maintained and continue to operate effectively to remove pollutants in stormwater to the MEP through inspections, self-certification, surveys, or other equally effective approaches."

4.2 Temporal Mitigation

The Regional MS4 Permit Provision E.3.c.(3)(b)(viii) states that if an alternative compliance project is constructed after the PDP is constructed, the City must require temporal mitigation for pollutant loads and altered flows that are discharged from the PDP. Section 1.8 of the City's BMP Design Manual also requires the PDP to provide temporal mitigation to address this interim time period. Temporal mitigation must provide equivalent or better pollutant removal and/or hydrologic control (as applicable) as compared to the case where the offsite alternative compliance project is completed at the same time as the PDP. Temporal mitigation should consider both the quantity of DCV and duration between the PDP and ACP project implementation.

4.3 Location of Project

Location of an alternative compliance project will determine what area a PDP can be located to use credits. All ACP projects proposed under this program must be within the boundaries of the City of Chula Vista and may only provide credits for PDPs within the City of Chula Vista. The WQE Guidance and City of Chula Vista BMP Design Manual provides guidance on location requirements for an ACP project and where PDPs utilizing credits from the project may be located for both pollutant removal and hydromodification credits. This Program will use the same guidance and requirements for locating NSMP ACP projects approved under the program.

4.3.1 Pollutant Removal Credits

Current guidance from both WQE Guidance and the City of Chula Vista BMP Design Manual requires an alternative compliance project to be in the same WMA as the proposed PDP development for. (BMP Design Manual Section 1.8 and WQE Guidance Sections 1.3, 2.3.1.2, 3.3, and 3.6). Figure 4-3 provides an overview of the City of Chula Vista's jurisdictional boundaries, the Hydrologic Areas within the City's limits, and the San Diego Bay WMA. The entire City is within the San Diego Bay WMA. This program further restricts the use of pollutant removal credits from an ACP project to PDPs within the same Hydrologic Area.

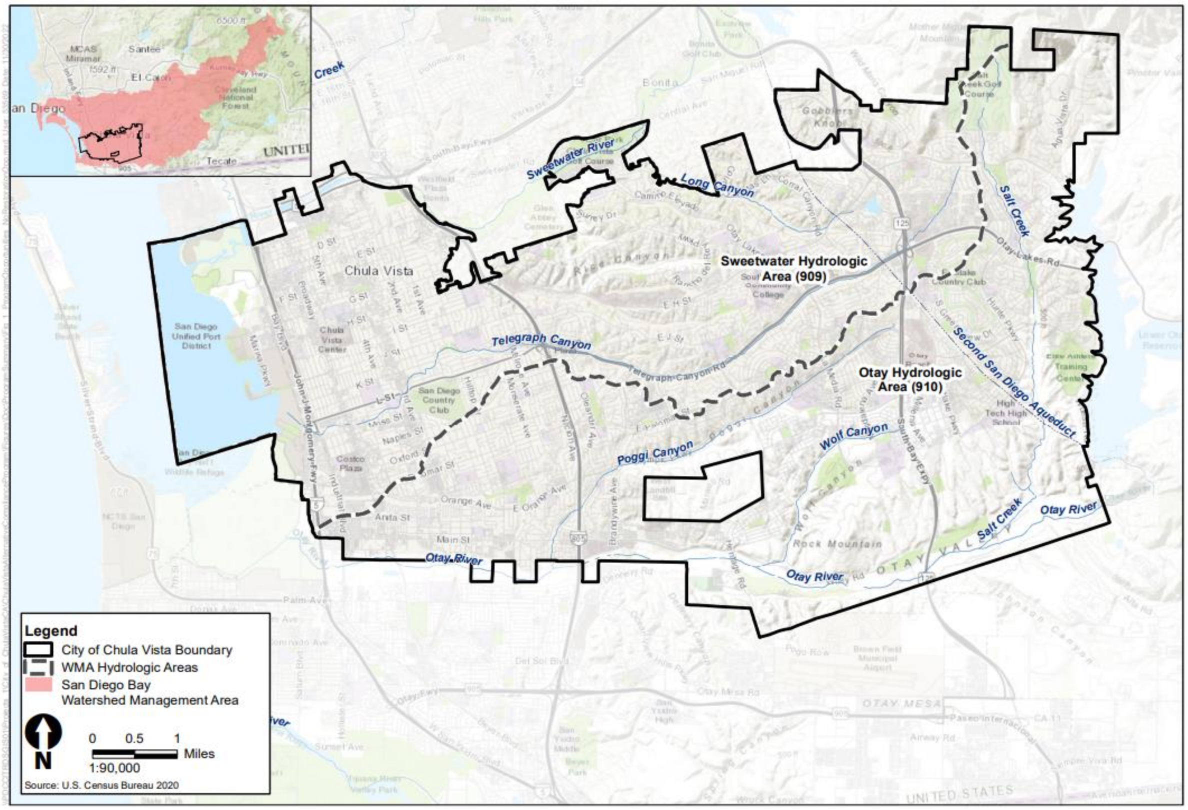


Figure 4-3. City of Chula Vista Boundary and San Diego Bay Watershed Management Area

4.3.2 Hydromodification Credits

Hydromodification credits are required for any project discharging to a non-exempt stream (Figure 4-4). In order for an alternative compliance project to provide full or partial compliance for a PDP's hydromodification management requirements, specific location requirements must be met and vary based on certain scenarios. Guidance on the proposed PDP scenarios (new development, redevelopment, etc.) and location requirements for an ACP project to provide compliance for each scenario are outlined in detail in Section 3.3 of the WQE Guidance Document. Section 3.6 of the WQE Guidance document provides specific requirements for using NSMPs for hydromodification flow control equivalency and the location requirements of the NSMP ACP project in relation to the PDP.

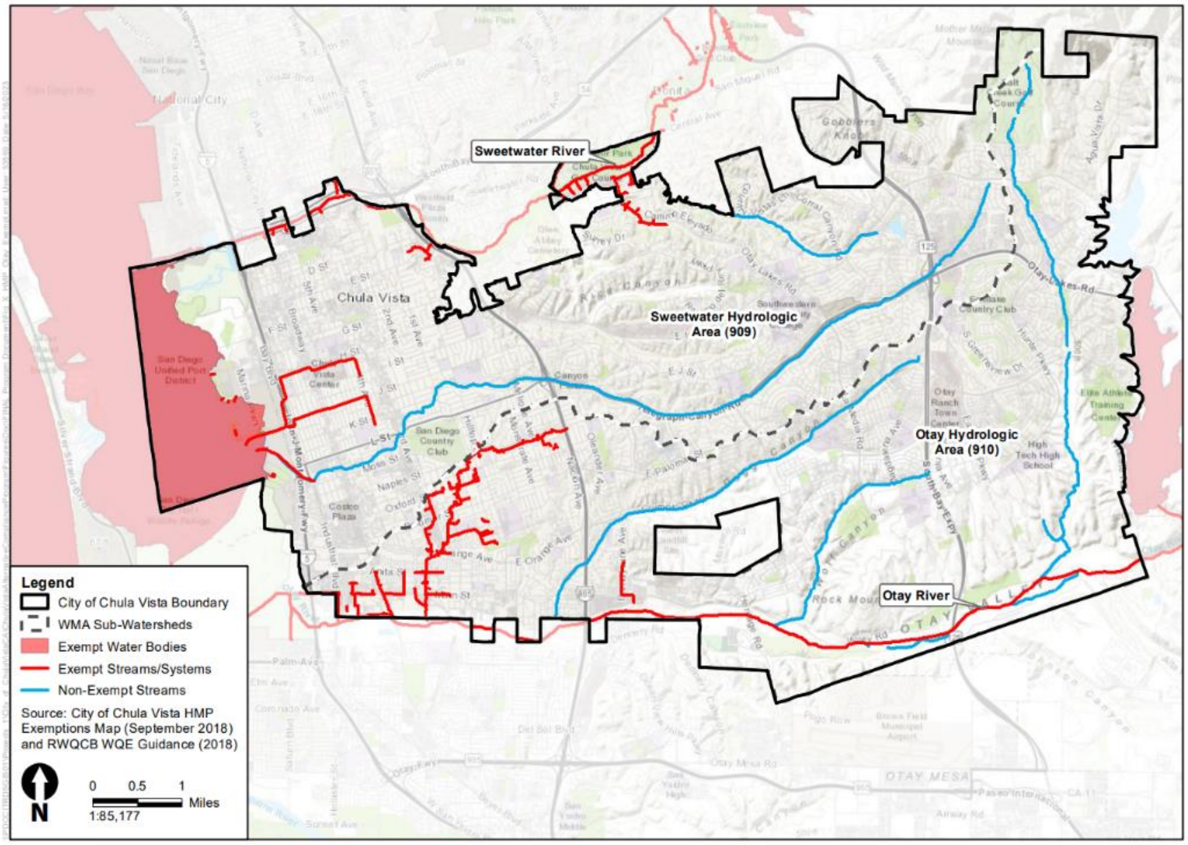


Figure 4-4. Hydromodification Exemptions in the Otay and Sweetwater Sub-Watersheds

4.3.3 Potential Project Opportunities

The city has identified the following stream sections as having the potential for restoration that would provide pollutant control or hydromodification credits under this program (Figure 4-5).

Lower Salt Creek – There are restoration opportunities within Salt Creek and its tributaries in the portion of Salt Creek between Olympic Parkway and the confluence with the Otay River.

Upper and Lower Wolf Canyon - There are restoration opportunities within Wolf Canyon between the area around Olympian High School and the confluence with the Otay River.

Lower Poggi Canyon – There are restoration opportunities in the lower reach of Poggi Canyon before the confluence with the Otay River.

Lower Telegraph Canyon – There are some limited restoration opportunities within lower Telegraph Canyon west of I-805.

Long Canyon – There are restoration opportunities in the portion of Long Canyon within the City.

Mid-Sweetwater River – There are restoration opportunities in the portion of the Sweetwater River within the City.

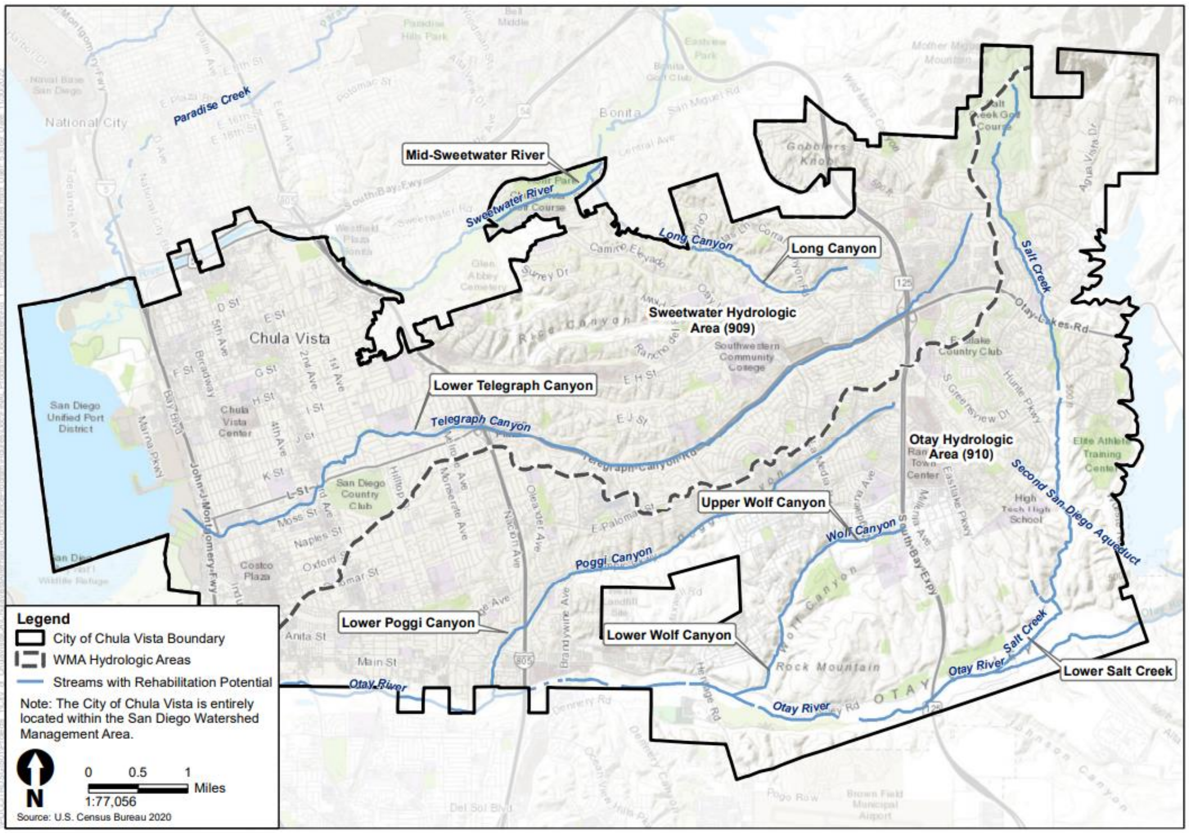


Figure 4-5. Project Opportunities in the City of Chula Vista

4.4 Coordination with Other Mitigation and Restoration Programs

NSMPs developed under this Program will need to comply with applicable federal, state, and local laws and regulation. Since this program focuses on stream restoration NSMPs, they will require compliance with the California Environmental Quality Act (CEQA), Clean Water Act (CWA) Sections 401 and 404, Porter-Cologne Water Quality Act (Porter-Cologne Act), and California Department of Fish and Wildlife Lake and Streambed Alteration Program. Additional compliance will be identified through the CEQA process.

In addition to complying with state and federal laws and regulations, the restoration projects implemented under this Program may provide mitigation opportunities for impacts to resources that fall outside the Regional MS4 permit regulations. However, when an NSMP considers providing mitigation under other programs, the NSMP proponent will need to recognize that there are limitations to how these programs may co-locate credits. These scenarios are discussed in the sections that follow.

4.4.1 Aquatic Resource Mitigation

Pollutant control or hydromodification credits developed by an NSMP may not also be used to meet mitigation obligations for impacts to waters of the state or waters of the US under either the CWA section 401 or 404 program, or the Porter-Cologne Act (jointly referred to as Aquatic Resources Mitigation). When a water of the US or water of the state is impacted, the Aquatic Resources Mitigation required under the laws previously referenced is intended to replace the entire suite of functions and values that were lost by the initial impact. The credits created under this Program address specific functions (i.e., pollutant control) that are provided by higher quality natural and restored stream features. Allowing water quality credits created under this Program to also be utilized as Aquatic Resource Mitigation would allow for an overall loss of functions of waters of the US or waters of the state and is therefore not allowed under this Program.

A restoration or mitigation project may, however, be designed to allow for both Aquatic Resources Mitigation and ACP credits if the credits are mutually exclusive. This can be done by determining the areas that may provide each type of credit and documenting how those credits will be divided between the programs, and how the credit use will be tracked to ensure that credits will only be used to mitigate for one impact type. An NSMP may also propose that areas that provide both types of credits may be used for either type of credit so long as the credit is then made unavailable for use by the other credit program. For example, if a proposed project includes stream restoration and buffer restoration that meet the requirements of both the Program and Aquatic Resources Mitigation, the area that is considered an aquatic resource would be available for Aquatic Resources Mitigation. That area could then be removed from the overall inundation area that would be expected to provide credits under this Program, and the quantity of water quality credits provided would be calculated based on the area remaining after the Aquatic Resources Mitigation is removed from the total inundation area. In this scenario, buffer add-on credits would also be available for the ACP project, which would be calculated based on the total potential pollutant control credits that the NSMP would provide. The ACP project would then be able to provide credits based on the proportion of the site that is not considered aquatic resources, plus the buffer add-on credits.

4.4.2 Habitat and Species Mitigation

Pollutant control and hydromodification credits generated under this program may be able to be bundled with species habitat mitigation to provide mitigation for species habitats under laws such as the California or federal Endangered Species Acts, with approval of the California Department of Fish and Wildlife and Fish and Wildlife Service, respectively. In this situation, the credit would be able to provide habitat credits and water quality credits to meet permit compliance for a PDP, however, the water quality credit would not be able to be severed from the species habitat credit to be used to compensate for impacts from different PDPs.

4.5 Life of Credit and Reporting Requirements

4.5.1 Life of Credits

Credits established under the Program will be perpetual in duration. As discussed in Section 2.4, *Alternative Compliance Project Options,* the Program will require all projects have a perpetual site protection mechanism in place and funding to support the long-term maintenance and management of the credits. All projects designed and installed under the Program will provide natural systems that are expected to be resilient to changing conditions. Adaptive management and contingency funding will be included in the required long-term funding to address required remedies to situations that may affect the material conditions of the ACP project (those that provide stormwater treatment).

4.5.2 Annual Reporting by the City

The City will submit to the SDRWQCB an annual report of all activity under the Program including the development and approval of an ACP project, implementation of an ACP project, ACP credit reservations or purchases by a PDP, status of success criteria for an implemented ACP project during its success monitoring period, remaining time to fulfill any sold credits for which the ACP project has not yet been implemented, and closeout of any ACP project when all credits have sold. All details of success monitoring will be submitted through the Clean Water Act Section 401/Waste Discharge Requirement permit process and do not need to be separately submitted under this Program reporting. If any new ACP projects are approved or implemented within the reporting period, the City will report on the location of the project, including the WMAA and subwatershed, project size, anticipated or constructed credits, and any reserved credits allocated to the project. Annual reporting will be included in the WQIP annual report.

As part of the City's Annual reporting process on the ACP, information on both the ACPs developed and approved by the Program and the PDPs using credits of the program to meet compliance requirements will be reported. This additional information will be included with each WQIP Annual Report. Information requirements are as follows:

PDP

1. Pollutants treated at the PDP; and
2. Map of PDP that includes the following information:
   i. Name of PDP;
   ii. Location of PDP with latitude and longitude;
   iii. Name of receiving water that the PDP discharges to;
   iv. Latitude and longitude of all onsite PDP flow through pollutant control BMPs with type of BMP indicated; and
   v. Latitude and longitude of onsite post project runoff control mitigation.
3. Documentation of greater water quality benefit provided (using Appendix D)

ACP

1. ACP inventory in the Credit System. For each ACP in the inventory include:
   a. ACP name;
   b. ACP type (stream restoration, stream restoration with buffer, stream restoration with bioassessment, stream restoration with buffer and bioassessment);
   c. Quantity of Pollutant Control credits generated by ACP;
2. Map of ACP with the following information included:

   a. Location of the ACP with latitude and longitude;
   b. Type of ACP;
   c. Drainage area treated by the ACP; and
   d. Receiving water that will receive the ACP discharges.
3. Ledger documenting released credits, credits reserved, and credits sold
4. Documentation of the greater overall water quality benefits provided by the Program.

4.6 Long-Term Assurances and Management

All projects implemented under the In-Lieu Fee Program must provide for the operation and maintenance of the ACP projects. As this Program is designed to implement stream rehabilitation and natural systems restoration, long-term operation costs are expected to be low, while long-term maintenance costs will vary due to site-specific conditions that may affect the condition of the restoration project such as prevalence of invasive species or detrimental human visitation. To ensure that the ACP projects meet or exceed their design conditions, the fees assessed for each project will include sufficient funding to cover annual monitoring, expected maintenance costs, legal fees or legal insurance, and a contingency fund (recommended to be at least 10% of the long-term costs) to cover unexpected costs. Each ACP project, whether public or private, must identify the party responsible for ACP project maintenance, monitoring, and management, including reporting the dates and findings of ACP project maintenance and corrective actions when applicable. The City Engineer will require private ACP project property owners to provide annual self-certification that inspection and maintenance has been performed, provide details of the inspection results and maintenance activities, and confirm or update the contact information for the party responsible to ensure inspection and maintenance is performed.

Each ACP project must provide a secure long-term funding source to support the long-term maintenance, monitoring, and management of the ACP project. The long-term funding mechanism for private ACP projects will be in the form of a non-wasting endowment where funding is designated solely to support the maintenance, monitoring, and management of the ACP project.

The City may decide to establish a designated account to accept ACP credit sale fees, where monies held in the account will only be used to fund design, development, construction, operation, maintenance, monitoring, and management of the ACP projects. This fund would need to establish a sub-account to separately hold long-term maintenance, monitoring, and management funds to ensure these funds are preserved for future use.

In addition to funding to cover the long-term maintenance and monitoring of the ACP project, each project will need to provide perpetual site protection for the entire ACP area. Site protection on privately owned lands must be in the form of a conservation easement that meets the requirements of California Civil Code Section 815, or other perpetual site protection mechanism approved by a resource agency with permitting authority over the project. The CE, or other mechanism, must identify the water quality benefits provided by the ACP project as the conservation values protected by the conservation easement. When ACP projects are implemented on private lands, property owners must provide documentation of the monitoring and maintenance of the ACP project to support the City's reporting requirements to the San Diego RWQCB.

Publicly owned lands may be placed under a conservation easement, or other mechanism to provide permanent protection of the ACP project water quality functions. Examples of alternative protections for publicly held lands may be including the goal, maintenance, and monitoring of the ACP project into an existing land management plan, resource management plan, or similar management document that directs the activities on the included plan areas.

4.7 Adaptive Management and Future Actions

4.7.1 Adaptive Management

If any portion of the Program is found unsuccessful, then adaptive management measures will be identified to make program adjustments in order to become successful. For example, if the 4-year timeline to implement credits is not attainable due to there being a longer time period between when credits are released for sale and when the ACP is implemented, as identified in this document, then adaptive management measures would be implemented. Possible solutions could include requesting an extension of time for implementing the ACP project from the RWQCB Executive Officer, assessing whether the delay was due to an issue that is expected to occur on other projects, and adjusting the credit release and implementation times to avoid this problem on future ACP projects. As the City implements this program and re-evaluates its components, adjustments will be made in order to improve processes. Additionally, if new TMDLs are added for the watersheds within the City, the City will assess if the Program supports how the City addresses the new TMDL, or if additional measures will be needed.

4.7.2 Future Actions

Future actions will be at the discretion of the City and the needs of the community. Currently, the City has identified the possibility of including a water quality crediting system in future iterations of the Program.

Chapter 5
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Appendix A
Technical Memorandum on Alternative Compliance Program: Water Quality Equivalency Using Natural System Management Practices

Technical Memorandum

Alternative Compliance Program: Water Quality Equivalency Using Natural System Management Practices

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December 2022

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ICF Jones & Stokes. 2022. *Alternative Stormwater Compliance: Water Quality Equivalency Using Natural System Management Practices*. Technical Memorandum. December. (ICF 429.20.) San Diego, CA. Prepared for the City of Chula Vista, CA.

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Tables

Figures

Acronyms and Abbreviations

Acronym	Definition
°C	degrees Celsius
ACP	Alternative Compliance Program
BANCS	Bank Assessment for Non-point Source Consequences of Sediment
BMP	Best Management Practice
BSTEM	Bank Stability and Toe Erosion Model
Cd	cadmium
CEQA	California Environmental Quality Act
City	City of Chula Vista
Cr	chromium
CRAM	California Rapid Assessment
Cu	copper
DCIA	Directly Connected Impervious Area
DCV	design-capture volume
FC	fecal coliform
FCU	functional capacity units
Fe	iron
HGM	Hydrogeomorphic Method
ICW	integrated constructed wetlands
MBAS	methylene blue activated substances
MS4	Municipal Separate Storm Sewer System
MSCP	Multiple Species Conservation Plan
Ni	nickel
NSMP	Natural System Management Practices
PAH	polycyclic aromatic hydrocarbon
Pb	lead
PDP	Priority Development Projects
RSC	regenerative stormwater conveyance
RSC	Regenerative Stormwater Conveyance
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SCM	Stormwater Control Measures
SUSTAIN	Stormwater Treatment and Analysis Integration
SWAT	Soil and Water Assessment Tool
SWBRP	San Diego Bay Responsible Parties
TCu	total copper
TDS	total dissolved solids
TMDL	Total Maximum Daily Load
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
WQE	Water Quality Equivalency

Acronym	Definition
WQE Guidance	Water Quality Equivalency Guidance Document for Region 9
WQIP	Water Quality Improvement Plan
Zn	zinc

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Executive Summary

The City of Chula Vista (City) is seeking to utilize Natural Systems Management Practices (NSMP) as a form of compliance for their Municipal Separate Storm Sewer System (MS4) permit. California Regional Water Quality Control Boards (RWQCB) issue MS4 permits, with oversight of the Environmental Protection Agency (EPA) under Clean Water Act (CWA) Section 402 of the National Pollutant Discharge Elimination System (NPDES) regulations, which was implemented to provide oversight and numerical criteria for dischargers that release pollutants into rivers, lakes, and other surface waters of the United States. Under CWA Section 402, municipal stormwater dischargers are regulated and mandated to reduce pollutant loads to receiving waters by utilizing treatment Best Management Practices (BMP). MS4 permittees generally comply with MS4 requirements through onsite BMPs or low impact development that act to reduce both hydromorphological changes and pollutant loads correlated with development and urbanization. Although onsite treatment of stormwater is often preferred, development constraints can sometimes require the use of approved offsite and alternative stormwater-management strategies, as is the case with the City.

In a March 2019 amendment, the RWQCB adopted an updated version of the Water Quality Equivalency Guidance Document: Region 9 (WQE Guidance) which allows co-permittees to design and implement an offsite Alternative Compliance Program (ACP) to meet water-quality requirements as defined in the region's MS4 permit. Under the updated WQE Guidance, co-permittees can enter into agreements with Priority Development Projects (PDP) to meet all or part of their stormwater requirements offsite so long as proposed projects provide greater water-quality benefits to the watershed than onsite structural BMPs. The WQE Guidance also provides for the exploration and development of Natural Systems Management Practices (NSMP) as alternatives to structural BMPs, identifying Land Preservation, Land Restoration, and Stream Rehabilitation as potential avenues for calculating and crediting for Water Quality Equivalency (WQE).

In March 2019, the City of Chula Vista submitted a grant application to the California Department of Housing and Community Development's (HCD) Senate Bill (SB) 2 Planning Grant Program which provides funding to help municipalities streamline housing approvals and accelerate housing production. Recognizing the City's critical-need status for housing developments and compliance, HCD awarded the City $625,000 to implement an Alternative Compliance Program using NSMPs. The deliverables proposed under the ACP program include an RWQCB-approved WQE framework plan, establishment of WQEs for NSMPs, stakeholder outreach meetings, and an in-lieu fee structure and credit system for PDPs to employ.

This technical memorandum, *Alternative Compliance Program: Water Quality Equivalency Using Natural System Management Practices*, summarizes a literature review performed to better understand available scientific information related to use of NSMPs for stormwater management and watershed and water-quality benefits in support of the City's efforts to develop an ACP to streamline the approval process for PDPs. Therefore, this memorandum is the first step toward developing the methodologies for applying NSMPs toward WQE credits as an ACP option.

Findings

1. ***Land Preservation* is the act of permanently preserving undeveloped land in its current state.** This NSMP may provide quantifiable stormwater pollutant control and hydromodification flow control benefits by preventing increases in stormwater runoff volumes and pollutant concentrations associated with development, as well as maintaining natural habitat and functions such as interception, evapotranspiration, and infiltration of precipitation.

   Land preservation should not be considered for hydromodification or pollutant removal credits on its own, but can act as a credit multiplier if coupled with Land Restoration and Stream Rehabilitation, keeping in mind that floodplain Land Preservation likely provides greater ecosystem and watershed benefits per acre than upland Land Preservation and should be assessed as such. This NSMP only provides water-quality benefits to the catchment in which it is located and should be placed within the hydrologic areas and subareas where the development will occur.

2. ***Land Restoration* is the act of restoring currently developed land back to a stabilized pre-development condition** by removing impervious surface cover from existing developed land, regrading, decompacting, and stabilizing disturbed ground, and restoring predevelopment land use and land cover through native plant community revegetation and adaptive management. These actions re-establish natural interception and infiltration mechanisms to reduce pollutants and flow volume.

   Reductions in stormwater volumes and benefits to hydromodification flow control resulting from implementation of Land Restoration NSMPs can be counted as WQE credits for a proposed development. However, there are no methods identified for calculating pollutant reduction resulting from retention, biofiltration, or flow-thru methods despite strong empirical evidence in scientific literature. Therefore, further research and development of calculations are required to quantify stormwater pollutant control for WQE credits.

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

   The WQE Guidance provides methodologies to credit stormwater volume reduction and hydromodification flow control benefits provided by Stream Rehabilitation NSMPs, but does not identify calculations for pollutant reduction. Review of scientific literature indicates that stream rehabilitation projects provide measurable pollutant-reduction benefits through sediment retention, vegetative uptake, and biogeochemical cycling. Therefore, further research and development of calculations are required to quantify stormwater pollutant control for WQE credits.

4. **A review of existing alternative compliance programs provides insight into program feasibility and obstacles**. Currently, no such pollutant-reduction crediting programs exist in southern California, but this approach has been employed in Chesapeake Bay and New Hampshire.

The Chesapeake Bay protocols and calculations for stream rehabilitation were based on published sediment and nutrient fluxes in restored streams, floodplains, wetlands, and regenerative stormwater conveyance (RSC) systems from select watersheds. There, credits were provided for preventing sediment during storm flows, providing in-stream and riparian hyporheic zone nutrient processing during base flow, increasing floodplain-reconnection volumes, and stormwater retrofits using RSC.

The New Hampshire program incorporates regional pollutant loading and reduction performance curves based on site characteristics such as contributing area, land use, impervious cover, hydrologic soil groups, and slope. To address the inherent variability between sites, the crediting program set minimum and maximum riparian buffer widths, slope categories, and pollutant-specific removal rates. Their approach relied heavily on a local expert panel and regional stormwater runoff and water-quality trends to develop credit determinations.

Conclusions

The most appropriate NSMP alternatives for the City must provide a combination of water quality, watershed, and ecosystem benefits to provide justification for use in the ACP. In practice, no single NSMP is likely to manage the stormwater runoff associated with a PDP, and, thus, the ability to combine multiple NSMPs for WQE is necessary and should be encouraged. The three NSMP categories are not mutually exclusive. The most effective and appropriate WQE strategy using NSMPs would incorporate many of the restoration actions described above, functioning in tandem to provide reliable benefits to water quality and ecosystem health.

Determination of realistic pollutant-reduction credit ratios for the various NSMPs is a primary objective for the ACP. Credit determinations in the Otay River Watershed are limited by the availability of regionally specific pollutant retention rates for each NSMP. Empirical nutrient processing or pollutant retention rates from comparable systems in San Diego County should be incorporated into adaptations of this method to reflect the appropriate conditions for Chula Vista streams.

Water quality monitoring is critical to assess and adequately credit Stream Rehabilitation projects. These data are invaluable for subsequent ACP reviews, allowing WQE credit determinations to be adjusted to reflect anticipated versus actual water-quality benefits. Therefore, a monitoring program should be developed to collect data before and after Land Restoration and Stream Rehabilitation projects within Chula Vista.

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Chapter 1
Background Information

This technical memorandum summarizes a literature review performed to better understand available scientific information related to use of Natural System Management Practices (NSMP) for stormwater management and watershed and water-quality benefits. This memorandum was prepared as part of the City of Chula Vista's efforts to develop an Alternative Compliance Program (ACP) to expand stormwater-management practices, improve water quality, and streamline the approval process for Priority Development Projects (PDP). The following sections describe the ACPs, both existing and proposed, relevant to the City of Chula Vista (City), the NSMPs selected by the San Diego Regional Water Quality Control Board (RWQCB), and the scope of the literature review.

1.1 Alternative Compliance Programs

The RWQCB, in a March 2019 amendment, adopted an updated version of the *Water Quality Equivalency Guidance Document: Region 9* (WQE Guidance) submitted by the County of San Diego (RWQCB 2018). This update outlines standards and guidelines for co-permittees to design and implement an offsite ACP to meet water-quality requirements as defined in the Regional Municipal Separate Storm Sewer System (MS4) permit. The ACP grants co-permittees the ability to enter into voluntary agreements with PDP applicants to provide offsite pollutant reduction and hydromodification management. The WQE Guidance allows for numerically sized offsite structural Best Management Practices (BMP), such as retention or detention basins, to meet all or part of the required onsite stormwater-management practices if the proposed project provides greater water-quality benefits to the watershed than onsite structural BMPs. The WQE Guidance also provides for the exploration and development of NSMPs as alternatives to structural BMPs. The document identifies Land Preservation, Land Restoration, and Stream Rehabilitation as potential avenues for calculating and crediting for Water Quality Equivalency (WQE). This memorandum summarizes scientific information related to the capacity for NSMPs to enhance stormwater management and improve water quality, while accounting for additional benefits to the greater watershed and ecosystem.

1.2 Senate Bill 2 Planning Grant

In March 2019, the City submitted a grant application to the California Department of Housing and Community Development's Senate Bill (SB) 2 Planning Grant Program, which provides funding to help municipalities "prepare, adopt, and implement plans and process improvements that streamline housing approvals and accelerate housing production" (California Department of Housing and Community Development 2019). In this grant application, the City proposed to develop a WQE framework for NSMPs to expedite PDP approval while meeting MS4 Permit requirements. The grant application proposed to use SB 2 grant funding to develop an ACP for three categories of NSMPs—including environmental analyses—to provide alternative management options consistent with the City's MS4 Permit. The proposed project represents significant opportunities for PDP applicants to streamline permit review and approval processes, increase onsite buildable acreage, and still meet MS4 Permit requirements for stormwater pollutant control and hydromodification management (City of Chula Vista 2019).

Recognizing the critical-need status for housing developments and compliance, in March 2020 the SB 2 Planning Grant Program awarded $625,000 to the City to implement the proposed project. The deliverables proposed under the ACP program include:

- RWQCB-approved framework plan
- Establishment of WQE guidelines for NSMPs
- Stakeholder outreach meetings
- In-lieu fee structure and credit system for PDPs to employ

Funding will also be used to identify mitigation opportunities within the Otay River and Sweetwater River Watershed and draft the California Environmental Quality Act (CEQA) compliance document for the program.

1.3 Natural System Management Practices

The WQE Guidance (2018) defines NSMPs as:

> Stormwater management practices implemented to restore or preserve predevelopment watershed functions in lieu of providing direct pollutant removal and hydromodification flow control. NSMPs may include structural or engineered elements, but these elements do not expressly provide stormwater pollutant removal (page xv)

Table ES-1 of the WQE Guidance provides the various ACP categories for both BMP and NSMP approaches and identifies which of those categories can be applied for pollutant reduction (i.e., retention, biofiltration, or flow-thru), volume reduction, or hydromodification control credits (Figure 1). The table presents the three NSMP categories—Land Preservation, Land Restoration, and Stream Rehabilitation—and the availability of each category for use in WQE determinations. These categories are defined in the WQE Guidance as follows:

- **Land Preservation** is an NSMP that permanently preserves undeveloped land in its current state. In limited scenarios, Land Preservation may provide quantifiable stormwater-pollutant control and hydromodification flow-control benefits by preventing increases in stormwater runoff volumes and pollutant concentrations associated with the future built-out condition of a tributary (page xv).
- **Land Restoration** is an NSMP that restores currently developed land back to a stabilized pre-development condition. Land Restoration practices are similar to Retrofit BMPs that provide reductions in impervious surfaces but require appropriate stabilization techniques (page xv).
- **Stream Rehabilitation** includes remedial measures or activities for the purpose of improving or restoring the beneficial uses of streams, channels, or river systems. Techniques may vary from in-stream restoration techniques to in-line stormwater-management practices installed in the system corridor or upland areas, or a combination of in-stream and out of stream techniques. Rehabilitation techniques may include but are not limited to riparian-zone restoration, constructed wetlands, channel modifications that improve habitat and stability, and daylighting of drainage systems (page xvi).

ACP Category		Stormwater Pollutant Control Benefits: Pollutant Reduction			Stormwater Pollutant Control Benefits: Volume Reduction	Hydromod Flow Control Benefits
		Retention	Biofiltration	Flow-Thru		
BMP	Retrofit	Available	Available	Limited Availability	Available	Available
BMP	Regional	Available	Available	Limited Availability	Available	Available
BMP	Water Supply	Available	Available	Limited Availability	Available	Available
NSMP	Land Restoration	Not Available	Not Available	Not Available	Available	Available
NSMP	Land Preservation	Not Available	Not Available	Not Available	Limited Availability	Available
NSMP	Stream Rehabilitation	Not Available	Not Available	Not Available	Limited Availability	Available

Figure 1. The various BMP and NSMP categories with potential stormwater pollutant and hydromodification control benefits

Source: RWQCB 2018

The WQE Guidance provides detailed instructions, equations, and examples for calculating the hydromodification flow-control benefits of Land Preservation, Land Restoration, and Stream Rehabilitation NSMPs. At the time of the approval of the updated WQE Guidance, calculations had not yet been determined for NSMP pollutant-reduction benefits (i.e., retention, biofiltration, and flow-thru), and only limited applications had been developed for volume reduction. The WQE Guidance states that

> It is understood that some stream restoration techniques should reduce volumes of runoff through infiltration within streambeds. The techniques for quantifying this volume reduction have not been developed as of yet, nor have the design criteria for stream restoration to achieve additional infiltration. (page ES-3)

Moreover, the WQE Guidance acknowledges that

> Pollutant reduction associated with changes in riparian vegetation and stream velocities through stream restoration projects have not been assessed or quantified as part of this effort. For an applicant to obtain pollutant reduction credit associated with volume reduction or other pollutant uptake processes in a stream restoration project, the jurisdiction will be required to develop the methodology to be followed through its own approval processes (page ES-3).

Therefore, this memorandum is the first step toward developing the methodologies for applying NSMPs toward WQE credits as an ACP option. This memo also highlights the lack of accounting frameworks for the additional benefits beyond water quality—including ecosystem and watershed functions—that NSMPs provides and identifies potential qualitative approaches for evaluating these additive benefits for WQE crediting. The following sections highlight and summarize the best-available science for developing these methodologies for the watersheds of the City of Chula Vista.

1.4 Intent and Purpose

The intent of this memorandum and literature review is to understand and compile the latest scientific information available related to employing NSMPs as alternative stormwater-management strategies, with a focus on enhancing ecosystem health, watershed function, and water quality. This information is used to identify, evaluate, and quantify water-quality benefits associated with respective NSMPs and inform the development of water-quality ratios and credit values.

This review focuses on the response of ecosystem functions and water-quality pollutants to the implementation of NSMPs. Pollutants considered range from nutrients and sediment to pesticides, hydrocarbons, and other constituents. This review is not intended to be exhaustive; rather, its purpose is to compile and understand the realizable watershed and water-quality benefits that may result from natural system-management practices.

Chapter 2
Introduction

2.1 Urban Development and Water Quality

The urbanization of a watershed and its subsequent decline in water quality typically is characterized by the extent of impervious surface cover (Brabec et al. 2002). Impervious surfaces do not allow for infiltration of precipitation and result in increased frequency and intensity of surface-water runoff events, simultaneously transporting the dissolved and particulate pollutants that accumulate in built environments. Pollutants such as fertilizers, sediment, pesticides, petroleum products, pharmaceuticals, microplastics, and trace metals abound in urban areas and are mobilized to waterways quickly following each rain event, acting as episodic pulses of contamination that reduce water quality and the biological integrity of aquatic resources (EPA 1999). As impervious urban surfaces increase in both density and magnitude across the landscape, changes in watershed structure and function result in substantial impacts on surface water quality and ecosystem health.

The ratio of total imperviousness is often used as a key parameter in runoff modeling and can reliably predict the degree of water-quality degradation resulting from planned development and land use change (Brabec et al. 2002, San Diego DPW 2019). This enables planners to account for the anticipated impacts on water quality and design mitigation and treatment strategies to offset those impacts. Although onsite treatment is often preferred, development constraints can sometimes require the use of approved offsite and alternative stormwater-management strategies. For many years, engineered structural BMPs have been the predominant strategy for stormwater management. More recently, NSMPs are being considered as management alternatives in the stormwater and water-quality accounting framework.

2.2 Water Quality Issues in Chula Vista

The City's municipal boundaries span sections of both the Otay River and Sweetwater River watersheds, each with various water-quality issues, spanning from headwater tributaries to the San Diego Bay. The San Diego Bay Water Quality Improvement Plan (WQIP) acknowledged that Lower Otay Reservoir, Jamul Creek, and Poggi Canyon Creek are on the CWA Section 303(d) List as impaired warm freshwater habitat due to nitrogen and toxicity (SDBRP 2016). The listed portions of Lower Otay Reservoir and Jamul Creek are outside the Chula Vista City limits, but are included because they are part of the larger watershed. Otay River monitoring data supports considering multiple receiving water conditions, including *Enterococcus*, *E. coli*, fecal coliform (FC), multiple indices of biological integrity, methylene blue activated substances (MBAS), nitrogen, organophosphate and pyrethroid insecticides, phosphorus, salinity, California Rapid Assessment (CRAM) scores, total copper (TCu), total suspended solids (TSS), turbidity, and several biological indicators. Of these considerations, bacteria and trash were listed as a receiving-water conditions and focused priority conditions for the Coronado and Otay Valley hydrologic areas. The Lower Sweetwater River is listed as impaired water freshwater habitat due to benthic community effects, chlorpyrifos, indicator bacteria, nitrogen, phosphorus, selenium, total dissolved solids (TDS), and toxicity. Telegraph Canyon Creek is currently listed as impaired for selenium, although recent data submittals support and call for delisting the stream. As of 2016, receiving-water conditions and focused priority conditions for the Lower Sweetwater River included trash, bacteria, and nutrients and considered over 30 potential conditions based on available monitoring data. The two watersheds share similar water-quality issues, and the majority manifest during the dry season or from early wet season storms. Table 2-1 of the WQE Guidance (2018) listed TSS, TN, TP, TCu, and FC as the primary pollutants of concern in the Otay and Sweetwater hydrologic units. As a result, these pollutants are the primary focus for all BMP, and potential NSMP, WQE calculations.

The San Diego RWQCB confirmed a dearth of water-quality sampling efforts in the Otay River watershed, likely due to higher-priority issues in faster-developing watersheds with explicit Total Maximum Daily Load (TMDL) standards (Loflen pers. comm.). The lack of a TMDL in the Otay River does not exclude the system from historical or current degradation and alteration, as evidenced by the fragmented and hydrologically disconnected reaches downstream of Lower Otay Reservoir. The most recent data point toward increasing water-quality concerns primarily related to toxicity, pyrethroids, and nutrients, all of which can be tied to stormwater-management issues. Thus, NSMP WQE calculations should anticipate future additions to the list of pollutants of concern in the Otay River Watershed.

2.3 Natural Systems for Water Quality and Stormwater Management

As urbanization replaces wetlands, floodplains, and uplands with impervious surfaces, there is a loss of ecosystem services (e.g., infiltration, evapotranspiration, attenuation of floodwaters, nutrient cycling) that would otherwise naturally manage runoff and preserve water quality. These natural systems provide ecosystem functions by helping to attenuate flooding, cycle nutrients, regulate sediment-transport processes, and preserve water quality and functional habitat. In theory, NSMPs would mimic ecosystem services to provide watershed and water-quality benefits as an alternative to traditional stormwater-management approaches. In practice, NSMPs may manifest as preserved open lands, restoration of impervious areas within development to natural habitats, or rehabilitated ecosystems.

Chapter 3
Water Quality Equivalency Using Land Preservation

One of the NSMP categories the WQE Guidance proposes describes the preservation of undeveloped land in perpetuity to provide ecosystem and water-quality benefits that offset stormwater-pollutant or hydromodification impacts from development. Because this NSMP prevents development impacts and does not actively treat stormwater, the WQE Guidance acknowledged the limited capacity for it to provide quantifiable stormwater-pollutant control and hydromodification flow-control benefits. Thus, the WQE Guidance requires the preserved land to be zoned for development, physically developable, below the PDP thresholds for structural BMP performance requirements, and preferably within the same local catchment. Land Preservation is typically achieved through conservation easements that preserve undeveloped lands for their beneficial ecosystem services. The following sections address Land Preservation and its applicability for WQE.

3.1 Land Preservation Using Conservation Easements

Conservation easements are voluntary legal agreements that permanently restrict land uses to protect conservation values (NCED 2020). As an NSMP, Land Preservation may lessen the water-quality impacts of urban stormwater runoff from new developments by permanently preserving undeveloped land zoned for future built-out conditions. To guarantee ecosystem and water-quality benefits and ensure protection in perpetuity, a conservation easement or similar legal agreement must be the ultimate end goal for any Land Preservation NSMP. Conservation easements in the state of California are defined and governed under Civil Code Sections 815–816 (California Legislative Information 2020).

3.2 Land Preservation and Water Quality

A foundational study in watershed science monitored the change in water quality and flow regime in a catchment subject to clearcut logging and herbicide treatment—a disturbance akin to rapid urbanization (Likens et al. 1970). In the 2 years following, stream flow increased by 28–39 percent, nitrate export rose 41–56-fold, and daily maximum water temperature increased by 3–4 degrees Celsius (°C), among other significant changes. Although representing a catchment and ecosystem quite different from those found in Chula Vista, this study demonstrates the drastic degradation of water quality that results from development of previously conserved lands. However, this study also suggests Land Preservation may be a viable tool for protecting and potentially improving water quality when carefully sited to provide beneficial ecosystem and watershed functions.

Preserved undeveloped land placed under a conservation easement provides ecosystem and water-quality benefits by maintaining natural habitat and functions, such as interception, evapotranspiration, and infiltration of precipitation. Conservation easements have been used extensively in California to protect riparian buffers (Furman 1989), wetland habitat (Westervelt 2021), and working range and forest lands (Huntsinger et al. 2010). Increasingly, open-land conservation easements are used to protect drinking-water source areas, in effect preserving the natural functions that benefit water quality and ecosystem health within the watershed by reducing runoff and enhancing groundwater recharge, riparian buffers, and watershed function (NH DES 2021; Price 2014). These natural functions prevent or reduce stormwater pollutant and flow volumes compared to unpreserved developed conditions.

More recent studies addressing the water-quality benefits of Land Preservation often rely on broad generalizations of watershed function and ecosystem services and focus more on the public's willingness to pay or be paid for conservation easements (Kreye et al. 2014; Nohner et al. 2018). As a result, limited empirical data exist documenting the measurable water-quality benefits of Land Preservation, particularly with respect to southern California. This lack of available data highlights the challenges associated with measuring short-term water-quality benefits that may result from long-term land-preservation strategies. Although it is difficult to quantify the water-quality benefits of Land Preservation because of the inherent variability among catchments, conservation easements have proven to be a useful tool for ecosystem- and watershed-scale conservation planning.

Although ecosystem benefits from Land Preservation may extend beyond the immediate project area (e.g., habitat connectivity, native seed dispersal source), this NSMP likely only provides water-quality benefits to the catchments in which they are located or where they are hydrologically connected (Nohner et al. 2017). In the case of Chula Vista, *catchments* may refer to the various hydrologic areas and subareas within the Otay River or Sweetwater River watersheds the RWQCB identified (RWQCB 2018). As such, Land Preservation NSMPs should be located within the same hydrologic area of the proposed development. Moreover, preserved land provides greater water-quality benefits when located in floodplains, channel migration zones, or stream corridors. For example, Cunningham et al. (2010) documented measurable improvements in total inorganic nitrogen levels and macroinvertebrate communities along a preserved open-space stream corridor in an urban setting. Where floodplain preservation is not possible, emphasis should be placed on locating Land Preservation NSMPs upstream of the proposed development or adjacent to existing conservation lands, as metastudies have found headwater systems provide disproportionately greater control of water-quality indicators than systems farther down the watershed (Peterson et al. 2001). Finally, Land Preservation NSMPs should require approved management plans and incorporate Land Restoration or Stream Rehabilitation NSMPs to enhance ecosystem function and ensure preserved lands provide water-quality benefits in perpetuity.

3.3 Land Preservation Credit Valuation

Land Preservation permanently prevents increases in impervious surface cover associated with development and, thus, can be compared directly to future built-out conditions with minimal assumptions. Under this premise, both stormwater-volume reduction and hydromodification-flow control benefits from Land Preservation NSMPs can be estimated using the protocols set forth in WQE Guidance Sections 2 and 3 (RWQCB 2018). Stormwater volume reduction is calculated using the affected versus mitigated DCV approach and site-specific land-use factors, providing a volumetric (cubic feet) measurement of earned stormwater-control credit. The stormwater DCV for a proposed development is a function of imperviousness and runoff coefficients dictated by the change in land cover types between existing and future built-out conditions. In Chula Vista, future built-out conditions of as-yet undeveloped lands can be assumed to be 85 percent impervious, and DCV calculations must use the 85th-percentile rain event over a 24-hour period. Therefore, DCV calculations can be used to compare the stormwater-pollutant volumes of undeveloped preservation land to future built-out conditions. Alternatively, hydromodification flow-control benefits of Land

Preservation are calculated using preserved versus developed DCIA, resulting in area measurements of stormwater control credit. The difference in hydromodification flow control between preserved land and future built-out conditions effectively evaluates the relative water-quality protection provided by a proposed Land Preservation NSMP.

Although the approach for determining the relative stormwater-volume reduction and hydromodification flow control, Land Preservation provides has been developed, the WQE Guidance does not provide a framework for determination of pollutant-reduction (e.g., retention, biofiltration, flow-thru) credits. This is because preservation of undeveloped land, in and of itself, does not work to improve water quality; it merely preserves the existing conditions and functions. Moreover, preserved land does not treat stormwater directly, and therefore does not qualify for a pollutant-reduction efficiency without the combined use of structural BMPs or NSMPs. This makes quantifying standalone Land Preservation pollutant-control credits difficult because measurable water-quality improvements are unlikely to be found in the local watershed. As such, Land Preservation should not be eligible for pollutant-reduction credits as a standalone NSMP. However, Land Preservation does act to protect and preserve water quality by maintaining natural ecosystem and watershed functions on the landscape and can be coupled with both Land Restoration and Stream Rehabilitation to provide additive benefits in perpetuity. Thus, Land Preservation should be considered a preferred end-goal for Land Restoration and Stream Rehabilitation NSMPs to provide measurable water-quality benefits while ensuring long-term management and protection.

Land Preservation should be eligible as additive WQE credits when coupled with Land Restoration or Stream Rehabilitation NSMPs, perhaps as a credit multiplier to encourage their adoption. However, not all Land Preservation NSMPs are the same, and functional differences should be accounted for in the credit-multiplier determination process. Ecosystem and water-quality benefits resulting from different Land Preservation NSMPs are influenced by their physical properties, namely topography, soil type, vegetation communities, and longitudinal position in the watershed. Thus, credit multipliers should be developed to account for the functional differences among possible Land Preservation NSMPs. For example, floodplain Land Preservation likely provides greater ecosystem and watershed benefits per acre than upland Land Preservation, and soils with higher infiltration rates will better manage runoff than those with low infiltration rates. Landscape characteristics such as hydrologic soil group, slope, landscape position, and habitat quality should be assessed to determine credit multipliers for different Land Preservation NSMPs. Although Land Preservation should not be eligible for pollutant retention credits as a standalone NSMP, its value as a long-term management tool, in conjunction with other NSMPs and conservation goals, warrants its water-quality protection evaluation and crediting to encourage its use by PDPs.

The City should identify and prioritize specific locations of eligible Land Preservation sites to coordinate multiple benefits for the watershed, water quality, conservation areas, and public access. This will give the City an inventory of potential Land Preservation sites that meet the requirements and goals of multiple planning efforts. In addition, the City may consider specific requirements (e.g., public access, trails, easements, educational resources) as part of the Land Preservation NSMPs based on the projected needs of the community.

3.4 Opportunities for Land Preservation in Chula Vista

As of 2014, approximately 133 acres within Chula Vista's Multiple Species Conservation Plan (MSCP) Subarea are designated as 75–100 percent Conservation Areas (City of Chula Vista 2014). Of this, about 97 acres fall within the Otay River Valley, and 36 acres are in the Sweetwater River Valley. These relatively small, primarily private landholdings are limited to a maximum of 25 percent development impacts within the mapped Conservation Areas based on MSCP requirements and City ordinance. Where possible, additional acquisition and preservation of Conservation Area lands in exceedance of the 75 percent minimum land area may allow for co-designation as watershed—and thus water quality—improvements. For example, a 10-acre parcel designated as a 75 percent Conservation Area (i.e., 7.5 acres conserved) is limited to 2.5 acres of development impacts. In this case, a PDP applicant might acquire and preserve 1.5 acres of the 2.5 developable acres—effectively preventing development and associated runoff. Thus, by increasing the Conservation Area from 75 percent to 90 percent, the land continues to meet its 75–100 percent designation, but provides an additional 1.5 acres of mitigation that could be eligible for water-quality credits.

The authors of the 2014 *Alternative Compliance Strategy Final Report* (City of Chula Vista 2014) emphasized provisions set in Chula Vista's MSCP Subarea Plan that allow for future facilities to be installed in Conservation Areas. These provisions limited future facilities at 50 cumulative acres, with single-facility impacts capped at 2 acres. Allowable future facilities include storm-drain and flood-control/detention facilities, desiltation and sedimentation basins, extensions of utility services, fire access roads, operations and maintenance roads, brush-management roads, and new trails. Although stormwater-management facilities were explicitly allowed, the provisions did not intend MSCP Preserve areas to provide for large-scale detention basins.

The 75–100 percent Conservation Areas the Chula Vista Subarea Plan identified may present opportunities to use Land Preservation, when coupled with Land Restoration or Stream Rehabilitation, to generate WQE credits. Land Preservation could expand existing Conservation Areas to increase habitat extent and quality, while also preserving or enhancing watershed functions that benefit water quality. MSCP provisions explicitly allow for up to 50 cumulative acres of future facilities that may include stormwater- and flood-control features. These future facilities could be designed using Land Restoration or Stream Rehabilitation NSMPs to provide functional habitat, water-quality benefits, and stormwater management. The combination of Land Preservation to expand Conservation Areas and host Land Restoration or Stream Rehabilitation projects to enhance watershed and ecosystem functions provide the greatest opportunities for meeting multiple planning objectives in Chula Vista.

Chapter 4
Water Quality Equivalency Using Land Restoration

A second NSMP category the WQE Guidance proposes describes the conversion of currently developed land to a restored and stabilized predeveloped state. In effect, this NSMP provides water-quality and ecosystem benefits through three restoration actions: (1) removing impervious surface cover from existing developed land; (2) regrading, decompacting, and stabilizing disturbed ground; and (3) restoring predevelopment land use and land cover through native plant community revegetation and adaptive management. The removal of impervious surface cover directly reduces runoff during storm events, whereas restoration to predevelopment conditions improves functional habitat and engenders long-term resiliency through regenerative ecosystems that naturally manage stormwater. As such, specific restoration measures to re-establish historic natural topography, hydrology, and vegetation communities should be proposed and approved on a site-specific basis to demonstrate quantifiable stormwater pollutant and flow volume reductions. Moreover, the use of Land Restoration NSMPs for WQE should require all three restoration actions (i.e., impervious cover removal; regrading, decompaction, and stabilization; and revegetation and adaptive management) to promote natural conditions and ecological functions that benefit water quality. Where applicable, approved BMPs may be incorporated into Land Restoration NSMPs to generate WQE credits.

It is important to distinguish Land Restoration from Stream Rehabilitation based on landscape position and jurisdictional (e.g., waters of the United States) features. For example, WQE credits for Land Restoration NSMPs should not be granted for restoring currently developed land that resides within a historic floodway, channel-migration zone, or waterway of the United States. Land Restoration should not be implemented in settings where prolonged flooding may occur because stabilization and restoration techniques for upland systems are not designed to withstand the magnitude and duration of certain flood events. Moreover, Land Restoration WQE credits should not be applicable for settings where historic floodplain wetlands existed, as this land-use conversion is more characteristic of Stream Rehabilitation. Although incorporation of non-floodplain wetlands (e.g., vernal pools) into Land Restoration NSMPs should be encouraged where applicable, these habitats are heavily regulated and banked in California and are not within the scope of NSMP WQE crediting. The following sections discuss values, recommendations, and challenges associated with Land Restoration as an NSMP.

4.1 Land Use Conversion as an NSMP

Land Restoration through land use conversion works to recreate the natural structure and function of pervious surfaces such as grassland, wetlands, scrub-shrub, and forest. Land Restoration focuses on removal of impervious surface cover, regrading to predevelopment topography, and creation of naturally functioning soils, vegetation communities, and hydrology to restore natural watershed functions for the benefit of water quality. This NSMP has the potential to offset water-quality impacts from PDP applicants when situated in the same hydrologic area or subarea as the proposed development and implemented to provide net-zero change in imperviousness. In addition, this NSMP may include the use of structural BMPs and Stormwater Control Measures (SCM) to enhance stormwater management and site stability.

Land Restoration NSMPs have the potential to provide both direct and indirect ecosystem and water-quality benefits. Removal of impervious surface cover may provide immediate, direct benefits to water quality by reducing stormwater pollutant and flow volumes (Shuster et al. 2005). Although reduction of runoff may be attained by removing impervious surface cover, this action alone does not restore a landscape and leaves it vulnerable to erosion, colonization by invasive species, and other forms of degradation that may continue to degrade water quality. In a review of imperviousness and its implications for water-quality and watershed planning, Brabec et al. (2002) found that impervious surface cover alone does not adequately characterize water-quality degradation and pressed for the inclusion of a continuum of ecological parameters to improve stormwater management and watershed function. These findings suggest that the mere removal of impervious surface cover may not provide the desired water-quality benefits and that ecological-restoration measures must be incorporated into Land Restoration NSMPs. Therefore, Land Restoration should include measures to provide indirect ecosystem and water-quality benefits by re-establishing natural habitat structure and function in addition to the removal of impervious surface cover.

Land Restoration must include actions beyond reductions in imperviousness to ensure proper functioning conditions for water quality and habitat benefits. Following impervious surface cover removal, the soils underlying formerly developed land may require remedial actions to allow for successful restoration. For example, removal of impervious surface cover does not inherently decompact or restore altered soils. Further actions may be necessary to provide adequate soil conditions for optimal infiltration (Pitt et al. 2008) and native vegetation establishment (Ruthrof et al. 2013). Therefore, Land Restoration should demonstrate soil bulk densities that allow for adequate infiltration rates as well as physical soil properties that promote native vegetation establishment (e.g., percent organic matter, nutrient availability). Soil remediation and conditioning is especially important in areas where commercial or industrial wastes may have contaminated soils, such as listed or suspected Brownfields[1] (DEHQ 2021). In some cases, contamination may exclude a site from eligibility for use as a Land Restoration NSMP until proper remedial actions have been completed. Prior to revegetation, Land Restoration should work to restore natural topography and hydrology to stabilize the site and reduce the risk of failure. This may require measures such as soil decompaction or ripping, regrading, removal of contaminated soils, import of fill, organic or inorganic fertilization, topsoil and organic matter amendments, or erosion BMPs. To ensure successful restoration and promote realizable water-quality benefits, all Land Restoration NSMPs should require native vegetation community management plans, discussed in further detail in Section 4.2, *Native and Invasive Vegetation Community Management for Water Quality*. In total, Land Restoration should work to negate the water-quality impacts of PDPs by removing impervious surface cover and actively rehabilitating landscapes to restore habitat and enhance ecosystem services that directly or indirectly benefit water quality.

Specific Land Restoration actions—including earthwork, soil preparation, and re-establishment of native vegetation communities—will vary by site depending on the type of development being removed (e.g., residential, commercial, industrial) and the desired habitat type (e.g., grassland, scrub-shrub, wetlands, forest). Those developments with higher percent imperviousness are likely to provide greater water-quality benefits. As such, WQE credit valuation strategies should address the landscape position, development type, and habitat form that is being restored.

[1] A *Brownfield* is a former industrial or commercial site where future use is affected by real or perceived environmental contamination.

4.2 Native and Invasive Vegetation Community Management for Water Quality

Land Restoration NSMPs should require ongoing (i.e., 5–10 years) native and nonnative vegetation community management to ensure successful restoration following land-use conversion. Successful restoration is only achieved when predevelopment conditions are met, and this includes managing for native vegetation communities. The *Otay River Watershed Management Plan* (Aspen Environmental Group 2006) identified eradication of nonnative flora as a high-priority strategy for protecting, enhancing, and restoring habitat and water quality in Chula Vista. Invasion of habitat by nonnative plant species can result in detrimental effects on water quality and quantity through mechanisms such as increased plant density and subsequent evapotranspiration rates, clogging of waterways, or increased runoff resulting from wildfire regime shifts. Beyond water quality, invasive plant species degrade habitat quality by reducing complexity and disrupting natural processes. Thus, some researchers have argued for controlling invasive and exotic species populations to promote native communities and improve water quality and quantity, with mixed results.

Perhaps most relevant to the watersheds of Chula Vista is the presence and potential benefits of controlling saltcedar (*Tamarix spp.*), arundo (*Arundo donax*), pampas grass (*Cortaderia selloana*), castor bean (*Ricinus communis*), and other nonnative plant species. Shafroth et al. (2005) report that millions of dollars are spent each year in the western United States to control saltcedar populations in hopes of increasing water yield and ecosystem health. Proponents suggest saltcedar control may alleviate ecosystem health and water-quality issues related to "streamflow depletion resulting from high evapotranspiration rates, displacement of native vegetation, simplified wildlife habitat structure, increased soil salinization, stream channel narrowing, increased potential for flood damage, and increased frequency and magnitude of riparian forest fires" (Shafroth et al. 2005). Invasion of restored areas by exotic species such as saltcedar, eucalyptus *(Eucalyptus spp.)*, arundo, and cheatgrass (*Bromus tectorum)* often result in a shift in wildfire severity and frequency in Mediterranean climates, indirectly influencing water quality through increases in hillslope runoff and erosion (Sheridan et al. 2007). The *Otay River Watershed Management Plan* (Aspen Environmental Group 2006) mapped and assessed nonnative invasive species and described the ongoing habitat and water-quality degradation these undesirable populations cause. Within the study area, eucalyptus woodlands occupied 102 acres, monotypic stands of arundo occupied 14 acres, and mixed nonnative invasive riparian or upland species occupied approximately 144 acres. Although somewhat dated, these figures highlight the extent of invasive species populations and lend support to the call for vegetation management as a necessary component of Land Restoration NSMPs. Although water-quality benefits resulting from nonnative invasive vegetation management are not always clear and can be exceedingly difficult to quantify, the importance of managing for native vegetation communities to ensure resilient ecosystem functions that preserve water quality and provide valuable habitat cannot be understated. As such, the City should require and approve nonnative invasive species-management plans in conjunction with proposed Land Restoration NSMPs, but vegetation management should not be eligible as a standalone NSMP for WQE credits.

4.3 Quantifying Land Restoration Benefits

Although precise modeling of water-quality benefits from various restoration strategies is still under development, the literature has documented empirical support for this approach. Using the

Soil and Water Assessment Tool (SWAT) and the System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) models, Martinez-Martinez et al. (2015) assessed the impacts of four different restoration scenarios at catchment and watershed scales in Ohio. The models helped identify the importance of restoration placement within the watershed for sediment and flow reduction efficiencies, finding restoration actions to be most effective at the sub-basin (i.e., hydrologic sub-area) scale. Both SWAT and SUSTAIN could be employed to quantify the potential effects of various degrees of Land Restoration in Chula Vista because the underlying principles remain the same: removal of impervious surface cover and re-establishment of natural interception and infiltration mechanisms through direct soil and vegetation restoration actions can result in stormwater pollutant and flow volume reductions.

The WQE Guidance provides protocols for calculating stormwater volume reduction using the affected versus mitigated design-capture volume (DCV) approach described above, accounting for the volumetric change in runoff following land-use conversion. Similarly, hydromodification flow control benefits from Land Restoration can be calculated using affected versus mitigated Directly Connected Impervious Area (DCIA). Thus, reductions in stormwater volumes and benefits to hydromodification flow control resulting from implementation of Land Restoration NSMPs can be counted as WQE credits for a proposed development. However, there are no methods identified for calculating pollutant reduction resulting from retention, biofiltration, or flow-thru methods. To be eligible for pollutant-reduction credits, an ACP would have to demonstrate retention, biofiltration, or flow-thru practices that treat stormwater runoff generated from within the Land Restoration site or elsewhere, prior to discharging to a waterway. Because it is currently possible for Land Restoration to generate volume reduction and hydromodification credits through land-use conversion, there is potential for pollutant-reduction credits if additional retention, biofiltration, or flow-thru BMPs increase the overall capacity for a Land Restoration project to treat stormwater.

The WQE Guidance approach also lacks an accounting process for ecosystem and watershed benefits that extend beyond stormwater pollutant and hydromodification controls. For example, the DCV- or DCIA-based approaches might capture changes in volumetric runoff and impervious area following land-use conversion, but it fails to adequately credit restoration actions that enhance habitat complexity, increase biodiversity, and improve ecosystem and watershed functions. Thus, the DCV and DCIA method does not adequately account for the greater benefits to the watershed that are provided by Land Restoration. This ecosystem benefit accounting discrepancy may be addressed through functional assessments that evaluate existing conditions and compare them to the potential restored conditions. These approaches—explored further in Chapter 5, *Water Quality Equivalency Using Stream Rehabilitation*—may be modified for terrestrial ecosystems and used to quantify the relative functional lift (e.g., ecosystem benefits) provided by proposed Land Restoration, thereby acting as a method to generate additive scores or multipliers for calculating WQE credits. Ultimately, DCV- and DCIA-based calculations of stormwater volume reduction and hydromodification flow control will be needed to quantify the direct water quality benefits, and a qualitative functional assessment can be incorporated to determine the indirect water-quality benefits attributed to ecological restoration.

4.4 Challenges Associated with Land Restoration

This review was not able to identify studies that explored the direct water-quality benefits resulting from restoration of developed lands through the lens of urban runoff. This provides little information from which pollutant-reduction credit determinations can be drafted with respect to specific Land Restoration actions beyond physical measures (i.e., volume and imperviousness reductions). However, there are principles of Land Restoration that can be assumed to play important roles in determining the degree of tractable water-quality benefits that will result from restoration actions. Regardless, restrictions should be considered for limiting the applicability of Land Restoration as a WQE alternative based on the principles and dynamics of watershed hydrology and urban stormwater runoff management.

4.4.1 Moving Beyond Imperviousness

As mentioned above, removal of impervious surface cover, in and of itself, does not qualify as a standalone NSMP because it can leave the land in vulnerable states that are prone to further degradation and water-quality issues. Thus, removal of impervious surface cover must be coupled with restoration actions that enhance soil conditions, hydrologic functions, vegetation communities, habitat quality, and long-term stability of the site. The relative significance of ecological restoration measures suggests that opportunities may exist to apply Land Restoration NSMPs to degraded sites that do not have expansive impervious surface cover but suffer from other forms of degradation. For example, a potential Land Restoration NSMP site that exhibits relatively low imperviousness may disproportionately degrade water quality due to undesirable vegetation communities or contaminated soils and groundwater resources. In this case, the benefits to water quality and ecosystem function provided by Land Restoration measures are not captured by the small change in imperviousness. Thus, the City of Chula Vista may need to establish a list of potentially eligible Land Restoration sites that incorporates both imperviousness and contamination sources as eligible criteria. Alternatively, the City may consider allowing PDPs to propose Land Restoration sites that provide water-quality benefits beyond reduced imperviousness so long as they can demonstrate benefits using reliable and replicable methods (e.g., precipitation-runoff modeling, groundwater contaminant modeling).

4.4.2 Pollutant Reduction from Land Restoration

The WQE Guidance does not provide protocols for determining pollutant-reduction credits resulting from Land Restoration NSMPs. Pollutant reduction credits for structural BMPs are calculated using geometric dimensions (e.g., area, depth), components (e.g., vegetation, soil media), and efficacy factors based on pollutant removal efficiencies of 1.0 for retention, 0.666 for biofiltration, and a conditions-dependent framework for flow-thru treatment strategies. Clarifications are needed to determine if pollutant reduction via retention, biofiltration, or flow-thru practices can only be achieved through incorporation of structural BMPs on Land Restoration sites, or if Land Restoration strategies (e.g., grading, soil amendments) are eligible for pollutant reduction. It remains unclear if pollutant-reduction credits can only be earned by treating stormwater generated from the Land Restoration site itself, or if these practices can be used to treat stormwater conveyed to the Land Restoration site from PDPs.

4.4.3 Determining Desired Restored Conditions

The use of historic natural conditions as the baseline to which Land Restoration NSMPs are designed and implemented may pose challenges for optimizing stormwater management, water quality, and habitat benefits. Although historic natural conditions developed in direct response to local and regional geologic and climatic drivers, they may not represent the most beneficial conditions for present-day water quality and functional habitat. For example, historic natural conditions for an existing development may have been a low-diversity grassland with high-percent bare ground, providing limited habitat value and retaining only a portion of runoff. During the Land Restoration NSMP proposal process, it may be determined that the site is suited to host vernal pools or other desirable habitats, even though the historic natural conditions did not support vernal pools. Due to the rapid decline in sensitive habitats throughout California, historic natural conditions—although certainly applicable for the site—may not provide as many ecosystem and water-quality benefits as proposed restored conditions. Thus, Land Restoration NSMPs may require guidelines on how to mimic historic natural conditions while also considering opportunities to provide for more beneficial habitat types or watershed functions. These guidelines should require, at minimum, that proposed restoration actions beyond historic natural conditions (e.g., addition of vernal pools) can be supported by the site without excessive management or intervention.

The WQE Guidance allows for Land Restoration NSMPs to be combined with structural or engineered elements to adequately manage stormwater and benefit water quality. Although important for site stability and management purposes, guidelines should be developed that limit or define the types of structural elements allowed through Land Restoration to promote natural structure and function and reduce long-term maintenance requirements.

Chapter 5
Water Quality Equivalency Using Stream Rehabilitation

Stream Rehabilitation has been used to enhance ecosystem function and water quality in waterways across the United States and abroad. Stream Rehabilitation is a $1 billion annual industry (Bernhardt et al. 2005), and the presumed benefits of rehabilitation on water quality have been explored in great lengths. The most frequent topics of study relate to sediment and nutrient retention, driven in part by CWA regulations, TMDL requirements, and the ubiquitous nature of these constituents. In general, Stream Rehabilitation has been shown to be most beneficial to water quality when implemented in small streams (first–third order) subject to considerable pollutant loads delivered during low to moderate flows (Craig et al. 2008). The next several sections highlight studies documenting the capacity for riparian buffer restoration, stream channel and floodplain restoration, regenerative stormwater conveyance (RSC), and constructed wetlands to provide water-quality benefits and enhance watershed functions. Lastly, existing Stream Rehabilitation water-quality crediting programs are discussed and evaluated for their applicability to the City's ACP.

5.1 Riparian Buffer Restoration

Riparian areas are characterized as interfaces between upland and wetland or stream systems, often demonstrating high biodiversity, productivity, and watershed function. *Riparian buffers* are vegetated zones that border streams and wetlands, providing ecosystem and watershed benefits, including complex habitat, stormwater runoff management, flood attenuation, biogeochemical cycling, sediment regulation, and shading—all of which benefit water quality. As a result of these beneficial functions, the protection, enhancement, and restoration of riparian buffers is a frequently used strategy for managing runoff and enhancing surface water quality (Klapproth et al. 2000).

Research on the effects of riparian buffers on water quality range from agricultural to urban settings, but the findings are consistent: adequately sized riparian buffers can effectively intercept and treat runoff prior to discharge to surface waters. For example, riparian buffers in agricultural areas in Connecticut decreased overland concentrations of nitrate, total phosphorus (TP), and TSS by 83, 73, and 92 percent, respectively, leading to significantly lower surface-water pollutant loads (Clausen et al. 2000). A 2005 study in San Francisco found that intentionally diverting urban stormwater runoff to an existing riparian buffer resulted in *E. coli* and total coliform reductions of up to 99 percent in receiving lake waters (Casteel et al. 2005). A study by Boyd et al. (2003) found that vegetative filter strips—a form of riparian buffer often used in agricultural settings—provided moderate adsorption of the herbicide atrazine and high adsorption of the insecticide chlorpyrifos, effectively reducing pesticide runoff loads to surface waters. These studies identified runoff infiltration, soil-water interactions, vegetative cover, and treatment contributing area ratios as significant drivers of nutrient, sediment, bacteria, and insecticide removal rates.

In addition to chemical water-quality issues, riparian buffers enhance physical properties and functions that protect water quality. Dense riparian vegetation greatly reduces streambank erosion rates by preventing mass wasting events (Purvis and Fox 2016). Increased shading from riparian canopies effectively moderates maximum daily water temperatures (Kalny et al. 2017) and can potentially mitigate stream eutrophication (Burrell et al. 2014). During overbank flooding events, riparian vegetation helps to retain suspended sediment (Västilä and Järvelä 2018), protect the near-stream environment from erosive hydraulics (Simon and Collison 2002), and provide much-needed organic substrate for enhanced biogeochemical cycling in the floodplain (Valett et al. 2005). Depending on the system, riparian buffers may also help regulate base flows, enhance local groundwater recharge, and increase hyporheic exchange through infiltration and evapotranspiration.

Riparian buffers can be cost-competitive with engineered treatment facilities while also providing ecosystem benefits and aesthetic and recreational improvements for the public. A 2008 analysis of the monetary value of riparian buffers for water treatment in Santa Monica found that a demonstration urban runoff treatment plant cost as much and provided similar water-quality services as 4,000–5,000 linear feet of riparian buffers (Riley 2008). Moreover, the author argues that treatment plant cost analyses were based on 20-year operational life spans, whereas riparian buffers may function for up to 100 years or in perpetuity, reducing the long-term costs considerably. As mentioned above, floodplains tend to exhibit increasing runoff and pollutant control capacity with time since restoration. This suggests the capacity for water-quality benefits from riparian buffer restoration may also increase over time as vegetation develops.

Stormwater pollutant and volume reduction by riparian buffers is dependent on many conditions that vary widely across watersheds. Although studies overwhelmingly report measurable reductions in runoff pollutant concentration, actual removal rates are ultimately dictated by buffer width, loading rate, soil type, and subsurface biogeochemistry. A meta-analysis found that nitrogen removal by riparian areas varied greatly across studies and typically peaked in forested–herbaceous buffers larger than 50 meters (164 feet) wide (Mayer et al. 2007). The *Otay River Watershed Management Plan* collated recommended setback widths for riparian and stream functions, distinguishing by physical and biological properties (Aspen Environmental Group 2006). Riparian buffer width recommendations included 50–140 feet for water temperature, four times the bankfull width to 220 feet for channel complexity, 98–540 feet for amphibian and reptile habitat, 130–1,600 feet for bird habitat, 30–100 feet for plant diversity, and 80–600 feet for ecosystem function. Scientific studies and programmatic policies often set minimum riparian buffer widths while encouraging the widest possible buffers for maximum water quality and ecosystem benefits.

5.2 Stream Channel and Floodplain Restoration

Stream Rehabilitation often manifests as streambank stabilization, floodplain reconnection, and channel reconfiguration. The purpose of these projects typically is to restore hydrologic and geomorphic structure, processes, and functions to provide increased flood resiliency and attenuation, enhance pollutant retention, improve in-stream habitat conditions, and protect water quality by recreating natural conditions in degraded systems. The practice of designing Stream Rehabilitation projects to provide quantifiable water-quality benefits is still an emerging field, but evidence shows that retention of pollutants in urban runoff can be achieved. Although the majority of reviewed studies focus on sediment and nutrient loads, parallels are drawn to additional water-quality constituents where available. The following highlights relevant studies that demonstrate water quality and ecosystem benefits from four approaches to Stream Rehabilitation suitable for the City of Chula Vista: hydrologic restoration, overbank flooding, channel reconfiguration, and urban stream daylighting.

5.2.1 Restore Stream Hydrology to Retain Pollutants

Restoration of natural stream hydrology should be a primary objective for Stream Rehabilitation projects that aim to benefit water quality. Hydrologic restoration actions may include filling incised channels to historical invert elevations, installing grade control structures to raise water tables, removing concrete liners or levees, and increasing connection between wetlands, side channels, and backwater environments. A meta-analysis by Newcomer-Johnson et al. (2016) synthesized global nutrient-retention rates in hydrologically reconnected rivers and streams from 79 studies. The authors used nutrient spiraling methods—an approach for measuring the interdependent processes of nutrient cycling and downstream transport—to identify relationships between dissolved nitrate, ammonium, and soluble reactive phosphorus uptake and various watershed characteristics. The study found high pollutant-uptake rates immediately following restoration construction, indicating that disturbance from restoration stimulates rapid nutrient cycling. They found nitrate retention had a negative relationship with watershed surface area and impervious surface cover, but a positive relationship with average reach width. Ammonium retention increased with longer transient storage, but decreased with increasing water velocity and discharge. Soluble reactive phosphorus retention was a function of concentration, discharge, watershed area, and chlorophyll-a concentrations, with mixed relationships. In general, the authors suggest nutrient removal is most efficient in small headwater streams, where watershed area and discharge are lowest, and transient storage and interaction with the benthos are greatest. Recommendations for stream restoration projects include raising water levels to activate floodplains, lowering water velocities, increasing transient storage capacity, and enhancing sediment and organic matter accumulation (Figure 2). Issues the authors identified centered on the predominance of base flow data over peak discharge, indicating a data gap in nutrient retention processes at storm flows (Newcomer-Johnson et al. 2016).

The above findings agree with those from other studies that identified a disproportionate influence of low-order streams on water quality (Peterson et al. 2001; Craig et al. 2008) and suggest Stream Rehabilitation projects in Chula Vista should target tributaries as well as mainstem rivers. Although most of the headwater streams in the Otay and Sweetwater watersheds are located outside of the jurisdiction of Chula Vista, first- and second-order streams, such as Telegraph Canyon, Poggi Canyon, and Salt creeks, should be assessed for hydrologic restoration potential. Stream Rehabilitation strategies can be adapted to provide specific ecosystem and water-quality benefits in urban settings where conditions are suitable, particularly in the lower Otay and Sweetwater River watersheds where intermittent streams are encroached on, buried, or routed into culverts.

5.2.2 Restore Frequent Overbank Flooding for Water Quality

Evidence of elevated biogeochemical cycling and sedimentation rates resulting from the flood pulse indicate floodplain connection plays an important role in pollutant retention in fluvial systems (Valett et al. 2005). The mechanisms for pollutant retention via overbank flooding (Figure 2) include filtration, settling of suspended sediments and particulate matter, biogeochemical cycling of nutrients, sorption of dissolved pollutants such as trace metals and pesticides, and respiration of organic matter. Stream Rehabilitation projects often achieve more frequent overbank flooding through floodplain grading, floodplain bench terraces, and channel reconfiguration (Chagrin River Watershed Partners 2012; Figure 2). Therefore, restoration of overbank flooding should provide water-quality benefits when designed for higher flood flow frequencies, expanded floodplain extents, and longer floodplain inundation times.

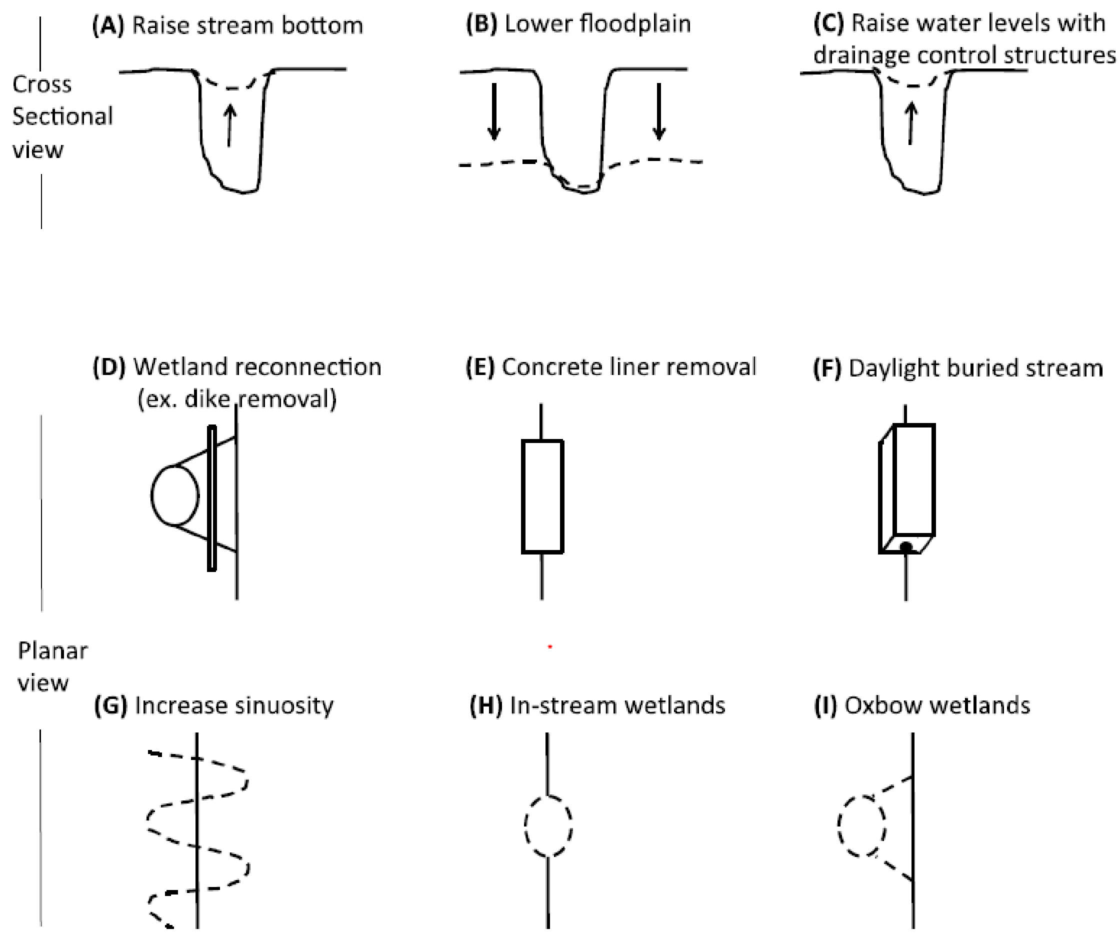

Figure 2. Stream restoration strategies to increase hydrologic connectivity

Source: Newcomer-Johnson et al. 2016

McMillan and Noe (2017) show sedimentation and nutrient retention rates increase following floodplain restoration, particularly when sited immediately downstream of sources of impairment. The authors stress the importance of building undersized channels or floodplain benches at lower grades to increase flood frequency beyond bankfull events. In addition, findings indicate sediment and nutrient retention rates surge immediately following restoration and continue to increase with time because restoration as vegetation matures and soil organic matter increases. Although this suggests maximum pollutant-retention and water-quality benefits may lag behind floodplain restoration, immediate benefits should be realized on reactivation of flood pulse dynamics.

In a 2020 study, Doll et al. explored the concept of increased flood-flow frequency for pollutant retention in urban stream restoration projects. In this study, Doll et al. used flood-frequency analyses to estimate floodplain flow volumes, treated floodplain flow volumes, and nitrogen load retention for each overbank event in five moderately incised streams in North Carolina—an issue also common to the streams of Chula Vista. The authors then compared the floodplain treatment potential of unrestored systems to theoretical restoration scenarios that focus on channel reconfiguration and lower floodplain elevations. They found only 9–15 percent of annual stream flow accessed the unrestored floodplain, and only 1–5.1 percent of the annual stream flow was potentially treated, equating to 0.2–1.0 percent of total nitrogen (TN) load retention. Although restored systems typically provided greater flood attenuation, the low overall retention rates were attributed to most of the floodplain flow occurring during relatively few overbank events. The authors suggest substantial benefits would be gained by focusing on floodplain treatment of runoff from uplands or stormwater outflows during smaller storm events. Intercepting more frequent, less intense storm flows prior to discharge to streams would increase the total pollutant load retained. Although these hydrologic and morphologic characteristics apply for the Chesapeake Bay area, systems draining Chula Vista tend to exhibit flashier hydrographs within deeply incised channels. Therefore, local adaptations of the lessons offered by Doll et al. (2020) should take into consideration regional precipitation and runoff patterns to reduce water velocities by increasing floodplain connectivity and enhancing pollutant retention.

Figure 3. A cross-section of Stream Rehabilitation designed to maximize floodplain connection via overbank flooding

Source: Chagrin River Watershed Partners 2012.

5.2.3 Reconfigure Channels to Influence Water Quality

Channel reconfiguration—the realignment and reconstruction of degraded stream channels—has been shown to have complex effects on water quality. Channel reconfiguration can be performed with or without floodplain restoration, depending on the constraints and desired conditions of individual project sites. In general, channel reconfiguration focuses on increasing channel stability, sinuosity, complexity, and interaction with hyporheic (i.e., subsurface) and floodplain compartments. This typically results in decreases in slope and water velocity and increases in residence time and surface-groundwater exchange, all of which promote retention of sediment, particulate matter, and dissolved pollutants. Channel reconfiguration is a major temporary disturbance to stream ecosystems, with potential short- and long-term water-quality impacts. Short-term impacts may include higher water temperatures, episodic sediment pulses, or loss of macroinvertebrate diversity during and after construction and following the first major flow events until the site is adequately stabilized. Long-term impacts may include alterations to local hydrology through more frequent flooding and changes in community composition of benthic, free-swimming, and near-stream floodplain organisms.

Dyste and Valett (2018) assessed nine stream-channel reconfiguration sites of varying degrees of maturity and found that some biotic variables had not recovered to reference conditions even 20 years following restoration. Notably, canopy cover, algal biomass, dissolved oxygen concentration, and macro-invertebrate diversity were significantly lower in restored compared to reference reaches. Conversely, water temperatures were significantly higher in restored reaches. However, when the authors compared response ratios of restored reaches with existing water-quality impairments to restored reaches without impairments, a clear divergence was found: restored streams with existing water-quality impairments (e.g., nutrients or trace metals) had not recovered to reference conditions for macroinvertebrate community composition, whereas restored systems without impairments had recovered to reference conditions. The results highlighted the importance of existing water-quality conditions and riparian canopy cover on the recovery trajectory of benthic macroinvertebrates and suitable temperature regimes following channel reconfiguration. The study suggests that the disturbance associated with channel reconfiguration can negatively affect biota and water-quality parameters for prolonged periods following restoration, particularly if water-quality impairments are already present and riparian restoration is delayed or insufficient. When placed in the context of Chula Vista, channel reconfiguration should simultaneously work to address existing water-quality issues and preserve or rapidly replace riparian vegetation to ensure ecological recovery.

An unpublished study assessing channel reconfiguration as a climate-change mitigation tool found enhanced hydraulic exchange and alluvial aquifer storage following restoration, which resulted in longer periods of alluvial aquifer recharge during peak flow and greater volumetric discharge during base flow (Brissette 2017). This study found that an increase in geomorphic complexity from channel reconfiguration may increase transient storage and base flow discharge, but emphasized that site-specific conditions can outweigh intended effects.

Although the above studies were not conducted in the context of urban stormwater management, they nonetheless demonstrate the mixed effects of channel reconfiguration on water quality. Most studies reviewed did not separate the effects of channel reconfiguration from floodplain restoration; however, methodologies have been developed to parse water-quality benefits from different hydrologic compartments and among various Stream Rehabilitation alternatives (see Table 1 in Section 5.5, *Creating Water-Quality Benefits from Stream Rehabilitation*). In Chula Vista, channel reconfiguration may provide water-quality benefits by effectively conveying additional runoff that would otherwise contribute to hydromodification. Moreover, channel reconfiguration can be designed to increase stream channel widths, sinuosity, transient storage, and hydrologic residence times to increase pollutant retention capacity.

5.2.4 Rehabilitate Buried Urban Streams for Stormwater Management

The rehabilitation of stream systems buried during urbanization is an expanding field of study with respect to water quality. The act of restoring a buried urban stream is often referred to as *daylighting*, in which the channel is unearthed and reconstructed to mimic pre-existing conditions. Foundational research has brought to light the extent of stream burial resulting from urbanization. In a tributary of the Chesapeake Bay watershed, Elmore and Kaushal (2008) determined that 20 percent of all streams were buried, and most of these were low-order headwater systems in low-density residential areas and suburban developments. Strikingly, 66 percent of all streams in catchments within Baltimore City were buried. As indicated by studies mentioned above, headwater streams play a disproportionate role in regulating water quality, suggesting significant opportunities exist for restoring buried streams for stormwater management and water quality. Similar exercises should be performed to identify buried streams in Chula Vista and assess opportunities for stream daylighting and restoration.

Stream daylighting can result in rapid changes to stream health and water quality. For example, macroinvertebrate communities respond rapidly as habitat conditions shift following stream daylighting, as evidenced by investigations in San Francisco and New Zealand that show increased diversity and abundance of biotic indicator species (Neale and Moffett 2016). Comparisons of buried versus open streams in the Chesapeake Bay watershed show significant differences in biogeochemical processes: nitrate uptake lengths were 7.5 times greater, and whole-ecosystem metabolic rates were five to 11 times lower in buried streams (Pennino et al. 2014). The authors attributed the lower processing rates to the threefold greater water velocity and lack of sunlight in buried streams, which ultimately results in significantly lower transient storage, diminished pollutant retention, and negligible flood attenuation. The available evidence suggests stream daylighting, when coupled with SCMs and floodplain restoration, offers promising and realizable benefits to water quality in buried Chula Vista streams.

5.3 Regenerative Stormwater Conveyance

Regenerative Stormwater Conveyance (RSC) combines principles of stormwater management and stream restoration to provide treatment, infiltration, and conveyance of urban runoff to protect and preserve water quality. RSC is typically reserved for use in stormwater outfalls and restored ephemeral headwater stream channels and designed to convey storm flows in a nonerosive manner while providing enhanced pollutant removal. Implementation of RSC in stormwater outfalls and headwater streams often presents as a series of step-pool sequences, with grade control structures and riffle crests composed of native gravels, cobbles, and boulders (Figure 4). A mixture of 80 percent sand and 20 percent wood chips is installed beneath the entire length of the RSC to maximize infiltration, promote nutrient cycling, and increase adsorption potential for enhanced pollutant removal. An RSC design manual provides detailed calculations for sizing systems and reports removal rates of 90, 75, and 74 percent for TSS, TP, and TN, respectively (Biohabitats 2012).

A separate study by Thompson et al. (2018) monitored sediment and nutrient fluxes before and after RSC implementation at both reach and catchment scales. This study found strong evidence for water-quality benefits at the reach scale: the RSC resulted in reductions of 49.7 percent of TN, 45.8 percent of TP, and 73.8 percent of TSS. Although the authors found no detectable water-quality changes at the catchment scale—highlighting the challenges of small-scale stream restoration toward reaching watershed-level goals—they nonetheless advocate for the use of RSC in low-order urban streams and stormwater outfalls to manage runoff and improve water quality.

Implementation of RSC shows promise in Chula Vista when placed in the context of existing stormwater outfall retrofits, ephemeral drainages, and stream daylighting efforts. This Stream Rehabilitation NSMP is particularly well-suited to intercept and treat early wet-season storms that produce lower runoff volumes but greater pollutant concentrations. Notably, the sand-wood chip substrate mixture is often used in storm- and wastewater treatment systems to enhance retention of a wide variety of pollutants not limited to nutrients. With documented pollutant removal performance, the robust step-pool design can be adapted for steep, ephemeral channels and low-flow events and is easily coupled with structural BMPs, SCMs, and associated floodplain restoration.

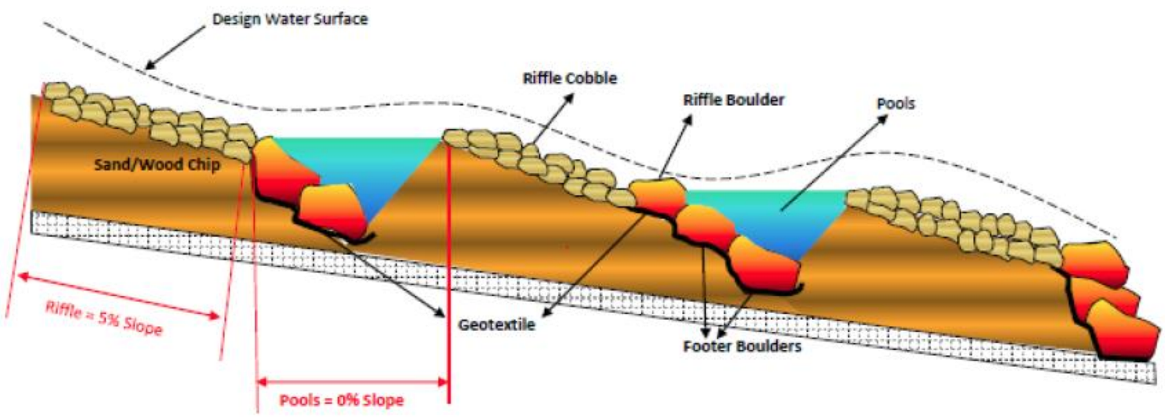

Figure 4. A typical cross-section of an RSC design for urban streams

Source: Biohabitats 2012.

5.4 Constructed Wetlands

In use for decades, *constructed wetlands* are designed and engineered to mimic the features and functions of natural systems to treat pollutants such as sediment, nutrients, organic matter, petroleum products, oil and grease, trace metals, pharmaceuticals, and various industrial chemicals. Treatment is achieved through settling, infiltration, and biological and chemical removal (EPA 1999). Although many constructed wetlands are heavily engineered and do not belong in riverine settings, some wetlands are designed purposefully for placement within stream corridors or stormwater-management systems. Typically located on floodplains and designed to receive flood flows from an adjacent stream, *off-line* wetlands attenuate floods and reduce pollutant loads while providing functional habitat and water-quality benefits. Other variations—sometimes referred to as *in-line* wetlands—position constructed wetlands below stormwater outfalls and within floodplains to intercept runoff prior to discharge to waterways. Depending on the application, constructed wetlands can provide direct stormwater treatment or additional flood capacity while enhancing habitat and watershed function, unlike engineered detention and retention ponds that offer minimal habitat. The following sections briefly discuss the performance of constructed wetlands for water-quality enhancement in the context of Stream Rehabilitation.

5.4.1 Constructed Wetlands for Water Quality

Constructed wetlands are designed to meet specific hydrologic and water-quality issues that vary between catchments. The five basic types of constructed wetland systems are shallow marshes, multi-basin wetlands, extended detention wetlands, pocket wetlands, and gravel wetlands, with variances and hybridization occurring frequently (MassDEP 2020). The basic types differ primarily in water depth, area, residence time, vegetation, and soils to treat specific pollutants of concern. Constructed wetlands can be designed to treat a long list of water-quality impairments. For example, a flow-thru wetland in a heavily urbanized catchment in Sydney, Australia, was shown to remove between 22 and 65 percent of trace metals chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn) and 76 percent of FC. In addition, it provides retention of 16, 12, and 46 percent of TN, TP, and TSS, respectively (Birch 2004). Other studies on trace metals and hybrid stormwater wetlands demonstrate up to 98 percent removal of cadmium (Cd), Cr, iron (Fe), Pb, Cu, and Zn when systems are designed to maximize interaction of water with sediments (Ventura et al. 2021).

Constructed wetlands also show promise for removal of various pesticides and hydrocarbons from urban and agricultural runoff. A constructed wetland treating agricultural irrigation return flows in the Central Valley, California demonstrated pesticide removal rates ranging from 52–94 percent, simultaneously reducing flow volumes by 68–87 percent through infiltration and evapotranspiration (Budd et al. 2009). A study using vertical flow sand filters in constructed wetlands provided 50 percent reductions in naphthalene, a polycyclic aromatic hydrocarbon (PAH), as well as 100 percent removal of particulate Zn (Walazek et al. 2017). Gaullier et al. (2017) determined that pesticide sorption to constructed wetland sediments can be enhanced by managing for lower water levels and resuspension or agitation of sediments between storm events. These management strategies promote interaction of dissolved pollutants with sorption sites on suspended sediments. Recent modeling exercises in the San Diego River watershed show that enhanced SCMs, such as biochar-amended biofilters, can reduce pesticide load and toxicity benchmark exceedances at the watershed scale (Wolfand et al. 2019).

5.4.2 Constructed Wetlands Within Stream Networks

A study from the Chesapeake Bay region compared the effects of in-line wetlands for nutrient removal in both restored and unrestored stream settings (Newcomer-Johnson et al. 2014). This study found in-line stormwater outfall wetlands and wet ponds (Figure 5) significantly decreased nitrogen concentrations prior to discharge to surface waters. In contrast, the restored stream network provided up to 150 times greater nitrogen retention than the constructed wetlands alone. The authors note there were no significant differences between denitrification rates in constructed wetlands and adjacent hydrologically connected floodplains. Overall, the combination of Stream Rehabilitation and in-line wetlands provided greater nutrient removal than either singular treatment. The study emphasizes the importance of maximizing surface and groundwater exchange, hydrologic residence time, and surface area of hydrologically connected features for maximum water-quality benefits (Newcomer-Johnson et al. 2014).

In Ontario, Canada, evaluations of flow attenuation and water-quality enhancement of an in-line pocket wetland located within a Stream Rehabilitation project provide mixed evidence of their efficacy in stormwater management (Krompart et al. 2018). Across 21 storm events, the pocket wetland consistently attenuated storm flows even when stormwater influent rates were four times greater than adjacent stream discharge, demonstrating a clear capacity to manage hydromodification. At base flows, the pocket wetland provided measurable maximum temperature buffering in downstream surface waters, but had the opposite effect at high flows. With a residence time of only 2 hours, the pocket wetland did not consistently provide significant reductions in TSS or TDS. However, unintended pocket wetland incision and upstream stormwater maintenance activities likely negated the expected water-quality benefits.

Proponents of constructed wetlands have developed the *integrated constructed wetlands* (ICW) concept, a framework for constructed wetland design that emphasizes hydraulic dissipation, vegetative interception, and evapotranspiration for enhanced treatment in agricultural and urban settings (Scholz et al. 2007; Harrington et al. 2011). Researchers have found ICWs perform best when sized to a minimum of 1.3 percent of stormwater drainage area and designed with an aspect ratio (width:length) less than 1:2.2 (Scholz et al. 2007). Follow-up studies provide general principles and recommendations for ICW sizing to treat various water-quality pollutants (Harrington et al. 2011).

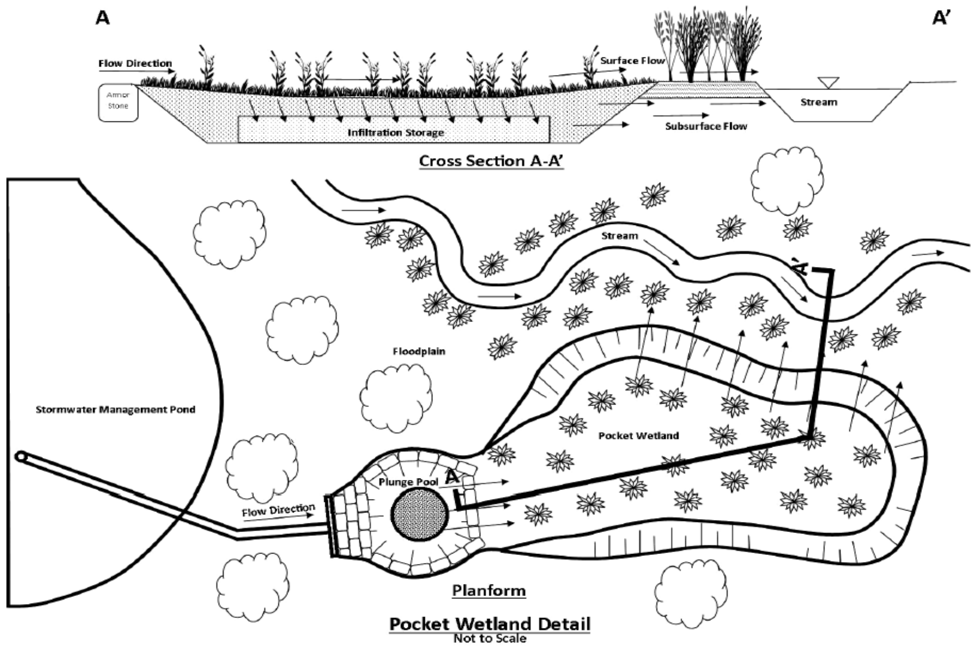

Figure 5. Planimetric and cross-sectional views of an off-line stormwater pocket wetland

Source: Krompart et al. 2018.

5.5 Crediting Water-Quality Benefits from Stream Rehabilitation

The WQE Guidance (2018) provides methodologies to credit stormwater volume reduction and hydromodification flow control benefits provided by Stream Rehabilitation NSMPs. Similar to the protocols for Land Preservation and Land Restoration, volume reduction credits are based on the difference between affected and mitigated DCV and the appropriate land-use factors for the site, dictating the total volume reduction credits earned. Alternatively, Stream Rehabilitation is eligible for hydromodification flow control credits only if a geomorphic channel stability assessment determines restoration of a receiving water is necessary and demonstrates the capacity to support the proposed additional imperviousness. There are multiple allowable scenarios for Stream Rehabilitation to provide hydromodification flow control benefits, determined primarily by the relative location of the PDP and ACP with respect to the sensitive stream segments and the downstream exempt waterbody. Although volume reduction and hydromodification flow control credits can be earned with the current WQE Guidance protocols, there is currently no avenue to determine pollutant-reduction credits from Stream Rehabilitation NSMPs.

Implementing Stream Rehabilitation to improve water quality is an evolving field, particularly with respect to stormwater pollutant reduction and water-quality crediting. Currently, no such pollutant-reduction crediting programs exist in southern California, but this approach has been employed in the Chesapeake Bay and New Hampshire, where TMDL requirements have prompted extensive water-quality improvement efforts. This approach embraces the concept that by restoring streambanks, channels, and floodplains to natural or seminatural conditions, beneficial functions such as filtration, infiltration, biogeochemical cycling, overbank flooding, erosion, deposition, and shading are reset on positive ecologic trajectories. In effect, Stream Rehabilitation works to improve water quality and habitat by restoring natural processes. Much of the research to quantify water-quality credits resulting from various forms of Stream Rehabilitation has been performed in the Chesapeake Bay watershed and is summarized in the *Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects* (Berg et al. 2013). Other efforts, such as the New Hampshire riparian buffer crediting program, address a narrower scope of riparian restoration actions to define water-quality benefits (Roca Communications 2019). Both programs focus on sediment and nutrients, the predominant pollutants of concern in the respective watersheds. In New Hampshire and the Chesapeake Bay area, expert panels reviewed available science, determined qualifying conditions for restoration projects, developed protocols for quantifying pollutant reductions, and provided credit calculations.

5.5.1 Riparian Buffer Restoration

The New Hampshire program uses an approach similar to San Diego County's stormwater DCV methodologies to evaluate and credit riparian buffer restoration efforts (Roca Communications 2019). There, riparian buffer restoration is eligible for water-quality credits—in the form of TN, TP, and TSS—when sized and located to meet certain criteria. This program incorporates regional pollutant-loading and reduction-performance curves based on site characteristics such as contributing area, land use, impervious cover, hydrologic soil groups, and slope. To address the inherent variability of riparian buffer conditions, contributing areas, and runoff treatment performance, the crediting program set minimum and maximum riparian buffer widths (20–100 feet), slope categories (0–5 percent, 5–10 percent, 10–15 percent), and pollutant-specific removal rates. Their approach relied heavily on a local expert panel and regional stormwater runoff and water-quality trends to develop credit determinations, emphasizing the need for empirical data and regional insight to the catchments draining Chula Vista. The New Hampshire program can be modified to work for Chula Vista by incorporating existing WQE protocols and developing regional applicability. For example, the WQE Guidance already provides relative pollutant concentrations and runoff factors for different land-use categories that are used to determine land-use factors and the relative pollutant impacts of a PDP. However, an expert panel would need to establish regional performance curves for riparian buffer pollutant retention rates (e.g., pounds TSS/acre/year) to substitute the New Hampshire-specific performance curves. For best results, the expert panel needs to address all relevant watershed pollutants (e.g., TSS, TN, TP, FC, TCu) and develop pollutant retention performance curves based on hydrologic soil groups, buffer widths, slope, vegetative cover, and buffer position relative to the PDP.

5.5.2 Stream and Floodplain Restoration and Regenerative Stormwater Conveyance

The Chesapeake Bay protocols and calculations for stream rehabilitation were based on published sediment and nutrient fluxes in restored streams, floodplains, wetlands, and RSC systems from select watersheds. There, credits were provided for (1) preventing sediment during storm flows; (2) providing in-stream and riparian hyporheic zone nutrient processing during base flow; (3) increasing floodplain reconnection volumes; and (4) stormwater retrofits using RSC (Table 1). Water quality benefits from bank stabilization efforts (Protocol 1) were calculated by monitoring or estimating annual erosion rates and sediment loads, converting those rates to nitrogen and phosphorus loads based on sediment TN and TP concentrations, and subtracting the estimated reduction attributed to bank stabilization. This process was facilitated by routine monitoring and the Bank Assessment for Non-point Source Consequences of Sediment (BANCS) or Bank Stability and Toe Erosion Model (BSTEM) methods. Benefits from hyporheic nutrient cycling (Protocol 2) were calculated using a defined black box hyporheic zone (restored stream length × width × depth) and regional denitrification rates. Floodplain reconnection credits (Protocol 3) for sediment and nutrients were determined using reconnection storm event curves and reported floodplain-wetland removal rates. Lastly, water-quality benefits from RSC retrofits (Protocol 4) were based on stormwater treatment volume and provided adjustor curves for pollutant removal (Berg et al. 2013).

A field evaluation of the expert panel recommendations at four restoration sites in North Carolina found reasonable agreement using the BANCS method for sediment and nutrient credits applicable to Protocol 1 (Doll et al. 2018; Table 1). However, the authors reported high uncertainty for Protocols 2 and 3, namely due to high variability in measured hyporheic and floodplain processes among restoration sites. As a result, this study recommended applying published areal denitrification rates to restored streambed and riparian zones in place of measured rates to simplify the process while providing realistic TN removal efficiencies (2–4 percent). Streambed and riparian denitrification rates of 1.85 and 1.01 milligrams of nitrogen per square meter per hour, respectively, were recommended based on a peer-review of 249 stream systems (Lammers and Bledsoe 2017).

Where empirical data are available, the Chesapeake's Nutrient Crediting Program framework can be modified to determine WQE credits earned through Stream Rehabilitation in Chula Vista. However, current methodologies for credit determinations are limited by the availability of regionally specific pollutant-retention rates for each NSMP. Empirical nutrient processing or pollutant-retention rates from comparable systems in San Diego County should be incorporated into adaptations of this method to reflect the appropriate conditions for Chula Vista streams. Where empirical data are not available, published retention rates may be used initially and later substituted with field-based monitoring studies to validate and calibrate retention capacity to reflect local conditions. Ultimately, WQE credits may be generated by calculating the difference in pollutant-reduction capacity between the affected stream and the restored stream. This approach may enable a quantitative evaluation of reductions in streambank/channel erosion, increases in hyporheic volume, expansions of floodplain area, and additions to regenerative stormwater conveyance.

Table 1. Stream Restoration Credits for Individual Restoration Projects[1,2]

Protocol	Name	Units	Pollutants	Method	Reduction Rate
1	Prevented Sediment (S)	Pounds per Year	Sediment TN, TP	Define bank retreat using BANCS or other method	Measured N/P content in streambed and bank sediment
2	Instream Denitrification (B)	Pounds per Year	TN	Define hyporheic box for reach	Measured unit stream denitrification rate
3	Floodplain Reconnection (S/B)	Pounds per Year	Sediment TN, TP	Use curves to define volume for reconnection storm event	Measured removal rates for floodplain wetland restoration projects

Protocol	Name	Units	Pollutants	Method	Reduction Rate
4	Dry Channel RSC as a Retrofit (S/B)	Removal Rate	Sediment TN, TP	Determine stormwater treatment volume	Use adjustor curves from retrofit expert panel

Source: Berg et al. 2013.

[1] Depending on project design, more than one protocol may be applied to each project, and the load reductions are additive.

[2] Sediment load reductions are further reduced by a sediment delivery ratio in the CBWM (which is not used in local sediment TMDLs).

S = stormflow conditions; B = base flow or dry weather conditions.

5.6 Quantifying Ecosystem Benefits of Stream Rehabilitation

As the above sections describe, different Stream Rehabilitation strategies can provide various ecosystem benefits that extend beyond stormwater pollutant and hydromodification flow control. Evaluation of ecosystem benefits resulting from Stream Rehabilitation is necessary to perform restoration-alternatives analyses and properly quantify total WQE credits. Because ecosystem benefits from restoration often defy quantitative or monetary valuation methods, functional assessments have been developed to determine the ecological benefits of riverine wetland rehabilitation projects by comparing existing conditions to “with-project” and “without-project” ecosystem functions. The U.S. Army Corps of Engineers (USACE) used one such approach, the Hydrogeomorphic (HGM) Approach, to evaluate ecosystem-restoration benefits of various stream rehabilitation alternatives in Aliso Creek, California (USACE 2002). The HGM analysis assessed 14 critical riverine wetland functions divided into three categories: physical/hydrological function; biogeochemical function; and habitat function (Table 2). Using this method, USACE measured gains or losses to ecosystem functions resulting from proposed rehabilitation as *functional capacity units* (FCU), defined as “an indicator of the capacity of four wetland functions in the Aliso Creek system.” The HGM Approach proved useful for evaluating the benefits of ecosystem restoration projects and comparing alternatives; however, the study acknowledged the inability of HGM to address unquantifiable benefits, such as watershed education.

For the proposed Aliso Creek mainstem restoration alternative, the HGM Approach demonstrated significant ecosystem benefits for future with-project conditions (421.9 FCUs) compared to both existing conditions (174.0 FCUs) and future without-project (165.4 FCUs) conditions (Table 2). The HGM found ecosystem functions in the Aliso Creek mainstem would continue to degrade without restoration project intervention, validating the observations and projections USACE made during the commission of the study. This study applied the HGM Approach to six different restoration alternatives spanning the Aliso Creek mainstem and tributaries, incorporating rehabilitation strategies ranging from riparian revegetation and invasive species removal to stream channel modification, floodplain restoration, and infrastructural upgrades. Accordingly, the HGM Approach can be applied to a suite of stream-rehabilitation options in Chula Vista to compare the functional benefits among restoration alternatives and can also be used to inform benefit-cost analyses to identify which projects provide the greatest ecosystem benefits per dollar.

Table 2. Environmental Evaluation of Aliso Creek Mainstem Restoration

Functions	Existing Conditions (FCUs)[1]	Future Without-Project (FCUs)[1]	Future With-Project (FCUs)[2]
Hydrology Subgroup			
Maintenance of Characteristic Channel Dynamics	10.4	9.9	36.0
Dynamic Surface Water Storage and Energy Dissipation	14.6	13.9	35.4
Long-Term Surface Water Storage	11.5	11.0	38.4
Subsurface Water Storage	17.5	16.7	32.7
Biogeochemical Cycling Subgroup			
Nutrient Cycling	10.5	9.9	31.0
Detention of Imported Elements and Compounds	16.0	15.2	36.6
Retention of Particulates	13.7	13.0	35.2
Organic Carbon Export	15.7	14.9	34.5
Habitat Subgroup			
Maintain Characteristic Plant Community	20.0	19.0	39.7
Maintain Characteristic Detrital Biomass	8.1	7.6	25.4
Maintain Spatial Structure of Habitat	15.6	14.8	34.0
Maintain Habitat Interspersion and Connectivity	20.4	19.5	43.1
Total	174.0	165.4	421.9

Notes:
[1] Existing and Future Without-Project Conditions based on area of 32.4 acres.
[2] Future With-Project Conditions based on an area of 49.8 acres.
FCU = functional capacity units

A stream and floodplain restoration project at the confluence of the Cosumnes and Mokelumne Rivers in southern Sacramento County provides a useful framework from which WQE credits may be determined for NSMPs in Chula Vista. The Cosumnes Floodplain Mitigation Bank restored more than 470 acres of riverine, floodplain, and wetland habitat in the delta by breaching a levee, excavating new channels, and rehabilitating historic wetlands (Westervelt 2021). This project generated credits for Floodplain Mosaic Wetlands, Floodplain Riparian Habitat, Shaded Riverine Aquatic Habitat, and Enhancement Riparian Habitat by restoring hydrologic and geomorphic functions, which in turn rehabilitated aquatic resources. Like the Aliso Creek study, the HGM Approach was modified and used to classify and evaluate the natural functions of nearby reference habitats and potential restoration scenarios. Through restoration actions, natural functions were returned to the mitigation bank site, and the HGM Approach was again used to monitor and evaluate the performance of the various habitats to determine how many credits were generated and available for sale. This approach allowed the project owners and regulatory agencies to perform generalized credit determinations based on habitat functions and extents. In Chula Vista, this approach could be applied to systems such as the Lower Otay River, where habitat functions can be extended to represent water-quality functions for credit determination.

5.7 Shortcomings of Stream Rehabilitation for Stormwater Management and Water Quality Benefits

The efficacy and appropriateness of quantifying water-quality benefits from stream restoration is debated because of the complex processes involved and the vast heterogeneity that characterizes fluvial systems. Moreover, directly measuring or modeling water-quality benefits is exceedingly difficult in the presence of upstream urbanization, particularly with respect to larger catchments. Currently, WQE calculations do not support the use of Stream Rehabilitation for pollutant reduction, and this shortcoming is the result of poorly understood natural processes and jurisdictional limitations to where stormwater management can be employed or credited.

5.7.1 Water-quality Benefits at Different Spatial and Temporal Scales

Studies that attempt to detect improvements in water quality resulting from Stream Rehabilitation often find discrepancies between signals at reach, catchment, and watershed scales (Locatelli et al. 2015; Martinez-Martinez et al. 2015; Williams et al. 2017; Thompson et al. 2018). This is the result of the rise in complexity and compounding factors that begin to influence water quality at increasing spatial scales. Unknown influences, such as legacy sediments, "old" groundwater, illicit discharge, and the variability of storm flows and pollutant loads, likely influence the realized water-quality benefits following Stream Rehabilitation.

5.7.2 Jurisdictional Status of Restored Floodplains and Wetlands

During Stream Rehabilitation planning, appropriate environmental permitting will determine the extent of jurisdictional waterways and the level of impact restoration actions may have on waters of the United States. It is important to consider jurisdictional regulations in the context of constructed wetlands and floodplain restoration and develop explicit management plans to ensure proper performance and maintenance of these systems. It is not uncommon for constructed wetlands to convert to jurisdictional wetlands in the absence of proper management practices (i.e., draining, vegetation removal, and dredging), and steps must be taken to ensure the desired outcomes will be met for both water quality and ecological function (Stromberg 2015). Strategies such as lowering floodplain elevations and creating additional wetlands for stormwater management will likely result in changes to official floodway map delineations and jurisdictional wetlands[2]. These considerations must be addressed early in the planning process and employed in long-term management plans. Moreover, MS4 Permit Finding 7 explicitly prohibits the use of in-stream treatment systems as stormwater-management facilities without treatment of runoff prior to discharge into receiving waters. Therefore, it is important to ensure pretreatment of runoff prior to their discharge into Stream Rehabilitation NSMPs, while also demonstrating greater overall water quality and watershed benefits than structural BMPs alone.

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[2] The Clean Water Act and Porter–Cologne Water Quality Control Act both allow for created treatment wetlands to remain outside of jurisdiction as waters of the United States and waters of the state, respectively. Wetlands created to treat stormwater are excluded from waters of the United States in 33 CFR 328.3(b)(10) and from waters of the state in Section II(3)(d)(iii) of the state definition of wetlands as provided in the Procedures for Discharges of Dredged or Fill Material to Waters of the State.

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Chapter 6
Summary

The intent of this review is to compile scientific information supporting the use of NSMPs for WQE to inform the development of guidelines for water-quality crediting in Chula Vista. To that end, the following sections discuss the applicability of specific NSMPs for realizing water-quality benefits and the implications of the above scientific information for developing WQE for NSMPs.

6.1 Suitability of NSMPs for Chula Vista

The most appropriate NSMP alternatives for the City must provide a combination of water-quality, watershed, and ecosystem benefits to provide justification for use in the ACP. In practice, no single NSMP is likely to manage the stormwater runoff associated with a PDP, and, thus, the ability to combine multiple NSMPs for WQE is necessary and should be encouraged. The three NSMP categories are not mutually exclusive. The most effective and appropriate WQE strategy using NSMPs would incorporate many of the restoration actions described above, functioning in tandem to provide reliable benefits to water quality and ecosystem health.

6.1.1 Land Preservation

The Land Preservation NSMP is an important asset to include in the WQE toolbox for protecting in perpetuity those projects undergoing Land Restoration or Stream Rehabilitation. Land Preservation is most appropriate when located in the same hydrologic area or subarea as the proposed development and should aim to increase habitat connectivity and public access to open lands. Priority areas for Land Preservation should include the 75–100-percent Conservation Areas identified in the MSCP Subarea Plan and active floodplains, channel migration zones, and waterways of the United States. Regardless of the setting, Land Preservation NSMPs must be bound by a legal agreement, such as a conservation easement, to preserve the undeveloped state of the parcel and provide water-quality benefits in perpetuity. Although currently eligible for hydromodification flow-control credits, Land Preservation must be coupled with Land Restoration or Stream Rehabilitation NSMPs to be eligible for pollutant or volume-reduction credits and is suitable as a credit multiplier to encourage its use. This whole-system approach to NSMPs will help ensure redundancy in the natural functions that benefit water quality and watershed function.

6.1.2 Land Restoration

Land Restoration is another opportunity to provide offsite stormwater management because it is a direct reduction of impervious surface cover that offsets the development proposed by a PDP applicant. Land Restoration should be located within the same hydrologic area or subarea to offset water-quality impacts from a PDP. Land Restoration is most appropriate for sites with high imperviousness, but may be appropriate for sites that act as sources of contamination with low relative imperviousness. Land Restoration NSMPs are not appropriate for use in historic floodways, channel migration zones, or waterways of the United States. Implementation of Land Restoration should be accompanied by structural BMPs and SCMs where necessary to adequately manage runoff and stabilize the restored site. Nonnative invasive species management is not appropriate for use as a standalone NSMP for WQE credits; however; the applicant and the City should agree on a long-term management plan to ensure runoff is controlled and native vegetation communities persist. A protocol for calculating stormwater-volume reduction and hydromodification flow-control credits from Land Restoration is already provided in the *County of San Diego BMP Design Manual* (San Diego DPW 2019). More information is required to determine the eligibility of Land Restoration to qualify for pollutant-reduction credits. In addition, the ecosystem benefits of Land Restoration should be estimated through qualitative assessments that determine the functional lift from existing conditions to restored conditions. Thus, modeled reductions in stormwater volume and hydromodification flow-control should be coupled with the anticipated ecosystem functional lift to determine total WQE credits. This approach will require the determination of a conversion factor to translate functional lift to WQE credits.

6.1.3 Stream Rehabilitation

The variety of possible Stream Rehabilitation NSMPs highlights the functional overlap that can be achieved to enhance water quality and watershed function. All the Stream Rehabilitation alternatives mentioned in the WQE Guidance were found to have been scrutinized in various combinations, providing a scientific basis for their performance and suitability as pollutant-reduction strategies. These studies support the theory that stream-channel and floodplain restoration, constructed wetlands, riparian buffer restoration, and regenerative stormwater conveyance can provide multiple, quantifiable water-quality benefits in addition to habitat enhancement in urban settings. The range of alternatives allow Stream Rehabilitation to be appropriate for virtually all drainages within Chula Vista. Riparian buffer restoration is suitable for any stream or wetland boundary within City limits that is degraded or poorly functioning and capable of receiving runoff flow. Stream channel reconfiguration—with or without floodplain restoration—is appropriate throughout the Otay and Sweetwater Rivers and tributaries, so long as the systems demonstrate altered functions and impaired water-quality conditions. Inline constructed wetlands are valuable strategies for storm-sewer outfalls and offsite treatment facilities, whereas offline constructed wetlands situated in floodplains are suited uniquely to receive storm flows from adjacent streams. Finally, regenerative stormwater conveyance is most appropriate for storm-sewer outfalls and ephemeral drainages or in conjunction with urban stream daylighting.

The variety of Stream Rehabilitation alternatives increases the difficulty of characterizing water-quality benefits resulting from these NSMPs. This inherent variability requires the development of individual methodologies to characterize the pollutant-reduction benefits of each approved NSMP alternative. For example, pollutant-reduction credits generated from stream channel reconfiguration, floodplain restoration, or RSC may be calculated by modifying the protocols the Chesapeake Bay Program developed. Alternatively, riparian buffer restoration credits may be calculated using a modified New Hampshire methodology. Therefore, determination of pollutant-reduction credits for each of the individual NSMPs should be evaluated using methodologies that are customized to Chula Vista watersheds and communities.

6.2 Implications for WQE and Credit Ratios

Determination of realistic pollutant-reduction credit ratios for the various NSMPs is a primary objective for the ACP. As mentioned above, Land Preservation likely will be most beneficial to water quality and ecosystem health when employed as a credit multiplier to encourage the adoption of conservation easements on Land Restoration or Stream Rehabilitation projects. For example, a Stream Rehabilitation NSMP might generate 100 credits as a standalone project, but may be eligible for a 1.3 multiplier if simultaneously put under a conservation easement, adaptively managed, and protected in perpetuity. By implementing both Stream Rehabilitation and Land Preservation NSMPs, a PDP may be eligible for 130 credits to offset development impacts. Because it is widely held that Stream Rehabilitation provides greater water-quality benefits on a per-unit basis than Land Restoration, this approach will require the development of a range of multipliers to account for the difference between various NSMPs. In addition, this range of multipliers could include requirements or incentives for PDP applicants to incorporate features such as public access and adaptive management, if applicable.

As discussed in Chapter 4, *Water Quality Equivalency Using Land Restoration,* calculating measurable pollutant-reduction benefits from Land Restoration is a convoluted process that greatly depends on specific site conditions and restoration actions that are not as easily defined as Stream Rehabilitation alternatives. To streamline the PDP approval process and promote the use of NSMPs as WQE strategies, a navigable process needs to be developed that quantifies realistic benefits without intensive field and desktop exercises. Pollutant-reduction credit determination for Land Restoration could be based on a variant of the DCV calculations used in structural BMP protocols (San Diego DPW 2019). The original DCV calculations use relative pollutant concentrations, imperviousness, and runoff coefficients for each land use type to determine the pollution impacts of developed versus restored conditions. Therefore, it may be possible to modify this protocol to calculate the increase in pollutant-retention capacity exhibited by a site following restoration, rather than simply calculating the reduction in pollutants generated. However, the empirical data to support this approach is not available readily. Furthermore, these calculations do not account for additional benefits beyond water quality, including restored habitat, watershed function, and aesthetics. Although capturing the volume reduction and hydromodification flow-control benefits that result from Land Restoration, the current WQE Guidance does not provide credit for benefits to ecosystem health. Because of these credit-accounting deficiencies, PDP applicants may favor offsite structural BMPs over Land Restoration NSMPs due to cost-effectiveness. To remedy this disincentive, Land Restoration NSMPs could generate WQE credits following establish protocols, with additive scores based on the functional lift provided to the ecosystem. Like the Land Preservation multipliers, a range of additive scores could provide incentives for incorporating indirect water-quality benefits, such as sensitive-habitat restoration, native-vegetation management, public access and trails, recreational facilities, and educational components.

Pollutant-reduction benefits resulting from Stream Rehabilitation are difficult to quantify, but protocols have been developed in the Chesapeake Bay area and New Hampshire that perform well when compared with field studies of actual restoration projects. This framework can be modified for Chula Vista and surrounding watersheds, but regionally specific natural system pollutant-retention rates are needed to accurately valuate WQE credits. To develop and use these approaches, the City would need local or regional data that represents average retention rates for nutrients, sediment, pesticides, trace metals, and bacteria for each of the Stream Rehabilitation NSMP alternatives. These data may be available from local or regional organizations. Where empirical treatment rates are unavailable for Chula Vista or nearby systems, an expert panel should evaluate published rates that may be substituted to estimate pollutant-control capacity associated with individual NSMPs. However, this approach does not account for indirect water-quality benefits and increased ecosystem and watershed function, resulting in the need for additional qualitative assessments to evaluate functional lift.

An alternative to WQE credit determination using empirical pollutant retention rates would involve a citywide restoration project cost analysis, coupled with the HGM Approach, much like the strategy USACE used in Aliso Creek and Westervelt used on the Cosumnes River. Using this strategy, the City would perform a cost analysis of all major candidate Stream Rehabilitation projects that might be eligible for the ACP and WQE crediting. The cost analysis would document the project locations, extents, and cost estimations for full-suite restoration and long-term management to the level that can be supported by each candidate site. The HGM Approach would be employed to establish reference conditions, identify restoration opportunities and actions, and estimate the increase in functional capacity that can be achieved through Stream Rehabilitation. Following the Cosumnes Floodplain Mitigation Bank, the HGM Approach could qualitatively evaluate hydrology (i.e., hydromodification), biogeochemistry (i.e., pollutant volumes), and habitat in reference systems and existing conditions and could be used to create and monitor performance standards. For each site, WQE credits could be calculated based on the functional lift provided by Stream Rehabilitation. The cost analysis would provide unit-cost estimations for each water-quality credit and would enable accurate pricing for sale through a City-run credit bank or in-lieu fee.

The benefits of this combined cost analysis-HGM approach include the familiarity and willingness of regulatory agencies to support and approve this crediting framework and the control the City exhibited in determining which candidate projects are eligible for WQE credits. Tackling all of the candidate projects through one comprehensive cost analysis and credit determination would be more efficient than asking PDP applicants to handle the process for each project. This also provides consistency between project sites for credit determination, does not require the consideration of every water-quality parameter, and allows for project prioritization to occur from a watershed perspective.

The disadvantages to this approach include the need to develop a regional HGM Guidebook that applies to the Otay and Sweetwater River watersheds, the assumptions made during preliminary cost-estimation efforts, and the as-yet-undetermined credit-valuation strategy for increases in functional capacity units Stream Rehabilitation provides. Furthermore, it is likely that this approach will still require the calculation of anticipated stormwater pollutant-reduction credits or NSMP-specific pollutant retention rates to satisfy the technical components for determining WQE.

6.3 Potential Projects to Determine Water Quality Equivalency Using NSMPs

The 2014 *City of Chula Vista Alternative Compliance Strategy – Final Report* included a list of potential open-space area project types that focused on stream or riparian area rehabilitation, watershed preservation land acquisitions, and groundwater recharge projects (City of Chula Vista 2014). Table 3 of the Final Report described the project types, provided existing project examples and potential project sites, identified water quality and watershed benefits, and speculated on the operations and maintenance responsible parties for each project. For example, restoration of unlined channels through stream and buffer restoration could occur on City-owned open-space parcels along various drainages to better manage hydromodification, infiltration, sediment transport, and pollutant removal—with stewardship responsibility falling on the City. Similarly, another project might provide "net add" of conservation benefit and restriction over current conditions by enhancing 75 percent-conserved MSCP lands to 100 percent-conserved and placing areas with informal management under permanent, active stewardship. This form of watershed preservation land acquisition could occur in the Otay River buffer areas and the edges of the San Diego University site to improve watershed function through land cover enhancement to reduce runoff. Groundwater recharge projects, such as infiltration basins, trenches, and dry wells, might provide joint stormwater benefits for the Sweetwater Authority or along Western Chula Vista rights-of-way by increasing hydromodification capacity and pollutant removal. Although this report did not identify site-specific projects suitable for alternative compliance, it provided a foundation from which a potential project inventory could be developed.

The co-permittees in the 2014 San Diego Bay Watershed Management Area Analysis developed a template for identifying and compiling potential candidate projects that may provide greater overall benefit to the watershed than requiring implementation of structural onsite BMPs. This spreadsheet template assigned each candidate project a unique identifier and specified the watershed management areas, hydrologic areas and subareas, jurisdiction, project name, ownership(s), locational data, and various site-specific criteria to help classify and assess project feasibility (San Diego County 2014), although the template was intended to be used by the co-permittees within each respective municipality. Figure 6 shows streams within Chula Vista with potential to provide NSMP credits.

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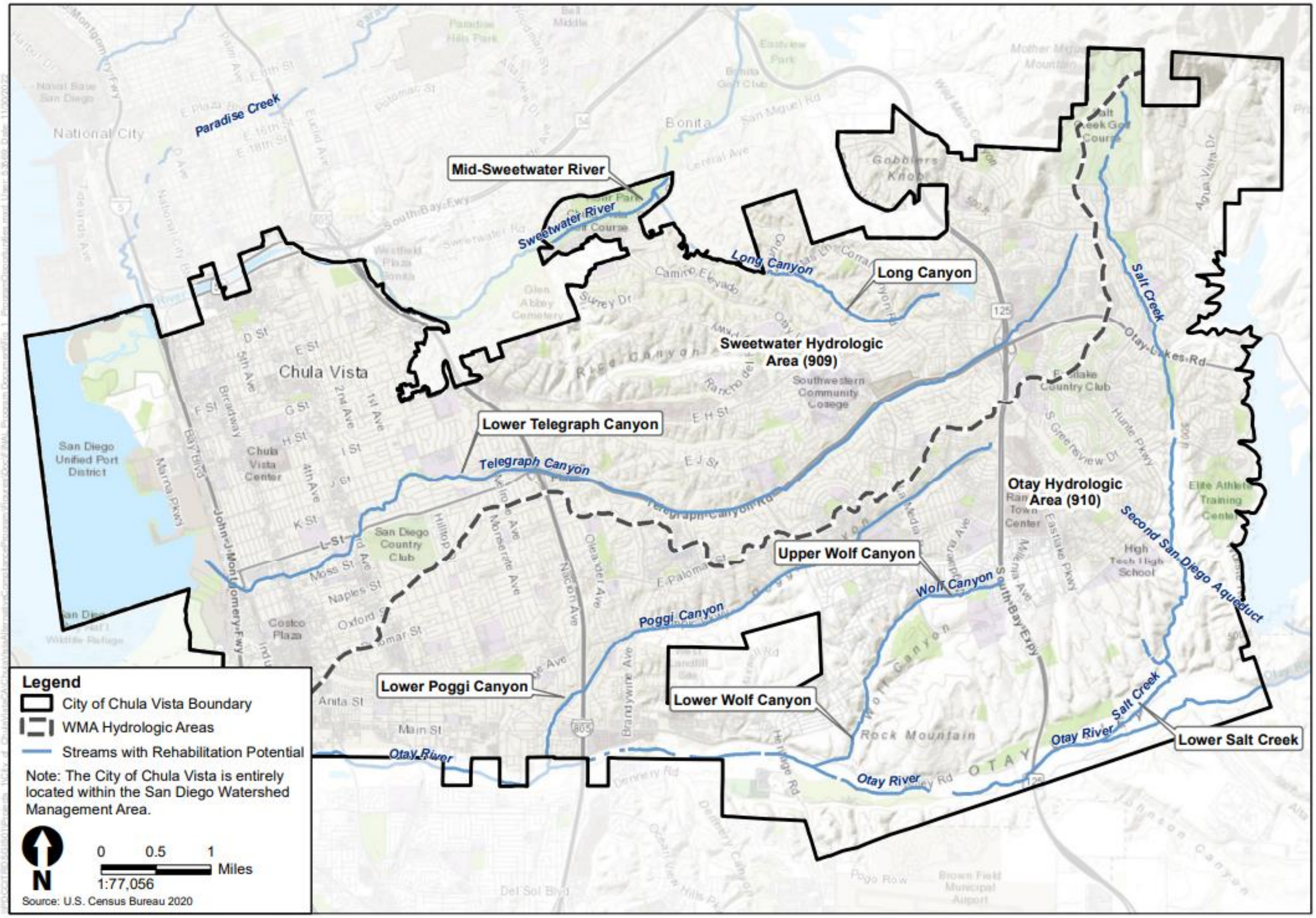

Figure 6. Streams with potential for NSMP Restoration Projects under the Proposed Chula Vista ACP

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6.4 WQE Monitoring Program and NSMP Pilot Project

The scientific literature consistently reiterates the need for empirical data for stormwater management using NSMPs. Moreover, many studies identified the discrepancy between water-quality benefits at reach, catchment, and watershed scales. The message is clear: water-quality monitoring is critical to assess and adequately credit Stream Rehabilitation projects. These data are invaluable for subsequent ACP reviews, allowing WQE credit determinations to be adjusted to reflect anticipated versus actual water-quality benefits. Therefore, a monitoring program should be developed to collect data before and after both a Land Restoration and Stream Rehabilitation project within Chula Vista. The implementation of a Land Restoration and Stream Rehabilitation pilot project in the Salt Creek drainage provides an opportunity to fill the local data gap and provide the information necessary to evaluate and refine the WQE crediting calculations to streamline PDP permitting approval and stormwater-management efficacy. The City of Chula Vista and ICF have developed a comprehensive watershed assessment project that will be used to monitor and assess the performance of such a pilot project. Funding for this assessment is anticipated to be provided by the Proposition 1 Watershed Restoration Grant.

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Chapter 7
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Appendix B

Technical Memorandum on Alternative Compliance Program: Water Quality Equivalency Credit Equation Application

DRAFT

ALTERNATIVE COMPLIANCE PROGRAM: WATER QUALITY EQUIVALENCY CREDIT EQUATION APPLICATION

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Overview

Development and application of the City of Chula Vista Water Quality Equivalency (WQE) credit equation for Natural Systems Management Practices (NSMPs) focused on adapting the existing regional WQE equation (2018 update) for Best Management Practices (BMP) accepted by the California Regional Water Quality Control Board to represent relevant processes and functions provided by stream restoration that impact water quality (RWQCB 2018). The stormwater pollutant control volume equation for NSMPs is shown below.

Equation 1. Calculation of ACP Earned Stormwater Pollutant Control Volume

$$V_E = L\,(\Delta V + V_2 N_2 - V_1 N_1)$$

$$N = C_R N_R + C_S N_S + (C_V E_V * \text{Ecological Benefit Factor})$$

Variables	Consideration
V_E: Earned stormwater pollutant control volume of ACP	Calculated water quality credit
L: Land use factor	Pollutant supply
V_2: Restored condition design capture volume at ACP	Pollutant reduction
N_2: Restored condition NSMP efficacy factor	Pollutant reduction
V_1: Existing condition design capture volume at ACP	Existing conditions
N_1: Existing condition NSMP efficacy factor	Existing conditions
ΔV: Change in design capture volume ($V_1 - V_2$) at ACP	Change in existing conditions
E: Pollutant reduction efficiency	Dependent on site conditions
C: Provided capture	Calculated volume captured / DCV

ACP = Alternative Compliance Program; DCV = design capture volume

This NSMP credit calculation equation follows the same format as the BMP equation, except for calculation of the efficacy factor ("N" for NSMPs, "B" for BMPs). As the BMP is a closed system with specific guidance on capture volume and pollutant reduction, development of a new equation was needed to represent the functions of a NSMP that is more spatially and temporally dynamic. Determination of DCV for the 85th percentile, 24-hour storm event and the Land Use Factor for NSMPs follows the same methodology used for BMPs. When calculating the Land Use Factor for independent ACPs within the City of Chula Vista, the reference tributary is based on the future land use acreage for the Otay Sub-Watershed or Sweetwater Sub-Watershed (Table 1) (SANDAG, 2014).

The three functions used to calculate N in this equation are (1) retention, (2) sediment, and (3) vegetation. The NSMP efficacy factor is assessed for both existing (N_1) and proposed (N_2) conditions.

Table 1. Future Land Use Acreages for the Sub-Watersheds within the City of Chula Vista

	Otay Future Land Use Acreage[1]	Sweetwater Future Land Use Acreage[1]
Agriculture	0	5
Commercial	2,375	2,785
Education	1,271	1,996
Industrial	3,184	1,550
Multi-Family Residential	2,291	2,534
Orchard	0	0
Rural Residential	24,768	52,177
Single Family Residential	5,302	19,469
Transportation	5,141	10,260
Vacant / Open Space	49,056	59,908
Water	1,048	2,978
Total	**94,436**	**153,662**

[1] Future land use acreages are based on current projections and are subject to change.
Source: SANDAG, 2014

Task 1. Retention Efficacy Subfactor ($N_{Retention}$)

Retention represents the water volume and pollutants reduced by the natural system. Calculations for provided capture are provided below, but alternatively provided capture may be determined with dispersion nomographs from previously approved WQE and BMP manuals. Project-specific modeling (i.e., storm water management model [SWMM]) would also be allowed to quantify retention subject to local jurisdiction review and approval.

Equation 2. Calculation of Retention Efficacy Subfactor

$$N_{Retention} = C_R E_R = (C_{R\_Infiltration} + C_{R\_Evapotranspiration}) * E_R$$

$N_{Retention}$: retention efficacy subfactor

C_R: provided capture through retention

E_R: retention pollutant reduction efficiency

$C_{R\_Infiltration}$: provided capture through infiltration

$C_{R\_Evapotranspiration}$: provided capture through evapotranspiration

Task 1.a. Provided Capture through Infiltration ($C_{R\_Infiltration}$)

Infiltration represents the water volume captured by percolation into the soil. The saturated hydraulic conductivity can be determined for the inundated area with Web Soil Survey (USDA, NRCS 2019) or from onsite measurements. It is assumed that infiltration occurs uniformly over the entire inundation extent.

Equation 3. Calculation of Provided Capture through Infiltration

$C_{R\_Infiltration} = (A * K_{sat} * t * 3630) / DCV$
$C_{R\_Infiltration}$: fraction of DCV retained by infiltration (dimensionless)
A: maximum inundation extents of the 85th percentile, 24-hour storm event (acres)
K_{sat}: minimum saturated hydraulic conductivity rate of soils within A (inches/hour)
3630: conversion from acres to square feet for A (43,560 square feet/1 acre) multiplied by conversion from inches to feet for K_{sat} (1 foot/12 inches) to give the volume result in cubic feet
t: duration of infiltration during the storm event (maximum of 3 hours)
DCV: design capture volume (cubic feet)

Task 1.b. Provided Capture through Evapotranspiration ($C_{R\_Evapotranspiration}$)

Evapotranspiration represents the water volume captured by the evapotranspiration process in vegetation. Evapotranspiration can be determined for the project site by consulting the City of Chula Vista BMP Design Manual (2019 update). It is assumed that evapotranspiration occurs uniformly within vegetated portions of the entire inundation extent.

Equation 4. Calculation of Provided Capture through Evapotranspiration

$C_{R\_Evapotranspiration} = (A_V * ET * t * 3630) / DCV$
$C_{R\_Evapotranspiration}$: fraction of DCV retained by evapotranspiration (dimensionless)
A_V: maximum inundation extents of the 85th percentile, 24-hour storm event that intersects with vegetation (acres)
ET: average evapotranspiration rate during October–March determined by City of Chula Vista BMP Design Manual (inches/hour)
t: duration of evapotranspiration during the storm event (maximum of 3 hours)
3630: conversion from acres to square feet for A (43,560 square feet/1 acre) multiplied by conversion from inches to feet for ET (1 foot/12 inches) to give the volume result in cubic feet
DCV: design capture volume (cubic feet)

Task 1.c. Retention Pollutant Reduction Efficiency (E_R)

The E_R is 100% for both infiltration and evapotranspiration. This assumes that all pollutants in the captured water are reduced due to percolation into the soil or uptake by vegetation.

Task 2. Sediment Efficacy Subfactor ($N_{Sediment}$)

The sediment-related portion of the equation is primarily focused on calculating the anticipated capability of the NSMP to reduce sediment transport in the system. This will primarily occur through sediment capture and is expected to be higher in NSMPs that restore degraded and eroding channels.

Equation 5. Calculation of Sediment Efficacy Subfactor

$$N_{Sediment} = C_S E_S$$

$N_{Sediment}$: sediment efficacy subfactor

C_S: percent change of sediment leaving the system

E_S: reduction efficiency of sediment

Task 2.a. Provided Capture of Sediment (C_S)

Sediment captured by the stabilized, post-restoration stream is calculated as follows.

Equation 6. Calculation of Percent Change of Sediment

$$C_S = (S_1 - S_2)/S_1$$

C_S: percent change of sediment leaving the system

S_1: sediment leaving the NSMP in existing conditions

S_2: sediment leaving the NSMP in proposed conditions

Task 2.b. Sediment Pollutant Reduction Efficiency (E_S)

The sediment reduction efficiency is 1 (100% of sediment captured is removed, similar to retention).

Task 3. Vegetation Efficacy Subfactor ($N_{Vegetation}$)

The final pollutant reduction process represented in the equation is for biofiltering benefits provided by vegetation.

Equation 7. Calculation of Vegetation Efficacy Subfactor

$N_{Vegetation} = C_V * E_V *$ Ecological Benefit Factor
$N_{Vegetation}$: vegetation efficacy subfactor C_V: fraction of DCV filtered by vegetation E_V: vegetation pollutant reduction efficiency Ecological Benefit Factor: quantitative multiplier based on condition of the resources and benefits it is anticipated to provide based on that condition (more details in Task 3.c)

Task 3.a. Provided Capture through Vegetation Filtering (C_V)

Provided capture for vegetation is calculated as the percent of DCV that flows over vegetation and is not deeper than 1.5 feet. Any water during the storm event that is more than 1.5 feet above the bed surface or does not intersect with vegetation is not captured in this category. Project-specific modeling (i.e., HEC-RAS) would be allowed to quantify provided capture by vegetation, subject to local jurisdiction review and approval.

Task 3.b. Vegetation Pollutant Reduction Efficiency (E_V)

The E_V value was set at 19%, consistent with the lowest pollutant reduction efficiency provided by vegetated swales in the Regional WQE Guidance (RWQCB 2018). The total vegetation efficacy increases when multiplied with the Ecological Benefit Factor but does not exceed the published maximum reduction efficiency of biofiltration BMPs (67%).

Task 3.c. Ecological Benefit Factor

California Rapid Assessment Method (CRAM) provides a comprehensive, score-based approach to quantify the condition of the feature both before and after the NSMP is implemented. For the City WQE equation, the magnitude of change between the CRAM scores for pre- and post-restoration conditions is translated to an Ecological Benefit Factor that is used as a multiplier for E_V.

Equation 8. Calculation of the Ecological Benefit Factor

Ecological Benefit Factor = (CRAM $Score_{post}$ – CRAM $Score_{pre}$) / 7
- If calculated factor is greater than 3.0, then a maximum value of 3.0 will be imposed. - If calculated factor is greater than 4.0, then an additional bonus of 0.2 will be added. - If calculated factor is less than 1.0, then a minimum value of 1.0 will be imposed. Note: 7 is the magnitude of change between CRAM scores required for significant improvement from existing to proposed conditions.

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Appendix C

Technical Memorandum on Alternative Compliance Program: Water Quality Equivalency Credit Equation Development

DRAFT

ALTERNATIVE COMPLIANCE PROGRAM: WATER QUALITY EQUIVALENCY CREDIT EQUATION DEVELOPMENT FOR NATURAL SYSTEMS MANAGEMENT PROJECTS

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Tables and Figures

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Acronyms and Abbreviations

ACP	Alternative Compliance Program
AOI	area of interest
Bank	Otay Mitigation Bank
BMP	Best Management Practices
City	City of Chula Vista
CRAM	California Rapid Assessment Method
DCV	Design Capture Volume
DCV	design control volume
EV	efficiency
HEC-HMS	Hydraulic Engineering Center Hydrology Modeling System
HEC-RAS	Hydrologic Engineering Center River Analysis System
MS4	municipal separate storm sewer system
NSMP	natural system management practices
NSMPs	Natural Systems Management Projects
PDP	Priority Development Project
SWMM	Storm Water Management Model
VE	volume
WMA	watershed management area
WQE	Water Quality Equivalency

Executive Summary

The City of Chula Vista (City) is developing an alternative compliance program (ACP), which includes a City water quality equivalency (WQE) framework for natural system management practices (NSMP). With this framework the City aims to implement a greater water quality benefit concurrently with expediting approval of priority development projects (PDP), while meeting municipal separate storm sewer system (MS4) permit requirements. under the San Diego Water Board Order R9-2013-0001, as amended (Regional MS4 Permit). The ACP program consists of a City WQE for NSMPs water quality and use of the Regional 2018 WQE for BMPs.

This memorandum contains supporting material for the ACP and the City of Chula Vista Best Management Practices (BMP) Design Manual and was specifically created for use by the City of Chula Vista only. This memorandum demonstrates the methodologies for applying NSMPs toward water quality credits as an ACP option. Equations were developed to calculate the WQE credits generated by NSMPs for water quality. In addition, this exercise provides an opportunity to evaluate the functions provided by BMPs and NSMPs, and their ability to meet the water quality requirements of the Regional MS4 Permit.

The 2018 Regional WQE credit methodologies for structural BMPs are the foundation for NSMP equation development. The calculation of earned stormwater control volume for NSMPs is based on three processes: (1) runoff retention; (2) sediment stabilization; and (3) vegetation biofiltration. The overall uplift in ecological benefits for a restored system is represented by a multiplier in the equation that increases credit volume. The design capture volume and pollutant removal efficiency provided by these three processes can be consistently calculated based on the existing conditions and proposed design.

Two case studies were evaluated with the City WQE equation for NSMPs (Salt Creek) and the Regional 2018 WQE equation for BMPs (Example Infill Project), respectively. Each site provided unique existing conditions and design intent for comparison of generated credits. The capital, maintenance, land, and admin costs associated with each project were also compared. Results indicated that Salt Creek generated the most pollutant credits and had the lowest cost per cubic-foot.

The following conclusions were determined during this exercise:

- The NSMP equation is based on BMP methodology but accounts for water quality processes and benefits provided by natural systems.
- The calculated pollutant control volume for a NSMP is highly dependent on design intent but can match or exceed BMP volumes.
- The NSMP case study was lower cost alternative to the infill project on a per cubic-feet of treatment, per project acre, and per impervious acre basis.

Technical Memorandum for Equation Development

Background

The City of Chula Vista (City) obtained SB 2 grant funding to develop an Alternative Compliance Program (ACP) for Natural Systems Management Projects (NSMPs) to provide alternative compliance and treatment options for stormwater consistent with the Regional MS4 Permit (Order R9-2013-0001, as amended, California Regional Water Quality Control Board, 2015). The proposed program represents significant opportunities for Priority Development Project (PDP) applicants to implement or contribute to NSMPs that can provide treatment. The ACP will also allow for streamlined permit review and approval processes increase onsite buildable acreage which will help the City meet its housing and community development goals, and meet Regional MS4 Permit requirements for stormwater pollutant control and hydromodification management through providing a mechanism for the creation and approval of stormwater credits.

There are two primary mechanisms utilized in ACPs: Structural best management practices (BMPs) and NSMPs. Structural BMPs are physical structures or features that are designed to collect, treat, infiltrate, and/or convey stormwater. Examples include retention ponds, rain gardens, constructed wetlands, and pervious pavement (RWQCB, 2018: ES-2). Structural BMPs (BMPS) have pollutant control calculations based on defined pollutant removal efficiencies and design control volume reductions specified in the Regional MS4 Permit.

NSMPs are stormwater management practices implemented to restore and/or preserve predevelopment watershed functions in lieu of providing onsite direct pollutant removal and hydromodification flow control (RWQCB, 2018: xv) for projects that cannot reliably retain or fully treat the DCV onsite. The existing Regional Water Quality Equivalency (WQE) guidance outlines stormwater pollutant control benefits through a reduction in stormwater runoff volume but does not define "pollutant removal" by restoring natural biogeochemical processes for NSMPs. For an applicant to obtain pollutant reduction credit associated with the design control volume (DCV) not reliably retained onsite for pollutant reduction processes in a stream restoration project, the City is required by the Regional MS4 Permit to develop the methodology to be followed through its own approval process (RWQCB, 2018: Section 2.3.2). Therefore, the focus of this project was to develop the needed methodology to quantify pollutant removal credits for NSMPs. The WQE developed and discussed in this memo for NSMPs addresses the ability of an ACP project to remove typical pollutants in runoff from the drainage area.

Note that this memorandum only addresses credit for stormwater pollutant control benefits for NSMPs. Hydromodification flow control benefits for NSMPs should be calculated in accordance with Section 3 of the Water Quality Equivalency Guidance Document for Region 9 (RWQCB, 2018).

Objectives

This report demonstrates the development and application of a WQE equation for NSMPs to generate stormwater credits. The technical memorandum includes:

- Chapter 1: Project background and objectives,

- Chapter 2: An overview of the existing BMP WQE equation, and
- Chapter 3: Development of a new WQE equation for NSMPs.
- Appendices:
- Appendix A: Calibration of the NSMP WQE equation using a comparative methodology,
- Appendix B: Literature review for vegetation pollutant removal efficiencies,
- Appendix C: Supporting material for development of Ecological Condition Factor,
- Appendix D: Application of equations to one NSMP and one BMP case study, and
- Appendix E: Comparison of credit and cost results across the case studies.

Alignment with Clean Water Act Section 401 and Porter Cologne Water Quality Control Act

Stream restoration projects are regulated by the RWQCB through the 401 Water Quality Certification Program and under the Porter-Cologne Water Quality Control Act. These programs focus on the physical, chemical, and biological qualities of streams as well as the functions and values provided by these features. These programs use different terminology to describe the functions and values provided by streams and stream restoration than the MS4 program uses to describe BMPs and water quality measures. Terms such as pollutant reduction in this document are including functions such as biofiltration or processing of organic matter and nutrients. This WQE was developed specifically to address stormwater pollutant control from NSPMs, so the governing language used throughout the document is that of the MS4 program.

Overview of Existing Guidance

Water quality equivalency for stormwater pollutant control is established based on the Regional MS4 Permit DCV not fully retained on site and the pollutant removal efficiency. Structural BMPs are a subset of BMPs which detain, retain, filter, infiltrate, remove, or prevent the release of pollutants to surface waters from development projects in perpetuity, after construction of the project is completed. The WQE Guidance document provides a comprehensive methodology for calculating the earned volume provided by a BMP based on the contributing watershed and design of the structure (RWQCB, 2018). Copermittees including San Diego, Orange, and Riverside County submitted the WQE Guidance document to the San Diego Water Board for approval in 2015 (updated in 2018) to provide standards and guidelines for a Copermittee to implement an offsite ACP project for PDP projects that cannot feasibly implement the full DCV or HMP requirements of the Regional MS4 permit onsite. The WQE calculations provided by this document are required to allow the City and PDP applicants an alternate strategy for compliance with onsite pollutant control BMPs that cannot be fully implemented onsite. A general overview of this methodology is presented in the following sections, as it provides the foundation for development of the NSMP WQE equation.

WQE Equation

The earned stormwater pollutant control volume (V_E) is the amount of water that is effectively treated by the ACP project considering the site-specific factors presented in Table 1. V_E can be used to offset the deficit of retained or biofiltered stormwater volume for PDPs

Table 1. Structural BMP ACP project stormwater pollutant control volume calculation

$$V_E = L\,(\Delta V + V_2B_2 - V_1B_1)$$

$$B = E * C$$

Variables	Consideration
V_E: Earned stormwater pollutant control volume of ACP project	Calculated water quality credit
L: Land use factor	Pollutant supply
V_2: Mitigated condition design capture volume at ACP project	Pollutant removal
B_2: Mitigation condition BMP efficacy factor	Pollutant removal
V_1: Impacted condition design capture volume at ACP project	Impacted conditions
B_1: Impacted condition BMP efficacy factor	Impacted conditions
ΔV: Change in design capture volume ($V_1 - V_2$) at ACP project	Change in impacted conditions
E: Pollutant removal efficiency	Dependent on site conditions
C: Provided capture	Calculated volume captured / DCV

The variables used in the equation for V_E are described in detail below.

Land Use Factor

The land use factor (L) is the ratio of pollutant concentrations generated by an ACP project tributary compared to the pollutant concentrations generated by a reference PDP tributary with emphasis on the pollutants for which the receiving water in the watershed management area is impaired. Its purpose is to account for variations in the pollutant concentrations delivered to ACP projects and PDPs. This factor is needed to allow a comparison between the pollutant concentrations within the contributing area of the PDP and ACP project anywhere within the same watershed management area (WMA). Applicants must conduct a number of pollutant and land use specific calculations and then select the Land Use Factor values that are the most protective.

Design Capture Volume

Traditional BMPs are sized using a Design Capture Volume (DCV)[1]. The DCV represents the volume of runoff for the 85th percentile, 24-hour storm event entering the location of interest. It is 100% of the PDP DCV as described in the Regional WQE guidance (2018 update) and is calculated as:

$$\mathbf{DCV = C * d * A * 3630}$$

Where:

DCV = design capture volume for the 85th percentile, 24-hour storm event (cubic-feet)

C = area weighted runoff factor (unitless),

d = depth of 85th percentile, 24-hour storm event rainfall (inches),

A = area of drainage (acres), and

3630 = conversion from acres to square feet (43560 square feet/1 acre) multiplied by conversion from inches to feet (1 feet/12 inches) to provide the volume result in cubic-feet.

The area weighted runoff factor is estimated using the equation from Section B.1.1 in the Model BMP Design Manual (Project Cleanwater, 2020 update).

$$\mathbf{C = (\Sigma C_X A_X)/(\Sigma A_X)}$$

Where:

C_x = runoff factor for area "X" (unitless), and

A_x = area "X" of tributary (acres).

The value of the runoff factor varies depending on land use, impervious area, and hydrologic soil group. Default values are provided in Table 2-3 or may be manually calculated per Section 2.3.1.2 in the Regional WQE Guidance (2018 update).

The 85th percentile 24-hour storm depth is determined from Figure B.1-1 in the Model BMP Design Manual (Project Cleanwater, 2020 update), an isopluvial map of San Diego County.

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[1] Within Appendix B of the Model BMP Design Manual (Project Cleanwater, 2020 update), Worksheet B.1 address the hydrologic calculations needed to determine the site's DCV.

BMP Efficacy Factor

The BMP efficacy factor (B) describes the ability of an ACP project to remove pollutants in runoff from the drainage area. This factor is represented as a ratio and can vary from 0.00 to 1.00. A BMP Efficacy Factor of 1.00 indicates that an ACP project provides a pollutant capture efficacy that meets the PDP BMP efficacy standards set forth in the Regional WQE Guidance (2018 update), while a lower value provides a fraction of that efficacy. It is calculated with the equation below from Equation 2-3 in the Regional WQE Guidance (2018 update):

$$B = E * C$$

Where E is the pollutant removal efficiency, and C is the provided capture. The provided capture for Retention BMPs is a function of fraction of DCV retained and drawdown time (Figure 2-9 from the WQE Guidance). Biofiltration BMPs are designed to capture 150% of DCV. The pollutant removal efficiency for retention and biofiltration BMPs is 1.0 and 0.666, respectively (RWQCB, 2018). While pollutant removal efficiency standards may evolve over time as more data are compiled and additional studies completed, this guidance relies on Regional WQE Guidance (2018 update) language as the most direct and reliable method for establishing equivalency.

Context for Development

There are three primary NSMP categories described in the Regional WQE Guidance – Land Preservation, Land Restoration, and Stream Restoration (RWQCB. 2018: ES-3). The WQE Guidance provides detailed instructions, equations, and examples for calculating the hydromodification flow control benefits of Land Preservation, Land Restoration, and Stream Restoration NSMPs. At the time of the approval of the updated 2018 Regional WQE Guidance, calculations had not yet been determined for NSMP pollutant reduction benefits (retention, biofiltration, or flow-thru) and only limited applications had been developed for volume reduction (Figure 1).

ACP	Category	Stormwater Pollutant Control Benefits				Hydromod Flow Control Benefits
		Pollutant Reduction			Volume Reduction	
		Retention	Biofiltration	Flow-Thru		
BMP	Retrofit	Available	Available	Available	Available	Available
BMP	Regional	Available	Available	Available	Available	Available
BMP	Water Supply	Available	Available	Limited Availability	Available	Available
NSMP	Land Restoration	Not Available	Not Available	Not Available	Available	Available
NSMP	Land Preservation	Not Available	Not Available	Not Available	Limited Availability	Available
NSMP	Stream Rehabilitation	Not Available	Not Available	Not Available	Limited Availability	Available

Figure 1. ACP categories quantified through WQE Guidance and the focus of this memo highlighted

This technical memorandum focuses only on the processes and benefits provided by stream restoration as these projects typically restore hydrologic and geomorphic structure, processes, and functions (Figure 2). The goal of these projects may be to increase flood resiliency and attenuation, enhance pollutant retention, improve in-stream habitat conditions, and protect water quality by recreating natural conditions and biogeochemical processes in degraded systems. Stream restoration often manifests as streambank stabilization, floodplain reconnection, and channel reconfiguration. Riparian buffers created through restoration offer ecosystem and watershed benefits, including complex habitat for native species, improving hydrologic flow regimes , flood attenuation, biogeochemical cycling, sediment regulation, and shading—all of which benefit water quality.

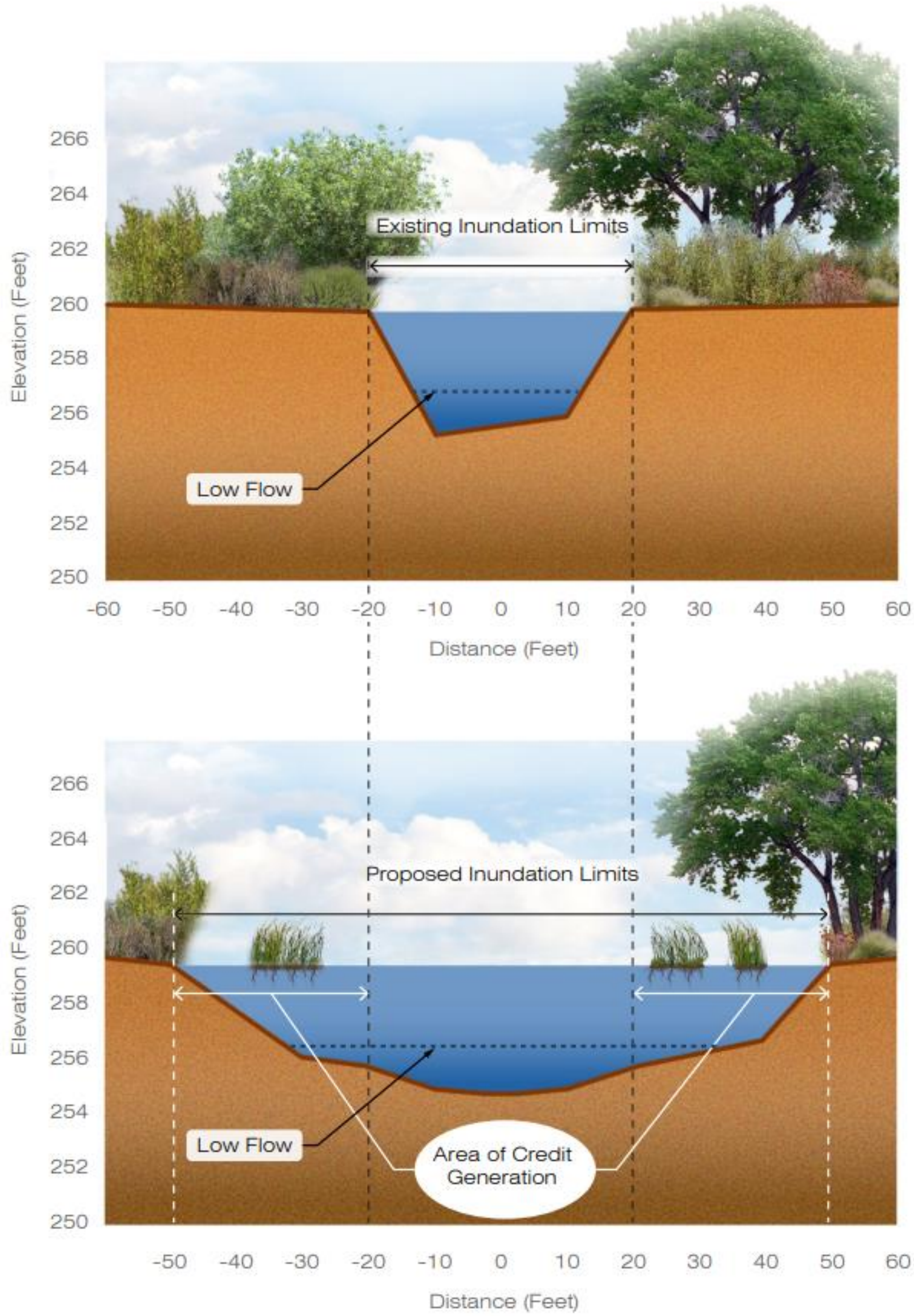


Figure 2. Example of simplified pre- and post-restoration conditions for an example NSMP project

Development of the WQE credit equation for NSMPs focused on adapting the existing BMP equation to represent relevant processes and functions provided by stream restoration that impact water quality. This process is described in the following section.

WQE Equation

The stormwater pollutant control volume equation for NSMPs is shown in Table 2. The definitions for the variables are consistent with the existing BMP WQE equation for clarity. The efficacy factors listed below describe the ability of an ACP project to remove typical pollutants in runoff from the drainage area. Although efficiencies are normally expected to vary according to pollutant type, the efficacy values in this report provide an average value that is useful for establishing equivalency (sensu Regional WQE Guidance, 2018 update).

Table 2. NSMP ACP stormwater pollutant control volume calculation

$$V_E = L\,(\Delta V + V_2N_2 - V_1N_1)$$

$$N = C_RN_R + C_SN_S + (C_VE_V * \text{Ecological Condition Factor})$$

Variables	Consideration
V_E: Earned stormwater pollutant control volume of ACP project	Calculated water quality credit
L: Land use factor	Pollutant supply
V_2: Restored condition design capture volume at ACP project	Pollutant removal
N_2: Restored condition NSMP efficacy factor	Pollutant removal
V_1: Existing condition design capture volume at ACP project	Existing conditions
N_1: Existing condition NSMP efficacy factor	Existing conditions
ΔV: Change in design capture volume ($V_1 - V_2$) at ACP project	Change in existing conditions
E: Pollutant removal efficiency	Dependent on site conditions
C: Provided capture	Calculated volume captured / DCV
C_R: Provided capture by retention	Infiltration and evapotranspiration
E_R: Pollutant removal by retention	
C_S: Provided capture by sediment	Bed and bank stabilization
E_S: Pollutant removal by sediment	
C_V: Provided capture by vegetation	Vegetation biofiltration
E_V: Pollutant removal by vegetation	
Ecological Condition Factor: Multiplier	Habitat complexity and benefits

This NSMP equation for follows the same format as the BMP equation, except for the calculation of the efficacy factor ("N" for NSMPs, "B" for BMPs). As the BMP is a closed system with specific guidance on capture volume and pollutant removal, development of a new equation was needed to represent the functions of a spatially and temporally dynamic NSMP (Figure 3). The same methodology used to determine DCV for BMPs is used for NSMPs. The DCV for NSMPs is 100% of the PDP DCV as described in the Regional WQE guidance (2018 update).

To ensure that the total pollutant removal is not calculated as greater than 100%, the maximum value for each individual pollutant removal efficiency (E) shall not exceed 1.0, the sum of provided capture for vegetation and retention ($C_V + C_R$) shall not exceed 1.0 and the total sum of the NSMP efficacy factor (N) shall not exceed 1.0.

$$N = C_R E_R + C_S E_S + (C_V E_V * \text{Ecological Condition Factor})$$

$$N = \text{Retention} + \text{Sediment} + \text{Vegetation}$$

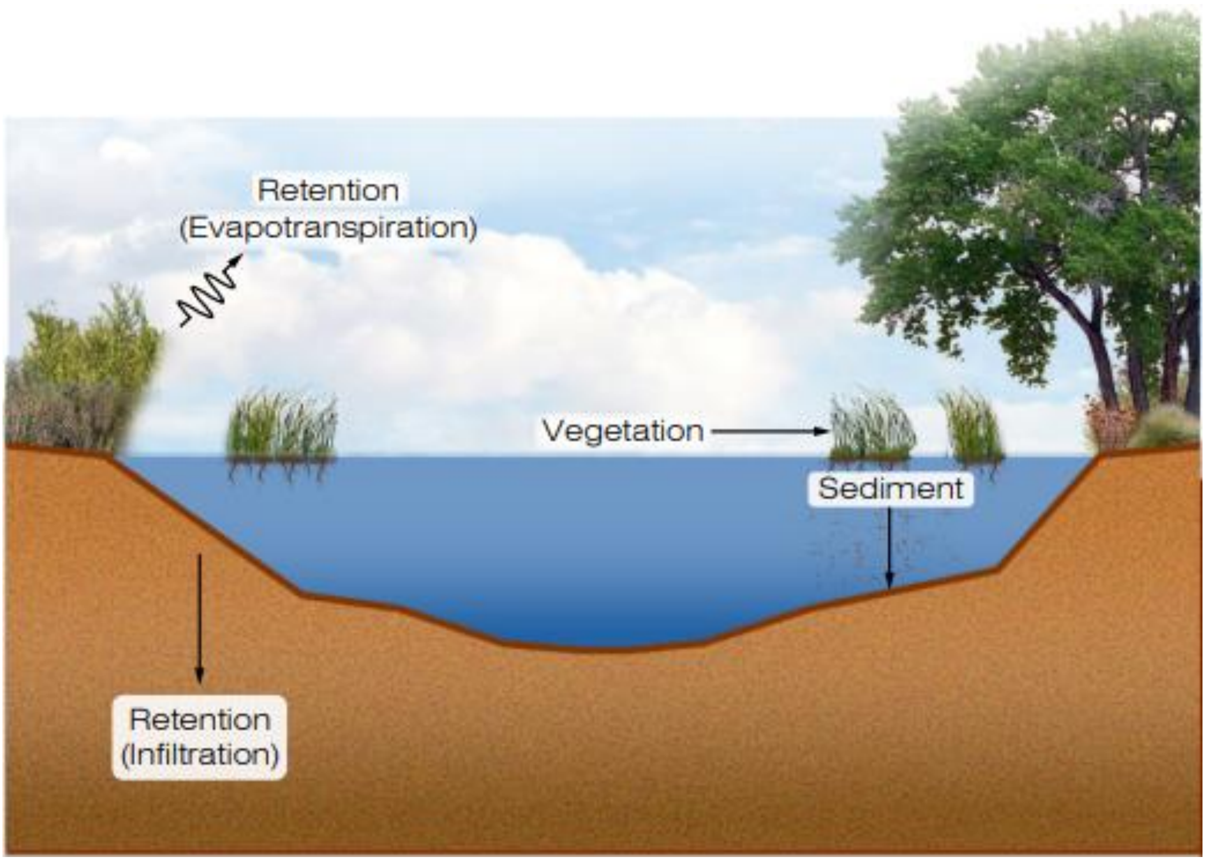


Figure 3. Illustration of processes represented in the NSMP efficacy factor equation.

The three functions included in this equation are (1) retention, (2) sediment, and (3) vegetation. These functions cover significant forms of volume capture and pollutant reduction provided in a natural system and are consistent with the focuses for structural BMPS (RWQCB, 2018). The NSMP efficacy factor is assessed for both existing (N_1) and proposed (N_2) conditions.

Land Use Factor

When calculating the Land Use Factor for independent NSMP ACPs within the City of Chula Vista, the reference tributary is based on the future land use acreage for the Otay Sub-Watershed or Sweetwater Sub-Watershed (Table 3) (SANDAG, 2014).

Table 3. Future Land Use Acreages for the Sub-Watersheds within the City of Chula Vista

	Otay Future Land Use Acreage	Sweetwater Future Land Use Acreage
Agriculture	0	5
Commercial	2,375	2,785
Education	1,271	1,996
Industrial	3,184	1,550
Multi-Family Residential	2,291	2,534
Orchard	0	0
Rural Residential	24,768	52,177
Single Family Residential	5,302	19,469
Transportation	5,141	10,260
Vacant / Open Space	49,056	59,908
Water	1,048	2,978
Total	**94,436**	**153,662**

Source: SANDAG, 2014

Retention

Retention represents the water volume and pollutant reduction by the natural system, as calculated here:

$$N_{Retention} = C_R E_R = (C_{R\_Infiltration} + C_{R\_Evapotranspiration}) * E_R$$

Where C_R is the fraction of DCV retained by the system through infiltration and evapotranspiration and E_R is the percent of pollutant reduction when water infiltrates or evapotranspirates. As described below, the C value for infiltration and evapotranspiration are calculated separately. However, the E value for both processes is 100%. This assumes that all pollutants in the captured water are removed due to percolation into the soil or uptake by vegetation.

Infiltration

Infiltration represents the water volume captured by percolation into the soil. Similar to structural BMPs, the infiltration provided is primarily dependent on the inundated area from the storm event, soil type, and duration of infiltration (RWQCB, 2018). Web Soil Survey is a publicly available database that can be used to generate a soil report for an area of interest (AOI) (USDA NRCS, 2019a). Using the project boundary for the area of interest, an applicant could use the survey results to determine the minimum hydraulic conductivity (K_{sat}) within the site (Figure 4). Representative on-site measurements would be preferential to define saturated hydraulic conductivity.

Figure 4. Example of saturated hydraulic conductivity rate based on Web Soil Survey for Salt Creek.

Therefore, volume capture by infiltration is calculated as:

$$C_{R\_Infiltration} = (A*K_{sat}*t*3630)/DCV$$

Where:

$C_{R\_Infiltration}$ = percent of DCV captured by infiltration (dimensionless),

A = maximum inundation extents of the 85th percentile, 24-hour storm event (acres),

K_{sat} = minimum saturated hydraulic conductivity rate of soils within A (inches/hour),

3630 = conversion from acres to square feet for A (43560 square feet/1 acre) multiplied by conversion from inches to feet for K_{sat} (1 foot/12 inches) to give volume result in cubic-feet, t = duration of storm event (maximum of 3 hours), and

DCV = design capture volume (cubic-feet).

It was assumed that infiltration occurs uniformly over the entire inundation extent. Although this may overestimate infiltration, it is offset by using the minimum saturated hydraulic conductivity and a storm duration of 3 hours (to represent the peak versus the entire 24-hour storm period). The distinction between infiltration rate and K_{sat} is also important, as infiltration rate is the rate at which water infiltrates into the ground at any given moment, regardless of the current soil saturation and K_{sat} is the infiltration rate once the ground has reached 100% saturation and the infiltration rate has become constant. Therefore, using K_{sat} is more conservative, consistent, and readily available through Web Soil Survey than independent infiltration testing by applicants.

Evapotranspiration

Evapotranspiration represents the water volume captured by evapotranspiration achieved by vegetation. Evapotranspiration can be determined for the project site by consulting the Model BMP Design Manual (Project Cleanwater, 2020 update). Table G.1-2 in Appendix G of this manual contains a table of monthly average reference evapotranspiration by ET_o zone in San Diego County (Figure 5).

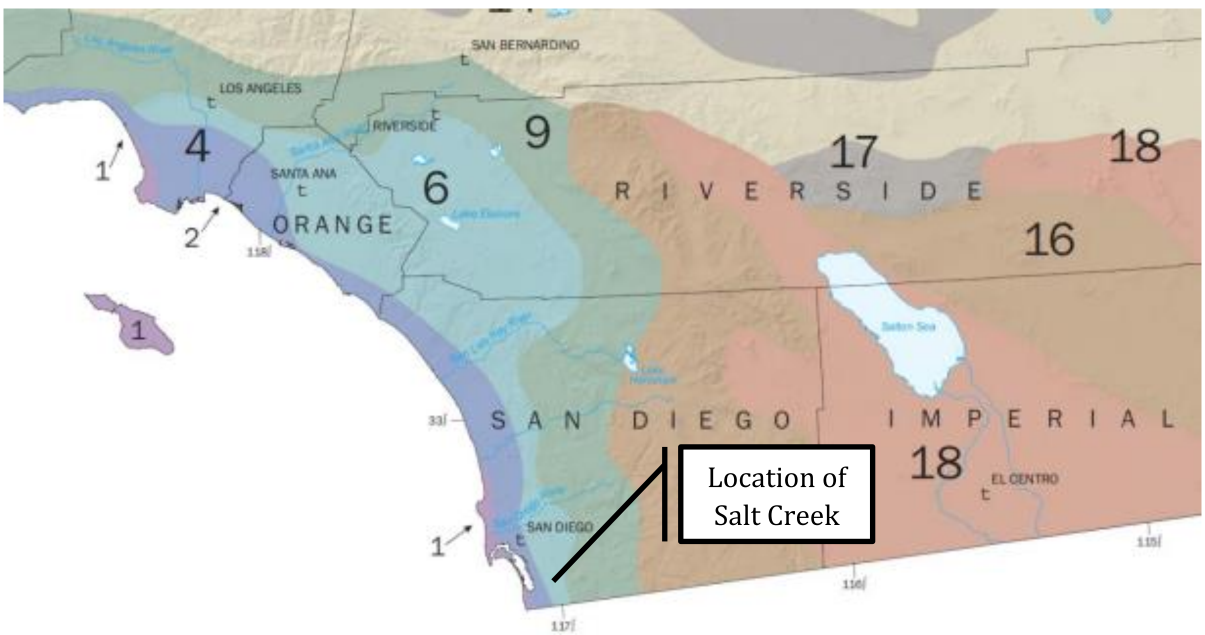


Figure 5. Example of evapotranspiration zone determined for Salt Creek

Therefore, capture by evapotranspiration is calculated as:

$$C_{R\_Evapotranspiration} = (A*ET*t*3630)/DCV$$

Where:

$C_{R\_Evapotranspiration}$ = percent of DCV captured by evapotranspiration (dimensionless),

A_V = maximum inundation extents of the 85th percentile, 24-hour storm event that intersects with vegetation (acres),

ET = average evapotranspiration rate during October – March determined by Model BMP Design Manual (Project Cleanwater, 2020 update) (note that this value must be recorded as inches/hr),

t = duration of evapotranspiration during the storm event (maximum of 3 hours),

3630 = conversion from acres to square feet for A_V (43560 square feet/1 acre) multiplied by conversion from inches to feet for ET (1 foot/12 inches) to give volume result in cubic-feet, and

DCV = design capture volume (cubic-feet).

It was assumed that evapotranspiration occurs uniformly over the entire inundation extent covering vegetation. Although this may overestimate evapotranspiration, it is offset by using the average evapotranspiration rate for the winter season as determined by the Model BMP Design Manual (Project Cleanwater, 2020 update). Additionally, using a storm duration of 3 hours (versus the entire 24-hour storm period) provides another conservative measure to avoid overestimation of evapotranspiration.

Alternatively, provided capture may be determined with dispersion nomographs from the Regional WQE (2018 update) and/or Model BMP Design Manual (Project Cleanwater, 2020 update). Project specific modeling (i.e., SWMM) would be allowed to quantify retention subject to local jurisdiction review and approval.

Sediment

The sediment related portion of the equation is primarily focused on calculating the anticipated capability of the NSMP to restore natural sediment transport and processes in the system, including sediment retention during variable storm events. This will primarily occur through sediment capture and portioning within the NSMP, which is expected to be higher in NSMPs that restore degraded and eroding channels (Figure 6). The NSMP efficacy factor for sediment is calculated as:

$$N_{Sediment} = C_S E_S$$

Where C_S is percent change of sediment leaving the system and E_S is the effective retention ability of sediment. Sediment capture is calculated as:

$$C_S = (S_1 - S_2)/S_1$$

Where:

S_1 = sediment leaving the NSMP in existing conditions, and

S_2 = sediment leaving the NSMP in proposed conditions.

The retention of sediment is estimated to be 1. Project specific modeling and calculations would be allowed to quantify sediment retention subject to local jurisdiction review and approval.

Figure 6. General example of severe geomorphic degradation during pre-restoration conditions.

Vegetation

The final pollutant removal process represented in the equation is for biofiltering benefits provided by vegetation. This is calculated as:

$$N_{Vegetation} = C_V * E_V * \text{Ecological Condition Factor}$$

Where C_V is the fraction of DCV filtered by vegetation, E_V is the percent of pollutants removed by vegetation, and the Ecological Benefit is a qualitative multiplier based on condition of the resource and benefits it is anticipated to provide based on that condition.

C_V is determined by calculating the percent total incoming water (DCV) that flows over vegetation and has a depth less than 1.5 feet. Any water during the storm event that is more than 1.5 feet above the bed surface or does not intersect with vegetation is not captured in this category. Project specific modeling (i.e., HEC-RAS) would be allowed to quantify C_V subject to local jurisdiction review and approval.

This equation assumes that the volume of water flowing through vegetation is uniformly filtered in the longitudinal, lateral, and vertical direction. The depth of filtering is up to a maximum value of 1.5 feet, under the assumption that suspended sediments more than 18 inches above the floodplain surface would flow through the project and not settle out onto the floodplain and that the most significant filtering provided by vegetation occurs below one foot. The Chesapeake methodology utilizes a depth of 1 foot for similar purposes (Atland et al., 2020) (Figure 7).

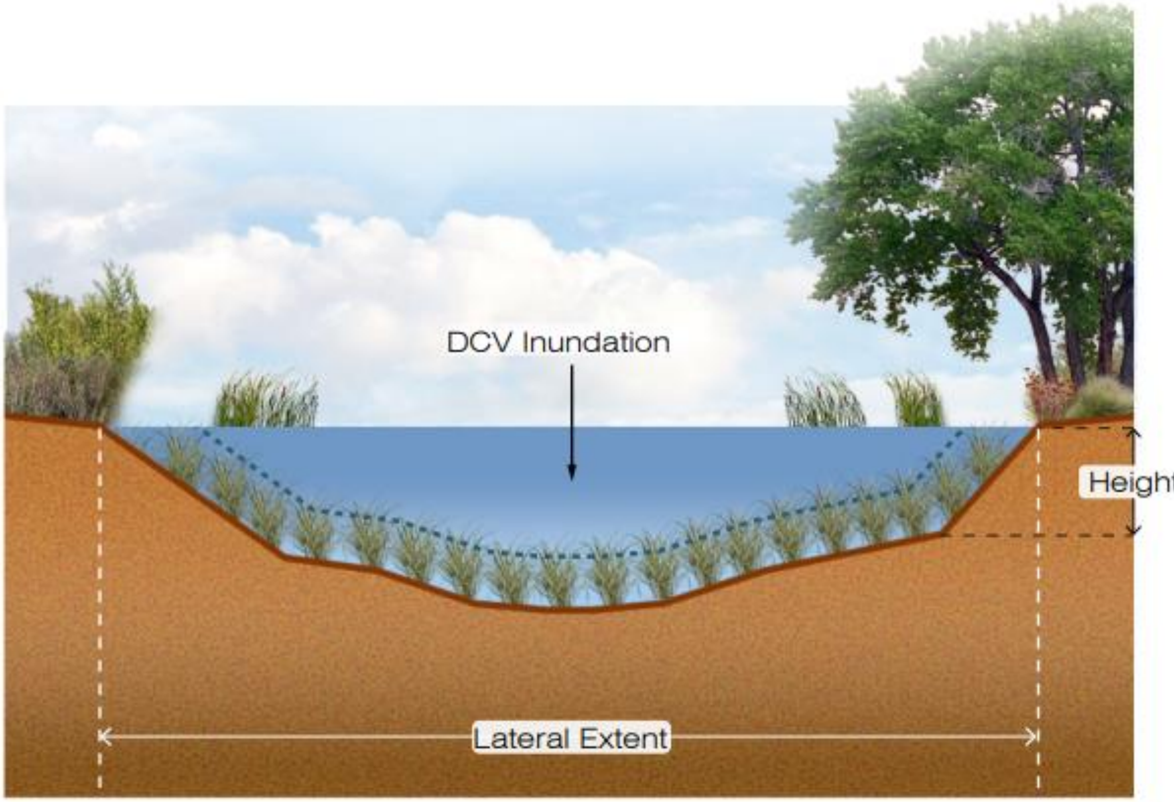


Figure 7. Simplified example of restored channel cross section with the entire DCV inundation shown, and the height and extent of captured volume drawn.

The removal efficiency (E_V) of vegetation was determined through robust literature review and consideration of standard BMP values (Appendix B). Every restoration site is different, whether it is the geological setting, hydraulic conditions, design goals, or existing disturbances. The Otay River does not have defined total maximum daily loads; therefore, this equation considers all pollutants to be removed equally. The E_V values used here attempt to provide consistent values for applicants while also considering the large range of project configurations. The minimum E_V value was set at 19%, consistent with the lowest pollutant removal efficiency provided by vegetated swales in Table 2-5 in the Regional WQE Guidance (2018 update). As biofiltration BMPs provide 67% pollutant removal efficiency, it was assumed than a NSMP would not exceed this performance standard. Therefore, using the Ecological Condition Factor as a multiplier, the maximum achievable E_V value is 61% (Table 4).

Table 4. Pollutant removal efficiencies for vegetation categories

	Pollutant Removal Efficiency Minimum	Pollutant Removal Efficiency Maximum
E_V	19%[2]	61%[3]
Ecological Condition Factor	1.0	3.2

Ecological Condition Factor

While developing the WQE equation for NSMPs, it became apparent that this methodology needed to account for the various benefits provided by natural systems beyond the direct influence on water quality. The Regional Water Quality Control Board considers the overall lift in functions and services of the watershed and receiving water to be equivalent to pollutant reduction (Walsh, 2021. *Pers. Comm.*). The functions and services provided by stream restoration NSMPs include: reduction in flow velocity, increased residence time, decreased water temperature from increased tree canopy, increased native habitat, increased receiving water biodiversity. All of these services and functions are natural processes that provide uptake of nutrients, disperse sediment for a more balanced habitat, and slow flow velocity for particulate settling and increased infiltration.

It was determined that a multiplier for the vegetation portion of the equation would best represent the influence of these benefits as they relate to the vegetative condition of the site before and after restoration. Therefore, the qualitative nature of the natural system could be quantified and adjust the final credit volume. To do this, a score-based system needed to be developed to determine how beneficial the before or after site condition is for providing ecosystem services.

California Rapid Assessment Method (CRAM) is a cost-effective and scientifically defensible rapid assessment method for monitoring the conditions of natural systems throughout California. It is used to assess ambient conditions as well as the performance of restoration projects (Figure 8). This methodology provides a comprehensive, score-based approach to quantify the condition of the feature both before and after the NSMP is implemented. The CRAM condition score is then used as a proxy to estimate the relative quantity of benefits provided by natural systems when compared to pre-project conditions.

[2] Per Table 2-5: Flow-Thru Pollutant Removal Efficiency (E) for Vegetated Swale from the Regional WQE Guidance (2018 update).

[3] Pollutant Removal Efficiency (E) for biofiltration basin is 0.67 from the Regional WQE Guidance.

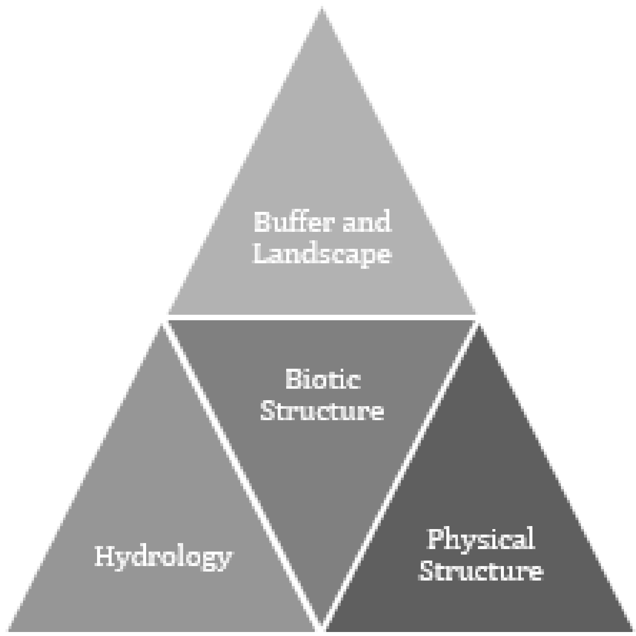


Figure 8. Spatial hierarchy of factors that control wetland conditions.

CRAM addresses 4 main attributes and their metrics:

- Buffer and landscape context – Stream corridor continuity, percent of aquatic area with buffer, average buffer width, and buffer condition.
- Hydrology – Water source, channel stability, and hydrologic connectivity.
- Physical structure – Structural patch richness and topographic complexity.
- Biotic structure – Number of plant layers, number of co-dominant species, percent invasion, horizontal interspersion, and vertical biotic structure.

Practitioners use these attributes to quantify the condition of the site. The attribute and metric scores, along with the stressor checklist, can be instrumental in identifying the restoration potential of a site as well as the potential positive and negative influences contributing to it.

The sum of scores given to the 4 attributes provides an overall score out of 100, with a minimum value of 25. For the WQE equation, the CRAM score is compared between pre- and post-restoration conditions and translated to an Ecological Condition Factor that is used as a multiplier for the vegetation removal efficacy. These values were used to span the range from low pollutant removal efficiency (Ecological Condition Factor = 1.0, E_V = 0.19) to high pollutant removal efficiency (Ecological Condition Factor = 3.2, E_V = 0.61).

$$\text{Ecological Condition Factor} = (CRAM_{post} - CRAM_{pre}) / 7$$

Where:

Ecological Condition Factor = dimensionless multiplier used to increase vegetation efficacy,

$CRAM_{post}$ = the predicted CRAM score for post-restoration conditions,

$CRAM_{pre}$ = the calculated CRAM score for pre-restoration conditions, and

7 = the magnitude of change between CRAM scores required for significant improvement[4].

If the calculated Ecological Condition Factor is greater than 3.0, then a maximum value of 3.0 will be imposed. If the calculated Factor is greater than 4.0, then an additional bonus of 0.2 will be added. If the calculated Factor is less than 1.0, then a minimum value of 1.0 will be imposed. The Ecological Condition Factor for existing conditions is always 1.0, therefore the maximum value possible is 3.2 for restored conditions.

The use of 7-point "bins" to characterize significant improvements between CRAM scores was primarily based on CRAM guidance from CWMW (2019) and Mazor (2015). Table 1-1 in the publication by Mazor included the separation of sites by class based on the CRAM score. The CRAM scores were binned into ranges between 7-9 points (i.e., Class 2 sites have a CRAM score between 72 to 79, Class 3 sites are between 63 to 72). These "classes" associated with score ranges are meant to broadly represent a stream's biology that may be intact, possible altered, likely altered, and very altered. Therefore, 7-point bins were determined to be appropriate to characterize significant changes in ecological condition between existing and proposed conditions for the WQE equation.

The City WQE equation for NSMPs should be calculated for proposed stream rehabilitation projects using the best available information for the site. As an example, this equation is applied to a NSMP case study in the problem statement below. This NSMP case study is then repeated in Appendix D and compared to a BMP case study in Appendix E.

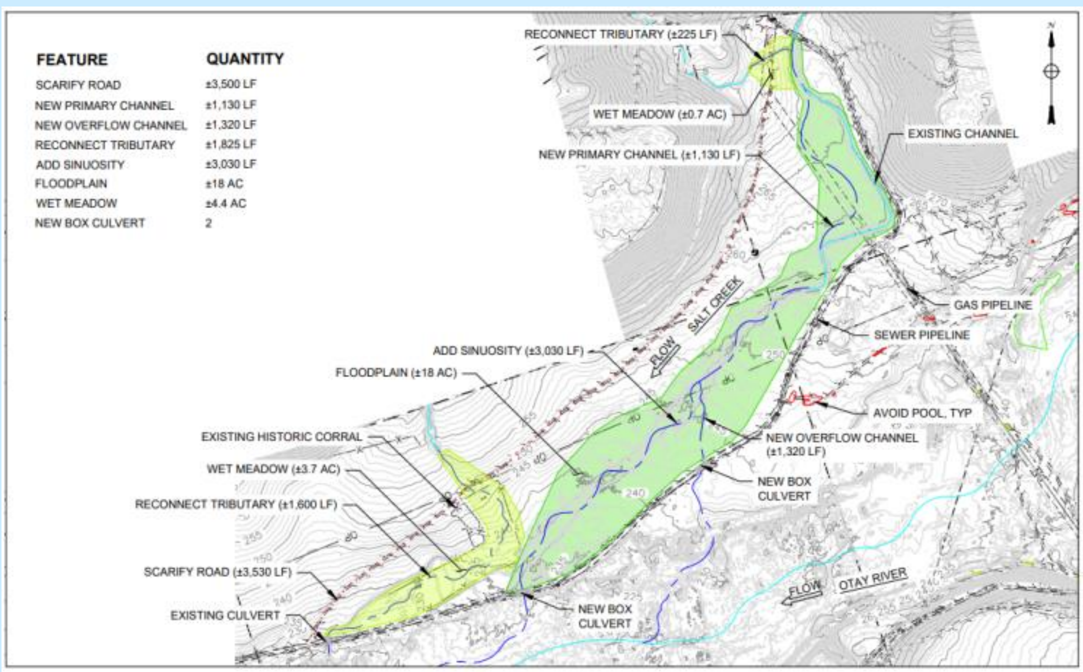
[4] There is 90% confidence that an Index Score is significantly greater than another Index Score if the score is more than or equal to 7 points different (CWMW, 2019).

Problem Statement

Salt Creek originates in National Wildlife Refuge land near San Miguel Mountain and flows into the northeast section of the Otay Mitigation Bank (Bank) (ICF, 2021). It is one of the primary tributary creeks of the Bank and may be implemented as a future phase of restoration work in the area (Problem Statement Figure 1). At this time Salt Creek is heavily incised and contained within a historically rerouted channel rather than the historical alluvial confluence.

The basic concept for this phase includes reestablishing the historical braided channel network and broad confluence connection with the Otay River Mainstem. In-stream structures and an increase in base elevations would help re-engage the currently cutoff floodplain and encourage breakout onto the valley floor. In addition, the channel banks would be set back and sinuosity would be added to the mainstem creek channel. Removal of non-native/invasive species in the creek would occur and the area would be revegetated with appropriate native riparian and floodplain species.

Salt Creek provides an example of how design intent can have a significant impact on the volume of credits generated by a project. For example, a larger provided capture volume for retention and vegetation filtration can be achieved by increasing the inundated area through design. Raising an incised channel, reconnecting the floodplain, or adding benches may all increase amount of treatable flow during the 85th percentile, 24-hour storm event. These design elements can also have a positive impact on the Ecological Condition Factor due to attributes like topographic complexity, hydrologic connectivity, and channel stability in the CRAM score. The planting plan for a restored channel may also be curated to increase the CRAM score for biotic structure, including number of plant layers, co-dominant species, percent of native fauna, and buffer width.



Problem Statement Figure 1. Concept Design for Salt Creek.

Part I: WQE for Stormwater Pollutant Control

Step 1: PDP Stormwater Pollutant Control Calculations

This is an Independent ACP and information pertaining to a specific PDP is not available to the ACP applicant at this time. Therefore, this step is not applicable for this ACP.

Step 2: ACP Stormwater Pollutant Control Calculations

The Earned Stormwater Pollutant Control Volume will be calculated per Equation 2-1 (RWQCB, 2018):

$V_E = L\ (\Delta V + V_2 N_2 - V_1 N_1)$

Where:
V_E: Earned stormwater pollutant control volume of ACP project (ft^3)
L: Land use factor
ΔV: Change in design capture volume ($V_1 - V_2$)
V_1: Impacted condition design capture volume for ACP project
V_2: Mitigated condition design capture volume for ACP project
N_1: Impacted condition NSMP efficacy factor
N_2: Mitigation condition NSMP efficacy factor

<u>Task 2-1: Determine Design Capture Volume (DCV) Tributary to the ACP (V_1, V_2, ΔV)</u>

In order to perform water quality equivalency calculations, the ACP applicant must determine the impacted condition DCV (V_1), the mitigated condition DCV (V_2), and the change in DCV (ΔV) as presented below.

Task 2-1A: Calculate Impacted Condition DCV (V_1)

The applicant delineates an ACP tributary area of 3,900 acres and identifies an 85th percentile rainfall depth of 0.52 inches per NOAA Atlas 14. Per methods presented in Appendix B.1 of the BMPDM, the area weighted average runoff coefficient is calculated as 0.38 based on land use. Therefore, the impacted condition DCV (V_1) for this project is calculated as:

d = 0.52 in A = 3901 acres C = 0.38

V_1 = Runoff Coefficient x Rainfall Depth x Tributary Area

$V_1 = 0.38 \times 0.52 \text{ in} \times 3{,}901 \text{ ac} \times (43{,}560 \text{ ft}^2/1 \text{ ac}) \times (1 \text{ foot}/12 \text{ in}) = 2{,}798{,}140$ cubic feet

Task 2-1B: Calculate Mitigated Condition DCV (V2)

The proposed ACP does not alter runoff coefficients within the ACP tributary; therefore, the mitigated condition DCV is equal to the impacted condition DCV ($V_1 = V_2$).

V_2 = Runoff Coefficient x Rainfall Depth x Tributary Area

$V_2 = 0.38 \times 0.52 \text{ in} \times 3{,}901 \text{ ac} \times (43{,}560 \text{ ft}^2/1 \text{ ac}) \times (1 \text{ foot}/12 \text{ in}) = 2{,}798{,}140$ cubic feet

Task 2-1C: Calculate Change in DCV (ΔV)

The impacted condition DCV is the same as the mitigated condition DCV; therefore, the change in DCV is calculated as:

$\Delta V = V_1 - V_2$

ΔV = 2,798,140 cubic feet – 2,798,140 cubic feet = 0 cubic feet

<u>Task 2-2: Calculate Land Use Factor</u>

In order to calculate an appropriate land use factor, the ACP applicant must identify the WQE pollutants of concern, calculate relative pollutant concentrations for the ACP tributary, and calculate relative pollutant concentrations for the reference tributary.

Task 2-2A: WQE Pollutants of Concern

The ACP is identified to be within the San Diego Bay WMA and Otay hydrologic unit, so the WQE pollutants of concern are TSS, TN, TCu, and FC per Table 2-1 (RWQCB, 2018).

Task 2-2B: ACP Tributary Relative Pollutant Concentrations

The ACP tributary is characterized by the land uses identified in the problem statement above.

Task 2-2C: Reference Tributary Relative Pollutant Concentrations

The reference tributary for an independent ACP is the sub-watershed it's located within. For this example, Salt Creek is located in the Otay Sub-Watershed.

Task 2-2D: Determine Land Use Factors

The appropriate land use compositions and associated runoff factors are then tabulated into the input fields of Worksheet A.5 and associated land use factors are calculated for each WQE pollutant of concern through utilization of Equation 2-2 (RWQCB, 2018). This step may also be performed through utilization of the automated land use factor calculation tool available on www.projectcleanwater.org, as is demonstrated in this example. (Problem Statement Table 1). The lowest resulting land use factor is selected for incorporation into the stormwater pollutant reduction calculations. Therefore, the land use factor for this ACP is based on Total Suspended Solids (TSS) which equals 0.32 as depicted in the table below.

<u>Task 2-3: Calculate NSMP Efficacy Factors (N1, N2)</u>

NSMP efficacy factors are a function of an ACP's pollutant removal efficiency and provided capture values (ICF, 2023). In order to perform water quality equivalency calculations, the applicant must determine the impacted condition NSMP efficacy factor (N_1), and the mitigated condition NSMP efficacy factor (N_2) for the ACP.

$N = N_{Retention} + N_{Sediment} + N_{Vegetation} = C_R E_R + C_S E_S + (C_V E_V$ * Ecological Condition Factor$)$

Where:
C_R: Provided capture by retention
E_R: Pollutant removal by retention
C_S: Provided capture by sediment
E_S: Pollutant removal by sediment
C_V: Provided capture by vegetation
E_V: Pollutant removal by vegetation
Ecological Condition Factor: Multiplier

Land Use Designation	ACP Tributary Characteristics		Reference Tributary Characteristics		Relative Pollutant Concentrations by Land Use						
	Area (Acres)	Runoff Factor	Area (Acres)	Runoff Factor	TSS	TP	TN	Tcu	TPb	TZn	FC
Agriculture	0	0.10	0	0.10	0.45	1.00	1.00	1.00	1.00	0.59	1.00
Commercial	82	0.80	2,375	0.80	0.13	0.16	0.16	0.56	0.48	1.00	0.87
Education	450	0.50	1,271	0.50	0.13	0.20	0.11	0.14	0.25	0.39	0.13
Industrial	88	0.90	3,184	0.90	0.13	0.19	0.15	0.54	0.68	0.89	0.49
Multi-Family Residential	383	0.60	2,291	0.60	0.10	0.13	0.13	0.14	0.15	0.29	0.27
Orchard	0	0.10	0	0.10	0.18	0.17	0.67	1.00	1.00	0.59	0.11
Rural Residential	0	0.30	24,768	0.30	1.00	0.51	0.14	0.10	0.71	0.13	0.19
Single Family Residential	803	0.40	5,302	0.40	0.13	0.20	0.15	0.27	0.43	0.35	0.63
Transportation	420	0.90	5,141	0.90	0.11	0.26	0.12	0.53	0.31	0.62	0.12
Vacant / Open Space	1,675	0.10	49,056	0.10	0.16	0.10	0.10	0.12	0.10	0.10	0.10
Water	0	0.00	1,048	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	3,901	0.38	94,436	0.27	-	-	-	-	-	-	-
Relative Pollutant Concentration for ACP Tributary					0.12	0.19	0.13	0.31	0.31	0.45	0.31
Relative Pollutant Concentration for Reference Tributary					0.38	0.27	0.13	0.28	0.44	0.39	0.28
Watershed Management Area					San Diego Bay						
Hydrologic Unit					Otay (910.00)						
Land Use Factor					0.32	-	0.98	1.10	-	-	1.09

Problem Statement Table 1. Land Use Factor Calculations for Salt Creek

Task 2-3A: Impacted Condition NSMP Efficacy Factor (N_1)

The impacted condition of a stream rehabilitation NSMP corresponds with the existing, degraded conditions of the stream and surrounding land that will be improved by rehabilitation. As outlined in the example statement, this site currently contains some stream function and riparian vegetation. Therefore, the impacted condition does provide some level of pollutant removal currently and the efficacy factor (N_1) is calculated as follows.

The hydraulic analysis of the existing and proposed conditions was performed using the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center River Analysis System (HEC-RAS) Version 5.0.7 computer program, a one- and two-dimensional hydraulic numerical model. This HEC-RAS model required the computation of a hydrograph to simulate the DCV, which was completed the US Army Corps of Engineers Hydraulic Engineering Center Hydrology Modeling System (HEC-HMS) v4.3 software. The DCV hydrograph was run through the Salt Creek site to generate inundation area and depths over the course of the storm for existing terrain (Problem Statement Figure 2).

Retention

$N_{Retention} = C_R E_R = (C_{R\_Infiltration} + C_{R\_Evapotranspiration}) * E_R$

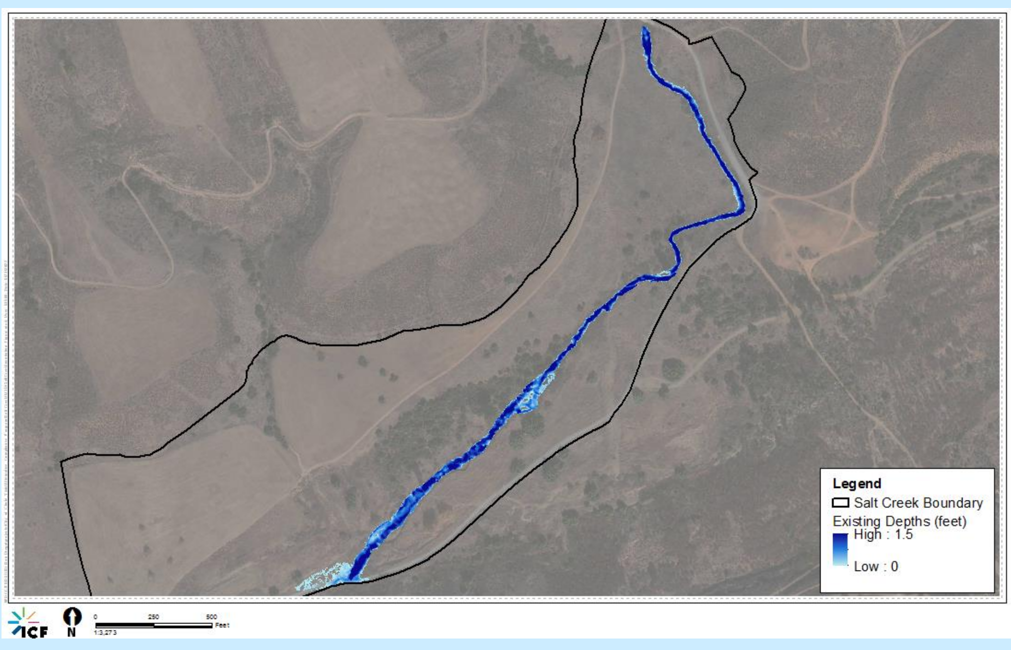
$C_{R\_Infiltration} = (A*K_{sat}*t*3630)/DCV$

$C_{R\_Evapotranspiration} = (A*ET*t*3630)/DCV$

C_R = (2.1 acres inundated) * [(0.38 in/hr infiltrated * 3-hr inundation duration * 3630 cf/acre-in) + (0.085 in/day evapotranspired * 3-hr evapotranspiration duration * 3630 cf/acre-in)] / (2,798,140 cf) = 0.0031

E_R = 1.0

N_R =0.004 * 1.0 = 0.0031



Problem Statement Figure 2. Existing Salt Creek hydraulic results.

Sediment

Although Salt Creek historically experienced erosion and currently has an incised channel, Salt Creek does not currently experience active erosion issues that would be analyzed in this section. Therefore, all values are zero.

S_1= 0

S_2 = 0

C_S = (0 – 0)/0 = 0

Vegetation

To determine provided capture by vegetation under existing conditions, the maximum inundation could be used to conservatively estimate the percent of DCV that is less than 1.5 feet. From the HEC-RAS modeling for Salt Creek, the maximum depth raster was generated and exported. In GIS, the volume of the raster that intersected with vegetation was computed to be 133,984 cubic-feet. Then the volume was re-calculated where cells could only have a maximum depth of 1.5 feet, resulting in a total treated volume of 118,027 cubic-feet. It was assumed that this maximum inundation (at the peak of the hydrograph) would be the moment where depths are deepest – therefore the rising and falling limbs of the hydrograph would have shallower results. The volume of depths less than 1.5 feet divided by the total volume for the maximum inundation was equal to 88%. Therefore, 88% of the DCV flowing through the site will experience filtration by vegetation. Existing conditions for Salt Creek were evaluated using CRAM, which generated a score of 68.

$N_{Vegetation}$ = C_V*E_V*Ecological Condition Factor

C_V = 0.88

E_V = 0.19

CRAM Score = 68

Ecological Condition Factor = 1.0

N_V = 0.88 * 0.19 * 1.0

N_V = 0.167

Task 2-3B: Mitigated Condition NSMP Efficacy Factor (N2)

Stream rehabilitation is a NSMP implemented to restore predevelopment watershed functions and provide direct management of stormwater pollutant control and hydromodification flow control. NSMPs may include structural/engineered elements, but these elements do not expressly provide stormwater pollutant control benefits. The mitigated condition NSMP efficacy factor (N_2) is based on the proposed site design and is calculated as follows.

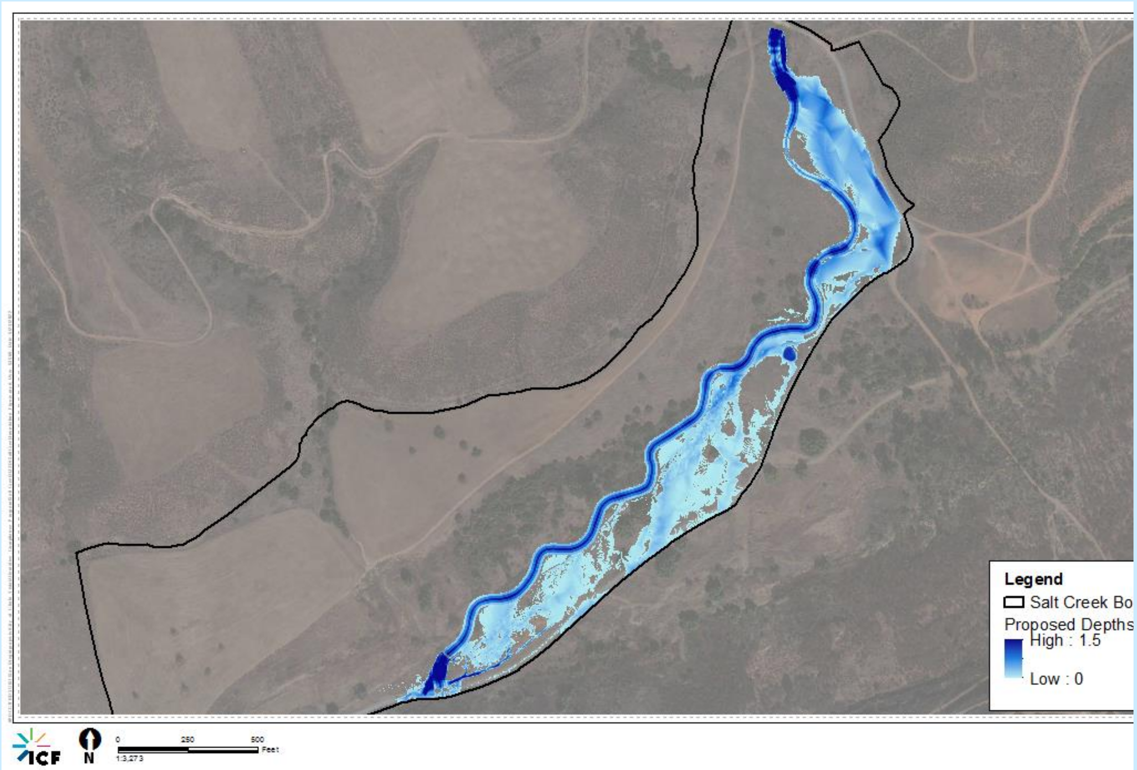
Retention

Salt Creek was re-modeled in HEC-RAS to generate inundation area and depths over the course of the storm for the proposed grading (Problem Statement Figure 3). The infiltration rate and evapotranspiration rate is unchanged from existing conditions.

C_R = (11.9 acres inundated) * [(0.38 in/hr infiltrated * 3-hr inundation duration * 3630 cf/acre-in) + (0.085 in/hr evapotranspired * 3630 cf/acre-in)] / (2,798,140 cf) = 0.018

E_R = 1.0

N_R = 0.018 * 1.0 = 0.018



Problem Statement Figure 3. Proposed Salt Creek hydraulic results.

Sediment

Although Salt Creek historically experienced erosion and currently has an incised channel, the proposed design for Salt Creek does not currently experience active erosion issues that would be analyzed in this section. Therefore, all values are zero.

$S_1 = 0$

$S_2 = 0$

$C_S = (0 - 0)/0 = 0$

Vegetation

The same process to determine provided capture above was completed for proposed conditions. The total volume was 183,395 cubic-feet, and the volume less than 1.5 feet was 173,606 cubic-feet. The ratio of these values was 95%.

$C_{V2} = 0.95$

$E_{V2} = 0.19$

Theoretical estimated CRAM Score = 83

Magnitude of Change = (83 – 68) / 7 = 2.14

Ecological Condition $Factor_2 = 2.14$

$N_{V2} = 0.95 * 0.19 * 2.14 = 0.385$

Task 2-4: Calculate Earned Stormwater Pollutant Control Volume (V_E)

The Earned Stormwater Pollutant Control Volume for an ACP is calculated by populating Equation 2-1 (RWQCB, 2018) with the appropriate volumes, land use factors, and NSMP efficacy factors determined per the guidelines set forth in the memo from ICF (2023). The Earned Stormwater Pollutant Control Volume for this ACP is calculated as:

$DCV = V_1 = V_2 = 2{,}798{,}140$ cf

$L = 0.32$

$\Delta V = 0$

$N_1 = 0.0031 + 0 + 0.167 = 0.170$

$N_2 = 0.018 + 0 + 0.385 = 0.403$

$V_E = 0.32*(0 + (2{,}798{,}140 \text{ cf} * 0.403) – (2{,}798{,}140 * 0.170)) = 211{,}304$ cf water quality pollution credits

Step 3: Determination of Stormwater Pollutant Control Credits

An overall water quality benefit for stormwater pollutant control can be demonstrated if the Earned Stormwater Pollutant Control Volume calculated in Step 2 is greater than or equal to the Deficit of Stormwater Pollutant Control Volume calculated in Step 1. Because this is an independent ACP, a volume has not yet been determined for Step 1. Therefore, the Earned Stormwater Pollutant Control Volume Credit of 211,304 cubic feet may be banked for potential future purchase by a PDP applicant with a Deficit of Stormwater Pollutant Control Volume of 211,304 cubic feet or less.

Part II: WQE for Hydromodification Flow Control

The project reach discharges to the Otay River, which is an exempt water body. Therefore, no hydromodification flow control credits will be generated by this project. Projects discharging to non-exempt systems should refer to Section 3 “Water Quality Equivalency Calculations For Hydromodification Flow Control” of the Regional WQE Guidance (2018) to calculate hydromodification credits.

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Appendices

Chesapeake Bay Report

Two groups of more than 25 experts worked to improve floodplain restoration project protocols for pollutant removal credits in the Chesapeake Bay Watershed (Altland et al., 2020). Stream restoration projects in this jurisdiction can qualify for credit by calculating denitrification in the hyporheic zone and the floodplain treatment volume. Our team used the methodology for calculating floodplain treatment volume to compare the generated credits to the results of the WQE equation for NSMPs.

This methodology was also used to calibrate County of San Diego Rainbow Creek Stream Restoration Tool, indicating its usefulness in locations beyond the East Coast. The flow duration curve for this exercise was created using a Storm Water Management Model (SWMM) for Salt Creek and its watershed (Appendix Figure 1) and the results were analyzed using the Federal Highway Administration's Hydraulic Toolbox (Appendix Table 1).

Chesapeake Bay Methodology

Determine Treatment depth in Floodplain Trapping Zone (FTZ)

Treatment depth = 0.5 ft (due to the incised condition of Salt Creek)

Identify the channel flow, floodplain flow at the treatment depth in the FTZ and mean baseflow

Baseflow = 5.7 cfs

Channel flow = 190 cfs (proposed conditions only, existing conditions are too incised)

Floodplain flow above 0.5 ft depth = 532 cfs (proposed conditions only, existing conditions are too incised)

Develop an appropriate flow duration curve

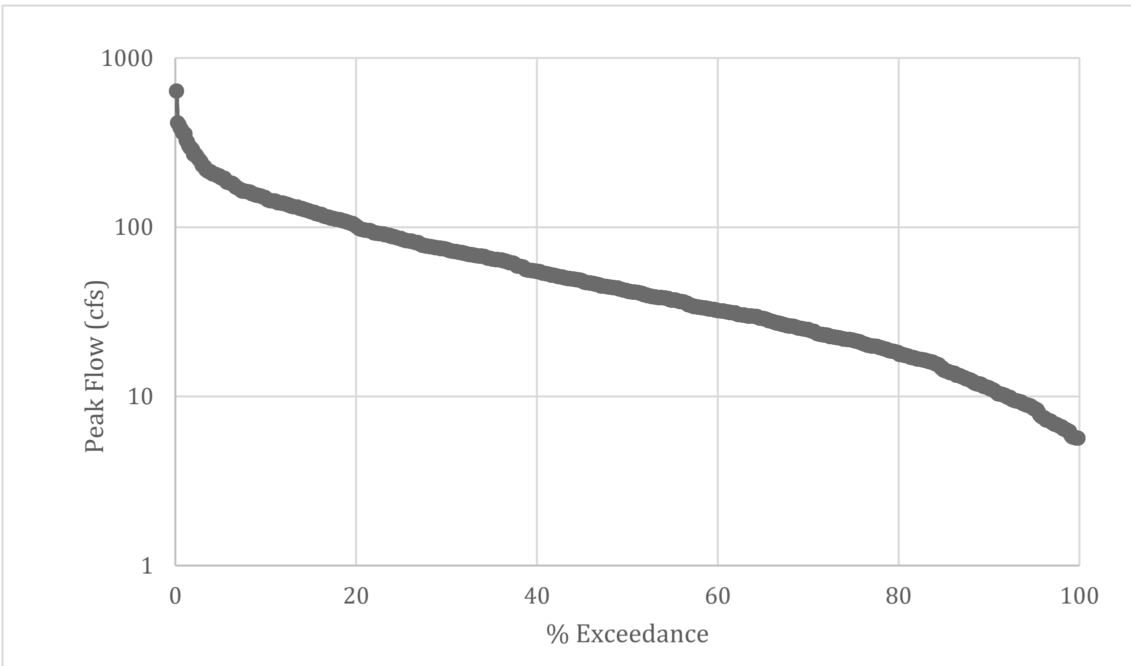
Treatable flow = (baseflow + area under the curve between Q_{1ft} and $Q_{channel}$) / total area under the curve above baseflow

Existing treatable flow = (5.7 cfs + 0) / 5713 cfs = 0.1%

Proposed treatable flow = (5.7 cfs + 860 cfs) / 4176 cfs = 20.7%

Appendix Table 1. Comparison of Flow Attributes for Existing to Proposed Conditions

Flow Attribute	Existing Conditions	Proposed Conditions
Total Flow (cfs)	638	638
Channel Flow (cfs)	0	190
Flow over 0.5 ft (cfs)	0	523
Baseflow (cfs)	5.7	5.7
Area under curve above baseflow	5713	4176
Treatable Flow (%)	0.1	20.7



Appendix Figure 1. Flow Duration Curve for Salt Creek

<u>Determine the treatable flow</u>

Percent of treatable flow = Proposed treatable flow – Existing treatable flow
= 20.7% - 0.1% = 20.6%

<u>Determine the load delivered to the project site</u>

Treatable pollutant load = Treatable flow * DCV * Pollutant concentration

TSS treatable load = 20.6% * 2,192,636 ft^3 * 639.08 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) * (1ton/2000lbs) = 9 tons

TP treatable load= 20.6% * 2,192,636 ft^3 * 0.84 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 23.7 lbs

TN treatable load= 20.6% * 2,192,636 ft^3 * 5.56 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 156.6 lbs

Apply the appropriate Wetland Pollutant Removal Efficiencies

Pollutant load reduction = Treatable pollutant load * Pollutant removal efficiency

Where removal efficiencies for: TSS = 19%, TP = 22%, TN = 16%

TSS removed = 9 tons * 19% = 1.7 tons

TP removed = 23.7 lbs * 22% = 5.2 lbs

TN removed = 156.6 lbs * 16% = 25.1 lbs

Comparison to WQE Methodology

Pollutant load reduction = Pollutant control volume (V_E) * Pollutant Concentration

When the Ecological Condition Factor for Salt Creek is equal to 1.0:

TSS treatable load = 67,933 ft^3 * 639.08 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) * (1ton/2000lbs) = 1.4 tons

TP treatable load= 76,202 ft^3 * 0.84 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 3.6 lbs

TN treatable load= 76,202 ft^3 * 5.56 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 23.7 lbs

When the Ecological Condition Factor for Salt Creek is equal to 2.2:

TSS treatable load = 546,804 ft^3 * 639.08 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) * (1ton/2000lbs) = 4.5 tons

TP treatable load= 546,804 ft^3 * 0.84 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 11.9 lbs

TN treatable load= 546,804 ft^3 * 5.56 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 78.9 lbs

Appendix Table 2. Pollutant Load Removal Comparison Between WQE and Chesapeake Methodologies

	Pollutant Load Reduction		
	Chesapeake Methodology	**WQE Methodology (ECF = 1.0)**	**WQE Methodology (ECF = 2.2)**
TSS Removed (tons)	1.7	1.5	4.5
TP Removed (lbs)	5.2	4.0	11.9
TN Removed (lbs)	25.1	26.4	78.9

Appendix B
Vegetation Pollutant Removal Efficiencies

When developing the pollutant removal efficiency for vegetation in the NSMP WQE equation, many sources were consulted to determine realistic removal rates. Appendix Table 3 illustrates the range of values that are presented in the literature for a variety of rehabilitation methods and pollutant types. There is a high variability in reported pollutant removal efficacies, with 51%-85% variation in reported efficacy for the different pollutants. Evidently the pollutant removal efficiency of a natural system is difficult to set consistently across projects that have varying designs, watershed sizes, pollutant types, and vegetation cover. Therefore, this memorandum instead used the standard values of pollutant removal for BMPs to be comparable to approved methodology.

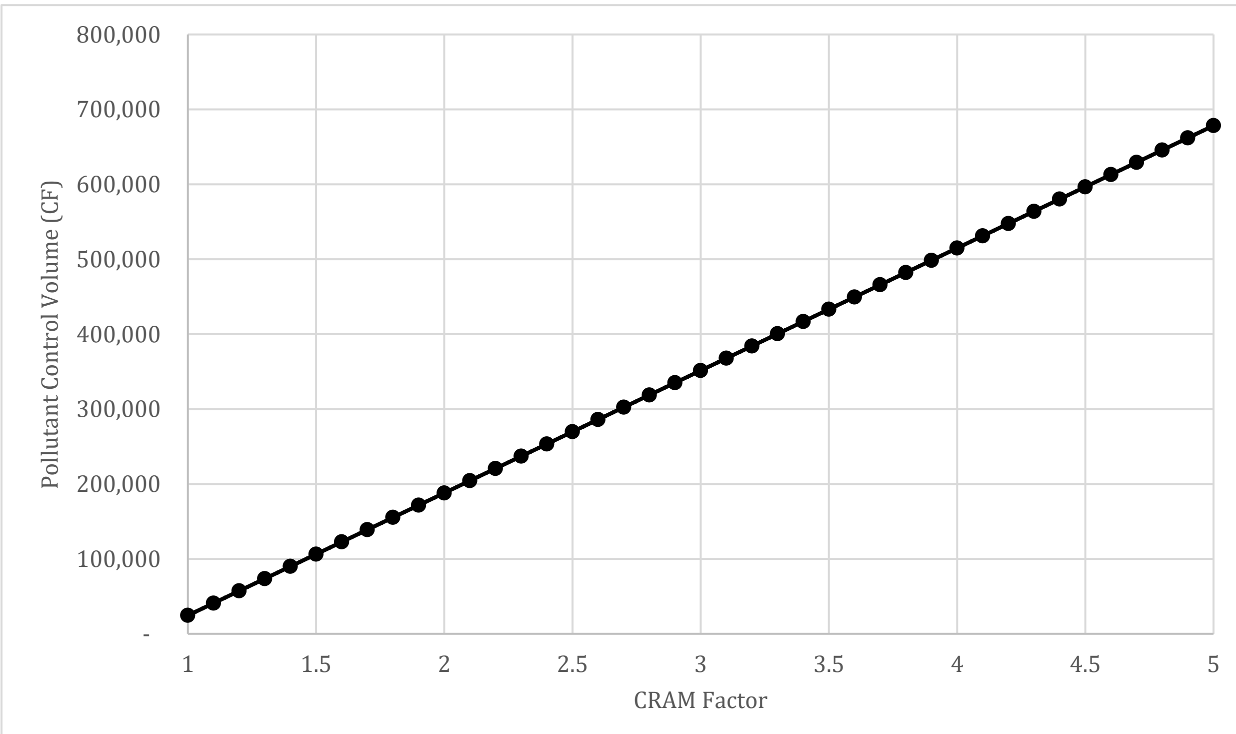
Appendix Table 3. Pollutant Removal Efficiencies from Literature Review.

		Removal Rate (%) per Pollutant Type		
Source	**Restoration Type**	**TN**	**TP**	**TSS**
Berg et al. (2013)	Stream Restoration	42	43	83
Altland et al. (2020)	Stream Restoration	71	71	71
Jordan et al. (2009)	Forest Buffer	45	42	53
Hawes & Smith (2005)	Forest Buffer	61	53	80
Fennessy and Cronk (1997)	Forest Buffer	70	-	-
Xu et al. (1992)	Forest Buffer	100	-	-
Shisler et al. (1987)	Forest Buffer	89	80	-
Jordan et al. (2009)	Grass Buffer	32	40	53
Neibling & Alberts (1979)	Grass Buffer	-	-	91
Borin & Bigon (2002)	Grass Buffer	81	-	-
Dillaha et al. (1989)	Grass Buffer	79	73	84
Dillaha et al. (1989)	Grass Buffer	61	54	70
Ghaffarzadeh et al. (1992)	Grass Buffer	-	-	85
Jordan et al. (2009)	Wetland	15	29	15
CCWG (2020)	Wetland	88	89	85
Ludwig (2010)	Wetland	29	23	71
Cooper (1994)	Wetland	66	-	-
Cooper (1990)	Wetland	93	-	-
Overall Minimum			**15**	
Overall Maximum			**100**	

Appendix C
Sensitivity Analysis for the Ecological Condition Factor

To understand the influence of the Ecological Condition Factor on the overall WQE, a sensitivity analysis was conducted for the Salt Creek case study. While keeping all other values the same, the equation was calculated for a large range of Ecological Condition Factor values, starting at 1 and increasing by 0.1 to a maximum value of 5.

For every 0.1 point added to the Ecological Condition Factor for Salt Creek, the resulting pollutant credit volume increases by approximately 16,344 cubic-feet (Appendix Figure 2).

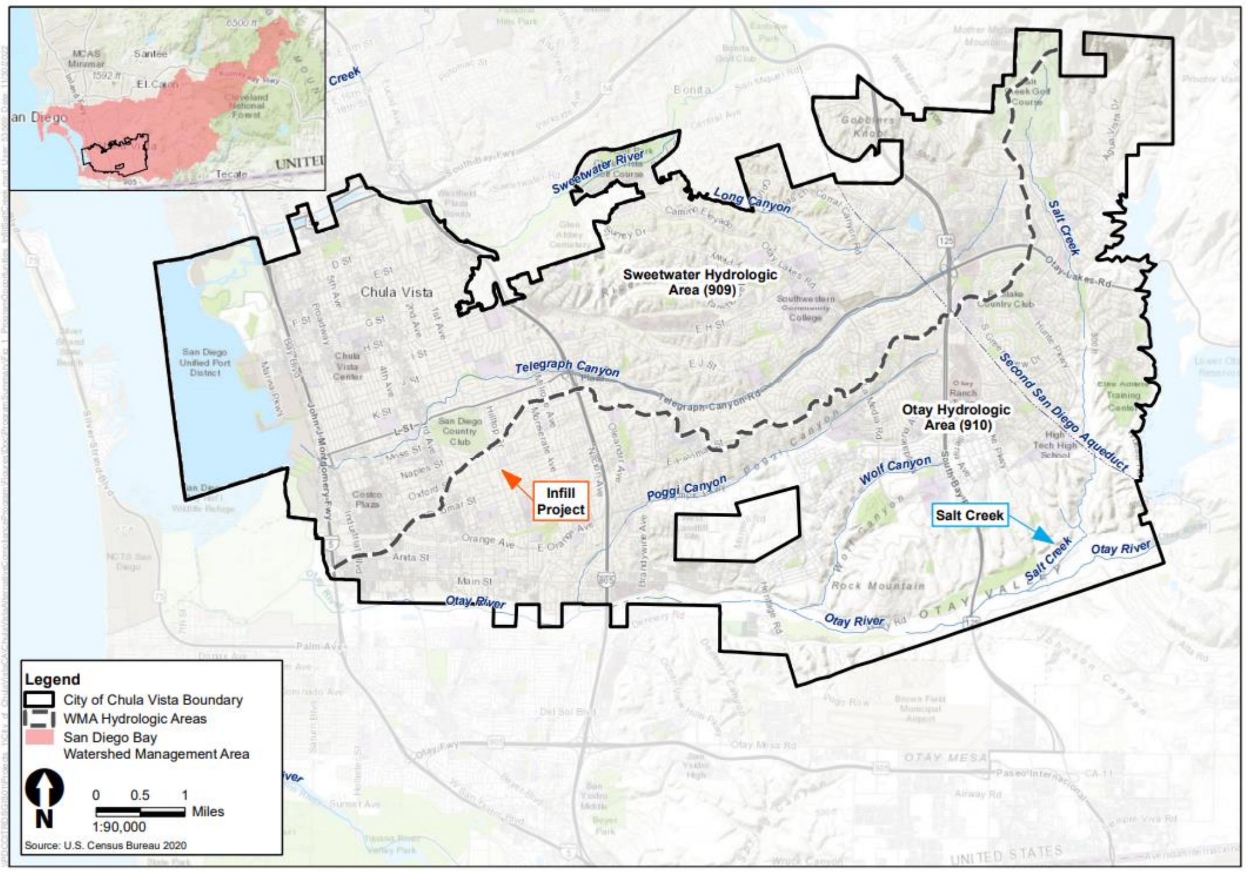


Appendix Figure 2. Change in credit volume for Salt Creek depending on Ecological Condition factor used.

Appendix D
Case Studies

Overview

The pollutant credit volumes and costs of two case studies were calculated and compared using the NSMP and BMP equations. Based on existing and opportune locations within the City of Chula Vista, one NSMP (Salt Creek) and one structural BMP (Infill Project) were selected for comparison (Appendix Figure 3). These case studies were selected due to the availability of design data and cost information, familiarity to the authors, and the range of existing conditions and design intents provided by each location.



Appendix Figure 3. Case study locations within the City of Chula Vista

Each case study covers:

- Background information on the project
- Calculations for existing and proposed conditions with net credit volume
- Cost assessment for all components of each project

The cost assessment breaks down the various components of a project, as shown in Appendix Table 4.

Appendix Table 4. Overview of costs considered in the exercise for BMPs and NSMPs

Onsite (Structural BMP)	Offsite (NSMP)
Capital Cost	**Capital Cost**
Project Management	Project Management
Design & Evaluation	Design & Evaluation
Construction	Construction
Permits	Permits
Success Period	**Success Period**
-	Annual Monitoring
-	Annual Maintenance
Long-Term Maintenance	**Long-Term Maintenance**
Annual Monitoring	Annual Monitoring
Annual Maintenance	Annual Maintenance
Recurring Significant Maintenance (5yrs)	-
Monitoring Present Value	Monitoring Present Value
Maintenance Present Value	Maintenance Present Value
Structural BMP Replacement – Present Value	-
Recurring Large Maintenance (5yrs) – Present Value	-
Discount factor = 2%	Discount factor = 2%
Land	**Land**
Opportunity Cost ($2 million per acre)	Onsite Flow-Thru
Assumed that land is used for housing	-
City Admin	**City Admin**
Plan Review / Certification	Plan Review / Certification
Recertification Inspections	Recertification Inspections

Project management costs including reporting, meetings, stakeholder coordination, administration support, and general project tracking.

The cost for design includes earthwork and landscape engineering from concept to 100 percent, approvals, inspections, and similar components. It is estimated to be 10 percent of hard (construction) costs.

Construction covers labor, grading, and materials. For NSMPs this may include site prep, rough and finish grading, surveying, trails and access roads, cleanup, planting, and irrigation. For BMPs this cost would also include storm drain materials, media layers, liners, and other miscellaneous components.

The success period includes the costs associated with the first 5 years of monitoring and maintenance for NSMPs, which are typically higher than the annual long-term maintenance and monitoring costs and thus are accounted for separately.

Long-term monitoring includes annual assessments of the state of the NSMP to ensure that it remains a natural system and has not suffered any major natural or anthropogenic event that removes or reduces its function, or incurred any minor damage that would affect the condition and function of the NSMP. Long-term maintenance costs include annual maintenance, along with recurring large maintenance (5 years), significant maintenance and end-of-life replacement present value for structural BMPs.

Land acquisition is not included under the assumption that future projects in this program will be implemented on City-owned lands. NSMPs may be located on privately owned lands that are placed under a conservation easement or similar perpetual site protection mechanism.

Permit costs vary. NSMPs include CEQA coordination, biological resources, cultural resources, regulatory permitting, jurisdictional delineation, surveys, and environmental site assessments. BMPs include regulatory permitting, plan check, and inspect. This is assumed to be 4 percent of hard (construction) costs.

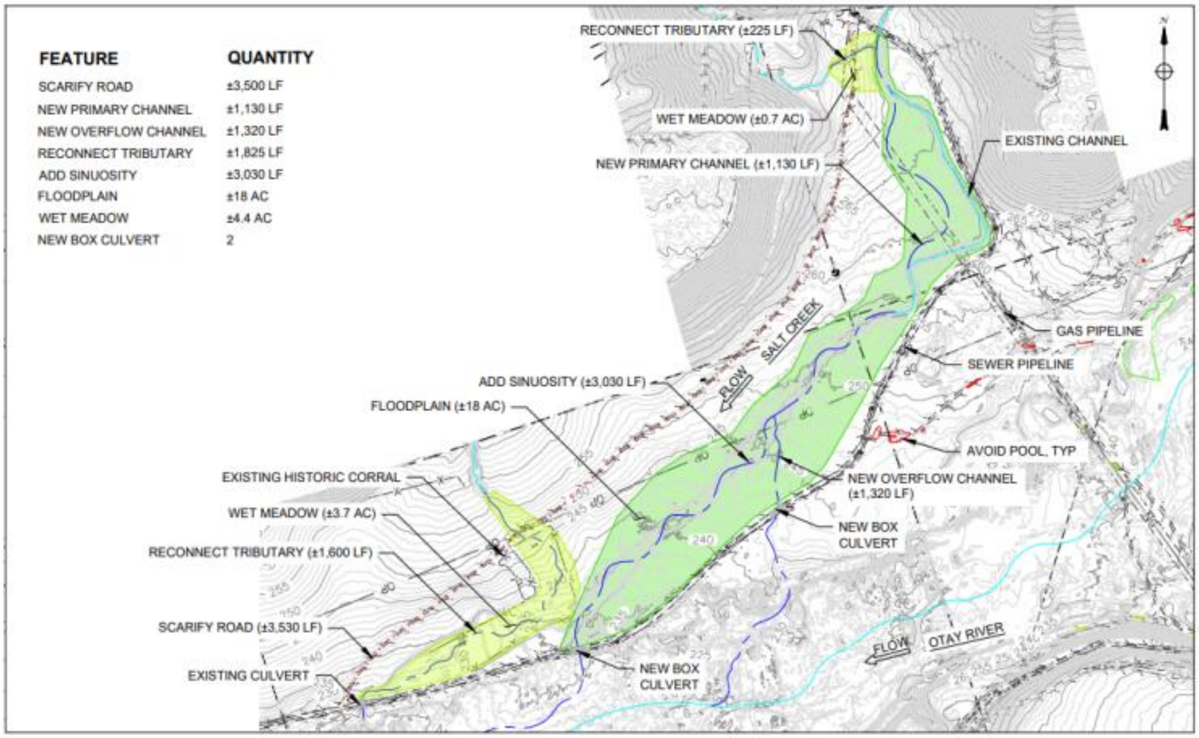
Salt Creek

Background

Salt Creek originates in National Wildlife Refuge land near San Miguel Mountain and flows into the northeast section of the Otay Mitigation Bank (Bank) (ICF, 2021). It is one of the primary tributary creeks of the Bank and may be implemented as a future phase of restoration work in the area (Appendix Figure 4). At this time Salt Creek is heavily incised and contained within a historically rerouted channel rather than the historical alluvial confluence.

The basic concept for this phase includes reestablishing the historical braided channel network and broad confluence connection with the Otay River Mainstem. In-stream structures and an increase in base elevations would help re-engage the currently cutoff floodplain and encourage breakout onto the valley floor. In addition, the channel banks would be set back and sinuosity would be added to the mainstem creek channel. Removal of non-native/invasive species in the creek would occur and the area would be revegetated with appropriate native riparian and floodplain species.

Salt Creek provides an example of how design intent can have a significant impact on the volume of credits generated by a project. For example, a larger provided capture volume for retention and vegetation filtration can be achieved by increasing the inundated area through design. Raising an incised channel, reconnecting the floodplain, or adding benches may all increase amount of treatable flow during the 85th percentile, 24-hour storm event. These design elements can also have a positive impact on the Ecological Condition Factor due to attributes like topographic complexity, hydrologic connectivity, and channel stability in the CRAM score. The planting plan for a restored channel may also be curated to increase the CRAM score for biotic structure, including number of plant layers, co-dominant species, percent of native fauna, and buffer width.



Appendix Figure 4. Concept design for Salt Creek

Credit Calculations

Design Capture Volume

d = 0.52 in

A = 3901 acres

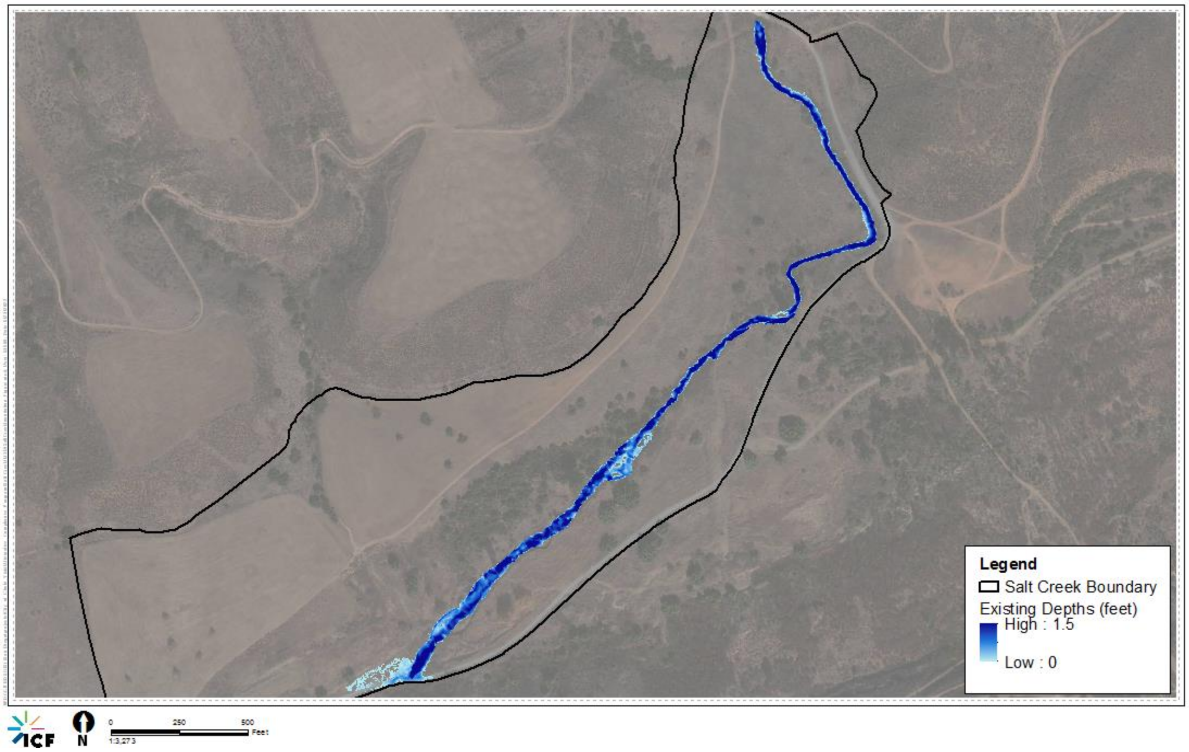
C = 0.38

V_1 = Runoff Coefficient x Rainfall Depth x Tributary Area

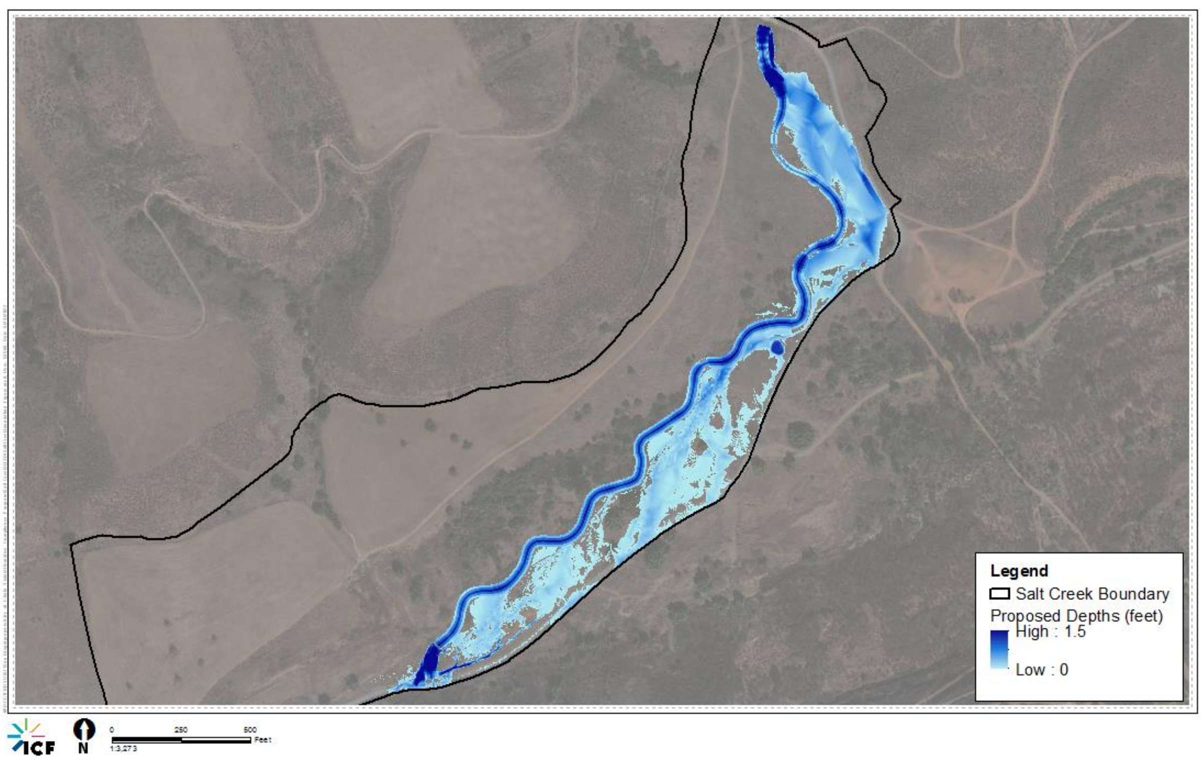
V_1 = 0.38 x 0.52 in x 3,901 ac x (43,560 ft^2 /1 ac) x (1 foot/12 in) = 2,798,140 cubic feet

Modeling performed for the case study

The hydraulic analysis of the existing and proposed conditions was performed using the U.S. Army Corps of Engineer's Hydrologic Engineering Center River Analysis System (HEC-RAS) Version 5.0.7 computer program, a one- and two-dimensional hydraulic numerical model. This HEC-RAS model required the computation of a hydrograph to simulate the DCV, which was completed the US Army Corps of Engineers Hydraulic Engineering Center Hydrology Modeling System (HEC-HMS) v4.3 software. The DCV hydrograph was run through the Salt Creek site to generate inundation area and depths over the course of the storm for existing terrain and proposed grading.



Appendix Figure 5. Existing Salt Creek hydraulic results.



Appendix Figure 6. Proposed Salt Creek hydraulic results.

Retention

Existing Conditions

C_R = (2.1 acres inundated) * [(0.38 in/hr infiltrated * 3-hr inundation duration * 3630 cf/acre-in) + (0.085 in/day evapotranspired * 3-hr evapotranspiration duration * 3630 cf/acre-in)] / (2,798,140 cf) = 0.0031

E_R = 1.0

N_R = 0.0031 * 1.0 = 0.0031

Proposed Conditions

C_R = (11.9 acres inundated) * [(0.38 in/hr infiltrated * 3-hr inundation duration * 3630 cf/acre-in) + (0.085 in/hr evapotranspired * 3630 cf/acre-in)] / (2,798,140 cf) = 0.018

E_R = 1.0

N_R = 0.018 * 1.0 = 0.018

Sediment

Although Salt Creek historically experienced erosion and currently has an incised channel, Salt Creek does not currently experience active erosion issues that would be analyzed in this section. Therefore, all values are zero.

S_1= 0

S_2 = 0

C_S = (0 – 0)/0 = 0

Vegetation

Existing Conditions

To determine provided capture by vegetation under existing conditions, the maximum inundation could be used to conservatively estimate the percent of DCV that is less than 1.5 feet. From the HEC-RAS modeling for Salt Creek, the maximum depth raster was generated and exported. In GIS, the volume of the raster that intersected with vegetation was computed to be 133,984 cubic-feet. Then the volume was re-calculated where cells could only have a maximum depth of 1.5 feet, resulting in a total treated volume of 118,027 cubic-feet. It was assumed that this maximum inundation (at the peak of the hydrograph) would be the moment where depths are deepest – therefore the rising and falling limbs of the hydrograph would have shallower results. The volume of depths less than 1.5 feet divided by the total volume for the maximum inundation was equal to 88%. Therefore, 88% of the DCV flowing through the site will experience filtration by vegetation.

C_{V1} = 0.88

E_{V1} = 0.19

CRAM Score = 68

Ecological Condition $Factor_1$ = 1.0

N_{V1} = 0.88 * 0.19 * 1.0 = 0.167

<u>Proposed Conditions</u>

The same process to determine provided capture above was completed for proposed conditions. The total volume was 183,395 cubic-feet, and the volume less than 1.5 feet was 173,606 cubic-feet. The ratio of these values was 95%.

C_{V2} = 0.95

E_{V2} = 0.19

Theoretical estimated CRAM Score = 83

Magnitude of Change = (83 – 68) / 7 = 2.14

Ecological Condition $Factor_2$ = 2.14

N_{V2} = 0.95 * 0.19 * 2.14 = 0.385

Net Credit Volume

DCV = V_1 = V_2 = 2,798,140 cf

L = 0.32

ΔV = 0

N_1 = 0.0031 + 0 + 0.167 = 0.170

N_2 = 0.018 + 0 + 0.385 = 0.403

V_E = 0.32*(0 + (2,798,140 cf * 0.403) – (2,798,140 * 0.170)) = 211,304 cf water quality pollution credits

Cost Assessment

The total cost estimated for stream restoration in Salt Creek was $8,452,000 (Appendix Table 5). Note the inclusion of costs for a Flow-Thru BMP, as the construction of this treatment structure would be required on-site in addition to the offsite NSMP. Capital costs makes up the largest cost in this estimate, such that the total cost per cubic-foot treated is $40/cf.

Appendix Table 5. Estimated summary of costs associated with Salt Creek

Capital Costs	
Project Management	$98,100
Design	$196,200
Construction	$2,157,950
Permits	$98,100
City Admin	$102,500
Flow-Thru BMP	$1,549,150
Sub Total	$4,202,000
Success Period (Total cost for 5 years)	
Monitoring	$500,000
Maintenance	$250,000
Sub total	$750,000
Long-Term Maintenance and Monitoring	
*Annual Long-Term Monitoring**	*$50,000*
*Annual Long-Term Maintenance**	*$20,000*
Long-Term Monitoring Present Value	$2,500,000
Long-Term Maintenance Present Value	$1,000,000
Sub total	$3,500,000
TOTAL†	$8,452,000
Cost per cubic-foot treated	$40/cf

*Not included in total but used to calculate present value with 2% discount factor
†This total is based on 2020 estimates. Reassess every 5-10 years to update costs.

Infill Project

Background

This project was selected so that a typical infill project could be evaluated, and the cost for standard, on-site water quality treatment could be compared to the cost to generate stream restoration credits for water quality offset. The project area is approximately seven acres and discharges to the San Diego Bay via a conveyance channel whose bed and bank are concrete lined all the way from the point of discharge to the Pacific Ocean. It is therefore exempt from hydromodification requirements per the Regional MS4 Permit (Order No. R9-2013-0001, as amended, California Regional Water Quality Control Board, 2015). The DCV for the project site was calculated to be 10,827 cf and based on project constraints the current design proposes on-site vaulted proprietary compact biofiltration basins. Land use was calculated using Sweetwater Sub-Watershed as the reference tributary.

Credit Calculations

DCV = V_1 = V_2 = 10,827 CF

L = 0.53 (lowest factor for TP as the pollutant of concern in Sweetwater sub-watershed)

$\Delta V = 0$

B_1 = 0 (assumes no water quality benefit in the impacted condition)

E_2 = 0.67

C_2 = 1.5

B_2 = 0.67 * 1.5 = 1.0

V_E = 0.53*(0 + (10,827 CF * 1.0) – (10,827 CF * 0)) = 5,753 CF water quality pollution credits

Cost Assessment

The total cost estimated for the Infill Project was $1,946,540 (Appendix Table 6). This case study has the smallest project area and lowest total cost. The present value of BMP replacement makes up more than half of the total cost, such that the cost per cubic-foot treated is $338/cf.

Appendix Table 6. Summary of costs associated with the Infill Project

Capital Costs	
Project Management	$28,270
Design	$56,540
Construction	$282,690
Permits	$14,130
City Admin	$19,500
Sub Total	$401,130
Long-Term Maintenance and Monitoring	
Monitoring Present Value	$56,540
Maintenance Present Value	$282,690
Significant Maintenance PV (~5 years)	$156,050
BMP Replacement PV (~20 years)	$1,050,140
Sub total	$1,545,420
Opportunity Cost	N/A
TOTAL	$1,946,550
Cost per cubic-foot treated	$338/cf

Appendix E
Credit and Cost Comparison

Credits

The volume of pollutant credits generated varies widely across sites due to DCV, existing conditions, and design intent (Appendix Table 7). Salt Creek generated the most pollutant credits with 211,304 cf while the Infill Project generated just 5,753 cf. The number of impervious acres treated followed the same trend, ranging from 124 to 3 acres.

Appendix Table 7. Comparison of credit volumes generated by each case study

Case Study	Salt Creek	Infill Project
Pollutant Credits (cf)	211,304	5,753
Impervious Acres Treated	124	3

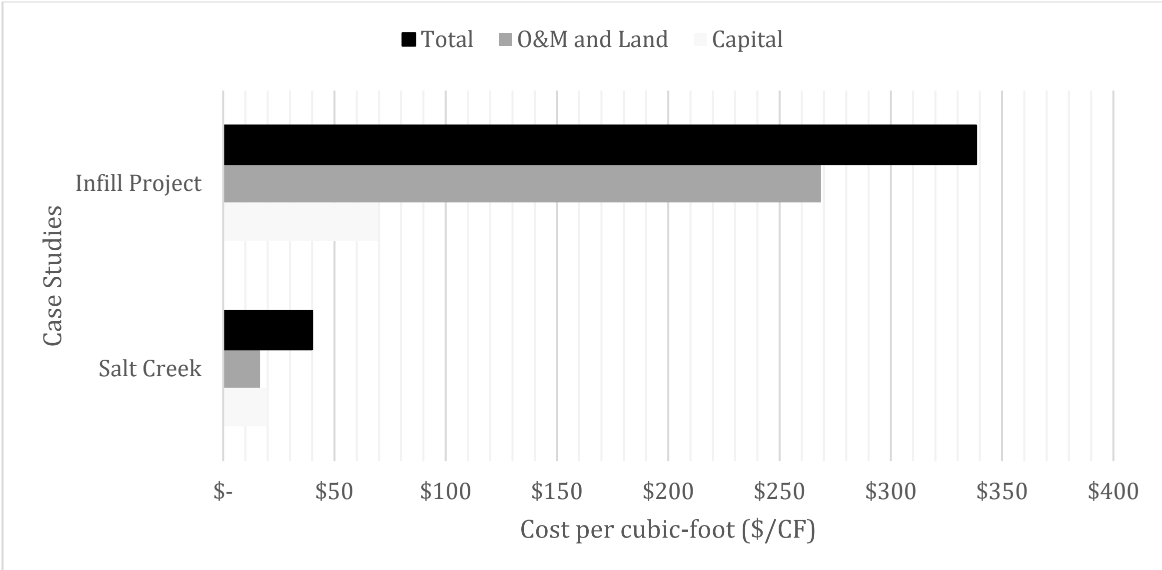
Costs

As illustrated in their respective sections, the costs associated with each case study were highly variable (Appendix Table 8). Maintenance, monitoring, and land costs made up the largest percentage of the total cost for the Infill Project, while capital costs were the largest percentage for Salt Creek. Salt Creek had the lowest total cost per cubic-feet treated at $40/cf, while the Infill Project had the highest total cost at $338/cf.

Appendix Table 8. Comparison of costs associated with each case study

Case Study	Salt Creek	Infill Project
Capital cost per cf treated	$19.90	$70
Success period cost per cf treated	$3.50	$0
Long-term monitoring and maintenance cost per cf treated	$16.60	$269
Total cost per cf treated	$40	$338

Another breakdown of the cost categories is illustrated in Appendix Figure 7. Note that the cost per cf is not directly related to site size, as the proposed Salt Creek floodplain encompasses 23 acres and has a lower cost per cf than the Infill Project, which encompasses just 7 acres.



Appendix Figure 7. Chart comparison of costs associated with each case study

The values presented here are the overall long term costs for comparison with the BMPs. However, the actual costs to fund an ACP project would include capital cost, success period, and endowment that would support the annual maintenance and monitoring. The estimated endowment is approximately $4.3 million for the Salt Creek case study, based on the annual long-term monitoring and maintenance and assuming a cap rate of 3.5%.

To provide a broader picture of costs for NSMPs and BMPs, we analyzed three other case sites to compare a variety of designs and locations (Appendix Table 9).

Appendix Table 9. Comparison of costs associated with additional case studies

Case Study	Regional Mitigation Bank*	Salt Creek	Stormwater Channel Retrofit	Water Quality Basin	Infill Project
Capital cost per cf treated	$12	$19.9	$5	$12	$70
Success period cost per cf treated	$2	$3.5	$0	$0	$0
Monitoring, maintenance, and land cost per cf treated	$10	$16.6	$5	$67	$268
Total cost per cf treated	$24	$40	$10	$79	$338

*Note that the restoration design and associated costs for this site were focused on habitat credits rather than water quality credits.

Conclusions

The ACP program supports watershed and regional level goals beyond what can be achieved through onsite compliance by improving the water quality of a larger quantity of water than onsite treatment, improving local resiliency to climate change, and facilitating implementation of watershed-scale natural system solutions that improve watershed functions, amongst other watershed-level benefits. The case studies evaluated in this memorandum show that NSMP projects can provide a greater cost benefit than BMP projects, when designed to maximize water quality and habitat benefits. The final comparison below illustrates the disparity between these two case studies with respect to cost, credit volume, and project area required to meet crediting needs.

If a traditional BMP cost $1 million, what would ACP project with a 25% discount provide?

<u>$1 million standard BMP</u> (Based on Example Infill Project)	vs	25% discount <u>$750,000 Stream Rehabilitation</u> (Based on Salt Creek)
~2,955 cf of treatment		~18,750 cf of treatment

How much area is needed to treat 50,000 gallons (~6,700 cf)?

<u>Standard BMP</u> (Based on Example Infill Project)	vs	<u>Stream Restoration</u> (Based on Salt Creek)
26.8 acres		0.73 acres

The following conclusions were determined during this exercise:

- The NSMP equation is based on BMP methodology but accounts for water treatment processes and benefits provided by natural systems.
- The calculated pollutant control volume for a NSMP is highly dependent on design intent but can match or exceed BMP volumes.
- The NSMP case study was a cheaper alternative on a per cubic-feet of treatment, per project acre, and per impervious acre basis.

Appendix D

Priority Development Project Credit Usage Worksheet

PDP Credit Usage Worksheet			
1	85th percentile 24-hr storm depth from Figure B.1-1	d =	inches
2	Area tributary to BMP(s)	A =	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C =	unitless
4	Tree well volume Note: In the SWQMP list the number of trees, size of each tree, amount of soil volume installed for each tree, contributing area to each tree and the inlet opening dimension for each tree.	TCV =	cubic-feet
5	Rain barrels Credit volume Note: In the SWQMP list the number of rain barrels, size of each rain barrel and the use of the captured storm water runoff.	RCV =	cubic-feet
6	Calculate DCV = (3630 x C x d x A) - TCV - RCV	DCV =	cubic-feet
7	Proposed ACP Credit Purchase	CP =	cubic-feet
8	Is Line 7 >= Line 6? If yes, then credit requirement is met. If no, purchase more ACP credits	Yes	

Note: Lines 1-6 are calculated using the design capture volume methodology outlined in the WQE Guidance Manual (section 2.3.1.1)

FINAL

ALTERNATIVE COMPLIANCE PROGRAM GUIDELINES AND DEVELOPMENT

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Acronyms and Abbreviations

ACP	Alternative Compliance Program
ASCI	Algal Stream Condition Index
BMP	best management practice
CEQA	California Environmental Quality Act
City	City of Chula Vista's
CSCI	California Stream Condition Index
CRAM	California Rapid Assessment Methodology
CWA	Clean Water Act
DCV	design capture volume
ILF	in-lieu fee structure
MEP	maximum extent practicable
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NSMP	Natural Systems Management Practices
PDP	Priority Development Project
Plan	City's 2005 General Plan
Porter-Cologne Act	Porter-Cologne Water Quality Act
PDP	Priority Development Project
Program	Alternative Compliance In-Lieu Fee Program
RWQCB	Regional Water Quality Control Board
SUSMP	Standard Urban Stormwater Program
SWAMP	Surface Water Ambient Monitoring Program
WMA	Watershed Management Area
WMAA	Watershed Management Area Analysis
WQE	Water Quality Equivalency
WQE Guidance	Water Quality Equivalency Guidance Document: Region 9
WQIP	Water Quality Improvement Plan

Executive Summary

The purpose of this document is to provide guidance on use of the City of Chula Vista's Alternative Compliance In-Lieu Fee Program (Program), which proposes the use of stream rehabilitation Natural Systems Management Practices (NSMP) as the mechanism for alternative compliance. The overall goal of this Program is to provide alternative mechanisms to meet stormwater compliance criteria while providing a greater water quality benefit and improved habitat within the City of Chula Vista's (City) watersheds.

The San Diego Regional Municipal Separate Storm Sewer System (MS4) Permit allows for a Priority Development Project (PDP) to participate in an Alternative Compliance Program (ACP) as an offsite alternative to meet the onsite structural best management practice (BMP) performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) of the Regional MS4 Permit while also meeting regional and watershed goals that are not met through onsite compliance. Participation in an ACP is allowed so long as the offsite alternative will have a greater overall water quality benefit than fully complying with the performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) onsite. An ACP can be used as an option for compliance so long as flow-thru treatment control BMPs sized and designed in accordance with Permit Provisions E.3.c.(1)(a)(ii)[a]-[c] are also implemented on the development site.

Alternative compliance can be achieved through the use of structural BMPs or NSMPs. Structural BMPs are physical structures or features that are designed to collect, treat, infiltrate, and/or convey stormwater. Examples include retention ponds, rain gardens, constructed wetlands, and pervious pavement (RWQCB, 2018: ES-2). The City obtained SB 2 grant funding to develop an ACP for NSMPs to provide alternative compliance and treatment options for stormwater consistent with the Regional MS4 Permit. NSMPs are stormwater management practices implemented to restore and/or preserve predevelopment watershed functions in lieu of onsite direct pollutant removal and hydromodification flow control treatment BMPs (RWQCB, 2018: xv).

This document was developed to provide guidance on use of the City's Program utilizing stream rehabilitation NSMP projects as an offsite alternative compliance mechanism. Participants in the City's program will follow the regulations outlined in the Regional MS4 Permit and other supporting regulatory guidance approved for use within the City's jurisdiction. The two main benefits for participation in this Program are greater water quality benefit to the watershed compared to onsite implementation of BMPs and enhanced flexibility of developing property within the City's jurisdiction. Additionally, this Program supports watershed and regional level goals beyond what can be achieved through onsite compliance as described in Provision E.3.c.(1)(a) by improving the water quality of a larger quantity of water than onsite treatment, improving local resiliency to climate change, and facilitating implementation of watershed-scale natural system solutions that improve watershed functions, amongst other watershed-level benefits.

Chapter 1
Program Purpose and Authority

1.1 Purpose

The purpose of the Program described in this document is to provide offsite pollution control treatment opportunities using NSMPs, specifically stream rehabilitation techniques, as allowed by provision E.3.c.(3), as an alternative to the onsite structural BMP performance standards set in Provisions E.3.c.(1) and E.3.c.(2)(a) of the San Diego Regional Municipal Separate Storm Sewer System (MS4) Permit (Order R9-2013-0001, as amended) and the *City of Chula Vista BMP Design Manual*. The Program is funded by a California Department of Housing and Community Development SB 2 Planning Grant that provides funding and technical assistance to local governments to help prepare, adopt, and implement plans and process improvements that streamline housing approvals and accelerate housing production. By doing so, the grant's goal is to increase the availability of affordable housing within California. The City's Program will increase project onsite buildable acreage which will help the City meet its housing and community development goals. The Program will also allow PDPs to meet Regional MS4 Permit requirements for stormwater pollutant control and hydromodification management through providing a mechanism for the creation and approval of stormwater credits.

Participation in the Program is allowed so long as the offsite alternative will have a greater overall water quality benefit than fully complying with the performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) onsite and flow-thru treatment control BMPs sized and designed in accordance with Permit Provisions E.3.c.(1)(a)(ii)[a]-[c] are implemented on the development site.

This document provides information on the authorities supporting the Program, identifies what a project is and gives context for NSMP projects, provides background and guidance for use regarding the Water Quality Equivalency developed for stream rehabilitation NSMPs for this Program, and provides guidance for use of the Program. The two main benefits for participation in this Program are greater water quality benefit to the watershed compared to onsite implementation of BMPs and enhanced flexibility of developing property within the City's jurisdiction. Authority

The guidelines and requirements in this document are designed to address the requirements in San Diego Region Municipal Permit, National Pollutant Discharge Elimination System (NPDES) Order No. CAS0109266, as modified by Order Nos. R9-2015-0001 and R9-2015-0100, Sections E.3.c.(3), as authorized under Section 402 of federal Clean Water Act and implementing regulations (Code of Federal Regulations, Title 40, Part 122) adopted by the United States Environmental Protection Agency, and Chapter 5.5, Division 7 of the California Water Code. Section 402(p)(3)(B)(iii) of the Clean Water Act requires that discharges from MS4s reduce the discharge of pollutants to the maximum extent practicable (MEP). To determine the MEP, a municipality may consider the effectiveness, cost, regulatory compliance, public acceptability, and feasibility of implementation (Regional MS4 Permit Attachment C).

Additional guidelines include the Chula Vista BMP Design Manual (City of Chula Vista 2021), San Diego Bay Watershed Management Area Water Quality Improvement Plan (WQIP) (San Diego Bay Responsible Parties 2016), San Diego Regional Water Quality Equivalency Guidance Document (Regional WQE Guidance) (RWQCB 2018), and San Diego Bay Watershed Management Area Analysis (WMAA).

1.2 Watershed and City-Wide Benefits Analysis

Provision E.3.c.(3) of the Regional MS4 Permit allows PDPs to participate in this Program if participation will result in a greater overall water quality and ecosystem benefits to the Watershed Management Area than fully complying with performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) onsite. This program supports watershed and regional level goals that are not accomplished through onsite compliance as described in Provision E.3.c.(1)(a) and provides an additional option for PDPs to achieve MEP.

The water quality of the larger watershed is impacted by water generated on older developments built prior to the current treatment requirements. When a PDP utilizes onsite treatment BMPs, the maximum amount of water that can be treated by those BMPs is limited by the amount of stormwater generated by the PDP. ACP projects implemented through this Program have the potential to increase the pollutant treatment function of the stream through stream rehabilitation NSMPs, allowing the Program to improve overall water quality within the system. To demonstrate greater overall water quality benefits, an ACP will consider pollutant control and hydromodification flow control separately. As defined in the Regional WQE Guidance: “Greater overall water quality benefit is demonstrated when Stormwater Pollutant Control Benefits are greater than or equal to Stormwater Pollutant Control Impacts, AND Hydromodification Flow Control Benefits are greater than or equal to Hydromodification Flow Control Impacts” (RWQCB 2018). The implementation of stream rehabilitation NSMPs through this Program will result in a greater water quality benefit to the watershed, and overall benefit to the City by:

a. Requiring each PDP participating in the Program to demonstrate that they are providing greater water quality benefits than they would through the onsite BMP performance requirements of Provision E.3.c.(1)(a). Greater overall water quality benefit for stormwater pollutant control is established by demonstrating that the earned volume from a NSMP is greater than the earned volume from an onsite BMP (See Appendix C, Section “NSMP WQE Equation Development”). The natural system project must also provide greater water quality benefits within the Watershed Management Area than fully complying with onsite BMP performance requirements (Provision E.3.c.(3)(b)(i)).

b. Improving the water quality of a larger quantity of water than onsite treatment. When a PDP utilizes onsite treatment control best management practices (BMPs), the maximum amount of water that can be treated by those BMPs is the amount of stormwater flow generated by the PDP not already addressed through source control or site design BMPs. Natural system projects implemented through this Program not only address the individual project’s runoff, but also have the potential to improve the water quality of the larger watershed that is impacted by runoff generated from older developments that were built prior to the current treatment requirements. PDPs participating in this Program will be required to implement flow-thru treatment control BMPs to treat onsite runoff in accordance with Provisions E.3.c.(1)(a)(ii)[a]-[c].

c. Facilitating implementation of watershed-scale natural system solutions that improve watershed functions not met through project level onsite compliance described in Provision E.3.c.(1)(a). The Regional WQE Guidance states that greater overall watershed benefit is achieved when stream rehabilitation measures are designed to mitigate both future and legacy hydromodification impacts associated with development that occurs within the watershed (RWQCB 2018). PDPs can demonstrate greater overall watershed benefit by calculating hydromodification flow control equivalency for stream rehabilitation with existing methodologies in Section 3.6 of the Regional WQE Guidance Document.

d. Allowing developers to maximize the developable space within a PDP and support the City's housing and community development goals. Implementation of onsite BMPs necessarily utilizes space within the PDP site that could be used to increase the density of development within the PDP site. The City has identified housing and community development goals in the 2021-2029 Housing Element of the General Plan and the 2020-2024 Five-Year Consolidated Plan for its HUD entitlement programs. While the Program is not restricted to PDPs that will supply additional housing, it would help the City to meet its identified housing density goals, and the housing needs in the region. Maximizing of the use of developable space at participating PDP locations by allowing pollutant control and hydromodification treatment to be implemented at an offsite ACP will have the potential to reduce the total number of PDP sites to meet these goals, allowing some areas to remain undeveloped.

e. Stream rehabilitation improves local resiliency to climate change. Healthy riparian areas are naturally resilient, provide thermal refugia for wildlife, and provide both habitat linkages as well as connectivity between aquatic and terrestrial habitats, which are all factors that can support resiliency to climate change in the ecosystem (Seavy et. al. 2009).

Based on the criteria listed above, the City has elected to allow PDPs to participate in this Program as an alternative mechanism to achieve MEP, when coupled with implementing low-impact development, onsite flow-through treatment, and source control, as appropriate. Per provisions E.3.c.(1)(a)(ii)[a]-[c] within the permit, onsite flow thru treatment is required by the PDP. The two main benefits for participation in this Program are greater water quality benefit to the watershed compared to onsite implementation of BMPs and enhanced flexibility of developing property within the City's jurisdiction while concurrently incentivizing improvements to water quality in locations that otherwise may not see improvements in the near term.

1.2.1 Citywide Watershed Baseline

In the calculation of earned volume by an ACP, the applicant must characterize the ACP tributary land uses and relative pollutant concentrations. This process is needed because ACPs may offset PDP impacts from anywhere within the same hydrologic area within the watershed management area (WMA). The Regional WQE Guidance contains existing methodologies in Section 2-2 and Appendix D of the guidance document to identify land uses and pollutants of concern in the San Diego River Watershed (San Diego Hydrologic Unit 907.00) (RWCQB 2018). Applicants proposing an NSMP ACP must utilize the existing methodology in the Regional WQE Guidance to establish a baseline of watershed conditions. The ACP will also conduct pre- and post-project condition surveys to document the improvement in condition and support that the planned benefits to the watershed are in place. The information provided below is specific to the Citywide Watershed and the various functions that NSMPs provide for greater overall watershed benefit.

Chula Vista is located within the San Diego Bay Watershed Management Area and contains portions of the Sweetwater and Otay Hydrologic Units. The Otay Hydrologic Unit encompasses nearly 98, 500 acres and is further broken down into the Coronado, Otay Valley, and Dulzura hydrologic areas, or sub-watersheds. Nearly 68% of the Otay Hydrologic Unit is composed of undeveloped and open space land. Land uses vary within the hydrologic areas, with 52% of the Coronado Hydrologic Area comprising of 52% military, the Otay Valley Hydrologic Area having dominant land uses of 47% open space and undeveloped land and 16% residential, and the Dulzura Hydrologic Unit being comprised of 83% open space and undeveloped land use and 18% residential (Project Clean Water 2022). Figure 1-1 and Table 1-1 provide context for existing land use in Otay watershed within the City limits. The entirety of the Sweetwater Hydrologic Unit encompasses over 145,000 acres and can be further broken down into three sub-watersheds: the Lower, Middle, and Upper Sweetwater Hydrologic Areas. More than half of the watershed is comprised of undeveloped land and open space, with much of the more densely populated areas, including the City of Chula Vista, existing in the Lower Sweetwater Hydrologic Area. Residential areas and transportation land uses make up 44% and 18%, respectively, of hydrologic area land use. Figure 1-2 and Table 1-1 provide context for existing land use in Sweetwater watershed within the City limits.

Table 1-1. Land Use Acreages for Existing (2022) and Future (2050) Conditions within Otay Sub-Watershed and Sweetwater Sub-Watershed

	Land Use Acreage			
Land Use[1]	Otay Existing	Otay Future[2]	Sweetwater Existing	Sweetwater Future[2]
Agriculture	0	0	7	0
Commercial	742	746	1,305	1,146
Education	673	1,053	746	738
Industrial	405	616	405	677
Multi-Family Residential	867	1,734	781	1,247
Orchard[1]	0	0	0	0
Rural Residential	11	1	19	15
Single Family Residential	3,704	4,040	5,034	4,875
Transportation	2,409	2,379	3,086	3,006
Vacant / Open Space	7,797	6,039	3,897	3,675
Water	0	0	1,453	1,355
Total	**16,608**	**16,608**	**16,734**	**16,734**

1 The land use classes presented here are the same as those presented in the 2018 WQE Table 2-2. Not all land use types are present in each sub-watershed.
2 Future land use acreages are based on current projections and are subject to change.

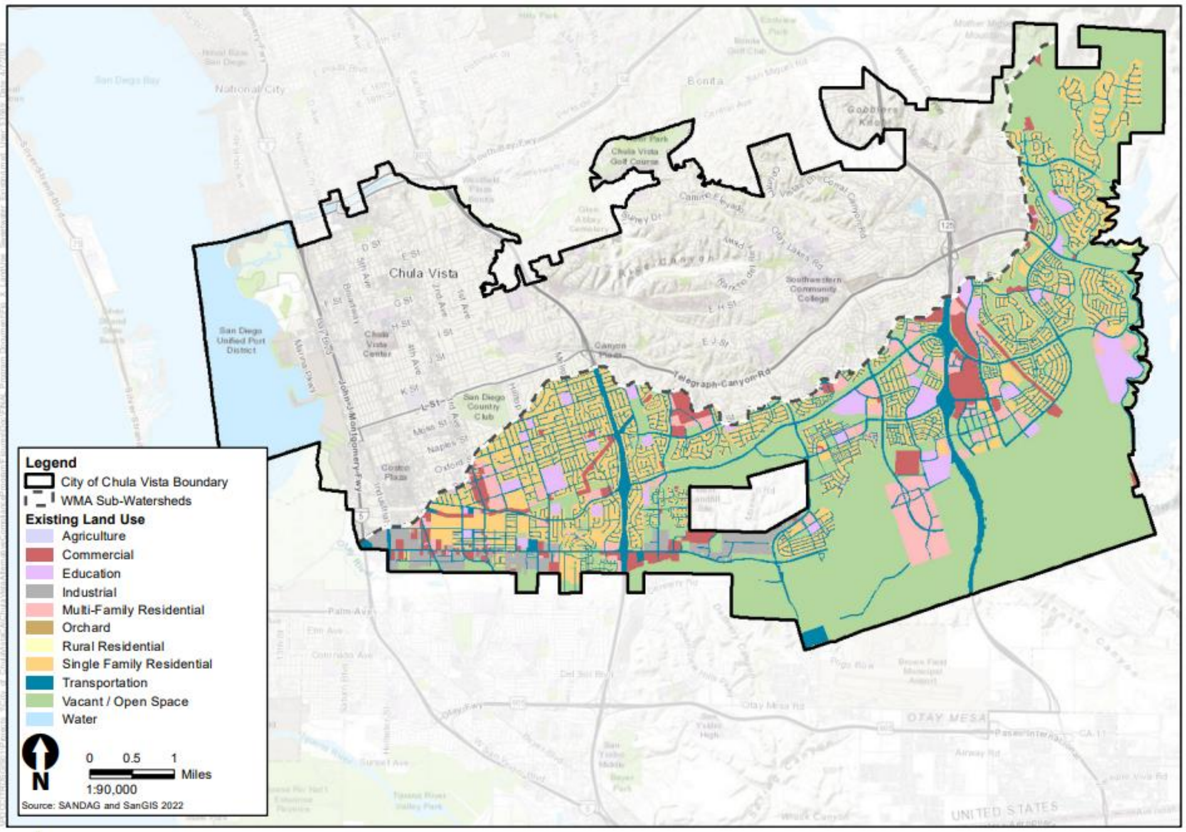


Figure 1-1. Existing Land Use in Otay Watershed within the City Limits

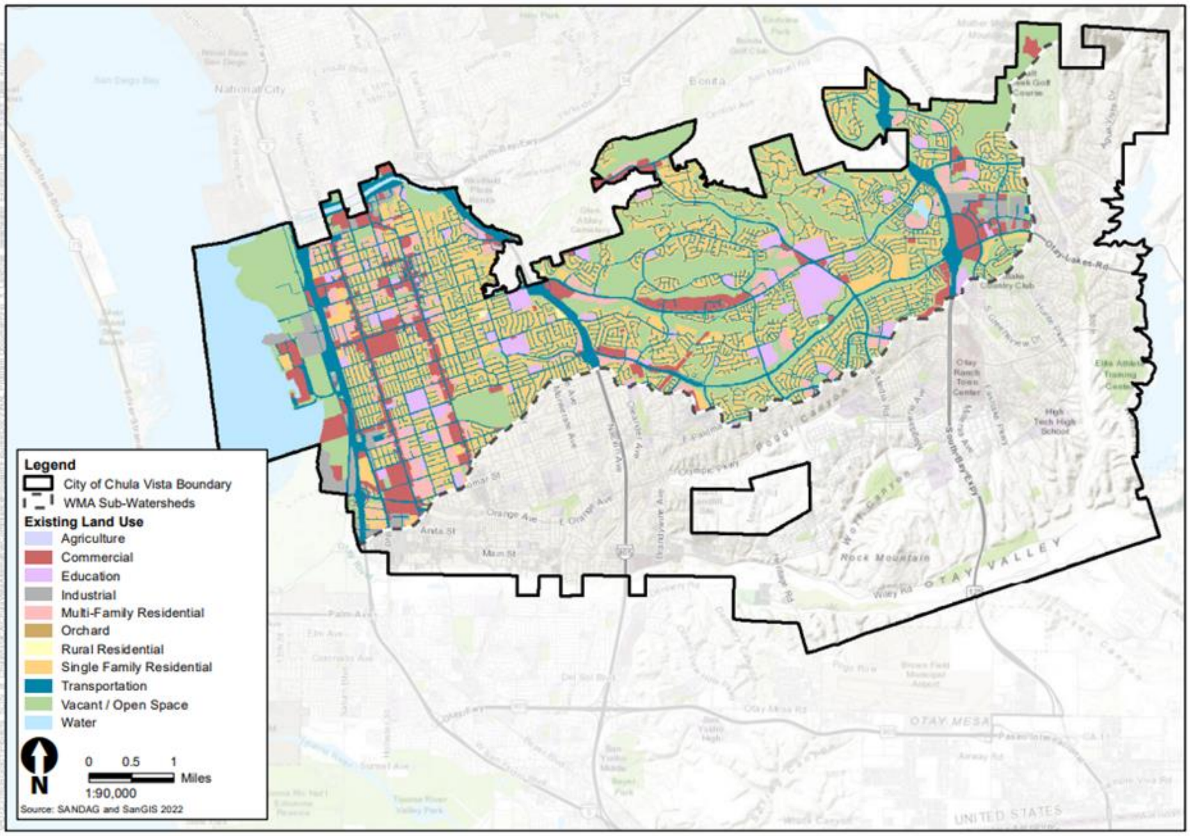


Figure 1-2. Existing Land Use in Sweetwater Watershed within the City Limits

This Program proposes to provide greater water quality and watershed benefits to the City of Chula Vista through stream rehabilitation NSMPs. Stream rehabilitation NSMPs can restore or enhance riverine functions that provide a variety of benefits for water quality, in addition to co-benefits for ecological, economic, and community interests. Floodplain connectivity can attenuate flood flows, maintain hyporheic exchange, provide high flow refugia, store sediment, and reduce erosive forces. Dynamism in the floodplain creates habitat diversity and variability, supporting different life stages of vegetation and wildlife, enhancing species composition and diversity. A naturally stabilized reach may have higher capacity to recover from a significant disturbance because it can return to the natural size, shape, or position imposed on it prior to disturbance.

Well-vegetated riparian areas can increase infiltration, filter pollutants, provide sources of food, migration corridors, shading to reduce water temperature, and nutrient cycling. Hydrogeomorphic and vegetative complexity provided by NSMPs on a watershed-scale can improve post-wildlife resiliency by minimizing the impacts of disturbance regimes (fire extent, floods, debris flows). NSMPs can provide better recreational spaces than traditional BMPs and create opportunities to incorporate traditional ecological knowledge and nature education with local communities.

These water quality benefits include waters generated on older developments that were not required to provide pollutant control or hydromodification treatment. This can lead to an overall improvement of water quality in the watershed. The Regional MS4 Permit currently requires that all development provide pollutant control and hydromodification treatment for all water generated from the project, however, this was not a requirement prior to 2013. Figure 1-3 shows the areas within the City developed before 2013 (“developed”), after 2013 (“stormwater PDP sites”), and that remain undeveloped. Table 1-2 provides the proportion of the City within each of these areas. This program assumes that the areas developed prior to 2013 do not include treatment control and that those areas contain little to no treatment. The Program will not change the nature of the development within the City, but the program will be able to document locations of ACPs implemented and may use that to show areas that are receiving greater watershed benefits within the City.

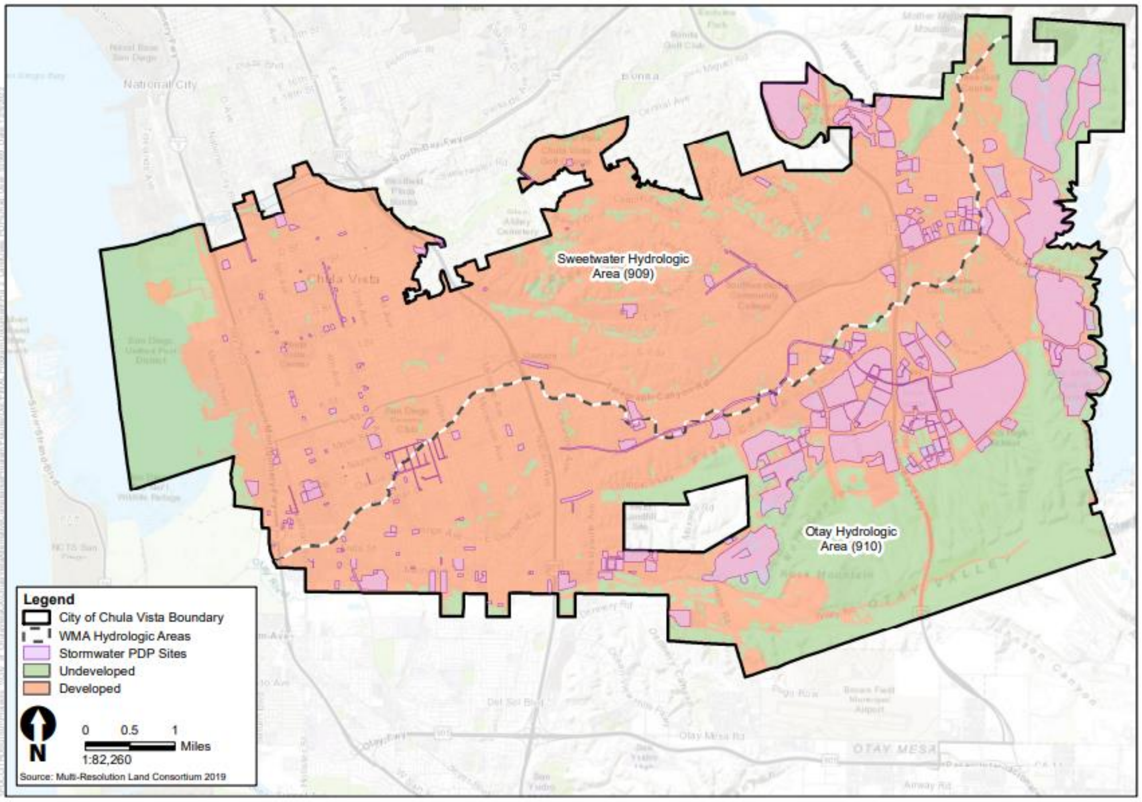


Figure 1-3. Spatial extent of developed areas within the City of Chula Vista, with and without stormwater treatment

The extent of development for the City was extracted from the National Land Cover Database and clipped to the City boundary (Figure 1-3) (Multi-Resolution Land Characteristics Consortium 2019). The location of stormwater PDP sites were obtained from the City's open GIS database (City of Chula Vista, last updated May 20, 2022). Please note that the PDP data from the GIS database is a snapshot in time and can change. A small portion of the stormwater PDP sites also include some 2007 Permit Standard Urban Stormwater Program (SUSMP) sites with partial treatment. The percent of hydrologic area for a given land use were calculated with the total area of the hydrologic area within the City boundary (Table 1-1). The hydrologic areas within the City are sub-watersheds of the San Diego Bay Watershed Management Area. Figure 1-3 shows the portions of the City developed pre and post- 2013 San Diego Region MS4 permit. The 2013 Regional MS4 Permit requires pollutant and hydromodification treatment of all stormwater effluent from development and redevelopment projects that meet PDP criteria. The pre-2013 development projects may have incorporated partial treatment, not to the extent that projects under the current 2013 Regional MS4 Permit are required to implement. ACP projects implemented under this Program will provide stormwater pollutant and volume control benefits that will include flows generated from developments built prior to 2013. It is important to note the vast potential of ACP NSMP projects, as they will treat a much larger area than the traditional onsite PDP compliance pathway.

Table 1-2. Percent of hydrologic area for a given development type

	Portion of Development within The Hydrologic Area	
	Sweetwater Hydrologic Area (909) 16,735 acres	Otay Hydrologic Area (910) 16,608 acres
Undeveloped	2,678 (16%)	5,979 (36%)
Developed	13,327 (79.6%)	7,393 (45%)
Stormwater PDPs	730 (4.4%)	3,236 (19%)
Number of PDPs	139	173

*Note that the percent of hydrologic area is based on the total area within the City of Chula Vista boundary.

The Series 14 Regional Growth Forecast land use data from San Diego Association of Governments (SANDAG) was used to develop the expected buildout conditions for 2050. The Series 14 Regional Growth Forecast includes analysis and assumptions about how local plans (General, etc.) and policies from the 18 incorporated cities and unincorporated County may evolve over time in response to the region's continuing growth. Additionally, the local jurisdictions provided detailed feedback on the projections to provide a realistic forecast to 2050 (SANDAG, 2023). Figure 1-4 shows future land use for Otay watershed and Figure 1-5 shows future land use for Sweetwater watershed.

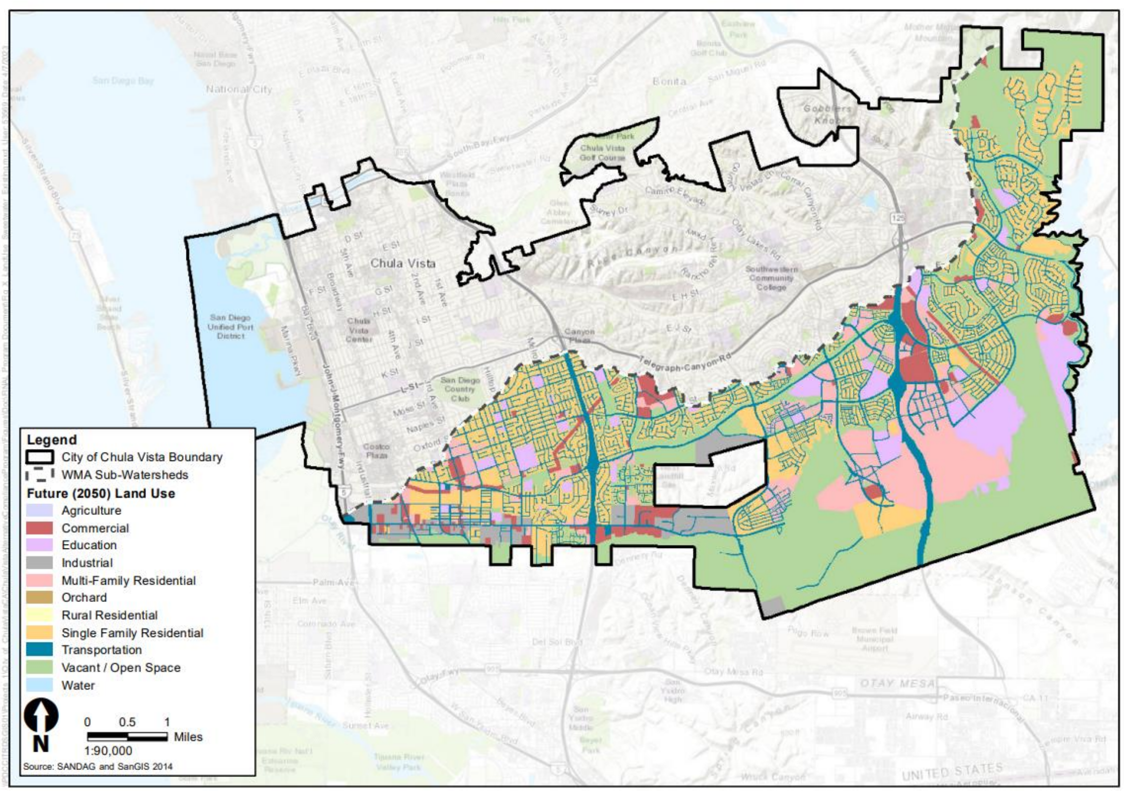


Figure 1-4. Future Land Use in Otay Watershed within the City Limits

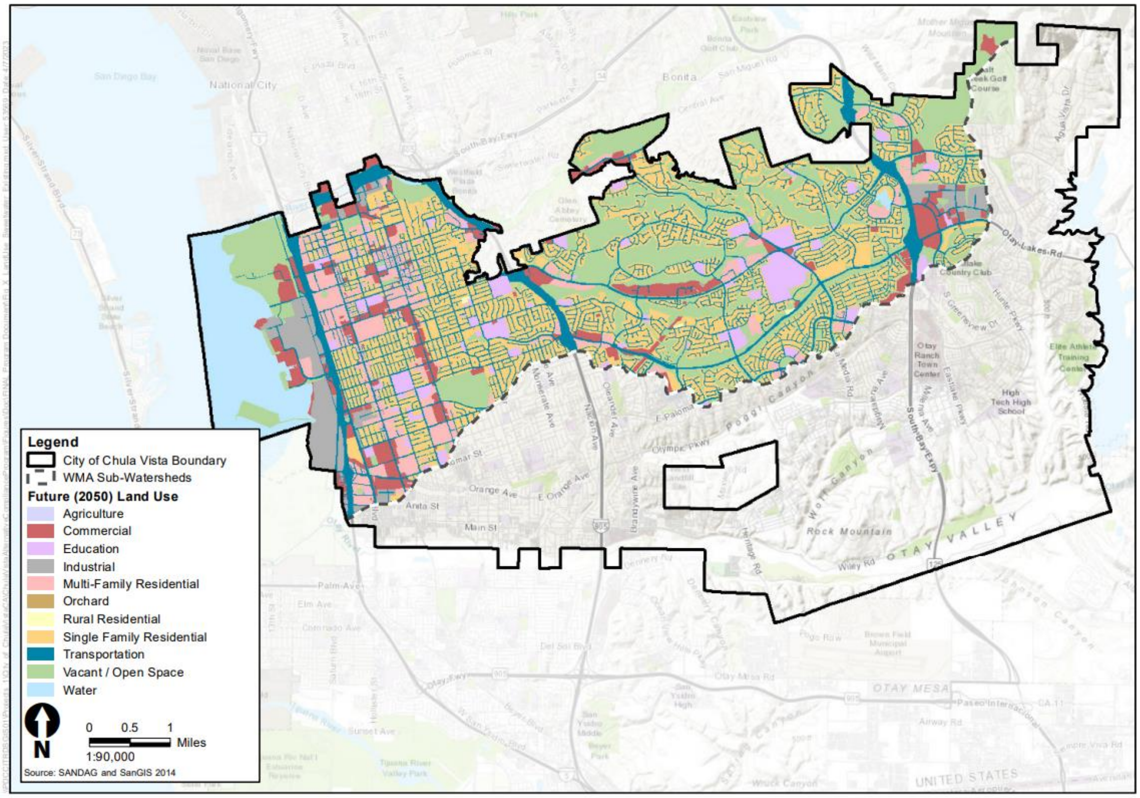


Figure 1-5. Future Land Use in Sweetwater Watershed within the City Limits

As of January 1, 2018, the City provided a total of 83,493 housing units (SANDAG 2019). The City's 2005 General Plan (Plan) provides expected build out acreages and land within its jurisdiction by the year 2030. A projected total of 124,958 dwelling units will be provided by 2030. All new development will be required to comply with the MS4 permit requirements, of which PDPs must meet on-site treatment BMPs requirements under the baseline condition. Alternative compliance has the potential to increase the overall density of dwelling units (dwelling units per acre) while potentially increasing the area of land in open space or water land uses. Additionally, stream rehabilitation NSMPs will improve the riparian habitat within the City, which will be documented by each ACP project. While there are additional benefits expected from these projects, such as climate change resiliency as described above, these benefits will be evident in response to climate related events, and will be documented when observed.

Chapter 2
NSMP Alternative Compliance

As discussed in Chapter 1, this document was developed to provide Guidance for use of the City's In-Lieu Fee Program implementing stream rehabilitation NSMP projects to provide pollutant removal credits to PDP applicants as an offsite alternative to onsite treatment BMPs. This Chapter provides a general overview of alternative compliance and alternative compliance project options allowed in the Regional MS4 permit and within the City's jurisdiction. Alternative compliance can be achieved through the use of structural BMPs or NSMP projects, so long as the correct methodologies are used to determine pollutant removal and hydromodification credit values. The Regional WQE Guidance provides methodologies to calculate pollutant removal values for structural BMPs and hydromodification values for structural BMPs and NSMPs. However, it does not provide methodologies to determine pollutant removal values for NSMPs. The Program discussed in this document solely addresses the development and use of alternative compliance project credits provided by stream rehabilitation NSMPs. In support of this Program, the City developed a City specific WQE framework for NSMPs, including an equation to calculate the WQE credits generated by NSMPs (Appendix B). The Regional WQE Guidance also provides methodologies to determine overall greater water quality benefit through use of an ACP.

2.1 Alternative Compliance Project

An alternative compliance project is defined by the *Water Quality Equivalency Guidance Document: Region 9* (WQE Guidance; RWQCB 2018) as a project implemented to provide a greater overall water quality benefit to the WMA and offset stormwater pollutant control impacts and impacts associated with PDP. Greater overall water quality benefit is defined in the San Diego Region Municipal Permit as a condition in which the quantifiable water quality benefits from an alternative compliance project are greater than the quantifiable water quality impacts from a PDP, where benefits and impacts for stormwater pollutant control and hydromodification flow control must be considered individually (RWQCB 2018:xii–xiv). Alternative compliance projects could be implemented using either structural BMPs or NSMPs so long as the proper methodologies for credit determination are applied. This Program addresses how to implement stream rehabilitation NSMPs to provide ACP credits.

An ACP project may also provide credits to offset hydromodification flow control impacts associated with PDPs per the WQE Guidance Document for Region 9, this is discussed further in Section 3.3. Table 2-1 illustrates the availability of Stormwater Pollutant Control Benefits and Hydromodification Flow Control Benefits currently available. All benefits listed as "Available" or "Limited Availability" are included in the Regional WQE Guidance as an existing methodology. In the development of this ACP for Natural Systems, the City has focused on developing a City-specific methodology for the Stream Rehabilitation NSMP category, which is highlighted in dark blue for emphasis.

Table 2-1. WQE Availability for Alternative Compliance Programs

ACP Category		Stormwater Pollutant Control Benefits				Hydromod Flow Control Benefits
		Pollutant Reduction			Volume Reduction	
		Retention	Biofiltration	Flow-Thru		
BMP	Retrofit	Available	Available	Limited Availability	Available	Available
	Regional	Available	Available	Limited Availability	Available	Available
	Water Supply	Available	Available	Limited Availability	Available	Available
NSMP	Land Restoration	Not Available	Not Available	Not Available	Available	Available
	Land Preservation	Not Available	Not Available	Not Available	Limited Availability	Available
	Stream Rehabilitation	Developed for Chula Vista ACP Program			Limited Availability	Available

2.2 Determining Greater Water Quality Benefit

The Regional WQE Guidance provides step by step guidelines to determine if an offsite alternative compliance project will provide a greater overall water quality benefit. First, the treatment required of and provided by the PDP must be characterized to define the remaining Deficit of Stormwater Pollutant Control Volume. Second, the treatment provided by the ACP is characterized to define the Earned Stormwater Pollutant Control Volume. Finally, if the volume from Step 2 is greater than the volume from Step 1, then the Permit standard for pollutant control has been met. These steps are detailed in the following sections of the Regional WQE Guidance: Sections 2.2 Step 1: PDP Stormwater Pollutant Control Impact, 2.3.2 Option B: Alternative Compliance Project Stormwater Pollutant Control Benefits for NSMPs, and 2.4 Determination of Stormwater Participants of the City's Program must use the listed sections to determine that overall greater water quality benefit is being provided. The Regional WQE Guidance does not, however, provide methods to determine pollutant removal WQE calculation for stream rehabilitation projects. For Step 2, PDPs choosing to participate in the City's Program shall use the Water Quality Equivalency (WQE) framework developed for NSMPs for the City of Chula Vista (Appendix B) to determine the water quality benefit and credit equivalency of the project and support use of an NSMP to provide MEP.

2.3 Natural Systems Management Practices

NSMPs are defined by the San Diego Regional Water Quality Control Board (RWQCB) as "[s]tormwater management practices implemented to restore and/or preserve predevelopment watershed functions in lieu of providing direct pollutant removal and hydromodification flow control. NSMPs may include structural or engineered elements, but these elements do not expressly provide stormwater pollutant removal. NSMPs include: Land Restoration, Land Preservation, and Stream Rehabilitation projects" (RWQCB 2018:xv). Land Preservation NSMPs "permanently preserve undeveloped land in its current state. In limited scenarios, Land Preservation may provide quantifiable stormwater pollutant control and hydromodification flow control benefits by preventing increases in stormwater runoff volumes and pollutant concentrations associated with the future built out condition of a tributary" (RWQCB 2018:xv). Land Restoration NSMPs "restore currently developed land back to a stabilized pre-development condition. Land restoration practices are similar to Retrofit BMPs that provide reductions in impervious surfaces, but require appropriate stabilization techniques" (RWQCB 2018:xv).

Projects designed as part of the City's ACP are limited to Stream Rehabilitation projects as they are likely to provide greater water quality benefit than either land restoration or land preservation NSMPs, as discussed in the *Technical Memorandum on Alternative Compliance Program: Water Quality Equivalency Using Natural System Management Practices* (Appendix A). Stream Rehabilitation is defined as remedial measures or activities for the purpose of improving or restoring the beneficial uses of streams, channels, or river systems. Techniques may vary from in-stream restoration techniques to in-line stormwater management practices installed in the system corridor or upland areas, or a combination of in-stream and out-of-stream techniques. Rehabilitation techniques may include but are not limited to the following: riparian zone restoration, constructed wetlands, channel modifications that improve habitat and stability, and daylighting of drainage systems (RWQCB 2018:xvi).

2.4 Alternative Compliance Project Options

Provision E.3.c.(3) of the Regional MS4 Permit allows PDPs and Copermittees to enter into voluntary agreements that authorize the use of an ACP in lieu of the onsite structural BMP performance requirements so long as a greater overall water quality benefit than complying with Provisions E.3.c.(1) and E.3.c.(2)(a) onsite would be achieved. Alternative compliance projects can be implemented in several different ways, which are described below and can be found in Provisions E.3.c.(3)(b)– E.3.c.(3)(e) of the Regional MS4 Permit. If a PDP participates in an ACP, they are required by both the Regional MS4 Permit and the City of Chula Vista's BMP Design Manual to, at a minimum, provide onsite flow-thru treatment control BMPs sized and designed in accordance with Permit Provisions E.3.c.(1)(a)(ii)[a]-[c], as well as implement low impact development and source control BMPs. The City BMP Design Manual allows for applicant implemented alternative compliance projects that may utilize either structural BMPs or NSMPs. The City will be submitting an update to the City BMP Design Manual to include this Program as part of the January 2023 WQIP Annual Report. The following subsections provide an overview of the alternative compliance project options allowed in the Regional MS4 Permit. This guidance document was developed to provide guidance on the City's In-Lieu Fee Program for NSMPs; Chapters 3 and 4 provide specific guidance to use of the Program.

2.4.1 Watershed Management Area Analysis Candidate Projects

The Regional MS4 Permit provides guidelines that allow PDP applicants to fund, contribute funds to, or implement a candidate project identified by the Copermittees in the Watershed Management Area Analysis (WMAA) included in the WQIP so long as requirements of Provisions E.3.c.(3)(b)(i)–(viii) of the Regional MS4 Permit are met. PDPs that will implement a WMAA NSMP candidate project should utilize the Water Quality Equivalency (WQE) framework developed for NSMPs for the City of Chula Vista (Appendix B) to determine the water quality benefit and credit equivalency of the project and support use of an NSMP to provide MEP.

2.4.2 Applicant Proposed

The Regional MS4 Permit provides guidelines that allow PDP applicants to fund, contribute funds to, or implement an alternative compliance project not identified by the WMAA included in the WQIP so long as requirements of Provisions E.3.c.(3)(b)(i)–(viii) of the Regional MS4 Permit are met. Any applicant proposing an ACP project under this provision will need to document to the City that each of these requirements has been met prior to City approval of the ACP project.

This is currently allowed by the City's BMP Design Manual. Under this option, the applicant is fully responsible for the alternative compliance project design, construction, operation, and long-term maintenance (in perpetuity, see Section 4.1.5). Applicant-proposed alternative compliance projects using NSMPs are required to utilize the WQE Framework developed for NSMPs for the City of Chula Vista (Appendix C) to demonstrate that a proposed alternative compliance project results in a greater overall water quality benefit.

2.4.3 In-Lieu Fee Structure

The Regional MS4 permit states that a Copermittee may choose to allow a PDP applicant to fund or partially fund a candidate or alternative compliance project through the development of an in-lieu fee structure (ILF), as is the City's intent and purpose of this document. Through development of the City's Program, the City will receive funds from PDP applicants to fund identified NSMP projects within the City's jurisdiction. ACP projects may include projects identified in the WMAA or other City proposed stream rehabilitation projects that would provide water quality benefits. Any NSMP proposed project should utilize the WQE framework developed for NSMPs for the City of Chula Vista (Appendix B) to determine the water quality benefit and credit equivalency of the project. The City may implement an ILF project themselves, or through a public-private partnership. Implementation is discussed further in Section 4.1.

2.4.4 Water Quality Credit System

The Regional MS4 permit states that a Copermittee may develop and implement an alternative compliance water quality credit system option. Under this system, alternative compliance projects could be implemented independently of a PDP and generate credits for PDP applicants to use in lieu of onsite BMP compliance. Such a system would need to clearly exhibit that it will not allow discharges from PDPs to cause or contribute to a net impact over and above the impact caused by projects meeting the onsite structural BMP performance requirements. Any water quality credit system program that a Copermittee chooses to implement is required to be submitted to the San Diego RWQCB Executive Officer for review and acceptance as part of the WQIP. The City is not proposing a water quality credit trading system at this time. If the city chooses to develop a water quality credit system, they will submit the proposed system with the WQIP Annual Report by January 31 of the year of submittal.

Chapter 3
Stream Rehabilitation NSMP Credit Determination

3.1 Pollutant Removal Treatment Credit Water Quality Equivalency Framework for NSMPs

In March 2019 the RWQCB accepted the WQE Guidance submitted by the County of San Diego on behalf of the Regional MS4 Copermittees (RWQCB 2018). This update outlines standards and guidelines for Copermittees to design and implement offsite alternative compliance projects to meet water quality requirements as defined in the Regional MS4 Permit. The WQE Guidance provides detailed instructions, equations, and examples for pollutant reduction, volume reduction, and hydromodification flow control for structural BMPs. The WQE Guidance also provides detailed instructions, equations, and examples for calculating the hydromodification flow control benefits of Land Preservation, Land Restoration, and Stream Rehabilitation NSMPs. At the time of the approval of the updated WQE Guidance, however, calculations had not yet been determined for NSMP pollutant reduction benefits (retention, biofiltration, or flow-thru) and only limited applications had been developed for volume reduction.

In support of this Program, the City developed a City specific WQE framework for NSMPs, specifically stream rehabilitation NSMPs, including an equation to calculate the WQE credits generated by NSMPs. Existing WQE credit methodologies for structural BMPs were the foundation for NSMP pollutant reduction benefit equation development. The calculation of earned stormwater control volume for NSMPs is based on three processes: (1) runoff retention, (2) sediment stabilization, and (3) vegetation biofiltration. Figure 3-1 below provides a visual representation of these processes in a proposed project. The overall uplift in ecological benefits for a restored system is represented by a multiplier in the equation that increases credit volume. The capture volume and pollutant removal efficiency provided by these three processes can be consistently calculated based on the existing conditions and proposed design. The NSMP must be sized and designed to remove pollutants in stormwater discharge to the MEP. The earned volume from the NSMP must be greater than the earned volume from an onsite BMP in order to comply with requirements for greater overall water quality benefits. Figure 3-2 below demonstrates the potential earned credit area for an NSMP.

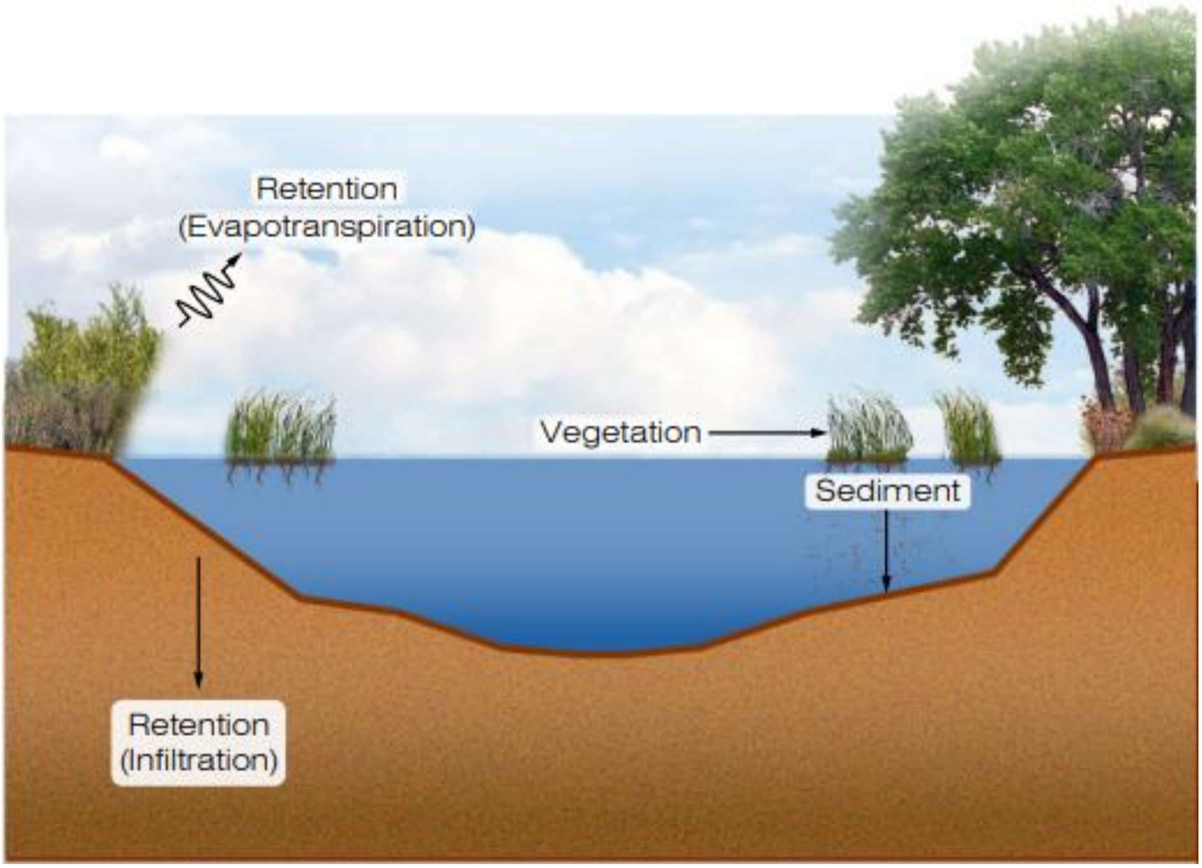


Figure 3-1. Provides an illustration of processes represented in the WQE framework for NSMPs

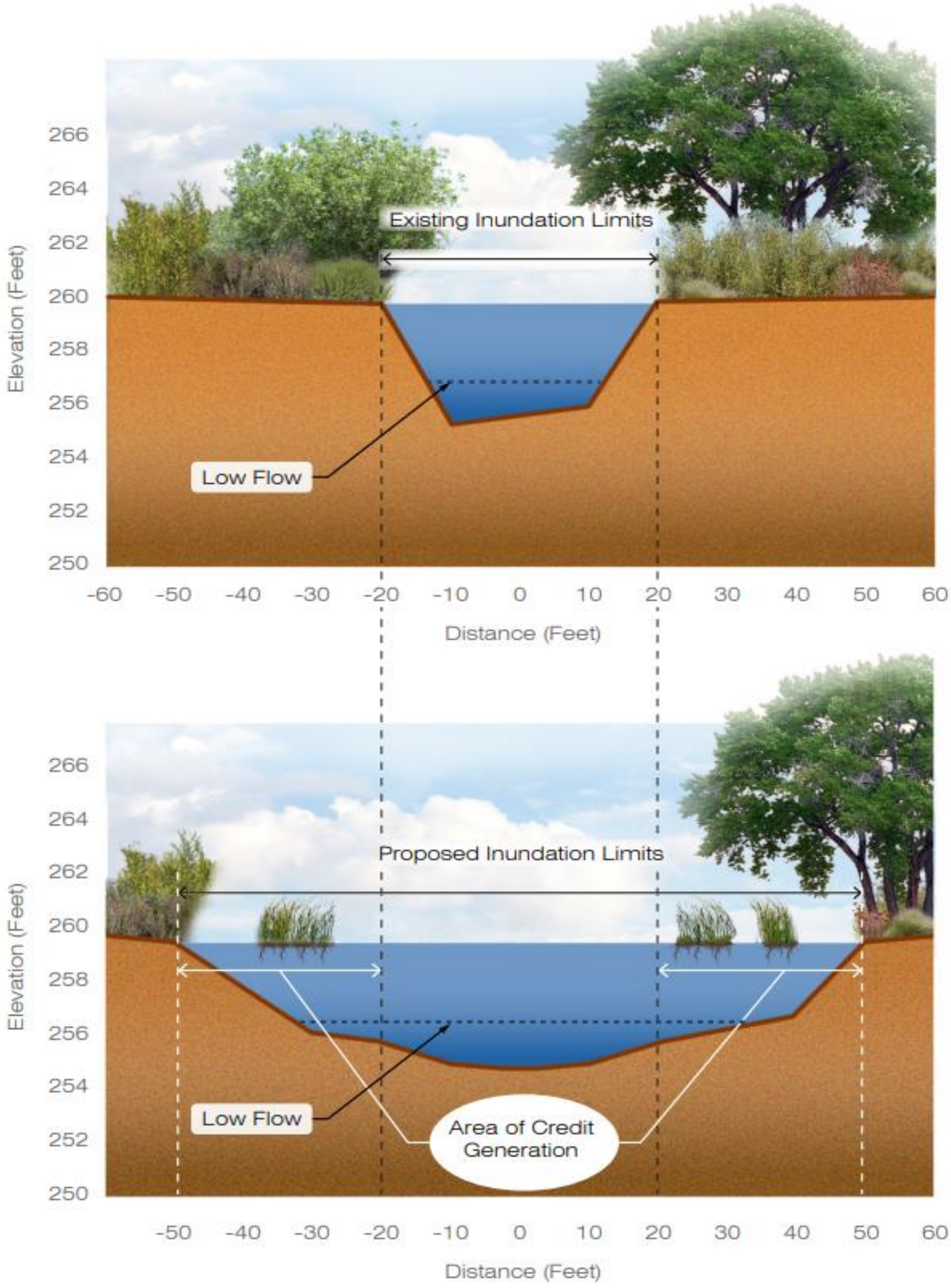


Figure 3-2 The figure demonstrates the pre- and post- restoration conditions for an example NSMP project

The City submitted this WQE credit methodology to the RWQCB for approval in January of 2023. Methods for use of the WQE equation can be found in Appendix B of this document. A detailed description of the equation development and support, including examples for calculating the pollutant control benefits of Stream Rehabilitation NSMPs can be found in Appendix C of this document and in Appendix B.6 of the City's BMP Design Manual. A worksheet to document credit usage and greater water quality benefit by a PDP in the Storm Water Quality Management Plan is included as Appendix D.

3.2 Add-On Pollutant Removal Credits

An ACP project may establish additional pollutant removal credits through the preservation of buffer, preservation and restoration of buffer or by completing bioassessment surveys as described below. The total credits created by an ACP project may not exceed 100% of the total design capture volume (DCV) under any circumstance.

3.2.1 Buffer Credits

Additional credits may be generated by preserving and restoring the upland buffer around the stream rehabilitation project. Buffer can be defined as the habitat immediately adjacent to the inundation area that is in a natural or semi-natural state, currently not dedicated to anthropogenic uses that would severely detract from the project's ability to entrap contaminants, has the ability to discourage forays into the project area by people and non-native predators, or otherwise protects the project from stress and disturbance. Buffers provide many ecological benefits including, but not limited to, entrapping contaminants before they enter a waterway, preventing erosion, and providing wildlife connectivity. Certain landcover types and uses are more compatible with upland buffer and do not detract from buffer functions. Table 3-1 provides examples of buffer types, compatible land uses that do not detract from buffer function, and high impact land covers that are not considered buffer.

The buffer must be between 15 and 820 feet (5 and 250 meters) wide laterally from the edge of the inundation area (85^{th} percentile storm event). The width of the buffer is determined by width of contiguous appropriate buffer land covers.

Buffer credits provided will be an additional percentage based on the total amount of credits generated by the ACP project as determined by applying the WQE to the project design. To qualify for buffer credits, the area preserved must be placed under a perpetual conservation easement as defined in California Civil Code Section 815. Additionally, the preserved buffer area must meet the width requirements stated above, and must be present and preserved along at least 50% of the ACP project length. The ACP project and buffer area may (and in most cases will) be placed under one conservation easement. The easement must restrict development and surface mineral extraction rights, and include the natural character of the land as the conservation value preserved by the easement.

To qualify for buffer credits by restoring the buffer area, the area must meet the standard for buffer preservation above, and the condition of the habitat must be demonstrably improved. The success criteria for buffer improvement can be determined by the project, however an example of demonstrating improvement would be increasing the buffer condition metric in the post-implementation California Rapid Assessment Method (CRAM) survey. Improvements can include restoration of non-buffer land uses to buffer land uses, or improvements of the buffer condition such as removal of nonnative species or reduction of impacts from human uses. Improvement of buffer condition will need to be included in the success criteria for the ACP project.

Table 3-1. Appropriate Buffer Landcovers

Examples of Buffer Land Covers	Land uses Compatible with Buffer Function	High Impact Land Uses Not Included as Buffer
• Natural upland habitats • Nature or wildland parks • Rangeland and pastures • Swales and ditches	• At-grade bike and foot trails with light traffic • Horse trails • Railroads (with infrequent use: <2 trains/day) • Infrequently used roads that are not hazardous to wildlife such as low traffic rural roads, forestry roads, private roads, or otherwise gate-controlled roads • Vegetated levees	• Commercial developments • Fences that interfere with wildlife movement (i.e., unbroken chain-link fences or food safety fences that prevent the movement of most or all sizes of native wildlife) • Intensive agriculture (row crops, orchards, and vineyards) • Golf courses • Paved roads (2 lanes or larger) • Active railroads (>2 trains/day) • Lawns • Parking lots • Horse paddocks, feedlots, turkey ranches, etc. • Residential areas • Sound walls • Sports fields • Urbanized parks with active recreation • Pedestrian bike trails with heavy traffic

Source: CWMW 2013.

Table 3-2 identifies the additional buffer credits multiplier that an ACP may include. The Credit Multiplier increases with increased buffer width as areas with wider buffers typically provide higher habitat value, better water quality, and other valuable ecosystem functions.

Table 3-2. Add-On Buffer Credit Multipliers

Type of Buffer Add-on	Buffer Width	Buffer Credit Multiplier
None	N/A	0
Preservation	15–410 feet (5–125 meters)	0.01
	410–820 feet (125–250 meters)	0.02
Restoration	15–410 feet (5–125 meters)	0.04
	410–820 feet (125–250 meters)	0.05

3.2.2 Bioassessment Survey Credits

An ACP project can generate additional credits by demonstrating stable or improving ecological condition through equal or higher bioassessment scores. Bioassessment surveys would be conducted before the implementation of the ACP project and at least once during the success monitoring period. Bioassessment surveys will include physical habitat transect data and biotic community sampling of both benthic macroinvertebrates and algae, which must be identified at a sufficient taxonomic resolution to calculate the California Stream Condition Index (CSCI) and Algal Stream Condition Index (ASCI), following the current Surface Water Ambient Monitoring Program (SWAMP) *Standard*

Operating Procedures for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat (California Water Boards 2016). Credits will be released for each survey year where CSCI scores are improving or are greater than 0.79. If the CSCI for a project improves from below 0.79 pre-project to above 0.79 for at least 2 surveys, then the full bioassessment add-on credit multiplier will be applied. Table 3-3 identifies the add-on buffer credits multiplier that an ACP may include.

Table 3-3. Bioassessment Survey Add-on Credit Multiplier

Number of Years of Bioassessment Surveys[1]	Bioassessment Credit Multiplier[2]
0[3]	0
2	0.025
3	0.03
4	0.035
5	0.04

[1] Project must complete pre-project bioassessment surveys and at least 1 year of post-implementation bioassessment surveys to obtain add-on credits. Surveys are recommended in alternating years as changes to the biotic community resulting from restoration are not expected to be observable at one-year intervals.

[2] Credit multipliers listed represent the total multiplier allowed based on the number of years of surveys showing improvements in scores completed. An improvement in CSCI must be demonstrated for any Bioassessment Add-on credits to be released.

[3] Year 0 data must be collected prior to implementation of the NSMP.

3.2.3 Add-On Credit Calculations

Add-on credits will be calculated separately for buffer and bioassessment survey credits. Each calculation will be completed by multiplying the appropriate credit multiplier by V_e (credit value earned) calculated from the WQE developed for stream rehabilitation NSMPs for use by the City to determine the number of each type of add-on credits. The add-on credits will then be added to the outcome of the V_e of the ACP project to determine the total credits that the project will generate. The total credits created by an ACP project may not exceed 100% of total DCV under any circumstance.

Total Credits = V_e + (V_e * Buffer Credit Multiplier) + (V_e * Bioassessment Credit Multiplier)

3.3 Hydromodification Credits

Stream rehabilitation projects implemented through this program have the potential to provide quantifiable hydromodification management flow control benefits that can be used to fulfill the requirements for PDPs set forth in Section E.3.c.(2) of the Regional MS4 Permit. Section 3 of the WQE Guidance provides water quality equivalency calculation guidance for hydromodification control. Projects developed under the City's ILF Program will use the methods outlined in Section 3.5.2 Regional WQE Guidance for independent alternative compliance projects. Additionally, section 3.7 provides guidance for partial hydromodification management flow control credit generation. In the case that a project may use or provide partial hydromodification control compliance, Method 3: project-specific modeling approach outlined in section 3.7.1.3 would be utilized. The Problem Statement presented in Section 5.6 of the 2018 WQE provides an example of the process used to determine HMP credits from a stream rehabilitation project.

An alternative compliance project implemented within the City of Chula Vista's jurisdiction can choose to follow the WQE Guidance and provide offsite hydromodification compliance. There are, however, specific limitations on locations of alternative compliance projects in relation to the PDP impact. An overview of this guidance can be found in Chapter 4.3 of the Regional WQE Guidance. The Regional MS4 Permit does not allow for hydromodification credit generation for critical coarse sediment. Greater overall watershed benefit is achieved when stream rehabilitation is designed to mitigate both future and legacy hydromodification impacts associated with development that occurs within the watershed (RWQCB 2018).

Chapter 4
Program Implementation

The Regional MS4 Permit allows the Copermittees and PDP developer to enter into a voluntary agreement to utilize alternative compliance as an offsite alternative to meet the onsite structural BMP performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) while also meeting regional and watershed goals that are not met through onsite compliance. Participation in an ACP is allowed so long as the offsite alternative will have a greater overall water quality benefit than fully complying with the performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) onsite and flow-thru treatment control BMPs sized and designed in accordance with Permit Provisions E.3.c.(1)(a)(ii)[a]-[c] are also implemented on the development site. Provision E.3.c.(3)(d) of the Regional MS4 Permit allows Copermittees to develop an in-lieu fee structure to serve as an alternative compliance mechanism. The City intends to implement an in-lieu fee structure to allow PDP applicants to fund or partially fund candidate projects identified by the City that will provide pollutant removal and/or hydromodification control benefits that offset PDP impacts.

4.1 In-Lieu Fee

The City's intention is to develop and administer an In-Lieu Fee Program to provide financial and spatial relief to PDP applicants within the City's jurisdiction. The WQE Guidance defines an in-lieu fee structure as "[a]n optional program that may be implemented by Copermittees individually or with other entities to allow a project proponent to fund or partially fund one or more alternative compliance projects in-lieu of fully complying with the onsite pollutant reduction or hydromodification management requirements of Order No. R9-2013-0001. In-lieu fee structures must be sufficient to ensure the proper design, development, construction, operation, and maintenance of alternative compliance projects. In-lieu fees must be transferred to the Copermittee (for public projects) or an escrow account (for private projects) prior to the construction of a PDP." The City intends to create a program incompliance with Provision E.3.c.(3)(d) of the Regional MS4 Permit. The Program will comply with the conditions set forth in Provision E.3.c.(b)(i)-(viii). In doing so, the Program will ensure:

- Purchasing credits through the City's Program would provide a greater overall water quality benefit for the PDP than fully complying with the performance requirements of Provisions E.3.c.(1) and E.3.c.(2)(a) onsite;
- The in-lieu fee structure described in Provision E.3.c.(3)(c) will be followed;
- If the PDP applicant chooses to fully or partially fund a candidate project, The City will ensure that the funds to be obtained from the PDP applicant are sufficient to mitigate for impacts caused by not fully implementing structural BMPs onsite, pursuant to the performance requirements described in Provisions E.3.c.(1) and E.3.c.(2)(a);
- If the PDP applicant chooses to implement a candidate project, the City will ensure that pollutant control and/or hydromodification management within the candidate project are sufficient to mitigate for impacts caused by not implementing structural BMPs fully onsite, pursuant to the performance requirements described in Provisions E.3.c.(1) and E.3.c.(2)(a);

- The voluntary agreement to fund, partially fund, or implement a candidate project must include reliable sources of funding for operation and maintenance of the candidate project;
- Design of the alternative compliance project will be conducted under an appropriately qualified engineer, geologist, architect, landscape architect, or other professional licenses where applicable.
- The candidate project will be constructed as soon as possible and no later than 4 years after the certificate of occupancy is granted for the first PDP that contributed funds toward the construction of the candidate project unless a longer period of time is authorized by the San Diego RWQCB Executive Officer.
- Temporal mitigation will be required for pollutant loads and altered flows that are discharged from a PDP in the case that the candidate project is constructed after the PDP is constructed. The required temporal mitigation will be determined on a case by case basis and is discussed further in Section 4.2.

4.1.1 City Implementation

City-developed alternative compliance projects utilizing ILF would be planned, designed, permitted, implemented, and maintained in perpetuity by the City. The City may use contractors to implement any portion of the project, however, responsibility for project success and long-term maintenance will remain with the City. All credits produced through City implemented projects would be available for use by the City or available for sale to the development community in-lieu of onsite BMP compliance with provisions E.3.c. Funds for the sale of an ILF credit will be transferred to the City, or into an escrow account established for the ILF project, prior to the construction of the PDP. Funds collected from the sale of any credits will be calculated to include all planning, development, implementation, and long-term costs associated with the ACP project. The City will hold the funds in an endowment, or other account established by the City solely for use by the ACP program.

4.1.2 Public-Private Partnership

The City may utilize public-private partnerships to implement ACP projects. Any project implemented through a public-private partnership will be developed in accordance with a project specific agreement between the City and the private entity that identifies the party responsible for each ACP project component as well as the allotment of credits and funding. The City will include oversight for any ACP project component implemented by the private entity. The City will retain all responsibilities that they have discretionary authority over such as design approval, meeting success criteria, credit release approval, and use of credits by a PDP.

Funding for the ACP project as provided by either the City, private developer, or from previous credit sales will be calculated to be sufficient to fund all costs associated with the planning, development, implementation, and long-term costs associated with the ACP project. Funds associated with long-term management and maintenance will be held in an endowment or other account established by the City solely for use by the ACP program. The partnership agreement will determine the number of credits that will be allotted to each partner, and when those credits will be available. The credit allocation will be commensurate with the level of effort and funding provided by each partner for the life of the ACP project All credits developed through a public-private partnership will be considered as part of the ILF program and will be available for transfer to a third party by either the City or the private partner. Any credit transfer will be overseen by the City and will require City approval for use of credits by the PDP purchasing credits.

The City anticipates that most ACP projects implemented through public-private partnerships will be constructed on City owned lands, however they may be constructed on lands outside of City ownership. In either scenario, the land will be placed under a perpetual site protection mechanism such as an open space easement (California Government Code Section 51050-51065) or conservation easement (California Civil Code Section 815-816) to preserve the conservation values provided by the ACP Project. Any such easement will be in favor of the City.

4.1.3 City Roles and Functions

The City will be responsible for program management, which includes project design and permitting, construction, monitoring, maintenance and management, and credit sales and tracking. The City will set a fee amount per credit that will be sufficient to cover the costs of project implementation. The City will develop and implement a process for collecting and managing these fees to utilize them from project development and design. By utilizing the In-Lieu Fee Program, responsibility for MS4 compliance will be transferred from the PDP applicant to the City.

4.1.4 Forms and Certifications

The City will maintain and administer a number of forms and certifications in association with the Program. These forms and certifications will be developed by City staff and utilized by PDP applicants participating in the Program. Documentation to support PDP eligibility to use the ILF must include:

For Pollutant Removal Credits

a. Demonstrate that the use of the ACP will have a greater overall water quality benefit than fully complying with the performance requirements of Provisions E.3.c.(1) onsite (use Priority Development Project Credit Usage Worksheet found in Appendix D)

b. Documentation that the PDP has implemented on-site flow through BMPs that are sized and designed in accordance with provisions E.3.c.(1)(a)(ii)[a]-[c] of the Regional MS4 Permit; and

c. For PDPs that use proprietary BMPs to meet onsite flow through pollutant control requirements, documentation must be submitted that demonstrates the proprietary BMP(s):

    i. Are sized and designed in accordance with provisions E.3.c.(1)(a)(ii)[a]-[c] of the Regional MS4 Permit;

    ii. Have met all the Washington State Department of Ecology TAPE9 certification tested design and sizing approval requirements for the primary project pollutants treated by proprietary BMP; and

For Hydromodification Credits

a. Demonstrate the offsite alternative will have a greater overall water quality benefit than fully complying with the performance requirements of Provisions E.3.c.(1) onsite

b. Documentation that PDPs approved for generating or using the ILF Program have mitigated for the post-project runoff conditions not fully managed onsite.

4.1.5 Process

PDP projects and alternative compliance projects in the ILF Program have a process by which they are implemented, from initial conceptual design through to construction. Figure 4-1 provides an overview of the Program process for a PDP to implement a WMAA Candidate Project or Applicant Proposed ACP project.

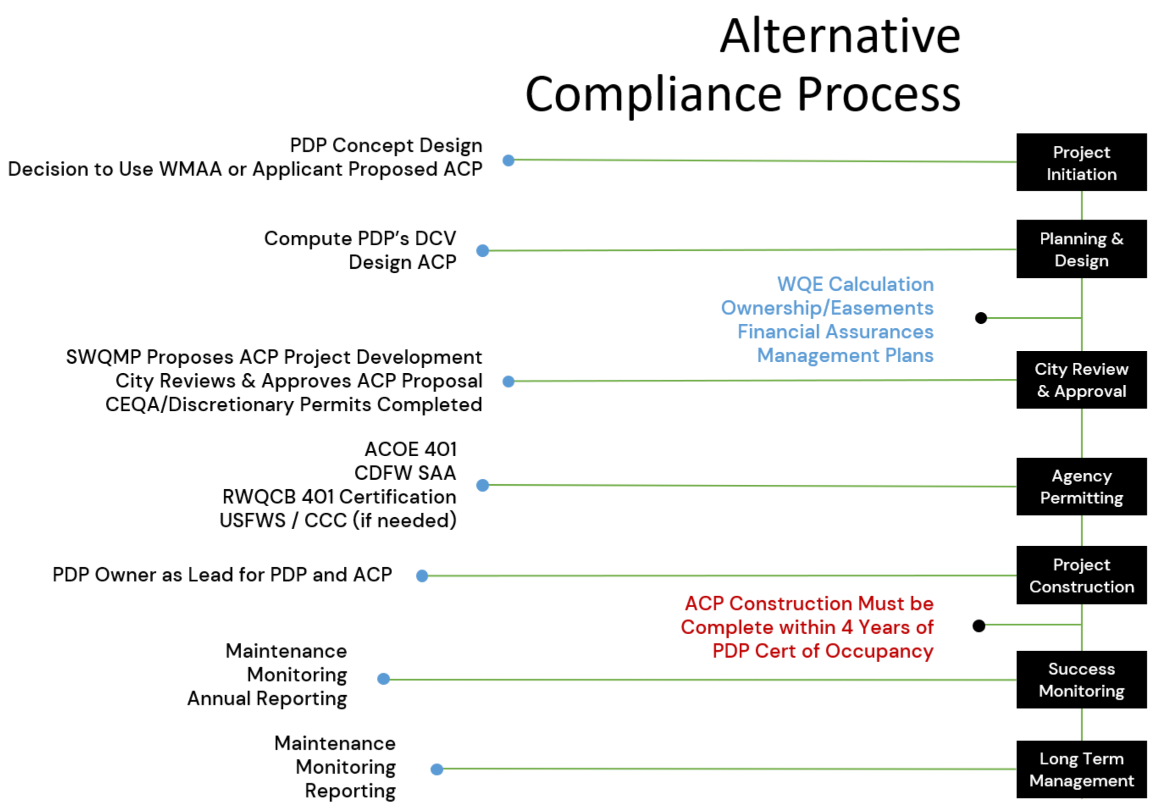
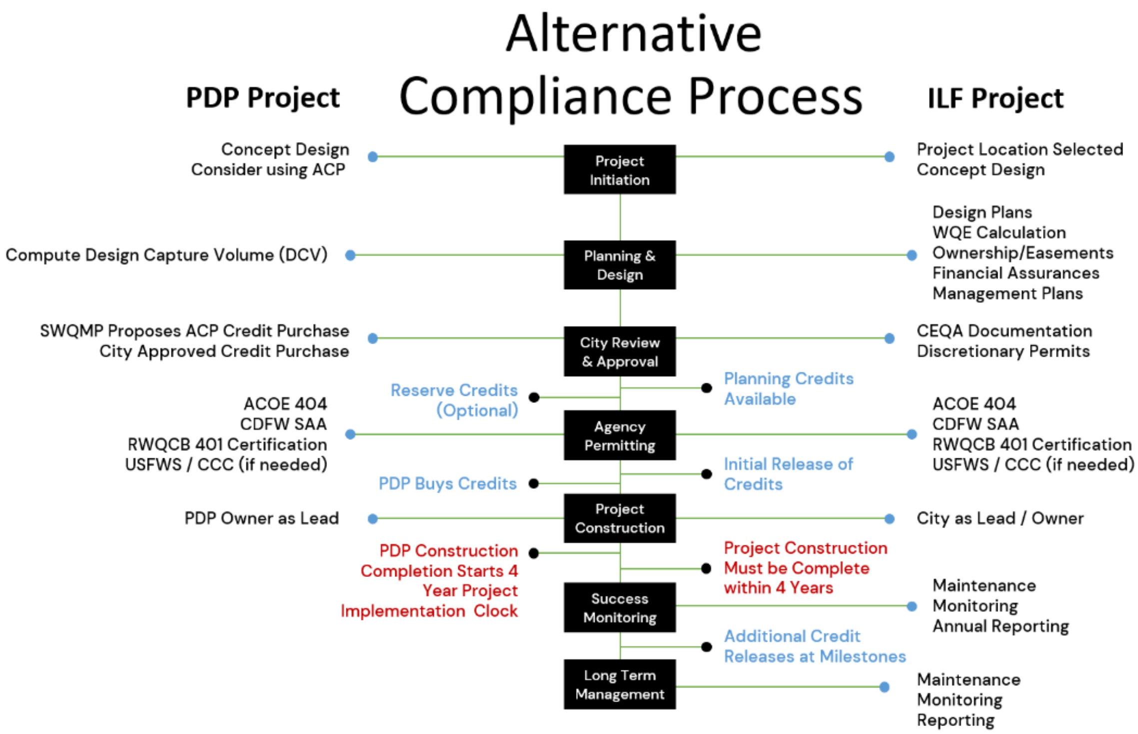


Figure 4-1. Overview of the Program Using WMAA or Applicant Proposed ACP Project

Figure 4-2 provides an overview of the Program process and explores the relationship that a PDP and an ILF project have within the Program. PDP and ILF project stages would not necessarily be synchronized. This chart illustrates the process for each independently (on the outside columns of information) and the key relationships between them (on the inside columns of information).



ACOE = U.S. Army Corps of Engineers; CCC= California Coastal Commission; CDFW = California Department of Fish and Wildlife; CEQA= California Environmental Quality Act; SWQMP = Stormwater Quality Management Plan; USFWS = U.S. Fish and Wildlife Service

Figure 4-2. Overview of the Program Process Using ILF Option

The following text provides detail on the various steps in the process outlined in Figure 4-2. These steps are specific to alternative compliance projects constructed under the ILF Program and are therefore discussed as ILF projects. The requirements for the PDP project and an ILF project in each step will differ. However, if the PDP chooses to utilize the ILF program to comply with the Regional MS4 permit requirements, certain alignments within the project timelines are necessary and are discussed below.

Project Initiation

During project initiation of the ILF project, a strategic location will be chosen based on project objectives and constraints using the conceptual design, and the design will utilize NSMP principles.

During the PDP's project initiation, it may choose to use the ACP to meet its Regional MS4 permit compliance requirements for pollutant control, hydromodification, or both.

Planning and Design

As the ILF project continues through planning and design, multiple steps and processes will be completed. These include completion of design plans, using the WQE equation designed for the NSMPs within the City's jurisdiction to calculate provided pollutant removal credits and the WQE guidance for hydromodification to determine provided hydromodification credits, and establishment of property ownership and easements, financial assurances, and project management plans.

When a PDP opts to use the ACP to meet its Regional MS4 Permit compliance for pollutant control credits, design of the PDP would include onsite flow-through treatment, as required under E.3.c.(1)(a)(ii)[a]-[c] of the Regional MS4 Permit. The ACP must be sized and designed to remove pollutants from stormwater to the MEP as defined by the Regional MS4 Permit. If the PDP opts to use the ACP to meet its Regional MS4 Permit compliance for hydromodification credits, it will address any critical coarse sediment concerns in the siting and design process. As part of the PDP development process, it will calculate the design capture volume (DCV) of the PDP in support of the SWQMP. Once a PDP has calculated its onsite DCV it will use the NSMP Pollutant Control WQE developed for the Program to determine its credit needs to meet compliance standards. Hydromodification credit needs will be determined according to the methods in the Region 9 WQE Guidance.

City Review and Approval

When planning and design of the ILF project are at an appropriate stage, the City will begin the CEQA process and apply for appropriate discretionary permits. Once CEQA is completed and the City approves the project, planning credits will be available for purchase to the development community.

The PDP can propose ILF credit purchase to meet its Regional MS4 Permit requirements during the City's review and approval of the project. If the City approves the credit purchase proposal, the PDP has the option to reserve credits.

Agency Permitting

Prior to ILF project or PDP construction, appropriate agency permits will be submitted. These may include, but are not limited to, the Army Corps of Engineers Section 404 Permit, California Department of Fish and Wildlife Lake and Stream Bed Alteration Agreement, and RWQCB 401 Water Quality Certification. The initial release of credits from the ILF project will occur once the project has been permitted. At this time, the PDP may officially purchase ACP credits.

Project Construction

The City and PDP developer will have full ownership over construction of their projects, respectively.

To comply with Regional MS4 permit requirements, the ILF project must be fully constructed within four years of the first issued certificate of occupancy from a PDP that purchased credits.

Success Monitoring

Success criteria for the ILF will be set during the planning phase of the project. Once the project is implemented, maintenance and monitoring will be conducted to ensure success criteria are met. Results from monitoring efforts will be reported annually. It is anticipated that success criteria will be a condition of the 401 Water Quality Certification required for the ACP project, and reporting on the results of success criteria monitoring will be provided to the Regional Board under that program, however, all monitoring actions and any credit releases based on documented success will be reported to the Regional Board in the WQIP annual report. Additional credit releases will occur as the project matures and meets predetermined milestones. This phase includes short term maintenance, monitoring, and reporting up to 5 years after construction is completed, or until final success criteria are met for two consecutive years.

Long Term Management

An ILF project will be maintained in perpetuity and the project area will be protected through a perpetual site protection mechanism, such as an open space easement, conservation easement, or restrictive covenant that is recorded onto the deed and conveys with the property. As such, a long-term maintenance plan will be developed during the planning process for the project. Maintenance, monitoring, and annual reporting to the City will be required. The Regional MS4 Permit requires the City to verify that projects are "adequately maintained and continue to operate effectively to remove pollutants in stormwater to the MEP through inspections, self-certification, surveys, or other equally effective approaches."

4.2 Temporal Mitigation

The Regional MS4 Permit Provision E.3.c.(3)(b)(viii) states that if an alternative compliance project is constructed after the PDP is constructed, the City must require temporal mitigation for pollutant loads and altered flows that are discharged from the PDP. Section 1.8 of the City's BMP Design Manual also requires the PDP to provide temporal mitigation to address this interim time period. Temporal mitigation must provide equivalent or better pollutant removal and/or hydrologic control (as applicable) as compared to the case where the offsite alternative compliance project is completed at the same time as the PDP. Temporal mitigation should consider both the quantity of DCV and duration between the PDP and ACP project implementation.

4.3 Location of Project

Location of an alternative compliance project will determine what area a PDP can be located to use credits. All ACP projects proposed under this program must be within the boundaries of the City of Chula Vista and may only provide credits for PDPs within the City of Chula Vista. The WQE Guidance and City of Chula Vista BMP Design Manual provides guidance on location requirements for an ACP project and where PDPs utilizing credits from the project may be located for both pollutant removal and hydromodification credits. This Program will use the same guidance and requirements for locating NSMP ACP projects approved under the program.

4.3.1 Pollutant Removal Credits

Current guidance from both WQE Guidance and the City of Chula Vista BMP Design Manual requires an alternative compliance project to be in the same WMA as the proposed PDP development for. (BMP Design Manual Section 1.8 and WQE Guidance Sections 1.3, 2.3.1.2, 3.3, and 3.6). Figure 4-3 provides an overview of the City of Chula Vista's jurisdictional boundaries, the Hydrologic Areas within the City's limits, and the San Diego Bay WMA. The entire City is within the San Diego Bay WMA. This program further restricts the use of pollutant removal credits from an ACP project to PDPs within the same Hydrologic Area.

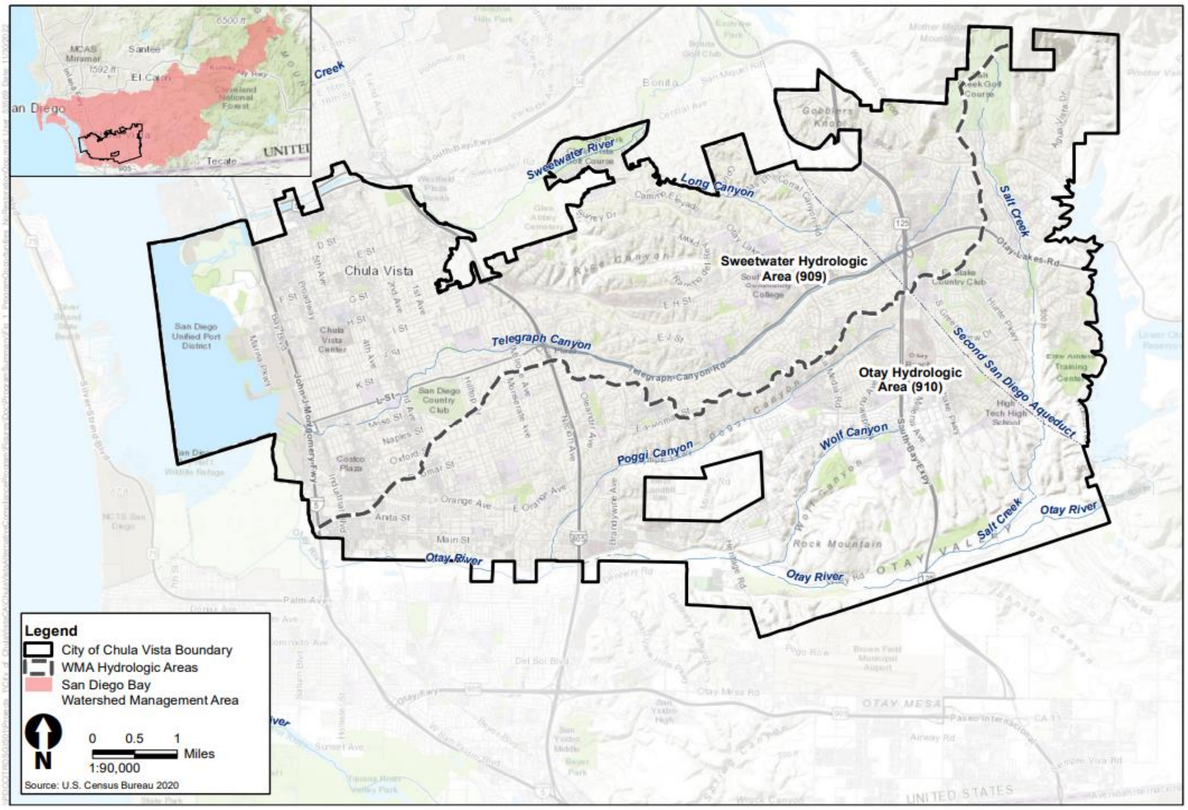


Figure 4-3. City of Chula Vista Boundary and San Diego Bay Watershed Management Area

4.3.2 Hydromodification Credits

Hydromodification credits are required for any project discharging to a non-exempt stream (Figure 4-4). In order for an alternative compliance project to provide full or partial compliance for a PDP's hydromodification management requirements, specific location requirements must be met and vary based on certain scenarios. Guidance on the proposed PDP scenarios (new development, redevelopment, etc.) and location requirements for an ACP project to provide compliance for each scenario are outlined in detail in Section 3.3 of the WQE Guidance Document. Section 3.6 of the WQE Guidance document provides specific requirements for using NSMPs for hydromodification flow control equivalency and the location requirements of the NSMP ACP project in relation to the PDP.

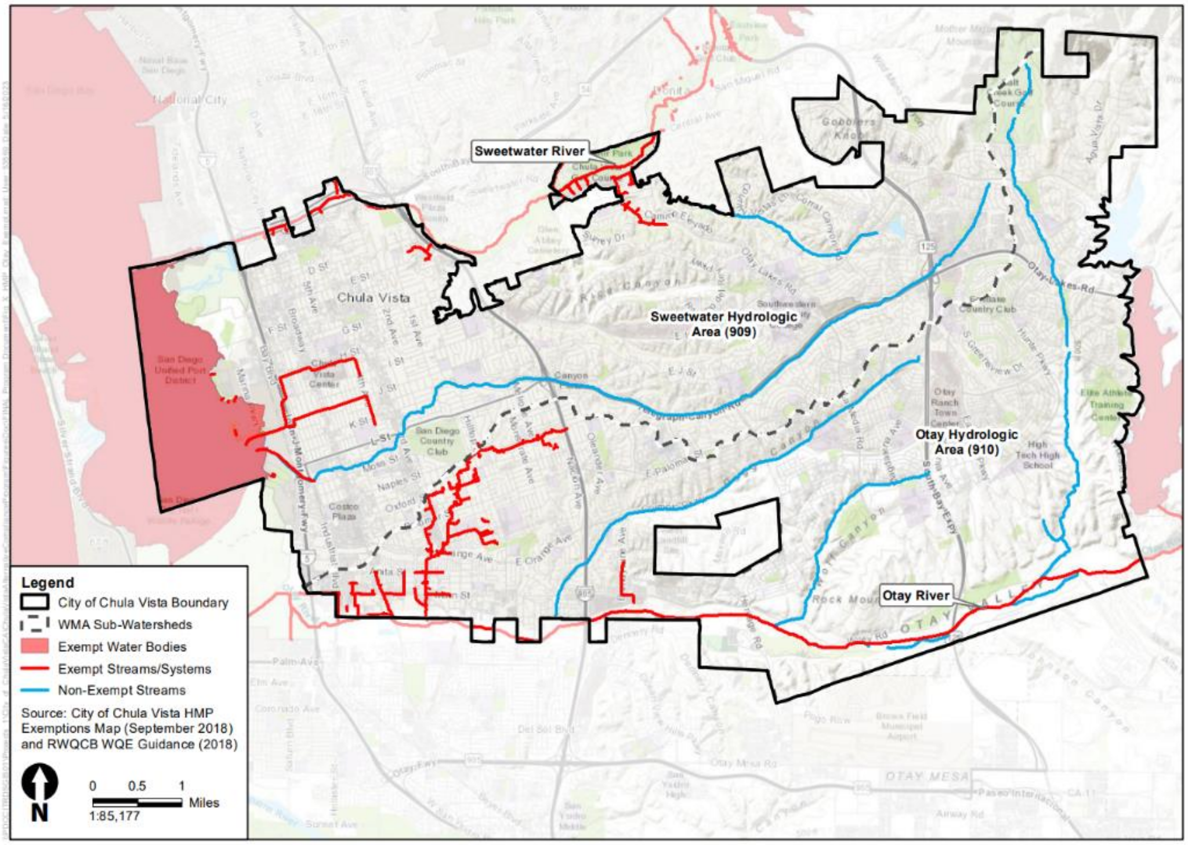


Figure 4-4. Hydromodification Exemptions in the Otay and Sweetwater Sub-Watersheds

4.3.3 Potential Project Opportunities

The city has identified the following stream sections as having the potential for restoration that would provide pollutant control or hydromodification credits under this program (Figure 4-5).

<u>Lower Salt Creek</u> – There are restoration opportunities within Salt Creek and its tributaries in the portion of Salt Creek between Olympic Parkway and the confluence with the Otay River.

<u>Upper and Lower Wolf Canyon</u> - There are restoration opportunities within Wolf Canyon between the area around Olympian High School and the confluence with the Otay River.

<u>Lower Poggi Canyon</u> – There are restoration opportunities in the lower reach of Poggi Canyon before the confluence with the Otay River.

<u>Lower Telegraph Canyon</u> – There are some limited restoration opportunities within lower Telegraph Canyon west of I-805.

<u>Long Canyon</u> – There are restoration opportunities in the portion of Long Canyon within the City.

<u>Mid-Sweetwater River</u> – There are restoration opportunities in the portion of the Sweetwater River within the City.

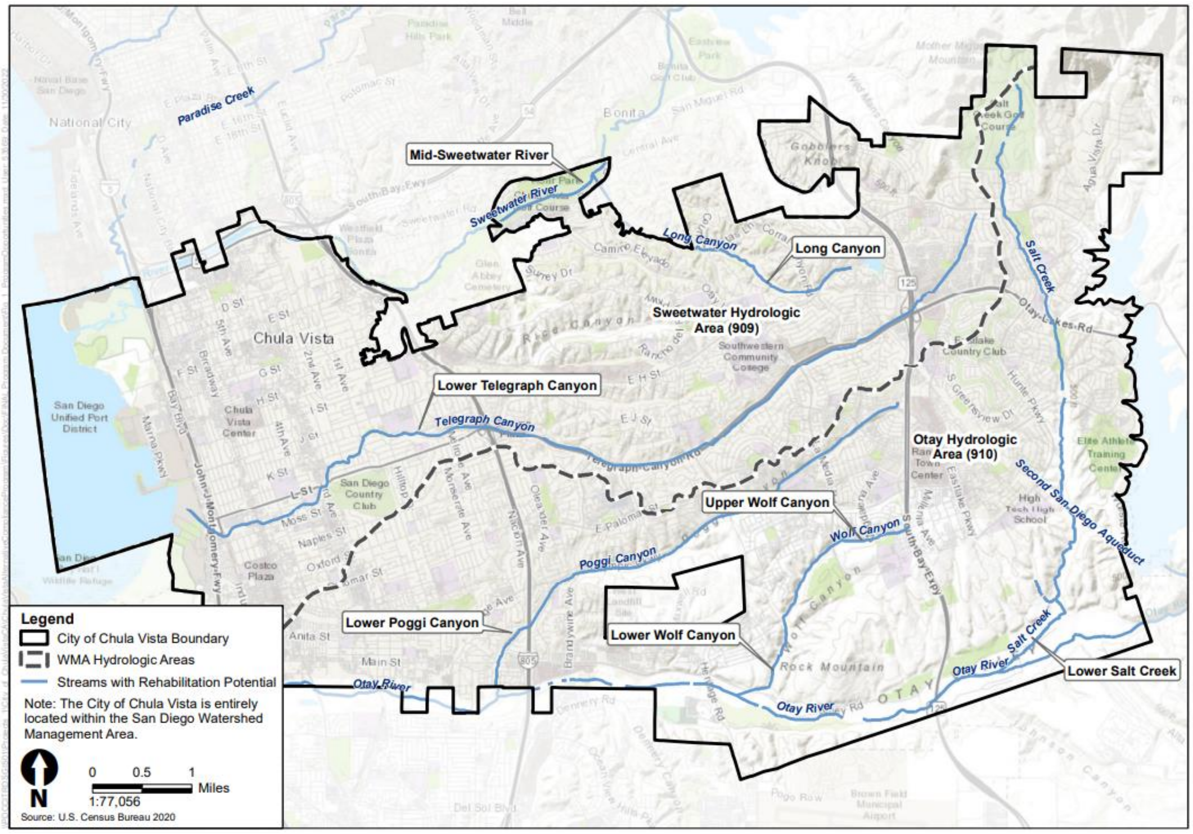


Figure 4-5. Project Opportunities in the City of Chula Vista

4.4 Coordination with Other Mitigation and Restoration Programs

NSMPs developed under this Program will need to comply with applicable federal, state, and local laws and regulation. Since this program focuses on stream restoration NSMPs, they will require compliance with the California Environmental Quality Act (CEQA), Clean Water Act (CWA) Sections 401 and 404, Porter-Cologne Water Quality Act (Porter-Cologne Act), and California Department of Fish and Wildlife Lake and Streambed Alteration Program. Additional compliance will be identified through the CEQA process.

In addition to complying with state and federal laws and regulations, the restoration projects implemented under this Program may provide mitigation opportunities for impacts to resources that fall outside the Regional MS4 permit regulations. However, when an NSMP considers providing mitigation under other programs, the NSMP proponent will need to recognize that there are limitations to how these programs may co-locate credits. These scenarios are discussed in the sections that follow.

4.4.1 Aquatic Resource Mitigation

Pollutant control or hydromodification credits developed by an NSMP may not also be used to meet mitigation obligations for impacts to waters of the state or waters of the US under either the CWA section 401 or 404 program, or the Porter-Cologne Act (jointly referred to as Aquatic Resources Mitigation). When a water of the US or water of the state is impacted, the Aquatic Resources Mitigation required under the laws previously referenced is intended to replace the entire suite of functions and values that were lost by the initial impact. The credits created under this Program address specific functions (i.e., pollutant control) that are provided by higher quality natural and restored stream features. Allowing water quality credits created under this Program to also be utilized as Aquatic Resource Mitigation would allow for an overall loss of functions of waters of the US or waters of the state and is therefore not allowed under this Program.

A restoration or mitigation project may, however, be designed to allow for both Aquatic Resources Mitigation and ACP credits if the credits are mutually exclusive. This can be done by determining the areas that may provide each type of credit and documenting how those credits will be divided between the programs, and how the credit use will be tracked to ensure that credits will only be used to mitigate for one impact type. An NSMP may also propose that areas that provide both types of credits may be used for either type of credit so long as the credit is then made unavailable for use by the other credit program. For example, if a proposed project includes stream restoration and buffer restoration that meet the requirements of both the Program and Aquatic Resources Mitigation, the area that is considered an aquatic resource would be available for Aquatic Resources Mitigation. That area could then be removed from the overall inundation area that would be expected to provide credits under this Program, and the quantity of water quality credits provided would be calculated based on the area remaining after the Aquatic Resources Mitigation is removed from the total inundation area. In this scenario, buffer add-on credits would also be available for the ACP project, which would be calculated based on the total potential pollutant control credits that the NSMP would provide. The ACP project would then be able to provide credits based on the proportion of the site that is not considered aquatic resources, plus the buffer add-on credits.

4.4.2 Habitat and Species Mitigation

Pollutant control and hydromodification credits generated under this program may be able to be bundled with species habitat mitigation to provide mitigation for species habitats under laws such as the California or federal Endangered Species Acts, with approval of the California Department of Fish and Wildlife and Fish and Wildlife Service, respectively. In this situation, the credit would be able to provide habitat credits and water quality credits to meet permit compliance for a PDP, however, the water quality credit would not be able to be severed from the species habitat credit to be used to compensate for impacts from different PDPs.

4.5 Life of Credit and Reporting Requirements

4.5.1 Life of Credits

Credits established under the Program will be perpetual in duration. As discussed in Section 2.4, *Alternative Compliance Project Options,* the Program will require all projects have a perpetual site protection mechanism in place and funding to support the long-term maintenance and management of the credits. All projects designed and installed under the Program will provide natural systems that are expected to be resilient to changing conditions. Adaptive management and contingency funding will be included in the required long-term funding to address required remedies to situations that may affect the material conditions of the ACP project (those that provide stormwater treatment).

4.5.2 Annual Reporting by the City

The City will submit to the SDRWQCB an annual report of all activity under the Program including the development and approval of an ACP project, implementation of an ACP project, ACP credit reservations or purchases by a PDP, status of success criteria for an implemented ACP project during its success monitoring period, remaining time to fulfill any sold credits for which the ACP project has not yet been implemented, and closeout of any ACP project when all credits have sold. All details of success monitoring will be submitted through the Clean Water Act Section 401/Waste Discharge Requirement permit process and do not need to be separately submitted under this Program reporting. If any new ACP projects are approved or implemented within the reporting period, the City will report on the location of the project, including the WMAA and subwatershed, project size, anticipated or constructed credits, and any reserved credits allocated to the project. Annual reporting will be included in the WQIP annual report.

As part of the City's Annual reporting process on the ACP, information on both the ACPs developed and approved by the Program and the PDPs using credits of the program to meet compliance requirements will be reported. This additional information will be included with each WQIP Annual Report. Information requirements are as follows:

PDP

1. Pollutants treated at the PDP; and
2. Map of PDP that includes the following information:
   i. Name of PDP;
   ii. Location of PDP with latitude and longitude;
   iii. Name of receiving water that the PDP discharges to;
   iv. Latitude and longitude of all onsite PDP flow through pollutant control BMPs with type of BMP indicated; and
   v. Latitude and longitude of onsite post project runoff control mitigation.
3. Documentation of greater water quality benefit provided (using Appendix D)

ACP

1. ACP inventory in the Credit System. For each ACP in the inventory include:
   a. ACP name;
   b. ACP type (stream restoration, stream restoration with buffer, stream restoration with bioassessment, stream restoration with buffer and bioassessment);
   c. Quantity of Pollutant Control credits generated by ACP;
2. Map of ACP with the following information included:

   a. Location of the ACP with latitude and longitude;
   b. Type of ACP;
   c. Drainage area treated by the ACP; and
   d. Receiving water that will receive the ACP discharges.
3. Ledger documenting released credits, credits reserved, and credits sold
4. Documentation of the greater overall water quality benefits provided by the Program.

4.6 Long-Term Assurances and Management

All projects implemented under the In-Lieu Fee Program must provide for the operation and maintenance of the ACP projects. As this Program is designed to implement stream rehabilitation and natural systems restoration, long-term operation costs are expected to be low, while long-term maintenance costs will vary due to site-specific conditions that may affect the condition of the restoration project such as prevalence of invasive species or detrimental human visitation. To ensure that the ACP projects meet or exceed their design conditions, the fees assessed for each project will include sufficient funding to cover annual monitoring, expected maintenance costs, legal fees or legal insurance, and a contingency fund (recommended to be at least 10% of the long-term costs) to cover unexpected costs. Each ACP project, whether public or private, must identify the party responsible for ACP project maintenance, monitoring, and management, including reporting the dates and findings of ACP project maintenance and corrective actions when applicable. The City Engineer will require private ACP project property owners to provide annual self-certification that inspection and maintenance has been performed, provide details of the inspection results and maintenance activities, and confirm or update the contact information for the party responsible to ensure inspection and maintenance is performed.

Each ACP project must provide a secure long-term funding source to support the long-term maintenance, monitoring, and management of the ACP project. The long-term funding mechanism for private ACP projects will be in the form of a non-wasting endowment where funding is designated solely to support the maintenance, monitoring, and management of the ACP project.

The City may decide to establish a designated account to accept ACP credit sale fees, where monies held in the account will only be used to fund design, development, construction, operation, maintenance, monitoring, and management of the ACP projects. This fund would need to establish a sub-account to separately hold long-term maintenance, monitoring, and management funds to ensure these funds are preserved for future use.

In addition to funding to cover the long-term maintenance and monitoring of the ACP project, each project will need to provide perpetual site protection for the entire ACP area. Site protection on privately owned lands must be in the form of a conservation easement that meets the requirements of California Civil Code Section 815, or other perpetual site protection mechanism approved by a resource agency with permitting authority over the project. The CE, or other mechanism, must identify the water quality benefits provided by the ACP project as the conservation values protected by the conservation easement. When ACP projects are implemented on private lands, property owners must provide documentation of the monitoring and maintenance of the ACP project to support the City's reporting requirements to the San Diego RWQCB.

Publicly owned lands may be placed under a conservation easement, or other mechanism to provide permanent protection of the ACP project water quality functions. Examples of alternative protections for publicly held lands may be including the goal, maintenance, and monitoring of the ACP project into an existing land management plan, resource management plan, or similar management document that directs the activities on the included plan areas.

4.7 Adaptive Management and Future Actions

4.7.1 Adaptive Management

If any portion of the Program is found unsuccessful, then adaptive management measures will be identified to make program adjustments in order to become successful. For example, if the 4-year timeline to implement credits is not attainable due to there being a longer time period between when credits are released for sale and when the ACP is implemented, as identified in this document, then adaptive management measures would be implemented. Possible solutions could include requesting an extension of time for implementing the ACP project from the RWQCB Executive Officer, assessing whether the delay was due to an issue that is expected to occur on other projects, and adjusting the credit release and implementation times to avoid this problem on future ACP projects. As the City implements this program and re-evaluates its components, adjustments will be made in order to improve processes. Additionally, if new TMDLs are added for the watersheds within the City, the City will assess if the Program supports how the City addresses the new TMDL, or if additional measures will be needed.

4.7.2 Future Actions

Future actions will be at the discretion of the City and the needs of the community. Currently, the City has identified the possibility of including a water quality crediting system in future iterations of the Program.

Chapter 5
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Appendix A
Technical Memorandum on Alternative Compliance Program: Water Quality Equivalency Using Natural System Management Practices

Technical Memorandum

Alternative Compliance Program: Water Quality Equivalency Using Natural System Management Practices

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ICF Jones & Stokes. 2022. *Alternative Stormwater Compliance: Water Quality Equivalency Using Natural System Management Practices*. Technical Memorandum. December. (ICF 429.20.) San Diego, CA. Prepared for the City of Chula Vista, CA.

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Acronyms and Abbreviations

Acronym	Definition
°C	degrees Celsius
ACP	Alternative Compliance Program
BANCS	Bank Assessment for Non-point Source Consequences of Sediment
BMP	Best Management Practice
BSTEM	Bank Stability and Toe Erosion Model
Cd	cadmium
CEQA	California Environmental Quality Act
City	City of Chula Vista
Cr	chromium
CRAM	California Rapid Assessment
Cu	copper
DCIA	Directly Connected Impervious Area
DCV	design-capture volume
FC	fecal coliform
FCU	functional capacity units
Fe	iron
HGM	Hydrogeomorphic Method
ICW	integrated constructed wetlands
MBAS	methylene blue activated substances
MS4	Municipal Separate Storm Sewer System
MSCP	Multiple Species Conservation Plan
Ni	nickel
NSMP	Natural System Management Practices
PAH	polycyclic aromatic hydrocarbon
Pb	lead
PDP	Priority Development Projects
RSC	regenerative stormwater conveyance
RSC	Regenerative Stormwater Conveyance
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SCM	Stormwater Control Measures
SUSTAIN	Stormwater Treatment and Analysis Integration
SWAT	Soil and Water Assessment Tool
SWBRP	San Diego Bay Responsible Parties
TCu	total copper
TDS	total dissolved solids
TMDL	Total Maximum Daily Load
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
WQE	Water Quality Equivalency

Acronym	Definition
WQE Guidance	Water Quality Equivalency Guidance Document for Region 9
WQIP	Water Quality Improvement Plan
Zn	zinc

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Executive Summary

The City of Chula Vista (City) is seeking to utilize Natural Systems Management Practices (NSMP) as a form of compliance for their Municipal Separate Storm Sewer System (MS4) permit. California Regional Water Quality Control Boards (RWQCB) issue MS4 permits, with oversight of the Environmental Protection Agency (EPA) under Clean Water Act (CWA) Section 402 of the National Pollutant Discharge Elimination System (NPDES) regulations, which was implemented to provide oversight and numerical criteria for dischargers that release pollutants into rivers, lakes, and other surface waters of the United States. Under CWA Section 402, municipal stormwater dischargers are regulated and mandated to reduce pollutant loads to receiving waters by utilizing treatment Best Management Practices (BMP). MS4 permittees generally comply with MS4 requirements through onsite BMPs or low impact development that act to reduce both hydromorphological changes and pollutant loads correlated with development and urbanization. Although onsite treatment of stormwater is often preferred, development constraints can sometimes require the use of approved offsite and alternative stormwater-management strategies, as is the case with the City.

In a March 2019 amendment, the RWQCB adopted an updated version of the Water Quality Equivalency Guidance Document: Region 9 (WQE Guidance) which allows co-permittees to design and implement an offsite Alternative Compliance Program (ACP) to meet water-quality requirements as defined in the region's MS4 permit. Under the updated WQE Guidance, co-permittees can enter into agreements with Priority Development Projects (PDP) to meet all or part of their stormwater requirements offsite so long as proposed projects provide greater water-quality benefits to the watershed than onsite structural BMPs. The WQE Guidance also provides for the exploration and development of Natural Systems Management Practices (NSMP) as alternatives to structural BMPs, identifying Land Preservation, Land Restoration, and Stream Rehabilitation as potential avenues for calculating and crediting for Water Quality Equivalency (WQE).

In March 2019, the City of Chula Vista submitted a grant application to the California Department of Housing and Community Development's (HCD) Senate Bill (SB) 2 Planning Grant Program which provides funding to help municipalities streamline housing approvals and accelerate housing production. Recognizing the City's critical-need status for housing developments and compliance, HCD awarded the City $625,000 to implement an Alternative Compliance Program using NSMPs. The deliverables proposed under the ACP program include an RWQCB-approved WQE framework plan, establishment of WQEs for NSMPs, stakeholder outreach meetings, and an in-lieu fee structure and credit system for PDPs to employ.

This technical memorandum, *Alternative Compliance Program: Water Quality Equivalency Using Natural System Management Practices*, summarizes a literature review performed to better understand available scientific information related to use of NSMPs for stormwater management and watershed and water-quality benefits in support of the City's efforts to develop an ACP to streamline the approval process for PDPs. Therefore, this memorandum is the first step toward developing the methodologies for applying NSMPs toward WQE credits as an ACP option.

Findings

1. ***Land Preservation* is the act of permanently preserving undeveloped land in its current state.** This NSMP may provide quantifiable stormwater pollutant control and hydromodification flow control benefits by preventing increases in stormwater runoff volumes and pollutant concentrations associated with development, as well as maintaining natural habitat and functions such as interception, evapotranspiration, and infiltration of precipitation.

   Land preservation should not be considered for hydromodification or pollutant removal credits on its own, but can act as a credit multiplier if coupled with Land Restoration and Stream Rehabilitation, keeping in mind that floodplain Land Preservation likely provides greater ecosystem and watershed benefits per acre than upland Land Preservation and should be assessed as such. This NSMP only provides water-quality benefits to the catchment in which it is located and should be placed within the hydrologic areas and subareas where the development will occur.

2. ***Land Restoration* is the act of restoring currently developed land back to a stabilized pre-development condition** by removing impervious surface cover from existing developed land, regrading, decompacting, and stabilizing disturbed ground, and restoring predevelopment land use and land cover through native plant community revegetation and adaptive management. These actions re-establish natural interception and infiltration mechanisms to reduce pollutants and flow volume.

   Reductions in stormwater volumes and benefits to hydromodification flow control resulting from implementation of Land Restoration NSMPs can be counted as WQE credits for a proposed development. However, there are no methods identified for calculating pollutant reduction resulting from retention, biofiltration, or flow-thru methods despite strong empirical evidence in scientific literature. Therefore, further research and development of calculations are required to quantify stormwater pollutant control for WQE credits.

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

   The WQE Guidance provides methodologies to credit stormwater volume reduction and hydromodification flow control benefits provided by Stream Rehabilitation NSMPs, but does not identify calculations for pollutant reduction. Review of scientific literature indicates that stream rehabilitation projects provide measurable pollutant-reduction benefits through sediment retention, vegetative uptake, and biogeochemical cycling. Therefore, further research and development of calculations are required to quantify stormwater pollutant control for WQE credits.

4. **A review of existing alternative compliance programs provides insight into program feasibility and obstacles**. Currently, no such pollutant-reduction crediting programs exist in southern California, but this approach has been employed in Chesapeake Bay and New Hampshire.

The Chesapeake Bay protocols and calculations for stream rehabilitation were based on published sediment and nutrient fluxes in restored streams, floodplains, wetlands, and regenerative stormwater conveyance (RSC) systems from select watersheds. There, credits were provided for preventing sediment during storm flows, providing in-stream and riparian hyporheic zone nutrient processing during base flow, increasing floodplain-reconnection volumes, and stormwater retrofits using RSC.

The New Hampshire program incorporates regional pollutant loading and reduction performance curves based on site characteristics such as contributing area, land use, impervious cover, hydrologic soil groups, and slope. To address the inherent variability between sites, the crediting program set minimum and maximum riparian buffer widths, slope categories, and pollutant-specific removal rates. Their approach relied heavily on a local expert panel and regional stormwater runoff and water-quality trends to develop credit determinations.

Conclusions

The most appropriate NSMP alternatives for the City must provide a combination of water quality, watershed, and ecosystem benefits to provide justification for use in the ACP. In practice, no single NSMP is likely to manage the stormwater runoff associated with a PDP, and, thus, the ability to combine multiple NSMPs for WQE is necessary and should be encouraged. The three NSMP categories are not mutually exclusive. The most effective and appropriate WQE strategy using NSMPs would incorporate many of the restoration actions described above, functioning in tandem to provide reliable benefits to water quality and ecosystem health.

Determination of realistic pollutant-reduction credit ratios for the various NSMPs is a primary objective for the ACP. Credit determinations in the Otay River Watershed are limited by the availability of regionally specific pollutant retention rates for each NSMP. Empirical nutrient processing or pollutant retention rates from comparable systems in San Diego County should be incorporated into adaptations of this method to reflect the appropriate conditions for Chula Vista streams.

Water quality monitoring is critical to assess and adequately credit Stream Rehabilitation projects. These data are invaluable for subsequent ACP reviews, allowing WQE credit determinations to be adjusted to reflect anticipated versus actual water-quality benefits. Therefore, a monitoring program should be developed to collect data before and after Land Restoration and Stream Rehabilitation projects within Chula Vista.

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Chapter 1
Background Information

This technical memorandum summarizes a literature review performed to better understand available scientific information related to use of Natural System Management Practices (NSMP) for stormwater management and watershed and water-quality benefits. This memorandum was prepared as part of the City of Chula Vista's efforts to develop an Alternative Compliance Program (ACP) to expand stormwater-management practices, improve water quality, and streamline the approval process for Priority Development Projects (PDP). The following sections describe the ACPs, both existing and proposed, relevant to the City of Chula Vista (City), the NSMPs selected by the San Diego Regional Water Quality Control Board (RWQCB), and the scope of the literature review.

1.1 Alternative Compliance Programs

The RWQCB, in a March 2019 amendment, adopted an updated version of the *Water Quality Equivalency Guidance Document: Region 9* (WQE Guidance) submitted by the County of San Diego (RWQCB 2018). This update outlines standards and guidelines for co-permittees to design and implement an offsite ACP to meet water-quality requirements as defined in the Regional Municipal Separate Storm Sewer System (MS4) permit. The ACP grants co-permittees the ability to enter into voluntary agreements with PDP applicants to provide offsite pollutant reduction and hydromodification management. The WQE Guidance allows for numerically sized offsite structural Best Management Practices (BMP), such as retention or detention basins, to meet all or part of the required onsite stormwater-management practices if the proposed project provides greater water-quality benefits to the watershed than onsite structural BMPs. The WQE Guidance also provides for the exploration and development of NSMPs as alternatives to structural BMPs. The document identifies Land Preservation, Land Restoration, and Stream Rehabilitation as potential avenues for calculating and crediting for Water Quality Equivalency (WQE). This memorandum summarizes scientific information related to the capacity for NSMPs to enhance stormwater management and improve water quality, while accounting for additional benefits to the greater watershed and ecosystem.

1.2 Senate Bill 2 Planning Grant

In March 2019, the City submitted a grant application to the California Department of Housing and Community Development's Senate Bill (SB) 2 Planning Grant Program, which provides funding to help municipalities "prepare, adopt, and implement plans and process improvements that streamline housing approvals and accelerate housing production" (California Department of Housing and Community Development 2019). In this grant application, the City proposed to develop a WQE framework for NSMPs to expedite PDP approval while meeting MS4 Permit requirements. The grant application proposed to use SB 2 grant funding to develop an ACP for three categories of NSMPs—including environmental analyses—to provide alternative management options consistent with the City's MS4 Permit. The proposed project represents significant opportunities for PDP applicants to streamline permit review and approval processes, increase onsite buildable acreage, and still meet MS4 Permit requirements for stormwater pollutant control and hydromodification management (City of Chula Vista 2019).

Recognizing the critical-need status for housing developments and compliance, in March 2020 the SB 2 Planning Grant Program awarded $625,000 to the City to implement the proposed project. The deliverables proposed under the ACP program include:

- RWQCB-approved framework plan
- Establishment of WQE guidelines for NSMPs
- Stakeholder outreach meetings
- In-lieu fee structure and credit system for PDPs to employ

Funding will also be used to identify mitigation opportunities within the Otay River and Sweetwater River Watershed and draft the California Environmental Quality Act (CEQA) compliance document for the program.

1.3 Natural System Management Practices

The WQE Guidance (2018) defines NSMPs as:

> Stormwater management practices implemented to restore or preserve predevelopment watershed functions in lieu of providing direct pollutant removal and hydromodification flow control. NSMPs may include structural or engineered elements, but these elements do not expressly provide stormwater pollutant removal (page xv)

Table ES-1 of the WQE Guidance provides the various ACP categories for both BMP and NSMP approaches and identifies which of those categories can be applied for pollutant reduction (i.e., retention, biofiltration, or flow-thru), volume reduction, or hydromodification control credits (Figure 1). The table presents the three NSMP categories—Land Preservation, Land Restoration, and Stream Rehabilitation—and the availability of each category for use in WQE determinations. These categories are defined in the WQE Guidance as follows:

- **Land Preservation** is an NSMP that permanently preserves undeveloped land in its current state. In limited scenarios, Land Preservation may provide quantifiable stormwater-pollutant control and hydromodification flow-control benefits by preventing increases in stormwater runoff volumes and pollutant concentrations associated with the future built-out condition of a tributary (page xv).
- **Land Restoration** is an NSMP that restores currently developed land back to a stabilized pre-development condition. Land Restoration practices are similar to Retrofit BMPs that provide reductions in impervious surfaces but require appropriate stabilization techniques (page xv).
- **Stream Rehabilitation** includes remedial measures or activities for the purpose of improving or restoring the beneficial uses of streams, channels, or river systems. Techniques may vary from in-stream restoration techniques to in-line stormwater-management practices installed in the system corridor or upland areas, or a combination of in-stream and out of stream techniques. Rehabilitation techniques may include but are not limited to riparian-zone restoration, constructed wetlands, channel modifications that improve habitat and stability, and daylighting of drainage systems (page xvi).

ACP Category		Stormwater Pollutant Control Benefits				Hydromod Flow Control Benefits
		Pollutant Reduction			Volume Reduction	
		Retention	Biofiltration	Flow-Thru		
BMP	Retrofit	Available	Available	Limited Availability	Available	Available
	Regional	Available	Available	Limited Availability	Available	Available
	Water Supply	Available	Available	Limited Availability	Available	Available
NSMP	Land Restoration	Not Available	Not Available	Not Available	Available	Available
	Land Preservation	Not Available	Not Available	Not Available	Limited Availability	Available
	Stream Rehabilitation	Not Available	Not Available	Not Available	Limited Availability	Available

Figure 1. The various BMP and NSMP categories with potential stormwater pollutant and hydromodification control benefits

Source: RWQCB 2018

The WQE Guidance provides detailed instructions, equations, and examples for calculating the hydromodification flow-control benefits of Land Preservation, Land Restoration, and Stream Rehabilitation NSMPs. At the time of the approval of the updated WQE Guidance, calculations had not yet been determined for NSMP pollutant-reduction benefits (i.e., retention, biofiltration, and flow-thru), and only limited applications had been developed for volume reduction. The WQE Guidance states that

> It is understood that some stream restoration techniques should reduce volumes of runoff through infiltration within streambeds. The techniques for quantifying this volume reduction have not been developed as of yet, nor have the design criteria for stream restoration to achieve additional infiltration. (page ES-3)

Moreover, the WQE Guidance acknowledges that

> Pollutant reduction associated with changes in riparian vegetation and stream velocities through stream restoration projects have not been assessed or quantified as part of this effort. For an applicant to obtain pollutant reduction credit associated with volume reduction or other pollutant uptake processes in a stream restoration project, the jurisdiction will be required to develop the methodology to be followed through its own approval processes (page ES-3).

Therefore, this memorandum is the first step toward developing the methodologies for applying NSMPs toward WQE credits as an ACP option. This memo also highlights the lack of accounting frameworks for the additional benefits beyond water quality—including ecosystem and watershed functions—that NSMPs provides and identifies potential qualitative approaches for evaluating these additive benefits for WQE crediting. The following sections highlight and summarize the best-available science for developing these methodologies for the watersheds of the City of Chula Vista.

1.4 Intent and Purpose

The intent of this memorandum and literature review is to understand and compile the latest scientific information available related to employing NSMPs as alternative stormwater-management strategies, with a focus on enhancing ecosystem health, watershed function, and water quality. This information is used to identify, evaluate, and quantify water-quality benefits associated with respective NSMPs and inform the development of water-quality ratios and credit values.

This review focuses on the response of ecosystem functions and water-quality pollutants to the implementation of NSMPs. Pollutants considered range from nutrients and sediment to pesticides, hydrocarbons, and other constituents. This review is not intended to be exhaustive; rather, its purpose is to compile and understand the realizable watershed and water-quality benefits that may result from natural system-management practices.

Chapter 2
Introduction

2.1 Urban Development and Water Quality

The urbanization of a watershed and its subsequent decline in water quality typically is characterized by the extent of impervious surface cover (Brabec et al. 2002). Impervious surfaces do not allow for infiltration of precipitation and result in increased frequency and intensity of surface-water runoff events, simultaneously transporting the dissolved and particulate pollutants that accumulate in built environments. Pollutants such as fertilizers, sediment, pesticides, petroleum products, pharmaceuticals, microplastics, and trace metals abound in urban areas and are mobilized to waterways quickly following each rain event, acting as episodic pulses of contamination that reduce water quality and the biological integrity of aquatic resources (EPA 1999). As impervious urban surfaces increase in both density and magnitude across the landscape, changes in watershed structure and function result in substantial impacts on surface water quality and ecosystem health.

The ratio of total imperviousness is often used as a key parameter in runoff modeling and can reliably predict the degree of water-quality degradation resulting from planned development and land use change (Brabec et al. 2002, San Diego DPW 2019). This enables planners to account for the anticipated impacts on water quality and design mitigation and treatment strategies to offset those impacts. Although onsite treatment is often preferred, development constraints can sometimes require the use of approved offsite and alternative stormwater-management strategies. For many years, engineered structural BMPs have been the predominant strategy for stormwater management. More recently, NSMPs are being considered as management alternatives in the stormwater and water-quality accounting framework.

2.2 Water Quality Issues in Chula Vista

The City's municipal boundaries span sections of both the Otay River and Sweetwater River watersheds, each with various water-quality issues, spanning from headwater tributaries to the San Diego Bay. The San Diego Bay Water Quality Improvement Plan (WQIP) acknowledged that Lower Otay Reservoir, Jamul Creek, and Poggi Canyon Creek are on the CWA Section 303(d) List as impaired warm freshwater habitat due to nitrogen and toxicity (SDBRP 2016). The listed portions of Lower Otay Reservoir and Jamul Creek are outside the Chula Vista City limits, but are included because they are part of the larger watershed. Otay River monitoring data supports considering multiple receiving water conditions, including *Enterococcus*, *E. coli*, fecal coliform (FC), multiple indices of biological integrity, methylene blue activated substances (MBAS), nitrogen, organophosphate and pyrethroid insecticides, phosphorus, salinity, California Rapid Assessment (CRAM) scores, total copper (TCu), total suspended solids (TSS), turbidity, and several biological indicators. Of these considerations, bacteria and trash were listed as a receiving-water conditions and focused priority conditions for the Coronado and Otay Valley hydrologic areas. The Lower Sweetwater River is listed as impaired water freshwater habitat due to benthic community effects, chlorpyrifos, indicator bacteria, nitrogen, phosphorus, selenium, total dissolved solids (TDS), and toxicity. Telegraph Canyon Creek is currently listed as impaired for selenium, although recent data submittals support and call for delisting the stream. As of 2016, receiving-water conditions and focused priority conditions for the Lower Sweetwater River included trash, bacteria, and nutrients and considered over 30 potential conditions based on available monitoring data. The two watersheds share similar water-quality issues, and the majority manifest during the dry season or from early wet season storms. Table 2-1 of the WQE Guidance (2018) listed TSS, TN, TP, TCu, and FC as the primary pollutants of concern in the Otay and Sweetwater hydrologic units. As a result, these pollutants are the primary focus for all BMP, and potential NSMP, WQE calculations.

The San Diego RWQCB confirmed a dearth of water-quality sampling efforts in the Otay River watershed, likely due to higher-priority issues in faster-developing watersheds with explicit Total Maximum Daily Load (TMDL) standards (Loflen pers. comm.). The lack of a TMDL in the Otay River does not exclude the system from historical or current degradation and alteration, as evidenced by the fragmented and hydrologically disconnected reaches downstream of Lower Otay Reservoir. The most recent data point toward increasing water-quality concerns primarily related to toxicity, pyrethroids, and nutrients, all of which can be tied to stormwater-management issues. Thus, NSMP WQE calculations should anticipate future additions to the list of pollutants of concern in the Otay River Watershed.

2.3 Natural Systems for Water Quality and Stormwater Management

As urbanization replaces wetlands, floodplains, and uplands with impervious surfaces, there is a loss of ecosystem services (e.g., infiltration, evapotranspiration, attenuation of floodwaters, nutrient cycling) that would otherwise naturally manage runoff and preserve water quality. These natural systems provide ecosystem functions by helping to attenuate flooding, cycle nutrients, regulate sediment-transport processes, and preserve water quality and functional habitat. In theory, NSMPs would mimic ecosystem services to provide watershed and water-quality benefits as an alternative to traditional stormwater-management approaches. In practice, NSMPs may manifest as preserved open lands, restoration of impervious areas within development to natural habitats, or rehabilitated ecosystems.

Chapter 3
Water Quality Equivalency Using Land Preservation

One of the NSMP categories the WQE Guidance proposes describes the preservation of undeveloped land in perpetuity to provide ecosystem and water-quality benefits that offset stormwater-pollutant or hydromodification impacts from development. Because this NSMP prevents development impacts and does not actively treat stormwater, the WQE Guidance acknowledged the limited capacity for it to provide quantifiable stormwater-pollutant control and hydromodification flow-control benefits. Thus, the WQE Guidance requires the preserved land to be zoned for development, physically developable, below the PDP thresholds for structural BMP performance requirements, and preferably within the same local catchment. Land Preservation is typically achieved through conservation easements that preserve undeveloped lands for their beneficial ecosystem services. The following sections address Land Preservation and its applicability for WQE.

3.1 Land Preservation Using Conservation Easements

Conservation easements are voluntary legal agreements that permanently restrict land uses to protect conservation values (NCED 2020). As an NSMP, Land Preservation may lessen the water-quality impacts of urban stormwater runoff from new developments by permanently preserving undeveloped land zoned for future built-out conditions. To guarantee ecosystem and water-quality benefits and ensure protection in perpetuity, a conservation easement or similar legal agreement must be the ultimate end goal for any Land Preservation NSMP. Conservation easements in the state of California are defined and governed under Civil Code Sections 815–816 (California Legislative Information 2020).

3.2 Land Preservation and Water Quality

A foundational study in watershed science monitored the change in water quality and flow regime in a catchment subject to clearcut logging and herbicide treatment—a disturbance akin to rapid urbanization (Likens et al. 1970). In the 2 years following, stream flow increased by 28–39 percent, nitrate export rose 41–56-fold, and daily maximum water temperature increased by 3–4 degrees Celsius (°C), among other significant changes. Although representing a catchment and ecosystem quite different from those found in Chula Vista, this study demonstrates the drastic degradation of water quality that results from development of previously conserved lands. However, this study also suggests Land Preservation may be a viable tool for protecting and potentially improving water quality when carefully sited to provide beneficial ecosystem and watershed functions.

Preserved undeveloped land placed under a conservation easement provides ecosystem and water-quality benefits by maintaining natural habitat and functions, such as interception, evapotranspiration, and infiltration of precipitation. Conservation easements have been used extensively in California to protect riparian buffers (Furman 1989), wetland habitat (Westervelt 2021), and working range and forest lands (Huntsinger et al. 2010). Increasingly, open-land conservation easements are used to protect drinking-water source areas, in effect preserving the natural functions that benefit water quality and ecosystem health within the watershed by reducing runoff and enhancing groundwater recharge, riparian buffers, and watershed function (NH DES 2021; Price 2014). These natural functions prevent or reduce stormwater pollutant and flow volumes compared to unpreserved developed conditions.

More recent studies addressing the water-quality benefits of Land Preservation often rely on broad generalizations of watershed function and ecosystem services and focus more on the public's willingness to pay or be paid for conservation easements (Kreye et al. 2014; Nohner et al. 2018). As a result, limited empirical data exist documenting the measurable water-quality benefits of Land Preservation, particularly with respect to southern California. This lack of available data highlights the challenges associated with measuring short-term water-quality benefits that may result from long-term land-preservation strategies. Although it is difficult to quantify the water-quality benefits of Land Preservation because of the inherent variability among catchments, conservation easements have proven to be a useful tool for ecosystem- and watershed-scale conservation planning.

Although ecosystem benefits from Land Preservation may extend beyond the immediate project area (e.g., habitat connectivity, native seed dispersal source), this NSMP likely only provides water-quality benefits to the catchments in which they are located or where they are hydrologically connected (Nohner et al. 2017). In the case of Chula Vista, *catchments* may refer to the various hydrologic areas and subareas within the Otay River or Sweetwater River watersheds the RWQCB identified (RWQCB 2018). As such, Land Preservation NSMPs should be located within the same hydrologic area of the proposed development. Moreover, preserved land provides greater water-quality benefits when located in floodplains, channel migration zones, or stream corridors. For example, Cunningham et al. (2010) documented measurable improvements in total inorganic nitrogen levels and macroinvertebrate communities along a preserved open-space stream corridor in an urban setting. Where floodplain preservation is not possible, emphasis should be placed on locating Land Preservation NSMPs upstream of the proposed development or adjacent to existing conservation lands, as metastudies have found headwater systems provide disproportionately greater control of water-quality indicators than systems farther down the watershed (Peterson et al. 2001). Finally, Land Preservation NSMPs should require approved management plans and incorporate Land Restoration or Stream Rehabilitation NSMPs to enhance ecosystem function and ensure preserved lands provide water-quality benefits in perpetuity.

3.3 Land Preservation Credit Valuation

Land Preservation permanently prevents increases in impervious surface cover associated with development and, thus, can be compared directly to future built-out conditions with minimal assumptions. Under this premise, both stormwater-volume reduction and hydromodification-flow control benefits from Land Preservation NSMPs can be estimated using the protocols set forth in WQE Guidance Sections 2 and 3 (RWQCB 2018). Stormwater volume reduction is calculated using the affected versus mitigated DCV approach and site-specific land-use factors, providing a volumetric (cubic feet) measurement of earned stormwater-control credit. The stormwater DCV for a proposed development is a function of imperviousness and runoff coefficients dictated by the change in land cover types between existing and future built-out conditions. In Chula Vista, future built-out conditions of as-yet undeveloped lands can be assumed to be 85 percent impervious, and DCV calculations must use the 85^{th}-percentile rain event over a 24-hour period. Therefore, DCV calculations can be used to compare the stormwater-pollutant volumes of undeveloped preservation land to future built-out conditions. Alternatively, hydromodification flow-control benefits of Land

Preservation are calculated using preserved versus developed DCIA, resulting in area measurements of stormwater control credit. The difference in hydromodification flow control between preserved land and future built-out conditions effectively evaluates the relative water-quality protection provided by a proposed Land Preservation NSMP.

Although the approach for determining the relative stormwater-volume reduction and hydromodification flow control, Land Preservation provides has been developed, the WQE Guidance does not provide a framework for determination of pollutant-reduction (e.g., retention, biofiltration, flow-thru) credits. This is because preservation of undeveloped land, in and of itself, does not work to improve water quality; it merely preserves the existing conditions and functions. Moreover, preserved land does not treat stormwater directly, and therefore does not qualify for a pollutant-reduction efficiency without the combined use of structural BMPs or NSMPs. This makes quantifying standalone Land Preservation pollutant-control credits difficult because measurable water-quality improvements are unlikely to be found in the local watershed. As such, Land Preservation should not be eligible for pollutant-reduction credits as a standalone NSMP. However, Land Preservation does act to protect and preserve water quality by maintaining natural ecosystem and watershed functions on the landscape and can be coupled with both Land Restoration and Stream Rehabilitation to provide additive benefits in perpetuity. Thus, Land Preservation should be considered a preferred end-goal for Land Restoration and Stream Rehabilitation NSMPs to provide measurable water-quality benefits while ensuring long-term management and protection.

Land Preservation should be eligible as additive WQE credits when coupled with Land Restoration or Stream Rehabilitation NSMPs, perhaps as a credit multiplier to encourage their adoption. However, not all Land Preservation NSMPs are the same, and functional differences should be accounted for in the credit-multiplier determination process. Ecosystem and water-quality benefits resulting from different Land Preservation NSMPs are influenced by their physical properties, namely topography, soil type, vegetation communities, and longitudinal position in the watershed. Thus, credit multipliers should be developed to account for the functional differences among possible Land Preservation NSMPs. For example, floodplain Land Preservation likely provides greater ecosystem and watershed benefits per acre than upland Land Preservation, and soils with higher infiltration rates will better manage runoff than those with low infiltration rates. Landscape characteristics such as hydrologic soil group, slope, landscape position, and habitat quality should be assessed to determine credit multipliers for different Land Preservation NSMPs. Although Land Preservation should not be eligible for pollutant retention credits as a standalone NSMP, its value as a long-term management tool, in conjunction with other NSMPs and conservation goals, warrants its water-quality protection evaluation and crediting to encourage its use by PDPs.

The City should identify and prioritize specific locations of eligible Land Preservation sites to coordinate multiple benefits for the watershed, water quality, conservation areas, and public access. This will give the City an inventory of potential Land Preservation sites that meet the requirements and goals of multiple planning efforts. In addition, the City may consider specific requirements (e.g., public access, trails, easements, educational resources) as part of the Land Preservation NSMPs based on the projected needs of the community.

3.4 Opportunities for Land Preservation in Chula Vista

As of 2014, approximately 133 acres within Chula Vista's Multiple Species Conservation Plan (MSCP) Subarea are designated as 75–100 percent Conservation Areas (City of Chula Vista 2014). Of this, about 97 acres fall within the Otay River Valley, and 36 acres are in the Sweetwater River Valley. These relatively small, primarily private landholdings are limited to a maximum of 25 percent development impacts within the mapped Conservation Areas based on MSCP requirements and City ordinance. Where possible, additional acquisition and preservation of Conservation Area lands in exceedance of the 75 percent minimum land area may allow for co-designation as watershed—and thus water quality—improvements. For example, a 10-acre parcel designated as a 75 percent Conservation Area (i.e., 7.5 acres conserved) is limited to 2.5 acres of development impacts. In this case, a PDP applicant might acquire and preserve 1.5 acres of the 2.5 developable acres—effectively preventing development and associated runoff. Thus, by increasing the Conservation Area from 75 percent to 90 percent, the land continues to meet its 75–100 percent designation, but provides an additional 1.5 acres of mitigation that could be eligible for water-quality credits.

The authors of the 2014 *Alternative Compliance Strategy Final Report* (City of Chula Vista 2014) emphasized provisions set in Chula Vista's MSCP Subarea Plan that allow for future facilities to be installed in Conservation Areas. These provisions limited future facilities at 50 cumulative acres, with single-facility impacts capped at 2 acres. Allowable future facilities include storm-drain and flood-control/detention facilities, desiltation and sedimentation basins, extensions of utility services, fire access roads, operations and maintenance roads, brush-management roads, and new trails. Although stormwater-management facilities were explicitly allowed, the provisions did not intend MSCP Preserve areas to provide for large-scale detention basins.

The 75–100 percent Conservation Areas the Chula Vista Subarea Plan identified may present opportunities to use Land Preservation, when coupled with Land Restoration or Stream Rehabilitation, to generate WQE credits. Land Preservation could expand existing Conservation Areas to increase habitat extent and quality, while also preserving or enhancing watershed functions that benefit water quality. MSCP provisions explicitly allow for up to 50 cumulative acres of future facilities that may include stormwater- and flood-control features. These future facilities could be designed using Land Restoration or Stream Rehabilitation NSMPs to provide functional habitat, water-quality benefits, and stormwater management. The combination of Land Preservation to expand Conservation Areas and host Land Restoration or Stream Rehabilitation projects to enhance watershed and ecosystem functions provide the greatest opportunities for meeting multiple planning objectives in Chula Vista.

Chapter 4
Water Quality Equivalency Using Land Restoration

A second NSMP category the WQE Guidance proposes describes the conversion of currently developed land to a restored and stabilized predeveloped state. In effect, this NSMP provides water-quality and ecosystem benefits through three restoration actions: (1) removing impervious surface cover from existing developed land; (2) regrading, decompacting, and stabilizing disturbed ground; and (3) restoring predevelopment land use and land cover through native plant community revegetation and adaptive management. The removal of impervious surface cover directly reduces runoff during storm events, whereas restoration to predevelopment conditions improves functional habitat and engenders long-term resiliency through regenerative ecosystems that naturally manage stormwater. As such, specific restoration measures to re-establish historic natural topography, hydrology, and vegetation communities should be proposed and approved on a site-specific basis to demonstrate quantifiable stormwater pollutant and flow volume reductions. Moreover, the use of Land Restoration NSMPs for WQE should require all three restoration actions (i.e., impervious cover removal; regrading, decompaction, and stabilization; and revegetation and adaptive management) to promote natural conditions and ecological functions that benefit water quality. Where applicable, approved BMPs may be incorporated into Land Restoration NSMPs to generate WQE credits.

It is important to distinguish Land Restoration from Stream Rehabilitation based on landscape position and jurisdictional (e.g., waters of the United States) features. For example, WQE credits for Land Restoration NSMPs should not be granted for restoring currently developed land that resides within a historic floodway, channel-migration zone, or waterway of the United States. Land Restoration should not be implemented in settings where prolonged flooding may occur because stabilization and restoration techniques for upland systems are not designed to withstand the magnitude and duration of certain flood events. Moreover, Land Restoration WQE credits should not be applicable for settings where historic floodplain wetlands existed, as this land-use conversion is more characteristic of Stream Rehabilitation. Although incorporation of non-floodplain wetlands (e.g., vernal pools) into Land Restoration NSMPs should be encouraged where applicable, these habitats are heavily regulated and banked in California and are not within the scope of NSMP WQE crediting. The following sections discuss values, recommendations, and challenges associated with Land Restoration as an NSMP.

4.1 Land Use Conversion as an NSMP

Land Restoration through land use conversion works to recreate the natural structure and function of pervious surfaces such as grassland, wetlands, scrub-shrub, and forest. Land Restoration focuses on removal of impervious surface cover, regrading to predevelopment topography, and creation of naturally functioning soils, vegetation communities, and hydrology to restore natural watershed functions for the benefit of water quality. This NSMP has the potential to offset water-quality impacts from PDP applicants when situated in the same hydrologic area or subarea as the proposed development and implemented to provide net-zero change in imperviousness. In addition, this NSMP may include the use of structural BMPs and Stormwater Control Measures (SCM) to enhance stormwater management and site stability.

Land Restoration NSMPs have the potential to provide both direct and indirect ecosystem and water-quality benefits. Removal of impervious surface cover may provide immediate, direct benefits to water quality by reducing stormwater pollutant and flow volumes (Shuster et al. 2005). Although reduction of runoff may be attained by removing impervious surface cover, this action alone does not restore a landscape and leaves it vulnerable to erosion, colonization by invasive species, and other forms of degradation that may continue to degrade water quality. In a review of imperviousness and its implications for water-quality and watershed planning, Brabec et al. (2002) found that impervious surface cover alone does not adequately characterize water-quality degradation and pressed for the inclusion of a continuum of ecological parameters to improve stormwater management and watershed function. These findings suggest that the mere removal of impervious surface cover may not provide the desired water-quality benefits and that ecological-restoration measures must be incorporated into Land Restoration NSMPs. Therefore, Land Restoration should include measures to provide indirect ecosystem and water-quality benefits by re-establishing natural habitat structure and function in addition to the removal of impervious surface cover.

Land Restoration must include actions beyond reductions in imperviousness to ensure proper functioning conditions for water quality and habitat benefits. Following impervious surface cover removal, the soils underlying formerly developed land may require remedial actions to allow for successful restoration. For example, removal of impervious surface cover does not inherently decompact or restore altered soils. Further actions may be necessary to provide adequate soil conditions for optimal infiltration (Pitt et al. 2008) and native vegetation establishment (Ruthrof et al. 2013). Therefore, Land Restoration should demonstrate soil bulk densities that allow for adequate infiltration rates as well as physical soil properties that promote native vegetation establishment (e.g., percent organic matter, nutrient availability). Soil remediation and conditioning is especially important in areas where commercial or industrial wastes may have contaminated soils, such as listed or suspected Brownfields[1] (DEHQ 2021). In some cases, contamination may exclude a site from eligibility for use as a Land Restoration NSMP until proper remedial actions have been completed. Prior to revegetation, Land Restoration should work to restore natural topography and hydrology to stabilize the site and reduce the risk of failure. This may require measures such as soil decompaction or ripping, regrading, removal of contaminated soils, import of fill, organic or inorganic fertilization, topsoil and organic matter amendments, or erosion BMPs. To ensure successful restoration and promote realizable water-quality benefits, all Land Restoration NSMPs should require native vegetation community management plans, discussed in further detail in Section 4.2, *Native and Invasive Vegetation Community Management for Water Quality*. In total, Land Restoration should work to negate the water-quality impacts of PDPs by removing impervious surface cover and actively rehabilitating landscapes to restore habitat and enhance ecosystem services that directly or indirectly benefit water quality.

Specific Land Restoration actions—including earthwork, soil preparation, and re-establishment of native vegetation communities—will vary by site depending on the type of development being removed (e.g., residential, commercial, industrial) and the desired habitat type (e.g., grassland, scrub-shrub, wetlands, forest). Those developments with higher percent imperviousness are likely to provide greater water-quality benefits. As such, WQE credit valuation strategies should address the landscape position, development type, and habitat form that is being restored.

[1] A *Brownfield* is a former industrial or commercial site where future use is affected by real or perceived environmental contamination.

4.2 Native and Invasive Vegetation Community Management for Water Quality

Land Restoration NSMPs should require ongoing (i.e., 5–10 years) native and nonnative vegetation community management to ensure successful restoration following land-use conversion. Successful restoration is only achieved when predevelopment conditions are met, and this includes managing for native vegetation communities. The *Otay River Watershed Management Plan* (Aspen Environmental Group 2006) identified eradication of nonnative flora as a high-priority strategy for protecting, enhancing, and restoring habitat and water quality in Chula Vista. Invasion of habitat by nonnative plant species can result in detrimental effects on water quality and quantity through mechanisms such as increased plant density and subsequent evapotranspiration rates, clogging of waterways, or increased runoff resulting from wildfire regime shifts. Beyond water quality, invasive plant species degrade habitat quality by reducing complexity and disrupting natural processes. Thus, some researchers have argued for controlling invasive and exotic species populations to promote native communities and improve water quality and quantity, with mixed results.

Perhaps most relevant to the watersheds of Chula Vista is the presence and potential benefits of controlling saltcedar (*Tamarix spp*.), arundo (*Arundo donax*), pampas grass (*Cortaderia selloana*), castor bean (*Ricinus communis*), and other nonnative plant species. Shafroth et al. (2005) report that millions of dollars are spent each year in the western United States to control saltcedar populations in hopes of increasing water yield and ecosystem health. Proponents suggest saltcedar control may alleviate ecosystem health and water-quality issues related to "streamflow depletion resulting from high evapotranspiration rates, displacement of native vegetation, simplified wildlife habitat structure, increased soil salinization, stream channel narrowing, increased potential for flood damage, and increased frequency and magnitude of riparian forest fires" (Shafroth et al. 2005). Invasion of restored areas by exotic species such as saltcedar, eucalyptus *(Eucalyptus spp.)*, arundo, and cheatgrass (*Bromus tectorum)* often result in a shift in wildfire severity and frequency in Mediterranean climates, indirectly influencing water quality through increases in hillslope runoff and erosion (Sheridan et al. 2007). The *Otay River Watershed Management Plan* (Aspen Environmental Group 2006) mapped and assessed nonnative invasive species and described the ongoing habitat and water-quality degradation these undesirable populations cause. Within the study area, eucalyptus woodlands occupied 102 acres, monotypic stands of arundo occupied 14 acres, and mixed nonnative invasive riparian or upland species occupied approximately 144 acres. Although somewhat dated, these figures highlight the extent of invasive species populations and lend support to the call for vegetation management as a necessary component of Land Restoration NSMPs. Although water-quality benefits resulting from nonnative invasive vegetation management are not always clear and can be exceedingly difficult to quantify, the importance of managing for native vegetation communities to ensure resilient ecosystem functions that preserve water quality and provide valuable habitat cannot be understated. As such, the City should require and approve nonnative invasive species-management plans in conjunction with proposed Land Restoration NSMPs, but vegetation management should not be eligible as a standalone NSMP for WQE credits.

4.3 Quantifying Land Restoration Benefits

Although precise modeling of water-quality benefits from various restoration strategies is still under development, the literature has documented empirical support for this approach. Using the

Soil and Water Assessment Tool (SWAT) and the System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) models, Martinez-Martinez et al. (2015) assessed the impacts of four different restoration scenarios at catchment and watershed scales in Ohio. The models helped identify the importance of restoration placement within the watershed for sediment and flow reduction efficiencies, finding restoration actions to be most effective at the sub-basin (i.e., hydrologic sub-area) scale. Both SWAT and SUSTAIN could be employed to quantify the potential effects of various degrees of Land Restoration in Chula Vista because the underlying principles remain the same: removal of impervious surface cover and re-establishment of natural interception and infiltration mechanisms through direct soil and vegetation restoration actions can result in stormwater pollutant and flow volume reductions.

The WQE Guidance provides protocols for calculating stormwater volume reduction using the affected versus mitigated design-capture volume (DCV) approach described above, accounting for the volumetric change in runoff following land-use conversion. Similarly, hydromodification flow control benefits from Land Restoration can be calculated using affected versus mitigated Directly Connected Impervious Area (DCIA). Thus, reductions in stormwater volumes and benefits to hydromodification flow control resulting from implementation of Land Restoration NSMPs can be counted as WQE credits for a proposed development. However, there are no methods identified for calculating pollutant reduction resulting from retention, biofiltration, or flow-thru methods. To be eligible for pollutant-reduction credits, an ACP would have to demonstrate retention, biofiltration, or flow-thru practices that treat stormwater runoff generated from within the Land Restoration site or elsewhere, prior to discharging to a waterway. Because it is currently possible for Land Restoration to generate volume reduction and hydromodification credits through land-use conversion, there is potential for pollutant-reduction credits if additional retention, biofiltration, or flow-thru BMPs increase the overall capacity for a Land Restoration project to treat stormwater.

The WQE Guidance approach also lacks an accounting process for ecosystem and watershed benefits that extend beyond stormwater pollutant and hydromodification controls. For example, the DCV- or DCIA-based approaches might capture changes in volumetric runoff and impervious area following land-use conversion, but it fails to adequately credit restoration actions that enhance habitat complexity, increase biodiversity, and improve ecosystem and watershed functions. Thus, the DCV and DCIA method does not adequately account for the greater benefits to the watershed that are provided by Land Restoration. This ecosystem benefit accounting discrepancy may be addressed through functional assessments that evaluate existing conditions and compare them to the potential restored conditions. These approaches—explored further in Chapter 5, *Water Quality Equivalency Using Stream Rehabilitation*—may be modified for terrestrial ecosystems and used to quantify the relative functional lift (e.g., ecosystem benefits) provided by proposed Land Restoration, thereby acting as a method to generate additive scores or multipliers for calculating WQE credits. Ultimately, DCV- and DCIA-based calculations of stormwater volume reduction and hydromodification flow control will be needed to quantify the direct water quality benefits, and a qualitative functional assessment can be incorporated to determine the indirect water-quality benefits attributed to ecological restoration.

4.4 Challenges Associated with Land Restoration

This review was not able to identify studies that explored the direct water-quality benefits resulting from restoration of developed lands through the lens of urban runoff. This provides little information from which pollutant-reduction credit determinations can be drafted with respect to specific Land Restoration actions beyond physical measures (i.e., volume and imperviousness reductions). However, there are principles of Land Restoration that can be assumed to play important roles in determining the degree of tractable water-quality benefits that will result from restoration actions. Regardless, restrictions should be considered for limiting the applicability of Land Restoration as a WQE alternative based on the principles and dynamics of watershed hydrology and urban stormwater runoff management.

4.4.1 Moving Beyond Imperviousness

As mentioned above, removal of impervious surface cover, in and of itself, does not qualify as a standalone NSMP because it can leave the land in vulnerable states that are prone to further degradation and water-quality issues. Thus, removal of impervious surface cover must be coupled with restoration actions that enhance soil conditions, hydrologic functions, vegetation communities, habitat quality, and long-term stability of the site. The relative significance of ecological restoration measures suggests that opportunities may exist to apply Land Restoration NSMPs to degraded sites that do not have expansive impervious surface cover but suffer from other forms of degradation. For example, a potential Land Restoration NSMP site that exhibits relatively low imperviousness may disproportionately degrade water quality due to undesirable vegetation communities or contaminated soils and groundwater resources. In this case, the benefits to water quality and ecosystem function provided by Land Restoration measures are not captured by the small change in imperviousness. Thus, the City of Chula Vista may need to establish a list of potentially eligible Land Restoration sites that incorporates both imperviousness and contamination sources as eligible criteria. Alternatively, the City may consider allowing PDPs to propose Land Restoration sites that provide water-quality benefits beyond reduced imperviousness so long as they can demonstrate benefits using reliable and replicable methods (e.g., precipitation-runoff modeling, groundwater contaminant modeling).

4.4.2 Pollutant Reduction from Land Restoration

The WQE Guidance does not provide protocols for determining pollutant-reduction credits resulting from Land Restoration NSMPs. Pollutant reduction credits for structural BMPs are calculated using geometric dimensions (e.g., area, depth), components (e.g., vegetation, soil media), and efficacy factors based on pollutant removal efficiencies of 1.0 for retention, 0.666 for biofiltration, and a conditions-dependent framework for flow-thru treatment strategies. Clarifications are needed to determine if pollutant reduction via retention, biofiltration, or flow-thru practices can only be achieved through incorporation of structural BMPs on Land Restoration sites, or if Land Restoration strategies (e.g., grading, soil amendments) are eligible for pollutant reduction. It remains unclear if pollutant-reduction credits can only be earned by treating stormwater generated from the Land Restoration site itself, or if these practices can be used to treat stormwater conveyed to the Land Restoration site from PDPs.

4.4.3 Determining Desired Restored Conditions

The use of historic natural conditions as the baseline to which Land Restoration NSMPs are designed and implemented may pose challenges for optimizing stormwater management, water quality, and habitat benefits. Although historic natural conditions developed in direct response to local and regional geologic and climatic drivers, they may not represent the most beneficial conditions for present-day water quality and functional habitat. For example, historic natural conditions for an existing development may have been a low-diversity grassland with high-percent bare ground, providing limited habitat value and retaining only a portion of runoff. During the Land Restoration NSMP proposal process, it may be determined that the site is suited to host vernal pools or other desirable habitats, even though the historic natural conditions did not support vernal pools. Due to the rapid decline in sensitive habitats throughout California, historic natural conditions—although certainly applicable for the site—may not provide as many ecosystem and water-quality benefits as proposed restored conditions. Thus, Land Restoration NSMPs may require guidelines on how to mimic historic natural conditions while also considering opportunities to provide for more beneficial habitat types or watershed functions. These guidelines should require, at minimum, that proposed restoration actions beyond historic natural conditions (e.g., addition of vernal pools) can be supported by the site without excessive management or intervention.

The WQE Guidance allows for Land Restoration NSMPs to be combined with structural or engineered elements to adequately manage stormwater and benefit water quality. Although important for site stability and management purposes, guidelines should be developed that limit or define the types of structural elements allowed through Land Restoration to promote natural structure and function and reduce long-term maintenance requirements.

Chapter 5
Water Quality Equivalency Using Stream Rehabilitation

Stream Rehabilitation has been used to enhance ecosystem function and water quality in waterways across the United States and abroad. Stream Rehabilitation is a $1 billion annual industry (Bernhardt et al. 2005), and the presumed benefits of rehabilitation on water quality have been explored in great lengths. The most frequent topics of study relate to sediment and nutrient retention, driven in part by CWA regulations, TMDL requirements, and the ubiquitous nature of these constituents. In general, Stream Rehabilitation has been shown to be most beneficial to water quality when implemented in small streams (first–third order) subject to considerable pollutant loads delivered during low to moderate flows (Craig et al. 2008). The next several sections highlight studies documenting the capacity for riparian buffer restoration, stream channel and floodplain restoration, regenerative stormwater conveyance (RSC), and constructed wetlands to provide water-quality benefits and enhance watershed functions. Lastly, existing Stream Rehabilitation water-quality crediting programs are discussed and evaluated for their applicability to the City's ACP.

5.1 Riparian Buffer Restoration

Riparian areas are characterized as interfaces between upland and wetland or stream systems, often demonstrating high biodiversity, productivity, and watershed function. *Riparian buffers* are vegetated zones that border streams and wetlands, providing ecosystem and watershed benefits, including complex habitat, stormwater runoff management, flood attenuation, biogeochemical cycling, sediment regulation, and shading—all of which benefit water quality. As a result of these beneficial functions, the protection, enhancement, and restoration of riparian buffers is a frequently used strategy for managing runoff and enhancing surface water quality (Klapproth et al. 2000).

Research on the effects of riparian buffers on water quality range from agricultural to urban settings, but the findings are consistent: adequately sized riparian buffers can effectively intercept and treat runoff prior to discharge to surface waters. For example, riparian buffers in agricultural areas in Connecticut decreased overland concentrations of nitrate, total phosphorus (TP), and TSS by 83, 73, and 92 percent, respectively, leading to significantly lower surface-water pollutant loads (Clausen et al. 2000). A 2005 study in San Francisco found that intentionally diverting urban stormwater runoff to an existing riparian buffer resulted in *E. coli* and total coliform reductions of up to 99 percent in receiving lake waters (Casteel et al. 2005). A study by Boyd et al. (2003) found that vegetative filter strips—a form of riparian buffer often used in agricultural settings—provided moderate adsorption of the herbicide atrazine and high adsorption of the insecticide chlorpyrifos, effectively reducing pesticide runoff loads to surface waters. These studies identified runoff infiltration, soil-water interactions, vegetative cover, and treatment contributing area ratios as significant drivers of nutrient, sediment, bacteria, and insecticide removal rates.

In addition to chemical water-quality issues, riparian buffers enhance physical properties and functions that protect water quality. Dense riparian vegetation greatly reduces streambank erosion rates by preventing mass wasting events (Purvis and Fox 2016). Increased shading from riparian canopies effectively moderates maximum daily water temperatures (Kalny et al. 2017) and can potentially mitigate stream eutrophication (Burrell et al. 2014). During overbank flooding events, riparian vegetation helps to retain suspended sediment (Västilä and Järvelä 2018), protect the near-stream environment from erosive hydraulics (Simon and Collison 2002), and provide much-needed organic substrate for enhanced biogeochemical cycling in the floodplain (Valett et al. 2005). Depending on the system, riparian buffers may also help regulate base flows, enhance local groundwater recharge, and increase hyporheic exchange through infiltration and evapotranspiration.

Riparian buffers can be cost-competitive with engineered treatment facilities while also providing ecosystem benefits and aesthetic and recreational improvements for the public. A 2008 analysis of the monetary value of riparian buffers for water treatment in Santa Monica found that a demonstration urban runoff treatment plant cost as much and provided similar water-quality services as 4,000–5,000 linear feet of riparian buffers (Riley 2008). Moreover, the author argues that treatment plant cost analyses were based on 20-year operational life spans, whereas riparian buffers may function for up to 100 years or in perpetuity, reducing the long-term costs considerably. As mentioned above, floodplains tend to exhibit increasing runoff and pollutant control capacity with time since restoration. This suggests the capacity for water-quality benefits from riparian buffer restoration may also increase over time as vegetation develops.

Stormwater pollutant and volume reduction by riparian buffers is dependent on many conditions that vary widely across watersheds. Although studies overwhelmingly report measurable reductions in runoff pollutant concentration, actual removal rates are ultimately dictated by buffer width, loading rate, soil type, and subsurface biogeochemistry. A meta-analysis found that nitrogen removal by riparian areas varied greatly across studies and typically peaked in forested–herbaceous buffers larger than 50 meters (164 feet) wide (Mayer et al. 2007). The *Otay River Watershed Management Plan* collated recommended setback widths for riparian and stream functions, distinguishing by physical and biological properties (Aspen Environmental Group 2006). Riparian buffer width recommendations included 50–140 feet for water temperature, four times the bankfull width to 220 feet for channel complexity, 98–540 feet for amphibian and reptile habitat, 130–1,600 feet for bird habitat, 30–100 feet for plant diversity, and 80–600 feet for ecosystem function. Scientific studies and programmatic policies often set minimum riparian buffer widths while encouraging the widest possible buffers for maximum water quality and ecosystem benefits.

5.2 Stream Channel and Floodplain Restoration

Stream Rehabilitation often manifests as streambank stabilization, floodplain reconnection, and channel reconfiguration. The purpose of these projects typically is to restore hydrologic and geomorphic structure, processes, and functions to provide increased flood resiliency and attenuation, enhance pollutant retention, improve in-stream habitat conditions, and protect water quality by recreating natural conditions in degraded systems. The practice of designing Stream Rehabilitation projects to provide quantifiable water-quality benefits is still an emerging field, but evidence shows that retention of pollutants in urban runoff can be achieved. Although the majority of reviewed studies focus on sediment and nutrient loads, parallels are drawn to additional water-quality constituents where available. The following highlights relevant studies that demonstrate water quality and ecosystem benefits from four approaches to Stream Rehabilitation suitable for the City of Chula Vista: hydrologic restoration, overbank flooding, channel reconfiguration, and urban stream daylighting.

5.2.1 Restore Stream Hydrology to Retain Pollutants

Restoration of natural stream hydrology should be a primary objective for Stream Rehabilitation projects that aim to benefit water quality. Hydrologic restoration actions may include filling incised channels to historical invert elevations, installing grade control structures to raise water tables, removing concrete liners or levees, and increasing connection between wetlands, side channels, and backwater environments. A meta-analysis by Newcomer-Johnson et al. (2016) synthesized global nutrient-retention rates in hydrologically reconnected rivers and streams from 79 studies. The authors used nutrient spiraling methods—an approach for measuring the interdependent processes of nutrient cycling and downstream transport—to identify relationships between dissolved nitrate, ammonium, and soluble reactive phosphorus uptake and various watershed characteristics. The study found high pollutant-uptake rates immediately following restoration construction, indicating that disturbance from restoration stimulates rapid nutrient cycling. They found nitrate retention had a negative relationship with watershed surface area and impervious surface cover, but a positive relationship with average reach width. Ammonium retention increased with longer transient storage, but decreased with increasing water velocity and discharge. Soluble reactive phosphorus retention was a function of concentration, discharge, watershed area, and chlorophyll-a concentrations, with mixed relationships. In general, the authors suggest nutrient removal is most efficient in small headwater streams, where watershed area and discharge are lowest, and transient storage and interaction with the benthos are greatest. Recommendations for stream restoration projects include raising water levels to activate floodplains, lowering water velocities, increasing transient storage capacity, and enhancing sediment and organic matter accumulation (Figure 2). Issues the authors identified centered on the predominance of base flow data over peak discharge, indicating a data gap in nutrient retention processes at storm flows (Newcomer-Johnson et al. 2016).

The above findings agree with those from other studies that identified a disproportionate influence of low-order streams on water quality (Peterson et al. 2001; Craig et al. 2008) and suggest Stream Rehabilitation projects in Chula Vista should target tributaries as well as mainstem rivers. Although most of the headwater streams in the Otay and Sweetwater watersheds are located outside of the jurisdiction of Chula Vista, first- and second-order streams, such as Telegraph Canyon, Poggi Canyon, and Salt creeks, should be assessed for hydrologic restoration potential. Stream Rehabilitation strategies can be adapted to provide specific ecosystem and water-quality benefits in urban settings where conditions are suitable, particularly in the lower Otay and Sweetwater River watersheds where intermittent streams are encroached on, buried, or routed into culverts.

5.2.2 Restore Frequent Overbank Flooding for Water Quality

Evidence of elevated biogeochemical cycling and sedimentation rates resulting from the flood pulse indicate floodplain connection plays an important role in pollutant retention in fluvial systems (Valett et al. 2005). The mechanisms for pollutant retention via overbank flooding (Figure 2) include filtration, settling of suspended sediments and particulate matter, biogeochemical cycling of nutrients, sorption of dissolved pollutants such as trace metals and pesticides, and respiration of organic matter. Stream Rehabilitation projects often achieve more frequent overbank flooding through floodplain grading, floodplain bench terraces, and channel reconfiguration (Chagrin River Watershed Partners 2012; Figure 2). Therefore, restoration of overbank flooding should provide water-quality benefits when designed for higher flood flow frequencies, expanded floodplain extents, and longer floodplain inundation times.

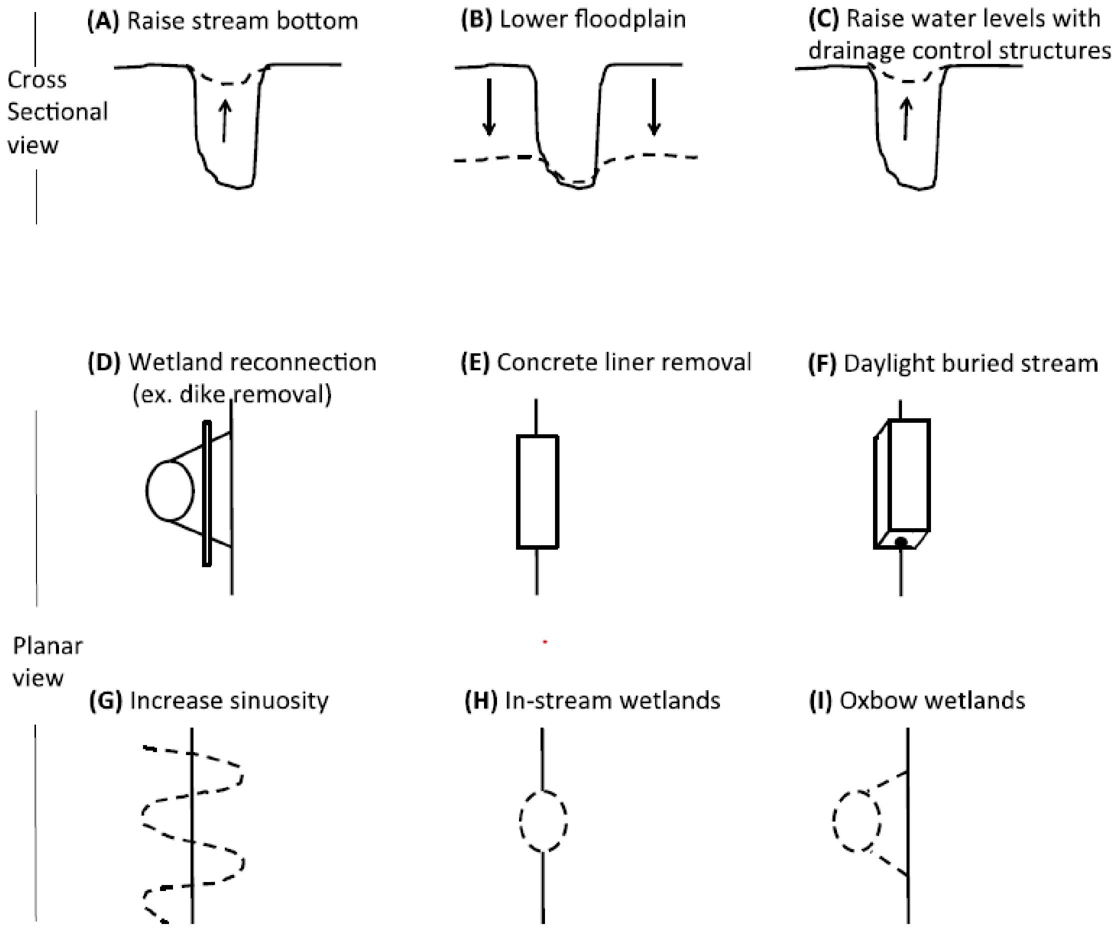

Figure 2. Stream restoration strategies to increase hydrologic connectivity

Source: Newcomer-Johnson et al. 2016

McMillan and Noe (2017) show sedimentation and nutrient retention rates increase following floodplain restoration, particularly when sited immediately downstream of sources of impairment. The authors stress the importance of building undersized channels or floodplain benches at lower grades to increase flood frequency beyond bankfull events. In addition, findings indicate sediment and nutrient retention rates surge immediately following restoration and continue to increase with time because restoration as vegetation matures and soil organic matter increases. Although this suggests maximum pollutant-retention and water-quality benefits may lag behind floodplain restoration, immediate benefits should be realized on reactivation of flood pulse dynamics.

In a 2020 study, Doll et al. explored the concept of increased flood-flow frequency for pollutant retention in urban stream restoration projects. In this study, Doll et al. used flood-frequency analyses to estimate floodplain flow volumes, treated floodplain flow volumes, and nitrogen load retention for each overbank event in five moderately incised streams in North Carolina—an issue also common to the streams of Chula Vista. The authors then compared the floodplain treatment potential of unrestored systems to theoretical restoration scenarios that focus on channel reconfiguration and lower floodplain elevations. They found only 9–15 percent of annual stream flow accessed the unrestored floodplain, and only 1–5.1 percent of the annual stream flow was potentially treated, equating to 0.2–1.0 percent of total nitrogen (TN) load retention. Although restored systems typically provided greater flood attenuation, the low overall retention rates were attributed to most of the floodplain flow occurring during relatively few overbank events. The authors suggest substantial benefits would be gained by focusing on floodplain treatment of runoff from uplands or stormwater outflows during smaller storm events. Intercepting more frequent, less intense storm flows prior to discharge to streams would increase the total pollutant load retained. Although these hydrologic and morphologic characteristics apply for the Chesapeake Bay area, systems draining Chula Vista tend to exhibit flashier hydrographs within deeply incised channels. Therefore, local adaptations of the lessons offered by Doll et al. (2020) should take into consideration regional precipitation and runoff patterns to reduce water velocities by increasing floodplain connectivity and enhancing pollutant retention.

Figure 3. A cross-section of Stream Rehabilitation designed to maximize floodplain connection via overbank flooding

Source: Chagrin River Watershed Partners 2012.

5.2.3 Reconfigure Channels to Influence Water Quality

Channel reconfiguration—the realignment and reconstruction of degraded stream channels—has been shown to have complex effects on water quality. Channel reconfiguration can be performed with or without floodplain restoration, depending on the constraints and desired conditions of individual project sites. In general, channel reconfiguration focuses on increasing channel stability, sinuosity, complexity, and interaction with hyporheic (i.e., subsurface) and floodplain compartments. This typically results in decreases in slope and water velocity and increases in residence time and surface-groundwater exchange, all of which promote retention of sediment, particulate matter, and dissolved pollutants. Channel reconfiguration is a major temporary disturbance to stream ecosystems, with potential short- and long-term water-quality impacts. Short-term impacts may include higher water temperatures, episodic sediment pulses, or loss of macroinvertebrate diversity during and after construction and following the first major flow events until the site is adequately stabilized. Long-term impacts may include alterations to local hydrology through more frequent flooding and changes in community composition of benthic, free-swimming, and near-stream floodplain organisms.

Dyste and Valett (2018) assessed nine stream-channel reconfiguration sites of varying degrees of maturity and found that some biotic variables had not recovered to reference conditions even 20 years following restoration. Notably, canopy cover, algal biomass, dissolved oxygen concentration, and macro-invertebrate diversity were significantly lower in restored compared to reference reaches. Conversely, water temperatures were significantly higher in restored reaches. However, when the authors compared response ratios of restored reaches with existing water-quality impairments to restored reaches without impairments, a clear divergence was found: restored streams with existing water-quality impairments (e.g., nutrients or trace metals) had not recovered to reference conditions for macroinvertebrate community composition, whereas restored systems without impairments had recovered to reference conditions. The results highlighted the importance of existing water-quality conditions and riparian canopy cover on the recovery trajectory of benthic macroinvertebrates and suitable temperature regimes following channel reconfiguration. The study suggests that the disturbance associated with channel reconfiguration can negatively affect biota and water-quality parameters for prolonged periods following restoration, particularly if water-quality impairments are already present and riparian restoration is delayed or insufficient. When placed in the context of Chula Vista, channel reconfiguration should simultaneously work to address existing water-quality issues and preserve or rapidly replace riparian vegetation to ensure ecological recovery.

An unpublished study assessing channel reconfiguration as a climate-change mitigation tool found enhanced hydraulic exchange and alluvial aquifer storage following restoration, which resulted in longer periods of alluvial aquifer recharge during peak flow and greater volumetric discharge during base flow (Brissette 2017). This study found that an increase in geomorphic complexity from channel reconfiguration may increase transient storage and base flow discharge, but emphasized that site-specific conditions can outweigh intended effects.

Although the above studies were not conducted in the context of urban stormwater management, they nonetheless demonstrate the mixed effects of channel reconfiguration on water quality. Most studies reviewed did not separate the effects of channel reconfiguration from floodplain restoration; however, methodologies have been developed to parse water-quality benefits from different hydrologic compartments and among various Stream Rehabilitation alternatives (see Table 1 in Section 5.5, *Creating Water-Quality Benefits from Stream Rehabilitation*). In Chula Vista, channel reconfiguration may provide water-quality benefits by effectively conveying additional runoff that would otherwise contribute to hydromodification. Moreover, channel reconfiguration can be designed to increase stream channel widths, sinuosity, transient storage, and hydrologic residence times to increase pollutant retention capacity.

5.2.4 Rehabilitate Buried Urban Streams for Stormwater Management

The rehabilitation of stream systems buried during urbanization is an expanding field of study with respect to water quality. The act of restoring a buried urban stream is often referred to as *daylighting*, in which the channel is unearthed and reconstructed to mimic pre-existing conditions. Foundational research has brought to light the extent of stream burial resulting from urbanization. In a tributary of the Chesapeake Bay watershed, Elmore and Kaushal (2008) determined that 20 percent of all streams were buried, and most of these were low-order headwater systems in low-density residential areas and suburban developments. Strikingly, 66 percent of all streams in catchments within Baltimore City were buried. As indicated by studies mentioned above, headwater streams play a disproportionate role in regulating water quality, suggesting significant opportunities exist for restoring buried streams for stormwater management and water quality. Similar exercises should be performed to identify buried streams in Chula Vista and assess opportunities for stream daylighting and restoration.

Stream daylighting can result in rapid changes to stream health and water quality. For example, macroinvertebrate communities respond rapidly as habitat conditions shift following stream daylighting, as evidenced by investigations in San Francisco and New Zealand that show increased diversity and abundance of biotic indicator species (Neale and Moffett 2016). Comparisons of buried versus open streams in the Chesapeake Bay watershed show significant differences in biogeochemical processes: nitrate uptake lengths were 7.5 times greater, and whole-ecosystem metabolic rates were five to 11 times lower in buried streams (Pennino et al. 2014). The authors attributed the lower processing rates to the threefold greater water velocity and lack of sunlight in buried streams, which ultimately results in significantly lower transient storage, diminished pollutant retention, and negligible flood attenuation. The available evidence suggests stream daylighting, when coupled with SCMs and floodplain restoration, offers promising and realizable benefits to water quality in buried Chula Vista streams.

5.3 Regenerative Stormwater Conveyance

Regenerative Stormwater Conveyance (RSC) combines principles of stormwater management and stream restoration to provide treatment, infiltration, and conveyance of urban runoff to protect and preserve water quality. RSC is typically reserved for use in stormwater outfalls and restored ephemeral headwater stream channels and designed to convey storm flows in a nonerosive manner while providing enhanced pollutant removal. Implementation of RSC in stormwater outfalls and headwater streams often presents as a series of step-pool sequences, with grade control structures and riffle crests composed of native gravels, cobbles, and boulders (Figure 4). A mixture of 80 percent sand and 20 percent wood chips is installed beneath the entire length of the RSC to maximize infiltration, promote nutrient cycling, and increase adsorption potential for enhanced pollutant removal. An RSC design manual provides detailed calculations for sizing systems and reports removal rates of 90, 75, and 74 percent for TSS, TP, and TN, respectively (Biohabitats 2012).

A separate study by Thompson et al. (2018) monitored sediment and nutrient fluxes before and after RSC implementation at both reach and catchment scales. This study found strong evidence for water-quality benefits at the reach scale: the RSC resulted in reductions of 49.7 percent of TN, 45.8 percent of TP, and 73.8 percent of TSS. Although the authors found no detectable water-quality changes at the catchment scale—highlighting the challenges of small-scale stream restoration toward reaching watershed-level goals—they nonetheless advocate for the use of RSC in low-order urban streams and stormwater outfalls to manage runoff and improve water quality.

Implementation of RSC shows promise in Chula Vista when placed in the context of existing stormwater outfall retrofits, ephemeral drainages, and stream daylighting efforts. This Stream Rehabilitation NSMP is particularly well-suited to intercept and treat early wet-season storms that produce lower runoff volumes but greater pollutant concentrations. Notably, the sand-wood chip substrate mixture is often used in storm- and wastewater treatment systems to enhance retention of a wide variety of pollutants not limited to nutrients. With documented pollutant removal performance, the robust step-pool design can be adapted for steep, ephemeral channels and low-flow events and is easily coupled with structural BMPs, SCMs, and associated floodplain restoration.

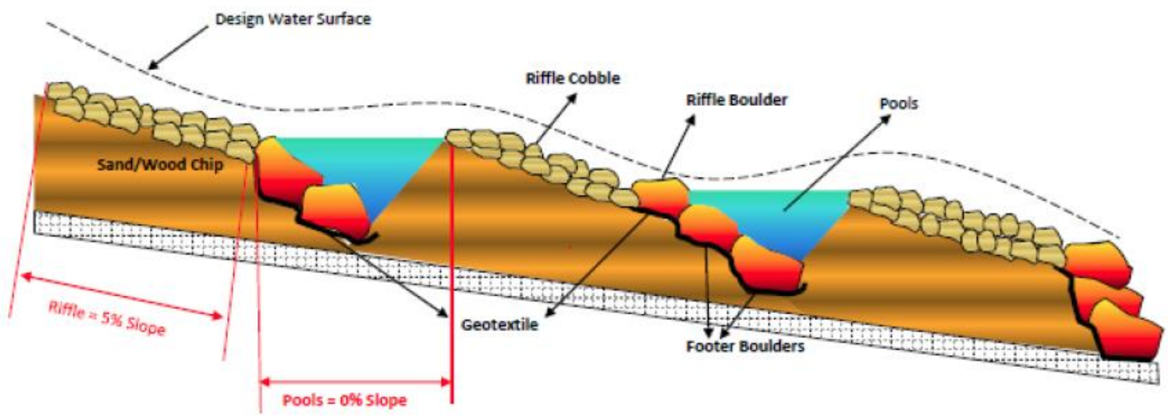

Figure 4. A typical cross-section of an RSC design for urban streams

Source: Biohabitats 2012.

5.4 Constructed Wetlands

In use for decades, *constructed wetlands* are designed and engineered to mimic the features and functions of natural systems to treat pollutants such as sediment, nutrients, organic matter, petroleum products, oil and grease, trace metals, pharmaceuticals, and various industrial chemicals. Treatment is achieved through settling, infiltration, and biological and chemical removal (EPA 1999). Although many constructed wetlands are heavily engineered and do not belong in riverine settings, some wetlands are designed purposefully for placement within stream corridors or stormwater-management systems. Typically located on floodplains and designed to receive flood flows from an adjacent stream, *off-line* wetlands attenuate floods and reduce pollutant loads while providing functional habitat and water-quality benefits. Other variations—sometimes referred to as *in-line* wetlands—position constructed wetlands below stormwater outfalls and within floodplains to intercept runoff prior to discharge to waterways. Depending on the application, constructed wetlands can provide direct stormwater treatment or additional flood capacity while enhancing habitat and watershed function, unlike engineered detention and retention ponds that offer minimal habitat. The following sections briefly discuss the performance of constructed wetlands for water-quality enhancement in the context of Stream Rehabilitation.

5.4.1 Constructed Wetlands for Water Quality

Constructed wetlands are designed to meet specific hydrologic and water-quality issues that vary between catchments. The five basic types of constructed wetland systems are shallow marshes, multi-basin wetlands, extended detention wetlands, pocket wetlands, and gravel wetlands, with variances and hybridization occurring frequently (MassDEP 2020). The basic types differ primarily in water depth, area, residence time, vegetation, and soils to treat specific pollutants of concern. Constructed wetlands can be designed to treat a long list of water-quality impairments. For example, a flow-thru wetland in a heavily urbanized catchment in Sydney, Australia, was shown to remove between 22 and 65 percent of trace metals chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn) and 76 percent of FC. In addition, it provides retention of 16, 12, and 46 percent of TN, TP, and TSS, respectively (Birch 2004). Other studies on trace metals and hybrid stormwater wetlands demonstrate up to 98 percent removal of cadmium (Cd), Cr, iron (Fe), Pb, Cu, and Zn when systems are designed to maximize interaction of water with sediments (Ventura et al. 2021).

Constructed wetlands also show promise for removal of various pesticides and hydrocarbons from urban and agricultural runoff. A constructed wetland treating agricultural irrigation return flows in the Central Valley, California demonstrated pesticide removal rates ranging from 52–94 percent, simultaneously reducing flow volumes by 68–87 percent through infiltration and evapotranspiration (Budd et al. 2009). A study using vertical flow sand filters in constructed wetlands provided 50 percent reductions in naphthalene, a polycyclic aromatic hydrocarbon (PAH), as well as 100 percent removal of particulate Zn (Walazek et al. 2017). Gaullier et al. (2017) determined that pesticide sorption to constructed wetland sediments can be enhanced by managing for lower water levels and resuspension or agitation of sediments between storm events. These management strategies promote interaction of dissolved pollutants with sorption sites on suspended sediments. Recent modeling exercises in the San Diego River watershed show that enhanced SCMs, such as biochar-amended biofilters, can reduce pesticide load and toxicity benchmark exceedances at the watershed scale (Wolfand et al. 2019).

5.4.2 Constructed Wetlands Within Stream Networks

A study from the Chesapeake Bay region compared the effects of in-line wetlands for nutrient removal in both restored and unrestored stream settings (Newcomer-Johnson et al. 2014). This study found in-line stormwater outfall wetlands and wet ponds (Figure 5) significantly decreased nitrogen concentrations prior to discharge to surface waters. In contrast, the restored stream network provided up to 150 times greater nitrogen retention than the constructed wetlands alone. The authors note there were no significant differences between denitrification rates in constructed wetlands and adjacent hydrologically connected floodplains. Overall, the combination of Stream Rehabilitation and in-line wetlands provided greater nutrient removal than either singular treatment. The study emphasizes the importance of maximizing surface and groundwater exchange, hydrologic residence time, and surface area of hydrologically connected features for maximum water-quality benefits (Newcomer-Johnson et al. 2014).

In Ontario, Canada, evaluations of flow attenuation and water-quality enhancement of an in-line pocket wetland located within a Stream Rehabilitation project provide mixed evidence of their efficacy in stormwater management (Krompart et al. 2018). Across 21 storm events, the pocket wetland consistently attenuated storm flows even when stormwater influent rates were four times greater than adjacent stream discharge, demonstrating a clear capacity to manage hydromodification. At base flows, the pocket wetland provided measurable maximum temperature buffering in downstream surface waters, but had the opposite effect at high flows. With a residence time of only 2 hours, the pocket wetland did not consistently provide significant reductions in TSS or TDS. However, unintended pocket wetland incision and upstream stormwater maintenance activities likely negated the expected water-quality benefits.

Proponents of constructed wetlands have developed the *integrated constructed wetlands* (ICW) concept, a framework for constructed wetland design that emphasizes hydraulic dissipation, vegetative interception, and evapotranspiration for enhanced treatment in agricultural and urban settings (Scholz et al. 2007; Harrington et al. 2011). Researchers have found ICWs perform best when sized to a minimum of 1.3 percent of stormwater drainage area and designed with an aspect ratio (width:length) less than 1:2.2 (Scholz et al. 2007). Follow-up studies provide general principles and recommendations for ICW sizing to treat various water-quality pollutants (Harrington et al. 2011).

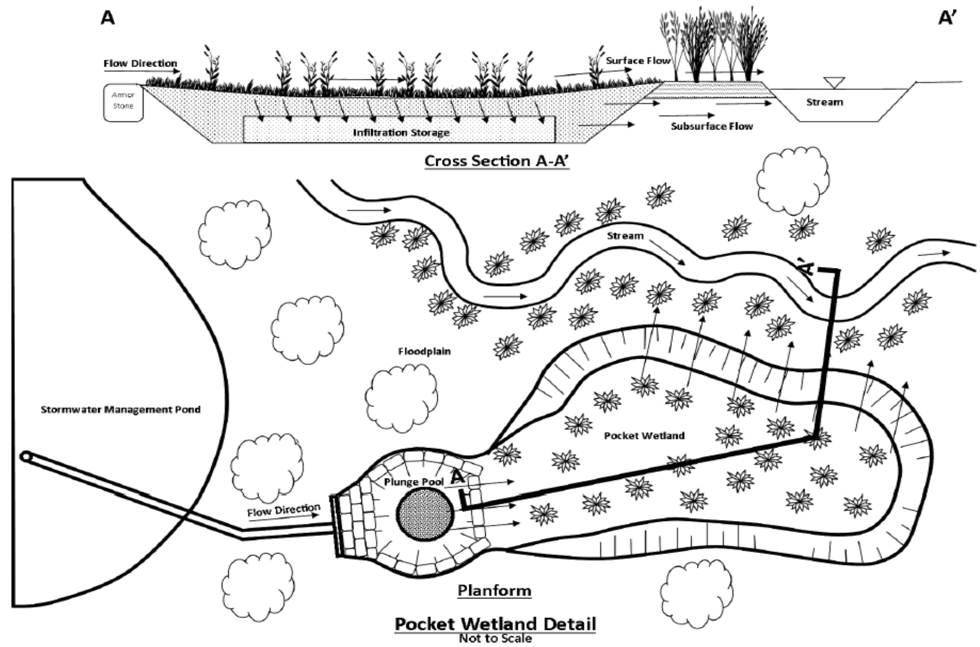

Figure 5. Planimetric and cross-sectional views of an off-line stormwater pocket wetland

Source: Krompart et al. 2018.

5.5 Crediting Water-Quality Benefits from Stream Rehabilitation

The WQE Guidance (2018) provides methodologies to credit stormwater volume reduction and hydromodification flow control benefits provided by Stream Rehabilitation NSMPs. Similar to the protocols for Land Preservation and Land Restoration, volume reduction credits are based on the difference between affected and mitigated DCV and the appropriate land-use factors for the site, dictating the total volume reduction credits earned. Alternatively, Stream Rehabilitation is eligible for hydromodification flow control credits only if a geomorphic channel stability assessment determines restoration of a receiving water is necessary and demonstrates the capacity to support the proposed additional imperviousness. There are multiple allowable scenarios for Stream Rehabilitation to provide hydromodification flow control benefits, determined primarily by the relative location of the PDP and ACP with respect to the sensitive stream segments and the downstream exempt waterbody. Although volume reduction and hydromodification flow control credits can be earned with the current WQE Guidance protocols, there is currently no avenue to determine pollutant-reduction credits from Stream Rehabilitation NSMPs.

Implementing Stream Rehabilitation to improve water quality is an evolving field, particularly with respect to stormwater pollutant reduction and water-quality crediting. Currently, no such pollutant-reduction crediting programs exist in southern California, but this approach has been employed in the Chesapeake Bay and New Hampshire, where TMDL requirements have prompted extensive water-quality improvement efforts. This approach embraces the concept that by restoring streambanks, channels, and floodplains to natural or seminatural conditions, beneficial functions such as filtration, infiltration, biogeochemical cycling, overbank flooding, erosion, deposition, and shading are reset on positive ecologic trajectories. In effect, Stream Rehabilitation works to improve water quality and habitat by restoring natural processes. Much of the research to quantify water-quality credits resulting from various forms of Stream Rehabilitation has been performed in the Chesapeake Bay watershed and is summarized in the *Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects* (Berg et al. 2013). Other efforts, such as the New Hampshire riparian buffer crediting program, address a narrower scope of riparian restoration actions to define water-quality benefits (Roca Communications 2019). Both programs focus on sediment and nutrients, the predominant pollutants of concern in the respective watersheds. In New Hampshire and the Chesapeake Bay area, expert panels reviewed available science, determined qualifying conditions for restoration projects, developed protocols for quantifying pollutant reductions, and provided credit calculations.

5.5.1 Riparian Buffer Restoration

The New Hampshire program uses an approach similar to San Diego County's stormwater DCV methodologies to evaluate and credit riparian buffer restoration efforts (Roca Communications 2019). There, riparian buffer restoration is eligible for water-quality credits—in the form of TN, TP, and TSS—when sized and located to meet certain criteria. This program incorporates regional pollutant-loading and reduction-performance curves based on site characteristics such as contributing area, land use, impervious cover, hydrologic soil groups, and slope. To address the inherent variability of riparian buffer conditions, contributing areas, and runoff treatment performance, the crediting program set minimum and maximum riparian buffer widths (20–100 feet), slope categories (0–5 percent, 5–10 percent, 10–15 percent), and pollutant-specific removal rates. Their approach relied heavily on a local expert panel and regional stormwater runoff and water-quality trends to develop credit determinations, emphasizing the need for empirical data and regional insight to the catchments draining Chula Vista. The New Hampshire program can be modified to work for Chula Vista by incorporating existing WQE protocols and developing regional applicability. For example, the WQE Guidance already provides relative pollutant concentrations and runoff factors for different land-use categories that are used to determine land-use factors and the relative pollutant impacts of a PDP. However, an expert panel would need to establish regional performance curves for riparian buffer pollutant retention rates (e.g., pounds TSS/acre/year) to substitute the New Hampshire-specific performance curves. For best results, the expert panel needs to address all relevant watershed pollutants (e.g., TSS, TN, TP, FC, TCu) and develop pollutant retention performance curves based on hydrologic soil groups, buffer widths, slope, vegetative cover, and buffer position relative to the PDP.

5.5.2 Stream and Floodplain Restoration and Regenerative Stormwater Conveyance

The Chesapeake Bay protocols and calculations for stream rehabilitation were based on published sediment and nutrient fluxes in restored streams, floodplains, wetlands, and RSC systems from select watersheds. There, credits were provided for (1) preventing sediment during storm flows; (2) providing in-stream and riparian hyporheic zone nutrient processing during base flow; (3) increasing floodplain reconnection volumes; and (4) stormwater retrofits using RSC (Table 1). Water quality benefits from bank stabilization efforts (Protocol 1) were calculated by monitoring or estimating annual erosion rates and sediment loads, converting those rates to nitrogen and phosphorus loads based on sediment TN and TP concentrations, and subtracting the estimated reduction attributed to bank stabilization. This process was facilitated by routine monitoring and the Bank Assessment for Non-point Source Consequences of Sediment (BANCS) or Bank Stability and Toe Erosion Model (BSTEM) methods. Benefits from hyporheic nutrient cycling (Protocol 2) were calculated using a defined black box hyporheic zone (restored stream length × width × depth) and regional denitrification rates. Floodplain reconnection credits (Protocol 3) for sediment and nutrients were determined using reconnection storm event curves and reported floodplain-wetland removal rates. Lastly, water-quality benefits from RSC retrofits (Protocol 4) were based on stormwater treatment volume and provided adjustor curves for pollutant removal (Berg et al. 2013).

A field evaluation of the expert panel recommendations at four restoration sites in North Carolina found reasonable agreement using the BANCS method for sediment and nutrient credits applicable to Protocol 1 (Doll et al. 2018; Table 1). However, the authors reported high uncertainty for Protocols 2 and 3, namely due to high variability in measured hyporheic and floodplain processes among restoration sites. As a result, this study recommended applying published areal denitrification rates to restored streambed and riparian zones in place of measured rates to simplify the process while providing realistic TN removal efficiencies (2–4 percent). Streambed and riparian denitrification rates of 1.85 and 1.01 milligrams of nitrogen per square meter per hour, respectively, were recommended based on a peer-review of 249 stream systems (Lammers and Bledsoe 2017).

Where empirical data are available, the Chesapeake's Nutrient Crediting Program framework can be modified to determine WQE credits earned through Stream Rehabilitation in Chula Vista. However, current methodologies for credit determinations are limited by the availability of regionally specific pollutant-retention rates for each NSMP. Empirical nutrient processing or pollutant-retention rates from comparable systems in San Diego County should be incorporated into adaptations of this method to reflect the appropriate conditions for Chula Vista streams. Where empirical data are not available, published retention rates may be used initially and later substituted with field-based monitoring studies to validate and calibrate retention capacity to reflect local conditions. Ultimately, WQE credits may be generated by calculating the difference in pollutant-reduction capacity between the affected stream and the restored stream. This approach may enable a quantitative evaluation of reductions in streambank/channel erosion, increases in hyporheic volume, expansions of floodplain area, and additions to regenerative stormwater conveyance.

Table 1. Stream Restoration Credits for Individual Restoration Projects[1,2]

Protocol	Name	Units	Pollutants	Method	Reduction Rate
1	Prevented Sediment (S)	Pounds per Year	Sediment TN, TP	Define bank retreat using BANCS or other method	Measured N/P content in streambed and bank sediment
2	Instream Denitrification (B)	Pounds per Year	TN	Define hyporheic box for reach	Measured unit stream denitrification rate
3	Floodplain Reconnection (S/B)	Pounds per Year	Sediment TN, TP	Use curves to define volume for reconnection storm event	Measured removal rates for floodplain wetland restoration projects

Protocol	Name	Units	Pollutants	Method	Reduction Rate
4	Dry Channel RSC as a Retrofit (S/B)	Removal Rate	Sediment TN, TP	Determine stormwater treatment volume	Use adjustor curves from retrofit expert panel

Source: Berg et al. 2013.

[1] Depending on project design, more than one protocol may be applied to each project, and the load reductions are additive.

[2] Sediment load reductions are further reduced by a sediment delivery ratio in the CBWM (which is not used in local sediment TMDLs).

S = stormflow conditions; B = base flow or dry weather conditions.

5.6 Quantifying Ecosystem Benefits of Stream Rehabilitation

As the above sections describe, different Stream Rehabilitation strategies can provide various ecosystem benefits that extend beyond stormwater pollutant and hydromodification flow control. Evaluation of ecosystem benefits resulting from Stream Rehabilitation is necessary to perform restoration-alternatives analyses and properly quantify total WQE credits. Because ecosystem benefits from restoration often defy quantitative or monetary valuation methods, functional assessments have been developed to determine the ecological benefits of riverine wetland rehabilitation projects by comparing existing conditions to “with-project” and “without-project” ecosystem functions. The U.S. Army Corps of Engineers (USACE) used one such approach, the Hydrogeomorphic (HGM) Approach, to evaluate ecosystem-restoration benefits of various stream rehabilitation alternatives in Aliso Creek, California (USACE 2002). The HGM analysis assessed 14 critical riverine wetland functions divided into three categories: physical/hydrological function; biogeochemical function; and habitat function (Table 2). Using this method, USACE measured gains or losses to ecosystem functions resulting from proposed rehabilitation as *functional capacity units* (FCU), defined as “an indicator of the capacity of four wetland functions in the Aliso Creek system.” The HGM Approach proved useful for evaluating the benefits of ecosystem restoration projects and comparing alternatives; however, the study acknowledged the inability of HGM to address unquantifiable benefits, such as watershed education.

For the proposed Aliso Creek mainstem restoration alternative, the HGM Approach demonstrated significant ecosystem benefits for future with-project conditions (421.9 FCUs) compared to both existing conditions (174.0 FCUs) and future without-project (165.4 FCUs) conditions (Table 2). The HGM found ecosystem functions in the Aliso Creek mainstem would continue to degrade without restoration project intervention, validating the observations and projections USACE made during the commission of the study. This study applied the HGM Approach to six different restoration alternatives spanning the Aliso Creek mainstem and tributaries, incorporating rehabilitation strategies ranging from riparian revegetation and invasive species removal to stream channel modification, floodplain restoration, and infrastructural upgrades. Accordingly, the HGM Approach can be applied to a suite of stream-rehabilitation options in Chula Vista to compare the functional benefits among restoration alternatives and can also be used to inform benefit-cost analyses to identify which projects provide the greatest ecosystem benefits per dollar.

Table 2. Environmental Evaluation of Aliso Creek Mainstem Restoration

Functions	Existing Conditions (FCUs)[1]	Future Without-Project (FCUs)[1]	Future With-Project (FCUs)[2]
Hydrology Subgroup			
Maintenance of Characteristic Channel Dynamics	10.4	9.9	36.0
Dynamic Surface Water Storage and Energy Dissipation	14.6	13.9	35.4
Long-Term Surface Water Storage	11.5	11.0	38.4
Subsurface Water Storage	17.5	16.7	32.7
Biogeochemical Cycling Subgroup			
Nutrient Cycling	10.5	9.9	31.0
Detention of Imported Elements and Compounds	16.0	15.2	36.6
Retention of Particulates	13.7	13.0	35.2
Organic Carbon Export	15.7	14.9	34.5
Habitat Subgroup			
Maintain Characteristic Plant Community	20.0	19.0	39.7
Maintain Characteristic Detrital Biomass	8.1	7.6	25.4
Maintain Spatial Structure of Habitat	15.6	14.8	34.0
Maintain Habitat Interspersion and Connectivity	20.4	19.5	43.1
Total	174.0	165.4	421.9

Notes:
[1] Existing and Future Without-Project Conditions based on area of 32.4 acres.
[2] Future With-Project Conditions based on an area of 49.8 acres.
FCU = functional capacity units

A stream and floodplain restoration project at the confluence of the Cosumnes and Mokelumne Rivers in southern Sacramento County provides a useful framework from which WQE credits may be determined for NSMPs in Chula Vista. The Cosumnes Floodplain Mitigation Bank restored more than 470 acres of riverine, floodplain, and wetland habitat in the delta by breaching a levee, excavating new channels, and rehabilitating historic wetlands (Westervelt 2021). This project generated credits for Floodplain Mosaic Wetlands, Floodplain Riparian Habitat, Shaded Riverine Aquatic Habitat, and Enhancement Riparian Habitat by restoring hydrologic and geomorphic functions, which in turn rehabilitated aquatic resources. Like the Aliso Creek study, the HGM Approach was modified and used to classify and evaluate the natural functions of nearby reference habitats and potential restoration scenarios. Through restoration actions, natural functions were returned to the mitigation bank site, and the HGM Approach was again used to monitor and evaluate the performance of the various habitats to determine how many credits were generated and available for sale. This approach allowed the project owners and regulatory agencies to perform generalized credit determinations based on habitat functions and extents. In Chula Vista, this approach could be applied to systems such as the Lower Otay River, where habitat functions can be extended to represent water-quality functions for credit determination.

5.7 Shortcomings of Stream Rehabilitation for Stormwater Management and Water Quality Benefits

The efficacy and appropriateness of quantifying water-quality benefits from stream restoration is debated because of the complex processes involved and the vast heterogeneity that characterizes fluvial systems. Moreover, directly measuring or modeling water-quality benefits is exceedingly difficult in the presence of upstream urbanization, particularly with respect to larger catchments. Currently, WQE calculations do not support the use of Stream Rehabilitation for pollutant reduction, and this shortcoming is the result of poorly understood natural processes and jurisdictional limitations to where stormwater management can be employed or credited.

5.7.1 Water-quality Benefits at Different Spatial and Temporal Scales

Studies that attempt to detect improvements in water quality resulting from Stream Rehabilitation often find discrepancies between signals at reach, catchment, and watershed scales (Locatelli et al. 2015; Martinez-Martinez et al. 2015; Williams et al. 2017; Thompson et al. 2018). This is the result of the rise in complexity and compounding factors that begin to influence water quality at increasing spatial scales. Unknown influences, such as legacy sediments, “old” groundwater, illicit discharge, and the variability of storm flows and pollutant loads, likely influence the realized water-quality benefits following Stream Rehabilitation.

5.7.2 Jurisdictional Status of Restored Floodplains and Wetlands

During Stream Rehabilitation planning, appropriate environmental permitting will determine the extent of jurisdictional waterways and the level of impact restoration actions may have on waters of the United States. It is important to consider jurisdictional regulations in the context of constructed wetlands and floodplain restoration and develop explicit management plans to ensure proper performance and maintenance of these systems. It is not uncommon for constructed wetlands to convert to jurisdictional wetlands in the absence of proper management practices (i.e., draining, vegetation removal, and dredging), and steps must be taken to ensure the desired outcomes will be met for both water quality and ecological function (Stromberg 2015). Strategies such as lowering floodplain elevations and creating additional wetlands for stormwater management will likely result in changes to official floodway map delineations and jurisdictional wetlands[2]. These considerations must be addressed early in the planning process and employed in long-term management plans. Moreover, MS4 Permit Finding 7 explicitly prohibits the use of in-stream treatment systems as stormwater-management facilities without treatment of runoff prior to discharge into receiving waters. Therefore, it is important to ensure pretreatment of runoff prior to their discharge into Stream Rehabilitation NSMPs, while also demonstrating greater overall water quality and watershed benefits than structural BMPs alone.

[2] The Clean Water Act and Porter–Cologne Water Quality Control Act both allow for created treatment wetlands to remain outside of jurisdiction as waters of the United States and waters of the state, respectively. Wetlands created to treat stormwater are excluded from waters of the United States in 33 CFR 328.3(b)(10) and from waters of the state in Section II(3)(d)(iii) of the state definition of wetlands as provided in the Procedures for Discharges of Dredged or Fill Material to Waters of the State.

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Chapter 6
Summary

The intent of this review is to compile scientific information supporting the use of NSMPs for WQE to inform the development of guidelines for water-quality crediting in Chula Vista. To that end, the following sections discuss the applicability of specific NSMPs for realizing water-quality benefits and the implications of the above scientific information for developing WQE for NSMPs.

6.1 Suitability of NSMPs for Chula Vista

The most appropriate NSMP alternatives for the City must provide a combination of water-quality, watershed, and ecosystem benefits to provide justification for use in the ACP. In practice, no single NSMP is likely to manage the stormwater runoff associated with a PDP, and, thus, the ability to combine multiple NSMPs for WQE is necessary and should be encouraged. The three NSMP categories are not mutually exclusive. The most effective and appropriate WQE strategy using NSMPs would incorporate many of the restoration actions described above, functioning in tandem to provide reliable benefits to water quality and ecosystem health.

6.1.1 Land Preservation

The Land Preservation NSMP is an important asset to include in the WQE toolbox for protecting in perpetuity those projects undergoing Land Restoration or Stream Rehabilitation. Land Preservation is most appropriate when located in the same hydrologic area or subarea as the proposed development and should aim to increase habitat connectivity and public access to open lands. Priority areas for Land Preservation should include the 75–100-percent Conservation Areas identified in the MSCP Subarea Plan and active floodplains, channel migration zones, and waterways of the United States. Regardless of the setting, Land Preservation NSMPs must be bound by a legal agreement, such as a conservation easement, to preserve the undeveloped state of the parcel and provide water-quality benefits in perpetuity. Although currently eligible for hydromodification flow-control credits, Land Preservation must be coupled with Land Restoration or Stream Rehabilitation NSMPs to be eligible for pollutant or volume-reduction credits and is suitable as a credit multiplier to encourage its use. This whole-system approach to NSMPs will help ensure redundancy in the natural functions that benefit water quality and watershed function.

6.1.2 Land Restoration

Land Restoration is another opportunity to provide offsite stormwater management because it is a direct reduction of impervious surface cover that offsets the development proposed by a PDP applicant. Land Restoration should be located within the same hydrologic area or subarea to offset water-quality impacts from a PDP. Land Restoration is most appropriate for sites with high imperviousness, but may be appropriate for sites that act as sources of contamination with low relative imperviousness. Land Restoration NSMPs are not appropriate for use in historic floodways, channel migration zones, or waterways of the United States. Implementation of Land Restoration should be accompanied by structural BMPs and SCMs where necessary to adequately manage runoff and stabilize the restored site. Nonnative invasive species management is not appropriate for use as a standalone NSMP for WQE credits; however; the applicant and the City should agree on a long-term management plan to ensure runoff is controlled and native vegetation communities persist. A protocol for calculating stormwater-volume reduction and hydromodification flow-control credits from Land Restoration is already provided in the *County of San Diego BMP Design Manual* (San Diego DPW 2019). More information is required to determine the eligibility of Land Restoration to qualify for pollutant-reduction credits. In addition, the ecosystem benefits of Land Restoration should be estimated through qualitative assessments that determine the functional lift from existing conditions to restored conditions. Thus, modeled reductions in stormwater volume and hydromodification flow-control should be coupled with the anticipated ecosystem functional lift to determine total WQE credits. This approach will require the determination of a conversion factor to translate functional lift to WQE credits.

6.1.3 Stream Rehabilitation

The variety of possible Stream Rehabilitation NSMPs highlights the functional overlap that can be achieved to enhance water quality and watershed function. All the Stream Rehabilitation alternatives mentioned in the WQE Guidance were found to have been scrutinized in various combinations, providing a scientific basis for their performance and suitability as pollutant-reduction strategies. These studies support the theory that stream-channel and floodplain restoration, constructed wetlands, riparian buffer restoration, and regenerative stormwater conveyance can provide multiple, quantifiable water-quality benefits in addition to habitat enhancement in urban settings. The range of alternatives allow Stream Rehabilitation to be appropriate for virtually all drainages within Chula Vista. Riparian buffer restoration is suitable for any stream or wetland boundary within City limits that is degraded or poorly functioning and capable of receiving runoff flow. Stream channel reconfiguration—with or without floodplain restoration—is appropriate throughout the Otay and Sweetwater Rivers and tributaries, so long as the systems demonstrate altered functions and impaired water-quality conditions. Inline constructed wetlands are valuable strategies for storm-sewer outfalls and offsite treatment facilities, whereas offline constructed wetlands situated in floodplains are suited uniquely to receive storm flows from adjacent streams. Finally, regenerative stormwater conveyance is most appropriate for storm-sewer outfalls and ephemeral drainages or in conjunction with urban stream daylighting.

The variety of Stream Rehabilitation alternatives increases the difficulty of characterizing water-quality benefits resulting from these NSMPs. This inherent variability requires the development of individual methodologies to characterize the pollutant-reduction benefits of each approved NSMP alternative. For example, pollutant-reduction credits generated from stream channel reconfiguration, floodplain restoration, or RSC may be calculated by modifying the protocols the Chesapeake Bay Program developed. Alternatively, riparian buffer restoration credits may be calculated using a modified New Hampshire methodology. Therefore, determination of pollutant-reduction credits for each of the individual NSMPs should be evaluated using methodologies that are customized to Chula Vista watersheds and communities.

6.2 Implications for WQE and Credit Ratios

Determination of realistic pollutant-reduction credit ratios for the various NSMPs is a primary objective for the ACP. As mentioned above, Land Preservation likely will be most beneficial to water quality and ecosystem health when employed as a credit multiplier to encourage the adoption of conservation easements on Land Restoration or Stream Rehabilitation projects. For example, a Stream Rehabilitation NSMP might generate 100 credits as a standalone project, but may be eligible for a 1.3 multiplier if simultaneously put under a conservation easement, adaptively managed, and protected in perpetuity. By implementing both Stream Rehabilitation and Land Preservation NSMPs, a PDP may be eligible for 130 credits to offset development impacts. Because it is widely held that Stream Rehabilitation provides greater water-quality benefits on a per-unit basis than Land Restoration, this approach will require the development of a range of multipliers to account for the difference between various NSMPs. In addition, this range of multipliers could include requirements or incentives for PDP applicants to incorporate features such as public access and adaptive management, if applicable.

As discussed in Chapter 4, *Water Quality Equivalency Using Land Restoration,* calculating measurable pollutant-reduction benefits from Land Restoration is a convoluted process that greatly depends on specific site conditions and restoration actions that are not as easily defined as Stream Rehabilitation alternatives. To streamline the PDP approval process and promote the use of NSMPs as WQE strategies, a navigable process needs to be developed that quantifies realistic benefits without intensive field and desktop exercises. Pollutant-reduction credit determination for Land Restoration could be based on a variant of the DCV calculations used in structural BMP protocols (San Diego DPW 2019). The original DCV calculations use relative pollutant concentrations, imperviousness, and runoff coefficients for each land use type to determine the pollution impacts of developed versus restored conditions. Therefore, it may be possible to modify this protocol to calculate the increase in pollutant-retention capacity exhibited by a site following restoration, rather than simply calculating the reduction in pollutants generated. However, the empirical data to support this approach is not available readily. Furthermore, these calculations do not account for additional benefits beyond water quality, including restored habitat, watershed function, and aesthetics. Although capturing the volume reduction and hydromodification flow-control benefits that result from Land Restoration, the current WQE Guidance does not provide credit for benefits to ecosystem health. Because of these credit-accounting deficiencies, PDP applicants may favor offsite structural BMPs over Land Restoration NSMPs due to cost-effectiveness. To remedy this disincentive, Land Restoration NSMPs could generate WQE credits following establish protocols, with additive scores based on the functional lift provided to the ecosystem. Like the Land Preservation multipliers, a range of additive scores could provide incentives for incorporating indirect water-quality benefits, such as sensitive-habitat restoration, native-vegetation management, public access and trails, recreational facilities, and educational components.

Pollutant-reduction benefits resulting from Stream Rehabilitation are difficult to quantify, but protocols have been developed in the Chesapeake Bay area and New Hampshire that perform well when compared with field studies of actual restoration projects. This framework can be modified for Chula Vista and surrounding watersheds, but regionally specific natural system pollutant-retention rates are needed to accurately valuate WQE credits. To develop and use these approaches, the City would need local or regional data that represents average retention rates for nutrients, sediment, pesticides, trace metals, and bacteria for each of the Stream Rehabilitation NSMP alternatives. These data may be available from local or regional organizations. Where empirical treatment rates are unavailable for Chula Vista or nearby systems, an expert panel should evaluate published rates that may be substituted to estimate pollutant-control capacity associated with individual NSMPs. However, this approach does not account for indirect water-quality benefits and increased ecosystem and watershed function, resulting in the need for additional qualitative assessments to evaluate functional lift.

An alternative to WQE credit determination using empirical pollutant retention rates would involve a citywide restoration project cost analysis, coupled with the HGM Approach, much like the strategy USACE used in Aliso Creek and Westervelt used on the Cosumnes River. Using this strategy, the City would perform a cost analysis of all major candidate Stream Rehabilitation projects that might be eligible for the ACP and WQE crediting. The cost analysis would document the project locations, extents, and cost estimations for full-suite restoration and long-term management to the level that can be supported by each candidate site. The HGM Approach would be employed to establish reference conditions, identify restoration opportunities and actions, and estimate the increase in functional capacity that can be achieved through Stream Rehabilitation. Following the Cosumnes Floodplain Mitigation Bank, the HGM Approach could qualitatively evaluate hydrology (i.e., hydromodification), biogeochemistry (i.e., pollutant volumes), and habitat in reference systems and existing conditions and could be used to create and monitor performance standards. For each site, WQE credits could be calculated based on the functional lift provided by Stream Rehabilitation. The cost analysis would provide unit-cost estimations for each water-quality credit and would enable accurate pricing for sale through a City-run credit bank or in-lieu fee.

The benefits of this combined cost analysis-HGM approach include the familiarity and willingness of regulatory agencies to support and approve this crediting framework and the control the City exhibited in determining which candidate projects are eligible for WQE credits. Tackling all of the candidate projects through one comprehensive cost analysis and credit determination would be more efficient than asking PDP applicants to handle the process for each project. This also provides consistency between project sites for credit determination, does not require the consideration of every water-quality parameter, and allows for project prioritization to occur from a watershed perspective.

The disadvantages to this approach include the need to develop a regional HGM Guidebook that applies to the Otay and Sweetwater River watersheds, the assumptions made during preliminary cost-estimation efforts, and the as-yet-undetermined credit-valuation strategy for increases in functional capacity units Stream Rehabilitation provides. Furthermore, it is likely that this approach will still require the calculation of anticipated stormwater pollutant-reduction credits or NSMP-specific pollutant retention rates to satisfy the technical components for determining WQE.

6.3 Potential Projects to Determine Water Quality Equivalency Using NSMPs

The 2014 *City of Chula Vista Alternative Compliance Strategy – Final Report* included a list of potential open-space area project types that focused on stream or riparian area rehabilitation, watershed preservation land acquisitions, and groundwater recharge projects (City of Chula Vista 2014). Table 3 of the Final Report described the project types, provided existing project examples and potential project sites, identified water quality and watershed benefits, and speculated on the operations and maintenance responsible parties for each project. For example, restoration of unlined channels through stream and buffer restoration could occur on City-owned open-space parcels along various drainages to better manage hydromodification, infiltration, sediment transport, and pollutant removal—with stewardship responsibility falling on the City. Similarly, another project might provide "net add" of conservation benefit and restriction over current conditions by enhancing 75 percent-conserved MSCP lands to 100 percent-conserved and placing areas with informal management under permanent, active stewardship. This form of watershed preservation land acquisition could occur in the Otay River buffer areas and the edges of the San Diego University site to improve watershed function through land cover enhancement to reduce runoff. Groundwater recharge projects, such as infiltration basins, trenches, and dry wells, might provide joint stormwater benefits for the Sweetwater Authority or along Western Chula Vista rights-of-way by increasing hydromodification capacity and pollutant removal. Although this report did not identify site-specific projects suitable for alternative compliance, it provided a foundation from which a potential project inventory could be developed.

The co-permittees in the 2014 San Diego Bay Watershed Management Area Analysis developed a template for identifying and compiling potential candidate projects that may provide greater overall benefit to the watershed than requiring implementation of structural onsite BMPs. This spreadsheet template assigned each candidate project a unique identifier and specified the watershed management areas, hydrologic areas and subareas, jurisdiction, project name, ownership(s), locational data, and various site-specific criteria to help classify and assess project feasibility (San Diego County 2014), although the template was intended to be used by the co-permittees within each respective municipality. Figure 6 shows streams within Chula Vista with potential to provide NSMP credits.

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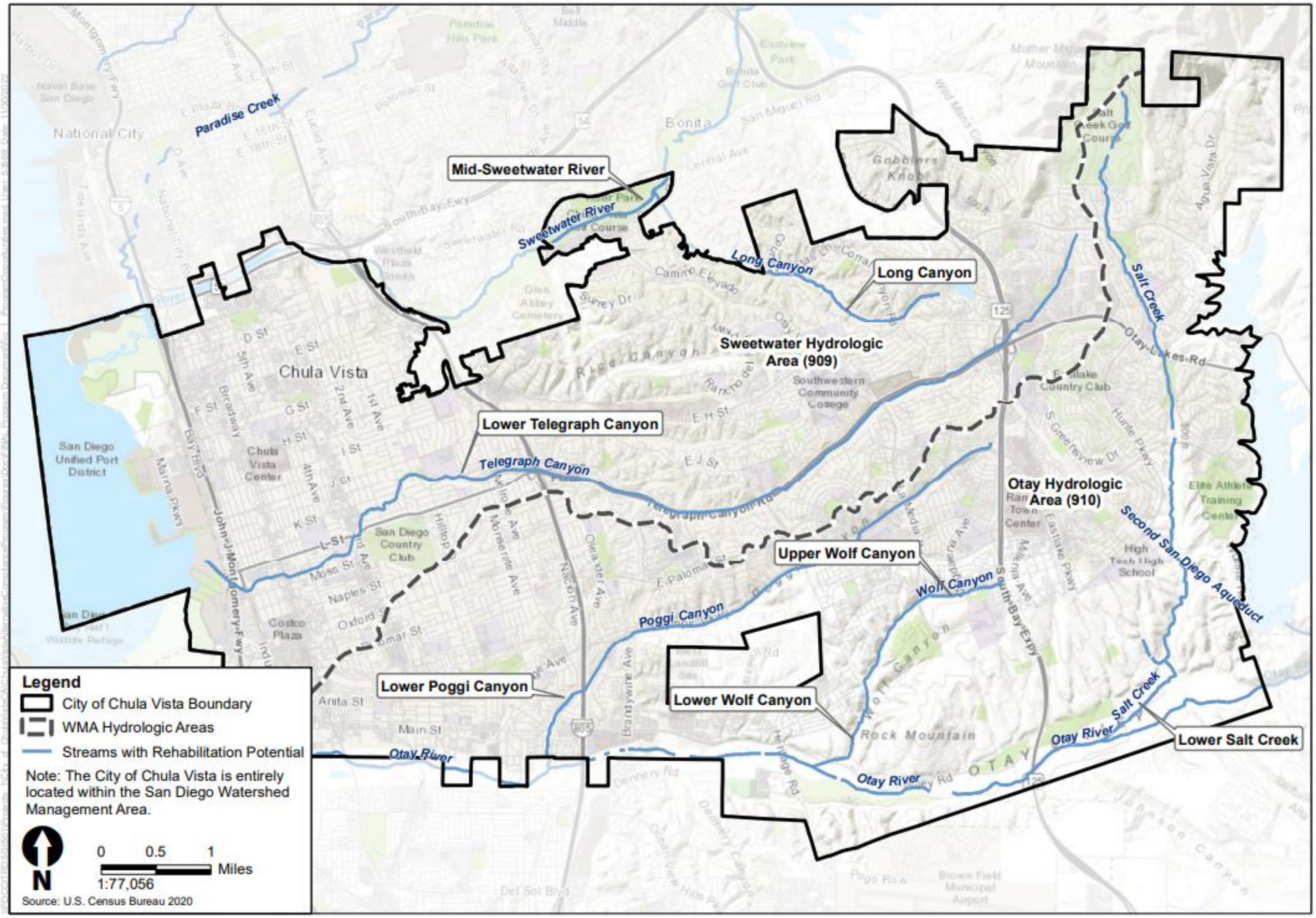

Figure 6. Streams with potential for NSMP Restoration Projects under the Proposed Chula Vista ACP

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6.4 WQE Monitoring Program and NSMP Pilot Project

The scientific literature consistently reiterates the need for empirical data for stormwater management using NSMPs. Moreover, many studies identified the discrepancy between water-quality benefits at reach, catchment, and watershed scales. The message is clear: water-quality monitoring is critical to assess and adequately credit Stream Rehabilitation projects. These data are invaluable for subsequent ACP reviews, allowing WQE credit determinations to be adjusted to reflect anticipated versus actual water-quality benefits. Therefore, a monitoring program should be developed to collect data before and after both a Land Restoration and Stream Rehabilitation project within Chula Vista. The implementation of a Land Restoration and Stream Rehabilitation pilot project in the Salt Creek drainage provides an opportunity to fill the local data gap and provide the information necessary to evaluate and refine the WQE crediting calculations to streamline PDP permitting approval and stormwater-management efficacy. The City of Chula Vista and ICF have developed a comprehensive watershed assessment project that will be used to monitor and assess the performance of such a pilot project. Funding for this assessment is anticipated to be provided by the Proposition 1 Watershed Restoration Grant.

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Chapter 7
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Appendix B

Technical Memorandum on Alternative Compliance Program: Water Quality Equivalency Credit Equation Application

DRAFT

ALTERNATIVE COMPLIANCE PROGRAM: WATER QUALITY EQUIVALENCY CREDIT EQUATION APPLICATION

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Overview

Development and application of the City of Chula Vista Water Quality Equivalency (WQE) credit equation for Natural Systems Management Practices (NSMPs) focused on adapting the existing regional WQE equation (2018 update) for Best Management Practices (BMP) accepted by the California Regional Water Quality Control Board to represent relevant processes and functions provided by stream restoration that impact water quality (RWQCB 2018). The stormwater pollutant control volume equation for NSMPs is shown below.

Equation 1. Calculation of ACP Earned Stormwater Pollutant Control Volume

$$V_E = L\,(\Delta V + V_2N_2 - V_1N_1)$$

$$N = C_RN_R + C_SN_S + (C_VE_V * \text{Ecological Benefit Factor})$$

Variables	Consideration
V_E: Earned stormwater pollutant control volume of ACP	Calculated water quality credit
L: Land use factor	Pollutant supply
V_2: Restored condition design capture volume at ACP	Pollutant reduction
N_2: Restored condition NSMP efficacy factor	Pollutant reduction
V_1: Existing condition design capture volume at ACP	Existing conditions
N_1: Existing condition NSMP efficacy factor	Existing conditions
ΔV: Change in design capture volume ($V_1 - V_2$) at ACP	Change in existing conditions
E: Pollutant reduction efficiency	Dependent on site conditions
C: Provided capture	Calculated volume captured / DCV

ACP = Alternative Compliance Program; DCV = design capture volume

This NSMP credit calculation equation follows the same format as the BMP equation, except for calculation of the efficacy factor ("N" for NSMPs, "B" for BMPs). As the BMP is a closed system with specific guidance on capture volume and pollutant reduction, development of a new equation was needed to represent the functions of a NSMP that is more spatially and temporally dynamic. Determination of DCV for the 85th percentile, 24-hour storm event and the Land Use Factor for NSMPs follows the same methodology used for BMPs. When calculating the Land Use Factor for independent ACPs within the City of Chula Vista, the reference tributary is based on the future land use acreage for the Otay Sub-Watershed or Sweetwater Sub-Watershed (Table 1) (SANDAG, 2014).

The three functions used to calculate N in this equation are (1) retention, (2) sediment, and (3) vegetation. The NSMP efficacy factor is assessed for both existing (N_1) and proposed (N_2) conditions.

Table 1. Future Land Use Acreages for the Sub-Watersheds within the City of Chula Vista

	Otay Future Land Use Acreage[1]	Sweetwater Future Land Use Acreage[1]
Agriculture	0	5
Commercial	2,375	2,785
Education	1,271	1,996
Industrial	3,184	1,550
Multi-Family Residential	2,291	2,534
Orchard	0	0
Rural Residential	24,768	52,177
Single Family Residential	5,302	19,469
Transportation	5,141	10,260
Vacant / Open Space	49,056	59,908
Water	1,048	2,978
Total	**94,436**	**153,662**

[1] Future land use acreages are based on current projections and are subject to change.
Source: SANDAG, 2014

Task 1. Retention Efficacy Subfactor ($N_{Retention}$)

Retention represents the water volume and pollutants reduced by the natural system. Calculations for provided capture are provided below, but alternatively provided capture may be determined with dispersion nomographs from previously approved WQE and BMP manuals. Project-specific modeling (i.e., storm water management model [SWMM]) would also be allowed to quantify retention subject to local jurisdiction review and approval.

Equation 2. Calculation of Retention Efficacy Subfactor

$$N_{Retention} = C_R E_R = (C_{R\_Infiltration} + C_{R\_Evapotranspiration}) * E_R$$

$N_{Retention}$: retention efficacy subfactor

C_R: provided capture through retention

E_R: retention pollutant reduction efficiency

$C_{R\_Infiltration}$: provided capture through infiltration

$C_{R\_Evapotranspiration}$: provided capture through evapotranspiration

Task 1.a. Provided Capture through Infiltration ($C_{R\_Infiltration}$)

Infiltration represents the water volume captured by percolation into the soil. The saturated hydraulic conductivity can be determined for the inundated area with Web Soil Survey (USDA, NRCS 2019) or from onsite measurements. It is assumed that infiltration occurs uniformly over the entire inundation extent.

Equation 3. Calculation of Provided Capture through Infiltration

$$C_{R\_Infiltration} = (A * K_{sat} * t * 3630) / DCV$$

$C_{R\_Infiltration}$: fraction of DCV retained by infiltration (dimensionless)

A: maximum inundation extents of the 85th percentile, 24-hour storm event (acres)

K_{sat}: minimum saturated hydraulic conductivity rate of soils within A (inches/hour)

3630: conversion from acres to square feet for A (43,560 square feet/1 acre) multiplied by conversion from inches to feet for K_{sat} (1 foot/12 inches) to give the volume result in cubic feet

t: duration of infiltration during the storm event (maximum of 3 hours)

DCV: design capture volume (cubic feet)

Task 1.b. Provided Capture through Evapotranspiration ($C_{R\_Evapotranspiration}$)

Evapotranspiration represents the water volume captured by the evapotranspiration process in vegetation. Evapotranspiration can be determined for the project site by consulting the City of Chula Vista BMP Design Manual (2019 update). It is assumed that evapotranspiration occurs uniformly within vegetated portions of the entire inundation extent.

Equation 4. Calculation of Provided Capture through Evapotranspiration

$$C_{R\_Evapotranspiration} = (A_V * ET * t * 3630) / DCV$$

$C_{R\_Evapotranspiration}$: fraction of DCV retained by evapotranspiration (dimensionless)

A_V: maximum inundation extents of the 85th percentile, 24-hour storm event that intersects with vegetation (acres)

ET: average evapotranspiration rate during October–March determined by City of Chula Vista BMP Design Manual (inches/hour)

t: duration of evapotranspiration during the storm event (maximum of 3 hours)

3630: conversion from acres to square feet for A (43,560 square feet/1 acre) multiplied by conversion from inches to feet for ET (1 foot/12 inches) to give the volume result in cubic feet

DCV: design capture volume (cubic feet)

Task 1.c. Retention Pollutant Reduction Efficiency (E_R)

The E_R is 100% for both infiltration and evapotranspiration. This assumes that all pollutants in the captured water are reduced due to percolation into the soil or uptake by vegetation.

Task 2. Sediment Efficacy Subfactor ($N_{Sediment}$)

The sediment-related portion of the equation is primarily focused on calculating the anticipated capability of the NSMP to reduce sediment transport in the system. This will primarily occur through sediment capture and is expected to be higher in NSMPs that restore degraded and eroding channels.

Equation 5. Calculation of Sediment Efficacy Subfactor

$$N_{Sediment} = C_S E_S$$

$N_{Sediment}$: sediment efficacy subfactor

C_S: percent change of sediment leaving the system

E_S: reduction efficiency of sediment

Task 2.a. Provided Capture of Sediment (C_S)

Sediment captured by the stabilized, post-restoration stream is calculated as follows.

Equation 6. Calculation of Percent Change of Sediment

$$C_S = (S_1 - S_2)/S_1$$

C_S: percent change of sediment leaving the system

S_1: sediment leaving the NSMP in existing conditions

S_2: sediment leaving the NSMP in proposed conditions

Task 2.b. Sediment Pollutant Reduction Efficiency (E_S)

The sediment reduction efficiency is 1 (100% of sediment captured is removed, similar to retention).

Task 3. Vegetation Efficacy Subfactor ($N_{Vegetation}$)

The final pollutant reduction process represented in the equation is for biofiltering benefits provided by vegetation.

Equation 7. Calculation of Vegetation Efficacy Subfactor

$$N_{Vegetation} = C_V * E_V * \text{Ecological Benefit Factor}$$

$N_{Vegetation}$: vegetation efficacy subfactor

C_V: fraction of DCV filtered by vegetation

E_V: vegetation pollutant reduction efficiency

Ecological Benefit Factor: quantitative multiplier based on condition of the resources and benefits it is anticipated to provide based on that condition (more details in Task 3.c)

Task 3.a. Provided Capture through Vegetation Filtering (C_V)

Provided capture for vegetation is calculated as the percent of DCV that flows over vegetation and is not deeper than 1.5 feet. Any water during the storm event that is more than 1.5 feet above the bed surface or does not intersect with vegetation is not captured in this category. Project-specific modeling (i.e., HEC-RAS) would be allowed to quantify provided capture by vegetation, subject to local jurisdiction review and approval.

Task 3.b. Vegetation Pollutant Reduction Efficiency (E_V)

The E_V value was set at 19%, consistent with the lowest pollutant reduction efficiency provided by vegetated swales in the Regional WQE Guidance (RWQCB 2018). The total vegetation efficacy increases when multiplied with the Ecological Benefit Factor but does not exceed the published maximum reduction efficiency of biofiltration BMPs (67%).

Task 3.c. Ecological Benefit Factor

California Rapid Assessment Method (CRAM) provides a comprehensive, score-based approach to quantify the condition of the feature both before and after the NSMP is implemented. For the City WQE equation, the magnitude of change between the CRAM scores for pre- and post-restoration conditions is translated to an Ecological Benefit Factor that is used as a multiplier for E_V.

Equation 8. Calculation of the Ecological Benefit Factor

$$\text{Ecological Benefit Factor} = (\text{CRAM Score}_{post} - \text{CRAM Score}_{pre}) / 7$$

- If calculated factor is greater than 3.0, then a maximum value of 3.0 will be imposed.
- If calculated factor is greater than 4.0, then an additional bonus of 0.2 will be added.
- If calculated factor is less than 1.0, then a minimum value of 1.0 will be imposed.

Note: 7 is the magnitude of change between CRAM scores required for significant improvement from existing to proposed conditions.

References

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Appendix C

Technical Memorandum on Alternative Compliance Program: Water Quality Equivalency Credit Equation Development

DRAFT

ALTERNATIVE COMPLIANCE PROGRAM: WATER QUALITY EQUIVALENCY CREDIT EQUATION DEVELOPMENT FOR NATURAL SYSTEMS MANAGEMENT PROJECTS

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Acronyms and Abbreviations

ACP	Alternative Compliance Program
AOI	area of interest
Bank	Otay Mitigation Bank
BMP	Best Management Practices
City	City of Chula Vista
CRAM	California Rapid Assessment Method
DCV	Design Capture Volume
DCV	design control volume
EV	efficiency
HEC-HMS	Hydraulic Engineering Center Hydrology Modeling System
HEC-RAS	Hydrologic Engineering Center River Analysis System
MS4	municipal separate storm sewer system
NSMP	natural system management practices
NSMPs	Natural Systems Management Projects
PDP	Priority Development Project
SWMM	Storm Water Management Model
VE	volume
WMA	watershed management area
WQE	Water Quality Equivalency

Executive Summary

The City of Chula Vista (City) is developing an alternative compliance program (ACP), which includes a City water quality equivalency (WQE) framework for natural system management practices (NSMP). With this framework the City aims to implement a greater water quality benefit concurrently with expediting approval of priority development projects (PDP), while meeting municipal separate storm sewer system (MS4) permit requirements. under the San Diego Water Board Order R9-2013-0001, as amended (Regional MS4 Permit). The ACP program consists of a City WQE for NSMPs water quality and use of the Regional 2018 WQE for BMPs.

This memorandum contains supporting material for the ACP and the City of Chula Vista Best Management Practices (BMP) Design Manual and was specifically created for use by the City of Chula Vista only. This memorandum demonstrates the methodologies for applying NSMPs toward water quality credits as an ACP option. Equations were developed to calculate the WQE credits generated by NSMPs for water quality. In addition, this exercise provides an opportunity to evaluate the functions provided by BMPs and NSMPs, and their ability to meet the water quality requirements of the Regional MS4 Permit.

The 2018 Regional WQE credit methodologies for structural BMPs are the foundation for NSMP equation development. The calculation of earned stormwater control volume for NSMPs is based on three processes: (1) runoff retention; (2) sediment stabilization; and (3) vegetation biofiltration. The overall uplift in ecological benefits for a restored system is represented by a multiplier in the equation that increases credit volume. The design capture volume and pollutant removal efficiency provided by these three processes can be consistently calculated based on the existing conditions and proposed design.

Two case studies were evaluated with the City WQE equation for NSMPs (Salt Creek) and the Regional 2018 WQE equation for BMPs (Example Infill Project), respectively. Each site provided unique existing conditions and design intent for comparison of generated credits. The capital, maintenance, land, and admin costs associated with each project were also compared. Results indicated that Salt Creek generated the most pollutant credits and had the lowest cost per cubic-foot.

The following conclusions were determined during this exercise:

- The NSMP equation is based on BMP methodology but accounts for water quality processes and benefits provided by natural systems.
- The calculated pollutant control volume for a NSMP is highly dependent on design intent but can match or exceed BMP volumes.
- The NSMP case study was lower cost alternative to the infill project on a per cubic-feet of treatment, per project acre, and per impervious acre basis.

Technical Memorandum for Equation Development

Background

The City of Chula Vista (City) obtained SB 2 grant funding to develop an Alternative Compliance Program (ACP) for Natural Systems Management Projects (NSMPs) to provide alternative compliance and treatment options for stormwater consistent with the Regional MS4 Permit (Order R9-2013-0001, as amended, California Regional Water Quality Control Board, 2015). The proposed program represents significant opportunities for Priority Development Project (PDP) applicants to implement or contribute to NSMPs that can provide treatment. The ACP will also allow for streamlined permit review and approval processes increase onsite buildable acreage which will help the City meet its housing and community development goals, and meet Regional MS4 Permit requirements for stormwater pollutant control and hydromodification management through providing a mechanism for the creation and approval of stormwater credits.

There are two primary mechanisms utilized in ACPs: Structural best management practices (BMPs) and NSMPs. Structural BMPs are physical structures or features that are designed to collect, treat, infiltrate, and/or convey stormwater. Examples include retention ponds, rain gardens, constructed wetlands, and pervious pavement (RWQCB, 2018: ES-2). Structural BMPs (BMPS) have pollutant control calculations based on defined pollutant removal efficiencies and design control volume reductions specified in the Regional MS4 Permit.

NSMPs are stormwater management practices implemented to restore and/or preserve predevelopment watershed functions in lieu of providing onsite direct pollutant removal and hydromodification flow control (RWQCB, 2018: xv) for projects that cannot reliably retain or fully treat the DCV onsite. The existing Regional Water Quality Equivalency (WQE) guidance outlines stormwater pollutant control benefits through a reduction in stormwater runoff volume but does not define "pollutant removal" by restoring natural biogeochemical processes for NSMPs. For an applicant to obtain pollutant reduction credit associated with the design control volume (DCV) not reliably retained onsite for pollutant reduction processes in a stream restoration project, the City is required by the Regional MS4 Permit to develop the methodology to be followed through its own approval process (RWQCB, 2018: Section 2.3.2). Therefore, the focus of this project was to develop the needed methodology to quantify pollutant removal credits for NSMPs. The WQE developed and discussed in this memo for NSMPs addresses the ability of an ACP project to remove typical pollutants in runoff from the drainage area.

Note that this memorandum only addresses credit for stormwater pollutant control benefits for NSMPs. Hydromodification flow control benefits for NSMPs should be calculated in accordance with Section 3 of the Water Quality Equivalency Guidance Document for Region 9 (RWQCB, 2018).

Objectives

This report demonstrates the development and application of a WQE equation for NSMPs to generate stormwater credits. The technical memorandum includes:

- Chapter 1: Project background and objectives,

- Chapter 2: An overview of the existing BMP WQE equation, and
- Chapter 3: Development of a new WQE equation for NSMPs.
- Appendices:
- Appendix A: Calibration of the NSMP WQE equation using a comparative methodology,
- Appendix B: Literature review for vegetation pollutant removal efficiencies,
- Appendix C: Supporting material for development of Ecological Condition Factor,
- Appendix D: Application of equations to one NSMP and one BMP case study, and
- Appendix E: Comparison of credit and cost results across the case studies.

Alignment with Clean Water Act Section 401 and Porter Cologne Water Quality Control Act

Stream restoration projects are regulated by the RWQCB through the 401 Water Quality Certification Program and under the Porter-Cologne Water Quality Control Act. These programs focus on the physical, chemical, and biological qualities of streams as well as the functions and values provided by these features. These programs use different terminology to describe the functions and values provided by streams and stream restoration than the MS4 program uses to describe BMPs and water quality measures. Terms such as pollutant reduction in this document are including functions such as biofiltration or processing of organic matter and nutrients. This WQE was developed specifically to address stormwater pollutant control from NSPMs, so the governing language used throughout the document is that of the MS4 program.

Overview of Existing Guidance

Water quality equivalency for stormwater pollutant control is established based on the Regional MS4 Permit DCV not fully retained on site and the pollutant removal efficiency. Structural BMPs are a subset of BMPs which detain, retain, filter, infiltrate, remove, or prevent the release of pollutants to surface waters from development projects in perpetuity, after construction of the project is completed. The WQE Guidance document provides a comprehensive methodology for calculating the earned volume provided by a BMP based on the contributing watershed and design of the structure (RWQCB, 2018). Copermittees including San Diego, Orange, and Riverside County submitted the WQE Guidance document to the San Diego Water Board for approval in 2015 (updated in 2018) to provide standards and guidelines for a Copermittee to implement an offsite ACP project for PDP projects that cannot feasibly implement the full DCV or HMP requirements of the Regional MS4 permit onsite. The WQE calculations provided by this document are required to allow the City and PDP applicants an alternate strategy for compliance with onsite pollutant control BMPs that cannot be fully implemented onsite. A general overview of this methodology is presented in the following sections, as it provides the foundation for development of the NSMP WQE equation.

WQE Equation

The earned stormwater pollutant control volume (V_E) is the amount of water that is effectively treated by the ACP project considering the site-specific factors presented in Table 1. V_E can be used to offset the deficit of retained or biofiltered stormwater volume for PDPs

Table 1. Structural BMP ACP project stormwater pollutant control volume calculation

$$V_E = L\,(\Delta V + V_2 B_2 - V_1 B_1)$$

$$B = E * C$$

Variables	Consideration
V_E: Earned stormwater pollutant control volume of ACP project	Calculated water quality credit
L: Land use factor	Pollutant supply
V_2: Mitigated condition design capture volume at ACP project	Pollutant removal
B_2: Mitigation condition BMP efficacy factor	Pollutant removal
V_1: Impacted condition design capture volume at ACP project	Impacted conditions
B_1: Impacted condition BMP efficacy factor	Impacted conditions
ΔV: Change in design capture volume ($V_1 - V_2$) at ACP project	Change in impacted conditions
E: Pollutant removal efficiency	Dependent on site conditions
C: Provided capture	Calculated volume captured / DCV

The variables used in the equation for V_E are described in detail below.

Land Use Factor

The land use factor (L) is the ratio of pollutant concentrations generated by an ACP project tributary compared to the pollutant concentrations generated by a reference PDP tributary with emphasis on the pollutants for which the receiving water in the watershed management area is impaired. Its purpose is to account for variations in the pollutant concentrations delivered to ACP projects and PDPs. This factor is needed to allow a comparison between the pollutant concentrations within the contributing area of the PDP and ACP project anywhere within the same watershed management area (WMA). Applicants must conduct a number of pollutant and land use specific calculations and then select the Land Use Factor values that are the most protective.

Design Capture Volume

Traditional BMPs are sized using a Design Capture Volume (DCV)[1]. The DCV represents the volume of runoff for the 85th percentile, 24-hour storm event entering the location of interest. It is 100% of the PDP DCV as described in the Regional WQE guidance (2018 update) and is calculated as:

$$\mathbf{DCV = C * d * A * 3630}$$

Where:

DCV = design capture volume for the 85th percentile, 24-hour storm event (cubic-feet)

C = area weighted runoff factor (unitless),

d = depth of 85th percentile, 24-hour storm event rainfall (inches),

A = area of drainage (acres), and

3630 = conversion from acres to square feet (43560 square feet/1 acre) multiplied by conversion from inches to feet (1 feet/12 inches) to provide the volume result in cubic-feet.

The area weighted runoff factor is estimated using the equation from Section B.1.1 in the Model BMP Design Manual (Project Cleanwater, 2020 update).

$$\mathbf{C = (\Sigma C_X A_X)/(\Sigma A_X)}$$

Where:

C_x = runoff factor for area “X” (unitless), and

A_x = area “X” of tributary (acres).

The value of the runoff factor varies depending on land use, impervious area, and hydrologic soil group. Default values are provided in Table 2-3 or may be manually calculated per Section 2.3.1.2 in the Regional WQE Guidance (2018 update).

The 85th percentile 24-hour storm depth is determined from Figure B.1-1 in the Model BMP Design Manual (Project Cleanwater, 2020 update), an isopluvial map of San Diego County.

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[1] Within Appendix B of the Model BMP Design Manual (Project Cleanwater, 2020 update), Worksheet B.1 address the hydrologic calculations needed to determine the site’s DCV.

BMP Efficacy Factor

The BMP efficacy factor (B) describes the ability of an ACP project to remove pollutants in runoff from the drainage area. This factor is represented as a ratio and can vary from 0.00 to 1.00. A BMP Efficacy Factor of 1.00 indicates that an ACP project provides a pollutant capture efficacy that meets the PDP BMP efficacy standards set forth in the Regional WQE Guidance (2018 update), while a lower value provides a fraction of that efficacy. It is calculated with the equation below from Equation 2-3 in the Regional WQE Guidance (2018 update):

$$B = E * C$$

Where E is the pollutant removal efficiency, and C is the provided capture. The provided capture for Retention BMPs is a function of fraction of DCV retained and drawdown time (Figure 2-9 from the WQE Guidance). Biofiltration BMPs are designed to capture 150% of DCV. The pollutant removal efficiency for retention and biofiltration BMPs is 1.0 and 0.666, respectively (RWQCB, 2018). While pollutant removal efficiency standards may evolve over time as more data are compiled and additional studies completed, this guidance relies on Regional WQE Guidance (2018 update) language as the most direct and reliable method for establishing equivalency.

Context for Development

There are three primary NSMP categories described in the Regional WQE Guidance – Land Preservation, Land Restoration, and Stream Restoration (RWQCB. 2018: ES-3). The WQE Guidance provides detailed instructions, equations, and examples for calculating the hydromodification flow control benefits of Land Preservation, Land Restoration, and Stream Restoration NSMPs. At the time of the approval of the updated 2018 Regional WQE Guidance, calculations had not yet been determined for NSMP pollutant reduction benefits (retention, biofiltration, or flow-thru) and only limited applications had been developed for volume reduction (Figure 1).

ACP Category		Stormwater Pollutant Control Benefits				Hydromod Flow Control Benefits
		Pollutant Reduction			Volume Reduction	
		Retention	Biofiltration	Flow-Thru		
BMP	Retrofit	Available	Available	Available	Available	Available
	Regional	Available	Available	Available	Available	Available
	Water Supply	Available	Available	Limited Availability	Available	Available
NSMP	Land Restoration	Not Available	Not Available	Not Available	Available	Available
	Land Preservation	Not Available	Not Available	Not Available	Limited Availability	Available
	Stream Rehabilitation	Not Available	Not Available	Not Available	Limited Availability	Available

Figure 1. ACP categories quantified through WQE Guidance and the focus of this memo highlighted

This technical memorandum focuses only on the processes and benefits provided by stream restoration as these projects typically restore hydrologic and geomorphic structure, processes, and functions (Figure 2). The goal of these projects may be to increase flood resiliency and attenuation, enhance pollutant retention, improve in-stream habitat conditions, and protect water quality by recreating natural conditions and biogeochemical processes in degraded systems. Stream restoration often manifests as streambank stabilization, floodplain reconnection, and channel reconfiguration. Riparian buffers created through restoration offer ecosystem and watershed benefits, including complex habitat for native species, improving hydrologic flow regimes , flood attenuation, biogeochemical cycling, sediment regulation, and shading—all of which benefit water quality.

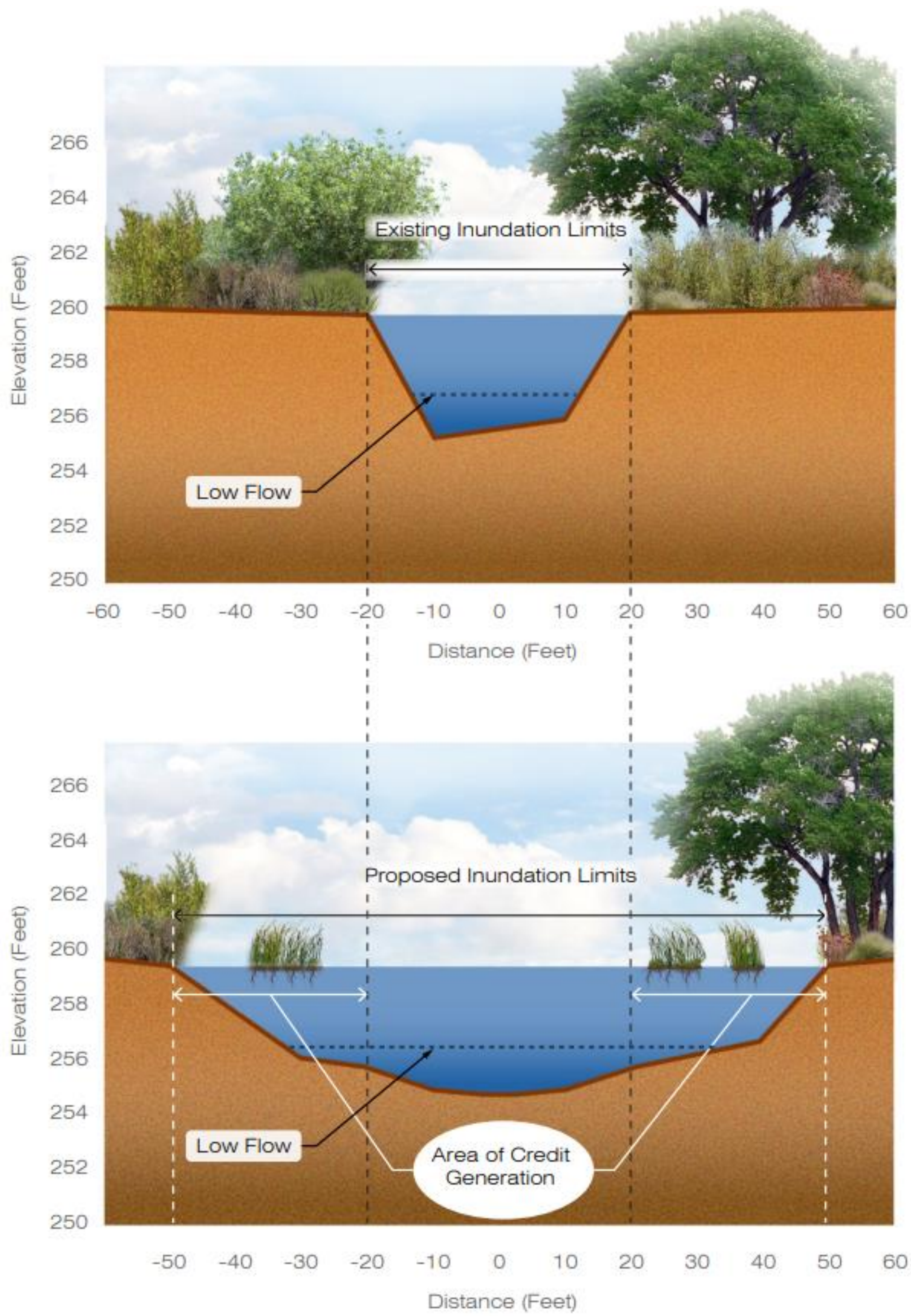


Figure 2. Example of simplified pre- and post-restoration conditions for an example NSMP project

Development of the WQE credit equation for NSMPs focused on adapting the existing BMP equation to represent relevant processes and functions provided by stream restoration that impact water quality. This process is described in the following section.

WQE Equation

The stormwater pollutant control volume equation for NSMPs is shown in Table 2. The definitions for the variables are consistent with the existing BMP WQE equation for clarity. The efficacy factors listed below describe the ability of an ACP project to remove typical pollutants in runoff from the drainage area. Although efficiencies are normally expected to vary according to pollutant type, the efficacy values in this report provide an average value that is useful for establishing equivalency (sensu Regional WQE Guidance, 2018 update).

Table 2. NSMP ACP stormwater pollutant control volume calculation

$$V_E = L\,(\Delta V + V_2N_2 - V_1N_1)$$

$$N = C_RN_R + C_SN_S + (C_VE_V * \text{Ecological Condition Factor})$$

Variables	Consideration
V_E: Earned stormwater pollutant control volume of ACP project	Calculated water quality credit
L: Land use factor	Pollutant supply
V_2: Restored condition design capture volume at ACP project	Pollutant removal
N_2: Restored condition NSMP efficacy factor	Pollutant removal
V_1: Existing condition design capture volume at ACP project	Existing conditions
N_1: Existing condition NSMP efficacy factor	Existing conditions
ΔV: Change in design capture volume ($V_1 - V_2$) at ACP project	Change in existing conditions
E: Pollutant removal efficiency	Dependent on site conditions
C: Provided capture	Calculated volume captured / DCV
C_R: Provided capture by retention	Infiltration and evapotranspiration
E_R: Pollutant removal by retention	
C_S: Provided capture by sediment	Bed and bank stabilization
E_S: Pollutant removal by sediment	
C_V: Provided capture by vegetation	Vegetation biofiltration
E_V: Pollutant removal by vegetation	
Ecological Condition Factor: Multiplier	Habitat complexity and benefits

This NSMP equation for follows the same format as the BMP equation, except for the calculation of the efficacy factor ("N" for NSMPs, "B" for BMPs). As the BMP is a closed system with specific guidance on capture volume and pollutant removal, development of a new equation was needed to represent the functions of a spatially and temporally dynamic NSMP (Figure 3). The same methodology used to determine DCV for BMPs is used for NSMPs. The DCV for NSMPs is 100% of the PDP DCV as described in the Regional WQE guidance (2018 update).

To ensure that the total pollutant removal is not calculated as greater than 100%, the maximum value for each individual pollutant removal efficiency (E) shall not exceed 1.0, the sum of provided capture for vegetation and retention ($C_V + C_R$) shall not exceed 1.0 and the total sum of the NSMP efficacy factor (N) shall not exceed 1.0.

$$N = C_R E_R + C_S E_S + (C_V E_V * \text{Ecological Condition Factor})$$

$$N = \text{Retention} + \text{Sediment} + \text{Vegetation}$$

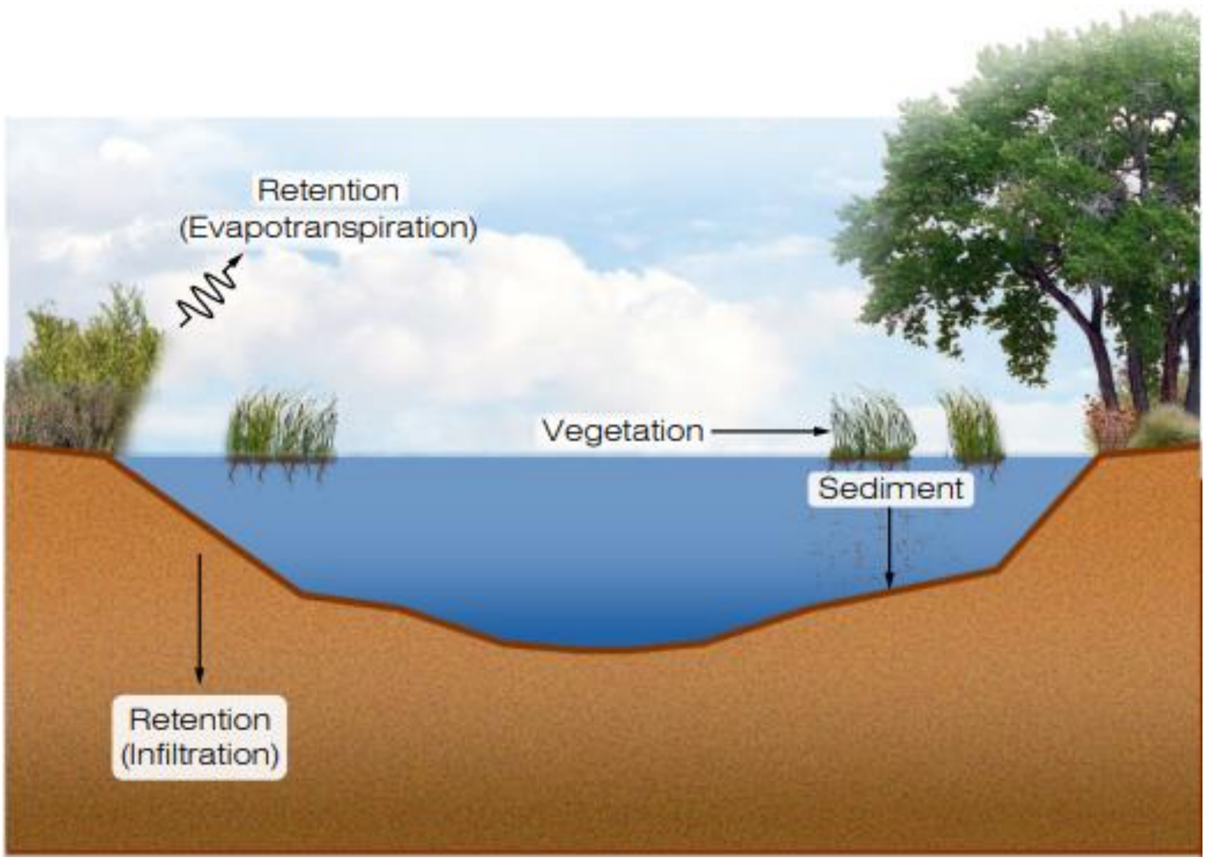


Figure 3. Illustration of processes represented in the NSMP efficacy factor equation.

The three functions included in this equation are (1) retention, (2) sediment, and (3) vegetation. These functions cover significant forms of volume capture and pollutant reduction provided in a natural system and are consistent with the focuses for structural BMPS (RWQCB, 2018). The NSMP efficacy factor is assessed for both existing (N_1) and proposed (N_2) conditions.

Land Use Factor

When calculating the Land Use Factor for independent NSMP ACPs within the City of Chula Vista, the reference tributary is based on the future land use acreage for the Otay Sub-Watershed or Sweetwater Sub-Watershed (Table 3) (SANDAG, 2014).

Table 3. Future Land Use Acreages for the Sub-Watersheds within the City of Chula Vista

	Otay Future Land Use Acreage	Sweetwater Future Land Use Acreage
Agriculture	0	5
Commercial	2,375	2,785
Education	1,271	1,996
Industrial	3,184	1,550
Multi-Family Residential	2,291	2,534
Orchard	0	0
Rural Residential	24,768	52,177
Single Family Residential	5,302	19,469
Transportation	5,141	10,260
Vacant / Open Space	49,056	59,908
Water	1,048	2,978
Total	**94,436**	**153,662**

Source: SANDAG, 2014

Retention

Retention represents the water volume and pollutant reduction by the natural system, as calculated here:

$$N_{Retention} = C_R E_R = (C_{R\_Infiltration} + C_{R\_Evapotranspiration}) * E_R$$

Where C_R is the fraction of DCV retained by the system through infiltration and evapotranspiration and E_R is the percent of pollutant reduction when water infiltrates or evapotranspirates. As described below, the C value for infiltration and evapotranspiration are calculated separately. However, the E value for both processes is 100%. This assumes that all pollutants in the captured water are removed due to percolation into the soil or uptake by vegetation.

Infiltration

Infiltration represents the water volume captured by percolation into the soil. Similar to structural BMPs, the infiltration provided is primarily dependent on the inundated area from the storm event, soil type, and duration of infiltration (RWQCB, 2018). Web Soil Survey is a publicly available database that can be used to generate a soil report for an area of interest (AOI) (USDA NRCS, 2019a). Using the project boundary for the area of interest, an applicant could use the survey results to determine the minimum hydraulic conductivity (K_{sat}) within the site (Figure 4). Representative on-site measurements would be preferential to define saturated hydraulic conductivity.

Figure 4. Example of saturated hydraulic conductivity rate based on Web Soil Survey for Salt Creek.

Therefore, volume capture by infiltration is calculated as:

$$C_{R\_Infiltration} = (A*K_{sat}*t*3630)/DCV$$

Where:

$C_{R\_Infiltration}$ = percent of DCV captured by infiltration (dimensionless),

A = maximum inundation extents of the 85th percentile, 24-hour storm event (acres),

K_{sat} = minimum saturated hydraulic conductivity rate of soils within A (inches/hour),

3630 = conversion from acres to square feet for A (43560 square feet/1 acre) multiplied by conversion from inches to feet for K_{sat} (1 foot/12 inches) to give volume result in cubic-feet, t = duration of storm event (maximum of 3 hours), and

DCV = design capture volume (cubic-feet).

It was assumed that infiltration occurs uniformly over the entire inundation extent. Although this may overestimate infiltration, it is offset by using the minimum saturated hydraulic conductivity and a storm duration of 3 hours (to represent the peak versus the entire 24-hour storm period). The distinction between infiltration rate and K_{sat} is also important, as infiltration rate is the rate at which water infiltrates into the ground at any given moment, regardless of the current soil saturation and K_{sat} is the infiltration rate once the ground has reached 100% saturation and the infiltration rate has become constant. Therefore, using K_{sat} is more conservative, consistent, and readily available through Web Soil Survey than independent infiltration testing by applicants.

Evapotranspiration

Evapotranspiration represents the water volume captured by evapotranspiration achieved by vegetation. Evapotranspiration can be determined for the project site by consulting the Model BMP Design Manual (Project Cleanwater, 2020 update). Table G.1-2 in Appendix G of this manual contains a table of monthly average reference evapotranspiration by ET_o zone in San Diego County (Figure 5).

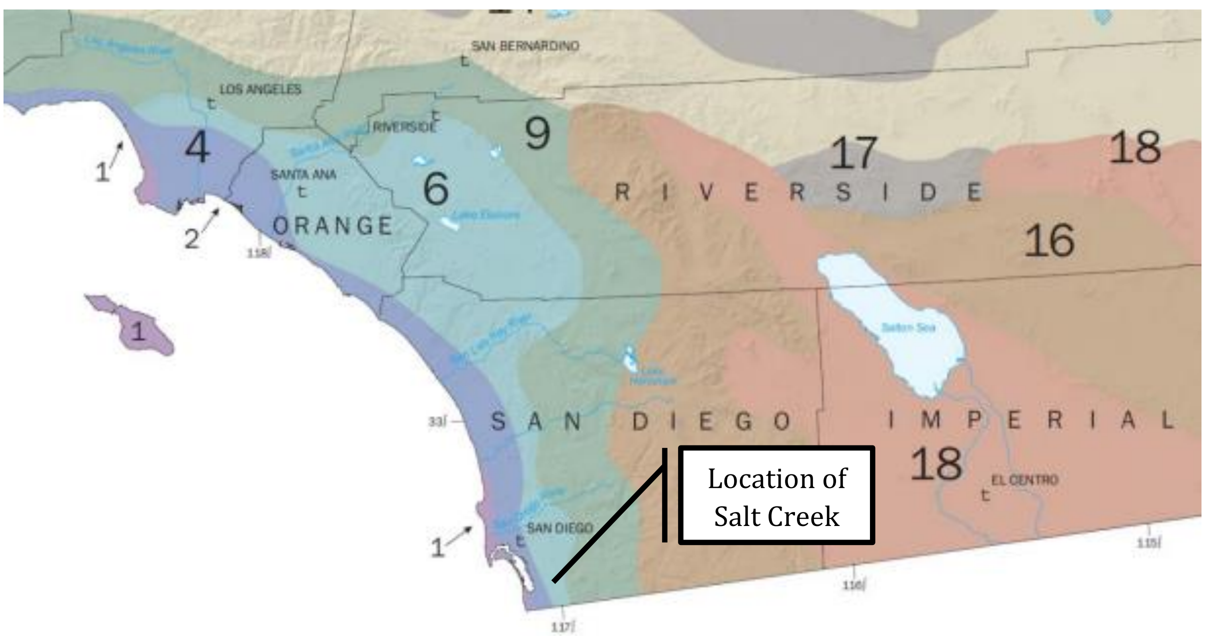


Figure 5. Example of evapotranspiration zone determined for Salt Creek

Therefore, capture by evapotranspiration is calculated as:

$$C_{R\_Evapotranspiration} = (A*ET*t*3630)/DCV$$

Where:

$C_{R\_Evapotranspiration}$ = percent of DCV captured by evapotranspiration (dimensionless),

A_V = maximum inundation extents of the 85th percentile, 24-hour storm event that intersects with vegetation (acres),

ET = average evapotranspiration rate during October – March determined by Model BMP Design Manual (Project Cleanwater, 2020 update) (note that this value must be recorded as inches/hr),

t = duration of evapotranspiration during the storm event (maximum of 3 hours),

3630 = conversion from acres to square feet for A_V (43560 square feet/1 acre) multiplied by conversion from inches to feet for ET (1 foot/12 inches) to give volume result in cubic-feet, and

DCV = design capture volume (cubic-feet).

It was assumed that evapotranspiration occurs uniformly over the entire inundation extent covering vegetation. Although this may overestimate evapotranspiration, it is offset by using the average evapotranspiration rate for the winter season as determined by the Model BMP Design Manual (Project Cleanwater, 2020 update). Additionally, using a storm duration of 3 hours (versus the entire 24-hour storm period) provides another conservative measure to avoid overestimation of evapotranspiration.

Alternatively, provided capture may be determined with dispersion nomographs from the Regional WQE (2018 update) and/or Model BMP Design Manual (Project Cleanwater, 2020 update). Project specific modeling (i.e., SWMM) would be allowed to quantify retention subject to local jurisdiction review and approval.

Sediment

The sediment related portion of the equation is primarily focused on calculating the anticipated capability of the NSMP to restore natural sediment transport and processes in the system, including sediment retention during variable storm events. This will primarily occur through sediment capture and portioning within the NSMP, which is expected to be higher in NSMPs that restore degraded and eroding channels (Figure 6). The NSMP efficacy factor for sediment is calculated as:

$$\mathbf{N_{Sediment} = C_S E_S}$$

Where C_S is percent change of sediment leaving the system and E_S is the effective retention ability of sediment. Sediment capture is calculated as:

$$\mathbf{C_S = (S_1 - S_2)/S_1}$$

Where:

S_1 = sediment leaving the NSMP in existing conditions, and

S_2 = sediment leaving the NSMP in proposed conditions.

The retention of sediment is estimated to be 1. Project specific modeling and calculations would be allowed to quantify sediment retention subject to local jurisdiction review and approval.

Figure 6. General example of severe geomorphic degradation during pre-restoration conditions.

Vegetation

The final pollutant removal process represented in the equation is for biofiltering benefits provided by vegetation. This is calculated as:

$$N_{Vegetation} = C_V * E_V * \text{Ecological Condition Factor}$$

Where C_V is the fraction of DCV filtered by vegetation, E_V is the percent of pollutants removed by vegetation, and the Ecological Benefit is a qualitative multiplier based on condition of the resource and benefits it is anticipated to provide based on that condition.

C_V is determined by calculating the percent total incoming water (DCV) that flows over vegetation and has a depth less than 1.5 feet. Any water during the storm event that is more than 1.5 feet above the bed surface or does not intersect with vegetation is not captured in this category. Project specific modeling (i.e., HEC-RAS) would be allowed to quantify C_V subject to local jurisdiction review and approval.

This equation assumes that the volume of water flowing through vegetation is uniformly filtered in the longitudinal, lateral, and vertical direction. The depth of filtering is up to a maximum value of 1.5 feet, under the assumption that suspended sediments more than 18 inches above the floodplain surface would flow through the project and not settle out onto the floodplain and that the most significant filtering provided by vegetation occurs below one foot. The Chesapeake methodology utilizes a depth of 1 foot for similar purposes (Atland et al., 2020) (Figure 7).

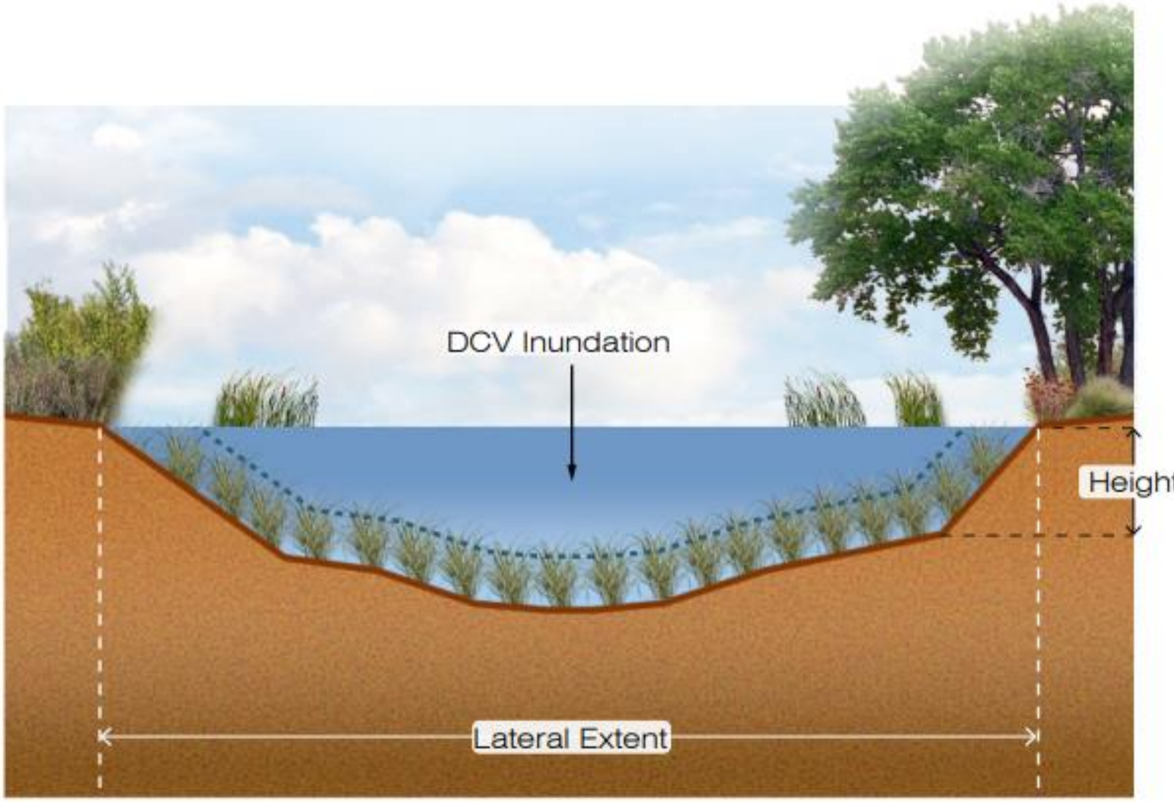


Figure 7. Simplified example of restored channel cross section with the entire DCV inundation shown, and the height and extent of captured volume drawn.

The removal efficiency (E_V) of vegetation was determined through robust literature review and consideration of standard BMP values (Appendix B). Every restoration site is different, whether it is the geological setting, hydraulic conditions, design goals, or existing disturbances. The Otay River does not have defined total maximum daily loads; therefore, this equation considers all pollutants to be removed equally. The E_V values used here attempt to provide consistent values for applicants while also considering the large range of project configurations. The minimum E_V value was set at 19%, consistent with the lowest pollutant removal efficiency provided by vegetated swales in Table 2-5 in the Regional WQE Guidance (2018 update). As biofiltration BMPs provide 67% pollutant removal efficiency, it was assumed than a NSMP would not exceed this performance standard. Therefore, using the Ecological Condition Factor as a multiplier, the maximum achievable E_V value is 61% (Table 4).

Table 4. Pollutant removal efficiencies for vegetation categories

	Pollutant Removal Efficiency Minimum	Pollutant Removal Efficiency Maximum
E_V	19%[2]	61%[3]
Ecological Condition Factor	1.0	3.2

Ecological Condition Factor

While developing the WQE equation for NSMPs, it became apparent that this methodology needed to account for the various benefits provided by natural systems beyond the direct influence on water quality. The Regional Water Quality Control Board considers the overall lift in functions and services of the watershed and receiving water to be equivalent to pollutant reduction (Walsh, 2021. *Pers. Comm.*). The functions and services provided by stream restoration NSMPs include: reduction in flow velocity, increased residence time, decreased water temperature from increased tree canopy, increased native habitat, increased receiving water biodiversity. All of these services and functions are natural processes that provide uptake of nutrients, disperse sediment for a more balanced habitat, and slow flow velocity for particulate settling and increased infiltration.

It was determined that a multiplier for the vegetation portion of the equation would best represent the influence of these benefits as they relate to the vegetative condition of the site before and after restoration. Therefore, the qualitative nature of the natural system could be quantified and adjust the final credit volume. To do this, a score-based system needed to be developed to determine how beneficial the before or after site condition is for providing ecosystem services.

California Rapid Assessment Method (CRAM) is a cost-effective and scientifically defensible rapid assessment method for monitoring the conditions of natural systems throughout California. It is used to assess ambient conditions as well as the performance of restoration projects (Figure 8). This methodology provides a comprehensive, score-based approach to quantify the condition of the feature both before and after the NSMP is implemented. The CRAM condition score is then used as a proxy to estimate the relative quantity of benefits provided by natural systems when compared to pre-project conditions.

[2] Per Table 2-5: Flow-Thru Pollutant Removal Efficiency (E) for Vegetated Swale from the Regional WQE Guidance (2018 update).

[3] Pollutant Removal Efficiency (E) for biofiltration basin is 0.67 from the Regional WQE Guidance.

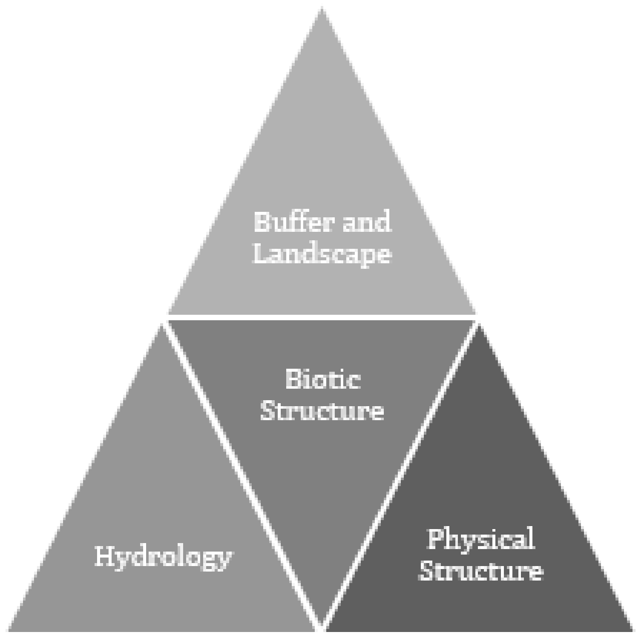


Figure 8. Spatial hierarchy of factors that control wetland conditions.

CRAM addresses 4 main attributes and their metrics:

- Buffer and landscape context – Stream corridor continuity, percent of aquatic area with buffer, average buffer width, and buffer condition.
- Hydrology – Water source, channel stability, and hydrologic connectivity.
- Physical structure – Structural patch richness and topographic complexity.
- Biotic structure – Number of plant layers, number of co-dominant species, percent invasion, horizontal interspersion, and vertical biotic structure.

Practitioners use these attributes to quantify the condition of the site. The attribute and metric scores, along with the stressor checklist, can be instrumental in identifying the restoration potential of a site as well as the potential positive and negative influences contributing to it.

The sum of scores given to the 4 attributes provides an overall score out of 100, with a minimum value of 25. For the WQE equation, the CRAM score is compared between pre- and post-restoration conditions and translated to an Ecological Condition Factor that is used as a multiplier for the vegetation removal efficacy. These values were used to span the range from low pollutant removal efficiency (Ecological Condition Factor = 1.0, E_V = 0.19) to high pollutant removal efficiency (Ecological Condition Factor = 3.2, E_V = 0.61).

$$\textbf{Ecological Condition Factor} = (CRAM_{post} - CRAM_{pre}) / 7$$

Where:

Ecological Condition Factor = dimensionless multiplier used to increase vegetation efficacy,

$CRAM_{post}$ = the predicted CRAM score for post-restoration conditions,

$CRAM_{pre}$ = the calculated CRAM score for pre-restoration conditions, and

7 = the magnitude of change between CRAM scores required for significant improvement[4].

If the calculated Ecological Condition Factor is greater than 3.0, then a maximum value of 3.0 will be imposed. If the calculated Factor is greater than 4.0, then an additional bonus of 0.2 will be added. If the calculated Factor is less than 1.0, then a minimum value of 1.0 will be imposed. The Ecological Condition Factor for existing conditions is always 1.0, therefore the maximum value possible is 3.2 for restored conditions.

The use of 7-point "bins" to characterize significant improvements between CRAM scores was primarily based on CRAM guidance from CWMW (2019) and Mazor (2015). Table 1-1 in the publication by Mazor included the separation of sites by class based on the CRAM score. The CRAM scores were binned into ranges between 7-9 points (i.e., Class 2 sites have a CRAM score between 72 to 79, Class 3 sites are between 63 to 72). These "classes" associated with score ranges are meant to broadly represent a stream's biology that may be intact, possible altered, likely altered, and very altered. Therefore, 7-point bins were determined to be appropriate to characterize significant changes in ecological condition between existing and proposed conditions for the WQE equation.

The City WQE equation for NSMPs should be calculated for proposed stream rehabilitation projects using the best available information for the site. As an example, this equation is applied to a NSMP case study in the problem statement below. This NSMP case study is then repeated in Appendix D and compared to a BMP case study in Appendix E.

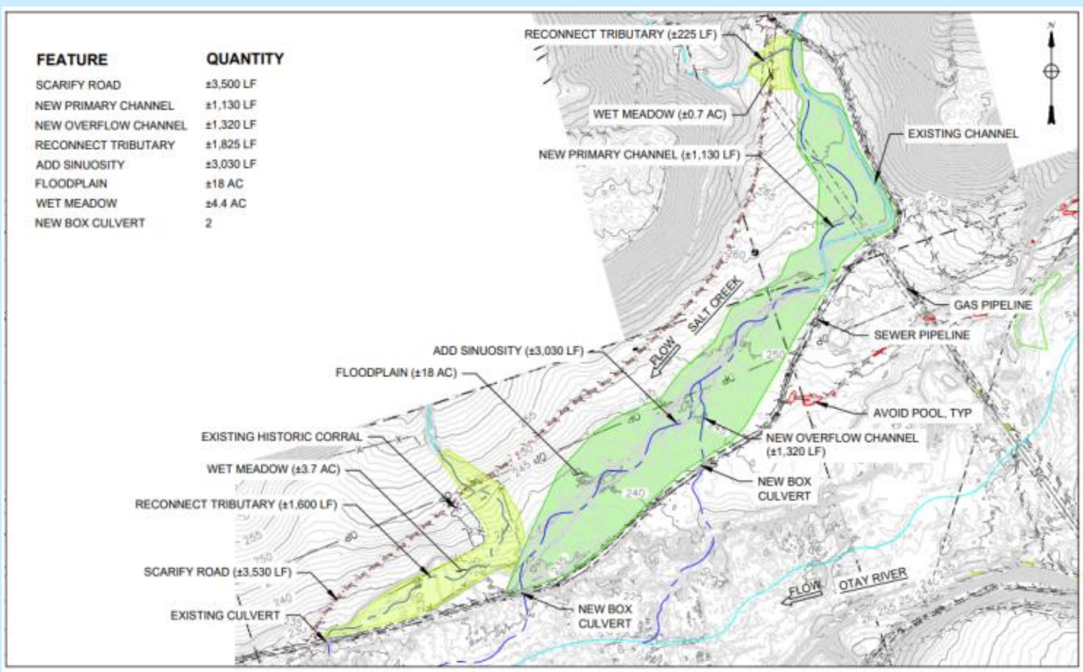
[4] There is 90% confidence that an Index Score is significantly greater than another Index Score if the score is more than or equal to 7 points different (CWMW, 2019).

Problem Statement

Salt Creek originates in National Wildlife Refuge land near San Miguel Mountain and flows into the northeast section of the Otay Mitigation Bank (Bank) (ICF, 2021). It is one of the primary tributary creeks of the Bank and may be implemented as a future phase of restoration work in the area (Problem Statement Figure 1). At this time Salt Creek is heavily incised and contained within a historically rerouted channel rather than the historical alluvial confluence.

The basic concept for this phase includes reestablishing the historical braided channel network and broad confluence connection with the Otay River Mainstem. In-stream structures and an increase in base elevations would help re-engage the currently cutoff floodplain and encourage breakout onto the valley floor. In addition, the channel banks would be set back and sinuosity would be added to the mainstem creek channel. Removal of non-native/invasive species in the creek would occur and the area would be revegetated with appropriate native riparian and floodplain species.

Salt Creek provides an example of how design intent can have a significant impact on the volume of credits generated by a project. For example, a larger provided capture volume for retention and vegetation filtration can be achieved by increasing the inundated area through design. Raising an incised channel, reconnecting the floodplain, or adding benches may all increase amount of treatable flow during the 85th percentile, 24-hour storm event. These design elements can also have a positive impact on the Ecological Condition Factor due to attributes like topographic complexity, hydrologic connectivity, and channel stability in the CRAM score. The planting plan for a restored channel may also be curated to increase the CRAM score for biotic structure, including number of plant layers, co-dominant species, percent of native fauna, and buffer width.



Problem Statement Figure 1. Concept Design for Salt Creek.

Part I: WQE for Stormwater Pollutant Control

Step 1: PDP Stormwater Pollutant Control Calculations

This is an Independent ACP and information pertaining to a specific PDP is not available to the ACP applicant at this time. Therefore, this step is not applicable for this ACP.

Step 2: ACP Stormwater Pollutant Control Calculations

The Earned Stormwater Pollutant Control Volume will be calculated per Equation 2-1 (RWQCB, 2018):

$V_E = L\ (\Delta V + V_2N_2 – V_1N_1)$

Where:
V_E: Earned stormwater pollutant control volume of ACP project (ft^3)
L: Land use factor
ΔV: Change in design capture volume ($V_1 – V_2$)
V_1: Impacted condition design capture volume for ACP project
V_2: Mitigated condition design capture volume for ACP project
N_1: Impacted condition NSMP efficacy factor
N_2: Mitigation condition NSMP efficacy factor

Task 2-1: Determine Design Capture Volume (DCV) Tributary to the ACP (V_1, V_2, ΔV)

In order to perform water quality equivalency calculations, the ACP applicant must determine the impacted condition DCV (V_1), the mitigated condition DCV (V_2), and the change in DCV (ΔV) as presented below.

Task 2-1A: Calculate Impacted Condition DCV (V_1)

The applicant delineates an ACP tributary area of 3,900 acres and identifies an 85th percentile rainfall depth of 0.52 inches per NOAA Atlas 14. Per methods presented in Appendix B.1 of the BMPDM, the area weighted average runoff coefficient is calculated as 0.38 based on land use. Therefore, the impacted condition DCV (V_1) for this project is calculated as:

d = 0.52 in   A = 3901 acres   C = 0.38

V_1 = Runoff Coefficient x Rainfall Depth x Tributary Area

V_1 = 0.38 x 0.52 in x 3,901 ac x (43,560 ft^2 /1 ac) x (1 foot/12 in) = 2,798,140 cubic feet

Task 2-1B: Calculate Mitigated Condition DCV (V2)

The proposed ACP does not alter runoff coefficients within the ACP tributary; therefore, the mitigated condition DCV is equal to the impacted condition DCV ($V_1 = V_2$).

V_2 = Runoff Coefficient x Rainfall Depth x Tributary Area

V_2 = 0.38 x 0.52 in x 3,901 ac x (43,560 ft^2 /1 ac) x (1 foot/12 in) = 2,798,140 cubic feet

Task 2-1C: Calculate Change in DCV (ΔV)

The impacted condition DCV is the same as the mitigated condition DCV; therefore, the change in DCV is calculated as:

$\Delta V = V_1 - V_2$

ΔV = 2,798,140 cubic feet – 2,798,140 cubic feet = 0 cubic feet

Task 2-2: Calculate Land Use Factor

In order to calculate an appropriate land use factor, the ACP applicant must identify the WQE pollutants of concern, calculate relative pollutant concentrations for the ACP tributary, and calculate relative pollutant concentrations for the reference tributary.

Task 2-2A: WQE Pollutants of Concern

The ACP is identified to be within the San Diego Bay WMA and Otay hydrologic unit, so the WQE pollutants of concern are TSS, TN, TCu, and FC per Table 2-1 (RWQCB, 2018).

Task 2-2B: ACP Tributary Relative Pollutant Concentrations

The ACP tributary is characterized by the land uses identified in the problem statement above.

Task 2-2C: Reference Tributary Relative Pollutant Concentrations

The reference tributary for an independent ACP is the sub-watershed it's located within. For this example, Salt Creek is located in the Otay Sub-Watershed.

Task 2-2D: Determine Land Use Factors

The appropriate land use compositions and associated runoff factors are then tabulated into the input fields of Worksheet A.5 and associated land use factors are calculated for each WQE pollutant of concern through utilization of Equation 2-2 (RWQCB, 2018). This step may also be performed through utilization of the automated land use factor calculation tool available on www.projectcleanwater.org, as is demonstrated in this example. (Problem Statement Table 1). The lowest resulting land use factor is selected for incorporation into the stormwater pollutant reduction calculations. Therefore, the land use factor for this ACP is based on Total Suspended Solids (TSS) which equals 0.32 as depicted in the table below.

Task 2-3: Calculate NSMP Efficacy Factors (N1, N2)

NSMP efficacy factors are a function of an ACP's pollutant removal efficiency and provided capture values (ICF, 2023). In order to perform water quality equivalency calculations, the applicant must determine the impacted condition NSMP efficacy factor (N_1), and the mitigated condition NSMP efficacy factor (N_2) for the ACP.

$N = N_{Retention} + N_{Sediment} + N_{Vegetation} = C_R E_R + C_S E_S + (C_V E_V$ * Ecological Condition Factor)

Where:
C_R: Provided capture by retention
E_R: Pollutant removal by retention
C_S: Provided capture by sediment
E_S: Pollutant removal by sediment
C_V: Provided capture by vegetation
E_V: Pollutant removal by vegetation
Ecological Condition Factor: Multiplier

Land Use Designation	ACP Tributary Characteristics		Reference Tributary Characteristics		Relative Pollutant Concentrations by Land Use						
	Area (Acres)	Runoff Factor	Area (Acres)	Runoff Factor	TSS	TP	TN	Tcu	TPb	TZn	FC
Agriculture	0	0.10	0	0.10	0.45	1.00	1.00	1.00	1.00	0.59	1.00
Commercial	82	0.80	2,375	0.80	0.13	0.16	0.16	0.56	0.48	1.00	0.87
Education	450	0.50	1,271	0.50	0.13	0.20	0.11	0.14	0.25	0.39	0.13
Industrial	88	0.90	3,184	0.90	0.13	0.19	0.15	0.54	0.68	0.89	0.49
Multi-Family Residential	383	0.60	2,291	0.60	0.10	0.13	0.13	0.14	0.15	0.29	0.27
Orchard	0	0.10	0	0.10	0.18	0.17	0.67	1.00	1.00	0.59	0.11
Rural Residential	0	0.30	24,768	0.30	1.00	0.51	0.14	0.10	0.71	0.13	0.19
Single Family Residential	803	0.40	5,302	0.40	0.13	0.20	0.15	0.27	0.43	0.35	0.63
Transportation	420	0.90	5,141	0.90	0.11	0.26	0.12	0.53	0.31	0.62	0.12
Vacant / Open Space	1,675	0.10	49,056	0.10	0.16	0.10	0.10	0.12	0.10	0.10	0.10
Water	0	0.00	1,048	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	3,901	0.38	94,436	0.27	-	-	-	-	-	-	-
Relative Pollutant Concentration for ACP Tributary					0.12	0.19	0.13	0.31	0.31	0.45	0.31
Relative Pollutant Concentration for Reference Tributary					0.38	0.27	0.13	0.28	0.44	0.39	0.28
Watershed Management Area					San Diego Bay						
Hydrologic Unit					Otay (910.00)						
Land Use Factor					0.32	-	0.98	1.10	-	-	1.09

Problem Statement Table 1. Land Use Factor Calculations for Salt Creek

Task 2-3A: Impacted Condition NSMP Efficacy Factor (N_1)

The impacted condition of a stream rehabilitation NSMP corresponds with the existing, degraded conditions of the stream and surrounding land that will be improved by rehabilitation. As outlined in the example statement, this site currently contains some stream function and riparian vegetation. Therefore, the impacted condition does provide some level of pollutant removal currently and the efficacy factor (N_1) is calculated as follows.

The hydraulic analysis of the existing and proposed conditions was performed using the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center River Analysis System (HEC-RAS) Version 5.0.7 computer program, a one- and two-dimensional hydraulic numerical model. This HEC-RAS model required the computation of a hydrograph to simulate the DCV, which was completed the US Army Corps of Engineers Hydraulic Engineering Center Hydrology Modeling System (HEC-HMS) v4.3 software. The DCV hydrograph was run through the Salt Creek site to generate inundation area and depths over the course of the storm for existing terrain (Problem Statement Figure 2).

Retention

$N_{Retention} = C_R E_R = (C_{R\_Infiltration} + C_{R\_Evapotranspiration}) * E_R$

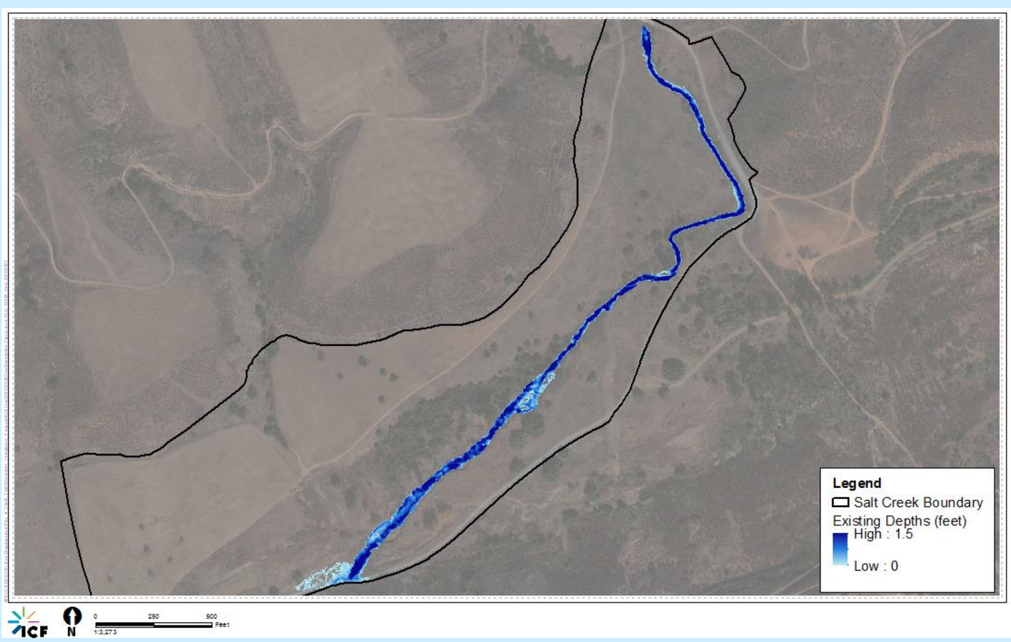
$C_{R\_Infiltration} = (A*K_{sat}*t*3630)/DCV$

$C_{R\_Evapotranspiration} = (A*ET*t*3630)/DCV$

C_R = (2.1 acres inundated) * [(0.38 in/hr infiltrated * 3-hr inundation duration * 3630 cf/acre-in) + (0.085 in/day evapotranspired * 3-hr evapotranspiration duration * 3630 cf/acre-in)] / (2,798,140 cf) = 0.0031

E_R = 1.0

N_R =0.004 * 1.0 = 0.0031



Problem Statement Figure 2. Existing Salt Creek hydraulic results.

Sediment

Although Salt Creek historically experienced erosion and currently has an incised channel, Salt Creek does not currently experience active erosion issues that would be analyzed in this section. Therefore, all values are zero.

S_1= 0

S_2 = 0

C_S = (0 – 0)/0 = 0

Vegetation

To determine provided capture by vegetation under existing conditions, the maximum inundation could be used to conservatively estimate the percent of DCV that is less than 1.5 feet. From the HEC-RAS modeling for Salt Creek, the maximum depth raster was generated and exported. In GIS, the volume of the raster that intersected with vegetation was computed to be 133,984 cubic-feet. Then the volume was re-calculated where cells could only have a maximum depth of 1.5 feet, resulting in a total treated volume of 118,027 cubic-feet. It was assumed that this maximum inundation (at the peak of the hydrograph) would be the moment where depths are deepest – therefore the rising and falling limbs of the hydrograph would have shallower results. The volume of depths less than 1.5 feet divided by the total volume for the maximum inundation was equal to 88%. Therefore, 88% of the DCV flowing through the site will experience filtration by vegetation. Existing conditions for Salt Creek were evaluated using CRAM, which generated a score of 68.

$N_{Vegetation}$ = C_V*E_V*Ecological Condition Factor

C_V = 0.88

E_V = 0.19

CRAM Score = 68

Ecological Condition Factor = 1.0

N_V = 0.88 * 0.19 * 1.0

N_V = 0.167

Task 2-3B: Mitigated Condition NSMP Efficacy Factor (N2)

Stream rehabilitation is a NSMP implemented to restore predevelopment watershed functions and provide direct management of stormwater pollutant control and hydromodification flow control. NSMPs may include structural/engineered elements, but these elements do not expressly provide stormwater pollutant control benefits. The mitigated condition NSMP efficacy factor (N_2) is based on the proposed site design and is calculated as follows.

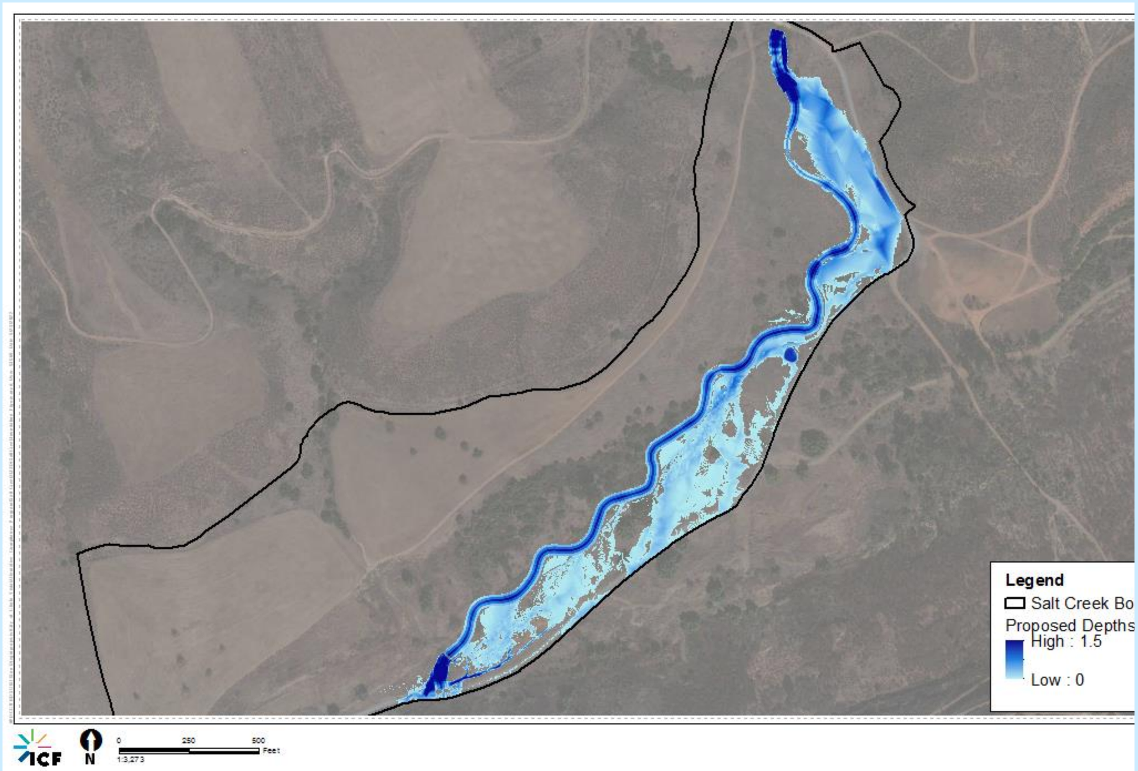
Retention

Salt Creek was re-modeled in HEC-RAS to generate inundation area and depths over the course of the storm for the proposed grading (Problem Statement Figure 3). The infiltration rate and evapotranspiration rate is unchanged from existing conditions.

C_R = (11.9 acres inundated) * [(0.38 in/hr infiltrated * 3-hr inundation duration * 3630 cf/acre-in) + (0.085 in/hr evapotranspired * 3630 cf/acre-in)] / (2,798,140 cf) = 0.018

E_R = 1.0

N_R = 0.018 * 1.0 = 0.018



Problem Statement Figure 3. Proposed Salt Creek hydraulic results.

Sediment

Although Salt Creek historically experienced erosion and currently has an incised channel, the proposed design for Salt Creek does not currently experience active erosion issues that would be analyzed in this section. Therefore, all values are zero.

$S_1 = 0$

$S_2 = 0$

$C_S = (0 - 0)/0 = 0$

Vegetation

The same process to determine provided capture above was completed for proposed conditions. The total volume was 183,395 cubic-feet, and the volume less than 1.5 feet was 173,606 cubic-feet. The ratio of these values was 95%.

$C_{V2} = 0.95$

$E_{V2} = 0.19$

Theoretical estimated CRAM Score = 83

Magnitude of Change = (83 – 68) / 7 = 2.14

Ecological Condition $Factor_2 = 2.14$

$N_{V2} = 0.95 * 0.19 * 2.14 = 0.385$

Task 2-4: Calculate Earned Stormwater Pollutant Control Volume (V_E)

The Earned Stormwater Pollutant Control Volume for an ACP is calculated by populating Equation 2-1 (RWQCB, 2018) with the appropriate volumes, land use factors, and NSMP efficacy factors determined per the guidelines set forth in the memo from ICF (2023). The Earned Stormwater Pollutant Control Volume for this ACP is calculated as:

$DCV = V_1 = V_2 = 2{,}798{,}140$ cf

$L = 0.32$

$\Delta V = 0$

$N_1 = 0.0031 + 0 + 0.167 = 0.170$

$N_2 = 0.018 + 0 + 0.385 = 0.403$

$V_E = 0.32*(0 + (2{,}798{,}140 \text{ cf} * 0.403) – (2{,}798{,}140 * 0.170)) = 211{,}304$ cf water quality pollution credits

Step 3: Determination of Stormwater Pollutant Control Credits

An overall water quality benefit for stormwater pollutant control can be demonstrated if the Earned Stormwater Pollutant Control Volume calculated in Step 2 is greater than or equal to the Deficit of Stormwater Pollutant Control Volume calculated in Step 1. Because this is an independent ACP, a volume has not yet been determined for Step 1. Therefore, the Earned Stormwater Pollutant Control Volume Credit of 211,304 cubic feet may be banked for potential future purchase by a PDP applicant with a Deficit of Stormwater Pollutant Control Volume of 211,304 cubic feet or less.

Part II: WQE for Hydromodification Flow Control

The project reach discharges to the Otay River, which is an exempt water body. Therefore, no hydromodification flow control credits will be generated by this project. Projects discharging to non-exempt systems should refer to Section 3 “Water Quality Equivalency Calculations For Hydromodification Flow Control” of the Regional WQE Guidance (2018) to calculate hydromodification credits.

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Appendices

Appendix A
Equation Calibration

Chesapeake Bay Report

Two groups of more than 25 experts worked to improve floodplain restoration project protocols for pollutant removal credits in the Chesapeake Bay Watershed (Altland et al., 2020). Stream restoration projects in this jurisdiction can qualify for credit by calculating denitrification in the hyporheic zone and the floodplain treatment volume. Our team used the methodology for calculating floodplain treatment volume to compare the generated credits to the results of the WQE equation for NSMPs.

This methodology was also used to calibrate County of San Diego Rainbow Creek Stream Restoration Tool, indicating its usefulness in locations beyond the East Coast. The flow duration curve for this exercise was created using a Storm Water Management Model (SWMM) for Salt Creek and its watershed (Appendix Figure 1) and the results were analyzed using the Federal Highway Administration's Hydraulic Toolbox (Appendix Table 1).

Chesapeake Bay Methodology

Determine Treatment depth in Floodplain Trapping Zone (FTZ)

Treatment depth = 0.5 ft (due to the incised condition of Salt Creek)

Identify the channel flow, floodplain flow at the treatment depth in the FTZ and mean baseflow

Baseflow = 5.7 cfs

Channel flow = 190 cfs (proposed conditions only, existing conditions are too incised)

Floodplain flow above 0.5 ft depth = 532 cfs (proposed conditions only, existing conditions are too incised)

Develop an appropriate flow duration curve

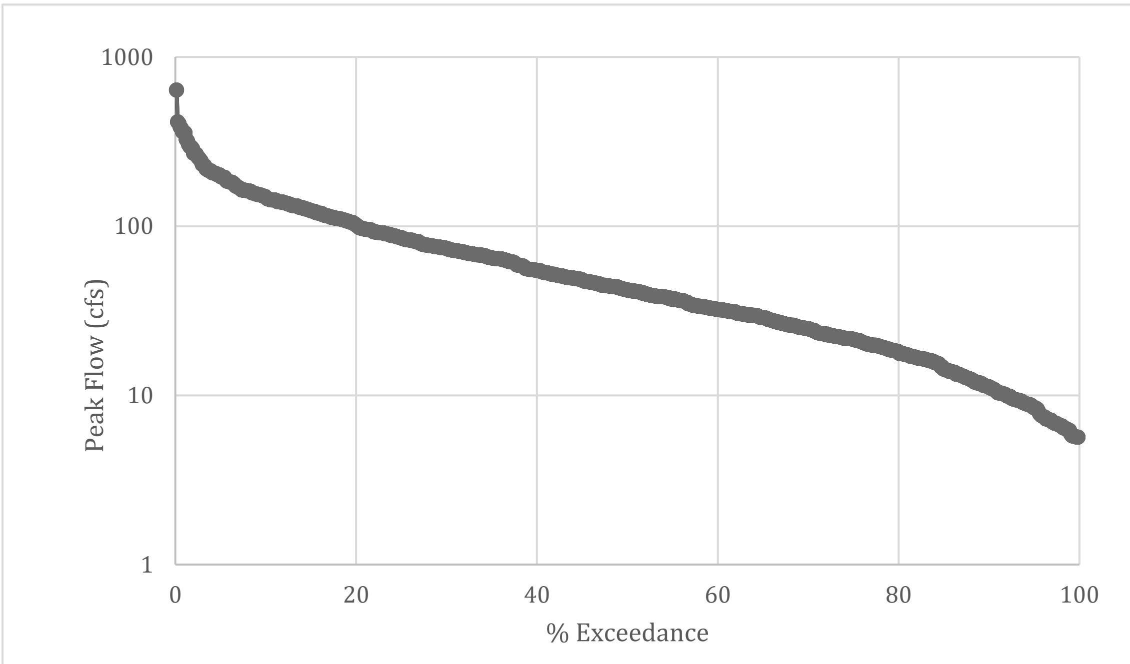
Treatable flow = (baseflow + area under the curve between Q_{1ft} and $Q_{channel}$) / total area under the curve above baseflow

Existing treatable flow = (5.7 cfs + 0) / 5713 cfs = 0.1%

Proposed treatable flow = (5.7 cfs + 860 cfs) / 4176 cfs = 20.7%

Appendix Table 1. Comparison of Flow Attributes for Existing to Proposed Conditions

Flow Attribute	Existing Conditions	Proposed Conditions
Total Flow (cfs)	638	638
Channel Flow (cfs)	0	190
Flow over 0.5 ft (cfs)	0	523
Baseflow (cfs)	5.7	5.7
Area under curve above baseflow	5713	4176
Treatable Flow (%)	0.1	20.7



Appendix Figure 1. Flow Duration Curve for Salt Creek

<u>Determine the treatable flow</u>

Percent of treatable flow = Proposed treatable flow – Existing treatable flow
= 20.7% - 0.1% = 20.6%

<u>Determine the load delivered to the project site</u>

Treatable pollutant load = Treatable flow * DCV * Pollutant concentration

TSS treatable load = 20.6% * 2,192,636 ft^3 * 639.08 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) * (1ton/2000lbs) = 9 tons

TP treatable load= 20.6% * 2,192,636 ft^3 * 0.84 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 23.7 lbs

TN treatable load= 20.6% * 2,192,636 ft^3 * 5.56 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 156.6 lbs

Apply the appropriate Wetland Pollutant Removal Efficiencies

Pollutant load reduction = Treatable pollutant load * Pollutant removal efficiency

Where removal efficiencies for: TSS = 19%, TP = 22%, TN = 16%

TSS removed = 9 tons * 19% = 1.7 tons

TP removed = 23.7 lbs * 22% = 5.2 lbs

TN removed = 156.6 lbs * 16% = 25.1 lbs

Comparison to WQE Methodology

Pollutant load reduction = Pollutant control volume (V_E) * Pollutant Concentration

When the Ecological Condition Factor for Salt Creek is equal to 1.0:

TSS treatable load = 67,933 ft^3 * 639.08 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) * (1ton/2000lbs) = 1.4 tons

TP treatable load= 76,202 ft^3 * 0.84 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 3.6 lbs

TN treatable load= 76,202 ft^3 * 5.56 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 23.7 lbs

When the Ecological Condition Factor for Salt Creek is equal to 2.2:

TSS treatable load = 546,804 ft^3 * 639.08 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) * (1ton/2000lbs) = 4.5 tons

TP treatable load= 546,804 ft^3 * 0.84 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 11.9 lbs

TN treatable load= 546,804 ft^3 * 5.56 mg/L * (1L/0.035ft^3) * (2.2*10^{-6}mg/1lb) = 78.9 lbs

Appendix Table 2. Pollutant Load Removal Comparison Between WQE and Chesapeake Methodologies

	Pollutant Load Reduction		
	Chesapeake Methodology	**WQE Methodology (ECF = 1.0)**	**WQE Methodology (ECF = 2.2)**
TSS Removed (tons)	1.7	1.5	4.5
TP Removed (lbs)	5.2	4.0	11.9
TN Removed (lbs)	25.1	26.4	78.9

Appendix B
Vegetation Pollutant Removal Efficiencies

When developing the pollutant removal efficiency for vegetation in the NSMP WQE equation, many sources were consulted to determine realistic removal rates. Appendix Table 3 illustrates the range of values that are presented in the literature for a variety of rehabilitation methods and pollutant types. There is a high variability in reported pollutant removal efficacies, with 51%-85% variation in reported efficacy for the different pollutants. Evidently the pollutant removal efficiency of a natural system is difficult to set consistently across projects that have varying designs, watershed sizes, pollutant types, and vegetation cover. Therefore, this memorandum instead used the standard values of pollutant removal for BMPs to be comparable to approved methodology.

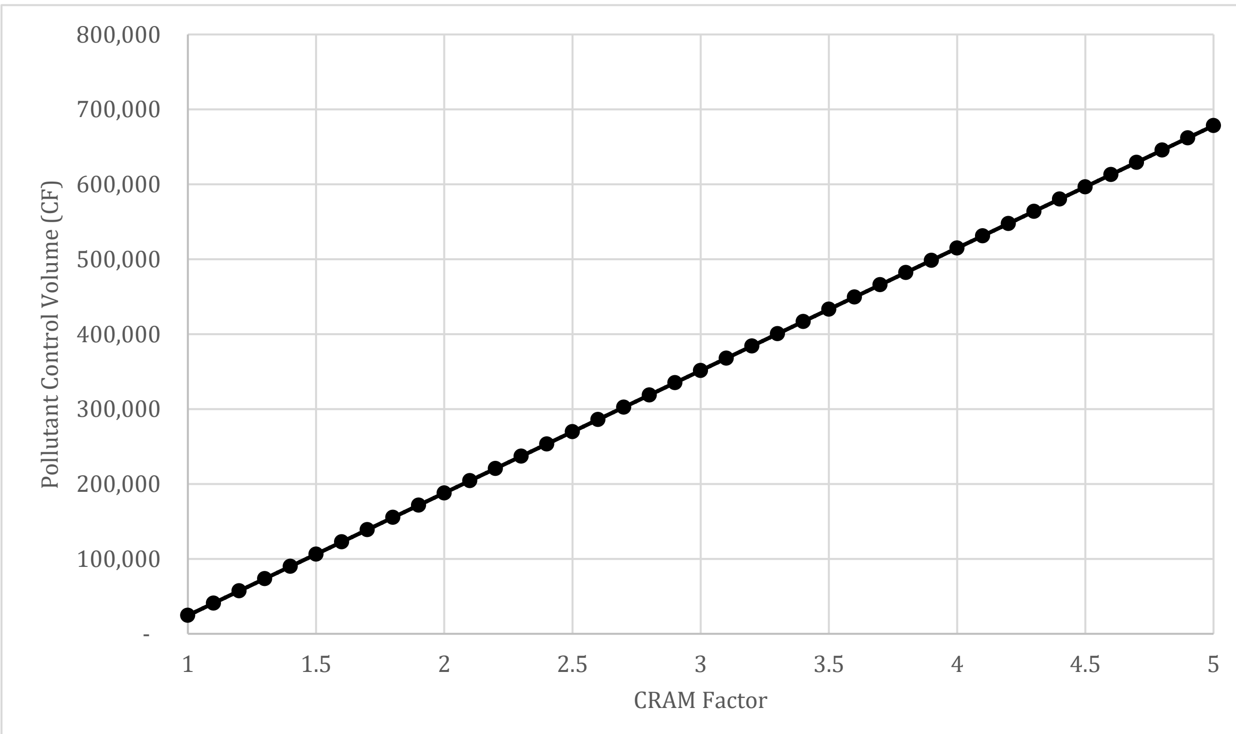
Appendix Table 3. Pollutant Removal Efficiencies from Literature Review.

		Removal Rate (%) per Pollutant Type		
Source	**Restoration Type**	**TN**	**TP**	**TSS**
Berg et al. (2013)	Stream Restoration	42	43	83
Altland et al. (2020)	Stream Restoration	71	71	71
Jordan et al. (2009)	Forest Buffer	45	42	53
Hawes & Smith (2005)	Forest Buffer	61	53	80
Fennessy and Cronk (1997)	Forest Buffer	70	-	-
Xu et al. (1992)	Forest Buffer	100	-	-
Shisler et al. (1987)	Forest Buffer	89	80	-
Jordan et al. (2009)	Grass Buffer	32	40	53
Neibling & Alberts (1979)	Grass Buffer	-	-	91
Borin & Bigon (2002)	Grass Buffer	81	-	-
Dillaha et al. (1989)	Grass Buffer	79	73	84
Dillaha et al. (1989)	Grass Buffer	61	54	70
Ghaffarzadeh et al. (1992)	Grass Buffer	-	-	85
Jordan et al. (2009)	Wetland	15	29	15
CCWG (2020)	Wetland	88	89	85
Ludwig (2010)	Wetland	29	23	71
Cooper (1994)	Wetland	66	-	-
Cooper (1990)	Wetland	93	-	-
Overall Minimum			**15**	
Overall Maximum			**100**	

Appendix C
Sensitivity Analysis for the Ecological Condition Factor

To understand the influence of the Ecological Condition Factor on the overall WQE, a sensitivity analysis was conducted for the Salt Creek case study. While keeping all other values the same, the equation was calculated for a large range of Ecological Condition Factor values, starting at 1 and increasing by 0.1 to a maximum value of 5.

For every 0.1 point added to the Ecological Condition Factor for Salt Creek, the resulting pollutant credit volume increases by approximately 16,344 cubic-feet (Appendix Figure 2).

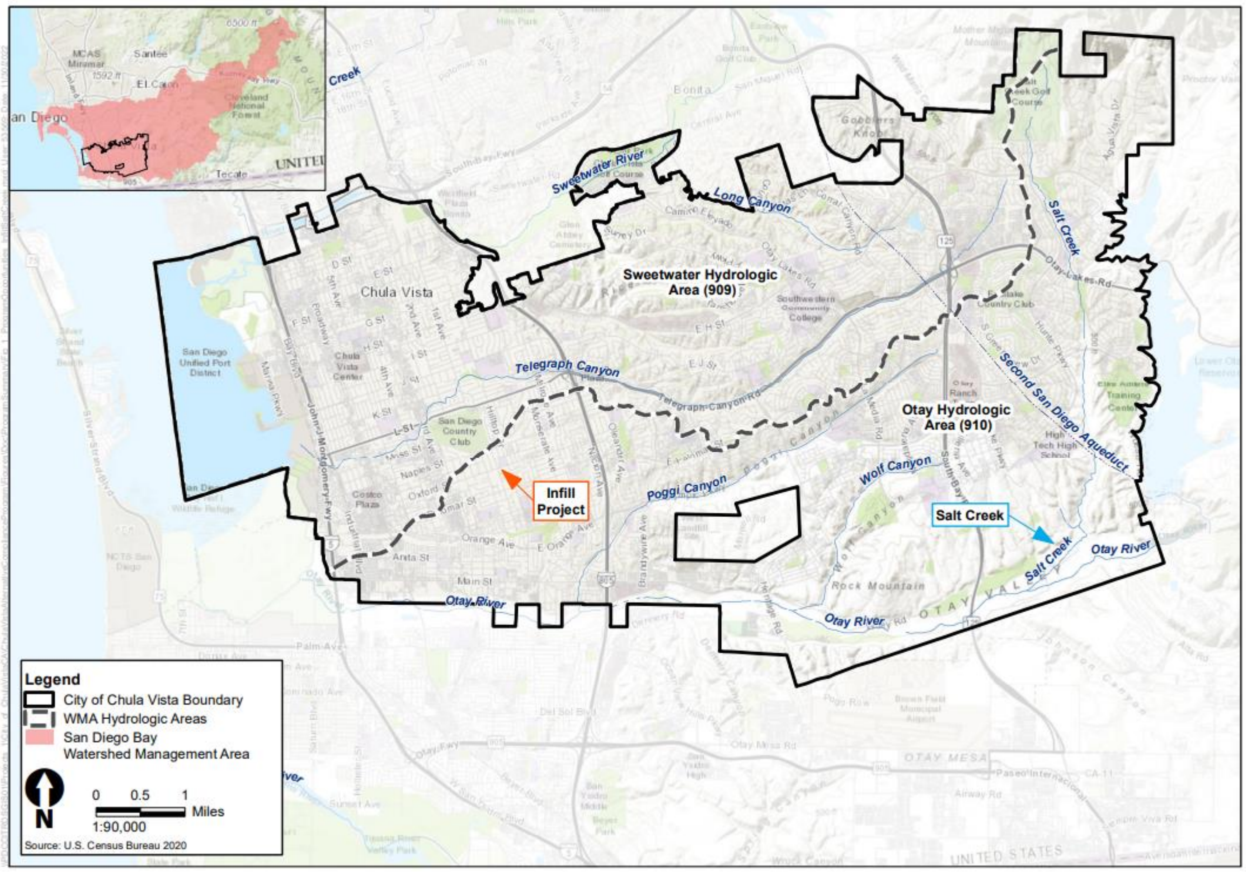


Appendix Figure 2. Change in credit volume for Salt Creek depending on Ecological Condition factor used.

Appendix D
Case Studies

Overview

The pollutant credit volumes and costs of two case studies were calculated and compared using the NSMP and BMP equations. Based on existing and opportune locations within the City of Chula Vista, one NSMP (Salt Creek) and one structural BMP (Infill Project) were selected for comparison (Appendix Figure 3). These case studies were selected due to the availability of design data and cost information, familiarity to the authors, and the range of existing conditions and design intents provided by each location.



Appendix Figure 3. Case study locations within the City of Chula Vista

Each case study covers:

- Background information on the project
- Calculations for existing and proposed conditions with net credit volume
- Cost assessment for all components of each project

The cost assessment breaks down the various components of a project, as shown in Appendix Table 4.

Appendix Table 4. Overview of costs considered in the exercise for BMPs and NSMPs

Onsite (Structural BMP)	Offsite (NSMP)
Capital Cost	**Capital Cost**
Project Management	Project Management
Design & Evaluation	Design & Evaluation
Construction	Construction
Permits	Permits
Success Period	**Success Period**
-	Annual Monitoring
-	Annual Maintenance
Long-Term Maintenance	**Long-Term Maintenance**
Annual Monitoring	Annual Monitoring
Annual Maintenance	Annual Maintenance
Recurring Significant Maintenance (5yrs)	-
Monitoring Present Value	Monitoring Present Value
Maintenance Present Value	Maintenance Present Value
Structural BMP Replacement – Present Value	-
Recurring Large Maintenance (5yrs) – Present Value	-
Discount factor = 2%	Discount factor = 2%
Land	**Land**
Opportunity Cost ($2 million per acre)	Onsite Flow-Thru
Assumed that land is used for housing	-
City Admin	**City Admin**
Plan Review / Certification	Plan Review / Certification
Recertification Inspections	Recertification Inspections

Project management costs including reporting, meetings, stakeholder coordination, administration support, and general project tracking.

The cost for design includes earthwork and landscape engineering from concept to 100 percent, approvals, inspections, and similar components. It is estimated to be 10 percent of hard (construction) costs.

Construction covers labor, grading, and materials. For NSMPs this may include site prep, rough and finish grading, surveying, trails and access roads, cleanup, planting, and irrigation. For BMPs this cost would also include storm drain materials, media layers, liners, and other miscellaneous components.

The success period includes the costs associated with the first 5 years of monitoring and maintenance for NSMPs, which are typically higher than the annual long-term maintenance and monitoring costs and thus are accounted for separately.

Long-term monitoring includes annual assessments of the state of the NSMP to ensure that it remains a natural system and has not suffered any major natural or anthropogenic event that removes or reduces its function, or incurred any minor damage that would affect the condition and function of the NSMP. Long-term maintenance costs include annual maintenance, along with recurring large maintenance (5 years), significant maintenance and end-of-life replacement present value for structural BMPs.

Land acquisition is not included under the assumption that future projects in this program will be implemented on City-owned lands. NSMPs may be located on privately owned lands that are placed under a conservation easement or similar perpetual site protection mechanism.

Permit costs vary. NSMPs include CEQA coordination, biological resources, cultural resources, regulatory permitting, jurisdictional delineation, surveys, and environmental site assessments. BMPs include regulatory permitting, plan check, and inspect. This is assumed to be 4 percent of hard (construction) costs.

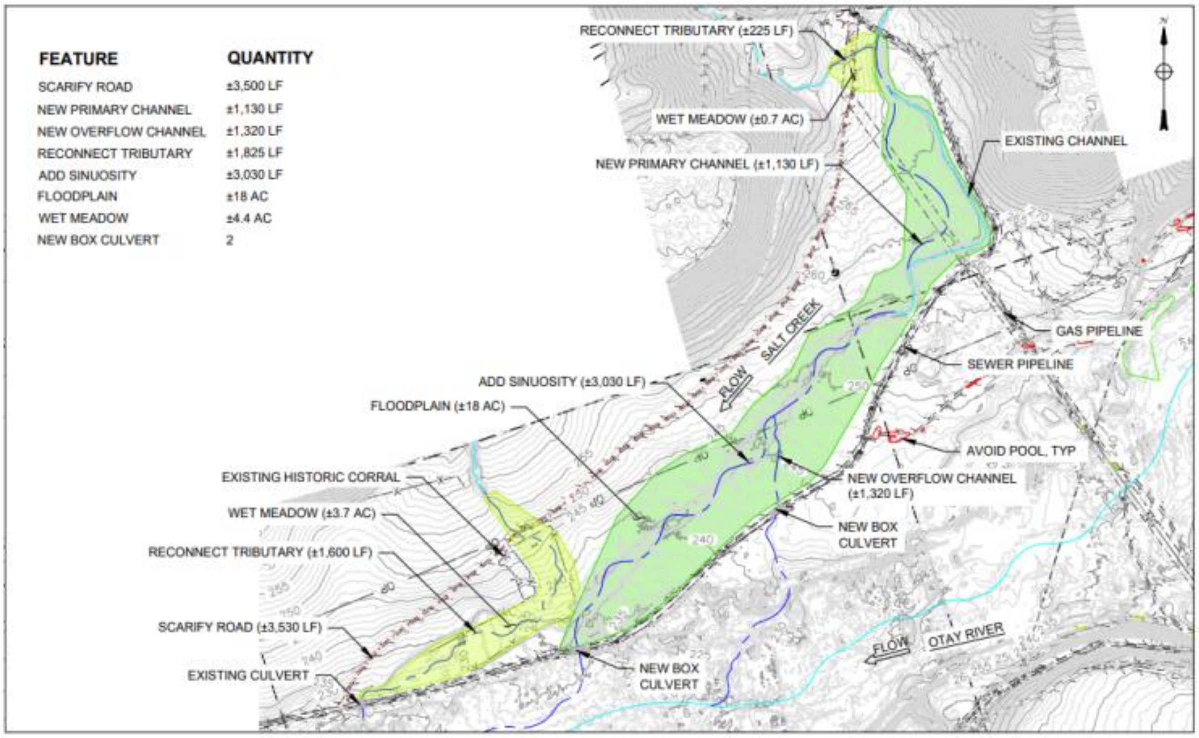
Salt Creek

Background

Salt Creek originates in National Wildlife Refuge land near San Miguel Mountain and flows into the northeast section of the Otay Mitigation Bank (Bank) (ICF, 2021). It is one of the primary tributary creeks of the Bank and may be implemented as a future phase of restoration work in the area (Appendix Figure 4). At this time Salt Creek is heavily incised and contained within a historically rerouted channel rather than the historical alluvial confluence.

The basic concept for this phase includes reestablishing the historical braided channel network and broad confluence connection with the Otay River Mainstem. In-stream structures and an increase in base elevations would help re-engage the currently cutoff floodplain and encourage breakout onto the valley floor. In addition, the channel banks would be set back and sinuosity would be added to the mainstem creek channel. Removal of non-native/invasive species in the creek would occur and the area would be revegetated with appropriate native riparian and floodplain species.

Salt Creek provides an example of how design intent can have a significant impact on the volume of credits generated by a project. For example, a larger provided capture volume for retention and vegetation filtration can be achieved by increasing the inundated area through design. Raising an incised channel, reconnecting the floodplain, or adding benches may all increase amount of treatable flow during the 85^{th} percentile, 24-hour storm event. These design elements can also have a positive impact on the Ecological Condition Factor due to attributes like topographic complexity, hydrologic connectivity, and channel stability in the CRAM score. The planting plan for a restored channel may also be curated to increase the CRAM score for biotic structure, including number of plant layers, co-dominant species, percent of native fauna, and buffer width.



Appendix Figure 4. Concept design for Salt Creek

Credit Calculations

Design Capture Volume

d = 0.52 in

A = 3901 acres

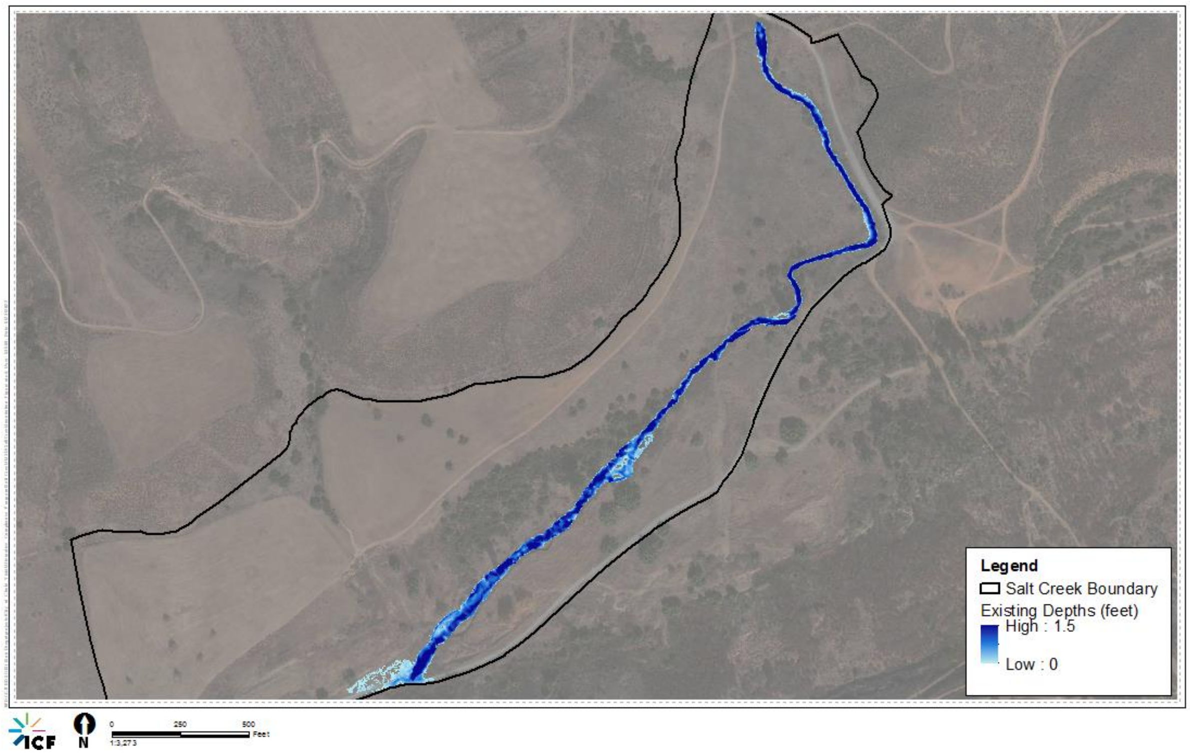
C = 0.38

V_1 = Runoff Coefficient x Rainfall Depth x Tributary Area

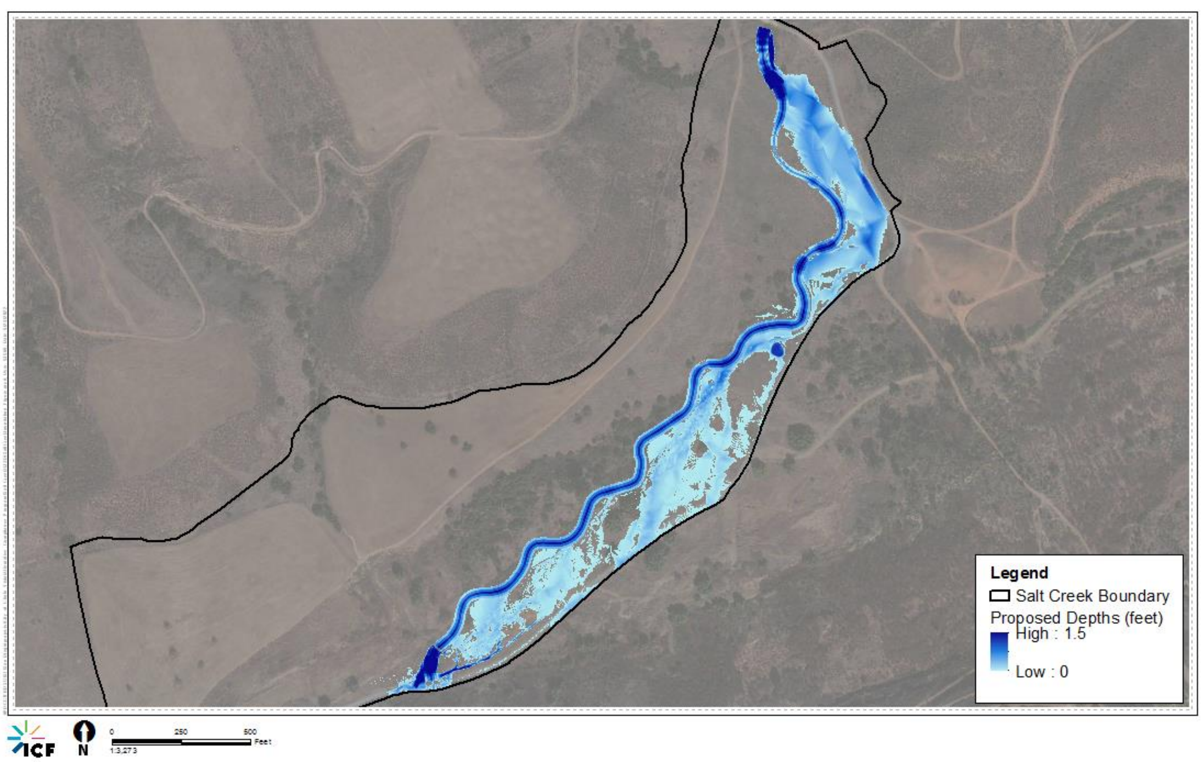
$V_1 = 0.38 \times 0.52 \text{ in} \times 3{,}901 \text{ ac} \times (43{,}560 \text{ ft}^2 / 1 \text{ ac}) \times (1 \text{ foot}/12 \text{ in}) = 2{,}798{,}140$ cubic feet

Modeling performed for the case study

The hydraulic analysis of the existing and proposed conditions was performed using the U.S. Army Corps of Engineer's Hydrologic Engineering Center River Analysis System (HEC-RAS) Version 5.0.7 computer program, a one- and two-dimensional hydraulic numerical model. This HEC-RAS model required the computation of a hydrograph to simulate the DCV, which was completed the US Army Corps of Engineers Hydraulic Engineering Center Hydrology Modeling System (HEC-HMS) v4.3 software. The DCV hydrograph was run through the Salt Creek site to generate inundation area and depths over the course of the storm for existing terrain and proposed grading.



Appendix Figure 5. Existing Salt Creek hydraulic results.



Appendix Figure 6. Proposed Salt Creek hydraulic results.

Retention

Existing Conditions

C_R = (2.1 acres inundated) * [(0.38 in/hr infiltrated * 3-hr inundation duration * 3630 cf/acre-in) + (0.085 in/day evapotranspired * 3-hr evapotranspiration duration * 3630 cf/acre-in)] / (2,798,140 cf) = 0.0031

E_R = 1.0

N_R = 0.0031 * 1.0 = 0.0031

Proposed Conditions

C_R = (11.9 acres inundated) * [(0.38 in/hr infiltrated * 3-hr inundation duration * 3630 cf/acre-in) + (0.085 in/hr evapotranspired * 3630 cf/acre-in)] / (2,798,140 cf) = 0.018

E_R = 1.0

N_R = 0.018 * 1.0 = 0.018

Sediment

Although Salt Creek historically experienced erosion and currently has an incised channel, Salt Creek does not currently experience active erosion issues that would be analyzed in this section. Therefore, all values are zero.

S_1= 0

S_2 = 0

C_S = (0 – 0)/0 = 0

Vegetation

Existing Conditions

To determine provided capture by vegetation under existing conditions, the maximum inundation could be used to conservatively estimate the percent of DCV that is less than 1.5 feet. From the HEC-RAS modeling for Salt Creek, the maximum depth raster was generated and exported. In GIS, the volume of the raster that intersected with vegetation was computed to be 133,984 cubic-feet. Then the volume was re-calculated where cells could only have a maximum depth of 1.5 feet, resulting in a total treated volume of 118,027 cubic-feet. It was assumed that this maximum inundation (at the peak of the hydrograph) would be the moment where depths are deepest – therefore the rising and falling limbs of the hydrograph would have shallower results. The volume of depths less than 1.5 feet divided by the total volume for the maximum inundation was equal to 88%. Therefore, 88% of the DCV flowing through the site will experience filtration by vegetation.

C_{V1} = 0.88

E_{V1} = 0.19

CRAM Score = 68

Ecological Condition $Factor_1$ = 1.0

N_{V1} = 0.88 * 0.19 * 1.0 = 0.167

<u>Proposed Conditions</u>

The same process to determine provided capture above was completed for proposed conditions. The total volume was 183,395 cubic-feet, and the volume less than 1.5 feet was 173,606 cubic-feet. The ratio of these values was 95%.

C_{V2} = 0.95

E_{V2} = 0.19

Theoretical estimated CRAM Score = 83

Magnitude of Change = (83 – 68) / 7 = 2.14

Ecological Condition $Factor_2$ = 2.14

N_{V2} = 0.95 * 0.19 * 2.14 = 0.385

Net Credit Volume

DCV = V_1 = V_2 = 2,798,140 cf

L = 0.32

ΔV = 0

N_1 = 0.0031 + 0 + 0.167 = 0.170

N_2 = 0.018 + 0 + 0.385 = 0.403

V_E = 0.32*(0 + (2,798,140 cf * 0.403) – (2,798,140 * 0.170)) = 211,304 cf water quality pollution credits

Cost Assessment

The total cost estimated for stream restoration in Salt Creek was $8,452,000 (Appendix Table 5). Note the inclusion of costs for a Flow-Thru BMP, as the construction of this treatment structure would be required on-site in addition to the offsite NSMP. Capital costs makes up the largest cost in this estimate, such that the total cost per cubic-foot treated is $40/cf.

Appendix Table 5. Estimated summary of costs associated with Salt Creek

Capital Costs	
Project Management	$98,100
Design	$196,200
Construction	$2,157,950
Permits	$98,100
City Admin	$102,500
Flow-Thru BMP	$1,549,150
Sub Total	$4,202,000
Success Period (Total cost for 5 years)	
Monitoring	$500,000
Maintenance	$250,000
Sub total	$750,000
Long-Term Maintenance and Monitoring	
*Annual Long-Term Monitoring**	*$50,000*
*Annual Long-Term Maintenance**	*$20,000*
Long-Term Monitoring Present Value	$2,500,000
Long-Term Maintenance Present Value	$1,000,000
Sub total	$3,500,000
TOTAL†	$8,452,000
Cost per cubic-foot treated	$40/cf

*Not included in total but used to calculate present value with 2% discount factor
†This total is based on 2020 estimates. Reassess every 5-10 years to update costs.

Infill Project

Background

This project was selected so that a typical infill project could be evaluated, and the cost for standard, on-site water quality treatment could be compared to the cost to generate stream restoration credits for water quality offset. The project area is approximately seven acres and discharges to the San Diego Bay via a conveyance channel whose bed and bank are concrete lined all the way from the point of discharge to the Pacific Ocean. It is therefore exempt from hydromodification requirements per the Regional MS4 Permit (Order No. R9-2013-0001, as amended, California Regional Water Quality Control Board, 2015). The DCV for the project site was calculated to be 10,827 cf and based on project constraints the current design proposes on-site vaulted proprietary compact biofiltration basins. Land use was calculated using Sweetwater Sub-Watershed as the reference tributary.

Credit Calculations

$DCV = V_1 = V_2 = 10{,}827$ CF

$L = 0.53$ (lowest factor for TP as the pollutant of concern in Sweetwater sub-watershed)

$\Delta V = 0$

$B_1 = 0$ (assumes no water quality benefit in the impacted condition)

$E_2 = 0.67$

$C_2 = 1.5$

$B_2 = 0.67 * 1.5 = 1.0$

$V_E = 0.53*(0 + (10{,}827 \text{ CF} * 1.0) - (10{,}827 \text{ CF} * 0)) = 5{,}753$ CF water quality pollution credits

Cost Assessment

The total cost estimated for the Infill Project was $1,946,540 (Appendix Table 6). This case study has the smallest project area and lowest total cost. The present value of BMP replacement makes up more than half of the total cost, such that the cost per cubic-foot treated is $338/cf.

Appendix Table 6. Summary of costs associated with the Infill Project

Capital Costs	
Project Management	$28,270
Design	$56,540
Construction	$282,690
Permits	$14,130
City Admin	$19,500
Sub Total	$401,130
Long-Term Maintenance and Monitoring	
Monitoring Present Value	$56,540
Maintenance Present Value	$282,690
Significant Maintenance PV (~5 years)	$156,050
BMP Replacement PV (~20 years)	$1,050,140
Sub total	$1,545,420
Opportunity Cost	N/A
TOTAL	$1,946,550
Cost per cubic-foot treated	$338/cf

Appendix E
Credit and Cost Comparison

Credits

The volume of pollutant credits generated varies widely across sites due to DCV, existing conditions, and design intent (Appendix Table 7). Salt Creek generated the most pollutant credits with 211,304 cf while the Infill Project generated just 5,753 cf. The number of impervious acres treated followed the same trend, ranging from 124 to 3 acres.

Appendix Table 7. Comparison of credit volumes generated by each case study

Case Study	Salt Creek	Infill Project
Pollutant Credits (cf)	211,304	5,753
Impervious Acres Treated	124	3

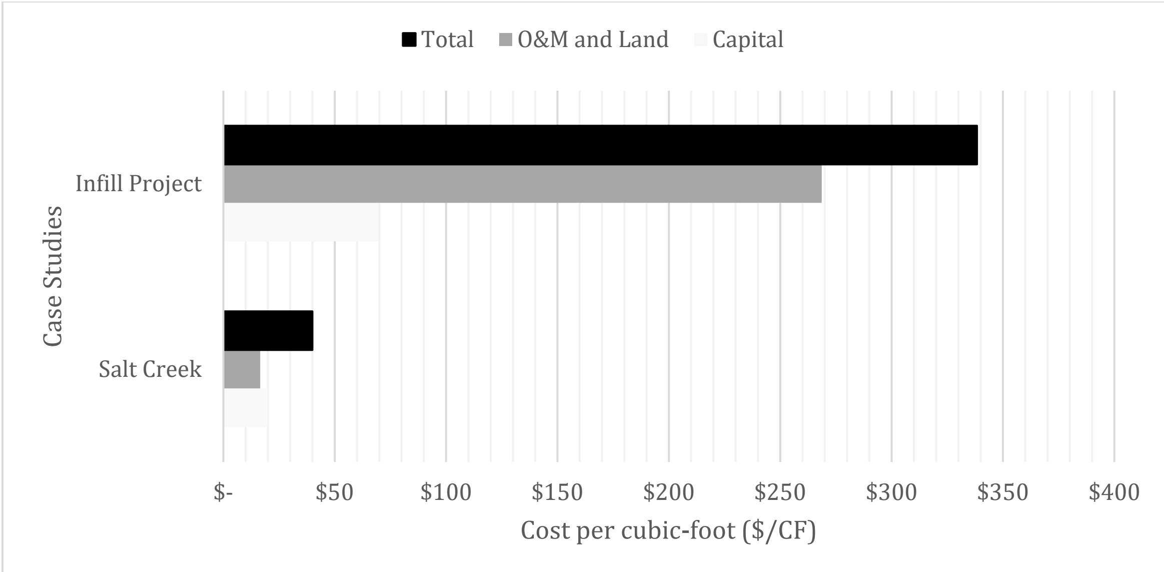
Costs

As illustrated in their respective sections, the costs associated with each case study were highly variable (Appendix Table 8). Maintenance, monitoring, and land costs made up the largest percentage of the total cost for the Infill Project, while capital costs were the largest percentage for Salt Creek. Salt Creek had the lowest total cost per cubic-feet treated at $40/cf, while the Infill Project had the highest total cost at $338/cf.

Appendix Table 8. Comparison of costs associated with each case study

Case Study	Salt Creek	Infill Project
Capital cost per cf treated	$19.90	$70
Success period cost per cf treated	$3.50	$0
Long-term monitoring and maintenance cost per cf treated	$16.60	$269
Total cost per cf treated	$40	$338

Another breakdown of the cost categories is illustrated in Appendix Figure 7. Note that the cost per cf is not directly related to site size, as the proposed Salt Creek floodplain encompasses 23 acres and has a lower cost per cf than the Infill Project, which encompasses just 7 acres.



Appendix Figure 7. Chart comparison of costs associated with each case study

The values presented here are the overall long term costs for comparison with the BMPs. However, the actual costs to fund an ACP project would include capital cost, success period, and endowment that would support the annual maintenance and monitoring. The estimated endowment is approximately $4.3 million for the Salt Creek case study, based on the annual long-term monitoring and maintenance and assuming a cap rate of 3.5%.

To provide a broader picture of costs for NSMPs and BMPs, we analyzed three other case sites to compare a variety of designs and locations (Appendix Table 9).

Appendix Table 9. Comparison of costs associated with additional case studies

Case Study	Regional Mitigation Bank*	Salt Creek	Stormwater Channel Retrofit	Water Quality Basin	Infill Project
Capital cost per cf treated	$12	$19.9	$5	$12	$70
Success period cost per cf treated	$2	$3.5	$0	$0	$0
Monitoring, maintenance, and land cost per cf treated	$10	$16.6	$5	$67	$268
Total cost per cf treated	$24	$40	$10	$79	$338

*Note that the restoration design and associated costs for this site were focused on habitat credits rather than water quality credits.

Conclusions

The ACP program supports watershed and regional level goals beyond what can be achieved through onsite compliance by improving the water quality of a larger quantity of water than onsite treatment, improving local resiliency to climate change, and facilitating implementation of watershed-scale natural system solutions that improve watershed functions, amongst other watershed-level benefits. The case studies evaluated in this memorandum show that NSMP projects can provide a greater cost benefit than BMP projects, when designed to maximize water quality and habitat benefits. The final comparison below illustrates the disparity between these two case studies with respect to cost, credit volume, and project area required to meet crediting needs.

If a traditional BMP cost $1 million, what would ACP project with a 25% discount provide?

<u>$1 million standard BMP</u> (Based on Example Infill Project) ~2,955 cf of treatment	vs	25% discount <u>$750,000 Stream Rehabilitation</u> (Based on Salt Creek) ~18,750 cf of treatment

How much area is needed to treat 50,000 gallons (~6,700 cf)?

<u>Standard BMP</u> (Based on Example Infill Project) 26.8 acres	vs	<u>Stream Restoration</u> (Based on Salt Creek) 0.73 acres

The following conclusions were determined during this exercise:

- The NSMP equation is based on BMP methodology but accounts for water treatment processes and benefits provided by natural systems.
- The calculated pollutant control volume for a NSMP is highly dependent on design intent but can match or exceed BMP volumes.
- The NSMP case study was a cheaper alternative on a per cubic-feet of treatment, per project acre, and per impervious acre basis.

Appendix D

Priority Development Project Credit Usage Worksheet

PDP Credit Usage Worksheet			
1	85th percentile 24-hr storm depth from Figure B.1-1	d =	inches
2	Area tributary to BMP(s)	A =	acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C =	unitless
4	Tree well volume Note: In the SWQMP list the number of trees, size of each tree, amount of soil volume installed for each tree, contributing area to each tree and the inlet opening dimension for each tree.	TCV =	cubic-feet
5	Rain barrels Credit volume Note: In the SWQMP list the number of rain barrels, size of each rain barrel and the use of the captured storm water runoff.	RCV =	cubic-feet
6	Calculate DCV = (3630 x C x d x A) - TCV - RCV	DCV =	cubic-feet
7	Proposed ACP Credit Purchase	CP =	cubic-feet
8	Is Line 7 >= Line 6? If yes, then credit requirement is met. If no, purchase more ACP credits	Yes	

Note: Lines 1-6 are calculated using the design capture volume methodology outlined in the WQE Guidance Manual (section 2.3.1.1)