Rapid Permit Checklist for Streams and Floodplains

A User's Guide

Technical Assistance Document

San Francisco Bay Regional Water Quality Control Board

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Background

The rapid permit checklist for stream channels and floodplains (checklist) represents a multi-year effort involving a diversity of agency scientists to produce project planning guidance for a wide range of stream and floodplain projects. The checklist and this description to guide its use are being integrated into the San Francisco Bay and North Coast Regional Water Quality Control Boards' (Water Board) Stream and Wetland Systems Protection Policy Basin Plans amendments.[1] The Stream and Wetland Systems Protection Policy Basin Plans amendments and the checklist will be peer reviewed. Permit applicants are encouraged, but not required, to use the checklist. Its purpose is to help increase clarity and predictability for the applicant on the information the Water Board staff considers adequate to meet the standards for a complete application/report of waste discharge under the Porter-Cologne Water Quality Control Act or an application for Clean Water Act Section 401 water quality certification. The checklist is currently in use by staff in a number of regulatory agencies and has been featured in stream protection training workshops in many regions in the state. User feedback has increased its utility and the Water Board will post updated and improved versions as they become available. The San Francisco Bay Water Board posts the checklist in two locations online.[2]

The checklist can be applied to small projects on creeks located in back yards and to larger river projects. The level of detail required to evaluate the watershed influences on a project site and develop strategies to avoid environmental impacts is obviously going to increase with the complexity and scale of a project. For cases in which the landscape is composed of inherently unstable features such as active landslides and or alluvial fans, detailed geotechnical reports may be needed in order to have the details necessary to identify the features and avoid impacts. Projects with complex hydrology and hydraulics involving the interactions of wetlands, stream channels, floodplains, and/or tides may need the latest generation of sophisticated hydraulic models. Projects supported by government grants to restore critical habitats may need detailed habitat assessments to correctly identify limiting factors for different life stages of the species being assisted. The checklist is organized listing first the most simple and easy inexpensive methods of data collection and assessment and ending with the more complicated and technical methods of data collection and evaluation.

The parameters contained in the checklist directly address the Water Board's goals for encouraging geomorphic dynamic equilibrium, protecting the dynamism of fluctuating stream systems, the protection of drainage networks, avoidance and correction of hydraulic constrictions, avoiding and addressing gullies and headcuts, and protection of floodplains and riparian functions and processes.

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[1] Still under development as of September 2009. More information available at: http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/streamandwetlands.shtml.

[2] http://www.swrcb.ca.gov/sanfranciscobay/water_issues/programs/stream_and_wetland_protection.shtml http://www.waterboards.ca.gov/sanfranciscobay/certs.shtml

The planning strategy employed through the checklist guides the permit applicant through a thought process which first involves evaluating watershed processes which are affecting a project site. These watershed influences, as well as the influences acting on a smaller more localized reach level where a project may be located, identify important factors which may be the causes of environmental degradation or good habitat conditions. The assessments support diagnostic work which determines **why** a project reach may have excessive erosion or deposition or other degraded conditions and **why** it may be vulnerable to new conditions imposed on the site. Using a medical analogy, we cannot successfully prescribe remedies for avoiding and reversing degraded or "unhealthy" conditions without a good diagnosis of what is causing them.

We also cannot devise a management strategy or restoration plan without having knowledge about a wide range of variables including hydrology, channel sediment sizes and loads, valley and channel slopes, soils and geology making up the stream and floodplain system and the degree to which vegetation affects the dynamics of the stream. For example, we are not going to know how to best return stability to an excessively eroding channel using a proposed grade control structure if we don't know whether a channel bed may already be controlled from future adjustments by bedrock or other naturally occurring slope adjustments which have already returned the channel to a "graded" condition (i.e., the slopes have stopped incising). We may not be able to successfully design a stream bank restoration project without the knowledge that there is a dam upstream catching significant portions of the sediment supply and the site we are working on is thereby sediment limited and prone to erosion. Encouraging the trapping of sediment in a channel "roughened" with vegetation may be the best strategy for stabilizing banks in sediment limited reaches. Finally, a stream may look "pretty" to an observer but an assessment of limiting factors on why the stream is not providing habitat may tell us that the stream needs more bank erosion, fallen trees, and channel complexity to support the aquatic organisms. Section IB asks for the permit applicant to summarize the causes of the stream instabilities or habitat degradation.

Summary of the Rapid Permit Assessment Checklist for Streams and Floodplains.

Section I. Watershed and Reach Influences

A. Watershed Influences
B. Reach Influences
This first portion of the checklist asks the permit applicant to consider where they are located in the watershed because watershed location provides the first clue to considering management strategies. Headwater streams generally support steeper step-pool channel types which require different management and restoration strategies than low gradient streams located in the lower reaches of a watershed.

Upper watershed areas are often characterized by steeper, more unstable hillslopes which perform an important function for the delivery of materials to a stream system. Because this function is important to downstream channel stability it may be important to know that we need to protect but not "stabilize" these dynamic areas. The middle portions generally function to transport these sediment supplies while the lower portions are generally where the stream constructs the widest floodplains and delta areas and sediment storage becomes a more dominant function. The supply reaches, common to upper watershed areas, are characterized by swales, straight bedrock, cascade or step- pool channel types which collect the materials weathering from the steeper slopes and use numerous channels to transport the materials downstream. These areas tend to be the most resilient to changes in sediment supply or discharge because they tend to be sediment "supply limited" (unless there was a recent landslide or other disturbance) and additional inputs of sediment have minor effects on channel form. Large size boulders, rocks and cobbles and or bedrock add to their stability. The transfer zones typical to the middle portions of the watershed accept sediment being moved from tributaries to the main channel and store sediment in the floodplains. These areas are typified by channels which are meandering, braided, pool- riffle and dune-ripple channel types which store, sort, and move sediment through its meandering and depositional bed forms. Often classified as "transport limited" these channels are more responsive in changing their planforms and slopes to changes in sediment and discharges and land use disturbances. The depositional zones at the bottom of the watershed systems where sediment is deposited in deltas, or fans at the confluences of larger rivers, can be very dynamic, unstable environments with multiple channels. While this is very basic information, the number of permit applicants who are unaware of the context for their site is surprisingly high. This information can inform the permit applicant on whether efficient sediment transport, sediment storage, or both are of concern.

Likewise, land uses located above the project site have significant management implications for a site, such as whether to expect increasing sediment loads from logging, increased runoff rates and peaks from urban development, or change in sediment sizes or loads entering a reach because of upstream mining or quarries or sediment catchment basins.

Natural influences occurring on either or both a watershed and reach level such as fire will affect the "flashiness" of the hydrology, and landslides may be relocating channels and changing their lengths and slopes. Natural lakes or sea levels may be controlling the slopes of channels. Loss of vegetation may be a primary control over changes occurring in the shape or meander of a channel. Past beaver occupation may have created flatter slopes and meadows, or the return of beaver may be recreating back channels and other channel complexity. Influences on a reach scale such as human caused (anthropogenic) channel straightening, or culvert placement, may be the source of instabilities and some reasonable strategies to address the problems may be to restore a more stable slope to the stream and or remove or replace the culvert. Changes to stream processes and conditions may be most attributable to reach land use activities such as row crops, livestock access to channels, or trails or road crossings.

Dominant stream processes such as excessive erosion or deposition need to be identified and it should be determined whether a stream may be in the process of getting deeper, wider, or both. These adjustments may need to complete themselves through natural processes before a sustainable stream planform is achievable.

C. Status of Channel Evolution

Channels tend to adjust in predictable ways to certain modifications of the watershed such as the addition of culverts, reservoirs, check dams, and removal of meanders, etc. and river scientists have described simple watershed or stream “models” which record how the stream channels adjust over time to these changes. In many cases we avoid doing more harm than good by knowing that the channel has probably completed an adjustment process and is re-stabilized so it makes the most sense to not modify it any further. The checklist includes some of the channel adjustment models or diagrams developed by scientists. The permit applicant can apply the information in these diagrams to consider the phase of adjustment a channel is moving through and thereby select the best remedies for addressing this phase.

Two of the most commonly used channel evolution models are included in the checklist: Schumm et al. 1984; and Simon 1989.The model provides a depiction of how a typical channel responds after it has been straightened, its base level lowered and slope steepened, and how it will experience a reduction in sediment supply and/or increased transport capacity. Any one or all these factors working together can lead to channel incision and or head-cutting erosion working up the channel. Many streams tend to readjust by deepening, widening, aggrading and filling, and recreating a new active channel and “inset” floodplain within the widened cross-section. There is a tendency to over-intervene in incising channels. The best interventions can be made by addressing the underlying causes of the incision such as a culvert installed at the wrong grade, or the reconnection of removed meanders or lengthening the channel. Grade controls are sometimes placed in channels to stabilize headcuts but may actually work against recovery by locking the channel into an unstable form that will unravel later. Bank stabilization projects or channel filling projects proposed for the later stages of evolution are usually unnecessary because the banks are at a stage where they are naturally stabilizing. If re-vegetated, and with newly adjusted sinuosity, incised channels are often “graded” and are very stable environments (Thorne 1999).

D. Existing Hydrology, Channel Geometry and Hydraulic Conditions

On average, many alluvial channels in the transport and storage reaches of channels develop channels that are formed by a frequent discharge such as the 1 to 1.5 year recurrence interval flood. This is usually considered one of the most very basic parameters for having sufficient knowledge to protect or restore stream channel equilibrium so that excessive deposition or erosion does not become a problem. It is usually necessary to know what flow discharges are conveyed through the channel and floodplain in order to plan a project well. Therefore, estimates of the 5, 10, 50 and 100 year flood discharges and depths are good to estimate to plan for protection of floodplains and avoidance of flood damages. Many areas do not have stream gages and so the checklist contains a report developed by the U.S. Geological Survey (USGS) which provides regression equations for estimating these values using a few watershed parameters. The hydrologic information may also be important to understanding what plants to select to grow at different elevations on the stream channel and floodplain. Plant survival can depend on their proper locations in the channel-floodplain cross-section.

D. Existing Hydrology, Channel Geometry and Hydraulic Conditions

The best hydrologic information can of course by obtained by stream gages maintained by the USGS, state, counties, or other entities. There has been a tragic reduction in stream gages forcing us to rely more on watershed models to estimate discharges for different recurrence interval floods. The checklist contains a multiple-regression analysis used to correlate flood discharges with selected watershed characteristics prepared by the USGS. This report derived its analysis from flood frequency relations from 40 gage stations for the nine Bay Area counties (Rantz 1971). Some county public works departments and flood control agencies have prepared flood frequency analysis for different watersheds based on rain gage and flow data. Stormwater models can produce estimates for the more frequent, lower magnitude floods although they generally produce conservative (higher) discharge values than those derived from field measured flood frequency. Other areas of the state may want to refer to another USGS publication (Jennings et al. 1993) in which regression equations estimating flood discharges are published for the North Coast, Northeast, Sierra, Central Coast and South Coast Regions of California.

Regional stream restoration “curves” or graphs can provide the first indication of equilibrium channel shapes for a project site because of the relationships which often exist among channel shapes, lengths, discharges, and drainage areas of a watershed. These graphs are developed for some regions of the Bay Area to help permit applicants understand how the drainage areas to their project site may indicate equilibrium channel shapes and bankfull discharges. These regional stream restoration curves will be incorporated into the checklist as they continue to be developed. In most stream channel design processes, additional information from reference sites and use of other design tools is needed. Other more complex tools for determining these “stable” channel shapes include dimensionless rating curves (Dunne and Leopold 1978) and computed effective discharges which require information on the discharges which transport the most sediment over some time period. Effective discharges are computed by numerically integrating a sediment transport rating curve and flow duration curve (FISRWG 1998). Hydraulic models can also help provide channel cross-sections and velocities for different frequency flows.

Section II. Existing Channel Characteristics

A. Landscape Types
B. Dominant Streambed Materials
C. Floodplain and Channel Conditions
D. Vegetation Function
E. Fish Habitat

While the first part of the checklist is concerned most with what processes are influencing the streams and floodplains this section is concerned with what landscape features compose the stream valley, floodplain, and channel. For example, the presence of confining channel terraces, bedrock, or project right-of-ways helps inform opportunities and constraints for the management or restoration of a stream reach. The permit applicant is encouraged to research the type of channel historic to the site to inform the possibilities for enhancement of channel functions. Many braided or multiple channel streams have been simplified to single thread channels because of changes in land use or channelization projects. Restoration plans should consider the potential for replicating the previous forms of the channel as a method to increase the habitat values. Information on the dominant stream materials forming channel beds or banks can be important indicators for determining channel forming discharges and also provide vital information on channel stability, potential erosion rates, and habitat potential. Existing and historic channel slopes and sinuosity can provide important information on how to re-stabilize channels which may be too short and steep to be stable and give clues on how to recover a channel from the damages of headcutting, a form of erosion commonly caused by channel straightening.

There are a number of channel classification and assessment systems (e.g., Montgomery and Buffington 1997; Montgomery and Buffington1998; Beechie et al. 2006; Rosgen 1996) which can help inform restoration objectives or strategies and the permit applicant may want to employ one or more of these existing systems if they find them helpful to devising management strategies. It is also important to be aware of native plant communities which probably existed at the site or exist now and the functions they may provide for shade, bank stability, and terrestrial and aquatic habitat. A number of assessment methodologies are available to assess stream bank stability, diversity of plant communities, and functionality of riparian and stream systems (e.g., Prichard 1999 Simon et al. 2000). Determining whether the site is a salmonid stream or has the potential to recover as a salmonid stream, or has federal and/or state species of special status (i.e., listed under the California Endangered Species Act or the Federal Endangered Species Act as rare, threatened or endangered, candidate, or sensitive) is obviously of central concern to Water Board staff because theses species must be protected under state and federal law.

Section III. Future Conditions Proposed By the Project

A. Project Design Objectives
B. Ecological Restoration Objectives
C. Methods Used to Estimate Future Dynamic Equilibrium Conditions

It is important to state the purpose or objectives of your project. Projects developed for flood damage reduction will help us focus on how to use a multi-objective approach to achieve the flood risk reduction needs. A project which intends to serve as a mitigation project and/or a project receiving state or federal grants or loans for achieving restoration objectives will be held to standards required to achieve the stated ecological restoration needs described in these regulatory or funding programs. It is desirable to know the historic or pre-disturbance environment of the site you are working on because this can inform restoration objectives. Historic information is even useful in greatly modified environments because it can serve as a starting point to inform on equilibrium conditions or ecological objectives even if the historic landscape cannot be re-created as it once was.

A list of increasingly technical methods is provided in the checklist which the permit applicant can consider for guiding restoration channel dimensions. The list of methods is similar to the one provided to assess current conditions and it is here where the permit applicant should compare how existing conditions or project proposals support or conflict with dynamic and resilient stream environments. It is recommended that a combination of assessment methods be used and that the permit applicant note where there is a convergence of values provided by the different methods.

Section IV. Describe How the Project Restores the Floodplain

The checklist asks the permit applicant to consider stormwater infiltration and vegetated buffers to protect floodplain habitats. The project thought process should consider available options to remove or modify levees or berms to increase floodprone areas. "Pond and plug" strategies employ re-creation of floodplains by raising the elevation of streambeds through plugging incised channel systems and using ponds to meter out flows at higher channel elevations (Mount and Hammersmark 2007; Wilcox 2008).

Section V. Describe How the Project Protects or Restores Native Streamside Vegetation

A. Current Status of Native Riparian Vegetation
B. Non-native and Invasive Plants
C. Non-native and Invasive Plant Control Methods
D. Revegetation Method
The checklist leads the permit applicant through identifying the existence of native plant community types, non-native (exotic) invasive species, identifying controls on these invasive species, and specifying any proposed revegetation strategies. If soil bioengineering methods are being employed the checklist user should proceed to section VII B. For the current status of vegetation a simple assessment can merely identify the basic plant community present on the site. This would involve designating the dominant community on the site such as: grassland; oak savanna; oak woodland; douglas fir; grey pine; redwood; sycamore savanna; willow-cottonwood; or chaparral. For larger scale, more complex projects the permit applicant is given a link to the California Department of Fish and Game website which provides additional information on publications and protocols which can be used to provide rapid assessments of the native vegetation on a site. A link is also provided to the California Native Plant Society Rare and Endangered

Species Plant List. The California Natural Diversity Data Base can also help people identify what species may be a potential concern in your locale. A list of riparian plants native to the Bay Area is provided and should guide proposed revegetation projects. Consistent with our objective to protect or enhance the functions of riparian environments, the Water Board expects to see native riparian species used in riparian corridors and not xeric landscaping with drought tolerant natives or ornamentals. A link is also provided to the Water Board's list of non-native invasive species to remove or avoid.

Section VI. Describe How the Project Protects or Restores the Stream Channel Slope

A. Existing Slope Retained
B. Proposed restoration Channel Slope
C. Pool Riffle Stream
D. Step-Pool Stream

The Water Board's stream and river protection circular (Riley 2003) describes how one of the most frequent problems encountered by the Water Board is assessing whether proposed well intended grade control structures are going to help a stream system attain a better equilibrium or whether the structures will prove to be counter-productive and cause unanticipated instability. The checklist includes the alternative that the permit applicant considers the re-establishment of meander or channel lengths for the re-stabilization of alluvial pool riffle stream types. This section contains a diagram which can help the permit applicant avoid grade controls or check dams that may over flatten stream slopes and cause unexpected meandering and erosion as the stream flanks the structures. The section also provides a reference on the design of step-pool channels found in steeper stream valleys. Naturally braided stream systems and alluvial fan stream systems should remain dynamic stream types to protect unique plant communities and ecosystems and to reduce hazards from placement of structures near high risk, unpredictable and dynamic environments. Appropriate options for managing channel slopes may include the re-introduction of woody debris or a range of cobble and rocks sizes, or rock weirs for breaking up channel slopes or creating localized sediment catchment or erosion.

Section VII. Describe How the Project Restores Stream Banks

A. Fencing and Vegetated buffers
B. Soil Bioengineering Systems
This section of the checklist asks for land management improvements being proposed to protect stream corridors. The checklist first directs the permit applicant to consider the causes of stream bank erosion identified in Section I. before prescribing a strategy to address the problem. One of the most over looked causes of stream bank erosion is stormwater runoff from roads and developed areas running over the tops of stream banks. Livestock access to channels and vegetation removal by property owners are also common causes of stream bank instabilities. Remedies included in the checklist include the use of soil bioengineering systems for bank stabilization. These stabilization strategies employ bundled plant materials which have intensive matrixes of rooting systems which can equal or exceed the ability of rock and hard materials to hold banks. The checklist includes tables developed by both the Natural Resources Conservation Service (NRCS) and the U.S. Army Corps of Engineers (USACE) which provide guidance on the shear stresses which different soil bioengineering system can perform under to provide bank stabilization. The checklist can be used to calculate the shear stresses acting on the channel to help the user consider bank stabilization strategies. Some permit applicants also calculate a value for critical shear stress to represent the resisting forces to the shear stresses or calculate the stream power per unit of bed area as criteria to inform steam stability. Soil bioengineering systems and specifications are provided in a number of federal manuals including those developed by the NRCS, USACE, and the National Cooperative Highway Research Program.

Section VIII. Describe How the Project Protects and/or Restores Aquatic Habitat

A. Habitat Enhancement for Native Wildlife Species
B. Proposed Exotic Wildlife Controls
This section of the checklist asks for the identification of invertebrate, fish, reptile, amphibian, bird and mammal habitat which could potentially be enhanced. Larger development projects will need to identify species which may be impacted or enhanced while back yard scale projects need only consider a planting plan which could provide general habitat benefits. The purpose of this section is to give the Water Board staff information as to whether habitat benefits are getting reasonable attention.

The checklist requests information on how the project will achieve enhancement of habitat functions. Greater detail should be provided for those projects involving public funding to achieve habitat restoration objectives. Species of special concern require a biological opinion prepared by the U.S. Fish and Wildlife Service with consultations also from the California Department of Fish and Game which is beyond the scope of this checklist. Any proposed controls on exotic species should be listed. If the stream currently or potentially may have a native salmonid fish population the applicant is encouraged to complete the Water Board's Rapid Permit Checklist for Existing or Potential Salmonid Habitat in addition to this one.

Section IX. Project Summary

A. Existing Conditions
B. Proposed conditions
C. Project Features Which Will Protect and Enhance Ecological Services and Address Causes of Instabilities and Degraded Habitat

Most Water Board staff require design plan information which can range from diagrammatic sketches for small simple projects, to detailed 100% completed construction drawings for larger more complex projects. It is recommended that any project description include a plan view, representative cross-sections for different reaches, and a profile of the project area. The cross-sections should designate estimated bankfull or active channel dimensions and include estimates of flood elevations for different recurrence interval floods. These estimates can be based on simple regional hydraulic geometry information (typical flood elevations in relationship to bankfull elevations) or hydraulic modeling. A distinction should be made between floodprone areas and floodplain terraces (older abandoned floodplains) which are not expected to flood. The most important component of the summary is a brief project description where you make your case that the project proposal represents a sustainable response to addressing the cause of channel instabilities, flooding hazards, or habitat degradation identified in the Watershed and Reach Influences section at the beginning of the checklist. If this done thoughtfully, you are providing Water Board staff with the information they can use to make informed permit decisions.

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