Chapter 15
Shoreline Stabilization

Shoreline Master Program Planning Process

Introduction

Shoreline stabilization includes a wide range of activities carried out at the water's edge to control erosion or to prepare shorelines for development. Stabilization generally employs hardened structures, built parallel to the shoreline, that protect soils and unstable banks from the action of currents and waves. Stabilization is widespread, occurring on all manner of lake, stream, and marine shorelines. Common stabilization methods include revetments, bulkheads, and seawalls.

Figure 15-1: Shoreline stabilization supports and protects houses on Lake Chelan. (Hugh Shipman photo.)

Shoreline stabilization policies and regulations are developed as part of Shoreline Master Program (SMP) updates. (Phase 3 of the SMP planning process for local governments that began updating prior to July 2013, Task 6 for those that began updating after that date.) The SMP Guidelines provide a framework for evaluating and permitting shoreline stabilization activities

[WAC 173-26-231]. In general, they discourage stabilization and encourage consideration of alternative site development and less impacting stabilization methods.

The mandate of the Guidelines to achieve no net loss of shoreline ecological functions applies to all shoreline modifications, including shoreline stabilization. For shoreline modifications, this applies to individual projects and on a cumulative basis. No net loss is to be achieved by a preference for shoreline modifications with less impact on ecological functions and mitigation of impacts that would result from shoreline modifications [WAC 173-26-231(2)(d)]. New development should be located to avoid the need for future shoreline stabilization to the extent possible [WAC 173-26-231(3)(a)(iii)(A)].

Chapter overview

This chapter provides guidance to develop and implement local SMPs regarding shoreline stabilization activities. It describes the types of shoreline stabilization methods, the impacts associated with its construction, the regulatory environment in which stabilization occurs, and how the SMA Guidelines address these issues. The chapter highlights key issues and provides examples. Although the examples draw heavily from Puget Sound, this guidance generally applies to shorelines throughout Washington. This chapter focuses on the more common forms of stabilization such as bulkheads and revetments and briefly discusses soft shoreline stabilization methods. *Soft Shoreline Stabilization: Shoreline Master Program Planning and Implementation Guidance* (Gianou, 2014) takes an in-depth look at this topic.

Description of shoreline stabilization

Shorelines are naturally dynamic environments and inherently subject to erosion by waves and currents. Stream banks and coastal bluffs are often unstable and prone to slope failures. Shorelines are subject to floods and storm damage; stabilization structures are often built to address threats associated with these processes as much as erosion itself. Artificial fill that has been placed along shorelines to create dry land or to facilitate development is particularly vulnerable to erosion if it is not armored.

Stabilization typically involves hardening the shoreline to prevent currents or wave action from eroding soils and damaging upland improvements. Stabilization structures often serve functions besides erosion control, influencing both their choice and their design. They may provide protection from flood events and storm waves. They may facilitate access to boats or to the water on commercial, recreational and residential properties. They also may aid in creating usable space near the water's edge.

Stabilization is typically a component of development that involves fill placed along shorelines and often occurs along with clearing and grading, site development and landscaping. Stabilization is also a common element of other shoreline projects, such as bridge and pier abutments, utility crossings, stormwater outfalls, and water diversion structures.

Figure 15-2: Riprap revetment protects the petroleum processing facility at Point Wells, Snohomish County (left). A residential bulkhead sits at the toe of a bluff on Whidbey Island (right). (Hugh Shipman photos.)

For these reasons, and because stabilization was long viewed as a fairly benign activity, historic modification of shorelines has been extensive and proposals for new stabilization are common.

However, shoreline stabilization directly impacts sensitive habitats at the shoreline edge, involves work in or adjacent to public waters, and interferes with important geological and ecological processes. Shorelines occur within dynamic geologic systems, so stabilization may have unintended consequences on adjacent or downstream properties. (See "Impacts of Shoreline Stabilization" (page 14) for additional information.)

Shoreline stabilization has a rich terminology. Much stabilization is *erosion contr*ol. The terms *hardening* and *armoring* are often employed to describe the placement of rock or other resistant material to reduce erosion. Traditionally, expressions such as *shore protection* and *coastal defense* have been applied. Terms such as *revetment, riprap, seawall, bulkhead, flood wall,* and *groin* describe specific types of structures.

Some of the most familiar applications of stabilization in Washington include:

- Bulkheads or seawalls built to protect residential property on lakes or on Puget Sound.
- Revetments built to stabilize river banks and levees.
- Structures built to protect roads or railroads that follow the shoreline.

- Riprap revetments associated with industrial development and large bulkheads built to facilitate cargo handling at port facilities.
- Armor used to protect bridge abutments, drainage outfalls, and other structures.

Stabilization most commonly takes the form of shore-parallel structures such as rock revetments or bulkheads, but can also include structures built perpendicular to the shoreline such as groins that trap sediment on beaches or training structures that redirect currents on rivers. Breakwaters on lakes and marine shorelines reduce erosion by waves. Armor may be used to protect dikes and levees, built for flood control, from erosion and breaching. A wide variety of stabilization methods are used to protect and buttress bluffs and unstable slopes.

Design of shoreline stabilization

The design and construction of shoreline stabilization and erosion control structures reflects many different requirements and engineering considerations. In order to understand the nature of stabilization proposals, the choices impacting property owners and contractors, and the options for more environmentally friendly options, it is useful to describe the factors that influence the selection and design of erosion control structures.

In general, structures need to address geotechnical factors such as hydrostatic pressure and soil loadings, hydraulic forces from waves and currents, and design requirements associated with the use of the structure, such as boat moorage, flood control, or recreational access.

Stabilization structures should be designed to:

- Resist both geotechnical and hydraulics forces for the life of the structure, including reasonably foreseeable extreme events such as floods, storms, and impacts.
- Accommodate features such as stairs, moorage facilities, pier abutments, and outfalls.
- Allow drainage without the loss of soils behind the structure.
- Reduce or accommodate erosion induced by the structure itself (scour and undermining).
- Employ affordable, durable, and non-hazardous materials.
- Utilize reasonable construction methods regarding site access, staging, crew safety, and environmental practices.
- Tie in effectively with adjacent structures.

Conventional structures are usually standard designs that are based on proven effectiveness, constructability, and relatively low cost. Larger shoreline stabilization projects may involve extensive engineering design, while smaller projects, such as residential bulkheads and simple stream bank protection measures, may be built by contractors based on previous experience and without site-specific design engineering. One benefit of many standard designs is that they are cost effective and can be used in a wide variety of settings.

Legal framework

The legal framework for shoreline stabilization projects is found in both state and federal laws and regulations. This section provides an overview of those, with an emphasis on shoreline management under the Shoreline Management Act.

Shoreline Management Act

The Shoreline Management Act's policy is to plan for and foster all reasonable and appropriate uses, while also "protecting against adverse effects to the public health, the land and its vegetation and wildlife, and the waters of the state and their aquatic life…" [RCW 90.58.020].

The SMA requires SMPs to include standards regarding protection of single family residences and appurtenant structures against damage or loss due to shoreline erosion. Standards shall govern issuance of substantial development permits for structural methods such as bulkheads and nonstructural methods of protection. The standards also shall provide a preference for issuing permits to protect single family residences occupied prior to January 1, 1992, where the proposal is "designed to minimize harm to the shoreline natural environment" [RCW 90.58.100(6)].

Other sections of the SMA specifically address bulkheads.

- RCW 90.58.030(3) (a) lists "bulkheading" as development.

- RCW 90.58.030(3)(e) states that construction of the "normal protective bulkhead common to single family residences" is not considered substantial development (and therefore does not require a shoreline substantial development permit.) See "Shoreline management permit and enforcement procedures" below for the parallel WAC provisions.
- RCW 90.58.140(11) establishes procedures for substantial development permit applications for bulkheads or limited utility extensions.

SMP Guidelines

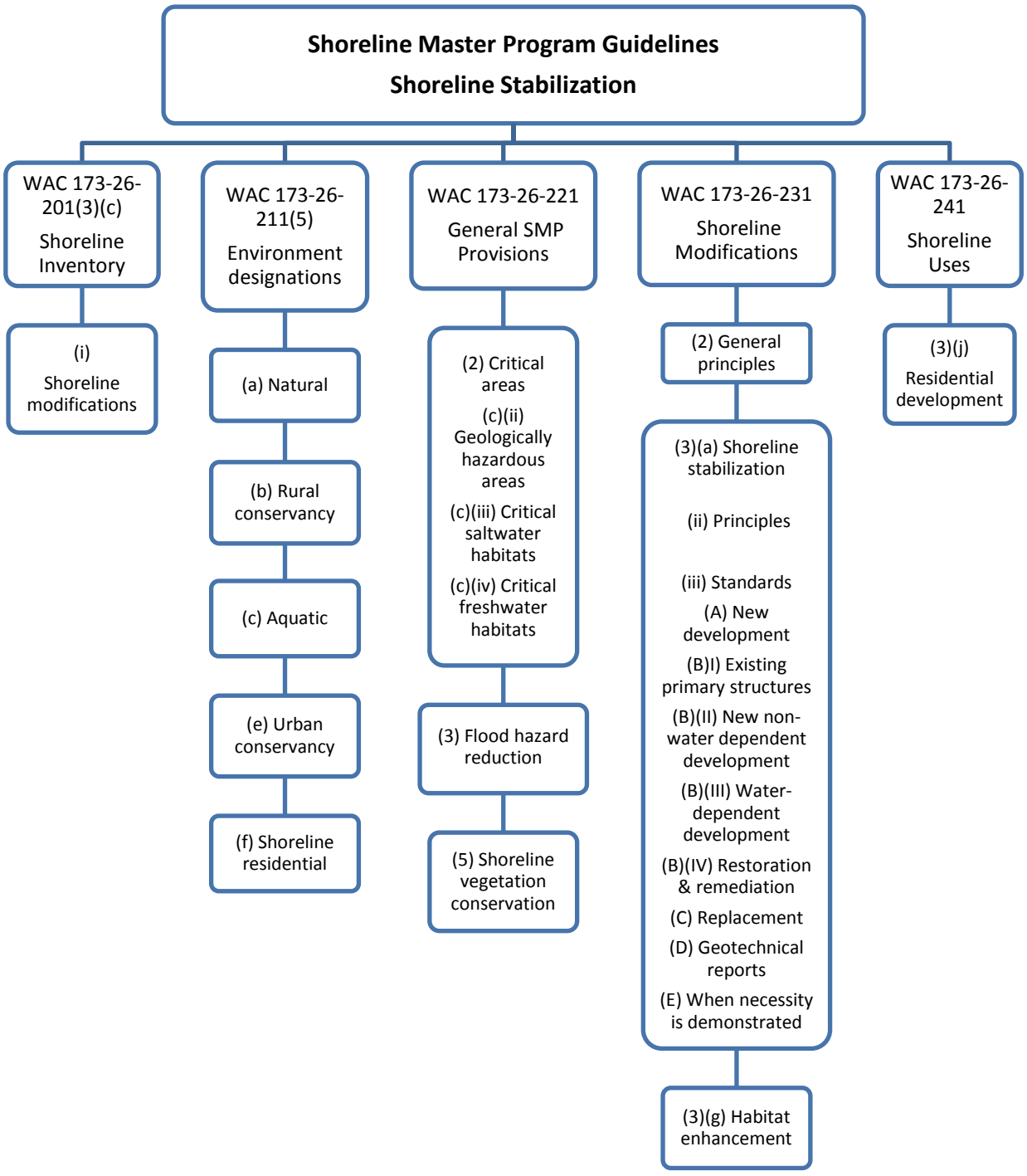
The SMP Guidelines provide direction on developing and updating Shoreline Master Programs. The section concerning shoreline stabilization is extensive and prescriptive and is addressed in the Shoreline Modifications section, WAC 173-26-231. Shoreline modifications are defined as "actions that modify the physical configuration or qualities of the shoreline area, usually through the construction of a physical element such as a dike, breakwater, pier, weir, dredged basin, fill, bulkhead, or other shoreline structure. They can include other actions, such as clearing, grading, or application of chemicals" [WAC 173-26-020(34)].

Shoreline modifications generally are undertaken in order to support or prepare for a shoreline use. For example, dredging, a shoreline modification, is performed so a marina, a shoreline use, can be built. Other shoreline modifications listed in the Guidelines include revetments and soft stabilization techniques; docks; groins; jetties; weirs; dredging; significant vegetation removal; and beach and dunes management.

This section provides a review of the Guidelines with the main focus on shoreline stabilization. The Guidelines are also discussed in other locations in this chapter, as relevant. Shoreline modifications and stabilization are discussed first, followed by additional requirements.

The chart below shows Guidelines provisions that provide direction for SMP updates regarding shoreline stabilization.

Figure 15-3: SMP Guidelines provisions related to shoreline stabilization



Shoreline modifications

Shoreline modifications, including stabilization measures, should be appropriate to the type of shoreline and environmental conditions. **The following general principles for shoreline modifications apply to shoreline stabilization** [WAC 173-26-231(2)].

- Allow only where demonstrated to be necessary to support or protect an allowed primary structure or legal existing shoreline use in danger of loss or substantial damage, or necessary for mitigation or enhancement purposes.
- Limit the number and extent of modifications and reduce their adverse effects.
- Do not result in a net loss of shoreline ecological functions.
- Base SMP provisions on scientific and technical information, including marine drift cells for marine waters and reach conditions for streams.
- Plan for enhancement of impaired ecological functions.
- Use the mitigation sequence to avoid significant ecological impacts.

Shoreline stabilization section

The following discussion provides highlights of the SMP Guidelines section on shoreline stabilization [WAC 173-26-231(3)].

Principles: Shorelines are unstable. The natural processes of erosion and accretion provide ecological functions. Hardening or armoring one property on the shoreline may have limited impacts at the site in the short term, but could have significant cumulative impacts, especially combined with the impacts of additional shoreline armoring in the vicinity. Impacts may include beach starvation, habitat degradation, sediment impoundment, exacerbation of erosion, hydraulic and groundwater impacts, loss of vegetation and large woody debris, and loss of channel movement. Hard structures may create conditions that lead to failure of the structure itself.

The Guidelines list a range of shoreline stabilization measures, from soft measures such as vegetation enhancement to hard measures such as seawalls. Generally, harder structures have greater impacts on shoreline processes than softer structures. Although this chapter tends to reflect experience on Puget Sound shorelines, it is applicable to all SMA shorelines in the state.

Standards: The Guidelines include shoreline stabilization standards that shall be included in SMPs and implemented when development occurs. These standards cover new development, new shoreline stabilization measures, replacement shoreline stabilization measures and geotechnical reports. Geotechnical reports that demonstrate need for stabilization are required for new stabilization measures to protect existing primary structures, new nonwater-dependent development, and water-dependent development. Geotechnical reports are also required for proposed development on steep slopes and bluffs, in order to demonstrate the development will be set back enough to not require shoreline stabilization. To replace existing stabilization structures with similar structures, a demonstration of need is required, although the Guidelines do not specify that this constitute a geotechnical analysis.

Shoreline modifications and stabilization projects are allowed for projects with a primary purpose to restore "the natural character and ecological functions of the shoreline." Such projects may include removal of nonnative or invasive plants, dredging, filling and shoreline stabilization. SMP provisions for these projects "should assure that the projects address legitimate restoration needs and priorities and facilitate implementation of the restoration plan developed pursuant to WAC 173-26-201 (2)(f)" [WAC 173-26-231(3)(g)].

Standards for shoreline stabilization are discussed in more detail in "Addressing Shoreline Stabilization in SMPs" starting on page 20.

Additional Guidelines requirements

Shoreline modifications and stabilization are also addressed in sections of the Guidelines other than WAC 173-26-231. The provisions specifically concerning shoreline modifications and stabilization are shown in Figure 15-3 and are briefly reviewed below. Please see the Guidelines for the complete language.

Shoreline inventory: The shoreline inventory, which is prepared early in the SMP update process, should include existing structures, including shoreline modifications [WAC 173-26-201(3)(c)(i)]. (See SMP Handbook Chapter 7, "Shoreline Inventory and Characterization.")

Cumulative impacts analysis: This analysis should consider the potential cumulative impacts of reasonably foreseeable future development. The Guidelines specifically address "effects such as the incremental impact of residential bulkheads" among the impacts on ecological functions that should be analyzed [WAC 173-26-201(3)(d)(iii)]. (See SMP Handbook Chapter 17, "Cumulative Impacts Analysis.")

Residential development: SMP standards for residential development that address the subdivision of land should "Prevent the need for new shoreline stabilization or flood hazard reduction measures that would cause significant impacts to other properties or public improvements or a net loss of shoreline ecological functions" [WAC 173-26-241(3)(i)].

Geologically hazardous areas: Within geologically hazardous areas, new development that would require shoreline stabilization over the life of the development should not be allowed. Exceptions can be made to protect allowed uses if alternative locations are not available and no net loss of ecological functions will result. If alternatives are not feasible, stabilization to protect existing primary residential structures may be allowed [WAC 173-26-221(2)(c)(ii)].

Critical saltwater habitats: Specific conditions must be met in order for bulkheads and other structures to intrude into or over critical saltwater habitats. These conditions include public need for the structure, infeasibility or unreasonable or disproportionate cost for an alternative alignment, no net loss of shoreline ecological functions, and consistency with the state interest in resource protection and species recovery [WAC 173-26-221(2)(c)(iii)].

Critical freshwater habitats: Various SMP provisions, including those for shoreline stabilization, should address protection of human health and safety and protection and restoration of lake and river corridor ecological functions and ecosystem processes [WAC 173-26-221(2)(c)(iv)].

Shoreline vegetation conservation: The Guidelines note the role of vegetation conservation in protecting and restoring ecological functions and ecosystem processes along shorelines. Vegetation conservation should also be used to reduce the need for structural shoreline stabilization measures [WAC 173-26-221(5)(b)].

Flood hazard reduction: SMPs should include provisions to limit development and shoreline modifications that would interfere with channel migration or result in a net loss of ecological functions associated with streams [WAC 173-26-221(3)(b)]. New development or uses and the subdivision of land should not be allowed in shoreline jurisdiction if it is "reasonably foreseeable" that they would require structural flood hazard reduction measures within the channel migration zone or floodway. However, measures to reduce shoreline erosion are allowed in channel migration zones if they can meet specific conditions. The applicant must demonstrate that the erosion rate exceeds "that which would normally occur in a natural condition." In addition, the demonstration of need must show that the stabilization measure will not interfere with normal fluvial hydrological and geomorphological processes, and that impacts to ecological functions are mitigated appropriately [WAC 173-26-221(3)(c)].

Shoreline management permit and enforcement procedures

WAC 173-27 includes the shoreline permit and enforcement procedures. Construction of the "normal protective bulkhead common to single-family residences" is exempt from requirements for a substantial development permit under certain conditions [WAC 173-27-040(20(c)]. The exemption applies to bulkheads to be built at or near and parallel to the ordinary high water mark **to protect an existing single family home and appurtenant structures from loss or damage by erosion.** A bulkhead is not exempt if it is built for the purpose of creating dry land. Any projects that are exempt from the SDP permit requirement must still meet requirements of the SMP.

The regulation also states:

- Not more than one cubic yard of fill per foot of wall may be used as backfill for a vertical or near vertical wall.
- A new vertical wall being built to repair an existing bulkhead must be built no further waterward of the existing bulkhead than necessary to build new footings.
- If a bulkhead has deteriorated to the extent that the ordinary high water mark (OHWM) has established landward of the bulkhead, a replacement bulkhead must be located at or near the current OHWM. (The OHWM may move over time.)
- Beach nourishment and bioengineered erosion control projects are considered normal protective bulkheads when structural elements are consistent with these requirements and when the project is approved by Washington Department of Fish and Wildlife.

Other regulatory authority

Shoreline stabilization projects may fall under other regulatory authority of state and federal agencies. This section provides a brief review.

Department of Ecology - federal consistency certification

The Department of Ecology reviews applications for "federal consistency certification" for projects that require federal approval, use federal funds or are undertaken by a federal agency. This would include bulkheads and rip-rap included in the Army Corps of Engineers permits discussed below.

This certification is required under Washington's Coastal Zone Management Program, the state program that implements the federal Coastal Zone Management Act in the 15 coastal counties with marine shorelines. Federal agencies cannot approve permits for projects that require federal approval until Ecology concurs that a project is consistent with the Coastal Zone Management Program.

Ecology also administers Section 401 of the federal Clean Water Act through issuance of a Water Quality Certification. Project impacts should be avoided and minimized, and unavoidable impacts should be mitigated so that there is reasonable assurance that a proposal will comply with state water quality standards and other aquatic resource protection requirements under Ecology's authority. The federal consistency certification is part of Ecology's review for projects receiving federal approvals, including a Water Quality Certification. Under the Corps' Nationwide Permit 13, Ecology must approve a Section 401 Water Quality Certification for new or expanded shoreline stabilization.

Washington Department of Fish and Wildlife

Any type of construction or performance of work that "will use, divert, obstruct, or change the natural flow or bed of any of the salt or fresh waters of the state" is a hydraulic project and requires a permit called a Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife [WAC 220-660-010]. Examples of shoreline stabilization construction activities that may require HPAs include bulkheads, stream bank protection, stabilization for piers and docks, and fills.

WAC 220-660 is the new administrative rule, effective July 1, 2015, that enacts RCW 77.55, "Construction projects in state waters."

WAC 220-660-130 addresses stream bank protection and lake shoreline stabilization. The rule requires the design of stream bank and lake shoreline protection to follow the mitigation sequence to protect fish life and habitat that supports fish life. The general design rule calls for protecting fish life and habitat by using the alternative with the least impact that is technically feasible. The area of stream bank protection and lake shoreline stabilization should be restricted to the least amount needed to protect the eroding banks.

WAC 220-660-370 addresses bank protection in saltwater areas and specifies bulkheads and other bank protection design. The alternative with the least impact that is technically feasible should be used. This section directs how HPAs for single family residence bank protection in saltwater areas are processed under RCW 77.55.

U.S. Army Corps of Engineers

Construction of shoreline stabilization may require a permit from the Army Corps of Engineers. Two categories of work require permits.

- Activities within navigable waters such as building bulkheads and docks, dredging and placing navigation aids. These require review under Section 10 of the Rivers and Harbors Act of 1899. This review is conducted to assure that these items will not obstruct navigation.

- Activities that may involve discharging dredged or fill material into waters of the United States. These require review under Section 404 of the Clean Water Act of 1972. Depositing dredged or fill material into open waters of the U.S. for construction of bulkheads, placement of riprap and other construction activities require Section 404 permits.

If a project has the potential to affect endangered or threatened species or their habitat, the Corps may consult with NOAA Fisheries and the U.S. Fish and Wildlife Service during permit application review. For Lake Washington shorelines, applicants who comply with the Lake Washington Bank Stabilization biological evaluation may be able to avoid this consultation requirement for individual projects.

Note that the Corps issues permits for development, including shoreline stabilization, at or below Mean Higher High Water (MHHW) elevation. New stabilization structures should be built at or above the OHWM, which is typically a higher elevation than MHHW. Therefore, the Corps may not be involved in permitting for stabilization at OHWM. However, if the project involves any work below MHHW, such as beach enhancement, the Corps will review the entire project.

More information is available from the Corps of Engineers at
http://www.nws.usace.army.mil/Missions/CivilWorks/Regulatory/PermitGuidebook/FAQ.aspx

Federal Emergency Management Agency (FEMA)

Shoreline stabilization within a mapped floodplain requires a floodplain development permit. Within the Puget Sound region, floodplain development requires compliance with a 2008 Puget Sound Biological Opinion for the National Flood Insurance Program.

FEMA has provided three distinct approaches to demonstrate compliance with the Biological Opinion. All three require FEMA approval. Most common is the preparation of a habitat assessment for each floodplain development permit. The habitat assessment must demonstrate "No Adverse Effect" to species listed under the Endangered Species Act. Another alternative is to adopt and implement the FEMA model floodplain ordinance for the Biological Opinion. The third alternative is adoption of a programmatic response that addresses the habitat concerns identified in the Biological Opinion.

Scrutiny of shoreline stabilization projects was heightened after completion of the 2008 Biological Opinion. The federal requirements apply even if the normal protective bulkhead for a single family residence is exempt from requirement for a shoreline substantial development permit under the SMA. Compliance with the Biological Opinion is necessary in order to maintain good standing in the National Flood Insurance Program.

FEMA's website, "National Flood Insurance Program & the Endangered Species Act," provides more information about compliance with the Endangered Species Act, including:

- Guidance on preparing habitat assessments in the Puget Sound region. http://www.fema.gov/media-library/assets/documents/85343.

- Model ordinance.

  http://www.fema.gov/media-library/assets/documents/85339.

- Guidance for preparing a program to comply with the Biological Opinion. http://www.fema.gov/media-library/assets/documents/85336.

Impacts of shoreline stabilization

Shorelines are physically dynamic and biologically sensitive environments. Stabilization measures occur at the water's edge and can have significant impacts on shoreline conditions. Stabilization is a common and widespread activity; therefore, it may have significant cumulative effects.

The SMP Guidelines, in addressing potential impacts, stress the importance of avoiding impacts by requiring demonstration of need for stabilization and use of soft stabilization once such need is demonstrated, unless it can be shown to be ineffective for the immediate situation.

Erosion control structures affect shoreline ecosystems, disrupt important physical processes, and may affect people's use and enjoyment of the shoreline. Stabilization measures can directly impact the shoreline, such as when a revetment buries a portion of a beach or leads to the loss of riverbank vegetation. They can also have indirect impacts, such as increasing erosion on adjacent property or causing degradation of downstream habitats.

The specific nature of the impacts depends on the type of structure (rock revetment, seawall) and its location in the landscape (on a river bend, on the edge of a wetland, below a coastal bluff, or on a sand spit).

The setting determines which geologic processes and ecological functions are acting at a site and therefore may be impacted by stabilization measures. The specific nature of the impacts depends on the type of structure (rock revetment, seawall) and its location in the landscape (on a river bend, on the edge of a wetland, below a coastal bluff, or on a sand spit). For example, armoring a riverbank has different consequences than stabilizing a coastal bluff. The former may affect channel migration and availability of freshwater habitat, whereas the latter may cut off a source of beach sediment and lead to diminishment of beaches elsewhere on the shoreline.

Regardless of the setting, shoreline stabilization can:

- Affect the natural erosion and shifting of shorelines, diminishing the processes that form habitat.
- Impact ecological functions such as aquatic habitat, the flow of nutrients and detritus, and the movement of organisms.
- Impact nearby locations and may lead to long-term disruptions to longer reaches of shoreline.
- Adversely affect public use of the shoreline, recreation activities, shoreline views and aesthetics.
- Encourage shoreline development in areas that remain vulnerable to other hazards, including stream avulsion and channel migration, flooding, and landslides, putting more people at greater risk in the future.

The following sections discuss impacts in more detail. In addition, see Appendix 1, Shoreline Settings, for more details about stabilization on stream banks, lake shorelines, and in the marine environment.

Physical processes

Stabilization measures are taken to prevent erosion, yet erosion is an important geological process that forms and maintains shoreline ecosystems. This process is recognized in the Guidelines: "Shorelines are by nature unstable, although in varying degrees. Erosion and accretion are natural processes that provide ecological functions and thereby contribute to sustaining the natural resource and ecology of the shoreline" [WAC 173-26-231(3)(a)(ii)].

River bank erosion and channel migration are crucial to efficiently conveying water and sediment in meandering river systems and for forming and renewing flood plain and off-channel habitat. On Puget Sound, bluff erosion is an important source of sediment for maintaining beaches and shoreline habitat within a longer stretch of shoreline (See Puget Sound Feeder Bluffs page). Although excessive erosion and sedimentation resulting from poor land use practices is a serious environmental problem, it is important to distinguish this from the natural erosional processes that shape shoreline landscapes.

Figure 15-4: The timber pile bulkhead prevents material from a feeder bluff from reaching the littoral system. Erosion is an important geological process that forms and maintains shoreline ecosystems. (Hugh Shipman photo.)

Shorelines are continuous features connected by the movement of water and sediment; stabilization structures directly affect these processes. They may redirect currents and wave action, causing problems on nearby sites. By preventing erosion and altering the transport of sediment, they may impact a much longer stretch of river or beach (Figure 15-4). In addition to impacting the flow of water and sediment, they can also diminish both the supply and the accumulation of large wood, which are important ecosystem processes on northwest rivers and coasts.

Ecological functions

Shorelines ecosystems play a key role in the health of Washington's streams, lakes, beaches, and estuaries. The shoreline is a transition between terrestrial and aquatic environments. Shoreline stabilization impacts the nature of this transition, typically replacing it with a harder, more abrupt edge (Figure 15-5). It results in the direct loss of habitat and may prevent the accumulation of organic materials that contribute to shoreline ecosystems. It also impedes the movement of material and organisms, reduces the availability of food resources, and disrupts habitat-forming processes.

Figure 15-5: Rock seawall on Wollochet Bay impacts marsh habitat and riparian area. (Hugh Shipman photo.)

Stabilization measures can affect riparian and wetland vegetation, the recruitment of large wood and organic detritus, the flow of surface water and groundwater, light and temperature, as well as the presence and quality of forage, refuge, and spawning habitat for fish.

Impacts on use and enjoyment of the shoreline

Figure 15-6: Bank stabilization along the Duwamish River uses debris and old tires. This type of bank stabilization has adverse environmental and aesthetic impacts. (Hugh Shipman photo.)

Shoreline structures, although sometimes built to improve access to the water, may also impede public use of the shorelines. Structures may restrict passage along a beach at high tides and may make getting to the water difficult or dangerous. They can also reduce the public's enjoyment of natural stream banks or backshore areas on beaches.

In some cases, stabilization structures can incorporate elements such as stairways or ramps that improve access to the water. In many cases, though, stabilization structures actually make access more difficult or more dangerous. The structures themselves may cover shallow water or beach areas and make walking along the water's edge challenging. Recently,

however, parks managers and property owners along Lake Washington and on Puget Sound have found that removing all or part of a bulkhead can make access to the water easier.

Stabilization structures can often impact views of the water and of the shoreline from the water. Many stabilization measures are visually unappealing (Figure 15-6).They often do not blend in with the natural environment because of their size, condition, or use of construction debris or other unattractive materials. The SMP Guidelines call attention to "failed bulkheads and walls" that "adversely impact beach aesthetics…" but do not provide specific standards regarding aesthetics [WAC 173-26-231(3)(a)(ii)].

This issue of aesthetics can be part of community discussion during the SMP update process. What is visually pleasing to one person or community may not be so to another person or community. What types of shoreline stabilization measures fit with the community's preference and sense of aesthetics? This issue can be addressed during public participation activities, particularly the community visioning step. (See Chapter 10, "Community Visioning.")

Most stabilization constructed on the shoreline has minimal effect on navigation. The SMP Guidelines do note that failed bulkheads and walls "may be a safety or navigational hazard" [WAC 173-27-231(3)(a)(ii)]. Structures such as groins, jetties, or breakwaters that are built to manage erosion may affect navigation and the use of the water. (Jetties and breakwaters are addressed in the SMP Guidelines at WAC 173-26-231(3)(d)).

Cumulative impacts

Figure 15-7: Although stabilization structures are often built and permitted on a site by site basis, on many shorelines this results in long stretches of armored shoreline. This example is from Whidbey Island; similar patterns can occur on lakes and rivers. (Hugh Shipman photo.)

The Guidelines direct that "master program policies and regulations should be developed to assure that the commonly occurring and foreseeable cumulative impacts do not cause a net loss of ecological functions of the shoreline" [WAC 173-26-201(3)(E)]. Stabilization often occurs at the scale of an individual property or short segment of shoreline, yet the rationale for stabilization typically would also apply to other parcels in the vicinity. As a result, although the regulations are applied at a site scale, the impacts ultimately relate to the aggregate effect of many similar structures along a reach of shoreline (Figure 15-7).

There is both a spatial and a temporal aspect to cumulative impacts. The spatial aspect is related to the fact that the effect of a single structure may be perceived as relatively minor, but that the cumulative impact of many similar actions over time may be much more significant and that these impacts can stretch to a longer reach of shoreline. The temporal aspect stems from the fact that the impacts of an action taken today may take years or decades to emerge because the processes that are affected occur slowly or episodically.

Sea level rise

The prospect of higher sea levels in future decades has ramifications for stabilization policy. Increased sea level will generally lead to higher rates of erosion and greater damage from coastal storms, which is anticipated to increase pressure to armor the coastline. At the same time, many of the existing impacts of armoring, such as loss of marsh and beach habitat, are expected to be exacerbated by higher sea levels.

The magnitude of future sea level rise remains extremely difficult to predict, largely due to uncertainty in projected carbon emissions, but there is little question that rates will be higher than in the past (Mote and others 2008, National Research Council 2012). The rate will accelerate over time, so while the initial effects will be difficult to recognize, the long term impacts will be large.

A storm at high tide on Whidbey Island in December 2012, illustrates events that will become more frequent and more damaging with higher sea level. (Hugh Shipman photo.)

Just how much sea level will increase over the coming decades remains highly uncertain. Both global and regional studies suggest that sea level could be almost a foot higher in 50 years and perhaps 2 feet higher by the end of the 21st century.

The impact of rising sea level will depend on local variations in rates due to geologic and oceanographic factors that influence local sea level patterns, the sensitivity of different shorelines to higher water levels (Shipman 2009, National Research Council 2012), and the character of shoreline development.

The potential for sea level rise has implications for shoreline stabilization policies:

- New development and redevelopment should be located and designed to reduce vulnerability and avoid the need for future stabilization measures.
- Pressure to stabilize shorelines will be high, particularly following damaging storms. Communities may identify in advance those areas where armoring is an appropriate option and those where it is not.
- Storm damage and failure of stabilization structures will be opportunities to relocate at-risk development and to adopt softer, more resilient stabilization. Communities will need to anticipate pressure to rebuild existing development in increasingly vulnerable areas and should adopt strategies that enhance resilience to future coastal hazards.
- Higher seawalls and stronger dikes require space and will impact existing waterfront development. Reserve space for future stabilization and drainage infrastructure along shorelines where engineering solutions are appropriate.

SMP Handbook Appendix 1 provides guidance on addressing sea level rise in SMPs.

Addressing shoreline stabilization in SMPs

This section provides direction on addressing shoreline stabilization in SMPs. It discusses environment designations, new shoreline stabilization, replacement and repair, and shoreline permits and provides examples of language on these topics from comprehensive SMP updates approved by Ecology.

The significance of SMP language cannot be overstated. SMP language determines what can be approved. Clear language takes out any guesswork when reviewing and approving shoreline permits. The Shorelines Hearings Board and courts consider SMP language when making decisions.

Environment designations

SMPs establish permitted uses and modifications among shoreline environment designations and also dictate what types of shoreline permits are required. These may vary among shoreline environments. (See SMP Handbook Chapter 13, "Shoreline Environment Designations."

Environment designations also provide an opportunity to identify shoreline reaches that are particularly vulnerable to long-term erosion and slope instability, and to establish standards that foster safe development while also protecting ecological functions. This might be particularly relevant in areas of known or emerging erosion problems, particularly where public facilities and road or utility corridors occur along the shoreline.

The SMP Guidelines address shoreline modifications and stabilization mostly in general terms in all environment designations but the High Intensity environment [WAC 173-26-211(5)].

- For the Urban Conservancy and Shoreline Residential designations, the Guidelines direct SMPs to include standards for shoreline stabilization.

- In the Rural Conservancy environment, new shoreline stabilization and flood control works should be allowed only where there is a documented need to protect an existing structure or ecological functions, and mitigation is applied.

- For the Natural environment, the Guidelines state that subdivision of property that would require shoreline modification that adversely impacts ecological functions should not be allowed.

- In the Aquatic environment, shoreline modifications should be designed and managed to prevent water quality degradation and alteration of natural hydrographic conditions.

In SMPs, the purpose and management policies for shoreline environments can help to determine whether stabilization should be a permitted use, conditional use or prohibited. This would apply whether the SMP includes the shoreline environments in the SMP Guidelines or custom environments.

For example, some local governments have prohibited new shoreline stabilization within the Natural environment. The purpose of the Natural environment, is, in part, "to protect those shoreline areas that are relatively free of human influence or that include intact or minimally degraded shoreline functions intolerant of human use" [WAC 173-26-211(5)(a)(i)]. Only "very low intensity uses" should be allowed. One of the management policies states that a use that would "substantially degrade the ecological functions or natural character of the shoreline areas should not be allowed." Another management policy states, "significant vegetation removal that would reduce the capability of vegetation to perform normal ecological functions should not be allowed." The designation criteria for the Natural environment include ecologically intact shorelines that are generally free of structural shoreline modifications.

If a shoreline reach has considerable existing primary structures that may need protection through stabilization in the future, the Natural environment may not be not the most appropriate shoreline environment. However, if a shoreline reach generally meets the Natural environment criteria and has existing primary structures that may need protection through stabilization, the SMP should not prohibit future stabilization in this environment. As in all environment designations, any stabilization proposal to protect primary structures must demonstrate need.

In contrast with the Natural environment, the purpose of the High-intensity environment is to "provide for high-intensity water-oriented commercial, transportation, and industrial uses while protecting existing ecological functions and restoring ecological functions in areas that have been previously degraded."

Facilities for water-dependent uses may require shoreline stabilization measures such as bulkheads. For shorelines with high-intensity uses, allowing for shoreline stabilization would be consistent with the uses in the High-intensity environment. Permit requirements and SMP standards would still apply. High-intensity environments are often already highly developed and stabilization is in place, so SMP provisions should account for the likely replacement that will occur.

Examples

Following are examples from updated SMPs that require different shoreline permits or prohibit shoreline stabilization in varying shoreline environments.

Kirkland

- Natural: Hard and soft structural shoreline stabilization is prohibited.
- Urban Conservancy: Requires a conditional use permit for hard structural stabilization and substantial development permit for soft structural stabilization.
- Residential – L and Residential – M/H and Urban Mixed environments: Requires substantial development permit for both hard and soft structural stabilization.

Whatcom County

- Natural: Shoreline stabilization is prohibited. However, bioengineering methods may be permitted as a conditional use.

- Aquatic: Bulkheads and revetments are prohibited except for an approved water-dependent development, subject to policies and regulations of the SMP.
- Other eight shoreline environments: Bulkheads and revetments are permitted. However, bulkheads, revetments or similar hard structures on marine and lake accretion shoreforms, marine feeder bluffs and estuarine shores, and on wetland and rock shores require a conditional use permit.

Anacortes

- Natural: Hard structural stabilization is prohibited. Soft stabilization is permitted.
- Conservancy and Shoreline Residential: Conditional use permit is required for hard stabilization; soft stabilization is permitted.
- Other three shoreline environments: Hard and soft stabilization is permitted.

Pateros

- Natural: Bulkheads and revetments are prohibited.
- Other five shoreline environments: Bulkheads and revetments require a conditional use permit.

Standards for shoreline stabilization

The SMP Guidelines establish standards for new development, new stabilization measures and replacement stabilization. The Guidelines emphasize that new development in shoreline areas should be located and designed to avoid any need for future stabilization. New stabilization must be based on documented need through a geotechnical analysis, employ nonstructural or soft measures unless they are demonstrated to be insufficient, and result in no net loss of shoreline ecological functions [WAC 173-26-231(30(a)(iii)(E)].

The following section discusses how the Guidelines address various situations where stabilization might be considered. In each of these circumstances, the Guidelines require consideration of the following issues, which are discussed in subsequent sections.

- Demonstrate the need for stabilization.
- Address other causes of erosion.
- Investigate nonstructural and softer measures of stabilization.
- Assure no net loss of ecological functions.

Table 15-1: SMP shoreline stabilization standards, WAC 173-26-231(3)(a)(iii).

New development	New stabilization measures -	Stabilization replacement measures
Must achieve no net loss of shoreline ecological functions. Locate and design to avoid need for future stabilization. Prohibit if needed stabilization would cause significant impacts. Geotechnical analysis is required if development is proposed for steep slopes or bluffs. .	Not allowed except as follows: *To protect existing primary structure, if*: • Need to protect primary structures is demonstrated through geotechnical analysis. *To support new nonwater-dependent development, if*: • Erosion is not caused by upland conditions. • Nonstructural measures are not feasible or sufficient. • Need to protect primary structures is demonstrated through geotechnical analysis. *To support water-dependent development, if*: • Erosion is not caused by upland conditions. • Nonstructural measures are not feasible or sufficient. • Need to protect primary structures is demonstrated through geotechnical analysis. *To protect projects for shoreline restoration or hazardous substance remediation, if*: • Nonstructural measures are not feasible or sufficient. Where stabilization is authorized: • Limit to minimum size needed. • Must achieve no net loss of shoreline ecological functions.	Similar replacement stabilization allowed if there is a demonstrated need to protect principal structures or uses. Geotechnical analysis is not required. Replacement stabilization is not placed waterward of existing stabilization or OHWM unless residence was built before 1/1/92 and safety and environmental concerns exist. Remove existing stabilization if it causes net loss of ecological functions in critical saltwater habitats. Soft stabilization that restores ecological functions may be permitted waterward of OHWM. Where stabilization is authorized: • Limit to minimum size needed. • Must achieve no net loss of shoreline ecological functions.

New development

The intent of the Guidelines is to avoid the individual and cumulative net loss of shoreline ecological functions associated with the construction of shoreline stabilization structures. This starts by designing and locating new development in a way that avoids the need for any future stabilization.

The Guidelines require the following standards to be included in SMPs:

Avoiding the individual and cumulative net loss of shoreline ecological functions starts with designing and locating new development in a way that avoids the need for any future stabilization.

- Lots created as part of the subdivision process should not require shoreline stabilization in order for reasonable development to occur. A geotechnical analysis should identify unstable portions of the site, assess long-term rates and patterns of erosion, and assure that development does not increase potential erosion or instability.

- New development on steep slopes and bluffs should be located and set back so that stabilization is not likely to be needed during the life of the structure. This should be demonstrated in a geotechnical analysis that considers erosion rates and expected life span of the development.

- New development should not result in stabilization measures that would impact adjacent properties or adversely affect downstream or downdrift shorelines, in either the short term or the long term.

Shoreline stabilization policies and regulations can be included in the relevant shoreline use sections of the SMP as well as the shoreline modifications or shoreline stabilization section. Following are a few examples of policies and regulations that address new development, from updated SMPs approved by Ecology.

> New shore stabilization for new development is prohibited unless it can be demonstrated that the proposed use cannot be developed without shore protection, and a geotechnical analysis documents that alternative solutions are not feasible or do not provide sufficient protection. The need for shore stabilization shall be considered in the determination of whether to approve new water-dependent uses. Proposed designs for new or expanded shore stabilization shall be designed in accordance with applicable Department of Ecology and Department of Fish and Wildlife guidelines and certified by a qualified professional (Whatcom County SMP, 23.100.13.B.1 Allowed Use).

> 3. New development requiring bulkheads and/or similar protection should not be allowed. Shoreline uses should be located in a manner so that bulkheads and other structural stabilization are not likely to become necessary in the future (City of Kent SMP, Chapter 4, C. 2.b. Policies).

3. New development on steep slopes or bluffs shall be set back sufficiently to ensure that shoreline stabilization will not be needed during the life of the structure, as demonstrated by a geotechnical analysis by a geotechnical engineer or related professional licensed and in good standing in the State of Washington (City of Kent SMP, Chapter 4, C. 2.c. Regulations).

New shoreline stabilization measures

The SMP Guidelines outline standards for new stabilization measures in several different situations, which are discussed below:

- Protect an existing primary structure.
- Support new nonwater-dependent development.
- Support water-dependent development.
- Protect ecological restoration and hazardous substance remediation projects.

The standards are similar for each of these categories. In all cases, the emphasis is on avoiding the need for structural stabilization in the first place, and where it is necessary, minimizing its impacts as much as possible.

This emphasis carries out the mitigation sequence in WAC 173-26-201(2)(e)(i) so that all development achieves no net loss of ecological function.

Avoiding impacts is carried out by requiring a demonstration of need for shoreline stabilization.

If shoreline stabilization is demonstrated to be necessary and consistent with the standards outlined in the Guidelines (summarized in the table), **minimizing and compensating for the impact** occurs through the following:

- Requiring soft shoreline stabilization "unless demonstrated not to be sufficient to protect primary structures, dwellings and businesses."
- Limiting the size of shoreline stabilization to the minimum necessary to protect the structure.
- Mitigating erosion control structures to offset adverse impacts to beach sediment systems (e.g., through beach nourishment) [WAC 173-26-231(3)(a)(iii)(E)].

The Kitsap County SMP incorporates the mitigation sequence in General regulations:

WAC 173-26-201(2)(e)(i): "Master programs shall indicate that, where required, mitigation measures shall be applied in the following sequence of steps listed in order of priority, with (e)(i)(A) of this subsection being top priority.

(A) Avoiding the impact altogether by not taking a certain action or parts of an action;

(B) Minimizing impacts by limiting the degree or magnitude of the action and its implementation by using appropriate technology or by taking affirmative steps to avoid or reduce impacts;

(C) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;

D) Reducing or eliminating the impact over time by preservation and maintenance operations;

(E) Compensating for the impact by replacing, enhancing, or providing substitute resources or environments; and

(F) Monitoring the impact and the compensation projects and taking appropriate corrective measures."

> Soft shoreline stabilization measures shall be utilized unless demonstrated through a geotechnical analysis not to be sufficient to protect primary structures, dwellings and businesses. Alternatives for shoreline stabilization shall be based on the following order of preference:
> a. No action, increase building setbacks, or relocate structures;
> b. Soft shoreline stabilization constructed of natural materials including bioengineering, beach nourishment, protective berms, or vegetative stabilization;
> c. Hybrid shoreline stabilization, usually constructed of a mix of rock, logs and vegetation;
> d. Hard shoreline stabilization constructed of materials such as rock, riprap or concrete.
> e. When hard shoreline stabilization measures are demonstrated to be necessary, they must:
>
> > i. Limit the size of stabilization measures to the minimum necessary.
> > ii. Assure no net loss of shoreline ecological functions.
> > iii. Ensure that publically financed or subsidized shoreline erosion control measures do not restrict appropriate public access to the shoreline except where such access is determined to be infeasible because of incompatible uses, safety, security, or harm to ecological functions.
> > iv. Where feasible, incorporate ecological restoration and public access improvements into the project.
>
> i. Placement of shoreline stabilization methods shall follow the natural contour of the existing shoreline, be parallel to and at or above the OHWM.
> j. Shoreline stabilization on marine feeder bluffs, when determined necessary pursuant to the standards of this section, may require additional mitigation measures, including those necessary to offset the loss of sediment supply (K.C.C. 22.600.175.D.1).

The Issaquah SMP regulation to limit the length of stabilization addresses the minimization step of the mitigation sequence:

> 11. When allowed pursuant to the provisions of this Program, structural shoreline stabilization must meet all of the following requirements:
> a. The length of hard structural shoreline stabilization structures shall be minimized to the extent feasible. It shall be limited to the portion of a site where necessary to protect the primary structure/use and/or to connect to existing hard structural shoreline stabilization structures on adjacent properties (Issaquah SMP, 6.1.4, Shoreline Stabilization Regulations).

Protect existing primary structure: Existing structures may have been sited poorly or site conditions changed dramatically over time. Relocating existing primary structures is an option, but it may be difficult or infeasible due to specific aspects of the site or costs. Therefore, property owners may seek to protect the structure with shoreline stabilization.

Figure 15-8: This soft shoreline stabilization stabilizes the bank of Moses Lake and helps to protect the house, a primary structure. Views from the house and the lawn above the retaining wall are not obstructed by the vegetation. The rocks in the foreground are at the property line. (Doug Pineo photo.)

In order for new or expanded stabilization structures to be authorized for existing primary structures:

- A geotechnical analysis must conclusively document that the structure is in danger from shoreline erosion caused by tidal action, currents or waves. **Normal sloughing and erosion that do not threaten a structure do not constitute demonstration of need**. (See "Demonstrating need for stabilization" later in this chapter.)

- Shoreline stabilization measures must not result in a net loss of shoreline ecological functions.

Where erosion has been demonstrated to threaten a primary structure, the Guidelines require that softer methods of stabilization be employed unless demonstrated to be infeasible (Figure 15-8). See additional discussion in the *Soft Shoreline Stabilization* document.

Local governments have discretion in defining both primary and accessory uses and structures. SMPs can combine these in one definition. Examples include:

> "Primary structure" means any permanent building, road, bridge or utility requiring a permit or approval which is necessary to support the primary use of a site. Primary use means the predominate use of any lot or development as determined by county zoning regulations (Snohomish County SMP, 30.91P.292).
>
> Primary Structure – A structure housing the main or principal use of the lot on which the structure is situated, including a detached garage associated with the primary structure. This term shall not include decks, patios or similar improvements, and accessory uses, structures or activities as defined in Chapter 5 KZC (City of Kirkland SMP, 83.80.87).

Roads and bridges are typically primary structures in their own right. For example, arterial roads, highways and bridges support more than just the primary use of one site.

Another approach is to separately define accessory uses and structures as those that are subordinate to and supportive of the primary use or structure. For example, accessory use can be defined as "a use that is demonstrably subordinate and incidental to the principal use and which

functionally supports its activity." Accessory structures include drainlines, stairways, sheds, gazebos and patios, for example.

Whatcom County defines accessory structure as “a structure that is incidental and subordinate to a primary use and located on the same lot as the primary use, such as barns, garages, storage sheds, and similar structures” (Whatcom County SMP, Chapter 11 Definitions #2).

Support new nonwater-dependent development: As described above, the Guidelines require that “new development should be located and designed to avoid the need for future shoreline stabilization to the extent feasible” [WAC 173-26-231(3)(a)(iii)(A)]. Where the size or configuration of a property precludes this, new structural stabilization measures may be allowed only if:

- Erosion is not caused by upland conditions, such as loss of vegetation and drainage.
- Planting vegetation, installing on-site drainage improvements or other nonstructural measures, such as placing development further from the shoreline, are not feasible or not sufficient.
- A geotechnical report demonstrates the need to protect primary structures from damage due to erosion caused by natural processes such as tidal action, currents and waves.
- The erosion control structure will not cause a net loss of shoreline ecological functions.

Support water-dependent development: Water-dependent development relies on a location on or adjacent to the water due to the nature of its operations. The need for physical proximity to the shoreline in order to moor boats, transfer marine cargo, and operate pump facilities, for example, may require shoreline stabilization. This does not apply to office space or materials handling facilities that may be part of the operation, but do not require direct access to the water. The SMP Guidelines require that even water-dependent developments should avoid the need for stabilization, if feasible, and avoid its adverse impacts. Stabilization is allowed if:

- Erosion is not caused by upland conditions, such as loss of vegetation and drainage.
- Planting vegetation, installing on-site drainage improvements or other nonstructural measures are not feasible or not sufficient.
- A geotechnical report demonstrates the need to protect primary structures from damage due to erosion.
- The stabilization structure will not result in a net loss of shoreline ecological functions.

Protect projects for restoration of ecological functions or hazardous substance remediation: Restoration projects may include stabilization due to site and project constraints such as adjacent development, flood potential or public access requirements. Restoration projects should allow for natural processes, such as erosion and stream processes, to occur.

Where hazardous substances are being removed, shoreline stabilization may no longer be needed. Stabilization structures that hold contaminated soils in place could be removed, for example. In cleaning up and redeveloping contaminated sites, there are often opportunities to remove, reduce, or avoid impacts to ecological functions that result from shoreline stabilization.

The stabilization standards for restoration and hazardous substance remediation are less strict than they are for the two preceding categories. A demonstration of need is not required. Requirements include:

- Nonstructural measures, planting vegetation or installing on-site drainage improvements are not feasible or not sufficient.
- Erosion control structure will not cause a net loss of shoreline ecological functions.

Shoreline stabilization to protect existing agriculture

Maintaining and enhancing agriculture and other natural resource industries is one of the goals of the Growth Management Act (GMA). Counties are directed to preserve rural-based economies while maintaining compatibility with the use of the land by wildlife and for fish and wildlife habitat [RCW 36.70A.020(8), RCW 36.70A.011]. Under the SMA, the legislature has directed that SMPs "shall not require modification of or limit agricultural activities occurring on agricultural lands." The definition of agricultural activities includes "maintaining agricultural lands under production or cultivation." However, *new* agriculture developments must meet SMP standards, including requirements for new stabilization structures [WAC 173-26-241(3)(a)(v)].

In some locations along streams in both Eastern and Western Washington, agricultural lands are being heavily eroded and farmers are losing valuable land. Counties have asked how Shoreline Master Programs can be written and interpreted to allow new stabilization structures to protect valuable agricultural lands while also ensuring environmental protection, consistent with their obligations under both the GMA and the SMA.

Provisions for protecting agriculture lands

The general principles in the Guidelines for shoreline modifications (including stabilization) provide direction regarding legally existing shoreline uses such as agriculture:

> Allow structural shoreline modifications **only where they are demonstrated to be necessary** to support or protect an allowed primary structure **or a legally existing shoreline use that is in danger of loss or substantial damage** or are necessary for reconfiguration of the shoreline for mitigation or enhancement purposes [WAC 173-26-231(2)(a)].

While the more detailed shoreline stabilization section of the SMP Guidelines generally focuses on new development and structures and does not specifically address the protection of shoreline uses, local governments may rely on this general principle to allow for shoreline stabilization measures to protect existing agriculture land when consistent with other provisions of the SMP guidelines.

Key provisions to consider when preparing SMPs or evaluating proposals for new stabilization on agricultural lands:

- New stabilization measures must be demonstrated to be necessary [WAC 173-26-231(2)(a)]. The Guidelines do not require a geotechnical report for a structural modification to protect a legally existing use but local governments may require one if desired. Documentation to demonstrate the need for new structures might include photographic time series, an analysis of lost farmland, and analysis of likely impacts if stabilization is not provided.

- The size of stabilization measures should be limited to the minimum necessary. Stabilization measures must not result in a net loss of shoreline ecological functions [WAC 173-26-231(3)(a)(iii)(E)]. Following the required mitigation sequence assures that potential impacts are first avoided, then minimized, and include mitigation for unavoidable impacts [WAC 173-26-231(2)(b); WAC 173-26-231(2)(d); WAC 173-26-201(2)(e)]. By following the mitigation sequence, any stabilization measure will be the minimum necessary and achieve the no net loss requirement.

- Soft stabilization shall be used unless it is demonstrated not to be sufficient [WAC 173-26-231(3)(a)(iii)(E)]. Vegetation enhancement, upland drainage control, and biotechnical measures are among the soft measures that must be considered.

- Stabilization and other modifications must be appropriate to the particular shoreline and environmental conditions [WAC 173-26-231(2)(c)]. Geologic processes and habitat vary along different types of shorelines and even in different locations on the same water body. If stabilization is proposed on a stream, an analysis of the stream reach and review of the shoreline inventory and characterization will provide useful information for determining an appropriate stabilization measure.

- Stabilizing agricultural fields may potentially interfere with natural channel migration zone processes. Channel migration promotes biodiversity on floodplains and is vital to habitat formation. In addition, impediments to this process can have significant consequences on migration and erosion rates downstream. Ecology's guidelines recognize that reducing shoreline erosion may be appropriate in channel migration zones provided the applicant demonstrates the erosion rate exceeds that which would normally occur in a natural condition. The applicant should show that the stabilization measure will not interfere with normal fluvial hydrological and geomorphological processes [WAC 173-26-221(3)(c)].

Bioengineering for habitat protection and shoreline stabilization

Some local governments have approved bioengineering techniques to both stabilize shorelines along agriculture lands and protect or enhance fish habitat. These bioengineering projects typically include structural elements (e.g., rock or large wood) together with live woody vegetation that establishes a root system resistant to erosion and provides habitat. Because they include habitat improvements, they may also be considered restoration.

These types of projects are consistent with the Guidelines provisions allowing structural stabilization to protect projects to restore ecological functions if they meet the following

conditions: 1) Nonstructural measures, on-site drainage improvements or planting vegetation are not feasible or not sufficient; and 2) The stabilization structure will not result in a net loss of shoreline ecological functions [WAC 173-26-231(3)(a)(iii)(IV)].

SMP examples

Snohomish County and Whatcom County address protection of agriculture lands through use of shoreline stabilization in their SMPs. Snohomish County's language specifies that stabilization may be used to protect farmland designated in the comprehensive plan. Whatcom County's SMP allows for protection of existing commercial farmsteads on low, inner-most stream channel banks but does not otherwise mention stabilization to protect farmland. Yakima County's SMP mentions "threat to existing property" but does not specify agriculture land.

Snohomish County SMP:

Shoreline stabilization measures are used to reduce sedimentation and erosion.

(1) The following general regulations apply to shoreline and bank stabilization within shorelines:

(a) Normal maintenance or repair of existing shoreline stabilization structures is allowed.

(b) New, enlarged or replacement structural shoreline stabilization measures may only be used:

(i) To protect:

(A) Existing primary structures, utilities, roads and bridge;

(B) New utilities or public bridges and transportation structures allowed pursuant to 30.62B.330(3)

(C) Designated farmland on the county's comprehensive plan; and

(D) Projects where the sole purpose is to protect or restore shoreline ecological functions; and

(ii) When a geotechnical analysis conducted by a qualified engineer or geologist with experience evaluating and constructing nonstructural stabilization techniques demonstrates that:

(A) Nonstructural shoreline stabilization solutions are not feasible;

(B) Structural stabilization is necessary to provide protection from erosion caused by natural processes such as tidal action, currents, waves or channel migration and that the erosion is not caused by upland conditions, such as loss of vegetation and drainage; and

(C) The erosion rate exceeds that which would normally occur in a natural condition and that the structural stabilization measure would not interfere with hydrological and geomorphologic processes normally acting under a natural condition (Snohomish County SMP, 36.67.575, Shoreline and bank stabilization).

Whatcom County SMP:

In those limited cases where a proposed bulkhead, revetment or other similar structure meets the criteria in this section for a shoreline permit or an exemption under SMP 23.60.02.2, and to assure that such revetment or similar structure will be consistent with this Program, the Administrator shall review the proposed design for consistency with state guidelines for stream bank protection as it relates to local physical conditions and issue written findings that the location and design meet all criteria of this Program, subject to the following:

c. A geotechnical analysis of stream geomorphology both upstream and downstream shall be performed to assess the physical character and hydraulic energy potential of the specific stream reach and adjacent reaches upstream or down, and assure that the physical integrity of the stream corridor is maintained, that stream processes are not adversely affected, and that the revetment will not cause significant damage to other properties or valuable shoreline resources. In addition:

(1) Revetments or similar structures shall not be developed on the low, inner-most channel banks in a stream except to protect public works, railways and existing commercial farmsteads. **(**Whatcom County Shoreline Management Program, 23.100.13.B.3 Shore Stabilization on Streams).

Yakima County SMP:

The following provisions shall apply to shore stabilization projects:

1) Shore stabilization projects shall be allowed only where there is evidence of erosion which clearly represents a threat to existing property, structures, or facilities, and which stabilization will not jeopardize other upstream or downstream properties

6) Stream bank and lakeshore protection shall be accomplished using bioengineered (biotechnical) designs employing living plant materials as primary structural components of resistance to erosion and mass wasting, unless a report prepared by a qualified engineer experienced in soil bioengineering (biotechnical) and shoreline protection demonstrates that conventional structural armoring is the only feasible means of stabilizing the subject stream bank or lakeshore (Yakima County SMP, 16D.06.19, Shore Stabilization).

Replacement and repair

In many areas with developed shorelines, replacing and repairing existing shoreline stabilization occurs more frequently than building new stabilization structures. The difference between replacement and repair sometimes is a point of confusion. For SMP implementation purposes, it's best if SMPs include clear, mutually exclusive definitions for repair, replacement, new and expansion of shoreline stabilization. Definitions should be consistent with those included in the WAC, discussed below.

This section provides suggestions on distinguishing between repair and replacement for writing or implementing SMPs in a way that is consistent with the underlying intent of the SMP Guidelines.

Replacement

Replacement occurs when a new structure is built at a location where an older (still intact) structure exists (Figure 15-9). Typical reasons to replace stabilization include:

- Site is being redeveloped.
- The structure is failing and major repairs would be insufficient to address the problem.
- An opportunity exists to improve the structure with better design.
- Existing stabilization inadequately protects the primary structure.

Figure 15-9: Replacing a structure such as this failing timber bulkhead often involves a new type of structure built to current standards. In some cases, replacement structures can provide an opportunity to improve shoreline conditions by incorporating softer design elements or moving the structure landward. (Hugh Shipman photo.)

The SMP Guidelines define replacement as "the construction of a new structure to perform a shoreline stabilization function of an existing structure which can no longer adequately serve its purpose" [WAC 173-26-231(3)(a)(iii)(C)].

Applicants for replacement stabilization must show a "demonstrated need to protect principal uses or structures from erosion caused by currents, tidal action or waves." However, unlike applications for new stabilization, a geotechnical report is not required. A local SMP may include options for how an applicant can demonstrate need for replacement stabilization or define information that can be used to demonstrate need for replacement. These may include:

- Photographs.
- Topographic data.
- Distance of the primary structure from MHHW.
- Observed effects of storms.
- Analysis of likely impacts if stabilization is not replaced. (See "Demonstrating need for stabilization" later in this chapter.

Replacement stabilization cannot result in the net loss of ecological functions. To ensure this, the Guidelines require structures to be built at or landward of their original location, unless there are overriding safety or environmental concerns. If that's the case, stabilization may be rebuilt immediately abutting the waterward side of the original stabilization [WAC 173-26-231(3)(a)(iii)(C)].

Ecology's permit rules require replacements be "comparable to the original structure or development including but not limited to its size, shape, configuration, location and external appearance" [WAC 173-27-040(2)(b)].

However, "comparable" does not mean a replacement must be exactly the same. In some cases, a replacement bulkhead cannot be built in the same location as the one being replaced. If the bulkhead has deteriorated to such an extent that the OHWM has moved landward of the bulkhead, then the replacement bulkhead must be built at or near the actual OHWM [WAC 173-27-040(2)(c)].

The Guidelines require that wherever they are authorized, stabilization measures shall be limited to the minimum necessary. SMPs can potentially minimize environmental impacts of the replacement structure by requiring evaluation of the potential to use softer design elements, to ease transitions to adjacent sites, or to incorporate more natural drainage into the replacement design.

"Additions to or increases in size of existing shoreline stabilization measures shall be considered new structures" [WAC 173-26-231(3)(a)(iii)(C)]. Realistically, a replacement structure may in some cases need to be slightly larger than the original, depending on site configuration and current design and construction methods, including those to reduce impacts on neighboring sites.

For example, footings for the replacement may need to be larger than those for the original, the structure may need to be designed to fit with an adjacent bulkhead, or the proposed replacement is a different type than the original, resulting in a slightly different size.

Repair

Repair of shoreline stabilization occurs when the overall structure is still functional, but a portion requires maintenance.

Repairs often occur following purchase of property or after storm damage. Typical reasons to repair stabilization structures include:

- Portion of collapsed or subsided riprap.
- Poor drainage.
- Portion of cracked or shifted concrete.
- Portions of rotting wood or other materials.
- Damaged segment due to storm or landslide.
- Settling of backfill.

Repairs are addressed in "Shoreline management permit and enforcement procedures" WAC 173-27-040(2)(b). (See box.) This rule also defines maintenance as "those usual acts to prevent a decline, lapse, or cessation from a lawfully established condition." For stabilization, maintenance may include clearing drains, minor patching of damaged materials, replacing hardware and chinking rock structures. Other than minor tasks such as cleaning drains, painting or resurfacing, much of the work on existing stabilization structures would be a repair, unless it's so extensive it constitutes replacement.

> WAC 173-27-040(2)(b): "'Normal repair' means to restore a development to a state comparable to its original condition, including but not limited to its size, shape, configuration, location and external appearance, within a reasonable period after decay or partial destruction, except where repair causes substantial adverse effects to shoreline resource or environment.
>
> Replacement of a structure or development may be authorized as repair where such replacement is the common method of repair for the type of structure or development and the replacement structure or development is comparable to the original structure or development including but not limited to its size, shape, configuration, location and external appearance and the replacement does not cause substantial adverse effects to shoreline resources or environment."

Distinguishing between replacement and repair

Ecology's permit procedures state that replacement may be authorized as repair "where such replacement is the common method of repair…" (See box.) However, if 60% of a wood bulkhead must be removed and replaced, is that repair or replacement? Questions like this have arisen. Although local governments may rely on the criteria in Ecology's rule, Ecology recommends the SMP provide a more definitive distinction.

For example, the city of Lacey SMP sets a 50% of value standard that makes a distinction between repair and replacement of a bulkhead:

> 2. Where the value of repair of an existing bulkhead designed and located for the protection of an existing single family home or accessory structure is equal to or exceeds 50% of the value of the bulkhead it shall be considered a replacement and processed as a conditional use permit pursuant to requirements of Section 17.30.047 (Lacey SMP, 17.51.020 Bulkheads - Development Standards).

The City of Kirkland SMP uses 50 % or 75% of the linear length of hard shoreline stabilization measures in defining replacement or major repair, based on the part of the structure in disrepair:

> 4. Replacement or Major Repair of Hard Structural Shoreline Stabilization
> a. For the purposes of this section, major repair or replacement of a hard shoreline stabilization measure shall include the following activities:
>
> 1) A repair needed to a portion of an existing stabilization structure that has collapsed, eroded away or otherwise demonstrated a loss of structural integrity, or in which the repair work involves modification of the toe rock or footings, and the repair is 50 percent or greater than the linear length of the shoreline stabilization measure; or
>
> 2) A repair to more than 75 percent of the linear length of the existing hard structural shoreline stabilization measure in which the repair work involves replacement of top or middle course rocks or other similar repair activities (Kirkland SMP, 83.300 Shoreline Stabilization).

The Kirkland SMP also clarifies the exemption from substantial development permit requirements for normal maintenance and repair activities in WAC 173-27-040(2)(b). This clarification states that replacement of a stabilization structure is a repair when hard structural shoreline stabilization is replaced with soft shoreline stabilization. The city's intention is to encourage soft shoreline stabilization by providing an easier path than would happen with a substantial development permit.

> *2*. Special Provisions – The following provides additional clarification on the application of the exemptions listed in WAC 173-27-040:
>
> b. Normal maintenance or repair of existing structures or developments - Normal maintenance or repair of existing structures or developments, including some replacement of existing structures, is included in the permit exemption provided in WAC 173-27-040(2)(b). For the purposes of interpreting this provision, the following replacement activities shall not be considered a substantial development:
>
> 1) Replacement of an existing hard structural shoreline stabilization measure with a soft shoreline stabilization measure consistent with the provisions contained in KZC 83.300 (Kirkland SMP, 141.40 Exemption from Permit Requirements).

Shoreline permits

During SMP updates, questions have come up about what type of shoreline permit to require for shoreline stabilization projects. For stabilization projects other than for single family residences, substantial development permits (SDPs) and sometimes conditional use permits (CUPs), or both, are typically required.

Permits and exemptions

Substantial development is development that exceeds a specific dollar threshold ($6,416 since 2012 and at time of publication) and development that "materially interferes with the normal public use of the water or shorelines of the state" [RCW 90.58.030(3)(e)]. A SDP is required for such development.

Shoreline stabilization projects generally would meet the dollar threshold of substantial development and require an SDP. However, the Shoreline Management Act states that "construction of the normal protective bulkhead common to single family residences" is not substantial development [RCW 90.58.030(30(e)(ii)]. An SDP may not be required for these bulkheads. While the SMA exempts these bulkheads from the procedural step of obtaining an SDP, the proposal still must comply with applicable policies and standards from the SMA and the local master program.

The shoreline permitting rules in WAC 173-27-040 further define the bulkhead exemption from the SDP process:

> A "normal protective" bulkhead includes those structural and nonstructural developments installed at or near, and parallel to, the ordinary high water mark for the sole purpose of protecting an existing single-family residence and appurtenant structures from loss or damage by erosion. A normal protective bulkhead is not exempt if constructed for the purpose of creating dry land.

Despite this exemption from the SDP process, some SMPs require conditional use permits (CUPs) for residential shoreline stabilization projects. CUPs are sent to Ecology for review and approval and subject to appeal to the Shorelines Hearings Board, while exemptions are not.

CUPs must be consistent with the review criteria in WAC 173-27-160. These include compatibility with other authorized uses in the area, no substantial detrimental effect to the public interest, and consideration of cumulative impact of additional requests for like actions in the area.

Considerations

When deciding what types of permits to require for shoreline stabilization projects, it may be helpful to review SMP reports such as the shoreline inventory, use analysis, cumulative impacts analysis and restoration plan. These resources describe existing development and anticipated future development. Is existing development likely to need the protection of shoreline stabilization? This knowledge will be helpful in preparing shoreline stabilization regulations tailored to local conditions.

Some local governments require CUPs for shoreline stabilization projects or for certain types of stabilization projects or under certain conditions. For example, one SMP requires a conditional use permit for a bulkhead if existing bulkheads are more than 100 feet away from the project

site's property lines. Other SMPs require CUPs for bulkheads in a Natural shoreline environment. One local government requires a CUP for replacement bulkheads.

Keep in mind the requirements established in the Guidelines. For most new or expanded stabilization projects, applicants must demonstrate need through a geotechnical analysis. Soft stabilization measures must be used, unless the analysis demonstrates they would not be sufficient to protect primary structures. All new stabilization must achieve no net loss of shoreline ecological functions. Cumulative impacts of reasonably foreseeable development must be analyzed in shoreline cumulative impacts analyses. Given these requirements, consider what would be gained by requiring CUPs.

Additional considerations include:

- Don't conflate a permit process with protection. Can specific regulations in the SMP address all likely circumstances in which shoreline stabilization would be sought? If so, a CUP may not be needed. For example, a road project in the capital improvement plan may require stabilization. If this is known, why not establish the requirements for an SDP in the master program?
- Would requiring a CUP result in different conditions and mitigation than not requiring a CUP?
- A local CUP process may allow for public review of the project, compared with projects that are exempt from the SDP process.
- CUPs require review and approval by Ecology, and that adds some time to the process. CUPs and SDPs may be appealed to the Shorelines Hearings Board, compared with projects that are exempt from permit requirements.

Demonstrating need for stabilization

The SMP Guidelines emphasize the avoidance of stabilization measures as the most effective way to reduce cumulative and long-term environmental impacts to the shoreline. SMPs must require applicants for new and replacement stabilization to demonstrate a need to protect primary structures. This section provides guidance for assessing threats to primary structures with some examples and reviews ways to estimate risk.

Assessing threats to primary structures

The SMP Guidelines identify when stabilization measures may be justified and briefly indicate the categories of structures that can be protected. As described earlier, these include existing primary structures, primary structures for new non water-dependent development, and primary structures for new water-dependent development. [WAC 173-26-231 (B)(I, II and III)].

In addition to the Guidelines requirements outlining when stabilization is warranted to protect primary structures, SMPs may include additional criteria that reflect local conditions. Considerations may include:

- Continued erosion would lead to a significant risk to public safety or the environment.
- No feasible options exist to move the at-risk structure out of harm's way.
- The primary structure is well-built and will be viable for a long time after stabilization is provided.
- There is an overriding public benefit.
- Cultural resources identified through the Department of Archaeology and Historic Preservation or through local ordinances warrant protection.
- Stabilization would not assure the long-term safety of the structure, perhaps due to its location within a large landslide or on historic fill in an area subject to flooding.

Examples

Following are examples of several shoreline uses identified in the SMP Guidelines and a discussion regarding when new and replacement shoreline stabilization may or may not be consistent with the Guidelines. These are provided to help with understanding of typical stabilization scenarios as SMP regulations are developed. The examples are simple, while the real world is not always so simple.

In general, natural features such as trees are normal elements of the shoreline landscape and subject to erosion. Stabilization would not be warranted to protect these features.

Residential development: A residence is a primary structure. It may warrant stabilization if there is an imminent risk to safety or the environment, the stabilization will not result in a net loss of shoreline ecological functions, and the stabilization assures long-term protection of the structure. If these conditions aren't met, stabilization may not be warranted and other options, such as relocation of the at-risk structure to a safer location on the site, should be considered.

Figure 15-10: This home is located on a shoreline with an eroding bank. The home is not in any danger; stabilization would not be allowed. In the future, lawns, trees, beach stairs or other features may be affected by erosion, but this would not justify construction of a bulkhead or other stabilization. (Hugh Shipman photo.)

Some accessories to primary structures, such as drainlines or stairways, are not primary structures and do not warrant stabilization. These are often built in areas that are inherently unstable. They should be designed to accommodate erosion or they should be replaced or relocated as necessary.

Sheds, gazebos and patios are not primary structures, are relatively easy to relocate and do not warrant shoreline stabilization. This is also true of landscaping in general, including lawns, paths, and irrigation systems.

New residential development, including appurtenant structures and uses, should be set back enough so that structural stabilization is not needed to protect them [WAC 173-26-241(3)(9)].

Recreational development: Many recreational developments are located on or near the shoreline. These include trails, roads, ball fields, restrooms, visitor centers, picnic tables and shelters and campgrounds, for example.

Some park structures provide a public benefit. A paved trail to or along the shoreline provides public access, giving people the opportunity to enjoy and learn about shoreline resources. However, if the trail can be moved relatively easy, or shoreline stabilization would not assure its long-term survival, stabilization may not be the best solution.

Primary permanent structures such as restrooms connected to utilities may warrant stabilization, if risk to the structure is documented through a geotechnical report. There may be significant safety or environmental risks if the structure or sewer lines are damaged by erosion. Alternatively, relocation of accessory structures to a safer area may be required in cases where stabilization is not warranted. For example, playground equipment, picnic tables, picnic shelters and outhouses are not primary structures. If erosion threatens them, they should be moved to areas that are not at risk of erosion.

Figure 15-11: Erosion affects the shoreline of this park, but there are no primary structures at risk. Upland improvements such as paths, picnic tables, and ball courts can be shifted or reconfigured to accommodate the erosion without the need for a stabilization structure. (Hugh Shipman photo)

Figure 15-12: This county road follows the top edge of a bluff on Hood Canal. Erosion impacts the road in some locations. Stabilization may be justified because of the public benefit conferred by the road. However, protecting a road in this location in the long-term will be extremely costly and will adversely impact the shoreline. Realignment of the road, perhaps combined with softer methods of erosion control, may be a more judicious response.

The risk to the road, a primary structure, should be evaluated in a geotechnical report. Any contributing factors, such as uphill drainage, should be addressed, and the potential for relocation should be evaluated. (Hugh Shipman photo.)

Transportation: Public roads along the shoreline are typically primary structures and are sometimes threatened by erosion. These roads generally provide a public benefit, allowing the movement of people and goods. Road failures may threaten the safety of those traveling on the road or living in the vicinity, or may affect emergency access. In addition, transportation corridors often serve as utility corridors. Erosion has the potential to harm both roads and utilities.

Modifying or relocating or the road may be considered and determined to be the best solution, even though the SMP Guidelines do not require relocation of primary structures. Some roads may be difficult to relocate, due to their location along bluffs or in the vicinity of critical areas.

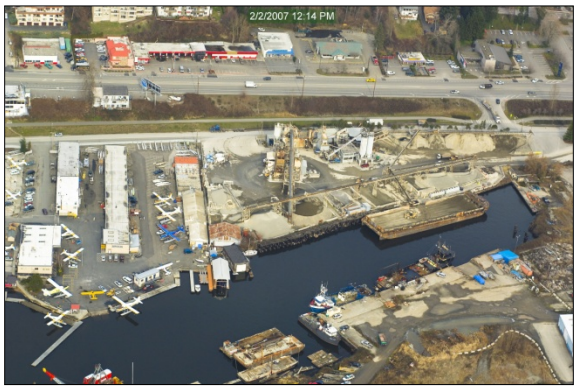


Figure 15-13: This industrial area in the city of Kenmore on Lake Washington includes a seaplane facility, concrete plant and asphalt plant. Should the shoreline stabilization need replacement, demonstration of need might include photographs, topographic data, distance of primary structures from the water, and analysis of likely impacts if stabilization is not replaced. (Washington State Coastal Atlas photo.)

Commercial and industrial development:
Commercial and industrial development on the shoreline often includes a water-dependent use such as a grain loading terminal or a boat yard. The specific functions or operations of these types of developments may depend on shoreline stabilization because the facility must be built at the water's edge in order to operate at that location. Other commercial uses, such as institutions, are not water-dependent.

For example, in a boat yard, cranes that move small boats from trailers to the water are a necessary component of the use and must be located near the shoreline in order to operate. Shoreline stabilization is likely necessary for this type of water-dependent development. However, an office building and rental shack are accessory structures, are not water-dependent, and do not need to be at the water's edge. Shoreline stabilization to support these accessory uses would not be justified as being consistent with the SMP Guidelines.

The need for new structural stabilization measures for primary structures that are part of a water-dependent development must be demonstrated through a detailed description of water-dependent components of the use and a geotechnical report describing the physical need for the stabilization.

What constitutes threat?

Figure 15-14: The old Smith Island lighthouse in the Strait of Juan de Fuca was clearly threatened by rapid erosion at the time of this photo in the 1980s and had already been replaced by a new structure farther landward. When structures are seriously threatened by erosion, relocation is often the best option. (Gerald Thorsen photo).

In general, the Guidelines discourage new stabilization of the shoreline except when it is necessary to protect primary structures from erosion and when other alternatives are not available. The Guidelines include general criteria for defining when a structure is determined to be sufficiently threatened to warrant stabilization. Local SMPs may provide more specificity to guide the work of geotechnical consultants.

The Guidelines standards for shoreline stabilization to protect **existing** primary structures requires conclusive evidence in a geotechnical report that the structure is in **danger** from shoreline erosion. The standards for **new primary structures** requires evidence from a geotechnical report that stabilization is needed to protect the structures from **damage** due to erosion.

Normal erosion

Erosion is an important natural process that provides ecological benefits and "normal sloughing, erosion of steep bluffs, and shoreline erosion itself, without a scientific or geotechnical analysis, is not demonstration of need" [WAC 173-26-231(3)(a)(iii)(B)(I)]. This emphasizes that **the need for stabilization is related to the threat from erosion**, not simply the fact that erosion is occurring.

For new development, normal patterns of erosion can often be anticipated and can be accommodated in a development plan that properly considers anticipated risks at a particular site. Stabilization should not be permitted in every situation where erosion is observed, as it would ultimately occur almost everywhere. Therefore, the language in the Guidelines prescribes the circumstances in which stabilization is allowed.

Substantial damage from erosion

The Guidelines' general principles for shoreline modifications allow for shoreline modifications to protect a primary structure or legal shoreline use where there is "danger of loss or substantial damage" [WAC 173-26-231(2)(a)]. Local governments may opt to define substantial damage to provide more direction for geotechnical reports. For example:

"Substantial damage may include undermining of a foundation or a support pier that affects the structural integrity, direct damage from waves and floating debris, or the loss of a portion of a road, utility corridor, or water-dependent operation. It would generally not extend to routine wear associated with proximity to the water such as from the effects of wave splash and salt spray. Potential damage to secondary structures, yard area and landscaping, or natural features such as trees, would not generally be a basis for structural stabilization measures."

Where potential substantial damage can be documented, stabilization may be justified if it will effectively address the threat. However, if an upland building or road will remain in long-term danger from erosion, slope failure, or high-water damage after an erosion control structure is built, then removal or relocation of the structure is optional and potentially a more durable long-term solution and would reduce the potential adverse consequences for the shoreline environment.

Time frame

To demonstrate the need for new or expanded stabilization, the Guidelines require a site-specific geotechnical report that addresses the time frame and rates of erosion (see box). The Guidelines state that as a general matter, hard armoring solutions should be allowed only when the "the report confirms that there is a significant possibility that such a structure will be damaged within three years." This underscores that the Guidelines intend stabilization to only be used as a last resort, not simply when erosion is observed. The Guidelines acknowledge that geotechnical reports may be used to justify the use of soft stabilization measures where "the need is not as immediate as the three years."

> WAC 173-26-231(3)(a)(iii)(D):
> "Geotechnical reports pursuant to this section that address the need to prevent potential damage to a primary structure shall address the necessity for shoreline stabilization by estimating time frames and rates of erosion and report on the urgency associated with the specific situation. As a general matter, hard armoring solutions should not be authorized except when a report confirms that there is a significant possibility that such a structure will be damaged within three years as a result of shoreline erosion in the absence of such hard armoring measures, or where waiting until the need is that immediate, would foreclose the opportunity to use measures that avoid impacts on ecological functions. Thus, where the geotechnical report confirms a need to prevent potential damage to a primary structure, but the need is not as immediate as the three years, that report may still be used to justify more immediate authorization to protect against erosion using soft measures."

Local governments may want to clarify that geotechnical reports address the full range of risks, and not generalize the risk based solely on long-term erosion rates. Erosion rates are difficult to measure and often vary greatly from one year to the next. On Puget Sound, for example, long-term rates are usually slow and few structures will be threatened within three years, based on historic long-term erosion rates. A geotechnical reports may identify the potential threats to a structure from single, infrequent events (such as a storm, a flood event, or a landslide), in addition to threats from chronic erosion.

A structure may be vulnerable to erosion due to proximity to the shoreline or due to very high and sustained erosion rates. A structure may also be vulnerable to rapid erosion accompanying a major flood or from a large bank failure. The SMP may describe some options to assessing risk as discussed below in "Approaches to evaluating risk" below.

The reason for requiring geotechnical reports is to demonstrate need for stabilization that will actually protect a primary structure. Even if a primary structure is in immediate danger from erosion, stabilization is only warranted if it will substantially reduce the risk. Stabilization should not provide a false sense of security, nor should it be built where it is likely to fail and cause other damage to the shoreline. If stabilization is likely to fail, or unlikely to protect the at-risk structure, then SMPs may encourage relocation or removal of the structure.

For example, if the threat is from flooding, not erosion, a geotechnical report may include recommendations for elevation or flood-proofing of structures or their relocation out of the flood-prone area.

Erosion scenarios in different settings

Shoreline erosion and storm damage can take several different forms, depending on the geomorphic setting. This can influence interpretations of "normal" erosion, the risk and timeframe of the threat, and the way in which geotechnical reports evaluate the risk.

Discussion of three common erosion scenarios follows:

- The first is chronic erosion, where the shoreline recedes relatively gradually over time. This is usually driven by waves (on lakes and marine shores) or by currents (on streams and rivers).

- The second scenario concerns high banks and bluffs that are subject to larger failures and landslides. In this case, single infrequent events can cause a large amount of erosion and potentially impact development many tens of feet from the edge of a stream bank or coastal bluff.

- The third case addresses low-lying shorelines subject to flood events and storm waves.

Chronic erosion

The simplest erosion scenario involves the chronic retreat of the shoreline over time. Most marine and freshwater shorelines are subject to long-term erosion. On rivers, the rate of erosion may be determined by the character of the river bank, the magnitude and frequency of high flows, and other factors that influence the migration of the channel. On lakes and marine shorelines, the rate is typically a function of wave action and the geology of the eroding shoreline, but also may be affected by nearby structures.

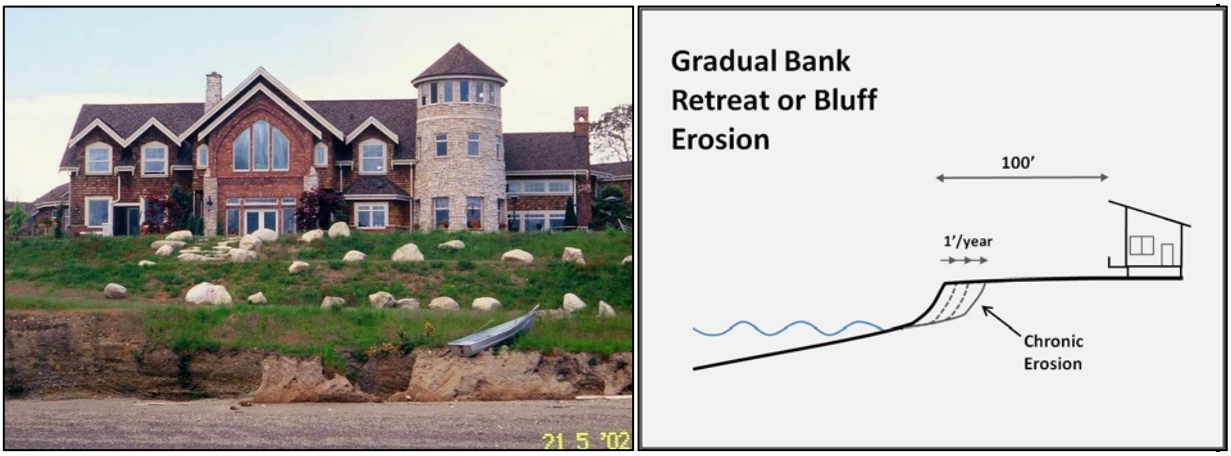


Figure 15-15: The new home was constructed on a shoreline experiencing chronic erosion. Although erosion is occurring, the long-term rate is slow and poses no threat to the structure. The cartoon illustrates chronic erosion and bank retreat. The risk to the upland structure is determined by the long-term rate of erosion and the distance of the structure from the eroding bank. (Hugh Shipman photo and graphic.)

The threat to a home or other structure is determined by 1) the rate of erosion and, 2) the distance of the structure from the edge. For example, if the long-term erosion rate is 6 inches/year, a building located 50 feet from the shoreline would be directly threatened in 100 years. On Puget Sound shorelines, long-term erosion rates are usually less than a few inches per year, but this may occur as a single 3-foot loss every few decades. Although such an event may be disconcerting to a property owner, a home built 60 feet from the bank will be in no direct danger for centuries.

In most cases, the gradual retreat of the shoreline can be anticipated, even if the precise rate of erosion or timing of erosion events is difficult to predict. This allows property owners and communities sufficient time to consider a range of options other than the installation of stabilization measures that adversely impact shoreline functions.

An assessment of this type of erosion should be a standard element of a geological or geotechnical analysis for a shoreline project. Typically, a report should estimate the amount of time before an existing or proposed structure is likely to be threatened by erosion. This would be based on both the long-term rate of erosion and the nature of individual events and maximum amount of erosion that might occur in a short period of time (three years, for example).

Unstable banks and slopes

Coastal bluffs and higher river banks are also subject to chronic erosion, but the risk they pose is complicated by the potential for larger slope failures or landslides. The nature of such failures depends on numerous factors, including the height and geometry of the slope, the geology and hydrology of the material, as well as the underlying rate of erosion at the toe. Some slopes fail in relatively small chunks, while others may be prone to deeper slumps or slides that may extend a substantial distance landward of the existing bluff edge (Figure 15-16).

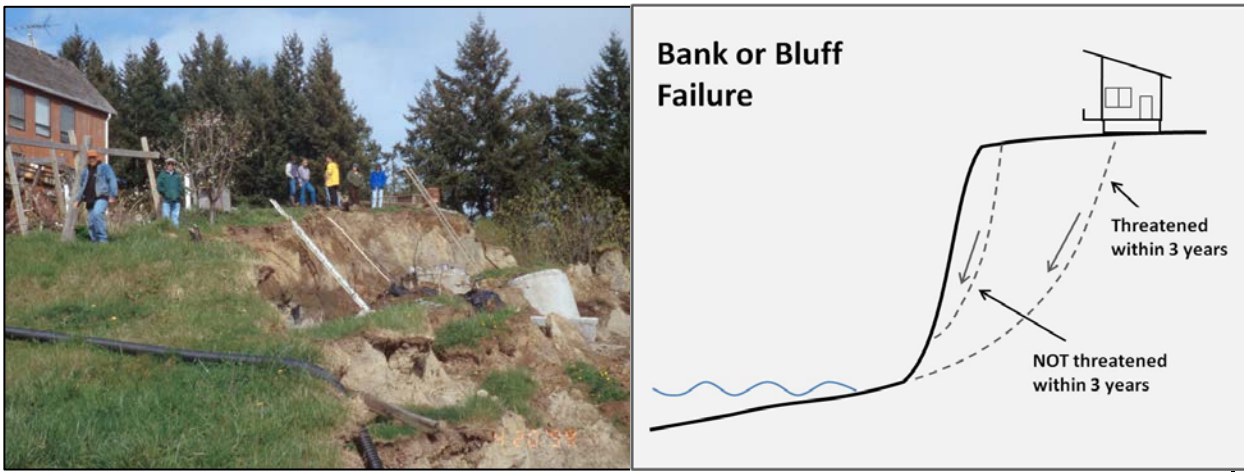


Figure 15-16: A large landslide on this high bluff property on Hood Canal has cut a significant distance into the upland area, damaging the on-site septic system. The cartoon illustrates the impact of slope failures on a high bank site. Geologic factors determine the likely size and geometry of failures. The dashed curves represent different landslide scenarios, one that poses no direct threat to the house, the other that does. (Hugh Shipman photo and graphic.)

The long-term erosion of these sites is a function of both erosional forces at the toe of the slope and the stability of the upper slope. Failures are often triggered by heavy rainfall and elevated groundwater, not by wave or current action at the toe. Therefore, under this scenario, stabilization structures at the water's edge may not necessarily address the stability of the slope itself and shoreline landslides can occur despite the presence of revetments or bulkheads.

In this situation, there is little basis for estimating whether an upland structure is threatened within a certain amount of time, such as three years. A geotechnical analysis can determine whether the structure is within a potentially unstable area, but not *when* that slope is likely to fail. In areas subject to larger failures, it may be appropriate to consider a structure at risk if it would be directly threatened by a single event, as long as that failure is geologically plausible and based on a rigorous analysis.

In many cases, a structure in such a vulnerable location will remain in jeopardy even after shoreline stabilization is installed. Stabilization may only be warranted if it would significantly reduce the risk and no other alternatives exist.

Floods and storm damage

Low-lying shorelines may be subject to erosion, but they are also at risk from flooding and storm damage. Damage may be caused by inundation, strong currents, wave action, or impacts from logs and debris (Figure 15-17). Short-term erosion can be a serious problem even if the site is not subject to chronic erosion. Examples of low-lying shorelines vulnerable to these hazards include floodways on rivers, spits on Puget Sound, and historically-filled lands along waterways.

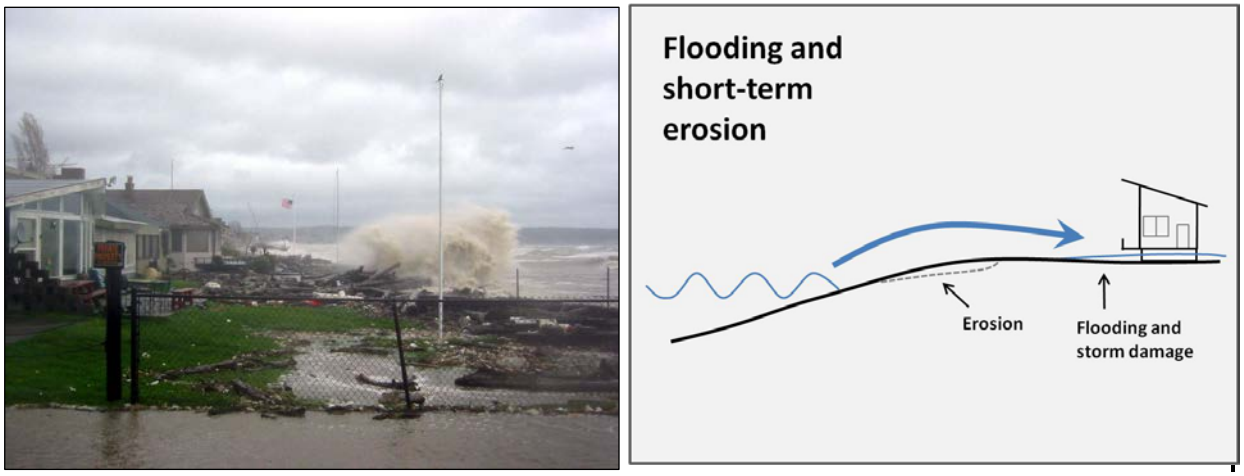


Figure 15-17: A 2006 wind storm combined with a very high tide to damage homes built on a spit on Whidbey Island. On low-lying shorelines, the threat to structures is from short-term erosion and from high water events (storms, floods), not from chronic erosion. (Hugh Shipman photo and graphic.)

Stabilization structures such as revetments and seawalls are often used to reduce damage during these events, even if the threat isn't specifically from erosion. As in other settings, these structures can negatively impact the shoreline environment. Stabilization structures in these situations may mitigate short-term risks and provide a false sense of security, which in turn may facilitate development in areas that remain highly vulnerable to serious hazards.

The threat from these hazards is related to the frequency and severity of high water events, which are typically described in terms of the likelihood of recurrence (such as a 100-year flood or a 20-year storm event). It is difficult to apply the standard of "damage within three years" in this context, since there is always a risk, even if very small, of a damaging storm or flood occurring in any given year. To more effectively evaluate risk from storms and floods, a jurisdiction could focus on the potential for serious damage during a single event, rather than a specific amount of time. (See "Approaches to evaluating risk," below.)

As with unstable slopes and the potential for large slope failures, stabilization structures should only be allowed if there are no other viable alternatives and the stabilization structures can be demonstrated as likely to significantly reduce potential damage from a hazard event while not impacting adjacent property.

Development in low-lying shoreline areas may already be subject to Critical Areas Ordinances (Frequently Flooded or Geologically Hazardous Areas) and to floodplain regulations. In some

cases, there may be alternatives to conventional structural stabilization that have fewer impacts and may be more effective.

Reasonable distance

With any of the above approaches, there may be a need to provide a minimum distance between the structure and water's edge or structure and top of the bluff. This provides an additional margin of safety, while also assuring a reasonable amount of space for utilities, pedestrian passage, and construction and maintenance access.

The rationale for this space, and the appropriate distance, will depend on the situation and may differ between residences, commercial structures, and water-dependent development. Regardless, the amount of space allowed should be the minimum necessary.

The SMP may address this issue with a regulation or as a standard for geotech reports. For example:

The geotechnical report may incorporate the need to provide a reasonable minimum distance between an existing primary structure or primary appurtenance and the Ordinary High Water Mark or the top of the bluff. This distance would provide a margin of safety, while also assuring a reasonable amount of space for utilities, pedestrian passage, and construction and maintenance access.

Approaches to evaluating risk

Typically, jurisdictions rely on applicants to obtain expert assistance in evaluating the potential risk to their property from erosion-related damage. This kind of analysis is normally provided in a geological report and is carried out by geologists and geotechnical engineers. Some jurisdictions have standards for geological or geotechnical reports in their critical areas codes or guidance for applicants specifically related to erosion hazards, landslides and steep slopes.

The SMP Guidelines require geotechnical reports for most new stabilization measures and for new development proposed for steep slopes or bluffs. These reports must address the need for shoreline stabilization. The reports should estimate time frames, rates of erosion and urgency of the situation [WAC 173-26-231(3)(a)(iii)(D)].

A number of approaches may be taken to estimate the risk from erosion, depending on the geologic setting, the amount of information available, and the nature of the threat.

- Geologists can use a variety of evidence to estimate the long-term rate of erosion, including an analysis of air photos and other historical information, erosion indicators such as vegetation and recent erosion events, and observations of nearby shorelines. Knowing long-term erosion rates allows for a calculation of the average annual rate of erosion.

- Where erosion proceeds irregularly (often the case), geologists can combine the expected erosion in three years (based on a geological analysis of the site) with an estimate of the *maximum* amount of shoreline that might be lost in a single event (again, based on a reasonable geological analysis). In many case, the latter will be a much more significant distance.

- On shorelines where there are insufficient observations to determine a specific erosion rate, it may be reasonable to adopt a standard rate. Based on an analysis of rates in similar situations, a community might choose to use a uniform rate of 12 inches/year to establish threat for a reach of shoreline (In reality, few shorelines erode this rapidly on a sustained basis.)

- On high banks or bluffs subject to deeper slope failures, one approach would be to look at the risk from a single large failure. Requiring a formal slope stability analysis by a geotechnical engineer or an engineering geologist would lead to an estimate of a Factor of Safety (an expression used to characterize the relative stability of a slope). A structure that lies within a zone with a Factor of Safety below an established level would be considered threatened. This type of analysis can be expensive and can be subject to significant errors due to model assumptions and the quality of geotechnical data. Local governments may need access to experts to review documents and provide legal support.

- On rivers subject to rapid erosion or avulsions, the threat might be based on a detailed geomorphic analysis of the site and the relevant reach of the river. Alternatively, a jurisdiction might be able to apply elements of a channel migration study to determine a threshold for allowing stabilization. Note that in these cases, stabilization at an individual site may not be an effective measure to prevent erosion.

- On some shorelines, it may be reasonable to adopt a standard distance from which to base an assessment of threat over an extended reach of shoreline. For example, a jurisdiction that has conducted a geotechnical analysis during the planning phase of the SMP may decide that for a given reach of shoreline, any structure within 10’ of the bank would warrant stabilization. This distance is arbitrary; the distance should be based on a geotechnical analysis of the reach in question. This approach may be particularly appropriate on certain uniform lake shorelines or on historically-filled shorelines.

Additional shoreline stabilization requirements

This section discusses additional Guidelines requirements for shoreline stabilization. These requirements include:

- Erosion is not due to upland conditions.
- Nonstructural measures are not feasible or not sufficient.
- No net loss of shoreline ecological functions will be attained.
- Public access should not be restricted if stabilization is publicly financed.
- Mitigate impacts or erosion control measures at feeder bluffs.
- Establish provisions for beach management districts.

Demonstration of need, required for new and replacement stabilization, is discussed in the previous section of this chapter.

Erosion is not due to upland conditions

Shoreline erosion is rarely due solely to erosion by waves and currents. Increased saturation of soils can lead to slope failure. Uncontrolled runoff can erode soils. Removal of vegetation can lead to increased erosion and loss of bank stability (Figure 15-18). Dumping of debris and disturbance of the slope can lead to erosion and bank failure.

Figure 15-18: Removal of vegetation, disturbance of soils, and altered upland runoff can all contribute to shoreline erosion. These types of problems should be addressed before resorting to a stabilization structure such as a bulkhead or revetment. (Hugh Shipman photo.)

The Guidelines recognize this and emphasize the need to identify and address upland conditions such as loss of vegetation and drainage before determining that a stabilization structure is necessary [WAC 173-26-231 (3)(a) (iii)(B)(II and III)]. Maintaining vegetation and reducing uncontrolled drainage have little environmental impact compared to the construction of a hard structure at the water's edge.

Addressing upland contributions to erosion may not completely prevent erosion on a naturally eroding shoreline, but it is often a simple and less expensive way to reduce the risk to upland improvements and avoid impacts to shoreline resources. A comprehensive geological evaluation of a site should identify these types of issues and propose remedies.

Nonstructural measures are not feasible or not sufficient

Nonstructural approaches to address erosion control must be considered before selecting a conventional stabilization structure. The Guidelines require consideration of the following alternatives:

- Placing new non-water dependent development further from the shoreline.
- Planting vegetation.
- Installing drainage improvements.
- Using soft shoreline stabilization methods, if need is adequately demonstrated.

These measures may not necessarily eliminate all erosion on a site, but they can reduce the rate of erosion as well as the risk posed by that erosion. They can reduce or eliminate the need for a conventional stabilization structure.

Applicants are expected to evaluate a reasonable range of options for reducing the risk from erosion to development. Typically, a geotechnical report would identify the causes of the erosion, the rate of erosion or the likelihood of a bank failure, and the most vulnerable portions of a site. Reports should also identify a wide range of options, including alternatives for siting or relocating development and other improvements on the site.

WAC 173-26-231 (B)(II): "Nonstructural measures, such as placing the development further from the shoreline, planting vegetation, or installing on-site drainage improvements, are not feasible or not sufficient. (B)(II) (Applies to new nonwater dependent development.)

(B)(III) Nonstructural measures, planting vegetation, or installing on-site drainage improvements, are not feasible or not sufficient." (Applies to water-dependent development.)

Similarly, when any structural shoreline stabilization measures are demonstrated to be necessary, the Guidelines require that "soft approaches shall be used unless demonstrated not to be sufficient to protect primary structures, dwellings, and businesses" [WAC 173-26-231(3)(iii)(E)]. Soft stabilization measures are described in the sidebar later in this section and in detail in *Soft Shoreline Stabilization: Shoreline Master Program Planning and Implementation Guidance*.

No net loss of shoreline ecological functions

The protection of shoreline ecological functions is a fundamental element of the Guidelines, which require shoreline stabilization to assure no net loss of shoreline ecological functions WAC 173-26-231(3)(a)(iii)(E)]. Some of the functions impacted by stabilization include the movement and transport of sediment, the maintenance of riparian and shoreline habitats, and the provision of large wood and organic material to aquatic environments (Figure 15-19). The impact of stabilization structures on ecological functions will depend on both the nature of the structure and maybe more importantly, on the geomorphic setting and the local habitats.

Figure 15-19: Ecological functions are preserved by avoiding bank stabilization and limiting the removal of natural riparian vegetation. (Hugh Shipman photo.)

Any project in an environmentally sensitive area such as a shoreline is likely to affect ecological functions, so it may be useful to focus on a suite of well-documented indicators. These will depend on the setting and the availability of relevant scientific guidance on potential impacts. Some possible indicators of ecological function are identified in SMP Handbook Chapter 4, "No Net Loss of Shoreline Ecological Functions." Those most relevant to shoreline stabilization include stabilization structures, riparian vegetation and levees and dikes.

Many of the impacts of stabilization structures on ecological functions can be avoided or reduced by following the general principles described in Appendix 2. Examples include building structures as far landward as possible, minimizing disturbance of riparian vegetation, and offsetting construction impacts by removing older existing structures and planting native vegetation.

The concept of no net loss implies the ability to balance unavoidable impacts with other improvements. This is challenging on small sites in relatively natural areas where opportunities to make improvements are limited. On large projects, mitigation may be possible, either with onsite enhancements or by making improvements offsite (although finding a site where removing a like amount of armor is feasible may be difficult). Where older structures are being replaced, there are often opportunities to improve conditions; these may be viable means of achieving no net loss on a larger scale.

Some ecological functions can be preserved through avoidance and mitigation. Others may be most impacted at the time of construction and may recover over time. Some impacts however, increase over time, simply because the stabilization structure disrupts an important ongoing process such as channel migration or sediment delivery from an eroding bluff. These impacts are very difficult to avoid, let alone mitigate.

Public access should not be restricted

Figure 15-20: Public access to the adjacent beach was built into this stabilized slope at the Kingston ferry terminal. (Hugh Shipman photo.)

The shoreline stabilization section of the SMP Guidelines affirms the public access standards established in the Guidelines at WAC 173-26-221(4). Those standards require shoreline development by public entities, including local governments, state agencies, port districts and public utility districts to include public access measures. This requirement applies unless public access is incompatible with the proposed development due to "safety, security, or impact to the shoreline environment."

The shoreline stabilization requirements are somewhat different, calling for local governments to ensure that publicly financed or subsidized stabilization projects not restrict appropriate public access when shoreline stabilization is demonstrated to be necessary. However, incompatible uses, safety, security or harm to ecological functions are potential reasons that public access could be infeasible. And, public access improvements and ecological restoration should be incorporated into the project, if feasible [WAC 173-26-231(3)(a)(iii)(E)].

Ecology recommends that SMPs include a regulation requiring applicants to demonstrate how public access is incompatible with the proposed stabilization project. See the SMP Handbook Chapter 9, "Shoreline Public Access" for more information about public access.

Where stabilization structures must be constructed on public sites and will be supported with public funds, they should accommodate or improve public access to the shoreline and incorporate restoration measures wherever possible. Stabilization, particularly larger-scale public projects to protect roads or infrastructure, can adversely impact public use of the shoreline. At

the same time, such projects offer opportunities to include steps, ramps, ADA access, viewing platforms, and other means of reaching or enjoying the water (Figure 15-20).

These projects can potentially include improvements that restore ecological functions, such as riparian vegetation, large wood, and beaches. In addition, public projects may be good opportunities to highlight innovative techniques and to include interpretive elements that educate the public about the history of the site, the origin of the erosion problem, the negative consequences of conventional stabilization, and the benefits of softer approaches used on the site.

Minimize impacts at feeder bluffs

The earlier section on "Impacts of shoreline stabilization" notes that bluff erosion on Puget Sound is an important source of beach sediment and that a major concern about stabilization is it reduces or eliminates the natural supply of sand and gravel from *feeder bluffs*. The most important sources of sediment are often the most rapidly eroding bluffs, so there is often pressure to stabilize these areas. Therefore, it's important to make every effort to guide development away from the most vulnerable areas. This includes associated improvements such as beach access stairs and outbuildings that are particularly likely to become threatened in the future.

> WAC 173-26-231(3)(a)(iii)(E): " Mitigate new erosion control measures, including replacement structures, on feeder bluffs or other actions that affect beach sediment-producing areas to avoid and, if that is not possible, to minimize adverse impacts to sediment conveyance systems. Where sediment conveyance systems cross jurisdictional boundaries, local governments should coordinate shoreline management efforts."

Feeder bluffs and impacts to feeder bluffs are described on Ecology's Feeder Bluff page and in a report, *Puget Sound Feeder Bluffs: Coastal erosion as a sediment source and its implications for shoreline management* (Shipman and others 2014). In addition, maps of Puget Sound shorelines showing the location of feeder bluffs are available on Ecology's *Washington Coastal Atlas* in the Coastal Landforms Layer.

It is difficult to mitigate the adverse impacts to feeder bluffs from stabilization structures, as the Guidelines require. Thus, there is a strong emphasis on avoiding the need for stabilization in the first place. Small-scale efforts to compensate for lost sources of beach sediment by artificially adding sand and gravel to the beach have been carried out to meet local or state (usually through WDFW's HPA permit) requirements, but they are difficult to enforce and their effectiveness is poorly understood.

Establish provisions for beach management districts

Erosion issues are often best addressed along a reach of shoreline or by a neighborhood, rather than on a site by site scale. This might apply to a group of homes along a short stretch of river or on a small lake, to a community built on a spit on Puget Sound (Figure 15-21), or to development within a large shoreline landslide area. The Guidelines suggest local governments address beach erosion through a beach management district or other institutional mechanism "to provide comprehensive mitigation for the adverse impacts of erosion control measures" [WAC 173-26-231(3)(a)(iii)(E)]

Addressing a problem at this scale may lead to better identification of underlying erosion problems, more effective coordination of engineering and design work, and improved ability to address or mitigate environmental concerns. In some cases, it might allow more constructive engagement between a local jurisdiction and a neighborhood with a common, ongoing stabilization issues.

Figure 15-21: Residents of this sand spit on Puget Sound (Point Monroe on Bainbridge Island) face problems with erosion, storm damage, and flooding. They share road access, utilities and infrastructure, and have experienced similar patterns of historical development and stabilization. A community-approach to managing erosion and stabilization may benefit both the community and the local jurisdiction (Washington State Coastal Atlas photo).

RCW 36.61 provides a mechanism for creating lake and beach management districts. Although the law was originally developed to address shared issues such as water quality or aquatic weed management, these approaches may be transferable to a stabilization context. The RCW also allows for another "institutional mechanism" to address beach erosion.

If beach erosion is threatening existing development, local governments should adopt master program provisions for a beach management district or other institutional mechanism to provide comprehensive mitigation for the adverse impacts of erosion control measures.

An example policy encouraging coordinated planning for beach management and other issues comes from the Bainbridge Island SMP:

> 10. Encourage neighboring property owners within an entire drift cell or shoreline reach to coordinate planning and development of shoreline stabilization or other solutions to avoid erosion of down-drift properties and to address ecological and geo-hydraulic processes, sediment conveyance, and beach management. (Bainbridge Island SMP, Section 6.2.3 Policies.)

Soft shoreline stabilization

The SMP Guidelines emphasize the use of softer, more environmentally friendly methods of shoreline stabilization. "Soft approaches shall be used unless demonstrated not to be sufficient to protect primary structures, dwellings, and businesses" [WAC 173-26-231(3)(a)(iii)(E)]. This is consistent with an overall emphasis on reducing the potential impacts of stabilization. The Guidelines reflect the concept of mitigation sequencing – avoidance, minimization, and mitigation. Avoiding the impacts is preferred and can often be accomplished with nonstructural measures. Where stabilization cannot be avoided, effective soft techniques can avoid some impacts and minimize others, although they rarely eliminate all potential effects of stabilizing a natural shoreline.

Soft techniques

Soft shoreline stabilization techniques include a variety of different approaches that preserve or mimic shoreline functions. Common methods involve planting vegetation, incorporating large wood, and using beach nourishment. In addition, soft projects may involve pulling structures landward (or removing them altogether), reorienting the shoreline, or adding in-water habitat benches and similar features. Specific approaches vary significantly among shoreline settings (rivers or marine shorelines, for example).

The Guidelines distinguish between "hard" and "soft" stabilization measures and provide a list of options generally arranged from soft to hard [WAC 173-26-231(3)(a)(ii)]. This idea that stabilization techniques fall along a continuum is developed more fully in *Soft Shoreline Stabilization: Shoreline Master Planning and Implementation Guidance* (Gianou 2014). Some of these techniques are more appropriate in some settings than others. In addition, what is considered soft along a heavily developed shoreline may have significant adverse impacts in a more natural environment.

Shoreline stabilization at this site in Anacortes employs plantings, added beach gravel, and strategically located large wood. (Hugh Shipman photo.)

Challenges

Where some sort of stabilization is shown to be necessary, conventional hard structures can only be considered if softer methods have been demonstrated to be infeasible or ineffective. This requirement will likely face some opposition. Property owners may have a particular solution in mind. Contractors are limited to structures they have the capacity and experience to construct. Consultants recommend solutions with which they are familiar and which they believe the property owner wants. Engineers and geologists favor standard solutions with relatively conservative designs. When local jurisdictions require consideration of alternatives, applications sometimes contain a fairly cursory dismissal of alternative approaches, often with little rigorous evaluation.

Local governments should require a meaningful and informed assessment of stabilization options. The onus is on applicants and their agents to carefully evaluate the nature of the erosion and the ecological functions of the site and to examine a range of potential alternatives. It is not enough to claim that a softer approach will not completely prevent erosion. Rather, the evaluation should show that the use of a soft approach will result in the loss of the primary structure in a relatively short period of time and that other measures will not reduce this risk. The recent *Marine Shoreline Design Guidelines* (2014) project contains useful information on types of techniques and their application.

Replacement

In general, replacement of existing stabilization structures should occur at or landward of the original location. Replacement projects can mitigate the impacts of stabilization by moving structures back or by employing softer techniques. In some cases, soft methods such as beach nourishment may occur farther waterward; the Guidelines allow this where there are clear benefits to ecological functions [WAC 173-26-231(3)(a)(iii)(C)].

Replacing a hard bulkhead with soft stabilization can improve ecological functions at the shoreline and improve the home owner's access to the shoreline. (Hugh Shipman photo.)

Long term threat

Section (D), on preparing geotechnical reports, states that "where the geotechnical report confirms a need to prevent potential damage to a primary structure, but the need is not as immediate as the three years, that report may still be used to justify more immediate authorization to protect against erosion using soft measures." This language allows for the use of softer solutions where even where the threat is not immediate, if waiting would preclude their use in the future.

For a more thorough review of soft stabilization issues related to the Guidelines, see *Soft Shoreline Stabilization: Shoreline Master Planning and Implementation Guidance* (Gianou, 2014). Also, for more detailed guidance on techniques, see the *Marine Shoreline Design Guidelines* (Johannessen, 2014).

Shorelines Hearings Board cases

This section provides summaries of Shorelines Hearings Board (SHB) cases that are relevant to shoreline stabilization. The first two cases involve adjacent parcels owned by the same property owners, so are presented together. The other cases are provided in reverse chronological order.

SHB cases are available at the Environmental & Land Use Hearings Office website. Open the "Case and Decision Search" pull-down menu.

John and Barbara Woodman v. San Juan County, SHB No. 08-032 (2009)

The Woodmans appealed San Juan County's denial of a substantial development permit to build a bulkhead to protect the shoreline bank from erosion on San Juan Island. The Board reversed the County's decision and remanded the case, instructing the County to issue the permit. The Board determined that the bank was slowly eroding and could suddenly fail due to wave action. Bank failure would damage an established yard and lawn, and also result in the loss of tress that shaded the beach. The Board concluded the proposed bulkhead would be located landward of the OHWM and would not affect surf smelt spawning habitat.

Friends of San Juans v. San Juan County and John and Barbara Woodman, SHB No. 13-015 (2014)

Friends of the San Juans appealed the County's approval of a substantial development permit issued to the Woodmans for construction of a two-tiered rock bulkhead along a pocket beach on San Juan Island. The parcel is a vacant lot and adjacent to the Woodmans' residential lot, which is bulkheaded. The Board reversed the County's decision and found the proposed bulkhead did not meet the standards of the SMA and the County's Shoreline Master Program. The Board's findings included: Erosion was not serious and did not threaten an established upland use; use of the lot as a yard for the adjacent residence was not an established residential use with protection under the SMA and SMP; the property owners did not sufficiently consider use of nonstructural methods to protect the bank.

Friends of the San Juans v. San Juan County and Harry and Martha Dickinson, SHB 13-001 (2013)

Friends of the San Juans appealed County approval of a substantial development permit for an 80-foot rock bulkhead on the Dickinsons' property. The Board determined that the Dickinsons failed to show that nonstructural protection was not adequate to protect the property and had not seriously considered shoreline protection other than the rock bulkhead. The Board also concluded the approved permit did not accurately reflect the project and was not based on the correct designation of the OHWM. The Board reversed the County approval.

Diane M. Patterson and David E. Engdahl v. City of Burien and Mario A. Segale, SHB 10-007 (2010)

Diane Patterson and David Engdahl appealed a substantial development permit issued by the City of Burien to replace a bulkhead on Mario Segale's property. The petitioners owned shoreline property nearby and were concerned about potential impacts to the beach, including aesthetic impacts. The Board concluded that the applicable Shoreline Master Program was the King County SMP, because the City did not adopt and obtain Ecology's approval on its own SMP following incorporation. The Board applied the provisions of the County SMP, determined the bulkhead met permitting requirements, and granted summary judgment to the City and applicant.

Leonel S. and Isle K. Stollar; and Paul B. and Margery M. Greenawalt v. City of Bainbridge Island; Ecology & Sealevel Bulkhead Builders, SHB No. 06-024, 027 (2007)

The petitioners appealed denials by Ecology and the City of Bainbridge Island for conditional use permits for five adjoining bulkheads at the base of the bluff below their properties. (The City had approved several of the five permits.) The bluff is an active feeder bluff that deposits sediments onto the beach and into Puget Sound. The Board affirmed denial of the permits by Ecology, stating that the city's SMP prohibited hard armoring on feeder bluffs that contribute to valuable geo-hydraulic and biologic processes. The Board concluded that the petitioners had failed to meet requirements of the SMP to conclusively demonstrate that alternative soft shoreline measures would not work at the site. The Board also concluded that approval of the bulkhead at the site would cause cumulative impacts and would allow for additional hard armoring at the site in the future, without requirement of a conditional use permit.

James and Kathleen Manza v. City of Lakewood, SHB No. 02-005, 006 (2003)

The SHB consolidated two appeals into one action, SHB 02-005. The Manzas, who were building a house, challenged the city's denial of a permit for a bulkhead and modification of a proposed dock. The neighbors, the Bennetts, challenged a dock permit, lack of a conditional use permit for a house and lack of a variance for a septic holding tank.

This discussion focuses on the bulkhead. The board upheld the city's denial of the bulkhead. WAC 173-27-040(2)(c) exempts the construction of a normal protective bulkhead common to single-family residences from the requirement for an SDP for the purpose of protecting a single-family residence and appurtenant structures from loss or damage by erosion. A bulkhead is not exempt from the SDP requirements if it is built for the purpose of creating dry land. The Manzas had indicated in their permit application that the purpose of the bulkhead was to protect the lawn. The board concluded that the bulkhead did not appear to be necessary to protect the residence.

Joseph W. and Nancy B. Kovalik & James Ritchie v. Whatcom County SHB No. 96-30 (1997)

The appellants contested a decision by Whatcom County to deny approval of a substantial development permit to build a revetment. Their homes are back from the top of a feeder bluff

that provides sediment to Semiahmoo Spit. The permit, for a beach gondola, also included conditions to require tightlines and vegetation. The board held that the County's permit denying the revetment was consistent with the SMP, which stated, "Defense works should not be located on shores…such as feeder bluffs…" The board determined that the appellant had not shown that alternatives to a revetment were not feasible. The board also noted that the revetment did not meet the requirements of the exemption for a bulkhead to protect a single family residence because "It would be located below the OHWM, it would create land, and arguably, given that the houses are in no current danger, it would not function to protect them." The beach gondola does not have the same protection as a house. The board upheld the County's denial of the revetment.

***Seawall Construction Company, Pete DeHaas and Steve Lovely v. King County*, SHB No. 90-51, 52 (1991)**

The appellants appealed denial by King County of a shoreline substantial development permit to build rock bulkheads. Both homes, on Puget Sound near city of Des Moines, were 220 feet back from proposed bulkhead location and 50 feet from top of bluff. About 20 feet of erosion had occurred in past 30 years. The King County SMP stated that shoreline protection "shall be permitted only when it has been demonstrated that shoreline protection is necessary for the protection of existing legally established structures…"

SHB decision states there is no evidence that ongoing erosion presents a threat to the homes in the foreseeable future or that the appellants demonstrated that erosion is a danger to the homes or that shoreline protection is necessary to protect the homes. Appellants did not meet requirements of SMP. The board upheld County denial of the permit.

Sources

This publication is part of a significant agency action under RCW 34.05.272 (http://www.ecy.wa.gov/publications/supportingliterature.html). To meet the law, the sources of information used to support this action are identified. The required 11 types of sources are listed below by number. Each reference is followed by a bracketed number which indicates the source.

1. Peer review is overseen by an independent third party.
2. Review is by staff internal to Department of Ecology.
3. Review is by persons that are external to and selected by the Department of Ecology.
4. Documented open public review process that is not limited to invited organizations or individuals.
5. Federal and state statutes.
6. Court and hearings board decisions.
7. Federal and state administrative rules and regulation.
8. Policy and regulatory documents adopted by local governments.
9. Data from primary research, monitoring activities, or other sources, but that has not been incorporated as part of documents reviewed under other processes.
10. Records of best professional judgment of Department of Ecology employees or other individuals.
11. Sources of information that do not fit into one of the other categories listed.

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Hydraulic Code Rules, Chapter 220-660 WAC. [7]

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City of Bainbridge Island Shoreline Master Program, effective July 30, 2014. [8]

City of Issaquah Shoreline Master Program, effective March 12, 2013. [8]

City of Kent Shoreline Master Program, effective February 11, 2010. [8]

City of Kirkland Shoreline Master Program, effective August 5, 2010. [8]

Kitsap County Shoreline Master Program, effective December 24, 2014. [8]

City of Lacey Shoreline Master Program, effective October 13, 2011. [8]

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Chapter 4: "No Net Loss of Shoreline Ecological Functions." [2]

Chapter 7: "Shoreline Inventory and Characterization." [2]

Chapter 9: "Shoreline Public Access." [3]

Chapter 13: "Shoreline Environment Designations." [2]

Chapter 17: "Cumulative Impacts Analysis." [2]

Appendix A: "Addressing Sea Level Rise in Shoreline Master Programs." [2]

Shorelines Hearings Board cases

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James and Kathleen Manza v. City of Lakewood, SHB No. 02-005, 006 (2003). [6]

Joseph W. and Nancy B. Kovalik & James Ritchie v. Whatcom County, SHB No. 96-30 (1997). [6]

Seawall Construction Company, Pete DeHaas and Steve Lovely v. King County, SHB No. 90-51, 52 (1991). [6]

Appendix 1: Shoreline Settings

Shoreline stabilization occurs on lake, stream and marine shorelines. Each of these settings presents different geomorphic processes, ecosystems, and varying land use patterns. As a result, the design, management, and impacts of stabilization decisions vary significantly from one setting to another.

Lakes

Washington has thousands of lakes, ranging in size from large reservoirs to many that are too small to be regulated under the Shoreline Management Act (less than 20 acres). Lakes vary in origin and geology, in shape and depth, in hydrology, and in geographic setting (e.g. Olympic Peninsula, Columbia Plateau). The nature of erosion depends on the character of the shoreline itself, the amount of wave action, and the way the shoreline has been developed.

Figure 1: Residential bulkheads on Lake Chelan, typical of lakefront development, can result in the loss of shallow water and riparian habitat. (Hugh Shipman photos.)

Figure 2: At Martha Washington Park on Lake Washington in Seattle, an old bulkhead was removed and the shoreline reconfigured to create a beach cove.

Water level is an important factor on lake shorelines. The level of reservoirs is clearly maintained artificially, and other lakes have also been raised or lowered historically. In addition, the seasonal and annual fluctuations of water levels on some lakes are managed with outlet structures. Water levels on lakes with developed shorelines are often carefully controlled. Water level influences both vegetation and erosion along the shoreline, along with the choice of stabilization measures.

Wind-generated waves are an important driver of erosion on larger lakes. Boat wakes can also be a significant factor on lakes with extensive recreational boat use. Where natural wave action is low and there is little erosion, lake shorelines are often fringed by wetlands or forest. Historically, development of lakeshores involved clearing of vegetation and the placement of fill to create dry land for building and recreating. Stabilization structures were built as much to

protect these artificially filled shoreline edges as they were to address any natural erosion problem.

The stabilization of lake shorelines, typically with bulkheads or rock revetments, results in the loss of riparian vegetation and large woody debris, increased erosion of beach sediment, and loss of shallow water habitat along the shore. Stabilization structures can make access to the water more difficult and more dangerous and can generally diminish waterfront aesthetics.

Erosion is usually relatively slow on most lakes. Stabilization for new development may be avoided through policies and regulations protecting shoreline vegetation and requiring structures to be set back from the shoreline. On developed lake shorelines, there may be opportunities to remove stabilization structures when sites are redeveloped or to enhance shoreline functions when replacing old stabilization structures. Jurisdictions around Lake Washington, including Seattle and Kirkland, have developed policies and guidance to achieve this. They encourage property owners to remove bulkheads to restore ecological functions while also improving access to the water. (For example, see the City of Seattle's *Green Shorelines: Bulkhead alternatives for a healthier Lake Washington*.)

Streams

Washington's streams include a wide range of environments from small creeks to large rivers such as the Columbia. Although erosion may occur in any of these settings, the causes and results of erosion differ significantly. In addition, the measures used to stabilize these shorelines differ as do the impacts of inappropriate stabilization measures.

Figure 3: Rock revetment stabilizes an eroding river bank. (Wolf Bauer photo.)

Figure 4: Erosion control structure was constructed by anchoring large wood along Beaver Creek in the Methow Valley. (Hugh Shipman photo.)

Many different techniques have been used to manage erosion on streams. Some of these involve protecting the bank directly with rock revetments and wood structures. Other methods, such as channel modifications, stream barbs, and artificial log jams attempt to modify or redirect flows in order to reduce erosion. Stream bank erosion is often the result of strong currents during flood conditions and much stabilization is associated with flood control structures – such as the armoring of levees.

Stabilization structures can lead to the loss of riparian vegetation, the redirecting of currents and flood waters, and the deepening of the channel near the bank. Over time, they can reduce the recruitment of large wood and impact habitat connectivity. Even simple streams can be complex systems and erosion is often the result of reach-scale processes such as channel aggradation and the migration of meanders. As a result, site-specific stabilization measures are often unsuccessful and can shift erosion problems up or down stream.

In Washington, one of the best sources of information on stream bank erosion and its management is the Integrated Streambank Protection Guidelines (WDFW, AHG 2003). It emphasizes the need to carefully identify the cause of the erosion problem, address erosion problems in the context of a longer reach of shoreline, select appropriate methods, and consider impacts on stream habitats.

Marine Shorelines

Washington's marine shorelines include its ocean coast and Puget Sound. Coastal erosion is usually driven by wave action, but the rate and nature of erosion is often tied closely to geology and local sediment budgets. To date, erosion on the ocean coast has been largely a localized problem associated with shorelines near the mouths of Willapa Bay and Grays Harbor and some areas within the large bays.

Puget Sound includes 2,500 miles of diverse shoreline that includes rocky islands, river deltas, and large stretches of sand and gravel beach. On Puget Sound, erosion typically occurs in the following settings:

Figure 5: This coastal bluff on Camano Island is eroding. (Hugh Shipman photo.)

- Coastal bluffs: Waves play an important role, but stability is governed by geology and topography, with landslides often triggered by heavy rainfall or ground water. Long-term retreat rates are slow, although individual slope failures can be dramatic.

- Beaches and spits: Erosion by waves and currents also affects low-lying spits and barrier beaches. These areas are also subject to flooding and storm damage.

- Historically filled shorelines: These areas are vulnerable in the absence of adequate erosion control because the shoreline has been extended waterward of its natural position, often with readily erodible material.

Although long-term erosion rates on Puget Sound are not rapid, stabilization has long been common practice along the shoreline. Most stabilization on Puget Sound is achieved with bulkheads and seawalls, although riprap revetments are also common, particularly in more industrial areas. Currently, an estimated 28% of this shoreline is armored and a little more than one mile of new armoring occurs every year. See Puget Sound Vital Signs.

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In the past two decades, concerns about the impacts of armoring on Puget Sound's shoreline have increased. These impacts vary from one type of shoreline to another, but generally include:

- Burial of the upper beach.

- Loss of riparian vegetation. Reduced sediment supply to beaches.
- Passive erosion – the ongoing loss of the beach in front of a static seawall.
- Increased erosion of adjacent beaches and shorelines.

Figure 6: A rock revetment protects homes built on a spit on Whidbey Island. (Hugh Shipman photo.)

This has led to more emphasis (*as seen in the SMP Guidelines*) on avoiding stabilization where possible and employing softer, more environmentally friendly approaches where feasible. Measures applied on Puget Sound include beach nourishment, the structural use of large woody debris, and use of vegetation to manage bank erosion. Soft stabilization is discussed in more detail in the sidebar on pages 58-59.

A unique concern on marine shorelines is the likelihood of much higher future sea level. Accelerated sea level rise will increase erosion and coastal flooding. It will also lead to significant loss of beaches and sensitive shoreline habitats where existing stabilization has eliminated sediment sources or prevented the natural shifting of the shoreline.

For more information on shoreline stabilization and its impacts on Puget Sound, see:

- *Puget Sound Shoreline and the Impacts of Armoring*, USGS, 2010.
- *Beaches and Bluffs of Puget Sound*, Puget Sound Nearshore Partnership, 2007.
- *Marine Shoreline Design Guidelines*, Aquatic Habitat Guidelines, WDFW, 2014.
- *Soft Shoreline Stabilization: Shoreline Master Planning and Implementation Guidance*, Gianou, 2014.

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Washington Department of Ecology. “Puget Sound Feeder Bluffs.” No date. [2]
Ecology’s web pages have changed; this page is no longer available. A revised page is available at Puget Sound Feeder Bluffs.

Appendix 2: General Principles for Shoreline Stabilization

The following are general principles for avoiding and minimizing the potential impacts of shoreline stabilization. Most are reflected in the SMP Guidelines. The examples are mostly residential because that is where a majority of new development on eroding shorelines is occurring.

Site planning

Most shorelines are susceptible to erosion, but the need for stabilization can often be avoided through careful development of a site and avoidance of the most hazardous or environmentally sensitive portions.

Figure 1: This shoreline on southern Whidbey Island was previously protected with a timber bulkhead. Rather than replace it, the owner reconfigured the bank, planted vegetation, and accepted that a modest level of erosion would continue without jeopardizing upland improvements. (Hugh Shipman photo.)

- Development of shoreline sites should be supported by geological analyses that characterize erosion patterns as well as other hazards such as deep-seated landslides, channel migration, and flooding.

- Identify the key geological and ecological processes influencing a site. Pay special attention to ecologically important features such as riparian vegetation, feeder bluffs, beach habitats, and stream mouths.

- Avoid development on unstable shorelines or in areas of rapid erosion where future stabilization measures are likely.

- Beware of activities, such as removing vegetation and altering drainage, which may aggravate existing erosion problems.

- Locate utilities, drainfields, landscaping features, and accessory structures so they can accommodate normal erosion and storm damage or can be readily relocated in the future.

- Consider the long-term cumulative effect of additional similar development along the same reach of shoreline.

Figure 2: A number of techniques have been used on this Tacoma shoreline to provide ecological functions, while also managing erosion on a heavily developed waterfront. The bulkhead has been kept landward and wood and marsh vegetation have been installed along the water. (Hugh Shipman photo.)

- On marine shorelines, consider the potential for increased erosion and flooding that will accompany higher sea levels.

Managing an eroding shoreline

Where erosion impacts a developed site, carefully assess the need for stabilization and whether there are more effective means of reducing the risk without recourse to conventional erosion control structures.

- Evaluate rates and mechanisms of erosion, and understand its causes, before selecting a stabilization method. Avoid short-term solutions that facilitate development of sites without addressing underlying hazards related to large landslides, channel migration, or sea level rise.

- Address upland contributors of erosion and instability, such as drainage, before building a stabilization structure at the water's edge.

- Emphasize removal or relocation of at-risk structures wherever possible to reduce their vulnerability and the need for stabilization measures.

- Locate and design other shoreline structures such as docks, stairways, and other improvements so as to accommodate existing site erosion and avoid the need for stabilization.

Design and construction of erosion control measures

Figure 3: Bank stabilization along Hangman Creek in Spokane County includes soil lifts, a rock toe and plants. The project, which was completed in 2014, will reduce erosion and stabilize the stream bank adjacent to U.S. 195. (Mike Maher photo.)

Where stabilization is necessary to protect upland development from imminent threat, the design and construction of erosion control measures should minimize impacts on ecological functions and on geological processes that could adversely impact nearby shorelines.

- Stabilization structures should be located as far landward as possible. Their length should be no longer than necessary to protect the at-risk development.

- Softer erosion control measures should be employed wherever possible. Stabilization should be designed to minimize impacts on shoreline habitats such as beaches and riparian vegetation.

- Methods should be appropriate for the site, address the underlying causes of erosion, and preserve the ecological functions observed on natural shorelines in the vicinity.

- Complex solutions such as groins, jetties, breakwaters, and channel realignment should only be used where there are significant public benefits, where their effect on a longer reach of shoreline is fully considered, and where adverse impacts can be mitigated.

- Construction of stabilization should minimize unnecessary disturbance to shoreline soils and vegetation, prevent the introduction of contaminants and construction debris, and assure rehabilitation of areas impacted by the work.

Replacing existing stabilization

Where existing stabilization measures need to be repaired or replaced, there are often opportunities to restore a more natural, better functioning shoreline, while continuing to address the underlying erosion problem.

- Where possible, locate replacement structures farther landward. Not only does this restore shoreline functions, but it can allow for the use of less expensive stabilization measures.
- Evaluate the need for stabilization in the first place. On some sites, reconfiguring the proposed development on the shoreline may make stabilization unnecessary.
- Employ softer stabilization methods such as bioengineering, beach nourishment and the incorporation of natural vegetation and large wood.
- Remove derelict structures, loose riprap, and construction debris from shoreline.

Figure 4: Replacing this riprap revetment at Twanoh State Park on Hood Canal could include shifting the structure landward, restoring the upper beach, replanting native vegetation, and removing loose riprap. (Hugh Shipman photo.)

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