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Restoration and Enhancement Plan

FINAL

Exhibit C to the DPD Shoreline Master Program Ordinance

FINAL

RESTORATION AND ENHANCEMENT PLAN

CITY OF SEATTLE SHORELINE MASTER PROGRAM

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LIST OF ACRONYMS AND ABBREVIATIONS

ALEA	Aquatic Lands Enhancement Account
City	City of Seattle
CMP	Campus Master Plan
CSO	combined sewer overflow
CWCAP	Carkeek Watershed Community Action Project
DRCC/TAG	Duwamish River Cleanup Coalition
Ecology	Washington State Department of Ecology
GIS	Geographic Information System
ILF	in-lieu fee
LWD	large woody debris
LDR Plan	Lower Duwamish River Habitat Restoration Plan
OHW	ordinary high water
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRDA	Natural Resource Damage Assessment
PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
Plan	Restoration and Enhancement Plan
Port	Port of Seattle
PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
PSP	Puget Sound Partnership
Puget Sound TRT	Puget Sound Technical Recovery Team
RCW	Revised Code of Washington
SDOT	Seattle Department of Transportation
SFLO	Washington Department of Natural Resources Small Forest Landowner Office
SMA (or the Act)	Washington State Shoreline Management Act
SMP	City of Seattle Shoreline Master Program
SRFB	Salmon Recovery Funding Board
State	State of Washington
TIA	total impervious surface area
UW	University of Washington
WAC	Washington Administrative Code

GLOSSARY

The following terms will have these definitions in the context of this Restoration and Enhancement Plan. They are listed in alphabetical order.

ecological function	The work performed or role played individually or collectively by the physical, chemical, and biological processes that contribute to the maintenance of the aquatic and terrestrial environments that constitute the natural environment.
goals	Measures by which the City of Seattle's vision can be met.
habitat	An ecological or environmental area that is inhabited by and may have capacity to support the survival and growth of organisms.
impairment	Habitat degradation; in this document, refers to the loss of ecological function of shorelines as described in the *City of Seattle Shoreline Characterization Report* (City of Seattle 2009).
impervious surface	Any surface exposed to rainwater from which most water runs off. Common impervious surfaces include, but are not limited to, roof tops, walkways, patios, driveways, formal planters, parking lots or storage areas, concrete or asphalt paving, permeable paving, gravel surfaces subjected to vehicular traffic, compact gravel, packed earthen materials, and oiled macadam or other surfaces which similarly impede the natural infiltration of stormwater. Open, uncovered retention/detention facilities shall not be considered as impervious surfaces for the purposes of determining whether the thresholds for application of minimum requirements are exceeded. Open, uncovered retention/detention facilities shall be considered impervious surfaces for purposes of stormwater modeling.
measures of success	Measurable criteria that are currently quantified and which are suitable for before/after comparison. The City of Seattle may use these to evaluate site-specific or overall restoration action success; e.g., compare total linear feet of bulkhead in an area before and after a restoration action takes place.
project	A site-specific set of habitat activities.
reach and sub-reach	For the purposes of this report, a reach is a contiguous area within the shoreline jurisdiction that has somewhat consistent physical and biological conditions. Sub-reaches are contiguous areas of

shorelands with relatively consistent levels of impairment, contiguous areas with variations in impairment that fall within a distinct range, contiguous areas with impairment that follows a consistent trend and in rare cases contiguous areas with heterogeneous levels of impairment.

restoration "the reestablishment or upgrading of impaired ecological shoreline processes or functions. This may be accomplished through measures including but not limited to re-vegetation, removal of intrusive shoreline structures and removal or treatment of toxic materials. Restoration does not imply a requirement for returning the shoreline area to aboriginal or pre-European settlement conditions" (Washington Administrative Code [WAC] 173-26-020). In the context of this document, restoration is a blanket term encompassed by four restoration strategies, which are described under "**restoration strategy**" below.

restoration strategy Refers to the four strategies of protection, restoration of ecological processes, rehabilitation, and creation. These are the Puget Sound Technical Recovery Team's (Puget Sound TRT's) proposed general habitat management strategies, including protection, restoration, rehabilitation, and substitution, that are to be used by watershed groups and others working for regional salmonid recovery (Puget Sound TRT 2003):

- Protection can be applied where habitat is presently functioning at a high level and supports natural habitat-forming or -sustaining processes. For example, conserve the natural sediment delivery processes from a feeder bluff to the intertidal zone by keeping that section of shoreline unarmored.
- Restoration of ecological processes can be applied where habitat is impaired but natural processes can be recovered. For example, restore the natural sediment delivery processes from a feeder bluff to the intertidal zone by removing shoreline armoring that currently prevents bluff material from eroding and entering the intertidal zone.
- Rehabilitation can be applied where habitat is impaired and restoration of full function and supporting processes appears infeasible; however, limited improvements to functions and

supporting processes can be achieved through partial re-establishment of ecosystem processes or functions. For example, rehabilitate the delivery of sediment from a feeder bluff to the intertidal zone in areas where armoring cannot/will not be removed, by moving any sediment that erodes from the bluff over the armoring and into the intertidal zone.

- Creation can be applied where habitat function is lost through anthropogenic degradation and restoration and/or rehabilitation are not possible, but creation of habitat features to lead to replacement of lost function can be accomplished. For example, substitute the delivery of sediment from a feeder bluff to the intertidal zone in areas where armoring cannot/will not be removed, by importing sediment and placing it in the intertidal zone to "nourish" the beach.

restoration actions A list of the actions on which effort and funding could be applied.

shorelands Those lands extending landward for 200 feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward two hundred feet from such floodways; and all wetlands and river deltas associated with the streams, lakes, and tidal waters.

structure The composition and arrangement of physical attributes that compose habitat and that are formed as a result of watershed processes.

sub-reach See "reach."

vision Conceptual description of desired future shoreline condition.

watershed processes The dynamic physical and chemical interactions that form and maintain the landscape at the geographic scales of watersheds to basins (hundreds to thousands of square miles; Stanley et al. 2005). These processes include the delivery, movement, and loss of water, large woody debris, sediment, phosphorus, nitrogen, toxins, and pathogens, as well as wave energy, tidal influences, and light energy.

EXECUTIVE SUMMARY

This Restoration and Enhancement Plan (Plan) has been prepared in support of the City of Seattle's Shoreline Master Program (SMP) update.

The State of Washington's (State's) SMP guidelines state that SMPs are to "include goals, policies and actions for restoration of impaired shoreline ecological functions" (WAC 173-26-186). The impaired functions are to be identified based on a detailed inventory and characterization of the shoreline ecosystem, and a restoration plan is to be formulated based on that information. Therefore, this Plan includes a description of the inventory and characterization completed for Seattle, and describes how and where potential exists for shoreline restoration within City of Seattle (City) boundaries. This Plan is not a regulatory document or a set of regulatory requirements. However, the SMP points to this Plan as a guide for identifying opportunities to improve the ecological function of Seattle shorelines.

The Plan includes the following elements, according to SMP recommendations:

- Plan scope and the overall vision and goals for restoration of degraded shoreline areas and impaired ecological functions (Section 1).
- Current and ongoing restoration plans applicable to City shorelines and a description of restoration programs and existing or potential partners (Section 2).
- Procedures used for identification of restoration actions: determining impairments, application of restoration strategies, and selection of sites for potential restoration (Section 3).
- Identification of impairments and applicable restoration actions needed to achieve restoration goals for various City shorelines (Section 4).
- Implementation strategies to bring restoration projects toward completion, and review of these projects in meeting overall restoration goals, including timelines and benchmarks, prospective funding sources, obstacles and challenges, and monitoring (Section 5).

Plan Purpose and Scope

The scope of this Plan is as a non-regulatory document prepared under the SMP guidelines. As such, it contains the inventory-based process and results for identification of restoration actions and projects in the City of Seattle. The Plan scope does not include regulatory language, will not fully incorporate or directly align with outside restoration planning documents, and does not contain mitigation requirements, concepts, or projects.

The State's shoreline guidelines define restoration as "the re-establishment or upgrading of impaired ecological shoreline processes or functions." In the context of this document, restoration is a blanket term covering four "restoration strategies" and is implemented by "restoration actions." The four restoration strategies discussed in this document are: protection, restoration of ecological processes, rehabilitation, and creation.

SMP Restoration Definition, Vision, and Goals

As part of the SMP update process, the City has developed an overall vision for shoreline restoration. Goals have been developed that describe the specific measures that should be undertaken to meet the vision and which, in most cases, can be used as metrics to monitor the City's progress in achieving the vision.

Existing Restoration Planning, Programs and Partners

Many groups are involved in shoreline restoration in and around the City, including the City of Seattle, the Port of Seattle, the University of Washington, the Puget Sound Partnership, watershed groups, and several local environmental nonprofit groups and community organizations.

Within the City of Seattle organization, Seattle Public Utilities is part of salmon recovery planning for Water Resource Inventory Areas 8 and 9, the Cedar–Sammamish and Green–Duwamish watersheds respectively. Seattle Public Utilities has helped coordinate and fund both scientific research regarding salmonid use of shorelines and effectiveness monitoring of restoration projects in this role. Seattle Parks and Recreation has implemented many shoreline restoration projects along Lake Washington, the Ship Canal, the Duwamish River and Puget Sound and has received funding from both the King Conservation District and Salmon Recovery Funding Board for these projects. Seattle Department of Transportation is involved with planning for the replacement of the seawall along Seattle's waterfront and has

been testing alternatives to the homogenous surface with the goal of improving habitat for salmonid species and other aquatic organisms in Elliott Bay.

The Port of Seattle (Port) has directly funded several shoreline restoration projects and is a contributor to shoreline restoration planning within the City of Seattle. The Port's 2007 Seaport Shoreline Plan and 2009 Lower Duwamish River Habitat Restoration Plan (Port of Seattle 2009) outline opportunities and plans for fish and wildlife habitat along Seattle shorelines.

The University of Washington (UW) plans for and implements shoreline restoration at its Seattle Campus through its Campus Master Plan, its certification by Salmon-Safe, its work in wetlands research, and by securing public access, open space, and water-dependent recreational areas along its shorelines.

The Puget Sound Partnership (PSP) has created a plan for cleanup, restoration, and protection for Puget Sound through its 2011 Action Agenda. The Action Agenda has identified priority strategies for implementation, as well as near-term actions to support these strategies.

Other nonprofit community groups involved in restoration in Seattle include Carkeek Watershed Community Action project, Duwamish River Cleanup Coalition and Technical Advisory Group, Earth Corps, Fauntleroy Watershed Council, Friends of Madrona Woods, Friends of the Cedar River Watershed, People for Puget Sound, Puget Soundkeeper Alliance, the Seattle Aquarium, and others.

Applicable Restoration Actions

Determining the applicable actions to implement restoration strategies on the City shorelines relied upon a detailed shoreline analysis, which classified impairment levels of basic ecological functions. These results were presented in the *City of Seattle Shoreline Characterization Report* (City of Seattle 2009). Shorelines assessed were Lake Washington; Lake Union and the Ship Canal; the Duwamish River; Puget Sound, including Elliott Bay and Shilshole Bay; and Green Lake. The framework was based on a method used by regional scientists that provides a streamlined approach for characterizing watershed processes. Processes evaluated included delivery, movement, and loss of water, large woody debris (LWD), sediment, phosphorus, nitrogen, toxins, and pathogens, as they enter, pass through, and eventually leave the watershed; wave energy and tidal influences for marine shorelines; and light energy, including artificial light. The assessment identified the level of impact on

habitat function in discrete shoreline reaches within City limits. Reaches were classified in the analysis into five categories of degradation: most impaired, more impaired, moderately impaired, less impaired, and least impaired.

This Plan acknowledges that the context of the impairments within the overall landscape should be considered. As sites vary in their landscape context and condition, they are appropriate for certain restoration strategies over others.

Needs were determined for shoreline areas by evaluating the degree of ecological impairment for various watershed processes, and by identifying restoration actions that would address conditions as they relate to the habitat these processes influence. Applicable restoration actions were thus set to improve impaired ecological functions and/or protect existing function. Restoration actions to be taken are provided with general descriptions on a reach scale. Detailed site-specific descriptions are not included because this information is already available in several existing restoration planning documents (documents listed in Section 3).

City-wide Impairments Summary

Within Seattle, all shoreline habitats have been impaired to some degree by human alterations; however, there are some areas that continue to provide relatively high quality habitat. The distribution of habitat impairments is uneven. The heavily industrialized shorelines of Lake Union downstream to the Ballard Locks, Elliott Bay, and the Harbor Island portion of the Duwamish River Estuary are the most impacted reaches, and even within these reaches, there are some areas with higher habitat function (i.e., less impairment). Among the least impacted areas in the City are Seward Park, Union Bay, West Point and Magnolia Bluffs and Lincoln Park to Fauntleroy Cove.

For each segment of Seattle's shorelines (e.g. Lake Washington, Puget Sound), the below table lists the following important findings: highest and lowest functioning habitats, most impaired processes, highest applicable restoration actions, and high priority areas for protection.

Summary Findings for Restoration of Seattle's Shorelines

Segment	Highest Functioning Habitats	Lowest Functioning Habitats	Most Impaired Processes	Highest Applicable Restoration Actions	High Priority Areas for Protection
Lake Washington	Mature vegetated areas of the segment along the Burke-Gilman Trail, Matthews Beach, the Thornton Creek delta, Union Bay Natural Area (northern Union Bay), and the parks	Residentially developed areas where docks and armoring predominate, particularly in the areas south of Seward Park and from Madison Park to Colman Park (not including the parks)	Toxins, pathogens, sediment, water and wave	Armoring removal, water treatment, and riparian vegetation restoration	Areas with the least impairments; among these are wetland habitats of Union Bay and the areas of unarmored shoreline and riparian vegetation at Seward Park, in addition to any recent restoration project sites Stream mouths
Lake Union and Ship Canal	South shoreline of Portage Bay	West shoreline of Portage Bay and Fisherman's Terminal	LWD, phosphorus, sediment, toxins, and water	Armoring removal, stormwater treatment, riparian vegetation restoration, substrate debris removal	East Montlake Park and recent restoration sites, such as Salmon Bay Natural Area Undeveloped shoreline areas in Lake Union Creek mouths Areas with kelp or eelgrass beds
Duwamish River	Kellogg Island, the adjacent shoreline, and	Industrial shorelines of remainder of Duwamish	Light, LWD, nitrogen, phosphorus, toxins,	Armoring removal, water treatment, and	Recent restoration sites, such as Herring's House

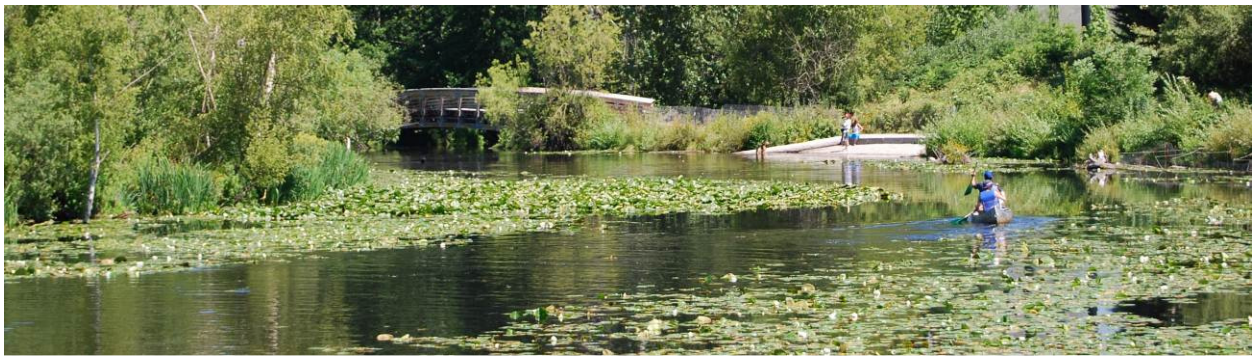
Segment	Highest Functioning Habitats	Lowest Functioning Habitats	Most Impaired Processes	Highest Applicable Restoration Actions	High Priority Areas for Protection
	the shore across the river from the island	River study area	water, and wave energy	riparian vegetation restoration	Park, and the Terminal 105 Coastal America site
Puget Sound, including Shilshole Bay and Elliott Bay	Unarmored portions of Golden Gardens Park, the creek mouth at the southern end of Golden Gardens Park, and their associated marshes; Discovery Park, Lincoln Park, and Seola Park	Shilshole Bay and Elliott Bay Marinas, the central waterfront, and Terminals 90 and 91	Pathogens and sediment	Armoring removal, stormwater treatment, riparian vegetation restoration, beach nourishment, LWD placement, and daylighting streams	Discovery Park, primarily West Point and Magnolia Bluffs, as well as recent restoration project sites such as Olympic Sculpture Park
Green Lake	Unarmored shores, vegetated riparian zones	Armored shores, unvegetated riparian zones	Nitrogen and phosphorus	Alum treatment or other similar action to treat high phosphorus levels; bioswales or similar treatments that would help to reduce the input of nutrients and pollutants into the lake	Unarmored shores, vegetated riparian zones

Implementation

Implementation of this Plan will be a joint effort within the City and between the City and its partners. As is the case for most restoration work, the opportunities described in this Plan will require extensive cooperation and coordination with citizens, public agencies, private landowners, and other stakeholders.

The City's Comprehensive Plan will direct City departments to continue their work restoring the City's shorelines and to use the Plan to guide their efforts. The City's work as it relates to this Plan will be monitored and evaluated on a set timeline against a suite of benchmarks to determine consistency with the State's SMP standard to improve ecological function over-time with the implementation of the Plan. This Plan will be implemented when Seattle's Shoreline Master Program is adopted by the Washington State Department of Ecology, with a timeline based on 10-year intervals. At each interval, ecological benchmarks will be evaluated for change.

There is currently no dedicated funding source for the restoration actions presented herein. Implementation of the work described in this Plan is dependent on grant funding, and a variety of other outside funding sources. It is expected that funding will be derived from various sources. Redevelopment of the shoreline is acknowledged as a key opportunity for restoration along urban shorelines such as Seattle's. When shoreline property is redeveloped, opportunities exist not only to mitigate for redevelopment-related impacts but also to go beyond regulatory mitigation and provide restoration of shoreline ecological function.



1 INTRODUCTION

This Restoration and Enhancement Plan (Plan) is prepared in support of the City of Seattle's Shoreline Master Program (SMP) update. The SMP is being updated to comply with the Washington State Shoreline Management Act (SMA or the Act) requirements (Revised Code of Washington [RCW] 90.58) and the state's SMP guidelines (Washington Administrative Code [WAC] 173-26, Part III-201 2[f]), which were adopted in 2003. The City of Seattle (City) SMP is composed of policies and regulations that regulate the use and development of the City's rivers, lakes and marine shorelines and this Restoration and Enhancement Plan.

The SMP must give preference to certain shoreline uses, in the order as follows: 1) reserve appropriate areas for protecting and restoring ecological functions to control pollution and prevent damage to the natural environment and public health; 2) reserve shoreline areas for water-dependent and associated water-related uses; 3) reserve shoreline areas for other water-related and water-enjoyment uses that are compatible with ecological protection and restoration objectives; 4) locate single-family residential uses where they are appropriate and can be developed without significant impact to ecological functions or displacement of water-dependent uses; and 5) limit non-water-oriented uses to those locations where the above described uses are inappropriate or where non-water-oriented uses demonstrably contribute to the objectives of the Shoreline Management Act (WAC 173-26-201(2)(d)).

The State's SMP guidelines state that SMPs are to "include goals, policies and actions for restoration of impaired shoreline ecological functions" (WAC 173-26-186). The impaired functions are to be identified based on a detailed inventory and characterization of the shoreline ecosystem, and a restoration plan is to be formulated based on that information (WAC 137-26-201). The results of Seattle's inventory assessment are presented in the *City of Seattle Shoreline Characterization Report* (City of Seattle 2009). This document uses that information to address the restoration plan requirements discussed in the SMP guidelines. This Plan is not a regulatory document or a set of regulatory requirements. However, the SMP points to this Plan as a guide outlining opportunities for improving shoreline ecological function.

The scope of this document, the vision for restored shorelines, and the context of this Plan in complying with the state's SMP policies are discussed next.

1.1 Plan Purpose and Scope

This section describes the purpose and scope of this Plan, as well context for topics outside the scope of the Plan.

1.1.1 What This Plan Contains

The purpose of this Plan is to describe how and where shoreline ecological functions can be restored within City boundaries. (City boundaries, shoreline reaches, and shoreline restoration actions are shown on Map A [separate document].) The SMP guidelines articulate that the Plan is to include: 1) an identification of existing and ongoing projects and programs, additional projects and programs needed to achieve local restoration goals, and implementation strategies including identifying prospective funding sources for those projects and programs; 2) an identification of timelines and benchmarks for implementing restoration projects and programs and achieving local restoration goals; and 3) provisions for mechanisms or strategies to ensure that restoration projects and programs will be implemented according to plans and to appropriately review the effectiveness of the projects and programs in meeting the overall restoration goals.

In accordance with the SMP guidelines, this Plan discusses the overall goals and applicable restoration actions of degraded shoreline areas and impaired ecological functions (Section 1). Then, the Plan identifies current and ongoing plans applicable to the City shorelines and a description of restoration partners and programs in the vicinity (Section 2). Section 3 includes a discussion of the procedures used in an analysis to identify degraded areas, impaired ecological functions, and sites with potential for restoration of City shorelines. The results of this analysis and the most applicable restoration actions for various City shorelines are provided in Section 4.

Finally, the Plan identifies strategies to ensure that restoration actions will be implemented and to appropriately review its effectiveness in meeting the overall restoration goals (Section 5). This includes timelines and benchmarks for implementing the strategy, prospective funding sources for restoration actions, obstacles and challenges to achieving goals, and an overview of monitoring for the Plan.

1.1.2 What This Plan Does Not Contain

While the Plan incorporates elements of other shoreline restoration planning documents that involve the City's shorelines, the scope of this Plan under the SMA guidance does not extend to that of a master document combining and aligning priorities of other shoreline restoration documents, plans, or efforts. As previously stated, the scope is significantly smaller: this Plan is required to base its conclusions on a detailed inventory and characterization of the shoreline ecosystem. However, in recognition that the contributions of these other shoreline restoration documents, plans, or efforts can have significant value to ecosystems, the Plan has been constructed to consider and incorporate priorities where the goals and objectives of the SMA and other documents converge.

It is important to clarify that restoration as it is discussed here is distinct from the concept of no net loss. The state's SMP policies include a standard of no net loss of ecological functions that are necessary to be achieved in the specific SMP regulations and through the implementation of the new SMP regulations. The Washington State Department of Ecology (Ecology) has clarified that this means that "establishing uses or conducting development are identified and mitigated with a final result that is no worse than maintaining the current level of environmental resource productivity" and "no uses or development supersede the requirement for environmental protection" (Ecology 2004). Thus, mitigation activities are the method by which no net loss is achieved. The distinction between the SMP's no net loss requirements and the requirements of the restoration plan is that the goals of the restoration plan is to go beyond no net loss by increasing ecological functions by repairing ecological processes or by increasing the amount, size, and/or functions of components of an ecosystem compared to the baseline conditions (Thom et al. 2005). Therefore, mitigation activities required to achieve no net loss because of impacts caused by a development project is not considered restoration under this Plan.

The Plan does not include guidance for in-lieu fees (ILFs) as a restoration tool because ILFs are considered mitigation meeting the state's requirement for "no net loss" (WAC 173-26-241(2)(a)(iv). The Plan is not a mitigation instrument or guidance document; an ILF program would be handled with City regulations outside the scope of this document.

1.2 SMP Restoration Definition, Vision, and Goals

Washington State's shoreline guidelines define restoration as "the reestablishment or upgrading of impaired ecological shoreline processes or functions". This may be accomplished through measures including but not limited to re-vegetation, removal of

intrusive shoreline structures and removal or treatment of toxic materials. Restoration does not imply a requirement for returning the shoreline area to aboriginal or pre-European settlement conditions" (WAC 173-26-020). In the context of this document, "restoration "is a blanket term covering four "restoration strategies" and is implemented by "restoration actions." Restoration strategies are described in detail in Section 3.

The City's vision for restoration in this SMP is based on science, policy, and public input. The *Seattle's Urban Blueprint for Habitat Protection and Restoration* (Seattle 2003) is a document which provides the science behind the City's desired future shoreline conditions and describes a variety of project actions that along with policy and public education actions can lead to restored habitats in Seattle. The SMA policy goals for SMPs were considered, (preferred shoreline uses, environmental protection, and public access). To develop the vision, the City undertook a community visioning process. During this process the citizens of Seattle expressed the desire to balance the three goals of the SMA and a strong interest in a natural and functioning shoreline (details on the visioning process are described in the Vision Report; City of Seattle 2012). Vision statements are summarized here.

The City's vision for restoration includes a shoreline with net gains in:

- Preferred shoreline uses:
  - Thriving water-dependent industrial and commercial uses.
  - Educational opportunities to reflect Seattle's maritime history and water-dependent business.
- Environmental protection:
  - Shoreline ecological function by protecting and/or improving watershed processes and habitat features.
  - Salmon populations and other fish and wildlife that depend on resources or habitat associated with the shoreline (e.g. eagles, great blue herons, otters).
  - Public understanding of the impact of policy and land use changes on environmental health
- Public access:
  - Variety of public access points for various users.
  - Views of the water and connectivity in green spaces with pedestrian and bicycle corridors.
  - Public transit and parking that serves public shoreline access.

This Plan describes a variety of applicable restoration actions that along with policy and public education actions can help the City to achieve the vision. Goals have been developed to meet the vision which can be used as metrics to monitor the City's progress in achieving the vision.

The City's goals for shoreline restoration are to:

- Protect and restore shoreline processes and functions, especially in those areas identified as having geological or biological significance.
- Protect and restore softer, more natural shorelines that feature native plants and control of noxious weeds; more trees in more locations; and improved water quality.
- Protect and restore a diversity of habitats and strengthen ecological and physical connections between habitats.
- Support the monitoring and study of the shoreline systems that will provide a continuously updated baseline against which to judge the impact of any action.
- Support programs that inform the public about shoreline conservation practices, and identify methods by which public and private shoreline owners or community groups may encourage wild, aquatic, and botanical life, and require such methods when appropriate and provide incentives for such projects.

These restoration goals can be met by applying appropriate restoration strategies and implementing restoration actions for Seattle shorelines (see Sections 4 and 5 of this Plan). An implementation strategy and benchmarks will be used to determine whether these goals are being met and the vision is being achieved (see Section 6 of this Plan).

2 EXISTING RESTORATION PLANNING, PROGRAMS, AND PARTNERS

There is a sizable body of literature on recent habitat and environmental planning that pertain to City shoreline ecosystems, flora, and fauna. These documents collectively describe a number of plans, projects, and status of the science within the City. The documents are:

- *Seattle's Urban Blueprint for Habitat Protection and Restoration* (Seattle 2003)
- *Seattle Shoreline Park Inventory and Habitat Assessment* (Anchor 2003)
- *Marine Shoreline Inventory Report: Seattle WRIA 9* (Anchor 2004)
- *Inventory and Assessment of Current and Historic Beach Feeding Sources/Erosion and Accretion Areas for the Marine Shorelines of Water Resource Inventory Areas 8 and 9* (CGS 2005)
- *Lake Washington/Cedar/Sammamish Watershed Chinook Salmon Conservation Plan* (WRIA 8 2005)
- *Salmon Habitat Plan, Green/Duwamish and Central Puget Sound Watershed Resource Inventory Area 9* (WRIA 9 2005)
- *Prioritization of Marine Shorelines of WRIA 9 for Juvenile Salmonid Habitat Protection and Restoration* (Anchor 2006)
- *Synthesis of Salmon Research and Monitoring, investigations conducted in the western Lake Washington Basin* (SPU and USACE 2008)
- *Lower Duwamish River Habitat Restoration Plan* (Port of Seattle 2009)
- *Draft Puget Sound Action Agenda* (PSP 2011)

Many groups are involved in shoreline restoration in and around the City, including the City of Seattle, the Port of Seattle, the University of Washington, watershed groups, and many environmental nonprofit groups and community organizations. This restoration work is summarized below in alphabetical order following the City of Seattle. The summary is intended to be a list of key parties and may not include all groups that have contributed to shoreline restoration to date.

2.1 City of Seattle

Several City of Seattle departments are involved with planning and implementing shoreline restoration. Seattle Public Utilities (SPU) implemented the Aquatic Habitat Matching Grant Program, which has funded projects aimed to improve the environmental conditions in Seattle's streams and shorelines. Two shoreline projects day lighted streams at their mouths; Madrona Creek, which feeds Lake Washington, and Fauntleroy Creek, which feeds

the Puget Sound. Additionally, SPU has secured funding for important monitoring work at several habitat projects in the City including: the seawall test panels along the Central Waterfront, the Olympic Sculpture Park, and Salmon Bay Natural Area.

In addition, the City of Seattle is working to complete its Natural Resource Damage Assessment (NRDA) requirements in the Duwamish and continues to fund monitoring of the restoration sites to determine whether restoration sites converge with the monitored reference sites.

Seattle Parks Department is active in undertaking shoreline restoration work and managing shorelines to a more natural state. Examples of this work include less riparian vegetation removal along Lake Washington Boulevard before the Seafair boat races and improvements at maintenance and operations facilities that minimize the potential for contaminating stormwater.

Over the past ten years Parks Department has made improvements including one or more of the following: bulkhead removal, beach creation, beach nourishment and riparian plantings; at Chinook Beach Park, Seward Park, the Arboretum, Magnuson Park, Denny Blaine Park, Golden Gardens Park, Herrings House Park, Martha Washington Park, Lake Washington Boulevard at Alaska and Adams Streets, Lake Washington Pritchard Preserve and Intertidal marsh restoration at Lowman Beach Park. Many of these projects received grants from the King Conservation District and the Salmon Regional Funding Board.

Additionally, a marina was removed at Chinook Beach Park and wetlands were restored at the Montlake playfield (Portage Bay) and Lake Union Park. Seattle Parks Department also offers educational programs and employs beach naturalists at their shoreline parks and the Seattle Aquarium and Environmental Learning Centers. The beach naturalists program is partially funded by the King Conservation District.

The City of Seattle is involved with government and non-government agencies partnering on shoreline restoration planning. Seattle is a partner with King County and other city governments for implementing the adopted Salmon Plans for WRIAs 8 and 9, administered

under Interlocal Agreements within each watershed. The City participates in the governing forums, which direct and oversee implementation as well as addresses policy and funding issues. Each WRIA has a 3 year work-plan, which are updated annually as more information is available or as opportunities arise to implement the plans. Seattle is the alternate for King County on the Stakeholder Advisory Group for the South Puget Sound Central Action area for the Puget Sound Partnership Ecosystem Coordination Board.

Puget Sound Partnership Coordinated Monitoring Program – Seattle with other local jurisdictions and State and Federal agencies is participating in developing a model monitoring program to measure the impacts from stormwater runoff. This information will help inform the next National Pollutant Discharge Elimination System (NPDES) permit requirements.

Through the Seattle Department of Transportation's (SDOT) street vacation process public access and shoreline restoration is a requirement and SDOT's shoreline street end permit requirements often require shoreline restoration. Additionally SDOT is involved with planning for the replacement of the seawall along Seattle's waterfront and has been testing alternatives to the homogenous surface with the goal of improving habitat for salmonid species and other aquatic organisms in Elliott Bay.

Bluefield Holdings, a Seattle "eco-development" company worked with former Seattle Mayor Greg Nickels and City Council on an agreement to lease and restore salmon habitat at seven city-owned parcels on the Duwamish River (City of Seattle 2008b). This work was initiated in an attempt to accelerate the completion of habitat restoration in the Duwamish, providing increased habitat function for the species that utilize this area. Following restoration implementation, the company made restoration credits available to the City for resolving natural resource liability in the Duwamish Waterway Superfund cleanup.

Seattle is leading green roof monitoring at four sites over the course of three years. These projects are being monitored for stormwater quantity to inform the effectiveness for Ecology to apply appropriate credit for these types of projects.

In addition to restoration work and monitoring, the City of Seattle has funded research on habitat use and behavior of juvenile Chinook salmon in the Lake Washington system. This research has been used by jurisdictions throughout Lake Washington to improve the management of their shorelines.

The City of Seattle assisted with staff time and funding for four Green Shorelines workshops that were intended to both gather and provide information to regulatory agencies and the

public regarding the appropriate places for green shorelines and identifying the barriers to green shorelines. The City of Seattle funded a survey regarding green shorelines to determine barriers to these types of projects and University of Washington students supplemented the survey by including residents from other jurisdictions along Lake Washington. Additionally the City produced a Green Shores for Homes guidebook for residential home owners to provide information regarding alternatives shoreline treatments that provide increased ecological function and the City received a grant from the Environmental Protection Agency to develop additional guidance for home owners and to create incentives that will promote green shores.

2.2 Carkeek Watershed Community Action Project

The Carkeek Watershed Community Action Project (CWCAP) serves the Carkeek Watershed in northwest Seattle. The CWCAP currently sponsors several programs which support salmon and salmon habitat restoration, as well as beach and riparian health: Salmon Feeders, Salmon Count Program, Salmon Stewards, Beach Docents, Demonstration Garden Volunteers, Earth Day, and Salmon Celebration.

2.3 Duwamish River Cleanup Coalition and Technical Advisory Group

The Duwamish River Cleanup Coalition (DRCC/TAG) was formed in 2001 and works toward final cleanup of the Lower Duwamish River. The group is composed of environmental, tribal, and community organizations in the area who represent the priorities, values, and will of the local residents. The DRCC/TAG's programs are many and varied, and include habitat restoration work as well as tours of the river, educational forums, youth programs, and neighborhood festivals and events on the river.

2.4 Earth Corps

Seattle-based EarthCorps is a nonprofit group that maintains a mission of local environmental service. It offers programs for young adults in conservation techniques and volunteer leadership. In addition, it provides a suite of restoration services to agencies, nonprofit organizations, community groups, and businesses throughout the state of Washington. In addition to its local work, EarthCorps also encourages international volunteers in its service learning programs.

2.5 Fauntleroy Watershed Council

Two groups, Friends of Fauntleroy Creek and Friends of Fauntleroy Park, merged in 2001 to form the Fauntleroy Watershed Council. The new group adopted an action plan to steward the creek and park. Under its action plan, the council now works to gather watershed, city, and regional stakeholders to maintain, restore, and address habitat and pollution topics in the Fauntleroy Park and Creek area.

2.6 Friends of Madrona Woods

Friends of Madrona Woods is a group of Seattle residents who volunteered to "adopt" the Madrona Park urban forest in cooperation with the Seattle Department of Parks and Recreation. Under its comprehensive plan, the group has facilitated invasive plant removal, trail improvement, and environmental education, along with other work. The group's largest project to date was the 2009 daylighting of Madrona Park Creek and construction of a new wetland at the mouth of the creek on the Lake Washington shoreline.

2.7 Friends of the Cedar River Watershed

Friends of the Cedar River Watershed is a nonprofit organization working toward protection and restoration of the Cedar River/Lake Washington Watershed and associated communities. Its key service areas are ensuring long-term stewardship of the watershed, facilitating environmental education, public education on watershed restoration. To do this, it maintains several programs focused on restoration, habitat, and stewardship with its base of volunteers, community leaders, and educators.

2.8 People for Puget Sound

People for Puget Sound is a nonprofit group established to restore Puget Sound through education and action. Its vision includes Puget Sound environmental education for youth and adults, community involvement, and working for accountability in enforcement of environmental laws and regulations. A major component of their work is the Habitat Restoration program, which works to preserve and enhance ecosystems across the Sound.

2.9 Port of Seattle

The Port of Seattle (Port) funds and contributes to habitat restoration within the City of Seattle. The Port has planned a large body of future restoration work, as described in its 2009 Habitat Restoration Plan (Port of Seattle 2009). This plan discussed approximately 50 acres of restoration within the City of Seattle. The Port's work has resulted in restoration of more than 30 acres of fish and wildlife habitat along Seattle shorelines, with an additional 9 acres in design and permitting stage, with construction planned for 2014 (Stebbins 2012).

2.10 Puget Sound Partnership

Through its 2011 Draft Action Agenda, the Puget Sound Partnership (PSP) has created a plan for cleanup, restoration, and protection for Puget Sound (PSP 2011). The Action Agenda places Seattle in its South Central Action Area and identifies priority strategies for implementation, as well as near-term actions to support these strategies. The strategies include the following, in brief: acquisition and protection of habitat, revisiting SMA statutes, organizing strategic funding for habitat restoration and protection, funding/implementing stormwater retrofits, implementing salmon recovery recommendations, following low impact development requirements, addressing toxics and excess nutrients and securing Model Toxics Control Account (MTCA) funding, restoring floodplains, and working with local governments to implement the Action Agenda.

2.11 Puget SoundKeeper Alliance

The Puget Soundkeeper Alliance is a staff and citizen group working toward better water quality, specifically, eliminating pollution releases in Puget Sound. It implements programs to patrol and monitor Puget Sound waters, conduct legal action under the Clean Water Act, and engage with business, government agencies, and citizens regarding water and pollution issues.

2.12 Seattle Aquarium

The Seattle Aquarium implements education programs, including school field trips, citizen science, beach naturalists, and camps and family programs to educate the public about issues affecting aquatic biota in Washington. In 2011, the Aquarium initiated a convention of the major organizations working in Puget Sound conservation to form the Marine

Conservation Network, which brings awareness, cooperation, and action to its member groups.

2.13 University of Washington

The University of Washington (UW) has undertaken several efforts for shoreline restoration at its Seattle Campus. The UW has been awarded certification by Salmon-Safe, a regional environmental certification program, is active in wetlands restoration research, and has ensured public access, open space, and water-dependent recreational areas along its shorelines. By the adoption and implementation of the 2003 Campus Master Plan (CMP), the UW committed to promote elements of open space, transportation and circulation, and potential development, all within the intention to conserve and develop the campus in the future. As one example of this work, under the CMP, the UW owns and maintains the Union Bay Natural Area in northern Lake Union for recreation and natural shoreline environment purposes.

3 RESTORATION STRATEGY

This Section describes the methods by which SMP restoration strategies and applicable restoration actions were determined for Seattle shorelines. Identifying the applicable restoration actions relied upon the results of Seattle's Shoreline Characterization Report, which included a classification of impairment levels for basic ecological functions. The restoration actions identified are those actions that will lead to an improvement in the impaired ecological functions and/or those actions that protect existing functions.

3.1 Restoration Strategies

Restoration strategies are rooted in an understanding of how habitats are formed and maintained. The habitat type and habitat functions provided to specific species in shoreline and aquatic areas are products of the interaction of physical, chemical, and biological processes that occur in both the aquatic system and adjacent terrestrial areas (Naiman et al. 1995). In Ecology's *Guide to Watershed Planners to Understand Watershed Processes* (Stanley et al. 2005; Ecology publication No. 05-06-027), the authors use the term watershed processes to refer to "the dynamic physical and chemical interactions that form and maintain the landscape at the geographic scales of watersheds to basins (hundreds to thousands of square miles)." These processes and human-caused stressors combine to create, maintain, or destroy habitat.

This Plan considers ten processes in identifying the applicable restoration actions: delivery, movement, and loss of water, large woody debris (LWD), sediment, phosphorus, nitrogen, toxins, and pathogens, as they enter, pass through, and eventually leave the watershed. It also includes wave energy and tidal influences (tidal for marine shorelines only) because they are important processes affecting the shape and function of shorelines. Light energy is also included because light is an important control on vegetation and animal growth, distribution, and behavior. Changes in these processes impact the functions that the habitat supports for organisms. Therefore, the distribution and behavior of plants and animals are a response to the watershed processes that occur and the structure of habitat that is created. Where unfavorable changes have occurred in habitat structure and function due to interruption of these watershed processes, organisms are directly or indirectly negatively impacted, and there is a need to reinstate these processes for ecological health.

The four restoration strategies used in this document are protection, restoration of ecological processes, rehabilitation, or creation. These are derived from the Puget Sound Technical Recovery Team's (Puget Sound TRT's) concept of general habitat management

strategies developed for use used by watershed groups and others working for regional salmon recovery (Puget Sound TRT 2003), but apply well to shoreline habitats in general because salmon are highly dependent on shoreline areas for their growth and survival. The four strategies are described as follows.

- Protection can be applied where habitat is presently functioning at a high level and supports natural habitat-forming or -sustaining processes. For example, conserve the natural sediment delivery processes from a feeder bluff to the intertidal zone by keeping that section of shoreline unarmored.
- Restoration of ecological processes can be applied where habitat is impaired but natural processes can be recovered. For example, restore the natural sediment delivery processes from a feeder bluff to the intertidal zone by removing shoreline armoring that currently prevents bluff material from eroding and entering the intertidal zone.
- Rehabilitation can be applied where habitat is impaired and restoration of full function and supporting processes appears infeasible; however, limited improvements to functions and supporting processes can be achieved through partial re-establishment of ecosystem processes or functions. For example, rehabilitate the delivery of sediment from a feeder bluff to the intertidal zone in areas where armoring cannot/will not be removed, by moving any sediment that erodes from the bluff over the armoring and into the intertidal zone.
- Creation can be applied where habitat function is lost through anthropogenic degradation and restoration and/or rehabilitation are not possible, but creation of habitat features to lead to replacement of lost function can be accomplished. For example, substitute the delivery of sediment from a feeder bluff to the intertidal zone in areas where armoring cannot/will not be removed, by importing sediment and placing it in the intertidal zone to “nourish” the beach.

The order of these general strategies reflects the degree to which a watershed process would be re-established or protected if the action were taken. That is, protection maintains natural processes, process restoration fully establishes natural processes, rehabilitation will partially re-establish natural processes, and creation will provide habitat features but does not address processes. Ideally, the preference for use of the strategies would be: 1) protect, 2) restore processes, 3) rehabilitate, and 4) create. However, in a highly developed area, the order is dependent on the site conditions. Depending on the location of a restoration site, the preference order would be modified where there are considerations of feasibility and likelihood of project success (as is discussed in Section 3.2).

3.2 Assessment of Existing Shoreline Impairments

To assess degraded shoreline areas within the City, a science-based geographic information system (GIS) model was used to characterize the relative degree of habitat function or impairment of the City's shoreline habitat conditions. The results of this assessment are presented in the *City of Seattle Shoreline Characterization* Report (City of Seattle 2009). All City shorelines under SMP jurisdiction were evaluated, including those portions of the following waterbodies that occur in the City boundaries: Lake Washington, Lake Union and the Ship Canal, the Duwamish River, Puget Sound, including Elliott Bay and Shilshole Bay, and Green Lake. Associated wetlands along these shorelines also fall under shoreline management jurisdiction and were also evaluated the characterization report.

The characterization framework incorporated and applied current knowledge of Seattle's marine, estuarine, and lake shoreline ecology. The framework was based on a method that provides a streamlined approach for characterizing watershed processes developed by Stanley and others (2005), and adapted to this Plan using strategies identified by the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Nearshore Science Team (Simenstad et al. 2006) and Battelle Marine Sciences Laboratory. The details of the assessment methods were largely patterned after King County's SMP *Appendix E, Technical Appendix* (2007). This appendix may be consulted for further information.

The *City of Seattle Shoreline Characterization Report* (City of Seattle 2009) identified the level of impact on habitat function in discrete shoreline areas, called "sub-reaches" within City limits. A consistent method was used for delineating sub-reaches in both marine and freshwater environments of the assessment area. The approach used aggregated areas based on a manual interpretation of natural breaks in the model results. These included areas of the shoreline with relatively consistent scores and areas with scores that varied within a distinct range, areas with a consistent trend in the scores along the shoreline, and in some cases distinct areas with extremely heterogeneous scores. Sub-reaches were grouped together to form reaches. Reach breaks were determined based on a transition in shoreline habitat condition or a change based on land use (e.g., include a park in one reach) or ecosystem (e.g., separate freshwater from marine). Reaches are depicted in Map A, Sub Reaches are depicted in the accompanying Map Folio, maps 1 - 25. Map A and the Map Folio are located in two separate documents.

Reaches were classified into five categories of degradation: most impaired, more impaired, moderately impaired, less impaired, and least impaired. These categories were useful for interpreting the relative level of impact among reaches and were appropriate for comparison across all shoreline environments of Seattle.

3.3 Landscape Context Considerations in Restoration Planning

This Plan considers impairment at the site scale in the context of the impairments within the larger landscape that encompasses the site. Landscape context is an important consideration in determining the appropriate restoration strategies for a site. For example, consider two sites that both scored as being moderately impaired in terms of sediment processes. One site is within a larger area (reach) that maintains some degree of natural sediment processes. A process restoration strategy for this site that is targeted to sediment process would be an appropriate strategy due to the fact that restoration is more likely to be sustained by intact processes nearby. Then, consider a second site located within a landscape that is severely impaired with regard to natural sediment processes. Process restoration focused on sediment at the site scale is not likely to be sustained due to the lack of intact processes in the surrounding landscape. For the second site, a strategy of rehabilitating the habitat by providing sediment in the area (e.g., beach nourishment), or a strategy focusing on other functions that are not as impaired at a reach scale (e.g., wave energy or toxins) would be more appropriate.

The following table provides guidance for strategies for each reach that could be suitable with a given level of impairment at sub-reaches versus reaches, depending on site and landscape characteristics (Table 1). The organization of the table was based on similar work cited in Stanley and others (2005), by Shreffler and Thom (1993), and by Booth and others (2004) that contemplated suitable restoration and protection efforts based on the degree to which the watershed processes and site functions have been altered. The table axes reflect the City's shoreline characterization impairment categories, and the contents are adapted as appropriate for the City's shoreline conditions. The concept of "*likelihood*" was carried through the table to list strategies that were logical for each landscape context scenario covered in Seattle's SMP. For example, consider a site along Seattle's Central Waterfront located in a "most impaired" sub-reach within the context of a "most impaired" reach. Because the shoreline is highly developed and impaired in this context, the restoration

strategies that would be *likely* to succeed and be maintained over time are those that raise functionality by improving local habitat features, as opposed to restoring processes. For a highly modified reach, appropriate strategies would include rehabilitation and creation, which aim to improve existing habitat features at the site. Strategies that aim to restore processes here are less appropriate, since the process would not be sustainable long-term without some landscape level change to land use in the area. This said, a strategy of process restoration in an area like this could be appropriate if changes to landscape-level conditions occur and the opportunity for sustainable process restoration arises.

Table 1

Guidance for Suitability of Restoration Strategies based on Level of Impairment

		Reach Scale Impairment				
		Least	**Less**	**Moderate**	**More**	**Most**
Sub-reach Scale Impairment	**Most**	Restore Process Rehabilitate*	Restore Process Rehabilitate*	Rehabilitate Restore Process Create*	Rehabilitate Create	Rehabilitate Create
	More	Restore Process Rehabilitate*	Restore Process Rehabilitate	Rehabilitate Restore Process Create	Rehabilitate Create	Rehabilitate Create
	Moderate	Restore Process Protect Rehabilitate	Restore Process Protect Rehabilitate	Rehabilitate Protect Restore Process Create	Rehabilitate Create Protect	Rehabilitate Create Protect
	Less	Protect Restore Rehabilitate	Protect Restore Process Rehabilitate	Protect Restore Process Rehabilitate	Protect Rehabilitate Create	Protect Rehabilitate Create*
	Least	Protect	Protect Restore Process Rehabilitate	Protect Restore Process Rehabilitate	Protect Rehabilitate	Protect Rehabilitate*

Notes:

* Combinations shown are strategies for each reach that could be suitable with a given level of impairment at sub-reaches versus reaches. Some combinations did not occur in the City's shorelines, as described in the *Seattle Shoreline Characterization Report* (City of Seattle 2009).

Table 1 indicates strategies that are considered most likely to occur and succeed. The absence of certain strategies in various boxes of the guidance in Table 1 does not preclude using other strategies if opportunities arise for an appropriate restoration action. For example, in a highly impaired sub-reach in a highly impaired reach, "protect" is not identified as a restoration strategy. However, if an opportunity arose to protect a valuable area within the sub-reach, the effort to do so might still be valuable, and the strategy of protection should not be dismissed.

In this Plan, Table 1 is used as guidance to match potential restoration strategies to various shorelines within the City. For this analysis, each sub-reach of the City's shorelines was fitted to boxes in this table, depending on its impairment level and the impairment level of its landscape (results of the impairment assessment are described in Section 5).

3.4 Habitat Protection and Conservation

Given the urban nature of the City, existing areas with high ecological function are rare. The areas that do exist are generally parks or other open spaces. Any protections that can be offered through implementation of this Plan or the SMP should maximize the conservation of ecological function. This will help meet the City's goals of protecting shoreline processes and functions, creating more natural shorelines that feature native plants and a diversity of habitats, and strengthening ecological and physical connections between habitats.

3.5 Application of Restoration Strategies

Identifying applicable restoration actions are necessary in order to guide the City's restoration implementation. Table 2 provides a list of restoration actions that encompass the typical elements of shoreline projects reviewed for this analysis, and identifies which watershed processes these restoration actions would generally address. This is not a comprehensive list of all restoration actions that are possible; it is a generalized list of the types of actions that have been proposed for Seattle shorelines.

Table 2

Restoration Actions and Watershed Processes Addressed

Restoration Action	Light	LWD	Nitrogen	Pathogens	Phosphorus	Sediment	Tide	Toxins	Water	Wave
Riparian Restoration, Noxious Plant Removal	X	X	X		X	X		X	X	
Daylighting Streams, Rehabilitate Channels		X	X	X		X	M			
Intertidal or Littoral Debris Removal, Groin Removal						X				X
Beach Nourishment						X				
Armoring Removal, LWD placement		X				X	M		X	X
Overwater Structure Removal	X	X								
Stormwater Treatment, Contaminant Removal			X	X	X			X		
Wetland Restoration			X	X	X	X		X	X	

Notes:
X Addresses process in both freshwater and marine waters
F Addresses process only in freshwater
M Addresses process only in marine waters

Restoration actions are later categorized in this Plan as High, Medium, or Low priority for large areas or waterbodies (i.e., multiple reaches) of the City shoreline. Priorities have been assigned corresponding to actions that address the specific, existing impacts to habitat function (these are discussed in more detail in the *Shoreline Characterization Report*; City of Seattle 2009).

Overall, the restoration actions shown in Table 2 and as later discussed in this Plan should be viewed in light of compatibility with current uses at a given site and scale in order to align with the goals and policies of the SMA and related rules. For example, this Plan may have armoring removal or LWD placement identified as an applicable restoration action along the Central Waterfront. While removal would provide the most ecological benefit to an unused shoreline, a beneficial retrofit or modification is more feasible, safer, and longer lasting in this setting.

3.6 Project Identification

This Plan makes use of existing research, monitoring and restoration planning efforts to identify feasible shoreline habitat restoration opportunities that could offer improvement in

shoreline ecosystem functions. These potentially improved functions are then compared against the results of the shoreline characterization effort to determine where the greatest need for restoration occurs. To determine restoration actions, the land use of the site, the level of impairment at the site, the opportunity for restoration and how well the restoration actions are able to address the impairments to specific processes are considered.

Every waterbody and shoreline that is the subject of this Plan is included in one or more of the following restoration or monitoring plans;

- Green Lake Vegetation Management Plan (Seattle 1996)
- *Seattle's Urban Blueprint for Habitat Protection and Restoration* (Seattle 2003)
- *Seattle Shoreline Park Inventory and Habitat Assessment* (Anchor 2003)
- *Lake Washington/Cedar/Sammamish Watershed Chinook Salmon Conservation Plan* (WRIA 8 2005)
- *Salmon Habitat Plan, Green/Duwamish and Central Puget Sound Watershed Resource Inventory Area 9* (WRIA 9 Steering Committee 2005)
- *Prioritization of Marine Shorelines of WRIA 9 for Juvenile Salmonid Habitat Protection and Restoration* (Anchor 2006)
- *Synthesis of Salmon Research and Monitoring, investigations conducted in the western Lake Washington Basin* (SPU and USACE 2008)
- *Lower Duwamish River Habitat Restoration Plan (Port of Seattle 2009)*
- The Elliott Bay General Investigation (USACE 2009)

Projects identified as a priority for implementation within each of the restoration documents were reviewed for this Plan and categorized by the specific restoration actions included in the description of the project. Projects typically include more than one restoration action (i.e., bulkhead removal, littoral debris removal and restoration of riparian vegetation). This information was used to determine which potential projects have been identified as feasible and the specific impairments to shoreline habitat the restoration actions are most likely to address.

Strictly based on the analysis the results of the Shoreline Characterization Report, projects in highly impaired areas have a greater capacity for improvement to shoreline ecological function than areas with low impairments. However, depending on the restoration strategy, some projects in highly impaired areas in urban industrial shoreline environments may not be consistent with the City's vision for thriving water-dependent industrial and commercial uses (see Section 1.2 of this document) and the goals of the SMP to reserve shoreline areas for water-dependent and associated water-related uses (WAC 173-26-201). Some projects can also be less sustainable due to impairments of the processes necessary to sustain them over the long term (see section 3.2). Therefore, rather than setting high priorities for projects in the most impaired areas strictly based on high impairment, this Plan also sets priority for projects that have a priority status in one or more of the existing restoration plans, as well as actions that address the City's overall vision.

4 APPLICABLE RESTORATION ACTIONS

A summary of city-wide impairments and detail on impairments and the applicable restoration actions and projects for Seattle's shorelines is described below. Specific waterbodies are discussed in the following order: Lake Washington; Lake Union and the Ship Canal; the Duwamish River; Puget Sound, including Elliott and Shilshole Bays; and Green Lake. Impairments and restoration strategies are discussed on a reach scale, and then restoration actions that would be the most productive in meeting the overall plan goals are identified. Following the description of restoration actions, a short discussion highlights select projects that have been proposed and other restoration actions that address shoreline impairments identified in the *Shoreline Characterization Report* (City of Seattle 2009). For detailed descriptions of previously developed site-specific projects, see the existing restoration planning documents listed in Section 3.6.

4.1 City-wide Impairments Summary

Within Seattle, all shoreline habitats have been impaired to some degree by human alterations. There are some areas, however, that continue to provide relatively high quality habitat to a diversity of species, and have relatively intact shoreline ecosystem processes. The distribution of habitat impairments is uneven; the heavily industrialized shorelines of Lake Union downstream to the Ballard Locks, Elliott Bay, and the Harbor Island portion of the Duwamish River Estuary are the most impacted reaches with respect to their historic function. Even within these most impacted reaches, there are some areas with higher habitat function (i.e., less impairment). The least impacted areas in Seattle include Seward Park, Union Bay, West Point and Magnolia Bluffs, and Lincoln Park to Fauntleroy Cove. These areas provide relatively high quality habitat and intact processes. Between these two ends of the impairment spectrum are reaches with moderate amounts of impairment.

As explained in Section 3.1, as part of the shoreline characterization, each reach within the City was categorized as most, more, moderate, less, or least impaired. Reaches were comprised of smaller assessment units called sub-reaches which offer a finer scale indication of functional impairment (Maps 1 through 25). The restoration strategies for each sub-reach are determined by the level of impairment of that sub-reach and the reach that encompasses it (see Table 1). The number of sub-reaches with similar levels of impairment at the reach and sub-reach scale are shown below in Tables 3 and 4 for freshwater and marine shorelines, respectively. For freshwater habitats, many sub-reaches fall into the more impaired and most impaired categories at both the sub-reach and reach scale; according to Table 1, rehabilitation and creation are key strategies for a large number of

Seattle's freshwater sub-reaches. For marine/estuarine sub-reaches, many were moderately impaired or most impaired categories on the sub-reach scale as well as the reach scale, and therefore the strategies of rehabilitation, protection, restoration, and creation are important in these sub-reaches. Overall, this table illustrates that much of the City's highly impaired shoreline habitat is within a landscape context of high impairment as a whole. Similarly, habitat that is highly functional is generally within the context of highly functional landscapes as well.

Table 3

Freshwater Reach Assignments Based on Reach and Sub-reach Impairment Category

		Reach Scale Impairment				
		Least	**Less**	**Moderate**	**More**	**Most**
Sub-reach Scale Impairment	**Most**				3	12
	More		4	1	7	13
	Moderate	1	3	3	8	4
	Less	1	4	5	5	
	Least	5	6		1	

Table 4

Marine Reach Assignments Based on Reach and Sub-reach Impairment Category

		Reach Scale Impairment				
		Least	**Less**	**Moderate**	**More**	**Most**
Sub-reach Scale Impairment	**Most**				8	10
	More				8	3
	Moderate			13	18	6
	Less	3	7	6	4	
	Least	6	1	2	3	

4.2 Lake Washington

Lake Washington has lost much of its shoreline habitat connectivity and complexity because of hydrologic modifications within the Lake Washington system, including the lowering of lake level by approximately 10 feet, loss of riparian vegetation, installation of bank armoring, and construction of overwater structures associated with the urbanized watershed today. About 66 percent of the lake shoreline in the City is armored and more than 900 overwater structures are in place (Toft et al. 2003a and 2003b). Less than 25 percent of the shoreline contains natural vegetation (Toft 2001). Overwater structures have the potential to negatively impact benthic production and fish communities, including the rearing and migration of juvenile salmon and other fish species supported by the shallow water habitat.

4.2.1 Impairments

The number of sub-reaches in Lake Washington with specific levels of impairment at the reach and sub-reach scale are summarized below in Table 5, based on the restoration strategies in Table 1.

Table 5

Lake Washington Reach Assignments Based on Reach and Sub-reach Impairment Category

		Reach Scale Impairment				
		Least	**Less**	**Moderate**	**More**	**Most**
Sub-reach Scale Impairments	**Most**				2	
	More		4	1	6	
	Moderate	1	3	2	6	
	Less	1	4	4	5	
	Least	5	6			

On the northern shores of Lake Washington within City limits, residential development has contributed to higher amounts of impervious surface, a lack of overhanging and riparian vegetation, extensive shoreline armoring, and numerous docks and overwater structures.

Riparian vegetation does occur at some small locations, such as parks along the Burke Gilman multi-use Trail and the Thornton Creek delta. South of Magnuson Park, there is a large wetland complex and intact mixed forest near the shore, and further south, the northern portion of Union Bay has extensive marshy shorelines with unarmored conditions and some mature trees. Between the Washington Park Arboretum and Seward Park, shorelines decrease in ecological function, as docks and armoring increase and shoreline vegetation is limited. Park shorelines are typically not as impaired; in fact the arboretum, Seward Park and Colman Park shorelines all have relatively high ecological function, with generally little shoreline armoring and relatively high native or mixed-native vegetation cover. The remainder of the Lake Washington segment to the southern City limit is characterized by patches of higher habitat functionality, generally where parks occur. In much of this area, shoreline armoring, docks, and lawns occur, and habitat function is more impaired.

In summary, highest functioning areas include mature vegetated areas of the segment along the Burke-Gilman Trail, Matthews Beach (although these shorelands are set back from the water's edge), the Thornton Creek delta, Union Bay Natural Area (north Union Bay), and parks including the Washington Park Arboretum. Lowest functioning habitats include residentially developed areas where docks and armoring predominate, particularly in the areas south of Martha Washington Park and from Madison Park to Colman Park (not including the parks).

Using the analysis described in Section 4.1, reaches were scored based on the condition of the various ecosystem processes. This score information can be further used to identify processes contributing most to shoreline impairment for a given area. *The Shoreline Characterization Report* (City of Seattle 2009) provided process rank scores for each reach and charted the score distribution among reaches with the classification breaks between high, moderate, and low impairment. Table 6 shows these impairment categories.

These results indicate that the most impaired process in the Lake Washington shoreline segment is nitrogen; however, data taken by King County indicate that nitrogen is not a problem unless current levels of phosphorous increase (Tetra Tech and Parametrix 2003). Nitrogen can be a problem for Puget Sound and because Lake Washington drains into Puget Sound the nitrogen from Lake Washington will enter the Sound. The many tributary streams and drainage pipes that enter Lake Washington carry both phosphorous and nitrogen from runoff that contains fertilizers sourced from lawns in residential areas. Wetlands that historically provided nutrient uptake for streams entering Lake Washington have been removed and there are now more impervious surfaces in the watersheds.

Table 6

Impairment Category from *Shoreline Characterization Report* (City of Seattle 2009) for Various Watershed Processes at Lake Washington—City Shorelines

Reach No.	Reach Description	Reach Impairment Category	Light	LWD	Nitrogen	Pathogens	Phosphorus	Sediment	Toxins	Water	Wave
1	Northern City Limit to Magnuson Park	Moderately Impaired									
2	Magnuson Park	Less Impaired									
3	Laurelhurst	Less Impaired									
4	Union Bay	Least Impaired									
5	Madison Park to Colman Park	More Impaired									
6	Colman Park to Seward Park	Less Impaired									
7	Seward Park	Least Impaired									
8	Seward Park to Southern City Limit	More Impaired									

Notes:

High Impairment

Moderate Impairment

Low Impairment

Other highly impacted processes are sediment, toxins, pathogens, phosphorus, water and waves. Sediment processes are more impaired at the northern and southern city limits, due to the high amounts of impervious surface area near the shoreline. Pathogens and toxins impair shorelines on a patchy basis, depending on the level of development of the nearby shoreline. The water process is more impaired south of Union Bay as development increases and unarmored shorelines are limited. Wave processes are impacted by extensive overwater structures and shoreline armoring.

As shown in Table 6, model results suggested that the least impaired processes in the Lake Washington segment are LWD and light. LWD occurs along lake shorelines where shores are less developed, such as near the parks and vegetation cover is present in many areas

within shorelands (200 feet of the shoreline), light conditions are not likely to be limited in these areas. The City's Lake Washington shoreline, however, does have approximately 750 residential docks that extend 30 to 100 feet from the shoreline and cover an estimated 4 percent of the lake surface area within 100 feet of the shore (Weitkamp et al. 2000). Residential structures are densely concentrated at the shoreline in many areas, creating a barrier between the shorelands and the water. Natural light conditions would be limiting in the shallow aquatic zones just waterward of these areas due to the overwater pier structures.

Artificial lighting at night was not part of the characterization report; however, artificial light has been shown to impact fish predation (Tabor et al. 1998). Projects that reduce the amount of artificial light would benefit fish habitat within Seattle.

4.2.2 Applicable Restoration Actions

Based on these impairments, the applicable restoration actions for the Lake Washington segment determined to be High, Moderate, or Low in Table 7. This table was completed by combining the impairment levels for each reach presented in Table 6 with the restoration actions and watershed processes addressed that were described previously in Table 2. For example, Table 6 shows that in Reach 1 (Northern City Limit to Magnuson Park), the watershed process "nitrogen" and "sediment" are highly impaired. Table 2 identifies the restoration actions that would address nitrogen issues as: riparian restoration/noxious plant removal, daylighting streams/rehabilitating channels, stormwater treatment/contaminant removal, and wetland restoration and these five actions would be assigned as most applicable restoration actions for this reach. The sediment process was also highly impaired, so the actions of intertidal/littoral rubble/groin removal, beach nourishment, armoring removal/LWD placement, and wetland restoration would also be assigned as the most applicable restoration actions for this reach. The LWD process was moderately impaired, so riparian restoration/noxious plant removal, daylighting streams/rehabilitating channels, armoring removal/LWD placement, and overwater structure removal would be assigned as moderately applicable for this reach. However, riparian restoration/noxious plant removal and armoring removal/LWD placement were already assessed as being most applicable; therefore these actions remain highly applicable. Restoration actions to address "low impairment" light conditions would include riparian restoration/noxious plant removal and overwater structure removal, and riparian and overwater structure work are already assigned as most applicable, so these actions remain highly applicable. Additionally, the actions identified for restoration are also considered important for providing habitat for juvenile Chinook salmon.

Reaches that have the greatest need for restoration actions are those that are highest impaired in the Lake Washington segment, referenced by Reach Impairment Category in Table 7: Reach 5 (Madison Park to Colman Park) and Reach 8 (Seward Park to Southern City Limit).

Previous restoration planning documents (see Section 3.6) do not identify any projects for Reach 5, but protecting high quality habitat where it exists in small patches has been suggested. The *Seattle Shoreline Park Inventory and Habitat Assessment* (Anchor 2003) recommended protecting the high quality aspects of swim beach habitat at Madison Park, Madrona Beach, and Colman Park. Compared to armored shorelines of most of Lake Washington, swim beaches typically have small substrates with gentle shoreline slopes that can provide refuge and feeding habitat for juvenile salmon and other small fish. Tabor and others (2004) noted relatively high juvenile Chinook salmon use of such areas in the southern parts of Lake Washington. Therefore, creating additional natural beach areas with riparian vegetation in the reach are appropriate restoration actions.

Additional restoration actions that are applicable in this reach include those that would address toxin inputs and its upstream tributary subbasins, with actions such as riparian restoration, stormwater treatment/contaminant removal and wetland restoration, as suggested above. The remaining processes are “moderately” impacted; therefore, additional restoration actions would include overwater structure removal, LWD placement and removal of shoreline armoring.

Table 7

Applicable Restoration Actions—Lake Washington

Reach #	Reach	Reach Impairment Category[1]	Reach Protection Category[2]	Riparian Restoration	Daylighting Streams (where piped streams occur)	Nearshore Debris Removal/ Groin Removal	Beach Nourishment	Armoring Removal	Overwater Structure Removal	Stormwater treatment	Wetland Restoration
1	Northern City Limit to Magnuson Park	Moderately Impaired	Low	High	High	High	High	High	High	High	High
2	Magnuson Park	Less Impaired	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate
3	Laurelhurst	Less Impaired	Moderate	High	High	Moderate	Moderate	Moderate	Moderate	High	High
4	Union Bay	Least Impaired	High	Moderate	Moderate	Low	Low	Low	Low	Moderate	Moderate
5	Madison Park to Colman Park	More Impaired	Low	High	High	Moderate	Moderate	Moderate	Moderate	High	High
6	Colman Park to Seward Park	Less Impaired	Moderate	High	High	Low	Low	Moderate	Low	High	High
7	Seward Park	Least Impaired	High	Low	Low	Low	Low	Low	Low	Low	Low
8	Seward Park to Southern City Limit	More Impaired	Low	High	High	Moderate	Moderate	Moderate	Moderate	High	High

Notes:

a. Based on the results of the *Shoreline Characterization Report* (City of Seattle 2009).

b. Reach was considered High priority for protection if reach impairment category was “least”; moderate priority if reach impairment category was “less”; low priority for all other reach impairment categories (“moderate,” “more,” and “most”).

In Reach 5, a project sponsored by Friends of Madrona Woods, affiliated with the Madrona Community Council, recontoured existing stream beds, constructed culverts to flow under 38th Avenue and Lake Washington Boulevard, and created a new stream channel and wetland cove at the lakeshore in Madrona Park. This project addressed the restoration actions of riparian and wetland restoration, as well as stream daylighting, all of which are listed as High priority in Table 7.

In Reach 8, several projects have been proposed and implemented, including completed beach nourishment and substrate enhancements at Seward Park and in-progress enhancements near South Alaska Street (Seattle 2003). Three littoral zone and shoreline riparian projects have been proposed or completed: one proposed at Pritchard Island Beach, and two completed, one at Martha Washington Park and the other at Rainier Beach, also known as Chinook Beach (Anchor 2003). Additionally, daylighting Mapes Creek at its mouth is a proposed project that will occur in the next several years. The completed projects were too recent to be reflected in datasets used in the GIS model, but they address most of the applicable restoration actions because they provide riparian vegetation and improvements to substrate that will benefit fish and wildlife using the shoreline. Similar to the northern reach discussed previously, restoration actions are still needed that would address the nitrogen problem in the reach as well as its contributing drainage areas.

High priority areas for habitat protection include those with the least impairments: the wetland habitats of Union Bay and the areas of unarmored shoreline and riparian vegetation at Seward Park, in addition to any recent restoration project sites. The Union Bay Natural Area contains areas of former landfill with specific landfill cap maintenance requirements that were incorporated into existing athletic field construction and maintenance programs, so any proposed protection for this area will need to incorporate recognition of these activities.

In addition to the information regarding the level and detail of impairments and the applicable restoration actions to be taken on Lake Washington shorelines provided in *The Shoreline Characterization Report* (City of Seattle 2009), the *Synthesis of Salmon Research and Monitoring, investigations conducted in the western Lake Washington Basin* (SPU and

USACE 2008) should be used when evaluating shoreline habit conditions and the appropriate restoration actions for the shoreline of Lake Washington. The information in this synthesis document includes the results and analysis of many years of studies focusing on the use by Chinook salmon of the Lake Washington and Ship Canal shorelines.

Table 8 provides a list of projects for the Lake Washington shoreline segment, including the name of the habitat plan that proposed the project, the sub-reach ID number from the *Shoreline Characterization Report* (City of Seattle 2009), and the sub-reach impairment and reach impairment categories from the report. For each project, applicable restoration actions and the processes that would be addressed by those restoration actions are identified.

Table 8

Projects for Lake Washington

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Processes Addressed by Restoration Actions[3]
Matthews Beach	Parks	1-e	More Impaired	Moderately Impaired	• **Riparian** • **Armor**	Light LWD **Nitrogen** Pathogens Phosphorus **Sediment** Toxins Water Wave
Matthews Beach	Parks	1-f	Less Impaired	Moderately Impaired	• **Riparian** • **Armor**	Light LWD **Nitrogen** Pathogens Phosphorus **Sediment** Toxins Water Wave
Sand Point Magnuson Park	Parks	1-g	Moderately Impaired	Moderately Impaired	• **Riparian** • **Armor**	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave
Sand Point Magnuson Park	Parks	2-a	More Impaired	Less Impaired	• Riparian • Beach • Armor	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave
Sand Point Magnuson Park	Parks	2-b	Least Impaired	Less Impaired	• Protect[4] • Riparian • Beach • Armor	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Processes Addressed by Restoration Actions[3]
Sand Point Magnuson Park	Parks	2-c	More Impaired	Less Impaired	• Riparian • Beach • Armor	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave
East Montlake Park	Parks	4-c	Least Impaired	Least Impaired	• Protect	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave
Madison Park	Parks	5-a	More Impaired	More Impaired	• Armor	LWD Sediment Water Wave
Madison Park	Parks	5-b	Less Impaired	More Impaired	• Armor	LWD Sediment Water Wave
Lake WA Blvd, C287[1]	WRIA 8	5-f	More Impaired	More Impaired	• Riparian • Debris removal	Light LWD Nitrogen Phosphorus Sediment **Toxins** Water
Colman Park	Parks	6-a	Least Impaired	Less Impaired	• Protect	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave
Lake WA Blvd South near South McClellan St	Blueprint	6-c	Least Impaired	Less Impaired	• Protect • **Riparian**	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave
Lake WA Blvd South, C281	WRIA 8	6-d	Moderately Impaired	Less Impaired	• **Riparian** • Debris Removal	Light LWD Nitrogen Phosphorus Sediment Toxins Water
Lake WA Blvd South, C281	WRIA 8	6-e	Moderately Impaired	Less Impaired	• **Riparian** • Debris Removal	Light LWD Nitrogen Phosphorus Sediment Toxins Water

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Processes Addressed by Restoration Actions[3]
Seward Park	Parks	7-a	Least Impaired	Least Impaired	• Protect • Riparian • Beach • Armor	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave
Seward Park	Parks	7-b	Least Impaired	Least Impaired	• Protect • Riparian • Beach • Armor	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave
Pritchard Island Beach	Parks	8-c	Less Impaired	More Impaired	• Riparian • Armor	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave
Mapes Creek Daylighting *(currently scheduled for 2013-2014)*	N/A	8-e	More Impaired	More Impaired	• Daylighting Streams • Riparian • Armor	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave

Notes:

1 Parks: *Seattle Shoreline Park Inventory and Habitat Assessment* (Anchor 2003)
Blueprint: *Seattle's Urban Blueprint for Habitat Protection and Restoration* (Seattle 2003)
WRIA 8: *Lake Washington/ Cedar/ Sammamish Watershed Chinook Conservation Plan* (WRIA 8 2005)

2 Restoration Actions are those listed in the proposed project in the relevant plan. **Bold** indicates that the Restoration Action is highly applicable within the reach based on Table 7.
- Riparian: riparian vegetation restoration
- Beach: beach nourishment or enhancement, Armor: removal of artificial shoreline hardening including bulkheads and seawalls.
- Armor: armoring removal, LWD placement

3 These numbered codes correspond to project numbers given in the WRIA 8 document (WRIA 8 2005). "Protect" is listed as an action for the project if both reach/sub-reach impairment categories were either "least" or "less" or if sub-reach category was "least." If "protect" is listed, then all processes are listed as addressed by the restoration action.

4.3 Lake Union and Ship Canal

For the Lake Union and Ship Canal segment, reach assignments based on reach and sub-reach impairment categories are summarized in Table 9. This table illustrates that most Lake Union shorelines are located within a landscape context of most impairment.

Table 9

Lake Union Reach Assignments Based on Reach and Sub-reach Impairment Category

		Reach Scale Impairment				
		Least	**Less**	**Moderate**	**More**	**Most**
Sub-reach Scale Impairment	**Most**				1	9
	More				3	10
	Moderate				2	2
	Less				1	
	Least	1		1	1	

The following section describes the impairments in the Lake Union and Ship Canal segment, as well as applicable restoration actions.

4.3.1 Impairments

The shoreline in the Lake Union and Ship Canal segment is highly urbanized. Numerous water-dependent facilities dominate the shoreline and have displaced most riparian vegetation with heavy shoreline armoring, near continuous impervious surfaces, overwater structures, and combined sewer overflow (CSO) and stormwater outfalls. However, this area is the migration corridor for all salmonids into and out of the system. The south shoreline of Portage Bay is the highest functioning habitat in this segment, while the west shoreline of Portage Bay and Fisherman's Terminal are the most impaired.

Table 10 illustrates impairment ranges for the reaches in this segment. This table was completed in the same manner as Table 6.

Table 10

Impairment Ranges from *Shoreline Characterization Report* (City of Seattle 2009) for Various Watershed Processes at Lake Union and Ship Canal—City Shorelines

Reach No.	Reach	Reach Impairment Category	Light	LWD	Nitrogen	Pathogens	Phosphorus	Sediment	Toxins	Water	Wave
9	Montlake Cut and Portage Bay	More Impaired									
10	Lake Union	Most Impaired									
11	Fremont Cut	Most Impaired									
12	Salmon Bay Waterway	Most Impaired									

Notes:

High Impairment

Moderate Impairment

Low Impairment

These results indicate that the most highly impaired processes in Lake Union and Ship Canal shorelines are LWD, phosphorus, sediment delivery and movement, toxins, and water, with toxins as the most impaired. The impairment of toxins, as well as other water quality processes, is caused by contaminated surface water discharge from the upland areas in addition to several CSO locations in this segment. The lower levels of nitrogen impairment identified in the model result from differences in the inputs into the nitrogen process model relative to other water quality related process (namely, the presence of lawn areas within 200 feet of the shoreline). Sediment and water processes have been impaired by the high levels of impervious surface area throughout the shoreline of the segment. Water processes have also been impaired by the management and constriction of water flow to and from Lake Union through the Ballard Locks. Lack of source wood is one reason for LWD impairment, because riparian vegetation is almost completely absent from this urbanized and industrial shoreline.

Additionally, water quality studies indicate that high water temperatures and low dissolved oxygen are problems in late summer, which will causes stress in salmonids.

4.3.2 Applicable Restoration Actions

Based on these impairments, applicable restoration actions for the Lake Union and Ship Canal waterbody are categorized as High, Moderate, or Low in Table 11. This table was completed in the same manner as Table 7.

Given the reach impairment categories shown in Table 11, all restoration actions are applicable for all the reaches; Reach 9 (Montlake Cut and Portage Bay) is slightly less impaired than the other three reaches.

The WRIA 8 2005 Salmon Conservation Plan identifies several actions that could benefit habitat and water quality in the Lake Union and Ship Canal area. In Reach 9 (Montlake Cut and Portage Bay) these activities include exploring methods to reduce salmonid predation in Portage Bay and exploring options for deepening the Montlake Cut to allow colder water from Lake Washington to flow into Lake Union. The impetus behind this project is to address water temperature issues in Lake Union to benefit juvenile salmon, and it could potentially change the movement of water in the reach and beyond. The *Lake Washington/Cedar/Sammamish Watershed Chinook Salmon Conservation Plan* notes that technical water quality and hydrodynamic issues would need to be evaluated before this project could move forward. Restoration of sediment processes has been proposed for the area on the south side of the Ship Canal through Salmon Bay (CGS 2005).

Table 11

Applicable Restoration Actions—Lake Union and Ship Canal

Reach No.	Reach	Reach Impairment Category[1]	Reach Protection Category[2]	Riparian Restoration	Daylighting Streams (where piped streams occur)	Nearshore Debris Removal/ Groin Removal	Beach Nourishment/ Substrate Enhancement	Armoring Removal	Overwater Structure Removal	Stormwater Treatment	Wetland Restoration
9	Montlake Cut and Portage Bay	More Impaired	Low	High	N/A	Moderate	Moderate	High	Moderate	High	High
10	Lake Union	Most Impaired	Low	High	N/A	High	High	High	High	High	High
11	Fremont Cut	Most Impaired	Low	High	N/A	High	High	High	High	High	High
12	Salmon Bay Waterway	Most Impaired	Low	High	N/A	High	High	High	High	High	High

Notes:

1 Based on the results of the *Shoreline Characterization Report* (City of Seattle 2009).

2 Reach was considered High priority for protection if reach impairment category was "least"; moderate priority if reach impairment category was "less"; low priority for all other reach impairment categories ("moderate," "more," and "most").

In Reach 10 (Lake Union), Eastlake landowners and interested community and nonprofit groups have created a street-end park (Good Turn Park) at East Martin Street and Fairview Avenue. The park has enhanced substrate and riparian vegetation, both listed as High priority on Table 11.

Also in Reach 10, an action proposed is to improve drainage from Wallingford. In Reach 11 (Fremont Cut), projects proposed are to improve water quality by implementing riparian restoration near the Ballard Bridge and treatment of run-off from the bridge (WRIA 8 2005). This would improve the following processes: LWD, nitrogen, pathogens, phosphorus, sediment, toxins, and water in this area.

Reach 12 (Salmon Bay Waterway) terminates at the Ballard Locks, which constrain water flow between Lake Union and Puget Sound. There are two proposed projects in this area. One project proposes constructing a more natural, fairly wide, and long channel at the locks to allow for better salmon passage (WRIA 8 2005). This project would likely change movement of water in the reach and beyond, and the *Lake Washington/ Cedar/ Sammamish Watershed Chinook Salmon Conservation Plan* notes that there are significant design challenges and feasibility that would need to be evaluated before this project could move forward. Another project at Commodore Park, just downstream of the locks on the south bank, proposes to remove the seawall, re-grade the shoreline to a gentler slope, daylight Wolfe Creek (that flows into the park) and create a pocket estuary in this location (WRIA 8 2005). There are several other projects proposed at the locks, mostly related to improving fish passage and the location and size of the saltwater transition zone.

Because the impairment level of the Lake Union and Ship Canal reaches is so high, essentially every category of restoration action in Table 11 is an applicable restoration action in this area, and projects most needed are those that combine restoration actions to address several processes at once.

High priority areas for habitat protection include those with the least impairments, such as East Montlake Park, as well as any recent restoration project sites such as Salmon Bay Natural Area.

Table 12 provides a list of priority projects for the Lake Union and the Ship Canal shoreline segment, including the name of the habitat plan that proposed the project, the sub-reach ID number from the *Shoreline Characterization Report* (City of Seattle 2009), and the sub-reach impairment and reach impairment categories from the report. For each project, applicable restoration actions and the processes that would be addressed by those restoration actions are identified.

Table 12

Projects for Lake Union and the Ship Canal

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
7th Avenue Street End Restoration[6] *(completed project)*	WRIA 8	9-b	More Impaired	More Impaired	--	--
Montlake Playfield[6] *(completed project)*	--	4-c 4-d 4-e	Least Impaired	More Impaired	--	--
South Wallingford Drainage Improvements, M212[5]	WRIA 8	10-a 10-b 10-c 10-d 10-e 10-f 10-g 10-h 10-i 10-k 10-l	Moderately to Most Impaired	Most Impaired	• **Stormwater**	Nitrogen **Pathogens Phosphorus Toxins**
Bank Softening at Gasworks Park, M213	WRIA 8	10-b	Moderately Impaired	Most Impaired	• **Armor** • **Riparian**	**Light LWD** Nitrogen **Phosphorus Sediment Toxins Water**
Remove North Lake Union In-Water Structures, M214	WRIA 8	10-a 10-b 10-c 10-d	Moderately to Most Impaired	Most Impaired	• **Overwater**	**Toxins Light Sediment**
Aurora (99) Bridge Shoreline Restoration, M211	WRIA 8	10-d, 10-m	Most Impaired	Most Impaired	• **Armor** • **Riparian**	**Light LWD** Nitrogen **Phosphorus Sediment Toxins Water**

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
Fremont Bridge Shoreline Restoration, M210	WRIA 8	11-a, 11-e	Moderately Impaired, More Impaired	Most Impaired	• **Armor** • **Riparian**	**Light LWD** Nitrogen **Phosphorus Sediment Toxins**
Ballard Bridge Shoreline Restoration, M208	WRIA 8	12-a, 12-e	More Impaired, Most Impaired	Most Impaired	• **Riparian**	**Light LWD** Nitrogen **Phosphorus Sediment Toxins Water**
Ballard Bridge Water Quality Improvements, M209	WRIA 8	12-a, 12-e	More Impaired, Most Impaired	Most Impaired	• **Stormwater**	Nitrogen **Pathogens Phosphorus Toxins**
Commodore Park and Wolf Creek Restoration, M250	WRIA 8	17d	Less Impaired	More Impaired	• **Armor** • **Riparian** • Daylighting	**Light LWD** Nitrogen **Pathogens Phosphorus Sediment Toxins Water**

Notes:

1 WRIA 8: *Lake Washington/ Cedar/ Sammamish Watershed Chinook Conservation Plan* (WRIA 8 2005)

2 Restoration Actions are those listed in the proposed project in the relevant plan. **Bold** indicates that the Restoration Action is highly applicable within the reach based on Table 11.
Protect: protect and conserve
Riparian: riparian vegetation restoration
Debris Removal: Intertidal or littoral rubble removal, groin removal
Armor: removal of artificial shoreline hardening including bulkheads and seawalls
Stormwater: treat or deal differently with stormwater and/or runoff, especially that which contains contaminants and excess nutrients.

3 **Bold** indicates that the specific process addressed is highly impaired within one or more of the sub reaches covered by the project, based on Table 10.

4 "Protect" is listed as a restoration action for the project if both reach/sub-reach impairment categories were either "least" or "less" or if sub-reach category was "least." If "protect" is listed, then all processes are listed as addressed by the restoration action.

5 These numbered codes correspond to project numbers given in the WRIA 8 document (WRIA 8 2005).

6 Both the Montlake and the 7th Avenue projects were constructed after the shoreline inventory was completed (*Marine Shoreline Inventory Report*, Anchor 2004).

4.4 Duwamish River

For the Duwamish River segment, reach assignments based on reach and sub-reach impairment categories are summarized in Table 13. This table illustrates that many Duwamish River shorelines are located within a landscape context of more impairment.

Table 13

Duwamish River Reach Assignments Based on Reach and Sub-reach Impairment Category

		Reach Scale Impairment				
		Least	**Less**	**Moderate**	**More**	**Most**
Sub-reach Scale Impairment	**Most**				3	
	More				2	
	Moderate				9	1
	Less				2	
	Least				3	

The following section describes the impairments in the Duwamish River segment, as well as applicable restoration actions.

4.4.1 Impairments

In the Duwamish River segment, shoreline habitat conditions along Harbor Island and its waterways contain mainly port terminals and commercial shipping facilities. Because of this, shallow shoreline habitat is almost entirely absent or impacted due to the extensive dredging and overwater coverage created by numerous docks and wharfs. There is one small area along Harbor Island providing shallow water habitat despite armored shorelines: the southern shoreline of Terminal 27 on the eastern shore of the East Waterway. The headwaters of Puget Creek, located on the western shore of the Duwamish River, have been the focus of much restoration. Further upstream in the Duwamish, shorelines are heavily urbanized to support industrial activities, but the multiple small areas that have been restored contribute some functional value.

There are few high functioning habitat areas in the Duwamish River segment; these shoreline areas are found along Kellogg Island, the adjacent shoreline to the west, and the eastern shore across the river from the island. Lowest functioning habitats include the industrial shorelines of the rest of the segment.

Table 14, indicates impairment ranges for the reaches in the Duwamish River segment; lower values indicate lower function. This table was completed in the same manner as Table 6.

Table 14

Impairment ranges from *Shoreline Characterization Report* (City of Seattle 2009) for various watershed processes at Duwamish River – City shorelines

Reach No.	Reach	Reach Impairment Category	Light	LWD	Nitrogen	Pathogens	Phosphorus	Sediment	Tide	Toxins	Water	Wave
13	Harbor Island and Waterways	Most Impaired										
14	Lower Duwamish River	More Impaired										

Notes:

High Impairment

Moderate Impairment

Low Impairment

These results indicate that the most highly impaired processes along the Duwamish River segment are light, LWD, nitrogen, phosphorus, toxins, water, and wave energy. An almost complete lack of riparian vegetation in the zone within 200 feet of the shoreline and the numerous overwater structures such as docks and piers on the industrial shorelines of the river itself are key reasons for impaired shoreline light conditions. Impairment of the LWD process is caused by the lack of riparian vegetation that provides LWD sources both in the river and upstream. This lack of LWD is a persistent problem throughout Seattle's marine shoreline. Impairment of water and water quality processes is mainly due to urban development impacts such as wetland and shoreline vegetation loss in the Duwamish Estuary, and the high levels of impervious surface area in this segment. This problem occurs at a high level along the industrial shorelines of most of the segment.

Results also indicate that processes that are not as highly impaired across Duwamish River segment shorelines are sediment and tidal regime. These processes are still impaired, but not as highly as the other eight processes. The key reason for impairment of tidal regime is the encroachment of shoreline armoring on ordinary high water (OHW), which in the Duwamish River is often sheet-pile wall or other near-vertical armoring. Disruptions in sediment processes and wave energy are also due to this armoring, which occurs on virtually all of the shorelines in this segment.

4.4.2 Applicable Restoration Actions

Based on these impairments, the applicable restoration actions for the Duwamish River segment are categorized as High, Moderate, or Low in Table 15. This table was completed in the same manner as Table 7.

Given the reach impairment categories shown in Table 15, all restoration actions are highly applicable in both reaches; the Lower Duwamish River reach is slightly less impaired than the Harbor Island and Waterways reach.

Table 15

Applicable Restoration Actions—Duwamish River

Reach No.	Reach	Reach Impairment Category[1]	Reach Protection Category[2]	Riparian Restoration	Daylighting Streams (where piped streams occur)	Nearshore Debris Removal/ Groin Removal	Beach Nourishment/ Substrate Enhancement	Armoring Removal	Overwater Structure Removal	Stormwater Treatment	Wetland Restoration
13	Harbor Island and Waterways	Most Impaired	Low	High	High	Moderate	Moderate	High	High	High	High
14	Lower Duwamish River	More Impaired	Low	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate

Notes:

1 Based on the results of the *Shoreline Characterization Report* (City of Seattle 2009).

2 Reach was considered High priority for protection if reach impairment category was "least"; moderate priority if reach impairment category was "less"; low priority for all other reach impairment categories ("moderate," "more," and "most").

In Reach 13 (Harbor Island and Waterways), several projects have been proposed that include a number of the restoration actions listed as most applicable, which are armoring removal and riparian and wetland restoration at Terminal 105, West Bank line at River Mile 0.1, a pocket habitat project has been suggested, to include armoring removal, wetland and riparian vegetation plantings, and gentler shoreline slopes (Port of Seattle 2009). There is also a proposed Bluefield Holdings/City of Seattle project on the west side of West Waterway, which would include shoreline re-grading, riparian vegetation plantings, and an interpretive trail. An example of a completed project is the Terminal 105 Coastal America site, which constructed a long channel perpendicular to the river that provides riparian and wetland habitat (Seattle 2003).

In Reach 14 (Lower Duwamish River), many projects have been proposed that include armoring and rubble removal, shoreline re-grading, bank revegetation, marsh plantings, LWD installations, and other shoreline-focused activities, as detailed in the *Lower Duwamish River Habitat Restoration Plan* (LDR Plan; Port of Seattle 2009). A completed project of this type in this area is Herring's House Park, which established areas of high intertidal salt marsh vegetation with a protective perimeter buffer of upland riparian vegetation. These are the types of projects that are highest priority in order to address the impairments in this reach. Connecting several of these projects on a landscape level as suggested in the LDR Plan, is likely to have the most benefit, as this reach is highly impacted and industrial as a whole. Another project completed in Reach 14 is the street end at 8th Avenue South (sub-reach 14-z), which received native plantings in 1993, followed by subsequent plantings and maintenance to control invasive weeds.

High priority areas for habitat protection in the Duwamish River include those with the least impairments, which are sparse in Reach 14. These areas would likely be limited to recent project sites such as Herring's House Park, and the Terminal 105 Coastal America site.

Table 16 provides a list of priority projects for the Duwamish River shoreline segment, including the name of the habitat plan that proposed the project, the sub-reach ID number from the *Shoreline Characterization Report* (City of Seattle 2009), and the sub-reach impairment and reach impairment categories from the report. For each project, applicable restoration actions and the processes that would be addressed by those restoration actions are identified.

Table 16

Projects for the Duwamish River

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
BE-1[5]	Elliott Bay	13-a	Moderately Impaired	Most Impaired	• **Overwater**	Light LWD
BE-1	Elliott Bay	13-b	Most Impaired	Most Impaired	• **Overwater** • **Armor** • **Riparian**	**Light LWD Nitrogen Phosphorus** Sediment **Tide Toxins Water Wave**
Section 1, North, Terminal 106, East Bank Line, Project 2	LDR Plan	13-f	More Impaired	Most Impaired	• **Riparian** • Beach	**Light LWD Nitrogen Phosphorus** Sediment **Toxins Water**
Terminal 105, West Bank Line, Project 1	LDR Plan	13-g	Moderately Impaired	Most Impaired	• **Riparian** • Debris Removal • **Wetland restoration**	**Light LWD Nitrogen** Pathogens **Phosphorus** Sediment **Toxins Water**
Southwest Spokane St	Bluefield/ City of Seattle Master Lease	13-h	xxxxxx	Most Impaired	• Not listed in the source document	N/A
West Side West Waterway: Spokane St Bridge	Bluefield/ City of Seattle Master Lease	13-h,	xxxxxx	Most Impaired	• Not listed in the source document	N/A
East Side West Waterway: Spokane St Bridge	Bluefield/ City of Seattle Master Lease	13-l	Most Impaired	Most Impaired	• Not listed in the source document	N/A

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
West Waterway, north of Spokane, south of Fisher Mill	Bluefield/ City of Seattle Master Lease	13-l	Most Impaired	Most Impaired	• Not listed in the source document	N/A
Southwest Spokane St, SW Klickitat Way and Parcel 7666703000	Bluefield/ City of Seattle Master Lease	13-l	Most Impaired	Most Impaired	• Not listed in the source document	N/A
West Side East Waterway	Bluefield/ City of Seattle Master Lease	13-l	Most Impaired	Most Impaired	• Not listed in the source document	N/A
10th Avenue South	Bluefield/ City of Seattle Master Lease	13-l	Most Impaired	Most Impaired	• Not listed in the source document	N/A
Fisher Mills	Elliott Bay	13-l	Most Impaired	Most Impaired	• **Riparian**	**Light LWD Nitrogen Phosphorus** Sediment **Toxins Water**
Elliott Bay, West	WRIA 9 Prioritization	13-n	More Impaired	Most Impaired	• **Riparian**	**Light LWD Nitrogen Phosphorus** Sediment **Toxins Water**
Section 1, North, Terminal 106, East Bank Line, Project 2	LDR Plan	14-a	Moderately Impaired	More Impaired	• Riparian • Beach	Light LWD Nitrogen Phosphorus Sediment Toxins Water

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
Section 1, North, Terminal 106, East Bank Line, Project 3	LDR Plan	14-b	Moderately Impaired	More Impaired	• LWD • Riparian • Beach • Wetland Restoration (intertidal benches)	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Tide Water Wave
Section 1, North, Terminal 106, East Bank Line, Project 3 + extend bank line along Federal Center South shoreline	N/A	14-c	Moderately Impaired	More Impaired	• LWD • Riparian • Beach • Wetland Restoration (intertidal benches)	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Tide Water Wave
Section 2, North Central, Northwestern Glass Company, East Bank Line, Project 5	LDR Plan	14-e	Moderately Impaired	More Impaired	• Riparian • Debris Removal • Beach	Light LWD Nitrogen Phosphorus Sediment Toxins Water Wave
Section 2, North Central, Northwestern Glass Company, East Bank Line, Project 5	LDR Plan	14-f	Moderately Impaired	More Impaired	• Riparian • Debris Removal • Beach	Light LWD Nitrogen Phosphorus Sediment Toxins Water Wave
Section 2, North Central, British Plaster Board, East Bank Line, Project 6	LDR Plan	14-g	Moderately Impaired	More Impaired	• Riparian • Debris Removal (shoreline) • Beach	Light LWD Nitrogen Phosphorus Sediment Toxins Water Wave

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
Section 2, North Central, Southwest corner Slip Two, East Bank Line, Project 7	LDR Plan	14-h	Most Impaired	More Impaired	• Riparian • Debris Removal (shoreline) • Beach	Light LWD Nitrogen Phosphorus Sediment Toxins Water Wave
Section 2, North Central, North First Avenue South Bridge, East Shoreline, Project 9	LDR Plan	14-h	Most Impaired	More Impaired	• Beach (intertidal bench) • Riparian	Light LWD Nitrogen Phosphorus Sediment Toxins Water
North of 1st Ave South Bridge	Bluefield/ City of Seattle Master Lease	14-h	Most Impaired	More Impaired	• Not listed in the source document	N/A
Section 2, North Central, Cold Storage Warehouse / Industrial Upland Site, East Shoreline, Project 12	LDR Plan	14-k	Moderately Impaired	More Impaired	• Riparian • Debris Removal (shoreline)	Light LWD Nitrogen Phosphorus Sediment Toxins Water Wave
Section 3, South Central, South Othello Street to 8th Avenue South, East Shoreline, Project 16	LDR Plan	14-m	Moderately Impaired	More Impaired	• Riparian • Debris Removal (shoreline)	Light LWD Nitrogen Phosphorus Sediment Toxins Water Wave
Georgetown Steamplant Pump Station	Bluefield/ City of Seattle Master Lease	14-m	Moderately Impaired	More Impaired	• Not listed in the source document	N/A

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
8th Avenue South	Bluefield/ City of Seattle Master Lease	14-m	Moderately Impaired	More Impaired	• Not listed in the source document	N/A
Section 3, South Central, SW Corner, 8th Ave South, East Shoreline, Project 17	LDR Plan	14-n	Moderately Impaired	More Impaired	• Riparian • Debris removal (shoreline)	Light LWD Nitrogen Phosphorus Sediment Toxins Water Wave
Section 3, South Central, SW Corner Slip 4 and Adjacent Upstream Bank line, East Shoreline, Project 18	LDR Plan	14-o	Moderately Impaired	More Impaired	• Riparian • Debris Removal (shoreline) • Beach	Light LWD Nitrogen Phosphorus Sediment Toxins Water Wave
Section 3, South Central, SW Corner Slip 4 and Adjacent Upstream Bank line, East Shoreline, Project 18	LDR Plan	14-p	Most Impaired	More Impaired	• Riparian • Debris Removal (shoreline) • Beach	Light LWD Nitrogen Phosphorus Sediment Toxins Water Wave
West Marginal Way SW at Terminal 107, *(completed project)*	LDR Plan	14-t	Least Impaired	More Impaired	• Protect[4] • Riparian • Debris removal (shoreline and littoral)	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
Section 1, North, Terminal 107, Kellogg Island, West Bank Line, Project 4	LDR Plan	14-u	Least Impaired	More Impaired	• Protect • Riparian • Debris Removal (shoreline and littoral) • Beach	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave
Section 2, North Central, North First Avenue South Bridge, West Shoreline, Project 10	LDR Plan	14-x	More Impaired	More Impaired	• Beach • Riparian • LWD • Armor • Overwater	Light LWD Nitrogen Phosphorus Sediment Tide Toxins Water Wave
Section 2, North Central, Southwest Terminal 115, West Bank Line, Project 8	LDR Plan	14-x	More Impaired	More Impaired	• Riparian • LWD • Wetland Restoration • Overwater	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water
South of 1st Ave South Bridge	Bluefield/ City of Seattle Master Lease	14-x	More Impaired	More Impaired	• Not listed in the source document	N/A
Section 2, North Central, South First Avenue South Bridge, West Shoreline, Project 11	LDR Plan	14-y	More Impaired	More Impaired	• Riparian • Beach • Debris Removal (shoreline)	Light LWD Nitrogen Phosphorus Sediment Toxins Water Wave
South Orchard Street	Bluefield/ City of Seattle Master Lease	14-y	More Impaired	More Impaired	• Not listed in the source document	N/A

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
2nd Avenue South	Bluefield/ City of Seattle Master Lease	14-y	More Impaired	More Impaired	• Not listed in the source document	N/A
Section 2, North Central, South Orchard Street / Second Ave South, West Shoreline, Project 13	LDR Plan	14-y	More Impaired	More Impaired	• Riparian • Beach (intertidal bench) • Debris Removal (shoreline) • Wetland Restoration	Light LWD Nitrogen Pathogens Phosphorus Sediment Toxins Water Wave
Section 3, North Portion Existing Barge Cargo Facility, West Shoreline, Project 14	LDR Plan	14-y	More Impaired	More Impaired	• Riparian • LWD • Debris removal • Wetland Restoration	Light LWD Nitrogen Pathogens Phosphorus Sediment Tide Toxins Water Wave
Section 3, South Fontanelle Street/Fifth Avenue South Upstream Along Derelict Industrial Bank Line, West Shoreline	LDR Plan	14-y	More Impaired	More Impaired	• Riparian • LWD • Debris removal • Wetland Restoration	Light LWD Nitrogen Pathogens Phosphorus Sediment Tide Toxins Water Wave
Duwamish Waterway Park	Bluefield/ City of Seattle Master Lease	14-aa	Moderately Impaired	More Impaired	• Not listed in the source document	N/A

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
Section 3, South Central, South Chicago Street to South Kenyon Street, West Shoreline, Project 19	LDR Plan	14-aa	Moderately Impaired	More Impaired	• Riparian • Debris Removal (shoreline) • Beach	Light LWD Nitrogen Phosphorus Sediment Toxins Water Wave

Notes:

1 Elliott Bay: *Elliott Bay General Investigation* (USACE 2009)
CGS: *Inventory and Assessment of Current and Historic Beach Feeding Sources/Erosion and Accretion Areas for the Marine Shorelines of Water Resource Inventory Areas 8 and 9* (CGS 2005)
LDR Plan: *Lower Duwamish River Habitat Restoration Plan* (Port of Seattle 2009)
Bluefield/City of Seattle Master Lease: *City of Seattle Ordinance 122729, authorizing a master Lease Agreement with Bluefield Holdings, Inc.* (City of Seattle 2008b)

2 Restoration Actions are those listed in the proposed project in the relevant plan. **Bold** indicates that the Restoration Action is highly applicable within the reach based on Table 15.
Protect: protect and conserve
Riparian: riparian vegetation restoration
Debris removal: Intertidal or littoral rubble removal and/or groin removal
Beach: beach nourishment or enhancement
Armor: removal of artificial shoreline hardening including bulkheads and seawalls.
Overwater: removal of overwater structures.

3 **Bold type** indicates that the specific function addressed is highly impaired within one or more of the sub reaches covered by the project based on Table 14.

4 "Protect" is listed as a restoration action for the project if both reach/sub-reach impairment categories were either "least" or "less" or if sub-reach category was "least." If "protect" is listed, then all processes are listed as addressed by the restoration action.

5 These numbered codes correspond to project numbers given in the source document.

4.5 Puget Sound, including Shilshole Bay and Elliott Bay

For the Puget Sound segment within the City, reach assignments based on reach and sub-reach impairment are summarized in Table 17. This table illustrates that many Puget Sound shorelines are located within a landscape context of moderate, more, and most impairment.

Table 17
Puget Sound (including Shilshole and Elliott Bay) Reach Assignments Based on Reach and Sub-reach Impairment Category

		Reach Scale Impairment				
		Least	Less	Moderate	More	Most
Sub-reach Impairment	Most				1	3
	More				3	1
	Moderate			9	3	1
	Less	1	1	4	1	
	Least	2	1	1		

The following section describes the impairments in the Puget Sound segment, as well as the applicable restoration actions.

4.5.1 Impairments

In the northernmost portion of Puget Sound in the City, shorelines are entirely armored in association with the rail line along the shore. The presence of the rail line precludes adjacent riparian vegetation and impacts sediment processes due to interruption of sediment supply to the beach from the numerous shoreline bluffs. Additionally this area is impaired by fertilizer run-off from the many surrounding residential lawns. Two forested ravines (Broadview Creek and Pipers Creek) exist in this area, these ravines have less

impervious surface than the surrounding residential areas. Shilshole Bay Marina contains large amounts of overwater structures and shoreline armor.

Near the Ballard Locks, further impaired conditions occur in a critical ecological position, as this area is the estuary for the Lake Washington/Lake Sammamish/Cedar River drainage. In this area, juvenile salmon make the physiologically demanding transition from fresh water to salt water, and the presence of the locks makes the transition quite abrupt. Ecological function improves moving through Discovery Park, as the eroding bluffs along the south shoreline and the vegetated creek drainage in the north are particularly high functioning areas. Toward Elliott Bay and the urban core, conditions deteriorate due to increasing shoreline armoring, overwater cover, and impervious surfaces, and decreasing riparian vegetation and intertidal habitat. In the downtown area, shorelines are entirely armored, have extensive overwater cover and fill, and are almost entirely impervious surface. CSOs and stormwater outfalls are present, and roads are in direct proximity to the shoreline. Along western Elliott Bay and toward West Seattle, shorelines are still armored but impervious surface area decreases. Near Lincoln Park in South Seattle, extensive vegetation and minimal impervious surfaces abound, but the area surrounding the Fauntleroy ferry terminal is highly impaired for toxins, pathogens, and sediment processes. At the south end of the project boundary, Seola Park offers high functioning habitat due to vegetated and minimally impacted shorelines. Impairments to water quality in the southern portion of this segment result from outfalls from large basins and culverts that carry pollutants from upland activities.

In summary, the highest functioning habitats in the segment are found along the unarmored portions of Golden Gardens, the creek mouths, and their small associated wetlands, and Discovery, Lincoln, and Seola parks. Lowest functioning habitats in the segment include Shilshole Bay and Elliott Bay Marinas, the central waterfront, and Terminals 90 and 91.

Table 18 indicates impairment ranges for the reaches in the Puget Sound segment; lower values indicate lower function. This table was completed in the same manner as Table 6.

These results indicate that the most highly impaired processes in the City's marine nearshore include pathogens and sediment. Key reasons for the impairment of sediment processes is the urban and shoreline residential and transportation (rail and road) development which disconnects sediment source bluffs from the shoreline. In addition, jetties, breakwaters, and groins present throughout the marine shoreline restrict sediment movement once it reaches the shore, creating a persistent problem. Impairment of water quality due to pathogens is mainly linked to urban development impacts such as CSOs in the

downtown core, and wetland and shoreline vegetation loss and increased impervious surface area from Elliott Bay throughout the downtown core.

Other processes that are still impaired —but not as highly as the other two processes— include LWD, nitrogen, phosphorus, toxins, water, and wave energy. The reasons for impairment of the water quality processes of nitrogen, toxins, and phosphorus are the same as those listed above for pathogens. LWD processes have been disrupted on a large scale throughout the City's Puget Sound shorelines due to removal of source trees and vegetation from the nearby shore to facilitate urban development and due to encroachment of armoring into intertidal areas, which restricts accumulation. In addition, source wood is no longer provided from river mouths in the region due to development in their watersheds.

The water process has been impaired mainly by urban development and increased impervious surface area, now common on most City shorelines. Disruptions in wave energy along the Seattle shore include armoring, jetties, groins breakwaters, and overwater structures. These are interspersed throughout Seattle, but are particularly heavy near Shilshole and the downtown core.

Tidal regime is the process least impaired in this segment, although it is still impaired. Impacts to tidal regime in Puget Sound are due to channelized streams, the Ballard Locks, and encroachment of armoring on OHW. Armoring and tidal encroachment occurs throughout almost the entire Seattle shoreline.

Table 18

Impairment Ranges from *Shoreline Characterization Report* (City of Seattle 2009) for Various Watershed Processes at Puget Sound—City Shorelines

Reach No.	Reach	Reach Impairment Category*	Light	LWD	Nitrogen	Pathogens	Phosphorus	Sediment	Tide	Toxins	Water	Wave
15	North Bluffs	Less Impaired										
16	North Beach & Golden Gardens Park	Mod. Impaired										
17	Shilshole Bay and Marina	More Impaired										
18	West Point and Magnolia Bluffs	Least Impaired										
19	Magnolia	Less Impaired										
20	Elliott Bay Marina and T 90 and 91	Most Impaired										
21	Myrtle Edwards Park/ Centennial Park/ Olympic Sculpture Park	More Impaired										
22	Central Waterfront	Most Impaired										
23	Southwest Elliott Bay	More Impaired										
24	Duwamish Head	More Impaired										
25	Alki Beach to Lincoln Park	Mod. Impaired										
26	Lincoln Park and Fauntleroy Cove	Less Impaired										
27	South Seattle to Seola Creek	Mod. Impaired										

Notes:

High Impairment

Moderate Impairment

Low Impairment

4.5.2 Applicable Restoration Actions

Based on these impairments, applicable restoration actions for the Puget Sound segment are categorized as High, Moderate, or Low need in Table 19. This table was completed in the same manner as Table 7.

The reach impairment categories shown in Table 19 categorize Shilshole Bay and Marina and the reaches south from Elliott Bay Marina through Duwamish Head as the reaches with highest impairment in the Puget Sound segment.

In Reach 17 (Shilshole Bay and Marina), restoration of sediment processes has been proposed for the areas south of Carkeek Park through Salmon Bay, as well as from Shilshole Bay to West Point (CGS 2005). In Reaches 20 through 24 (south from Elliott Bay Marina through Duwamish Head), a number of projects have been proposed in Elliott Bay proper to create intertidal embayments and which would relocate armoring to above OHW (Anchor 2004), partly addressing the sediment issue. Projects of this kind that have been recently completed include the Myrtle Edwards Park beach project near Olympic Sculpture Park, which constructed a pocket beach and intertidal habitat on the eastern shoreline of Elliott Bay.

Because many of the Puget Sound reaches are “most” and “more” impaired reaches, highly applicable restoration actions would essentially include those in every category in Table 19. Projects most needed are those that combine restoration actions to address several processes at once.

High priority areas for habitat protection include Discovery Park, primarily West Point and Magnolia Bluffs, Magnolia, Lincoln Park and Fauntleroy reach, as well as any recently implemented sites such as the pocket beach at Myrtle Edwards Park.

Table 19

Applicable Restoration Actions—Puget Sound

Reach No.	Reach	Reach Impairment Category[1]	Reach Protection Category[2]	Riparian Work	Daylighting Streams (where piped streams occur)	Nearshore Debris/ Jetty/Groin/ Breakwater Removal	Beach Nourishment/ Enhancement	Armoring Removal	Overwater Structure Removal	Stormwater Treatment	Wetland Restoration
15	North Bluffs	Less Impaired	Moderate	Low	High	High	High	High	Moderate	Moderate	Moderate
16	North Beach and Golden Gardens Park	Moderately Impaired	Low	Moderate	High	Low	Low	Moderate	Moderate	High	High
17	Shilshole Bay and Marina	More Impaired	Low	High	High	High	Moderate	High	High	High	High
18	West Point and Magnolia Bluffs	Least Impaired	High	Low	Low	Low	Low	Low	Low	Low	Low
19	Magnolia	Less Impaired	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	High	High
20	Elliott Bay Marina and Terminals 90 and 91	Most Impaired	Low	High	High	High	High	High	High	High	High

Reach No.	Reach	Reach Impairment Category[1]	Reach Protection Category[2]	Riparian Work	Daylighting Streams (where piped streams occur)	Nearshore Debris/ Jetty/Groin/ Breakwater Removal	Beach Nourishment/ Enhancement	Armoring Removal	Overwater Structure Removal	Stormwater Treatment	Wetland Restoration
21	Myrtle Edwards/ Centennial/ Olympic Sculpture Parks	More Impaired	Low	High	High	High	High	High	High	High	High
22	Central Waterfront	Most Impaired	Low	High	High	High	High	High	High	High	High
23	Southwest Elliott Bay	More Impaired	Low	High	High	High	High	High	High	High	High
24	Duwamish Head	More Impaired	Low	High	High	High	High	High	High	High	High
25	Alki Beach to Lincoln Park	Moderately Impaired	Low	High	High	Moderate	Moderate	Moderate	Moderate	High	High
26	Lincoln Park and Fauntleroy Cove	Less Impaired	Moderate	Low	Low	Low	Low	Low	Low	Low	Low
27	South Seattle to Seola Creek	Moderately Impaired	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

Notes:

1 Based on the results of the *Shoreline Characterization Report* (City of Seattle 2009).

2 Reach was considered High priority for protection if reach impairment category was "least"; moderate priority if reach impairment category was "less"; low priority for all other reach impairment categories ("moderate," "more," and "most")

Table 20 provides a list of projects for the Puget Sound shoreline segment, including the name of the habitat plan that proposed the project, the sub-reach ID number from the *Shoreline Characterization Report* (City of Seattle 2009), and the sub-reach impairment and reach impairment categories from the report. For each project, applicable restoration actions and the processes that would be addressed by those restoration actions are identified.

Table 20
Projects for Puget Sound

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
SN-3[5] Northern Railroad (Carkeek)	CGS	15-d	Less Impaired	Less Impaired	• Protect[4]	Light LWD Nitrogen Pathogens Phosphorus **Sediment Tide** Toxins Water Wave
Pipers Creek to Golden Gardens	Blueprint	15-e	Less Impaired	Less Impaired	• Protect	Light LWD Nitrogen Pathogens Phosphorus **Sediment Tide** Toxins Water Wave
KI-2-1 Carkeek to Shilshole	CGS	16-a/b	Moderately/ Least Impaired	Moderately Impaired	• Protect	Light LWD Nitrogen **Pathogens** Phosphorus Sediment Tide Toxins Water Wave
KI-2-1/KI-2-2 South Golden Gardens, Shilshole N. Salmon Bay	CGS	17-b	More Impaired	More Impaired	• **Debris** Removal • **Overwater**	**Light** LWD Sediment **Wave**
KI-2-1/KI-2-2 South Golden Gardens, Shilshole N. Salmon Bay, KI-2-2 Salmon Bay into Ship Canal, North side	CGS	17-c	Moderately Impaired	More Impaired	• **Riparian** • **Debris** Removal • Beach • **Armor** • **Overwater**	**Light** LWD Nitrogen Phosphorus Sediment **Tide** Toxins Water **Wave**
Locks - Barnacle Removal	Blueprint	17-d	Less Impaired	More Impaired	N/A	N/A

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
KI-2-4 Shilshole Bay to Westpoint	CGS	18-b	Least Impaired	Least Impaired	• Protect	Light LWD Nitrogen Phosphorus Pathogens Sediment Tide Toxins Water Wave
KI-2-4 Shilshole Bay to Westpoint	CGS	18-d	Less Impaired	Least Impaired	• Protect • Riparian • Wetland Restoration • Debris Removal	Light LWD Nitrogen Phosphorus Pathogens Sediment Tide Toxins Water Wave
KI-3-2 Magnolia Bluffs to Smith Cove	CGS	18-e	Least Impaired	Least Impaired	• Protect • Debris Removal	Light LWD Nitrogen Phosphorus Pathogens Sediment Tide Toxins Water Wave
Magnolia Bluffs	WRIA 9 Prioritization	19-a	Less Impaired	Less Impaired	• Protect • Debris Removal (shoreline and in-water)	Light LWD Nitrogen Phosphorus **Pathogens** Sediment Tide Toxins Water Wave
Magnolia Bluffs	WRIA 9 Prioritization	19-b	Least Impaired	Less Impaired	• Protect • Debris (shoreline and in-water)	Light LWD Nitrogen Phosphorus **Pathogens** Sediment Tide Toxins Water Wave
KI-3-2 Magnolia Bluffs to Smith Cove	CGS	19-c	Less Impaired	Less Impaired	• Protect • Beach • Debris (in-water)	Light LWD Nitrogen Phosphorus **Pathogens** Sediment Tide Toxins Water Wave
KI-3-2/KI-3-3 Smith Cove Marina and Breakwater	CGS	20-a	Most Impaired	Most Impaired	• **Beach**	**Sediment**
KI-3-2/KI-3-3 Smith Cove Marina and Breakwater	CGS	20-b	Moderately Impaired	Most Impaired	• **Riparian** • **Beach** • **Stormwater treatment** • **Debris (in-water)**	**Light LWD Nitrogen Pathogens Phosphorus Sediment Tide Toxins Water Wave**

Project or Site Name	Plan that Identifies Project or Site[1]	Sub-Reach ID	Sub Reach Impairment Category	Reach Impairment Category	Applicable Restoration Actions[2]	Process Addressed by Restoration Actions[3]
KI-4-1[5] Smith Cove and Elliott Bay	CGS	20-b	More Impaired	Most Impaired	• **Riparian** **Beach**	**Light LWD Nitrogen Phosphorus Sediment Toxins Water**
Elliott Bay, Northeastern section	WRIA 9 Prioritization	20-c/d	Most/ Moderately Impaired	Most Impaired	• **Riparian** • **Beach**	**Light LWD Nitrogen Phosphorus Sediment Toxins Water**
Myrtle Edwards/ Centennial/ Olympic Sculpture Parks (constructed in 2007)	Blueprint, WRIA 9 Prioritization, WRIA 9 Watershed	21-a/b	Most/ Moderately Impaired	More Impaired	• **Riparian** • **Beach** (including intertidal habitat benches)	Light **LWD Nitrogen Phosphorus Sediment Toxins Water**
Elliott Bay, Industrial and Port Areas	WRIA 9 Prioritization	22-a,b	Most Impaired	Most Impaired	• **Riparian** • **Beach** • **Overwater**	**Light LWD Nitrogen Phosphorus Sediment Toxins Water**
Elliott Bay, Industrial and Port Areas	WRIA 9 Prioritization	22-c	Most Impaired	Most Impaired	• **Riparian** • **Beach**	**Light LWD Nitrogen Phosphorus Sediment Toxins Water**
Elliott Bay, West	WRIA 9 Prioritization	23-a	More Impaired	More Impaired	• **Riparian** • **Beach**	Light **LWD Nitrogen** Phosphorus **Sediment** Toxins **Water**
West Seattle, mouth of Schmitz Creek	WRIA 9 Prioritization	25-b	Less Impaired	Moderately Impaired	• Protect • **Daylight Stream** • Debris Removal (shoreline and in-water)	Light LWD Nitrogen Phosphorus **Pathogens** Sediment Tide **Toxins** Water Wave
Lincoln Park	Parks	26-b	Least Impaired	Least Impaired	• Protect	Light LWD Nitrogen Phosphorus Pathogens Sediment Tide Toxins Water Wave

1 Blueprint: *Seattle's Urban Blueprint for Habitat Protection and Restoration* (Seattle 2003)

CGS: *Inventory and Assessment of Current and Historic Beach Feeding Sources/Erosion and Accretion Areas for the Marine Shorelines of Water Resource Inventory Areas 8 and 9* (CGS 2005)
WRIA 9 Prioritization: *Prioritization of Marine Shorelines of Water Resource Inventory Area 9 for Juvenile Salmonid Habitat Protection and Restoration (Anchor 2006)*
WRIA 9 Watershed: *Salmon Habitat Plan, Green/Duwamish and Central Puget Sound Watershed Resource Inventory Area 9* (WRIA 9 2005)
Parks: *Seattle Shoreline Park Inventory and Habitat Assessment* (Anchor 2003)

2 **Bold** indicates that the Restoration Action is highly applicable within the reach based on Table 19.
Protect: protect and conserve
Riparian: riparian vegetation restoration
Debris removal: Intertidal or littoral rubble removal and/or groin removal
Beach: beach nourishment
Armor: removal of artificial shoreline hardening including bulkheads and seawalls.
Overwater: removal of overwater structures.

3 **Bold type** indicates that the specific process addressed is highly impaired within one or more of the sub reaches covered by the project based pm Table 18.

4 "Protect" is listed as a restoration action for the project if both reach/sub-reach impairment categories were either "least" or "less" or if sub-reach category was "least." If "protect" is listed, then all processes are listed as addressed by the restoration action.

5 These numbered codes correspond to project numbers given in the source document.

4.6 Green Lake

For the Green Lake segment within the City, reach assignments based on reach and sub-reach impairment are summarized in Table 21. This table illustrates that Green Lake's shorelines are located within a landscape context of moderate and less impairment.

Table 21

Green Lake Reach Assignments based on Reach and sub-reach Impairment

		Reach Scale Impairment				
		Least	**Less**	**Moderate**	**More**	**Most**
Sub-reach Scale Impairment	**Most**					
	More					
	Moderate			1		
	Less			1		
	Least					

The following section describes the impairments in the Green Lake segment, as well as applicable restoration actions.

4.6.1 Impairments

Green Lake's shoreline contains more riparian vegetation, has a wider corridor of open park areas with less impervious surfaces, fewer parking lots, and fewer filled wetlands than in most areas of the City. The main concern with Green Lake, however, is the high amounts of nitrogen and phosphorus in the lake and its resulting water quality. The north portion of Green Lake is less impacted than the southern shore.

Table 22 indicates impairment ranges for the reaches in the Green Lake segment; lower values indicate lower function. This table was completed in the same manner as Table 6.

Table 22

Impairment Ranges Impairment Ranges from *Shoreline Characterization Report* (City of Seattle 2009) for Various Watershed Processes at Green Lake–City shorelines

Reach No.	Reach	Overall Impairment Category	Light	LWD	Nitrogen	Pathogens	Phosphorus	Sediment	Toxins	Water	Wave
28	Green Lake	Moderately Impaired									

Notes:
High Impairment
Moderate Impairment
Low Impairment

These results indicate that the most highly impaired processes at Green Lake are nitrogen and phosphorus. Key reasons for this impairment are the sediment and inputs from adjacent lawn areas and nonpoint urban runoff. Processes not as highly impaired are light and sediment; vegetation cover is present in many areas within the area studied (200 feet of the shoreline) and light conditions are not likely to be limiting in these areas. The sediment process at Green Lake is not as impaired because lake slopes are typically gentle and armoring is generally limited.

4.6.2 Applicable Restoration Actions

Based on these impairments, applicable restoration actions for the Green Lake segment are categorized as High, Moderate, or Low in Table 23. This table was completed in the same manner as Table 7.

At Green Lake, no projects have been recently proposed to address any of the watershed processes described as impaired. The most applicable restoration actions would include

bioswales or similar stormwater treatments that would help address the nutrient issues in the lake and continued alum treatment to reduce the internal phosphorous levels. High priority areas for habitat protection include those with the least impairments, which would include the areas with riparian vegetation and unarmored shorelines at the lake identified in the Green Lake Vegetation Plan[1].

1 available at www.seattle.gov/parks/parkspaces/GreenLakePark/ VMP.htm.

Table 23

Applicable Restoration Actions—Green Lake

Reach No.	Reach	Reach Impairment Category[1]	Reach Protection Category[2]	Riparian Restoration	Daylighting Streams (where piped streams occur)	Nearshore Debris Removal	Beach Nourishment/ Substrate Enhancement	Armoring Removal	Overwater Structure Removal	Stormwater treatment	Wetland Restoration
28	Green Lake	Moderately Impaired	Low	High	High	Low	Low	Moderate	Moderate	High	High

Notes:

1 Based on the results of the *Shoreline Characterization Report* (City of Seattle 2009).

2 Reach was considered High priority for protection if reach impairment category was "least"; moderate priority if reach impairment category was "less"; low priority for all other reach impairment categories ("moderate," "more," and "most")

5 IMPLEMENTATION

5.1 Implementation Strategy

Implementation of the Plan will require close coordination within the City and between the City and the partners noted in Section 2 of this Plan, as well as with agency partners such as Washington Department of Fish and Wildlife, Ecology, U.S. Army Corps of Engineers, National Oceanographic and Atmospheric Administration's National Marine Fisheries Service, and U.S. Fish and Wildlife Service.

Within the City's departments, the Department of Planning and Development is including language in the City's Comprehensive Plan that will direct the City to continue to support restoration and to use this Plan as guidance. Seattle Public Utilities will help to implement this Plan through the Restore Our Waters initiative, which coordinates restoration of City shorelines. SDOT street end management will also use the restoration plan to guide actions on street ends. The recent adoption of the Parks and Green Spaces levy will provide $500,000 for street end work. Through the implementation of this work shoreline restoration will occur on street ends. Seattle Department of Parks and Recreation will use the restoration plan to guide the management and restoration planning of their shoreline property and will continue to seek funding for shoreline restoration projects.

5.2 Timeline, Benchmarks, and Monitoring

The City's restoration work as it relates to this Plan will be monitored and evaluated on a set timeline against a suite of benchmarks to determine consistency with the State's SMP policy standard of no net loss of ecological functions. This Plan will be implemented when the SMP is adopted by Ecology, with a timeline based on ten year intervals. At each 10 year interval, ecological benchmarks will be evaluated for change. These benchmarks will include variables occurring in currently available datasets such as GIS layers of shoreline features. Measurable benchmarks[2] may include the following:

- Linear distance of armoring above OHW mark
- Number of jetties/breakwaters/groins/boat ramps
- Area of overwater structures
- Linear distance with continuous trees adjacent to shore
- Linear distance with patchy trees adjacent to shore

2 Benchmarks apply for the area within 200 feet of the shoreline.

- Linear distance with no cover/grass or trees/shrubs separated from shore
- Linear distance with adjacent trees and overhanging
- Number of completely or partially altered channelized streams
- Number of CSO outfalls
- Wetland acreage existing or lost
- Number of concentrations of animals in public areas
- Number of feeder bluffs
- Linear distance of roads within 100 feet of shore
- Total impervious surface area (TIA) of basin
- Linear distance with less than 50 percent impervious (1 to 12.5, 12.5 to 50, etc.)
- Numbers of marinas or houseboats present
- Number of CSO events within the 7-year timeframe

At the conclusion of each ten year interval, current data for each of these benchmarks will be compiled and the GIS model (as described in Section 4.1) will be re-run to evaluate SMP policy consistency.

5.3 Potential Funding

There is currently no dedicated funding source for the restoration actions presented here. Restoration described in this Plan is dependent on grant funding, and there a variety of other outside funding sources available for restoration projects in the area. Funds are distributed through grant-making agencies at the local, state, and federal level; opportunities described below are primarily administered by state and federal agencies. It is expected that funding will be derived from various sources. Sources listed here do not represent an exhaustive list of potential funding opportunities, but are meant to provide an overview of the types of opportunities available. These sources include the following:

- Recreation and Conservation Office of Washington
- Ecology
  - Aquatic Weeds Financial Assistance Program
  - Water Quality Program
  - Coastal Protection Fund
  - Coastal Zone Management Administration/Implementation Awards
- Washington Department of Fish & Wildlife
  - Aquatic Lands Enhancement Account (ALEA) Volunteer Cooperative Projects Program
  - Landowner Incentive Program
- National Fish and Wildlife Foundation
  - Bring Back the Natives: A Public-Private Partnership for Restoring Populations of Native Aquatic Species
  - Five-Star Restoration Matching Grants Program
  - Marine Debris Prevention and Removal Program
  - Native Plant Conservation Initiative
  - Puget Sound Marine Conservation Fund
  - The Migratory Bird Conservancy
- King Conservation District
- Salmon Recovery Funding Board (SRFB)
- National Oceanic and Atmospheric Administration (NOAA) Restoration Center
  - Community-based Restoration Program
  - NOAA CRP 3-Year Partnership Grants
  - NOAA CRP Project Grants
- American Sportfishing Association's FishAmerica Foundation Grants
- Environmental Protection Agency Region 10: Pacific Northwest
  - The Clean Water State Revolving Fund Program
  - Nonpoint Source Implementation Grant (319) Program
  - Wetland Protection, Restoration, and Stewardship Discretionary Funding
- U.S. Fish & Wildlife Service
  - Partners for Fish and Wildlife Program
  - Puget Sound Program
  - National Fish Passage Program
  - Cooperative Endangered Species Conservation Fund

  - North American Wetlands Conservation Act Grants Program
- Puget Sound Nearshore Ecosystem Restoration Project
- Washington Department of Transportation City Fish Passage Grant Program
- Washington Department of Natural Resources Small Forest Landowner Office (SFLO)
- Private foundations, businesses, and other groups administer grant programs that include funding for shoreline habitat and ecosystems, including:
  - The Russell Family Foundation
  - William C. Kenney Watershed Protection Foundation
  - Northwest Fund for the Environment
  - Kongsgaard-Goldman Foundation
  - The Bullitt Foundation
  - The Compton Foundation
  - Doris Duke Charitable Foundation
  - The Hugh and Jane Ferguson Foundation
  - Washington Trout
  - Midsound Fisheries Enhancement Group
  - People for Puget Sound
  - The Seattle Aquarium

5.4 Conclusions

This Plan identifies the applicable restoration actions and the areas that should be protected based on the results of the Shoreline Characterization Report. As is the case for most restoration work, the restoration and protection actions described in this Plan will require extensive cooperation and coordination with citizens, public agencies, private landowners, and other stakeholders. Additionally some of the actions require the acquisition of private land, relocation of public infrastructure, changes in land use and potential restrictions on future development. It is the City's intent to use this Plan to guide restoration and habitat protection efforts so these actions result in a net increase in shoreline ecosystem function over time consistent with the vision for the shoreline of its citizens.

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