# The City of Normandy Park Draft Shoreline Inventory and Characterization Report

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# INTRODUCTION

## Background and Purpose

The purpose of this report is to provide both an inventory and characterization of existing conditions within the shoreline jurisdiction of the City of Normandy Park (City). This information will be used to provide context for how the City will update its Shoreline Master Program (SMP), which is required to comply with the Shoreline Management Act (SMA), Revised Code of Washington (RCW) 90.58 and its implementing guidelines, Washington Administrative Code 173-26. The City's current SMP can be found online at Title 16. The City is updating its SMP with assistance from a grant from Washington Department of Ecology (Ecology) (grant number G1000008). The development of the inventory and characterization report is the first major step in the process of updating the City's SMP.

## Overview of the Shoreline Management Act

The SMA was adopted through a public referendum in 1972. The SMA was created in response to concerns related to unplanned and uncoordinated development occurring along the shorelines of the states. It has three overarching goals (RCW 90.58.020):

1. Encourage water-dependent uses
2. Protect natural shoreline resources
3. Promote public access

The Act recognizes that "the shorelines of the state are among the most valuable and fragile of its natural resources" (RCW 90.58.020). The Washington Department of Ecology is responsible for adopting guidelines that each jurisdiction must follow when updating their Shoreline Master Program (SMP). After adopting a set of guidelines in the 1970s, Ecology did not substantially change the guidelines until 2003. The 2003 guidelines require that SMPs do not result in a net loss of current and potential ecological functions necessary to sustain shoreline natural resources. The guidelines also reinforce the SMA goal of improving the overall condition of habitat and resources within the shoreline area (WAC 173-26-201(2)(c)).

## Shoreline Management Jurisdiction

The SMA has jurisdiction over three main shoreline areas; marine shorelines, streams with mean annual flow greater than 20 cubic feet per second (cfs), and lakes with a surface area greater than 20 acres. These areas are known as "shorelines of the state." The jurisdiction extends 200 feet landward of the ordinary high water mark (OHWM), which is technically called "shorelands," as well as any associated wetlands. Associated wetlands are those wetlands that are in proximity to and either influence or are influenced by tidal waters subject to the SMA (RCW 90.58.030). Associated wetlands can extend the shorelands beyond the standard 200 foot jurisdiction. The SMA has a second category of jurisdiction, "shorelines of statewide significance." In western Washington, this category is defined as rivers with a mean annual flow of 1,000 cfs or greater, freshwater lakes with a surface area of 1,000 acres or more, and portions of Puget Sound. The Act intends that these areas be recognized and protected as a statewide resource.

None of the City's streams or lakes are classified as "shorelines of state" or "shorelines of statewide significance" since they are too small. The upland portion of the roughly 3.4 miles of marine shoreline along Puget Sound is classified as "shorelines of the state." There are two mapped associated wetlands within this shoreline along with several smaller dune grass marsh areas. For the two larger mapped wetlands, the shoreline jurisdiction extends landward beyond the minimum 200 feet required. Based on the criteria in the SMA, the area waterward of the extreme low tide line is considered "shorelines of statewide significance."

Normandy Park has chosen not to cover associated wetland buffers under its SMP. It has also chosen not to manage coastal floodplain areas under its SMP. Both of these issues will be managed under the City's CAO ordinance. The City will decide how to address critical areas that are outside of SMP jurisdiction but overlap with critical areas that are within SMP jurisdiction in the near future.

## *Shoreline Planning Segments*

The City of Normandy Park is located along the shores of Puget Sound between the city of Burien to the north and northeast and the city of Des Moines to the south and southeast (Map 1). The City is roughly 1,600 acres in size. It is roughly stretched out along the shores of Puget Sound, with a shoreline of 3.5 miles long, but with an average width of only about three quarters of a mile. The approximate extent of the City's shoreline jurisdiction is shown in Map 2, and makes up the planning area for this effort. The shoreline jurisdiction of the City was broken into 6 segments using zoning, land use patterns, and geologic data. A general description, including extent, is included in Table 1.

### Report Organization

The report is organized into six main sections. The first section describes the methodology used to construct the report. The second section provides a brief description of the regulatory context that the SMP is part of. The third section describes the basic land use patterns that occur within the City. The fourth section describes the larger watershed context within which the City sits. This section describes the larger characteristics of the landscape that affect ecosystem wide processes. The fifth section is a reach by reach description of the ecologically important attributes of shoreline segments and how various anthropogenic activities have impacted these attributes/functions. The final section is a reach by reach description of the various preservation and restoration opportunities that exist within the City. Tables and figures are located within the body of the report while maps are located in Appendix 1. Appendix 2 contains the list of data sources reviewed as part of writing this report.

**Table 1 City of Normandy Park's Planning Segments**

| Segment Name | Reach Number | Length (ft) | General description |
|---|---|---|---|
| Des Moines Beach | 1 | 1,487 | This reach extends north from the City's southern boundary with Des Moines to the last house that was built on the beach. |
| Marine View Park/Beaconsfield | 2 | 5,745 | This reach extends north from reach 1 to end of R15 zoning. |
| Beaconsfield to Edgecliff | 3 | 2,140 | This reach contains mostly low bank accretionaary shoreline and begins the R20 zoning that extends north through the rest of the city. |
| Edgecliff | 4 | 3,540 | This reach contains high bank shoreline, vegetated slopes, with houses at the top of the bluff. |
| Edgecliff to the Cove | 5 | 4,693 | This reach is mostly low bank shoreline, with houses located within 100 feet of a mostly bulkheaded shore |
| North City Limits | 6 | 764 | This reach extends from the mouth of Miller/Walker Creek to the northern city boundary with Burien |
| | total | 18,369 | Approximately 1.5 miles of shoreline is in R15 zoning with another 2 miles in R20 zoning |

# METHODOLOGY

## *Data Sources*

A large number of reports and data sources were reviewed and compiled to create this inventory and characterization.

The reports included:

- Chrzastowski, M. J., 1982. Net shore drift of King County, Washington: Western Washington University Master of Science Thsis, 153p., 1 plate.
- Johannessen, J.W., MacLennan, A., and McBride, A, 2005. Inventory and Assessment of Current and Historic Beach Feeding Sources/Erosion and Accretion Areas for the Marine Shorelines of Water Resource Inventory Areas 8 & 9, Prepared by Coastal Geologic Services, Prepared for King County Department of Natural Resources and Parks, Seattle, WA.
- Anchor Environmental, L.L.C., 2004. Marine Shoreline Inventory Report. Prepared for Seattle Public Utilities and WRIA 9.

- Anchor Environmental, L.L.C 2006. Final Report: Prioritization of Marine Shorelines of Water Resource Inventory Area 9 for Juvenile Salmonid Habitat Protection and Restoration. Prepared for Water Resource Inventory Area 9 Technical Committee.
- King County Department of Natural Resources, 2007. Technical Appendix: Shoreline Inventory and Characterization Methodology and Results.
- BHC Consultants, 2007. Memorandum: Normandy Park Critical Areas Development Regulations Update (Best Available Science). 31 op.
- Washington Trout Water Type Survey Results South King County (2004)

Many geographic information system (GIS) data sources were reviewed for this effort. Data sets from Johannessen et al. (2005), Anchor Environmental (2004), Shorezone (2000), PSNERP (2009), and Washington Department of Fish and Wildlife (WDFW) Priority Habitat and Species (PHS) (2010) were used heavily to describe the condition of the shoreline. A complete list of the data sources reviewed for this report is available in Appendix B.

Various maps and older aerial photography were assessed as part of this report. The maps and photographs include,

- Topographic "T-sheet" Coastal Mapping; U.S. Coastal Survey, 1876-1877.
- Vertical aerial photography by King County 1936.
- Vertical and oblique aerial photography by Department of Ecology, 1977.
- Oblique aerial photography by Department of Ecology, 2000 and 2006.
- Vertical aerial ortho-photography by King County, 2002, 2005, 2007, 2009.

Information on cultural and historic resources came from the King County Historic Preservation Program GIS data and the Washington Office of Archaeology and Historic Preservation.

## Approach to Inventory Characterization of Processes and Shoreline Functions

SMA guidelines require that this report evaluate ecosystem wide processes as part of the SMP update. The Department of Ecology states, "**Ecosystem-wide** *processes* refer to dynamic physical and chemical interactions that form and maintain natural landscapes… Ecosystem or watershed processes occur over larger landscapes that include both the shoreline and watersheds draining to the shoreline" (Ecology 2010). The section on watershed characterization describes many of the physical processes that are occurring throughout the City and beyond at a larger level. It also explains how those processes are affected by human activities. The reach level characterization section provides a more in depth look at those processes and how that specific reach of shoreline functions both physically and biologically.

# REGULATORY CONTEXT

## Current Shoreline Management Act Compliance

The Shoreline Management Act is implemented through the development of local Shoreline Master Programs (SMP). The City of Normandy Park adopted regulations contained in Ordinance No. 539 (December 15, 1991) as its Shoreline Master Program. Goals and policies are incorporated into the City of Normandy Park 2004 Comprehensive Plan as Objective 1.13: Shoreline Protection. Development regulations contained in the SMP are adopted as part of the City of Normandy Park Municipal Code Title 16.

Local SMP's establish a system to classify shoreline areas into specific "environment designations." The purpose of shoreline environment designations is to provide a uniform basis for applying policies and use regulations within distinctly different shoreline areas. Generally, environment designations should be based on existing and planned development patterns, biological and physical capabilities and limitations of the shoreline, and a community's vision or objectives for its future development. During development of its first SMP in 1991, the City evaluated the natural and built characteristics of its shoreline jurisdiction and developed a single shoreline environment designation:

- Rural residential (running the entire length of the City's shoreline).

According to Substitute Senate Bill (SSB) 6012, passed by the 2003 Washington State Legislature, cities within King County are required to amend their local shoreline master programs consistent with the Department of Ecology's revised guidelines. With the assistance of a grant administered by the Department of Ecology (SMP Grant No. G01000008), the City of Normandy Park is conducting a comprehensive SMP update, consistent with the current guidelines. This baseline inventory and analysis will inform development of the goals and policies and will provide a basis for the update of shoreline environment designations during the comprehensive SMP update process, anticipated to occur through June 2012.

## Comprehensive Plan, Zoning and Other City Regulations

***City of Normandy Park 2004 Comprehensive Plan –*** The City's existing Comprehensive Plan was adopted on November 9, 2004, by Ordinance No. 742. The City will begin updating the Comprehensive Plan in 2012, as required under the Growth Management Act (GMA). The Comprehensive Plan establishes goals and policies that define the community's vision for the physical, economic, and social development of the City for the next 20 years. The Comprehensive Plan land use designations near the Puget Sound shoreline include Park and Single Family Residential. City land use designations are relevant to this shoreline characterization as they establish the general land use patterns and vision of growth the City has adopted for areas both inside and outside the shoreline jurisdiction. The City's Shoreline Master Program goals and policies are adopted by reference as one element of the Comprehensive Plan.

***City of Normandy Park Municipal Code, Title 18: Zoning*** **–** Title 18 of the Normandy Park Municipal Code establishes zoning designations. Zoning designations near the Puget Sound shoreline include Low Density Single Family Residential (R-15) with a minimum lot size of 15,000 sq. ft. and Low Density Single Family Residential (R-20) with a minimum lot size of 20,000 sq. ft. Normandy Park's lone marine park is designated R-15 at this time.

***City of Normandy Park Municipal Code, Title 18.36: Critical Areas Development Regulations*** **–** Chapter 18.36 of the Normandy Park Municipal Code establishes development standards, construction techniques, and permitted uses in environmentally critical areas and/or their buffers (i.e., geologic hazard areas, fish and wildlife conservation areas, wetlands, streams, flood hazard areas and aquifer recharge areas) to protect these areas from adverse impacts. Designated critical areas are found throughout the City's shoreline jurisdiction, particularly flood hazard areas, streams, geologic hazard areas, and wetlands.

***City of Normandy Park: 2010 Normandy Park Stormwater Plan*** **–** The purpose of the Stormwater Management Plan is to comprehensively address how to meet the many different but related regulations, adopted plans and programs, and policies that affect urban stormwater, flooding and associated water resources. Because many of these requirements from different sources affect the same activities, an overall stormwater plan is needed to address the interrelationships of the programs and efficient approaches for meeting requirements and implementing policy, consistent with long-term goals, objectives, and policies as outlined in the City of Normandy Park Comprehensive Plan.

## State and Federal Regulations

A number of state and federal agencies may have jurisdiction over land or natural elements in the City's shoreline jurisdiction. Local development proposals most commonly trigger requirements for state or federal permits when they impact wetlands or streams; potentially affect fish and wildlife listed under the federal Endangered Species Act (ESA); result in over five acres of clearing and grading; or affect the floodplain or floodway. As with local requirements, state and federal regulations may apply throughout the City, but regulated resources are common within the City's shoreline jurisdiction. The state and federal regulations affecting shoreline related resources include but are not limited to:

Endangered Species Act: The federal ESA addresses the protection and recovery of federally listed species. The ESA is jointly administered by the National Oceanic and Atmospheric Administration (NOAA) Fisheries (Formerly referred to as the National Marine Fisheries Service) and the United States Fish and Wildlife Service (USFWS).

Clean Water Act (CWA): The federal CWA requires states to set standards for the protection of water quality for various parameters, and it regulates excavation and dredging in waters of the U.S., including wetlands. Certain activities affecting wetlands in the City's shoreline jurisdiction or work in adjacent rivers may require a permit from the U.S. Army Corps of Engineers and/or Washington State Department of Ecology under Section 404 and Section 401 of the CWA, respectively.

Hydraulic Project Approval (HPA): The Washington Department of Fish and Wildlife (WDFW) regulates activities that use, divert, obstruct or change the natural flow of the beds or banks of waters of the state and may affect fish habitat. Projects in the shoreline jurisdiction requiring construction below the ordinary high water mark of Puget Sound or streams in the city could require an HPA from WDFW. Projects creating new impervious surface that could substantially increase stormwater runoff to waters of the state may also require approval.

National Pollutant Discharge Elimination System (NPDES): Ecology regulates activities that result in wastewater discharges to surface water from industrial facilities or municipal wastewater treatment plants. NPDES permits are also required for stormwater discharges from industrial facilities, construction sites of five or more acres, and municipal stormwater systems that serve populations of 100,000 or more.

# LAND USE PATTERNS

The city of Normandy Park is located in southwest King County. Normandy Park is highly developed and has a well established pattern of land use. The City is bounded by approximately 3.5 miles of Puget Sound shoreline to the west and 1st Avenue South to the east. The city of Burien forms the northern boundary and the city of Des Moines forms the boundary to the south. The City's shoreline jurisdiction is composed of a variety of natural and human modified landscape features that include natural and modified beaches, concrete and rock bulkheads.

## Existing Land Use

The City is predominately developed with single-family residential properties within the shoreline environment and has one public park Marine View Park and one private park known as The Cove. There are no multi-family or commercial developments within the shoreline environment. The shoreline jurisdiction also contains a few undeveloped parcels of land. Vacant parcels are described in the reach by reach description of the shoreline.

## COMPREHENSIVE PLAN/ZONING DESIGNATIONS

### Comprehensive Plan

According to the City of Normandy Park 2004 Comprehensive Plan, the City's shoreline jurisdiction is largely comprised of properties designated Low Density Single-Family. The only other designation located within the shoreline jurisdiction is Open Space for the private park and the public park.

General goals and policies established in the City of Normandy Park 2004 Comprehensive Plan relate to a common desire to protect the quality of Normandy Park's natural and built environment. The forested, low-density residential character of Normandy Park is in large part due to the natural landscape that flows through the community. Natural open spaces and sensitive areas are major components of the city's character and it is essential that they be preserved.

The City's existing Shoreline Master Program goals and policies are included as an element of the City's current Comprehensive Plan. These goals and policies encourage minimal adverse effect on the quality of the shoreline environment.

**Zoning Designations**

Zoning designations in the City generally follow land use designations as discussed above under Comprehensive Plan designation. Within the City's shoreline jurisdiction, Low Density Single-Family Residential zoning (R-15 and R-20) dominates the entire shoreline.

## ROADS AND TRANSPORTATION FACILITIES

As described above, the majority of the City's shoreline is occupied by low density single family development, a private park and public park. There are generally very few roads that are found within the shoreline jurisdiction. The following road segments are located within shoreline jurisdiction:

- The westernmost 200 feet of SW Shorebrook Drive
- Normandy Terrace SW parallels the shoreline dipping in and out of shoreline jurisdiction
- The western end of SW 187th St
- Edgecliff Drive SW parallels the shoreline for most of its length, with the last 150 feet dipping into shoreline jurisdiction
- The western end of South 216th St
- The western end of 218th St
- The western end of 219th St

There are also various private roads or driveways located in shoreline jurisdiction. Within this group are two sizeable private roads. There is 500 feet of private road/driveway located along the steep slopes of Segment 2. There is roughly 600 feet of road in Segment 3 that is located at the ordinary high water mark and encircles a wetland

There are no public transit routes located within the shoreline environment of Normandy Park. The closest metro route stops at 1$^{st}$ Avenue South and 211$^{th}$ Street less than a mile away from Marine View Park.

## WASTEWATER AND STORMWATER UTILITIES

The Southwest Suburban Sewer District provides for the collection, treatment, and disposal of wastewater for most of the City. The Southwest Suburban Sewer District has a treatment plant located outside shoreline jurisdiction at 801 SW 168$^{th}$ Street. Two outfall pipes from the facility run to the Puget Sound. The Midway Sewer District serves the southernmost end of the City and has one outfall that is located just south of the City limits.

The City has jurisdiction over the storm and surface water management system within the city boundaries, within and outside of roadways. Stormwater utilities consist of over 750 catch basins, 50 manholes, over 12 miles of conveyance lines and over 8 miles of open ditches.

Other utilities in the shoreline jurisdiction include electric power, water, gas and cable.

## EXISTING AND POTENTIAL PUBLIC ACCESS SITES

The only a few existing shoreline areas in the City that are available for public access (Map 3). Due to the nature of the single-family development along the shoreline there are no pedestrian walkways, outside of the asphalt and dirt trails located in Marine View Park, that are open to the public.

The primary access area is Marine View Park, which is located at 20945 Marine View Drive SW (Map 3). There is also limited public access to the beach at the south end of the City. The 200 feet of access is available through Des Moines Beach Park, in the City of Des Moines. The City also owns several shoreline properties in the Beaconsfield development. However, these properties do not currently have a legal upland access point. The only legal public access is by boat.

The remainder of the shoreline is residential with one private park. The private park, known as The Cove, has beach access via SW Shorebrook Drive. There is a small private graveled parking area and boat launch. Only Lot A property owners in the community have access to The Cove.

There is the potential for increased shoreline access in the future, especially around the Beaconsfield area (Map 3). Areas with potential for public access are noted in the reach by reach description in the second half of the report.

There are also several road segments that are located either in shoreline jurisdiction or along the shore that provide visual access to the shore. While not as tangible as physical shoreline access, visual access still provides some level of enjoyment of the shoreline areas of the City.

## HISTORICAL/CULTURAL RESOURCES

The Historical/Cultural Element of the 1991 Normandy Park Shoreline Master Program provides a general goal and policy to retain and protect shoreline features having historic, cultural, scientific, or educational value locally or regionally. The Normandy Park 2004 Comprehensive Plan also addresses historic preservation. The Plan establishes the goal of protection and restoration of buildings, sites and areas having historic, cultural, educational or scientific value.

The King County Historic Preservation Program maintains a list of King County and local landmarks. There are three residences listed by the King County Resource Inventory within shoreline jurisdiction. The residences are known as the Hughett House at 17999 Normandy Terrace SW, the Clark House at 17915 Normandy Terrace SW, and the Gustin House at 17985 Normandy Terrace SW. While it has been noted that Native Americans used trails in the area to access the beaches there are no known archaeological sites within the community.

Washington State's Office of Archeological and Historic Preservation maintains the Washington State Inventory of Cultural Resources. A request for information on listed historic or archeological sites in the State's database has been made and will be reported at a later date.

# WATERSHED CHARACTERIZATION

## *Climate*

Normandy Park, being located along the eastern shores of Puget Sound, has a maritime climate with a fall and spring rainy season, dry summers, and cool winters. This area of Puget Sound receives between 35 and 40 inches of average annual rain fall (Woodward et al. 1995). The direction of wind is from the southwest through fall and spring and switches to coming from the northwest during the summer.

## *Topography, Geology, Soils*

The City is located along the broad, northerly trending Des Moines Plain, which is located between Puget Sound and the Duwamish River Valley (Map 4). The upland plateau is generally between 290 feet and 340 feet above sea level in the southern half of the City. In the northern half of the City, the topography is lower due to the occurrence of a historic glacial outwash channel and the long term erosion caused by the down cutting of Miller and Walker Creeks (Booth and Waldron 2004). The City generally slopes towards Puget Sound, with all creeks within the City flowing towards Puget Sound versus towards the Duwamish Valley. Large portions of the marine shoreline are bounded by steep bluffs along the shore, while relatively few areas have gently sloped shores.

The geology of the area was summarized by Booth and Waldron (2004). Some of the geologic features along the marine shoreline are summarized in Johannessen et al. 2005), but will be discussed under coastal processes section. The steep bluffs along the shore are the result of past glaciations, with the most recent glaciation (The Vashon Stade of the Fraser Glaciation), occurring only about 13,500 years ago. This most recent glaciation is responsible for most of the surficial deposits and generally north-south trending hills. Since the last glaciers left, upland erosion, coastal erosion, and landslides have weathered the landscape, creating the streams channels and floodplains and the steep bluffs along the shore that we see today.

The soils in the City are composed mostly of recessional outwash deposits and till. The till is present throughout most of the City, with relatively recessional outwash deposits on top of the till in many places (Booth and Waldron 2004). Till is generally a poorly sorted mixture of gravel, sand and silts that was deposited at the base of a glacier and was compacted by the overriding ice. Till is extremely dense and generally has low permeability. There are deposits of advance outwash in the steep slopes along the shores of Puget Sound (Booth and Waldron 2004). Soils maps also show the highly permeable Everett soils in the southern part of the City on the plateau. These deposits are made up of mostly well sorted sand and gravel, which provide ideal beach building materials.

## Land Cover (Vegetation), Wetlands and Imperviousness

Much of the City has been developed for residential use. 2007 land cover data for Normandy Park (King County 2009a) showed that almost 60 percent of the City was classified as having low, medium, or high levels of development See Table 2 and Map 5. Only about 35 percent of the City is covered in trees. Much of this vegetation is located along the steep bluffs along the shore and in stream corridors. The amounts and quality of the marine riparian area will be discussed in the reach level characterization. The generally low levels of forested areas in the City (and surrounding cities) have ramifications on the streams running through the City.

**Table 2 Shows the total and percent of various land cover classes within the City of Normandy Park based on 2007 Landsat imagery**

| Land cover type | Acres | % |
|---|---|---|
| Bare ground/Rock/Snow | 6.49 | 0.41% |
| Cultivated | 8.50 | 0.53% |
| Coniferous | 0.33 | 0.02% |
| Deciduous/mixed | 551.70 | 34.66% |
| Immature Conifer | 0.33 | 0.02% |
| Herbaceous | 50.46 | 3.17% |
| Scrub/Shrub | 40.67 | 2.55% |
| High Intensity Development | 171.59 | 10.78% |
| Medium Intensity Development | 584.12 | 36.69% |
| Low Intensity Development | 172.92 | 10.86% |
| Water | 4.78 | 0.30% |
| Total | 1,591.89 | 100.00% |

Mapped wetlands are limited to the marine shoreline where there are only two mapped wetlands present. If there were wetlands in the uplands historically, they have been lost to development. There are wetlands associated with Miller and Walker Creeks, but these are outside of Normandy Park's jurisdiction. Data collected in 2004 found 4 more small marshes located along the marine shoreline, but their boundaries have not been mapped (Anchor 2004).

As noted with the discussion of land cover, much of the City has been developed. Much of the development has brought with it impervious surfaces (Map 6), areas where water cannot be absorbed and is instead shed quickly into stream systems. Impermeable surfaces include buildings, pavement, and other compacted surfaces (i.e., lawns). This has the affect of causing much higher stream flows during the rainy season, along with reduced flows in summer. The Miller and Walker Creeks Basin Plan (2006) indicates that this basin is about 22 percent impervious with a predicated increase to 30 percent in the future without changes in zoning. This basin is fairly indicative of the development and impervious patterns throughout the City.

## Hydrology (Surface water, Groundwater, Floodplains)

In Washington State, the major river watersheds were delineated into Watershed Resource Inventory Areas (WRIA) and numbered (Williams et al. 1975). Areas that had direct drainage into Puget Sound were lumped into the closest major WRIA. The City is located within WRIA 9, or the Green/Duwamish Watershed. None of the water draining out of the City flows into the Green River itself, but flows directly into Puget Sound through three small streams and various undefined overland flow. Most previous efforts at mapping stream basins lump areas without defined channels into areas with defined drainage, generally creating an agglomeration of drainages. A recent effort by the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) created much finer scale subbasin boundaries that broke out actual direct drainages to Puget Sound from larger defined stream drainages. PSNERP data shows that there are two larger subbasins with defined streams that flow into Puget Sound (Miller, Walker, and Normandy Creeks) and three smaller subbasins that have no primary flow path to Puget Sound (PSNERP 2009) (see Map 7). The three small unnamed basins are only 167, 103, and 82 acres in size and located in the southern half of the City. Normandy Creek has a basin size of 865 acres. Miller and Walker Creeks are combined into one basin of 6,000 acres.

The combined low numbers of wetlands, high amounts of development and imperviousness has tremendous impacts on the hydrology of the City's streams. The Miller and Walker Creeks Basin Plan (2006) states, "Under forested conditions, it is expected that six cubic feet of water per second would flow past the mouth during a one-year return period (storm flow from a rain event likely to occur on average once a year). Currently storm flows at the mouth for the same type of rain event are at about 95 cubic feet per second, or about sixteen times higher than under forested conditions." The plan also noted that most of the runoff is conveyed to the creek by a series of pipes and ditches which are intended to speed up delivery of water to the creek. This type of change to the hydrology clearly has impacted flooding, erosion and deposition patterns throughout the basin. This stormwater pattern also has the added problem of not allowing for natural rates of recharge which would keep the streams flowing in summer. Thus aquatic habitat first experiences damaging high flows during the winter, and then reduced flow levels in summer which greatly limit the amount of physical habitat available.

As noted above, some recharge of groundwater can happen in areas that have appropriate soils and have not been impacted by impervious surfaces. The highly permeable Everett soils occur mostly in the southern part of the City on the plateau, providing recharge potential to Normandy Creek. Critical Aquifer Recharge Areas are defined as "areas designated by WAC 365-190-080 (2) that are determined to have a critical recharging effect on aquifers used for potable water as defined by WAC 365-190-030 (2)." These areas include wellhead protection areas, areas within a 10 year time of travel and other areas that effect groundwater. There are no public wells or wellhead protection areas located within the City. The City has no Critical Aquifer Recharge Areas (BHC 2007).

Most of the major streams within the City have had their floodplains mapped (Map 7). Miller and Walker Creeks have had their floodplains mapped for much of their length, and they are generally limited to the immediate stream corridor. The only substantial stream floodplain area is limited to the lower 1,500 feet of Miller/Walker Creeks, with a floodplain area about 800 feet wide. Normandy Creek's floodplain is mostly limited to the immediate stream channel, but it has broad forested floodplain at its headwaters. This area is mostly owned by the City. The marine shoreline has also had a floodplain/coastal inundation area mapped along the shore. In most places it is less than 100 feet wide. In Segment 5 there is one place where the inundation area goes in about 200 feet. Most of the houses in Segment 1 are entirely within the mapped floodplain of Puget Sound. Based on more recent topography, there appears to be at least two areas in Segment 3 that are likely within the 100-year inundation area of Puget Sound, but new mapping needs to be done to verify if this is the case.

## *Water Quality*

There has been limited water quality sampling of the marine environment in Puget Sound and the streams that are in the City of Normandy Park. Past work indicated that there were elevated levels of zinc, copper, fecal coliform bacteria and pesticides in Miller Creek (Miller and Walker Creeks Basin Plan 2006). The currently available data does indicate that there are still problems, especially in the Miller/Walker Creek basin. Section 303 of the Federal Clean Water Act requires that Washington State prepare a list of all surface waters that are impaired by pollutants. Washington Department of Ecology maintains the 303(d) list, which was last updated in 2008. Miller Creek is listed as not meeting the water quality standards for fecal coliform bacteria and dissolved oxygen. It is also listed as a "Water of Concern" under 305(b) for pH. The marine area just off the mouth of Miller/Walker Creeks is also listed as "Water of Concern" under 30 (b) for fecal coliform bacteria.

While Des Moines Creek is technically outside the City of Normandy Park's jurisdiction, the water flowing from it could still impact the marine waters along the City's shoreline. Des Moines Creek is listed under 303(d) as not meeting the water quality standards for fecal coliform bacteria and dissolved oxygen. It is also listed under 305(b) as a "Water of Concern" for temperature and copper. The Midway Sewer District also has direct marine outfall just south of the Normandy Park City limits.

Ambient marine water quality sampling by King County in 2005 through 2007 just off the mouth of Miller/Walker Creeks found various pesticides and other man-made chemicals at low levels (King County 2009b). Hexacholorobenzene was found at concentrations above the Lowest Apparent Effects Thresholds standard. There is no known source of hexachlorobenzene in the City, but this compound is still used in some pesticides and has previously been used in some wood preservatives and may have originated upstream of the City limits (King County 2009b). While the data from 2005-2007 showed the sample site meeting fecal coliform standards, data collected since have shown that the site is not meeting the fecal coliform water quality standards (S. Mickleson, personal communication, 2010). It should also be noted that the Southwest Suburban Sewer District has a marine outfall in close proximity to the ambient water quality sampling location.

## *Coastal Processes*

### Littoral Drift Cells

Unlike the freshwater systems which are primarily defined by their surrounding watershed or basin, marine shoreline areas are generally defined by the drift cell in which that shoreline is located. Drift cells, drift sectors, or littoral cells are all different ways to describe the process of how sediment moves along a particular segment of shoreline. Drift cells are independent segments of shoreline along which littoral movements of sediments occur at noticeable rates depending on wave energy and currents (Figure 1). Each drift cell typically includes one or more sources of sediment (e.g., a “feeder bluff” or stream outlet), one or more transport zones (within which the sediment moves along the shore), and one or more accretion areas (e.g., a sand spit) where the sediment is deposited. This process creates and maintains the habitat diversity along the shoreline. Since many intertidal organisms are tied to substrate type, any changes to this process can have profound changes throughout the ecosystem (Dethier 2009).

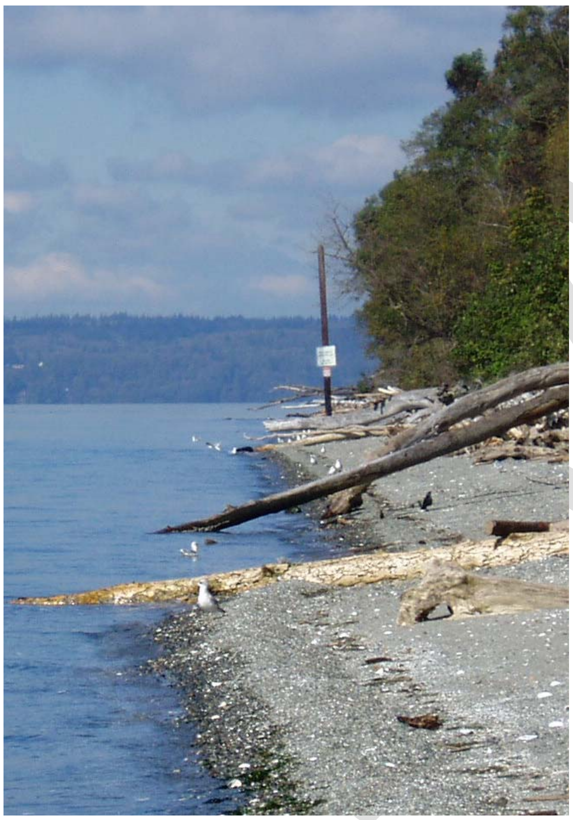

**Figure 1 Shows the direction of sediment drift is towards the sign in the background of the picture. Sediment has built up, via littoral drift, on the log in the foreground (Photograph from Coastal Geologic Services).**

Prior to the development of the Des Moines Marina, drift cell Ki-8-3 (all the drift cells in Puget Sound are numbered) moved sediment from just south of Saltwater State Park northward all the way to the tip of Three Tree Point (Map 8). The construction of the marina in the 1960s caused the drift cell to be split into 4 different pieces (Chrzastowski 1982). Ki-8-3 was shortened and now ends at the southern extent of the marina at the mouth of Massey Creek. It is slightly over 2 miles long. The marina itself (Ki-8-2/Ki8-3-NAD) represents an area where, due to the breakwaters, no drift occurs, and accounts for roughly 2,500 feet of the historic shoreline. Both of these drift cells are entirely located in the City of Des Moines. Just to the north of the marina, Ki-8-2, a very short drift cell transports sediment towards the marina. This drift cell is reversed from its historic drift direction due to being in the wave shadow of the marina. The northern 120 feet of this drift cell is located in Normandy Park, with the remaining 864 feet of the cell located in the City of Des Moines. The remaining piece of the original drift cell is now named Ki-7-3, and it exhibits northward drift all the way to Three Tree Point. Almost all of Normandy Parks' 3.5 miles of shoreline is located within this drift cell.

The areas within drift cells Ki-8-3, Ki-8-2/Ki-8-3NAD, and Ki-8-2 are no longer connected to and providing sediment to Ki-7-3. This 3.8 mile area that was cut off had significant amounts of feeder bluffs. Approximately 1 mile is currently classified as feeder bluff or exceptional feeder bluff, while almost a mile of what is armored was classified as having been feeder bluffs historically (Johannessen et al. 2005). Furthermore, a comparison of historic aerial photographs shows that large amounts of sediment can clearly be seen building up on the south side of the marina. Between 1977 and 2009, there has been at least 50 feet of horizontal build up of the beach for the 1,000 feet of shoreline south of the marina.

As noted above, drift cell Ki-7-3 was relatively recently (geologically) modified by the construction of the marina roughly 50 years ago. Changes to geomorphic processes do not necessarily display themselves on the landscape right away. It is possible that some of the effects that would be experienced in drift cell Ki-7-3 caused by the marina intercepting sediment will still not be experienced for some time to come.

Drift cell Ki-7-3 is 24,000 feet long (including the portion in the City of Burien). Slightly over 66 percent (15,850 feet) of its shoreline has been armored, mostly by residential development (Map 9). It is also composed of 3,300 feet (14 percent) of unmodified accretion shoreforms, 4,000 feet (16 percent) of feeder bluffs, and 850 feet (4 percent) of transport zones (Map 10). Based on historical reconstruction mapping (Johannessen et al. 2005), the areas that are currently bulkheaded were comprised mostly of feeder bluffs (47 percent), and accretion shoreforms (32 percent). A total of 65.4 percent of the all the sediment sources for the drift cell, as it now exists, have been lost due to bulkheading.

## Shoretypes and Shoreline Modifications

In 2004 the marine shorelines in King County were classified according by the type of roll it plays in the sediment delivery and transport process (Johannessen et al. 2005). This classification system relied on both field collected data and readily available GIS data sets. A more recent classification system was created to in order to classify all shorelines in the Puget Sound (Shipman 2008). However, the application of the newer classification system is based on only GIS data available Puget Sound wide and was done at a coarser level than the work done in 2005. The newer system also does not discreetly tie its classification to the different components of the sediment delivery/transport processes. For these reasons, the 2005 shoretype data will be used throughout the rest of this report.

These shoretypes were broken into exceptional feeder bluffs, feeder bluffs, transport zones, accretion shoreforms, and modifed (or armored). The exceptional feeder bluff classification was applied to areas with high erosion rates and had the highest volume of sediment input per linear foot. The feeder bluff classification was used for areas with the potential for substantial sediment delivery, but may be more episodic and have a longer recurrence interval than exceptional feeder bluffs. Transport zones are areas of shoreline that did not appear to contribute much sediment to the nearshore, nor did they appear to be building beaches in front of them. In essence, they are in a fairly stable equilibrium with sediment merely being transported alongshore. The modified classification was used to note areas that had been bulkheaded or altered so much that the natural geomorphic state was concealed and sediment delivery to the nearshore was halted. Accretion shoreforms denote areas that were or are depositional in nature. Given that even in depositional environments humans bulkheaded the shoreline, the classification was further broken into subcategories representing the level of development of the backshore, if a bulkhead existed, and if the depositional area was associated with a stream mouth.

While shoreline modifications are not a process, as a group, they can greatly impact the way processes interact on the landscape. Given their prevalence and level of impacts, especially to the sediment delivery and transport processes, they are described here. Shoreline modifications can be broken into four main categories, armoring (sea walls, revetments, bulkheads, etc), groins, boat ramps, and overwater structures (i.e., docks).

Groins are structures that are placed perpendicular to shore. The purpose of a groin is to catch all the sediment that is moving along the shore and build up a beach on the updrift side of the groin. While this can create a wider beach of finer substrate on one side, it also starves the beach down drift of the groin, creating a coarser beach that may down cut as the existing sediment is moved downdrift but not replaced due to groin stopping sediment transport. Generally, once one is built the downdrift landowners attempt to build others in order to protect their beach, creating a cascading affect through the system. While groins are not prevalent in the City, 6 groins were mapped as being in the City in 2004.

Boat ramps are generally structures that allow for a boat to be put into Puget Sound directly from a private landowner’s property. They are frequently made of cement and sometimes are protected on the updrift side by a groin intended to keep the ramp clear of vegetation. The bed of the ramp generally creates an area where epibenthic organisms are not able to colonize and creates an area where forage fish cannot spawn. The longer or wider the ramp is the greater the impact of the area where native naturally occurring organisms cannot find suitable habitat. Also, ramps are generally maintained so that beach berms and organic debris are not allowed to build up, changing the upper beach’s ecological community. There are private boat ramps throughout the shoreline of the City, but no public boat ramps.

Overwater structures generally refer to docks, but includes any other structure that floats or sits on top of or over the water the water. Docks can have an impact on various aspects of shoreline ecology. First, juvenile salmon are known to avoid swimming beneath substantial docks. They swim around the perimeter of the dock which makes them more susceptible to predation by larger fish that occupy deeper waters (Nightingale and Simenstad 2001). Depending on the spacing of the pilings supporting the dock, docks can also affect wave energy, which in turn impacts the ability to transport sediment by acting like a groin. The shade from docks can limit the growth of eelgrass underneath it and adjacent to it. Furthermore, invertebrates with shells generally build up on the pilings supporting the dock. These animals eventually die and create a mound of shell hash around the pilings, creating a sediment type in which eelgrass cannot grow. Most older docks in Puget Sound were constructed with creosote pilings, which are known to be toxic to various marine larvae (Stratus 2006).

Shoreline armoring is probably the most prevalent shoreline modification and the one with the greatest long-term impact. Shoreline armoring refers to any form of structure placed on the shoreline that's main purpose is to halt erosion of the adjacent land. These can include older creosote piling walls, concrete seawalls or more typical of current construction, riprap bulkheads. Shoreline armoring is currently present on slightly over 53 percent of the City of Normandy Parks shorelines.

As noted above, the armoring of the shoreline is normally undertaken in order to stop actual or perceived erosion of the shoreline. Since most beaches in Puget Sound are derived from bluff sediments and not fluvial sediments (Shipman 2004), armoring, especially on feeder bluffs, can have long lasting impacts. As more and more of a drift cell's sediment sources are bulkheaded, the ability for the beach and the nearshore habitats to maintain themselves is greatly diminished. Over time, this likely causes a loss of some beaches and downcutting (or lowering) of other beaches (MacDonald et al. 1994). Downcutting of the beach can exacerbate the original problem shoreline armoring was intended to fix, and cause the bulkheading to fail as it gets undermined by the downcutting.

Separate from the issue of locking up beach sediment sources, if the bulkhead was constructed below the OHWM, the bulkhead likely has several other impacts. First, the deeper into the intertidal zone the bulkhead goes the more it is likely to act like a groin. In this case, it can act to both stop sediment delivery and transport. Bulkheads also reflect wave energy differently than natural shorelines. This can lead to winnowing of the sediments on a beach, causing a general coarsening of the beach. Increasing the sediment sizes of materials on the beach can impact both the plant and invertebrate community found on the beach (Thom et al 1994).

Bulkheads also generally stop the eventual inland horizontal migration of the shoreline. Over time this can cause beaches to become steeper and narrower as wave energy acts on the shore and is unable to push the shoreline inland (MacDonald et al. 1994). The steepening and narrowing can both reduce the amount of physical habitat available to some species as well as physically change what species can exist on the beach.

The physical location of the bulkhead can also greatly affect the amount of physical habitat that is available to certain organisms. Sand lance and surf smelt spawn in the upper intertidal of beaches, from roughly +5 to +12 tidal elevation. Many bulkheads are located well below +12 elevation, possibly eliminating all of the potential spawning habitat. Several species of juvenile salmonids also use shallow water habitat as a place to feed, as refuge from predators and as a migration corridor. The deeper the shoreline armoring goes, the more the juvenile fish are pushed in deeper habitats where the food resources are likely different and the potential for predation is thought to be higher (Brennan et al. 2004). Several studies in other parts of the United States have shown that bulkheading impacts the number and type of shore birds found along the shore (Dugan et al. 2003, Urban-Malinga et al. 2008).

The tidal elevation also greatly impacts the amount of organic material that is recruited onto the beach. On an unmodified beach, there is typically a beach berm that forms just above the mean higher high tide line. Organic material (i.e., leaves, logs, algae) are deposited on this berm by the tides. On most bulkheaded shorelines the bulkhead is located on top of the location where this accumulation would occur, meaning that there is no place for organic material to accumulate. Higgins et al. 2005 showed that for WRIA 9 shorelines, drift log accumulations occurred on slightly over 38 percent of the unarmored shorelines, while only about 10 percent of the armored shorelines had drift log accumulations. Tonnes (2008) also showed that bulkheading reduced driftwood accumulations, but he also found significantly reduced the numbers of taltrid amphipods on armored beaches without drift logs. Work in 2003 (Sobosinski) to compare armored versus unarmored shorelines (irrespective of driftwood) showed similar results with taltrid amphipods being significantly reduced on armored beaches. While taltrid amphipods have not been heavily studied to understand how they fit into Puget Sound's food web, it is known that they are at least an important component of the diet of some shorebirds (Neuman et al. 2008).

Bulkheads can also stop the ability of salt water to reach low lying backshore habitats. The makeup and structure of coastal wetlands is greatly dependent on how often saltwater is able to overtop the natural beach berm system. In many cases within King County, the low lying habitats have been already converted into another use. Thus the bulkhead is not the primary cause for the loss or degradation of that habitat. However, there are some cases, with at least one within the City, where the bulkhead is the primary cause for degradation of an existing coastal wetland.

Shoreline armoring is also believed to affect how groundwater interacts with the beach (MacDonald et al 1994). Bulkheads either block water seepage onto the beach or they can focus it through discreet drainage points. Focusing flow into discreet discharge points would affect the microclimate of habitats on the beach (i.e., reducing moisture levels of the broader beach area at low tide), though this has not been studied. It is also believed that bulkheads can create an increase in elevation of the level of groundwater since they can act as a dam along a bluff toe where water would have naturally come out. This increase in groundwater level can increase the pore pressure on the beach itself, causing erosion of the beach (MacDonald et al. 1994).

When the shoreline is armored there appears to be a general tendency to remove the native shoreline vegetation (i.e., trees). This may simply be in order to have a view of the Sound or as part of construction of a house and or a bulkhead. In WRIA 9, it was shown that marine riparian vegetation was greatly reduced or heavily modified (turned into landscaped lawns) on armored shorelines in comparison to unarmored shorelines (Higgins et al. 2005). Not only were the amount of trees reduced, but the condition of the trees (density and location) were also heavily degraded in areas with armoring. For example, 80 percent of the trees in unarmored areas overhung the intertidal area, while less than 13 percent of the armored areas had trees overhanging the intertidal zone. In 2007, Toft found differences in the diets of juvenile Chinook salmon between shorelines that were armored and without vegetation compared to shorelines that were armored with vegetation. Given the changes in riparian condition noted above, Toft's results indicate that there may be significant impacts to the availability of prey to juvenile salmonids)

Perhaps the biggest, but least understood impact, is the cumulative effects of having so much shoreline that is so heavily altered. The cumulative effects of shoreline armoring are likely occurring at least at two spatial scales. First, since each drift cell's sediment delivery and transport processes are somewhat independent from one another, the physical cumulative effects of armoring is likely limited to each drift cell. However, the biological effects of shoreline armoring likely span much of Puget Sound. For example, juvenile Chinook salmon are known to migrate throughout Puget Sound, going from one drift cell to the next (Brennan et al 2004). Much more work needs to be done to quantify the cumulative effects of shoreline armoring, but it has the potential to be a significant driver in the declines of various aquatic and avian species.

## Coastal wetlands

Historical data on the marine shoreline area indicates that most of the area was composed of forested bluffs, with two larger wetland areas in Segment 5 (Map 11). The southern end of the segment contained a wooded marsh that was at least 7 acres in size and located at the mouth of Normandy Creek (1890's USGS and T-sheets). Based on the first maps available, development had all ready occurred along the edges of this wetland, indicating that it was likely originally a larger wetland complex that had already partially been filled for development purposes. The area is built out with residential homes and the wetland no longer exists. The wetland complex at the mouth of Miller and Walker Creeks also is indicated in early maps as a nine acre wooded marsh. This marsh also had development occurring along its edges by the time the first maps had been created. This wetland has been modified by development, and is currently partly managed as an emergent wetland. As, noted above, there are also five other small wetland areas along the shoreline. Four of these are extremely small occurrences of dune grass, while the fifth wetland is larger and was likely present, but missed in the historic mapping (Map 11).

## Tides

Both wave energy and tidal regimes are important processes in shaping shorelines. Humans modify how wave energy interacts with shorelines by building breakwaters or armoring and by creating waves through boat wakes (Williams et al. 2003). Tidal regimes on shorelines are modified by altering timing frequency, and magnitude of the freshwater flow of rivers and streams (Williams et al. 2003), through water diversions, dams, and increasing impervious surfaces. They can also be modified by filling intertidal areas, causing the ordinary high water mark of the marine shoreline to be moved seaward.

Tides along King County's marine, and estuarine shorelines are mixed semi-diurnal, resulting in two high tides and two low tides of unequal height every day. Generally, the tidal regime is affected at a regional scale and not controllable at the local level. Tidal influence can also be affected by changes in sea level over the long term by tectonic subsidence and global warming, and over the short term by storm surges and El Niño events (Williams et al. 2003).

The extent of tidal influence can be altered (truncated or lost) through alterations in beach profiles and elevations by shoreline armoring, and by artificial tidal restrictions at stream outlets caused by culverts, tide gates, and weirs. Shoreline armoring at or below ordinary high water levels shifts tidal influence to offshore areas which in turn can preclude the growth of important marine vegetation, such as eelgrass, and the existence of spawning habitat for certain fish species

(Williams et al. 2004). Tide gates and weirs on streams and wetlands can limit or prevent salinity gradients and backwatering effects that can create highly productive fresh- to-saltwater transition areas for vegetation and fish and wildlife. For example, in Segment 3, what is likely originally a salt marsh appears to be limited to being a freshwater emergent wetland due to a private road cutting off the ability of Puget Sound to inundate the area.

## Wave energy/exposure

A good description of wave energy can be found in Williams et al. (2003). They state: "Waves are characterized by length, period, and height, and are the physical representation of energy moving through water. The short-period waves generated by local winds and vessel wakes are superimposed on the water elevation that varies with tide, season, and longer-term influences. In addition to winds and vessels, waves may be generated by geologic sources (i.e., large-scale bluff collapse, seismic forces). The wave energy is translated across the water and is ultimately expended on the shoreline, working to erode, transport, and deposit beach sediment (U.S. Army Corps of Engineers 2002; Terich 1987). Compared with other locations in the U.S., Puget Sound is considered to be a moderate wave-energy environment, even in the most exposed locations (McDonald and Witek 1994)." All of the City's shorelines are considered semi-protected by the Shorezone database (Berry et al. 2000).

Under natural conditions, wave energy is primarily generated by localized wind patterns and can be increased greatly during high-wind events. It also can be increased through boat traffic (Anchor Environmental 2000). This impact is focused on areas of high boat traffic, where wave energy is increased on a regular basis, not everywhere boats might cause a wake to occur infrequently. The amount of wave energy reaching the shoreline can also be decreased by submerged aquatic vegetation, which can act to moderate wave energy (Williams et al. 2003). Given that there is a major commercial shipping lane in this portion of Puget Sound, running north to south between Vashon and Maury Islands and the City of Normandy Park, it is expected that the impact of increased wave energy has occurred fairly uniformly throughout the City's jurisdiction.

Wave energy translates its energy from the water to the shoreline, dissipating the energy on the shoreline. The natural transfer of energy onto the shoreline is altered by shoreline armoring, which tends to dissipate and deflect energy differently than natural banks. The type of natural shoreline (rocky or sandy) and artificial armoring (hard rock vs. vegetative, bio-engineered banks) and location of the armoring relative to the tidal elevation (well above the high tide line versus below tide line) play a strong role in the effect of the alteration. Williams et al. (2004) state,

> "Wave reflection forces generally increase as armoring methods intensify, with higher impacts to beach processes in areas with solid vertical or recurved seawalls, and lower impacts in areas using graded or porous structures (e.g., revetments and riprap) or dynamic "soft" solutions (Macdonald et al. 1994; Williams and Thom 2001).
>
> Hardened armoring approaches, such as bulkheads and revetments, represent the types of shoreline modifications most likely to affect wave-energy regimes. Encroachment of the

structure into the intertidal zone, measured as the vertical distance of the mean high-water line from the toe of the structure, also may increase the reflective energy of waves."

Existing data on marine shoreline armoring is limited to presence/absence and encroachment. It does not include data on type of armoring (i.e., recurved seawall, rip-rap, wood piling).

Other structures such as jetties, docks, piers and breakwaters decrease wave energy through intervention of wave motion before it reaches the shorelines. Thus, when the wave energy reaches the shoreline, the actual amount of energy being expended has been greatly reduced and changed. This can be seen in how the marina just south of the City has impacted drift patterns within the City.

## Sea Level Rise

The relative change in sea level is a response to a series of complicated processes that are in turn impacted by factors affecting other parameters on a global as well as local scale, such as temperature, wind patterns, oceanic currents, and precipitation. A recent report from Mote et al. 2008 provides a range of potential sea level rise based on three different projections and incorporating seasonal cyclic events (El Niño/La Niña), vertical land movement and thermal expansion. Their 2100 predictions for this area range from a low level of 6 inches to a high of 4 feet. The medium project was for about 1 foot over the next 100 years.

Looking at sea level rise at the a Puget Sound scale, increased sea elevations will make development and infrastructure in low-lying areas more susceptible to flooding due to high tides and storms. Waves will encroach further onto low-lying beaches and cause greater beach erosion and threatening or damaging low-lying structures. At the same time steep slopes may receive increased moisture, due to predicted changes in precipitation patterns, potentially resulting in an increase in landslides that deliver more material to the marine shoreline, but which may cause property destruction and threaten human safety as well (Shipman 2009).

A little over half of Normandy Park's shores are currently armored, so that a slightly higher sea level may have minimal impacts on natural processes, but a significant rise might begin to allow overtopping of armoring with storms and very high tides. Within the City, areas like Segment 1, where houses are built out on the beach, will be the most at risk to increased inundation and storm damage. Shoretypes, known as transport zones, are composed of mostly stable bluffs and gentle sloping shorelines. A significant rise in sea level will likely cause these areas to become active feeder bluffs, perhaps endangering residences currently considered safe. A rise in sea level also will likely cause current feeder bluffs to become more active and increase erosion rates.

## Light energy

Light energy plays an important role in biological processes such as reproduction, growth, and predator-prey relationships. Light energy also plays an important role in controlling water temperatures, but that aspect of light energy is not analyzed here due to a lack of stream shoreline jurisdiction. Alterations to both natural light patterns and artificial light at nighttime are two differing components of how light energy interacts with the shoreline. Alterations to light energy can happen by removing vegetation, increasing artificial light or shading out natural light through overwater structures.

Under natural conditions the delivery of light to the shoreline is controlled by topography, cloudiness, degree vegetative canopy closure, and seasonal day length. The primary alteration to the delivery of light during the daytime is the removal of shoreline vegetation. One example of an impact due to marine shoreline vegetation removal is the decrease in survival of surf smelt eggs, due to loss of shade and subsequent desiccation along marine shorelines (Rice 2006). In addition, it can affect the predator/prey relationships in aquatic ecosystems, by giving an adaptive advantage to visual predators over longer periods of time (i.e, no refuge at night for animals that must rise to the surface to feed).

During night time, the delivery of light can be increased by artificial lighting (sometimes called "light pollution"), which can have unintended consequences on the migration, predation and feeding of various animals. For a detailed discussion of some of the documented impacts, see the review by Longcore and Rich (2005). The primary indicators of increased night time lighting are the lack of trees and the presence of streets or houses along the shoreline, and the presence of docks and piers.

The primary alteration that decreases light's ability to penetrate the water along the shoreline is the presence of overwater structures like docks, piers, and marinas. This type of alteration has been associated with changes to the migration of fish and the ability of eelgrass to grow.

# REACH LEVEL CHARACTERIZATION

As noted earlier, Normandy Park's 3.5 miles of shoreline was split into six segments or reaches based a combination of zoning, geology, and land use patterns (Map 12). Segment 1 is the only reach that contains a portion of drift cell Ki-8-2. Segment 1 was defined primarily by a dense cluster of houses that are located mostly on the beach, backed by a bluff with houses overhead. Given the uniqueness of this combination of development patterns, this segment was broken out into its own reach. Segment 2 is predominately composed of steeper vegetated bluffs and the northern boundary ends at the break in zoning from RA15 to RA20. Marine View Park is located within this segment. Segment 3's southern boundary is based on the change in zoning and its northern boundary is based on a change in topography and land use. Segment 3 has mostly low bank shores with houses relatively close to the shoreline along with broad accretionary beaches. Segment 4 boundaries' are based on the shoreline changing from low bank and accretionary in nature (Segments 3 and 5) to being vegetated bluffs and a source of sediment. The segment is composed of vegetated bluffs with houses along the top of the bluff and miscellaneous armoring along the toe of the slope. Segment 5's shoreline is composed of low lying accretionary beaches with houses fairly close to the shore. Segment 5 contains the estuary area of Miller and Walker Creek mouths. Segment 6 contains the last part of the northern portion of the City. It is a high bank, vegetated bluff area with shoreline armoring along the entire toe of slope.

The next section provides a summary of each segment's specific physical and biological characteristics. Each segment's physical characteristics are broken into subsections covering geologic information (seismic hazards, landslide hazards, steep slopes, and erosion), coastal processes (shoretypes, changes to wave and light energy, and tidal barriers) and hydrology (stream inputs, or other water freshwater features). Each segment's biological characteristics are broken into Fish and Wildlife Habitat Conservation Areas (FWHCA), marine riparian areas and large wood and drift log accumulations.

Fish and Wildlife Habitat Conservation Areas (FWHCA) are areas that are called out in the Growth Management Act and are incorporated into the City's Critical Areas Ordinance (NPMC 18.36.610). Broadly, they are habitat areas that the City attempts to provide greater protection than habitats that do not fall into FWHCA. They include habitats used by threatened and endangered species, forage fish spawning areas, shellfish, eelgrass, kelp and ponds less than 20 acres.

Certain biological information is fairly course and applies to all the segments or certain aspects of the information is the same no matter what reach is being described. Since the information is the same for each segment, the data is summarized here and not by each reach.

<u>Salmonids</u>

Three salmonid species (Chinook salmon, bull trout, and steelhead trout) are listed as 'threatened under' the Endangered Species Act. Based on sampling in Marine View Park in 2001, and other areas throughout King County in 2001 and 2002, juvenile Chinook salmon are found in the shallow nearshore waters throughout much of the year (Brennan et al. 2004). Juvenile steelhead trout were also found in the shallow nearshore waters, but in much smaller numbers than Chinook salmon. Bull trout were rarely found in this sampling, though they are known to use marine waters in northern part of King County as well as northern Puget Sound (Goetz 2005). Thus, it is expected that Chinook salmon and steelhead trout use all of the shoreline within the City of Normandy Park, while it is much less likely that bull trout are present within the city limits.

<u>Forage Fish</u>

Three species of forage fish (herring, sand lance, and surf smelt) are known to spawn in nearshore areas in Central Puget Sound. Within King County, herring only spawn in the intertidal areas only in Quartermaster Harbor, though they can be present in the waters around Normandy Park. Sand lance and surf smelt both spawn on the upper intertidal (+5 to +12 tidal elevations) of beaches throughout Puget Sound (see Figure 2). The specific surveys of spawning beaches will be discussed in each segment.

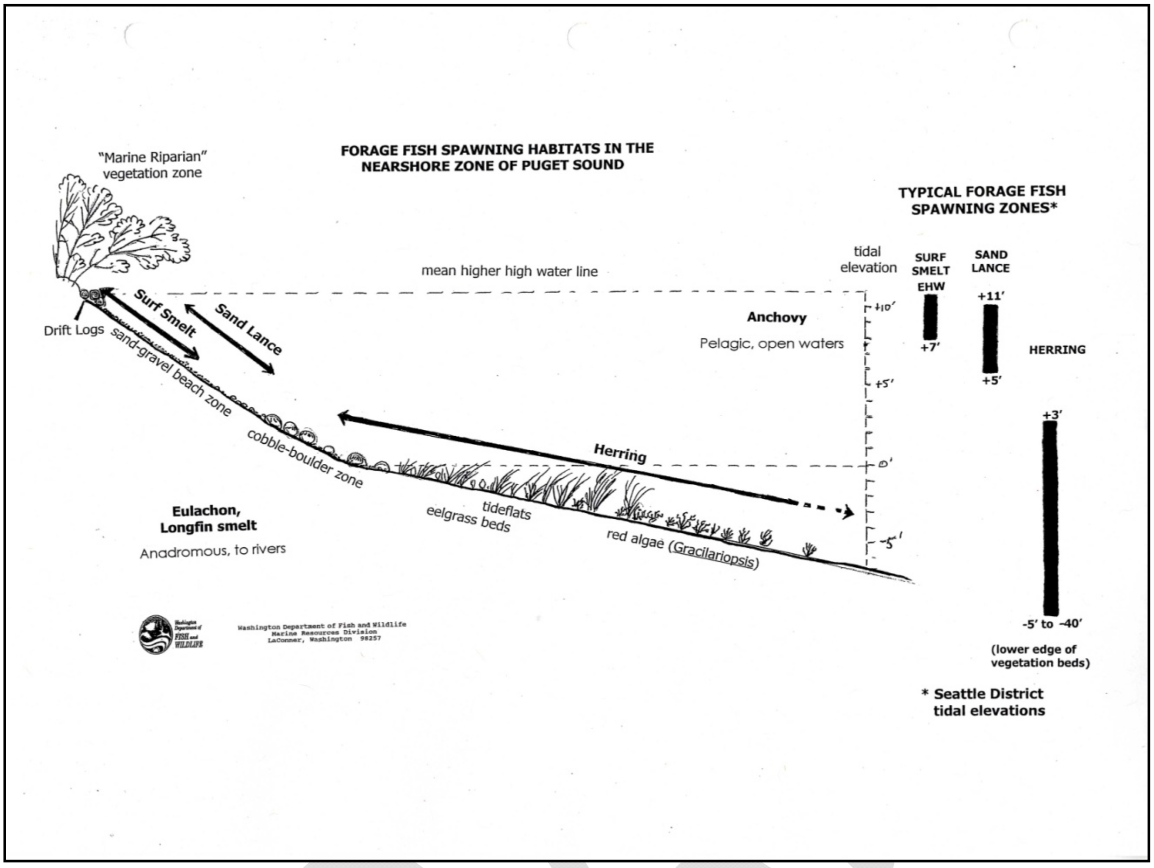

**Figure 2 Shows the tidal range for spawning forage fish species (From WDFW).**

<u>Marine Riparian</u>

The concepts related to the functions that riparian vegetation provides in the marine environment are primarily drawn from literature on freshwater riparian areas. The literature indicates that marine riparian areas provides the following: source of wood/organic material to the beach, prey source to fish, fish and wildlife habitat, shade, microclimate habitat conditions, water quality protection, and slope stability/erosion control (Brennan 2007).

While it is not clear how much of the logs on Puget Sound beaches come from freshwater sources (i.e., rivers) or from marine bluffs, it is clear that marine shorelines were historically a source of trees/drift logs to the beaches of Puget Sound (Tonnes 2008). This source of material has been greatly reduced in the City by residential development that has cleared much of the trees along the shore. It has been shown that there are significant differences with the intertidal invertebrate community in beaches with and without drift logs (Tonnes 2008, Sobocinski 2003).

The vegetation along the shores is also likely a significant source of food for various marine organisms. Romanuk and Levings (2003) found dramatic differences in the numbers of invertebrates associated with vegetated and non vegetated shores in Howe Sound of British Columbia. They found that aquatic arthropods were eight times more abundant at vegetated versus unvegetated shores. For terrestrial arthropods they found them at 65 times the level at vegetated versus nonvegetated. Juvenile salmonid diet data collected in 2001 and 2002 along the shores of central Puget Sound indicated that juvenile Chinook salmon were eating high numbers of terrestrial insects (Brennan et al. 2004).

Brennan and Culverwell (2004) found that 80 percent of all wildlife species in King County can be found in the marine riparian areas. This amounts to roughly 57 mammal species, at least 192 bird species, 5 species of reptiles, and 9 amphibians.

Shade and microclimate can also be an important function of the riparian areas for various animals. Rice (2007) showed that armored beaches had significantly higher daily mean light intensity, higher air temperature, higher substrate temperature, and lower daily mean relative humidity. Both Pentilla (2001) and Rice (2006) showed that beaches without shade had a significantly higher occurrence of mortality of surf smelt eggs.

In 2004, the riparian conditions of the marine shorelines of King County were characterized (Anchor 2004). This characterization focused on roughly a 200-foot zone landward from the OHWM. The vegetation was classified by type (trees, shrubs, etc.), density (continuous or patchy), adjacency (adjacent to the OHWM or separated), and if the vegetation was overhanging the intertidal. A related data set describes whether the shoreline has drift log accumulations parallel to shore and whether trees or large wood debris (LWD) are still attached by the roots perpendicular to the shore. These data are used in the reach by reach description to characterize the riparian conditions of each reach.

## Reach 1 (Des Moines Beach)

This reach has about 17 houses at the toe of a bluff that is 100 to 160 feet tall (Map 13). The 200 foot SMA jurisdiction extends up the bluff and includes the edges of many of the houses that are at located on the top of the bluff. This reach also has about seven vacant parcels along the shore. The houses at the toe of slope appear to have been built on the intertidal area of the beach (Figure 3). The 1936 aerial photos show many houses along were already present along the beach. These houses appear to be served by the Midway Sewer District. There is public access to the beach along the first 200 feet of the segment. The access originates from the City of Des Moines. The physical access to the most of the houses appears to be either from driving on the beach from Des Moines Beach Park (in the City of Des Moines) or from trails that lead from the public rights of way off of South 218th Street and South 219th Street.

**Figure 3 Shows the development pattern in Segment 1 and also shows that residents regularly drive on the beach in order to access their houses.**



## Physical

Geologic (Map 14)

All of Segment 1 is listed by Washington Department of Natural Resources (WADNR) as having very low liquefaction susceptibility (Palmer et al. 2007). There were no existing landslides mapped in 2005 (Johannessen et al.). WADNR's shallow-rapid landslide potential model indicates that this segment of shoreline has a mix of high and low probability of landslides susceptibility (Shaw and Vaugeois 1999). The City's Critical Area's Ordinance states, "any area with a slope of 25 percent or steeper and with a vertical relief of more than 20 or more feet shall be designated a landslide hazard area" (Normandy Park Municipal Code 18.36.510, 2010). Slope data for Normandy Park shows that the bluff face and most of the SMA jurisdiction throughout this segment has a slope greater than 25 percent and (King County 2010a). The bluff area has also been characterized as an erosion hazard area (King County, 2010b).

Coastal Processes (Map 15)

This segment has been completely bulkheaded. The bulkhead types are a mix of riprap and cement walls. Since the entire segment is armored, there are no other current shoretypes present other than 'modified' (Johannessen et al. 2005). Recent mapping classifying the historic nature of the shoreline showed that the majority of the segment was mapped as being an exceptional feeder bluff, with a small area mapped as feeder bluff. This indicates that this area used to provide sediment to the drift cell. Note that the southern 100 feet of this segment currently would supply sediment to the south under current conditions of the marina creating the wave shadow. Much of the armoring in this segment was classified as being located below the

OHWM (Anchor 2006). As noted above, the deeper into the intertidal the armoring goes, the bigger impact and more spread out through the ecosystem the armoring impacts occur. This segment did not have any groins built to catch sediment, however given that many of the bulkheads extend deep into the intertidal, many of the bulkheads act as groins, intercepting sediment moving along the shore. While there are no mapped boat ramps in this segment, a review of 2009 aerial photographs shows at least one boat ramp. There are no known overwater structures or tidal barriers in this segment. Given the very close proximity of the houses in this reach to the water, there is a greater potential for artificial light pollution at night in this segment than most of the others within the City.

<u>Hydrology (no map)</u>
There are no known streams, wetlands or other water sources in this segment, though it is entirely possible that there are seeps along the toe of the slope throughout this reach. There are also no known areas of smaller marshes from surveys in 2004 (Anchor 2004). Historically, there was a large wetland complex just south of the segment at the mouth of Des Moines Creek.

## Biological

Previous forage fish surveys in this reach have not found any sand lance or surf smelt spawning on the beaches, however only one survey has been done in this reach (WDFW 2010 ) (Map 16). Surveys of submerged aquatic vegetation in the 1990s showed that there are no known kelp beds in Segment 1 (Berry et al. 2000). However, Department of Agriculture maps from 1911-1912 indicate that kelp may was more prevalent along the shore in King County than it is now (Thom and Hallum 1990). Surveys in the 1990s showed that eelgrass is found in patchy beds throughout the segment (Berry et al. 2000). Washington Department of Fish and Wildlife shellfish data indicate that hardshell clams can be found close to shore throughout this reach and that geoducks can be found in a parallel band between 700 and 2,000 feet offshore (WDFW 2010).

The marine riparian area has been heavily modified by the development that has occurred over the last 100 years. The trees that are present are limited to the area between the houses at the toe of the bluff and the houses at the top of the bluff, thus providing only a few of the potential benefits of vegetated buffers. The primary benefit the vegetation is providing is slope stabilization. However, it should be noted that the trees along the top of the bluff slope have been thinned or removed throughout much of the segment. Also, most of the trees at the top of the bluff are gone and replaced with lawns. This was most likely done in order to provide unobstructed views of Puget Sound, but it is likely this has increased slope instability for the tall bluffs just above the houses on the shore. Given that the whole reach has been bulkheaded and that most of the bulkheads are well below the ordinary high water line, there are no accumulations of drift logs on the beach. Similarly, there is also no ability for LWD to accumulate and overhang the intertidal.

As noted above, one of the primary means of accessing the houses is driving along the beach. Driving along the beach has the potential to create a variety of damage to the beach. Any benthic or epibenthic organisms on the upper beach are likely to get crushed by vehicles. This includes any forage fish that might be spawning on the beaches. It is not know if residents drive along the lower intertidal areas during low tides, if they do there is the potential to heavily damage any eelgrass patches present. Having cars drive on the beach also creates a likely source of consistent pollution through leaks of various car fluids (i.e., oil, antifreeze). The cumulative impacts of all the stressors on the ecology of this segment of shoreline are potentially fairly high.

## *Reach 2 (Marine View Park/Beaconsfield)*

This mile long reach includes mostly steep bluffs throughout the segment, with about 600 feet of low bank shoreline in the northern portion of the segment (Map 17). The development pattern in this segment is fairly different from Segment 1 due the fact that the generally straight shoreline bluff has been interrupted by multiple reentrants created by localized surface and groundwater discharge. Since the bluff face undulates greatly in this segment, most of the development at the top of the bluff was set back much farther from shoreline than in Segment 1. In Segment 2, the top of the bluff is generally much greater than 300 horizontal feet away from the OHWM, in comparison to Segment 1, where it is generally less than 200 feet. There are 52 shoreline parcels in this reach. Only 7 of these parcels have houses within 200 feet of the shoreline, and there are 34 vacant parcels. Two of the houses are located on the shore, at the toe of bluff, and are located fairly close to Segment 1. Unlike the houses in Segment 1, these two houses have upland access via a road cutting across a steep slope. Many of the vacant parcels are found in the Beaconsfield area and are very skinny parcels, some only 20 feet wide, that contain only steep slopes. This segment also includes the Marine View Park, which is the only physical public access point to shore for residents of the City.

### Physical

<u>Geologic (Map 18)</u>
Most of Segment 2 is listed by WADNR as having very low liquefaction susceptibility (Palmer et al. 2007). There 2 small areas in the northern end of the segment (~3 acres total) that is classified as having a moderate to high susceptibility to liquefaction. These two low bank areas contain 3 of the 7 houses along the shore in this segment. There were nine different landslides mapped in 2005 (Johannessen et al.) comprising about 1,400 feet of the shoreline. WADNR's shallow-rapid landslide potential model indicates that this segment of shoreline has a mix of high and low probability of landslides susceptibility (Shaw and Vaugeois 1999). The City's Critical Area's Ordinance states, "any area with a slope of 25 percent or steeper and with a vertical relief of more than 20 or more feet shall be designated a landslide hazard area" (Normandy Park Municipal Code 18.36.510, 2010). Slope data for Normandy Park shows that the bluff face and most of the SMA jurisdiction throughout this segment has a slope greater than 25 percent (King County 2010a) and is characterized as an erosion hazard area (County 2010b). The only two shoreline areas that do not have steep slopes are the two areas that have a high susceptibility of liquefaction.

<u>Coastal Processes (Map19)</u>
This segment has been bulkheaded for 50 percent of the shore. Other shoretypes present include a modified accretion shoreform, a few hundred feet of transport zone, and roughly half a mile of active feeder bluff (Johannessen et al. 2005). Recent mapping classifying the historic nature of the shoreline showed that the majority (47 percent) of the armored area was mapped as being an exceptional feeder bluff, with a smaller area (30 percent) mapped as feeder bluff. This indicates that this area used to provide a significant amount of sediment to the drift cell. The accretion

areas located in this segment have a heavily modified backshore by houses and clearing. The bulkhead types are a mix of riprap, old creosote pilings and cement walls. Much of the armoring in this segment was classified as being located below the OHWM (Anchor 2006). All of this information indicates that the physical impacts of the bulkheading in this reach are high.

This segment did not have any groins built to catch sediment, however given that many of the bulkheads extend deep into the intertidal, many of the bulkheads act as groins, intercepting sediment moving along the shore. There are three mapped boat ramps in this segment. Two of the ramps are quite extensive, with one extending 110 waterward of the OHWM and the other extending 65 feet out. There are no known overwater structures or tidal barriers in this segment. Given the general lack of proximity of houses in this reach to the water and the highly vegetated slopes, there is a very low potential for artificial light pollution at night in this segment.

<u>Hydrology (Map 20)</u>
While no streams or other water features in this reach show up in the County's GIS stream layer, there are at least two small streams that are highly visible in most aerial and oblique photographs. The southerly stream mouth is highly constrained due to being located between the two houses that are located on the beach. The two houses and their bulkheads create a roughly 60-foot-long by 10-foot-wide flume. Given the steepness of the hillside it is unlikely that this stream could provide salmonid spawning habitat, but the stream mouth would provide rearing habitat. The other stream is located between Marine View Park and the Beaconsfield development and appears to have mostly a natural outlet. A survey done in 2003 of an upstream segment classified the water type as perennial with no fish (Washington Trout 2004).

There are also no known mapped wetlands or areas of smaller marshes from surveys in 2004 (Anchor 2004). However, there is a small patch of dune grass visible in 2006 oblique photographs at the very southern end of the segment. The dune grass is located behind the bulkhead, indicating that there is freshwater seepage coming out of the toe of slope.

## Biological

Previous surveys in this reach have not found any sand lance or surf smelt spawning on the beaches (WDFW 2010) (Map 21). Unlike Segment 2, surveys have occurred throughout the reach in four different time periods (in three different years). Given that some of the beaches in this segment could support surf smelt and sand lance (i.e., have appropriate physical space and appropriate substrate), it is unclear why they are currently not spawning in this segment. Surveys of submerged aquatic vegetation in 1990s showed that there are no known kelp beds in Segment 2 (Berry et al. 2000). The same surveys showed that eelgrass is found in patchy beds throughout the segment.

Washington Department of Fish and Wildlife shellfish data indicate that hardshell clams can be found close to shore in the southern portion of this segment and that geoducks can be found in a band parallel to shore more than 700 feet offshore (WDFW 2010). It should also be noted that the two large boat ramps in this segment extend fairly deep and appear to be cement structures that would preclude most naturally occurring subtidal organisms (i.e., various clams).

The marine riparian area in this segment is probably the most intact within the City. Trees make up slightly over 90 percent of the shoreline vegetation. While the trees are a fairly even mix of dense and patchy stands, most of the trees do not overhang the intertidal. The lack of overhanging vegetation is created by a combination of natural steep bluffs along the shore and shoreline armoring interrupting the ability of the trees to overhang the intertidal. Given the fairly broad area covered by steep slopes, this area is one of the more heavily treed areas in the City. Similar to Segment 1, many of the trees at the top of the bluff are gone and replaced with lawns. This was most likely done in order to provide unobstructed views of Puget Sound, and is likely to have created some slope instability.

There are no mapped areas of LWD, likely for the same reasons noted above for the generally low amount overhanging trees. However, there are significant areas (~60 percent of the segment) of drift log accumulations (see Figure 4). The areas of the segment that do not have drift logs are generally bulkheaded below the OHWM, providing no ability for the logs to accumulate.

**Figure 4. The picture shows drift log accumulations occurring in Marine View Park.**

## Reach 3 (Beaconsfield to Edgecliff)

This 2,000 foot long segment's geomorphology is fairly similar to Segment 2 (Map 22). This segment includes mostly low bank shoreline that is at the base of one of the areas that the bluff has substantially eroded inland due to localized surface and groundwater discharge. There is one short area (~400 feet) of bluff in the middle of the segment which is fairly stable due to beach in front of it being accretionary. Although the bluff face undulates greatly in this segment, there were more substantial flat areas near the toe of slope where development of sizable houses has occurred. There are 10 shoreline parcels in this reach. Four of these parcels have houses within 200 feet of the shoreline, though it looks like another house was being rebuilt within 200 feet of the shoreline in 2009 aerial photographs. The houses are between 25 feet to 50 feet from the OHWM. There is only one vacant parcel. This is the only segment within the City that has a private road along the beach. The road is about 500 feet long and the waterward edge is located at about the OHWM. This segment is also one of the only segments with a coastal wetland.

### Physical

Geologic (Map 23)

Most of the shoreline edge of Segment 3 is listed by WADNR as having moderate to high liquefaction susceptibility (Palmer et al. 2007). There is one area where the moderate to high rating goes inland 800 feet, but there are no houses located here. Most of the upland area is listed as having low susceptibility. The houses are located along the edge of the two classifications, but within the low classification. There were no landslides mapped in 2005 (Johannessen et al.). WADNR's shallow-rapid landslide potential model indicates that this most of this segment's shoreline has a low probability of landslides susceptibility (Shaw and Vaugeois 1999), though the data is absent for portion of the segment with a bluff in the backshore. Steep slope data for Normandy Park (calculated according to the City's CAO) shows that most of the SMA jurisdiction throughout this segment has a slope less than 25 percent (King County 2010a) though the bluff area in the center of the segment does have steep slopes approximately 50 feet back from the OHWM. The segment is characterized as having a mix of areas with and without erosion hazards (King County 2010b). The area of erosion hazard starts in the middle of the segment and extends north through the segment. The hazard is not mapped to the shoreline edge, but 40 to 90 feet inland from OHWM.

Coastal Processes (Map 24)

The entire segment is mapped as an accretion shoreform, but almost 45 percent of it has been heavily modified by clearing, bulkheads, and a road (Johannessen et al. 2005). The bulkhead types are a mix of riprap and cement walls. The armoring in this segment was classified as being located at or above OHWM (Anchor 2006). This generally indicates the impacts of these bulkheads is less on the actual beach environment, but the upland portion of the segment has been heavily modified by the development. This segment did not have any groins, boat ramps, or overwater structures mapped in 2005 (Anchor 2006). Given the general close proximity of houses in this reach to the water in the northern half and most southern portion, there is a moderate potential for artificial light pollution at night in this segment.

Hydrology (Map 25)

While no streams in this reach show up in the County's GIS stream layer, there are at least two small streams that are highly visible in most aerial and oblique photographs and were mapped in

2004 by Washington Trout. The southerly stream flows into the mapped wetland in this reach. The stream was not classified by Washington Trout as they did not have physical access to creek in order to classify it. The wetland is roughly three acres in size and appears to be isolated from the marine environment by a private road that runs along the shore. Given the generally low lying beach face it seems like it would under natural circumstances there would be a connection to the Sound, creating a salt marsh versus a freshwater dominated marsh. The northerly stream is highly constrained due to being located in cement flume. The flume is roughly 130 feet long by 2 feet wide and outlets onto the beach. This stream was classified by Washington Trout (2004) as being perennial without fish. It is unclear how much habitat would be opened up the flume barrier were made passable, but given the steepness of the hillside it is unlikely that this stream could provide salmonid spawning habitat. Washington Trout (2004) noted that the landowner said that there was a salt marsh at the mouth 50 years ago before the houses were built on top of the marsh. If the mouth was restored, or at least the flume made more passable, it is likely that the area would be used by rearing salmonids.

None of the segment is mapped as coastal floodplain, though it seems likely that new mapping of the coastal inundation area would probably show this area as being inundated during a 100-year storm event. Along with the one mapped wetland there are also two areas of smaller marshes noted in 2004 surveys (Anchor 2004). One of those is located at the mouth of the northerly stream. The other is located just to the south in dunes in front of one of the beach front houses.

### Biological

Previous surveys in this reach found surf smelt spawning on the beaches, but no sand lance (WDFW 2010) (Map 26). Surveys in 1994 found surf smelt in the center and at the northern end of the segment, amounting to a total of 1,300 feet of this segment being mapped as spawning beach. Spawner surveys have occurred mostly in the center of the reach in 1994 and 2006. Surveys of submerged aquatic vegetation in 1990s showed that there are no known kelp beds in Segment 2 (Berry et al. 2000). The same surveys showed that eelgrass is found in patchy beds throughout the segment, with a continuous band of eelgrass in the northern 300 feet of the segment.

Washington Department of Fish and Wildlife shellfish data indicate geoducks can be found in a band parallel to shore more than 700 feet offshore (WDFW 2010).

The marine riparian area in this segment is some of the least intact within the City. Trees make up slightly over 22 percent of the shoreline vegetation. This single dense patch of trees does not overhang the intertidal, though it does extend up the slope and onto the plateau above. The rest of the vegetation in this segment is made up of lawns and landscaping. Given the accretionary nature of this shoreline and that bulkheads were mostly built above the OHWM, there are drift log accumulations throughout the segment. However, given the lack of trees along the shore, there are no mapped areas of LWD.

## *Reach 4 (Edgecliff)*

This 3,500-foot-long segment's geomorphology is much more similar to Segment 1 than segments 2 and 3 (Map 27). The shoreline is typified by a vegetated, fairly steep, uniform bluff with no houses at the toe of slope. The bluff height starts at around 250 feet in the southern end and slowly transitions to a 50-foot-tall bluff at the northern most end. There are 33 shoreline parcels in this reach, with only 1 vacant parcel. Only four of these parcels have houses within 200 feet of the shoreline. Edgecliff road is approximately 350 feet from shore and parallels the shore for most of the segment (Figure 5). There is generally a row of houses between the road and the slope of the bluff. The houses are set back from the edge of bluff on average 30 feet. This segment does have one historic house (the "Tracy House") that is located just outside of shoreline jurisdiction, while much of the property is located on the bluff face.

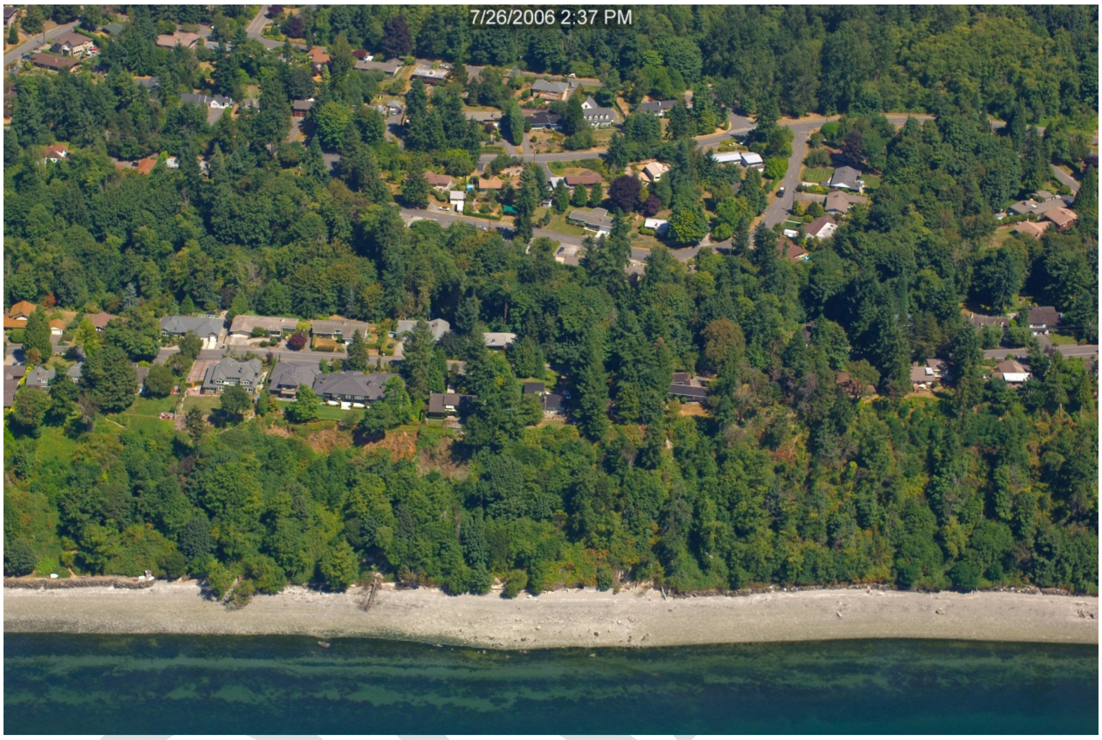


**Figure 5 The image is representative of the development pattern throughout this reach (Photograph from WADOE).**

## Physical

Geologic (Map 28)

All of the shoreline edge of Segment 4 is listed by WADNR as having low liquefaction susceptibility (Palmer et al. 2007). There was only one landslides mapped in 2005 (Johannessen et al.), at the very southern end of the segment. WADNR's shallow-rapid landslide potential model indicates that the southern two thirds of this segment's shoreline has a mostly a high or moderate probability of landslides susceptibility (Shaw and Vaugeois 1999). The northern third is mostly a mix of low and high probability of landslide susceptibility. Steep slope data for Normandy Park (calculated according to the City's CAO) shows that most of the SMA jurisdiction throughout this segment has a slope greater than 25 percent (King County 2010a) with the northern 500 feet having less steep slopes. The segment is characterized as having erosion hazards in only the southern half of the segment along the bluff face (King County 2010b).

<u>Coastal Processes (Map 29)</u>
Most of the segment is mapped as either a feeder bluff or modified (Johannessen et al. 2005). Bulkheads are found along 54 percent of this segment. The bulkhead types are mostly low rock revetments and with some cement walls. The armoring in this segment was classified as mostly being located below OHWM (Anchor 2006). The bulkheads in this reach appear to have mostly been constructed to limit erosion of the toe of slope. One larger (~350 feet) bulkhead was built fairly far into the intertidal and filled in behind the bulkhead in order to provide a level platform at the toe of slope. Historical reconstruction of the armored sections indicates that they were previously acting as feeder bluffs (Johannessen et al. 2005). Given that the bulkheads are below OHWM, and are blocking sediment from reaching the beach, they have a fairly significant impact on the nearshore environment. This segment had one groin mapped in the center of segment, but the groin appears to be falling apart and not effective. There were no boat ramps or overwater structures mapped in 2005 (Anchor 2006). Given the general lack of proximity of houses in this reach to the water, there is a low potential for artificial light pollution at night in this segment.

<u>Hydrology</u>
No streams or seeps are known to occur in this reach. There are no known wetlands or marshes. Most of the segment is mapped as having a twenty foot strip of coastal floodplain.

## Biological

Previous surveys in this reach found surf smelt spawning on the beach in the southern end of the segment, but no sand lance (WDFW 2010) (Map 30). Surveys in 1994 found surf smelt amounting to a total of 700 feet of this segment being mapped as spawning beach. Spawner surveys have occurred throughout the reach in 1994 and 2006. Surveys of submerged aquatic vegetation in 1990s showed that there are no known kelp beds in Segment 2 (Berry et al. 2000). The same surveys showed that eelgrass is found as a continuous band throughout the whole segment. Washington Department of Fish and Wildlife shellfish data indicate geoducks can be found in a band parallel to shore more than 1,000 feet offshore (WDFW 2010).

The marine riparian area in this segment is some of the most intact within the City. Trees are found along the entire length of shoreline, though approximately 65 percent of the trees are not dense, but patchy. Overhanging trees make up slightly over 73 percent of the shoreline, with much of overhanging vegetation being patchy in nature. It should be noted that much of treed area thins out as it gets to the top of the bluff, especially in the northern section of the segment. This is likely for views of Puget Sound, but the lack of trees and predominance of shrubs will likely affect the slope stability over the long term. There is one small area (~200ft) of LWD mapped in the southern portion of the segment. There are drift log accumulations in the southern and northern sections of the segment.

## *Reach 5 (Edgecliff to the Cove)*

This almost mile long segment's geomorphology is fairly different than the other segments to the south (Map 31). This segment includes mostly low bank shoreline that gently slopes towards

Puget Sound and is likely part of a remnant glacial outwash channel (Booth and Waldron 2004). Given the gentle slope, the area is also highly built out by residential land use. There are 32 shoreline parcels in this reach. None of these are vacant. Twenty-eight of the parcels have houses within 200 feet of the shoreline. Most of the houses are set back 60 to 100 feet from the OHWM. There are several houses that are located less than 30 feet from the OHWM. This segment also contains three historic houses in the northern half. They are the “Hughett House,” “Gustin House,” and another unnamed house (King County 2010c). Normandy Terrace SW parallels the shore in this segment, with a small portion of the road being in shoreline jurisdiction. This segment is also one of the only segments with a coastal wetland. The northern end of this segment also has a fairly large stream delta that protrudes out into Puget Sound 1,000 feet or more. The Southwest Suburban Sewer District has a direct outfall offshore of the delta. This outfall may be responsible for some of the unusual water quality data noted above.


**Figure 6. This oblique image shows the wetland complex at the mouth of Miller and Walker Creeks (photograph from WADOE).**

## Physical

<u>Geologic (Map 32)</u>

Most of the shoreline area of Segment 5 is listed by WADNR as having very low liquefaction susceptibility (Palmer et al. 2007). There are two areas where the moderate to high rating occurs. The first is located in the southern portion of the segment, where a freshwater wooded marsh was mapped in the 1870s (Collins and Sheikh 2005). It is approximately 900 feet long and goes inland 150 feet. Only one house was located within the high rating, though this house was recently demolished. It is unclear if a new house will be rebuilt in this location. The second area is located at the mouth of Miller and Walker Creeks. This area was also mapped as a wooded marsh in the 1870s (Collins and Sheikh 2005). The Cove community center buildings, as well as the Normandy Park Swimming Club are located within this area. There were no landslides mapped in 2005 (Johannessen et al.). WADNR’s shallow-rapid landslide potential model indicates that this most of this segment’s shoreline has a low probability of landslide susceptibility (Shaw and Vaugeois 1999). A small portion of shoreline just south of Miller and Walker Creek mouths has high probability mapped due to a slight increase in height of the shoreline in this area. Steep slope data for Normandy Park (calculated according to the City's CAO) shows that most of the SMA jurisdiction throughout this segment has a slope less than 25 percent (King County 2010a) though the area just south of Miller and Walker Creeks does have steep slopes for about 1,000 feet along the shore. There were no erosion hazards mapped in this area (King County 2010b).

<u>Coastal Processes (Map 33)</u>
The segment is mapped as a combination of accretion shoreforms and modified shorelines (Johannessen et al. 2005). Close to 50 percent of the shoreline has been bulkheaded (Anchor 2004). Historically reconstruction of the bulkheaded areas indicated that they were likely composed of accretion shoreforms (Johannessen 2005). The bulkheading is concentrated in the residential area in the central and southern portions of the segment. The bulkhead types are a mix of rock/riprap revetments and cement walls. Sixty percent of the armoring in this segment was classified as being below the OHWM (Anchor 2006). Combined this data indicates that the impact of these bulkheads is focused on the actual beach environment and backshore environments, and not on the sediment delivery functions. This segment has five groins throughout the segment. Most appear to be old and failing, but one appears to be relatively new and larger (20 feet wide by 80 feet long) and is clearly trapping a fair amount of drift logs and sediment on the updrift side. This groin is certainly affecting sediment transport to other properties downdrift. Immediately downdrift of this groin is the remnant of a boulder field that could also be removed. There are at least 7 boat ramps in this reach, most of which are fairly short and do extend far into the intertidal. There two overwater structures in this reach. The first one is at the southern end of the segment and is roughly 5 feet wide by 50 feet long. The northern one connects a private residence on the right bank of Miller Creek at its mouth to the very end of the beach berm spit where a helipad was constructed. Given the general close proximity of houses in this reach to the water in the southern and central portions, there is a moderate potential for artificial light pollution at night in this segment.

<u>Hydrology (Map 34)</u>
The three mapped stream in Normandy Park all outlet to Puget Sound in this segment. The southerly stream, Normandy Creek, is a fairly short stream that drains Nature Trails Park. While no fish were found during stream surveys in 2004, fish were believed to be present historically (Washington Trout 2004). The surveys were unable to classify if the piped outlet was a barrier to fish passage, but the habitat in the stream above the mouth was classified as having adequate spawning habitat. The outlet appears to be piped 80 feet waterward of the OHWM. This stream was most likely responsible for the historically mapped wooded marsh that was located at the mouth of this creek. There are no obvious signs of the historic seven acre wetland today. The wetland area is visible in 1936 aerial photographs. It appears that the wetland area was filled at some point between 1936 and 1974, the next available aerial photograph. The other two streams in this segment are Miller and Walker Creeks, which join together to a single stream channel just before the creek enters saltwater. Historically, both creeks fed into a nine acre wetland complex (Collins and Sheikh 2005). Portions of that wetland still remain. Approximately 2.3 acres appears to be scrub shrub wetland. This wetland area is focused around the two stream channels near where they combine to one channel. Most of this area is part of the private park, 'The

Cove.' An enhancement project in the recent past created a large pond along the channel of Walker Creek. The pond has a dam on its outlet in order to control water levels. It is not believed that salt water reaches the pond (Peter Landry, personal communication, 2010). At least two acres of the former wetland area is currently managed as a lawn. In 2004, Washington Trout's surveys showed high numbers of both coho salmon and cutthroat trout in both streams.

All of the shoreline has mapped coastal floodplain along it. The wetland area around the mouths of Miller and Walker Creeks is mostly mapped as floodplain. Along the shore of most of the segment, a 90-foot swath of the beach is mapped as floodplain. There is one section of shore in the southern end of the segment where the floodplain goes inland and incorporates 4 houses. This area is approximately where the historic wetland used to exist. Along with the one existing mapped wetland there are also two areas of smaller marshes noted in 2004 surveys (Anchor 2004). These are both located along the spit at the mouth of Miller and Walker Creeks and are probably contained within existing mapped wetland. The larger wetland area is likely to change as sea level rise occurs. It is likely that much of the lower area managed as lawn will eventually revert back to some form of salt marsh.

## Biological

Previous surveys in this reach did not find any surf smelt or sand lance spawning on the beaches (WDFW 2010) (Map 35). There have only been five documented surveys in this segment, which occurred in 1993, 1994 and 2006. Given that some of the beaches in this segment could support surf smelt and sand lance (i.e., have appropriate physical space and appropriate substrate), it is unclear why they are currently not spawning in this segment. Surveys of submerged aquatic vegetation in 1990s showed that there are no known kelp beds in Segment 2 (Berry et al. 2000). The same surveys showed that eelgrass is found in patchy beds throughout the segment. Washington Department of Fish and Wildlife shellfish data indicate geoducks can be found in a band parallel to shore more than 1,000 feet offshore (WDFW 2010).

The marine riparian area in this segment is some of the least intact within the City. Landscaping and grass make up over 80 percent of the riparian vegetation of this segment. There are two patches of trees in the center of the segment totaling 564 feet and one small patch at the northern edge of the segment. A large portion of the trees comes from a single parcel that contains one of the historic houses. Given that much of the bulkheading was built below the OHWM it is somewhat surprising that there are so many drift log accumulations along the shore. Drift log accumulations were mapped in almost 70 percent of the segment, mostly in the central and northern portions. However, given the lack of trees along the shore, there are no mapped areas of LWD.

## *Reach 6 (North City Limits)*

This 750 foot long segment's geomorphology is fairly similar to segment one and four (Map 36). The shoreline is typified by a vegetated, fairly steep, uniform bluff with one house at the toe of slope. The bluff height is about 100 feet throughout the segment. There are only six shoreline parcels in this reach, with 2 being vacant parcels. Portions of three houses are within the shoreline jurisdiction. One of these houses is built at the toe of the bluff and on the intertidal area.

## Physical

Geologic (Map 37)

All of the shoreline edge of Segment 6 is listed by WADNR as having either low or low to moderate liquefaction susceptibility (Palmer et al. 2007). There were no landslides mapped in 2005 (Johannessen et al.). WADNR's shallow-rapid landslide potential model indicates that southern half of the segment's shoreline has a low probability of landslide susceptibility, though small portions throughout are listed as having a high probability. (Shaw and Vaugeois 1999). There is no data for the northern half. Steep slope data for Normandy Park (calculated according to the City's CAO) shows that almost the entire SMA jurisdiction throughout this segment has a slope greater than 25 percent (King County 2010a). The segment was not characterized as any erosion hazards in the segment (King County 2010b).

Coastal Processes (Map 38)

All of the segment is mapped as modified (Johannessen et al. 2005) and is bulkheaded. The bulkhead types are mostly low rock revetments and with some cement walls. The armoring in this segment was classified as mostly being located below the OHWM (Anchor 2006), though based on 2006 oblique photos most of the armoring appears to actually be below the OHWM. Historical reconstruction of the armored sections indicates that they were probably acting as feeder bluffs (Johannessen et al. 2005). Given that the bulkheads are below the OHWM, and are blocking sediment from reaching the beach, they have a fairly significant impact on the nearshore environment. This segment had no groins, boat ramps, or overwater structures mapped within it (Anchor 2004). Given the general lack of proximity of houses in this reach to the water and the highly vegetated bluffs, there is a low potential for artificial light pollution at night in this segment.

Hydrology

No streams or seeps are known to occur in this reach. There are no known wetlands or marshes. Most of the segment is mapped as having a 50 foot strip of coastal floodplain

## Biological

Previous surveys in this reach found no surf smelt or sand lance spawning on the beach (WDFW 2010) (Map 39). There were only two recorded surveys done in this segment; one in 1994 and one in 2006. Surveys of submerged aquatic vegetation in 1990s showed that there are no known kelp beds in Segment 2 (Berry et al. 2000). The same surveys showed that patchy eelgrass was found throughout the whole segment. Washington Department of Fish and Wildlife shellfish data indicate geoducks can be found in a band parallel to shore more than 1,000 feet offshore (WDFW 2010).

The marine riparian area in this segment is composed mostly of trees. Patchy trees are found along the entire length of shoreline, though approximately 15% of the trees separated from the shoreline by a house. There are no overhanging trees within this segment. Unlike many of the other segments, there is a fair amount of vegetation along the top of the bluff. Given the shoreline armoring of the whole segment, no LWD was mapped in the segment. There is a very small area of drift log accumulations in the southern most edge of the segment (Anchor 2004).

# RESTORATION/PRESERVATION OPPORTUNITIES

As part of the characterization, opportunities for either restoring shoreline processes or preserving unique pieces of shoreline were described both for within segments and looking at the city as a whole.

There are a variety of programmatic actions that the City could undertake throughout the City as new or redevelopment proposals come in. These include:

- Protect existing native vegetation along the shore and bluff face.
- Protect and preserve functioning feeder bluffs.
- Protect existing LWD and drift log accumulations on the beach.
- Severely limit the circumstance where new bulkheads could be created in areas that currently don't have any.
- Promote the use of shoreline setbacks for all new construction
- Removing shoreline armoring where ever possible, especially in areas that were historically feeder bluffs. If shoreline armoring needs to be replaced, consider requiring that soft-shore armoring options be exhausted before allowing a standard rock revetment. If replacement rock revetment is allowed, move the revetment back so that it is located above the OHWM.
- Revegetate as much of the shoreline as possible. This is especially important in the bluff areas. There are many areas throughout the City where the vegetation at the top of the bluffs has been removed for views. There are many ways to plant and prune trees that still allow for views of Puget Sound. This could help to better stabilize bluffs, especially in areas where houses are located very close to the bluff edge or at the bottom of the bluff.
- Restore tributary stream mouths, which tend to provide wetland habitats that are extremely rare in central Puget Sound.
- Restore coastal wetland areas whenever opportunities arise.
- Remove abandoned human made structures (i.e., failing docks, creosote pilings, and creosote debris on the beach).
- Create an education program for shoreline landowners on the importance of the nearshore environment and on safety related to the various hazards that come with living on the shore.

The reach specific restoration/protection measures are described below by segment and can be found on map 40.

## Segment 1

There are no obvious parcels of land in this segment which are of high habitat quality that would be an ideal target for conservation efforts. The restoration potential in this segment is also highly constrained by the existing development pattern of houses on the beach and at the top of bluff. The entire segment of shoreline was called out in Joahnnessen et al. (2005) as the third highest restoration priority in the entire drift cell for bluff restoration. Restoration efforts in this segment need a programmatic approach to address: driving on the beach; houses that are generally not in a safe location due to be being below bluffs; houses that will likely be heavily impacted by changes in sea level; and houses that are mostly sitting on and displacing intertidal habitat.

## Segment 2

Beaconsfield is an active salmon recovery project being undertaken by the City and the Cascade Land Conservancy in the middle of this segment. The project involves purchasing approximately 1,000 feet of shoreline (27 vacant parcels) in order to undertake bulkhead removal. Most of the parcels are very skinny and have no upland access, but are bulkheaded (Figure 7). This stretch of shoreline ranked as the highest bluff restoration priority for the entire drift cell (Johannessen et al. 2005). There is a single house at the top of the bluff, which is located on a small promontory of land with steep slopes on three sides. The property owner also owns one of the shoreline properties. A feasibility study was done in 2006 (Johannessen et al. 2006) to look at how much of the bulkhead could be removed without endangering the house at the top of the bluff. This report showed that 535 feet of the bulkhead could be removed. Since then the Cascade Land Conservancy and the City have been acquiring properties in order to remove the portion of the bulkhead that was called out in the feasibility report. A follow up feasibility study will begin in 2010 to look at bulkhead removal alternatives.

This project could be expanded slightly by acquiring a combination of conservations easements and public access easements on the 2 nonvacant parcels that are between the Beaconsfield project and the City’s Marine View Park. The two parcels are generally well vegetated along the shore and they could provide the public with legal access to the recently acquired lands. This area was called out in Johannessen et al. (2005) as one of the highest priorities for protection throughout King County.

**Figure 7. Removal of the bulkheads at the toe of the slope at Beaconsfield is ideal candidates for restoration (Photograph from Coastal Geologic Services).**

At the southern most end of Segment 2, is an area that is bulkheaded and where the bulkhead does not appear to serve much of a purpose (i.e., parcels are vacant). Between 200 to 500 feet of bulkhead could potentially be removed. This location also has a small area of dune grass (~60 ft) behind the bulkhead, indicating that there is freshwater seepage coming out of the toe of slope. Creating connectivity between this small marsh and the shoreline could provide a variety of fish and wildlife benefits. The City should explore landowner willingness to remove the bulkhead or look at acquiring the properties in a similar fashion as Beaconsfield.

Just north of this location is a highly constrained stream mouth, which is pinched between two houses (Figure 8). If this stream mouth were restored, the location has the potential to provide excellent salmonid rearing habitat (Johannessen et al. 2005). However, this restoration would likely require removing at least one of the houses, if not both.

**Figure 8. The unnamed stream is currently high constrained at the mouth by two houses (Photograph from Coastal Geologic Services).**

## Segment 3

In this segment there is one main restoration option and one area that could be protected. There is a parcel that is close to 9 acres in size that has about 300 feet of the densely forested shoreline. This type of habitat gets rarer the further north you go in the City. The restoration action would be to restore the existing freshwater wetland to a salt marsh (Figure 9). This would entail creating some form of bridge or culvert under the private road, at a minimum. A more comprehensive restoration approach would be to remove much of the private road that is currently circling the wetland as it appears to be mostly superfluous since there is a second loop road around the upland portions of the wetland that connects the developed portions of the property. This could restore tidal inundation to what appears to be a mostly isolated three acre wetland.


**Figure 9. The area for potential preservation is the forested area in the left of the photograph. The potential restoration project is located along the right side of the photograph**

**(Photograph from WADOE).**

## *Segment 4*

As noted above there is one bulkhead in this reach that is located much farther out in the intertidal than the others. When this bulkhead needs to be repaired, the bulkhead could either be removed entirely or moved back above the OHWM, allowing for more access to the upper beach to forage fish and other aquatic species.

While the bluff vegetation along the water is mostly trees, there is definitely need for more trees along the bluff, especially along the top of the bluff. There could be a vegetation enhancement project along this entire segment that would be both ecologically beneficial and would likely benefit slope stability.

## *Segment 5*

The only obvious conservation action in this reach would be to preserve the existing vegetation on the four parcels that still have trees.

The mouth of Normandy Creek could be enhanced or partially restored. The creek could be daylighted between existing houses or routed through some of the lawns. It is not obvious how best to enhance this creek mouth within the given constraints of existing houses, but a significant amount of habitat was lost due to residential development. More effort should be undertaken to better understand how this system is currently piped into Puget Sound and if there are opportunities to change it.

Potentially related to restoring the mouth of Normandy Creek, the large groin noted above could be removed as part of shoreline redevelopment (Figure 10). This would allow sediment transport to be restored.

**Figure 10. The groin in the foreground could be removed to improve sediment transport processes.**

There are various aspects to the area around the mouth of Miller and Walker Creeks that could be restored or enhanced.

- The helipad, bridge, and the shoreline armoring surrounding the spit could be removed (see Figure 11)
- Work with the private residence on the right bank of Miller/Walker Creek to remove the overwater platform.
- The two acre area of historic wetland that is currently managed as lawn could have the grass removed and be revegetated with native wetland plants.
- The created pond near the outlet of Walker Creek could have the outlet dam removed so that water levels in the pond feature fluctuate naturally.
- Remove the road and boat ramp at the base of the spit.
- Look at ways to increase salt water inundation to the area behind the beach berm.

**Figure 11. Photograph shows the outlet of Miller and Walker Creeks. Note the bridge over the creek, riprap along both sides of spit and helicopter platform on spit.**

### *Segment 6*

There are few discreet restoration opportunities in this segment. The only obvious restoration opportunity would be to acquire the one house that is located on the beach and remove the structure, restoring the upper intertidal habitat.

# DATA GAPS

The following data gaps were identified in the process of compiling the information in the report:

1. Water quality data for the marine shorelines is limited to one area in the northern part of the City.
2. Data on the both the historic and current extent of wetlands within the City limits is not very extensive.
3. Most of the older mapping indicating the 100 year floodplain is very out of date and not very accurate. New mapping of the coastal floodplain/inundation areas needs to occur.
4. Information on potential public access points is lacking.
5. Flow patterns for surface water routes and general drainage patterns in the southern half of the City.
6. Data on the historic and current distribution of eelgrass and kelp.
7. Forage fish spawning beach data was collected infrequently in the past. More comprehensive surveys need to occur.

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# GLOSSARY

**Accretion shoreforms –**

Areas of the marine shoreline where sediment is deposited either currently or has done so in the past. These areas generally have broad backshores, large accumulations of drift logs, and marsh or dune grass vegetation communities. They are frequently part of a lagoon/spit complex, and are also frequently found at stream mouths along the marine shorelines.

**Armoring**

Refers to any structure that is placed along the shoreline that is intended to halt erosion or lateral movement of the shoreline. Seawalls, bulkheads, and revetments are typical forms of shoreline armoring.

**Critical Areas Ordinance or CAO**

Critical areas include aquatic areas, wetlands, wildlife habitat, geologic hazard areas, flood hazard areas, and critical aquifer recharge areas. The City of Normandy Park's Critical Areas Ordinance (NPMC Chapter 18.36) is authorized under the WA Growth Management Act and is intended to protect public safety and the existing functions and values of critical areas.

**Drift cell (also known as Littoral Cell)**

An independent reach of shoreline, along which littoral movements of sediment occurs depending on wave energy and currents. Each drift cell typically includes one or more sources of sediment, such as a feeder bluff, that introduces sediment onto a beach, and one or more accretion areas; an example of an accretion area is a sand spit where the drifted sediment material is deposited.

**Ecosystem-wide processes**

The suite of naturally occurring physical, biological, chemical and geologic processes that shape landforms within a specific shoreline ecosystem and determine both the types of habitat present and the associated ecological functions.

**Feeder bluff (also known as sea cliffs and coastal bluffs)**

Is a bluff along the marine shoreline that is actively contributing, or feeding, sediment to marine beaches. Bluff sediment is the primary source of beach sediment in Puget Sound.

**Impervious surface**

A hard surface which either prevents or retards the entry of water into the soil which causes water to run off the surface in greater quantities or at an increased rate of flow

**Groin**

A wall that is typically built perpendicular to shore with the intended purpose of intercepting littoral drift. The updrift side of the groin builds up sediment while the downdrift side can be starved of sediment.

**Ordinary High Water Mark or OHWM**

RCW 90.58.030(2)(b): "Ordinary high water mark" on all lakes, streams, and tidal water is that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department: PROVIDED, That in any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining salt water shall be the line of mean higher high tide and the ordinary high water mark adjoining fresh water shall be the line of mean high water.

**Restoration**

The reestablishment or upgrading of impaired ecological shoreline processes or functions. This may be accomplished through measures including but not limited to revegetation, 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.

**Shorelands or shoreland areas**

For tidal waters and lakes, shorelands are "those lands which extend landward two hundred feet as measured on a horizontal plane from the ordinary high water mark." Wetlands "which are in proximity to and either influence or are influenced by the tidal water" and "which are in proximity to and either influence or are influenced by the lake" are also shorelands. (See WAC 173-22-040.)

**Shorelines of Statewide Significance**

The following shorelines of the state:

1. Those areas of Puget Sound and adjacent salt waters and the Strait of Juan de Fuca between the ordinary high water mark and the line of extreme low tide as follows: (A) Nisqually Delta – from DeWolf Bight to Tatsolo Point, (B) Birch Bay – from Point Whitehorn to Birch Point, (C) Hood Canal – from Tala Point to Foulweather Bluff, (D) Skagit Bay and adjacent area – from Brown Point to Yokeko Point, and (E) Padilla Bay – from March Point to William Point;
2. Those areas of Puget Sound and the Strait of Juan de Fuca and adjacent salt waters north to the Canadian line and lying seaward from the line of extreme low tide;
3. Those lakes, whether natural, artificial, or a combination thereof, with a surface acreage of one thousand acres or more measured at the ordinary high water mark;
4. Those natural rivers or segments thereof as follows: (A) Any west of the crest of the Cascade range downstream of a point where the mean annual flow is measured at one thousand cubic feet per second or more, (B) Any east of the crest of the Cascade range downstream of a point where the annual flow is measured at two hundred cubic feet per second or more, or those portions of rivers east of the crest of the Cascade range downstream from the first three hundred square miles of drainage area, whichever is longer;
5. Those shorelands associated with the water bodies above.

**Shorelines, Shoreline jurisdiction, or Shorelines of the State**

Shorelines of the state are shorelines along:

- All marine waters.
- Rivers and streams with more than 20 cubic feet per second mean annual flow
- Lakes and reservoirs greater than 20 acres in area.
- Associated wetlands.
- Shorelands adjacent to these water bodies.

**Shoreline Master Program**

Means the cumulative total of all shoreline master program and amendments thereto approved or adopted by rule by the Washington Department of Ecology.

**Shoreline Master Program Guidelines**

The Shoreline Management Act gives the Washington Department of Ecology authority to adopt Shoreline Master Program Guidelines (WAC 173-26; Guidelines) that local governments must follow when adopting and updating their Shoreline Master Programs. Ecology substantially updated the Guidelines in 2003.

**Shoreline Uses**

The Shoreline Master Program Guidelines define shoreline uses as follows:

*Water dependent*

A use or portion of a use which cannot exist in a location that is not adjacent to the water but is dependent on the water by reason of the intrinsic nature of its operations. Examples of water dependent uses include ship cargo terminal loading areas, fishing, ferry and passenger terminals, barge loading facilities, ship building and dry docking, marinas, aquaculture, float plane facilities, surface water intake, and sewer outfalls.

*Water related*
A use or portion of a use which is not intrinsically dependent on a waterfront location but whose economic viability is dependent upon or substantially benefited by a shoreline location because: (a) the use has a functional requirement for a shoreline location such as the arrival or shipment of materials by water or the need for large quantities of water; or (b) the use provides a necessary service supportive of the water-dependent uses and the proximity of the use to its customers makes its services less expensive and/or more convenient. Water-related uses include manufacturing of ship parts large enough that transportation becomes a significant factor in the product's cost, professional services serving primarily water dependent uses, and storage of water-transported foods. Other examples of water-related uses include the warehousing of goods transported by water, seafood processing plants, hydroelectric generating plants, gravel storage when transported by barge, oil refineries where transport is by tanker, and upland log storage for water-borne transportation.

*Water enjoyment*
A recreational use or other use that facilitates public access to the shoreline as a primary characteristic of the use; or a use that provides for recreational use or aesthetic enjoyment of the shoreline for a substantial number of people as a general characteristic of the use and which through location, design, and operation ensures the public's ability to enjoy the physical and aesthetic qualities of the shoreline. In order to qualify as a water-enjoyment use, the use must be available to the general public and the shoreline-oriented space within the project must be devoted to the specific aspects of the use that fosters shoreline enjoyment. Primary water enjoyment uses may include, but are not limited to: Parks with activities enhanced by proximity to the water; Piers and other over water improvements that include substantial public access to shorelines of the state; Restaurants that directly incorporate visual access to and enjoyment of the water; Museums with an orientation to shoreline topics; Aquariums; and Resorts that directly incorporate access to and enjoyment of the water.

*Water-oriented*
A use that is water-dependent, water-related, or water-enjoyment, or a combination of such uses.

*Non-water-oriented*
Those uses that are not water-dependent, water-related, or water-enjoyment.

### Wetlands

Areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

### Water Resource Inventory Area or WRIA

Water Resource Inventory Areas were formalized under Washington Administrative Code (WAC) 173-500-040 and authorized under the Water Resources Act of 1971, Revised Code of Washington (RCW) 90.54.  The WRIA boundaries were used in Washington to develop recovery plans for salmonids listed as threatened under the federal Endangered Species Act.

# ACRONYMS

| | |
|---|---|
| CAO | Critical Area Ordinance |
| cfs | Cubic feet per second |
| City | The city of Normandy Park |
| CLC | Cascade Land Conservancy |
| Ecology | Washington Department of Ecology. |
| FWHCA | Fish and Wildlife Habitat conservation Areas |
| GIS | Geographic Information System |
| LWD | Large Woody Debris |
| OHWM | Ordinary High Water Mark |
| PHS | Priority Habitat and Species |
| PSNERP | Puget Sound Nearshore Ecosystem Restoration Project |
| RCW | Revised Code of Washington |
| SMA | Shoreline Management Act |
| SMP | Shoreline Master Program |
| WAC | Washington Administrative Code |
| WADNR | Washington Department of Natural Resources |
| WDFW | Washington Department of Fish and Wildlife |
| WRIA | Watershed Resource Inventory Area |

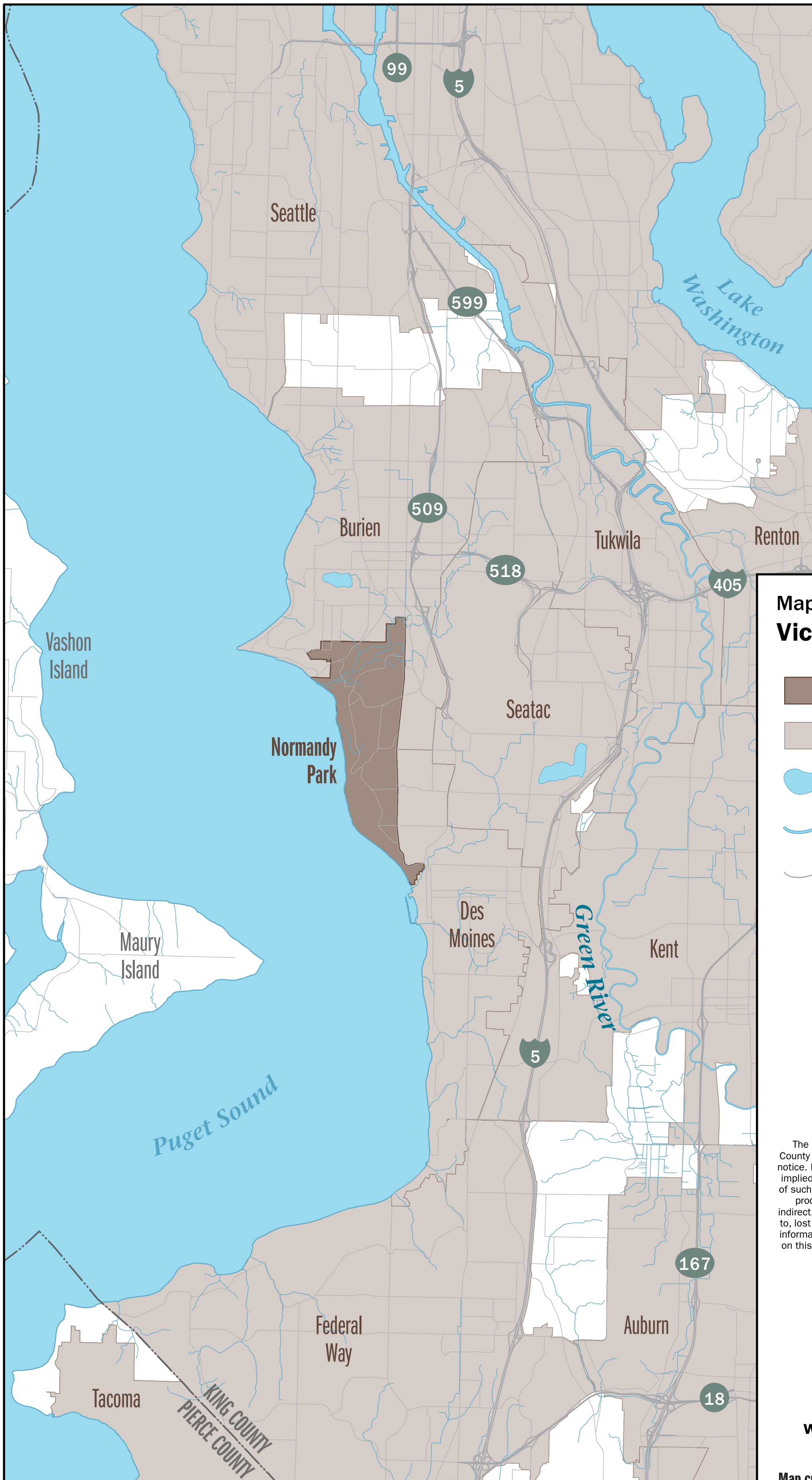
# APPENDIX 1 MAPS

Maps 1-40 are a separate attachment.

# APPENDIX 2. DATA SOURCES TABLE

Data sources table is a separate attachment.

# Normandy Park Shoreline Characterization Report




Map 1
**Vicinity Map**

**City of Normandy Park**
**Other Cities**
**Lake/Puget Sound**
**River/Stream**
**Major Road**

N

0 1 2 Miles

September 2010

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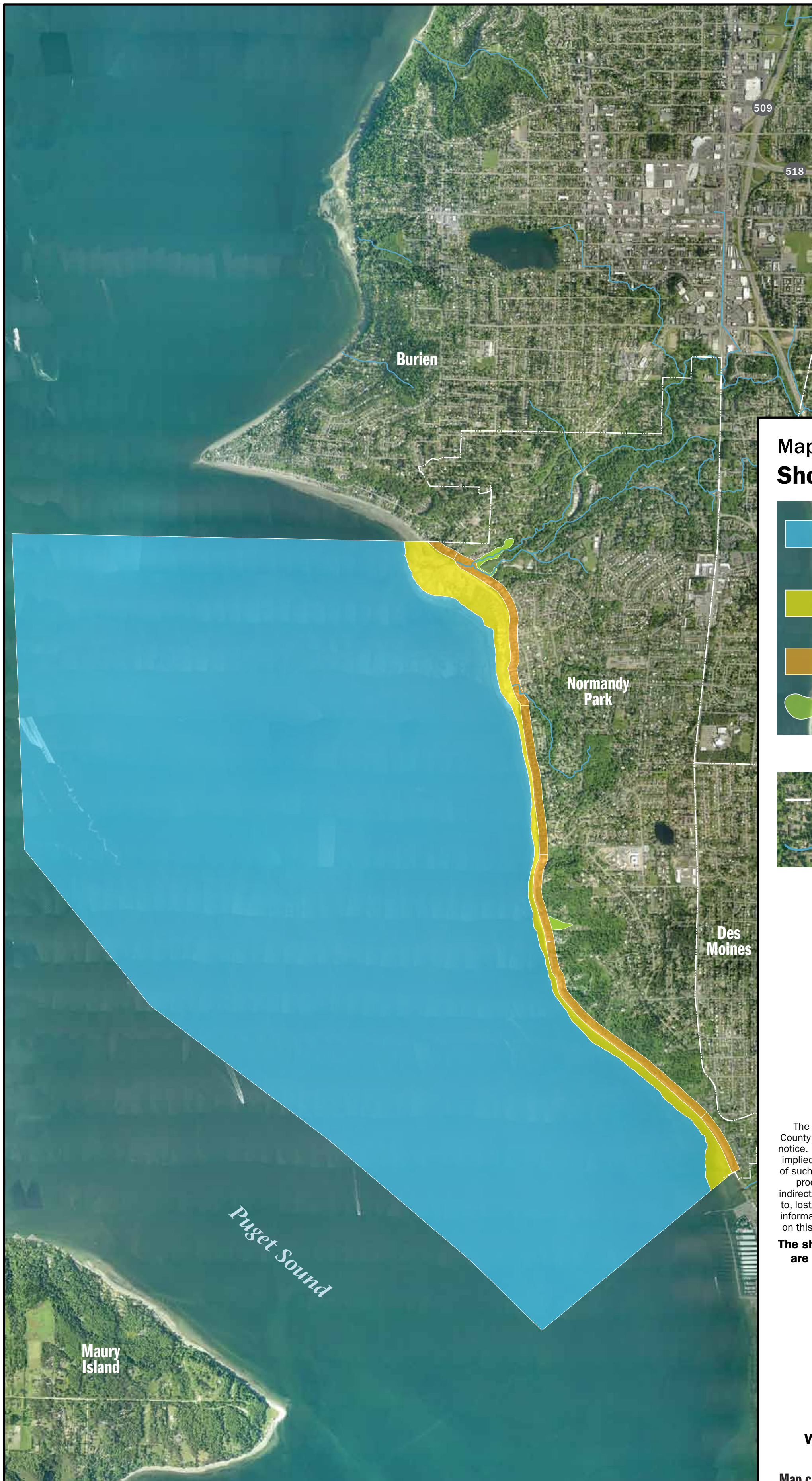
**Data** King County Datasets
**File** 1009npshr1_locator.ai wgab

# Normandy Park Shoreline Characterization Report




Map 2

## Shoreline Jurisdiction

Shoreline of Statewide Significance

Aquatic Shoreline Areas

Shoreland

Associated Wetland

City Boundary

Stream

N

0 1/2 1 Mile

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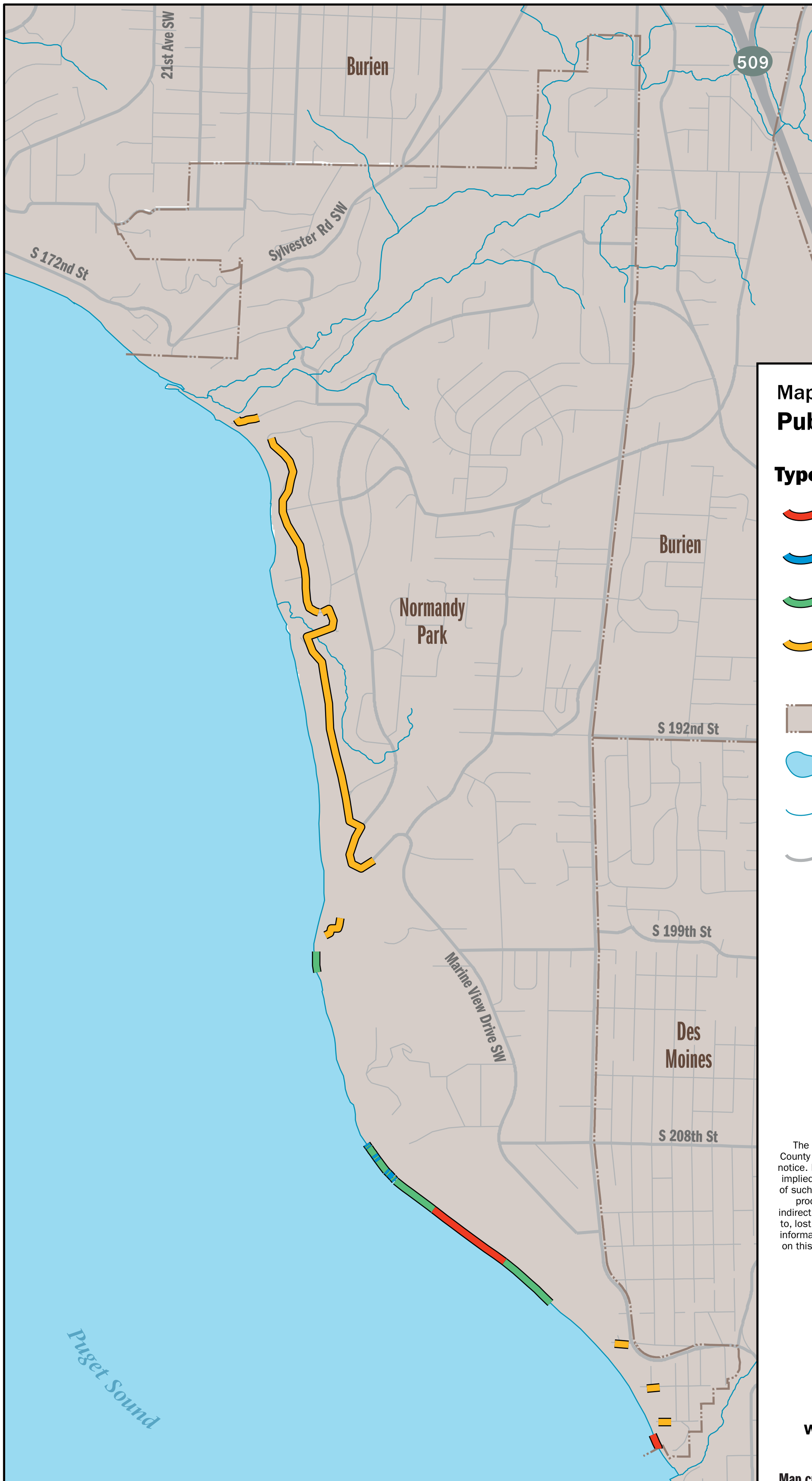
**File** 1009npshr2_shoreline.ai wgab

# Normandy Park Shoreline Characterization Report




Map 3
**Public Access**

**Type of Public Access**

- Physical – Upland
- Physical – Water Only
- Potential
- Visual

- Incorporated Area
- Puget Sound/Lake
- Stream
- Major Road

N

0 1/4 1/2 Miles

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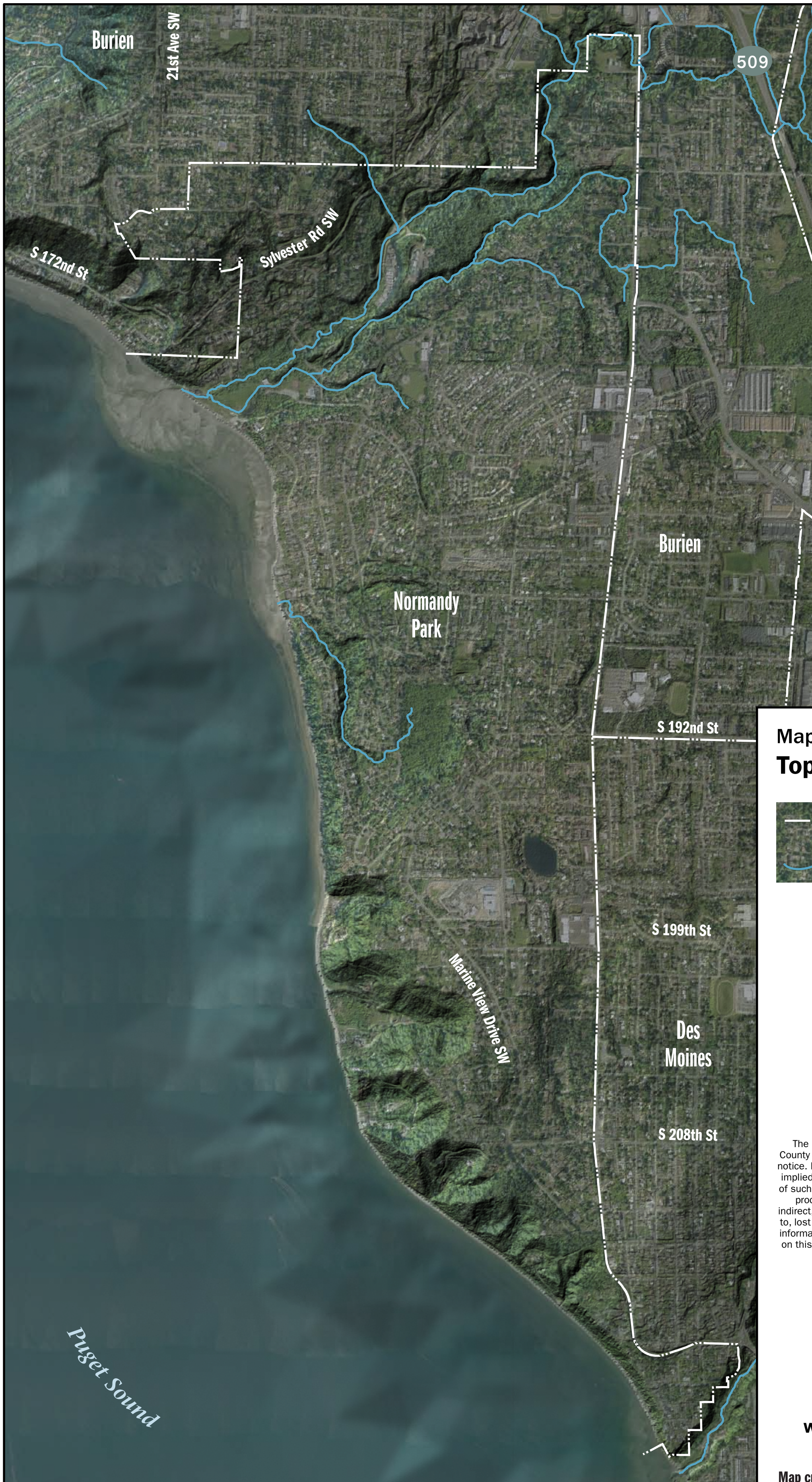
**File** 1009npshr3_pubaccess.ai wgab

# Normandy Park Shoreline Characterization Report




Map 4

## Topography

City Boundary

Stream

N

0 1/4 1/2 Miles

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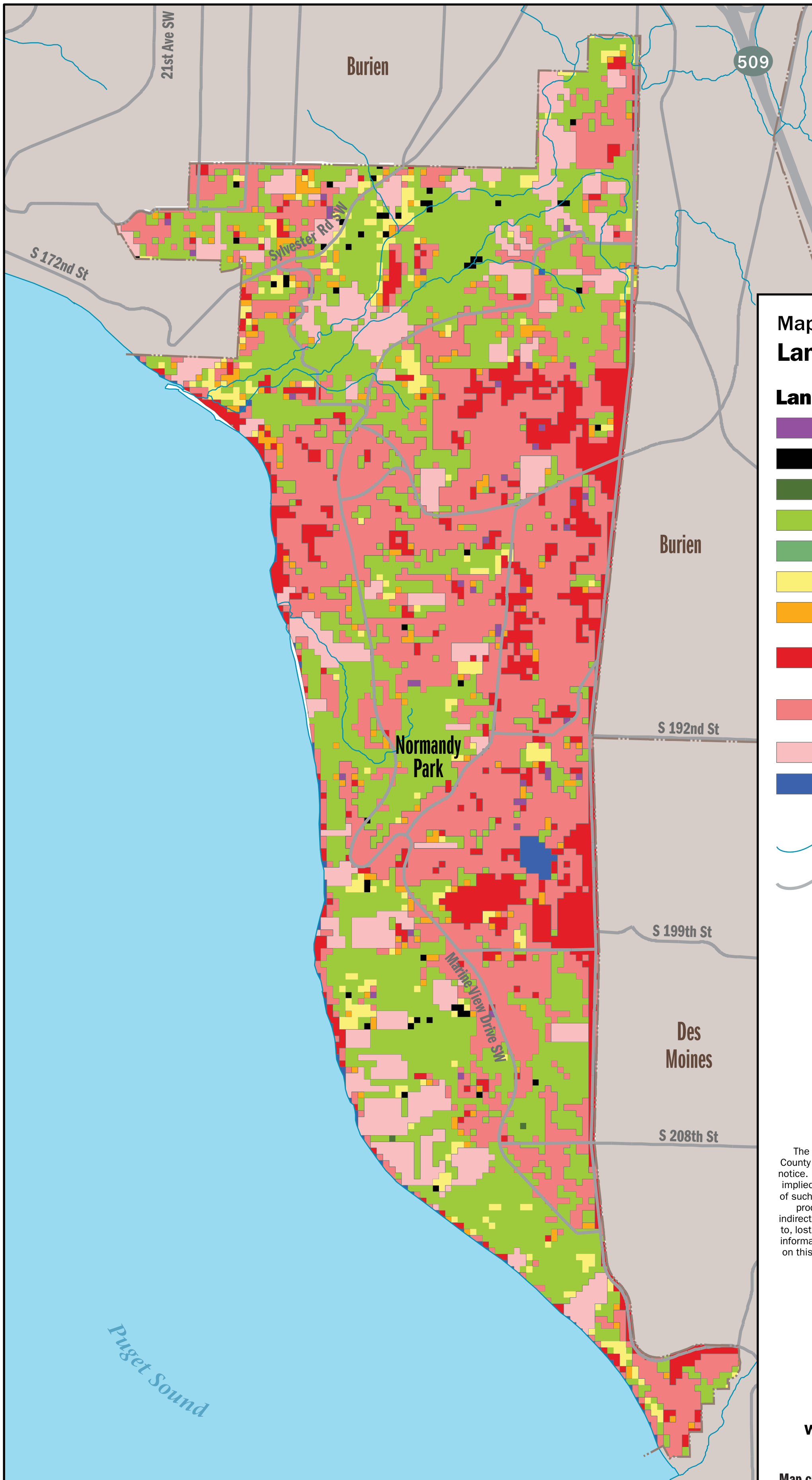
**Data** King County Datasets

**File** 1009npshr4_topography.ai wgab

# Normandy Park Shoreline Characterization Report




Map 5

## Land Cover

**Land Cover Categories**

- Bare Rock/Snow/Ice
- Cultivated
- Coniferous
- Deciduous/Mixed
- Immature Conifer
- Herbaceous
- Scrub-Shrub
- High Intensity Development
- Medium Intensity Development
- Low Density Development
- Water

- Stream
- Major Road

N

0 1/4 1/2 Miles

September 2010



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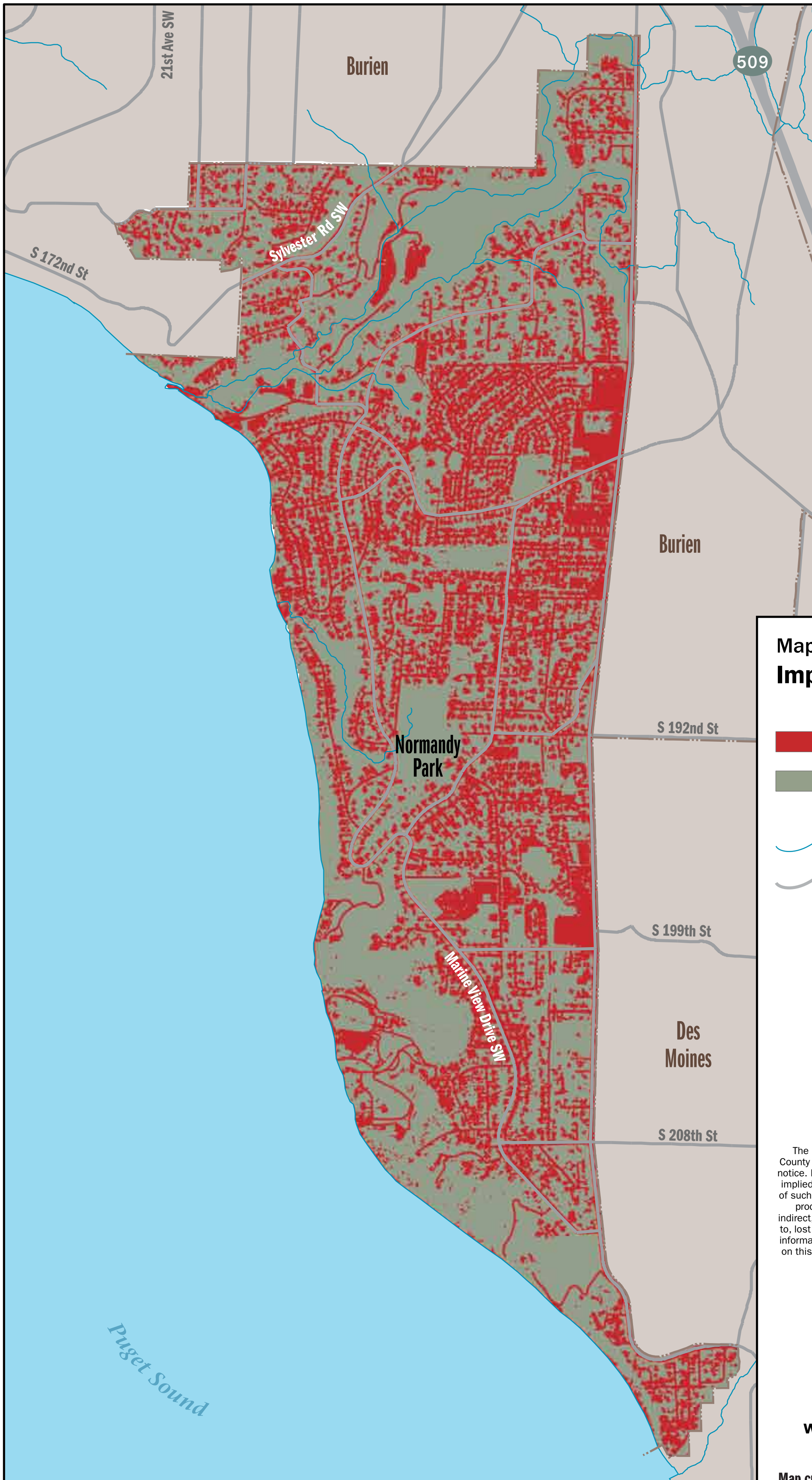
**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets

**File** 1009npshr5_landcover.ai wgab

# Normandy Park Shoreline Characterization Report




Map 6

**Impervious Surface**

- Impervious Surface
- Pervious Surface
- Stream
- Major Road

N

0 1/4 1/2 Miles

September 2010



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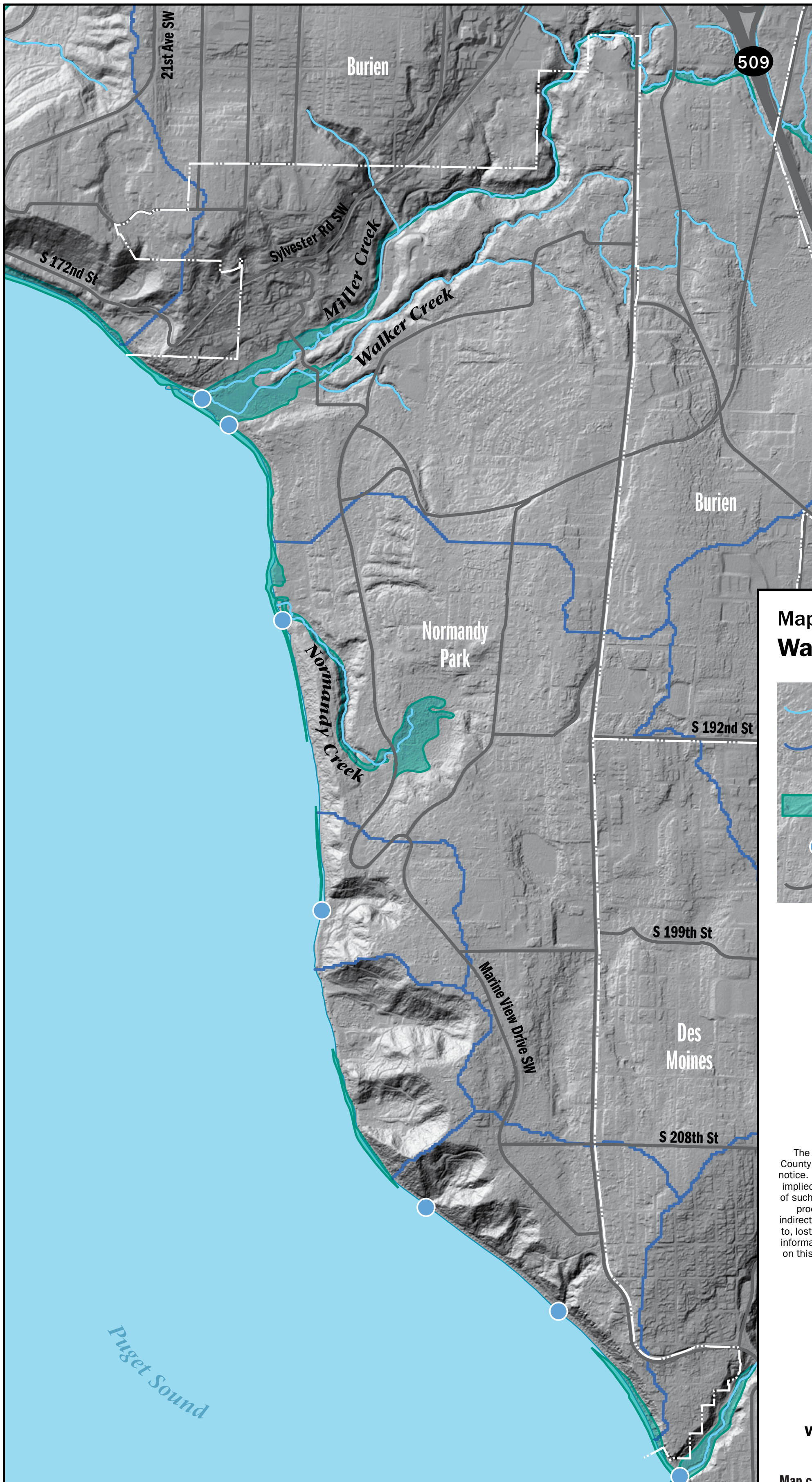
**Map created by** DNRP GIS/Visual Communications/Web Unit
**Data** King County Datasets
**File** 1009npshr6_impsurface.ai wgab

# Normandy Park Shoreline Characterization Report




Map 7

## Water Features

- Stream
- Catchment Boundary
- Floodplain
- Stream Mouth
- Major Road

N

0 1/4 1/2 Miles

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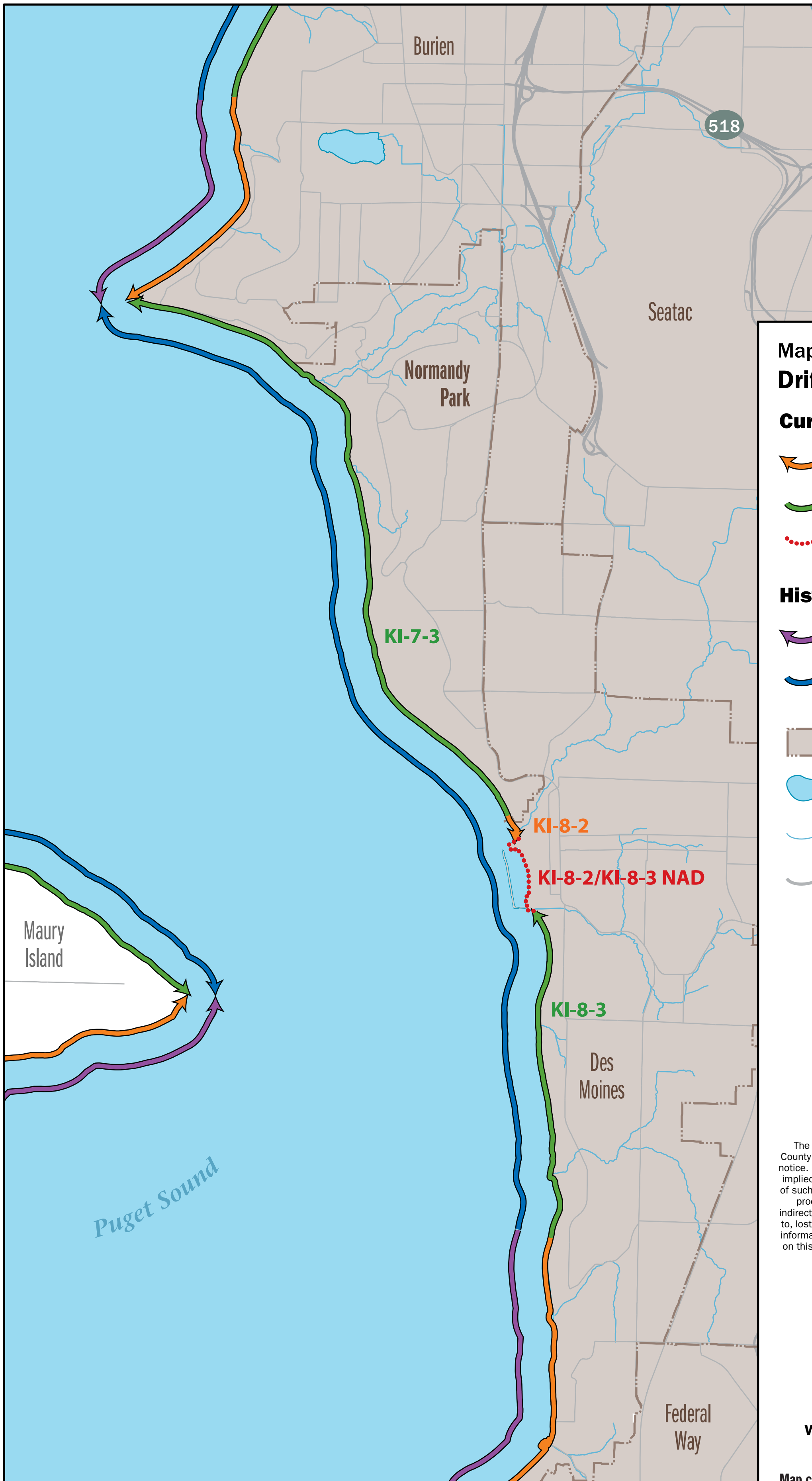
**Data** King County Datasets
**File** 1009npshr7_wtrfeat.ai wgab

# Normandy Park Shoreline Characterization Report




Map 8

## Drift Cells

**Current Drift Cell Results**

- Left to Right
- Right to Left
- No Available Drift (NAD)

**Historical Drift Cells**

- Left to Right
- Right to Left

- Incorporated Area
- Puget Sound/Lake
- Stream
- Major Road

N

0 1/2 1 Mile

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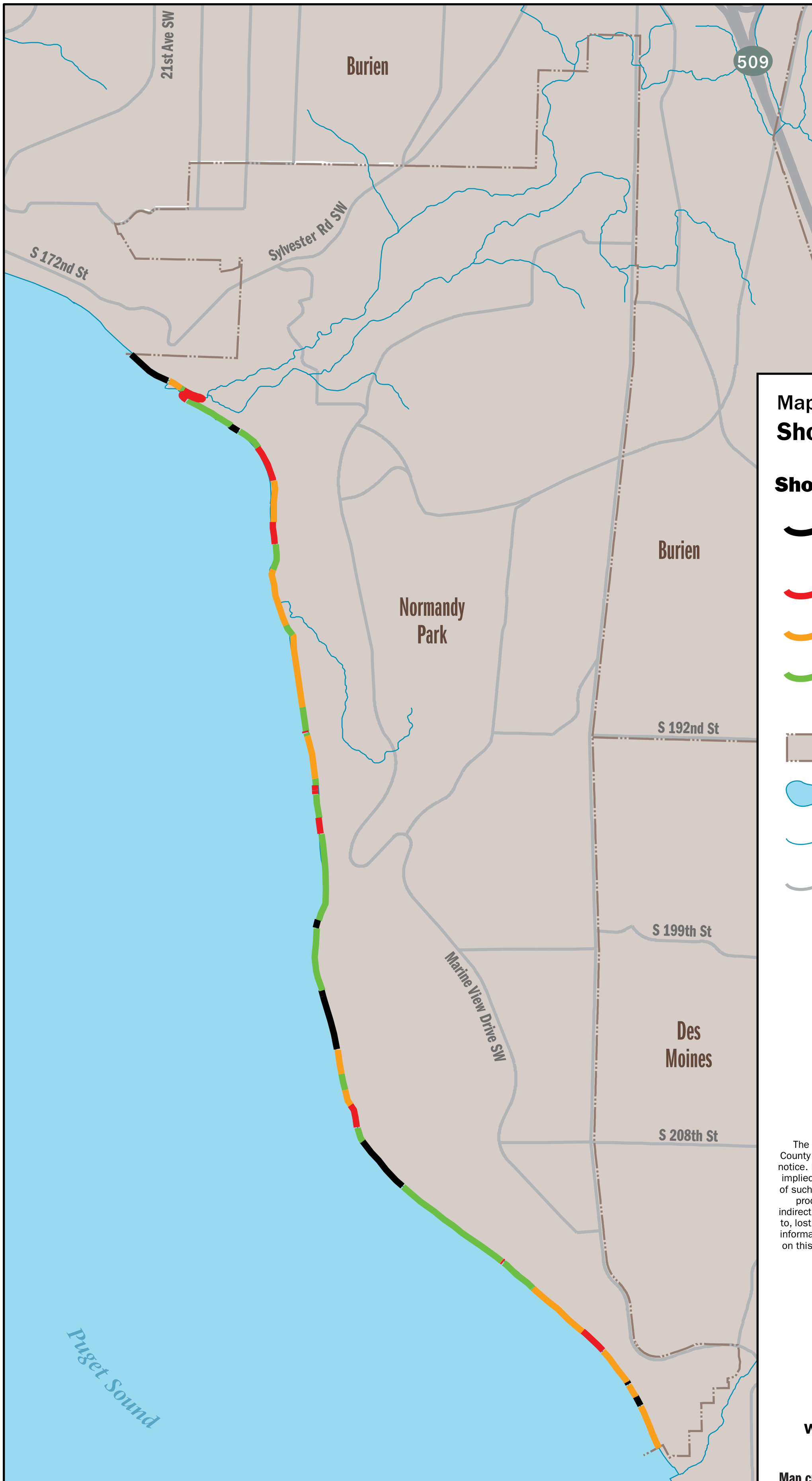
**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets

**File** 1009npshr8_driftcell.ai wgab

# Normandy Park Shoreline Characterization Report




Map 9

## Shoreline Armoring

**Shoreline Armoring**

- Armor Above Ordinary High Water (OHW)
- Armor at OHW
- Armor Below OHW
- No Armor
- Incorporated Area
- Puget Sound/Lake
- Stream
- Major Road

N

0 1/4 1/2 Miles

September 2010



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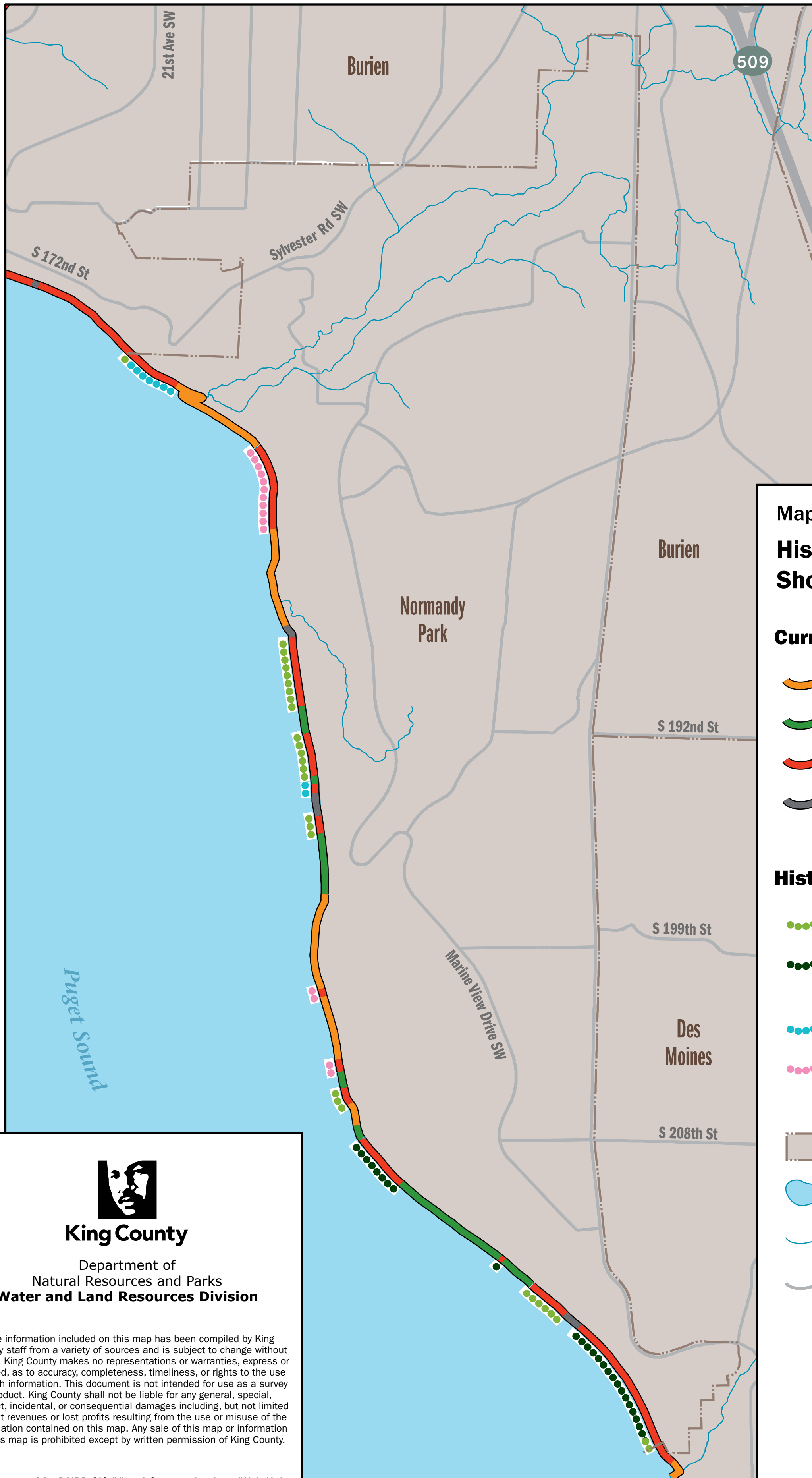
**Map created by** DNRP GIS/Visual Communications/Web Unit
**Data** King County Datasets
**File** 1009npshr9_armoring.ai wgab

# Normandy Park Shoreline Characterization Report




Map 10

## Historic and Current Shoretype

### Current Shoretype (Along Shore)

- Accretion Shoretype
- Feeder Bluff
- Modified/Armored
- Transport Zone

### Historic Shoretype (Offset)

- Feeder Bluff
- Feeder Bluff Exceptional
- Potential Feeder Bluff
- Not Feeder Bluff

- Incorporated Area
- Puget Sound/Lake
- Stream
- Major Road

N

0 1/4 1/2 Miles

September 2010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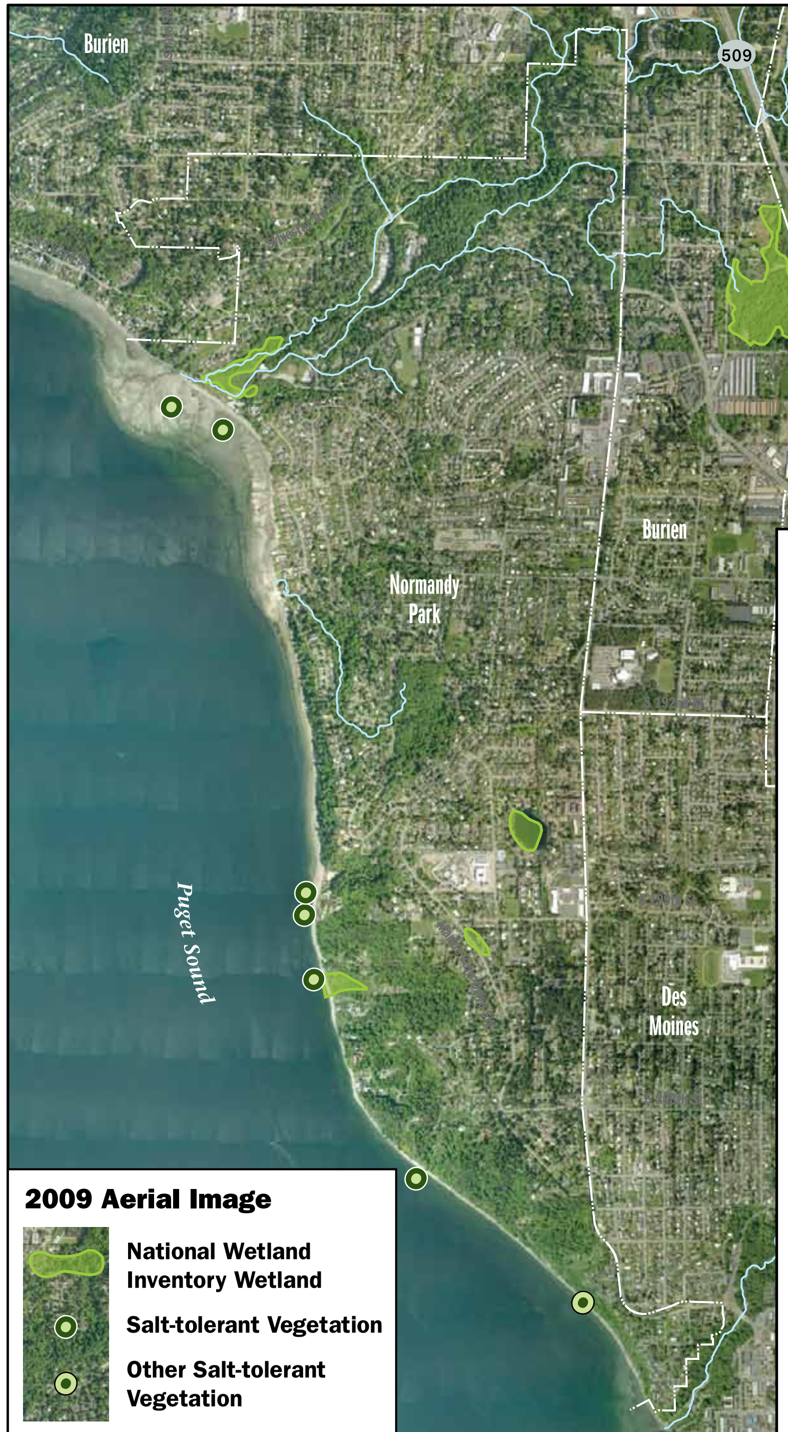
**Map created by** DNRP GIS/Visual Communications/Web Unit
**Data** King County Datasets
**File** 1009npshr10_shoretype.ai wgab

# Normandy Park Shoreline Characterization Report


Map 11

**Historic and Current Wetlands**

N

0 1/4 1/2 Mile

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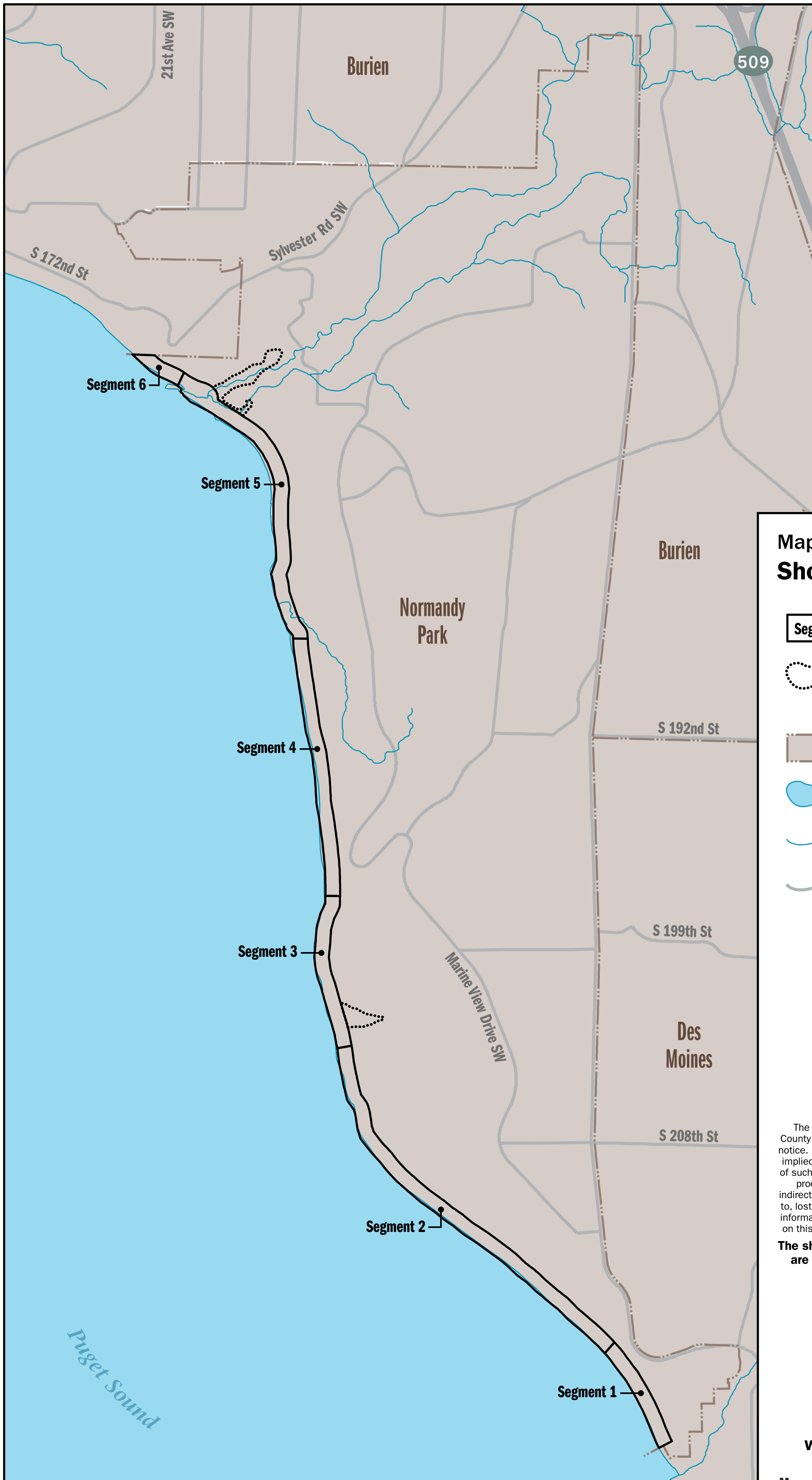
**Map created by** DNRP GIS/
Visual Communications/Web Unit
**Data** King County Datasets
**File** 1009npshr11_wetlands.ai wgab

# Normandy Park Shoreline Characterization Report




Map 12
**Shoreline Segments**

Segment 1 **Segment and Number**

**Associated Wetland**

**Incorporated Area**

**Puget Sound/Lake**

**Stream**

**Major Road**

N

0 1/4 1/2 Miles

September 2010



**The shoreline jurisdiction boundaries shown on this map are only an approximation. The Ordinary High Water Mark has not been precisely mapped.**

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**Map created by** DNRP GIS/Visual Communications/Web Unit
**Data** King County Datasets
**File** 1009npshr12_segments.ai wgab

# Normandy Park Shoreline Characterization Report


Map 13

## Segment 1

- Segment 1
- Associated Wetland
- Single Family Residential Parcel
- Vacant Parcel
- Undivided Interest Parcel
- Park
- Incorporated Area Boundary
- Stream

**Public Access**

- Known Upland
- Known Water Only
- Potential

N

0 200 400 Feet

September 2010



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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets

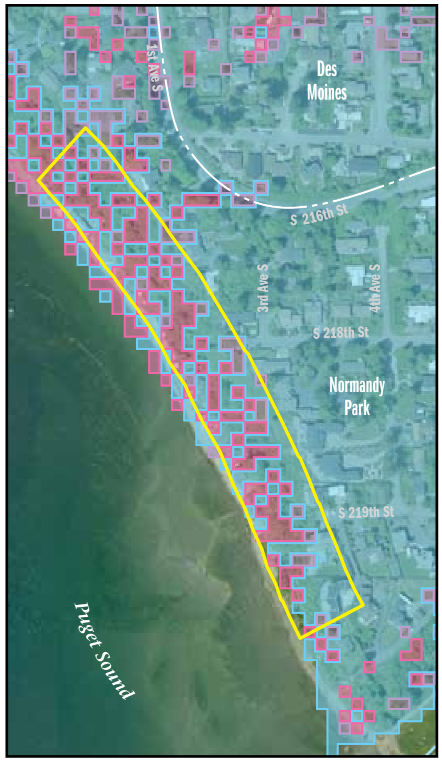
**File** 1009npshr13_seg1.ai wgab

# Normandy Park Shoreline Characterization Report

Maps 14a-d

## Segment 1 Geologic Features


14a. Liquifaction Susceptibilty




14b. Landslide Hazards


14c. Slopes 25% and Greater


14d. Erosion Hazards

**14a. Liquifaction Susceptibilty**

- Moderate to High
- Low to Moderate
- Very Low

**14b. Landslide Hazards**

Potential for Rapid Shallow Landslides

- High
- Moderate
- Low
- Landslides Mapped in 2005

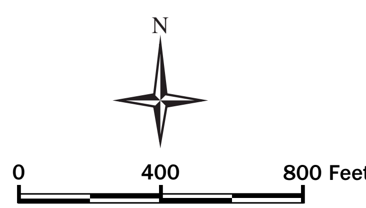
**14c. Slopes 25% and Greater**

- Slopes ≥ 25%

**14d. Erosion Hazards**

- Erosion Hazard Areas

- Segment
- Associated Wetland
- Incorporated Area Boundary
- Stream




September 2010



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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Liquefaction – WADNR 2004; Landslides – Johannessen et al 2005; Predictive Shallow-Rapid Slope Stability – WADNR 2000; Erosion Hazards – King County 1990; 25% Slopes or greater – unpublished KC data, created 2010

**File** 1009npshr14_seg1geol.ai wgab

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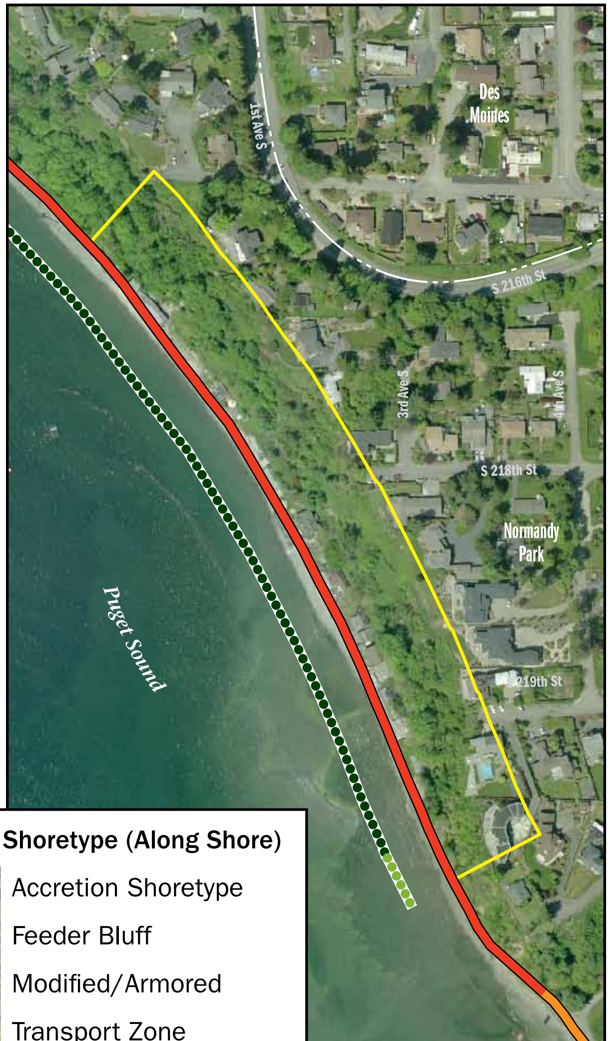
# Normandy Park Shoreline Characterization Report

Maps 15a-b

**Segment 1**
**Coastal Features**

Segment
Associated Wetland
Incorporated Area Boundary
Stream




**Current Shoretype (Along Shore)**
- Accretion Shoretype
- Feeder Bluff
- Modified/Armored
- Transport Zone

**Historic Shoretype (Offset)**
- Feeder Bluff
- Feeder Bluff Exceptional
- Potential Feeder Bluff
- Not Feeder Bluff

**15a. Current and Historic Shoretype**


**Shoreline Armoring**
- Armor Above Ordinary High Water (OHW)
- Armor at OHW
- Armor Below OHW
- Groin
- Dock
- Ramp

**15b. Coastal Features**

N

0 200 400 Feet

September 2010

**Map created by** DNRP GIS/ Visual Communications/Web Unit

**Data** King County Datasets; Current Shoretypes and Historic Shoretypes (Johannessen et al 2005);Groins (Anchor Environmental 2004);Boat Ramps (Anchor Environmental 2004); Overwater Structures (Anchor Environmental 2004); Shoreline Armoring (Johannessen et al 2005); Shoreline Armoring At, above or below OHWM (Anchor Environmental 2006)

**File** 1009npshr15_seg1coast.ai wgab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**Water and Land Resources Division**




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# Normandy Park Shoreline Characterization Report


16a. Forage Fish Spawning Areas


16b. Eelgrass Distribution


16c. Riparian Vegetation


16d. Drift Log/Large Woody Debris

Maps 16a-d

## Segment 1 Biological Features

**16a. Forage Fish Spawning Areas**

**Spawning Habitat**

Pacific Sand Lance
Surf Smelt
Forage Fish Survey Location

**16b. Eelgrass Distribution**

Continuous
Patchy

**16c. Riparian Vegetation**

**Trees**

Dense Overhanging
Patchy Overhanging
Dense Not Overhanging
Patchy Not Overhanging
Grass

**16d. Drift Log/Large Woody Debris**

Drift Log Accumulations
Large Woody Debris

Segment
Associated Wetland
Incorporated Area Boundary
Stream

N

0 400 800 Feet

September 2010



**The shoreline jurisdiction boundaries shown on this map are only an approximation. The Ordinary High Water Mark has not been precisely mapped.**

**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Forage Fish Spawning Surveys-WDFW 2010; Eelgrass and Kelp-WADNR: Shorezone 2001; Marine Riparian Vegetation–Anchor 2004; Drift Log/LWD–Anchor 2004

**File** 1009npshr16_seg1biol.ai wgab

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# Normandy Park Shoreline Characterization Report


Map 17
**Segment 2**

- Segment 2
- Associated Wetland
- Single Family Residential Parcel
- Vacant Parcel
- Undivided Interest Parcel
- Park
- Incorporated Area Boundary
- Stream

**Public Access**

- Known Upland
- Known Water Only
- Potential

N

0 400 800 Feet

September 2010



**The shoreline jurisdiction boundaries shown on this map are only an approximation. The Ordinary High Water Mark has not been precisely mapped.**

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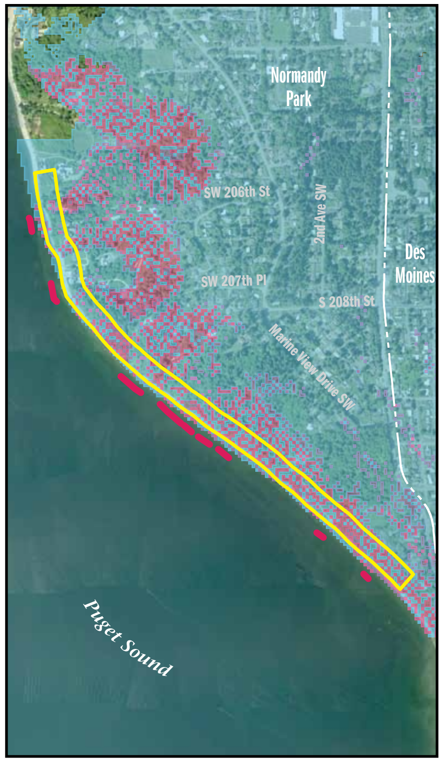
**Map created by** DNRP GIS/Visual Communications/Web Unit
**Data** King County Datasets
**File** 1009npshr17_seg2.ai wgab

# Normandy Park Shoreline Characterization Report

**Maps 18a-d**

## Segment 2 Geologic Features


**18a. Liquifaction Susceptibilty**




**18b. Landslide Hazards**


**18c. Slopes 25% and Greater**


**18d. Erosion Hazards**

**18a. Liquifaction Susceptibilty**

- Moderate to High
- Low to Moderate
- Very Low

**18b. Landslide Hazards**

Potential for Rapid Shallow Landslides

- High
- Moderate
- Low
- Landslides Mapped in 2005

**18c. Slopes 25% and Greater**

- Slopes ≥ 25%

**18d. Erosion Hazards**

- Erosion Hazard Areas

- Segment
- Associated Wetland
- Incorporated Area Boundary
- Stream

N

0 800 1600 Feet

September 2010



**The shoreline jurisdiction boundaries shown on this map are only an approximation. The Ordinary High Water Mark has not been precisely mapped.**


**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Liquefaction – WADNR 2004; Landslides – Johannessen et al 2005; Predictive Shallow-Rapid Slope Stability – WADNR 2000; Erosion Hazards – King County 1990; 25% Slopes or greater – unpublished KC data, created 2010

**File** 1009npshr18_seg2geol.ai wgab



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# Normandy Park Shoreline Characterization Report

Maps 19a-b

**Segment 2**
**Coastal Features**


**Current Shoretype (Along Shore)**

- Accretion Shoretype
- Feeder Bluff
- Modified/Armored
- Transport Zone

**Historic Shoretype (Offset)**

- Feeder Bluff
- Feeder Bluff Exceptional
- Potential Feeder Bluff
- Not Feeder Bluff

19a. Current and Historic Shoretype


**Shoreline Armoring**

- Armor Above Ordinary High Water (OHW)
- Armor at OHW
- Armor Below OHW
- Groin
- Dock
- Ramp

19b. Coastal Features

- Segment
- Associated Wetland
- Incorporated Area Boundary
- Stream

N

0 800 1600 Feet

September 2010

**Map created by** DNRP GIS/ Visual Communications/Web Unit

**Data** King County Datasets; Current Shoretypes and Historic Shoretypes (Johannessen et al 2005);Groins (Anchor Environmental 2004);Boat Ramps (Anchor Environmental 2004); Overwater Structures (Anchor Environmental 2004); Shoreline Armoring (Johannessen et al 2005); Shoreline Armoring At, above or below OHWM (Anchor Environmental 2006)

**File** 1009npshr19_seg2coast.ai wgab

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# Normandy Park Shoreline Characterization Report


Map 20

**Segment 2**
**Hydrologic Features**

**National Wetland Inventory Wetland**

**1874 Wooded Marsh Location**

**Salt-tolerant Vegetation**

**Other Salt-tolerant Vegetation**

**Stream**

**Stream Mouth**

**Segment**

**Associated Wetland**

**Incorporated Area Boundary**

N

0 400 800 Feet

September 2010



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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Streams-King County 2009; Wetlands-National Wetlands Inventory--WDFW 2010; Marsh-Anchor 2004; Floodplain–King County 2006

**File** 1009npshr20_seg2hydro.ai wgab


21a. Forage Fish Spawning Areas


21b. Eelgrass Distribution


21c. Riparian Vegetation


21d. Drift Log/Large Woody Debris

# Normandy Park Shoreline Characterization Report

Maps 21a-d

## Segment 2 Biological Features

### 21a. Forage Fish Spawning Areas

**Spawning Habitat**

- Pacific Sand Lance
- Surf Smelt
- Forage Fish Survey Location

### 21b. Eelgrass Distribution

- Continuous
- Patchy

### 21c. Riparian Vegetation

**Trees**

- Dense Overhanging
- Patchy Overhanging
- Dense Not Overhanging
- Patchy Not Overhanging
- Grass

### 21d. Drift Log/Large Woody Debris

- Drift Log Accumulations
- Large Woody Debris

- Segment
- Associated Wetland
- Incorporated Area Boundary
- Stream

N

0 800 1600 Feet

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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Forage Fish Spawning Surveys-WDFW 2010; Eelgrass and Kelp-WADNR: Shorezone 2001; Marine Riparian Vegetation–Anchor 2004; Drift Log/LWD–Anchor 2004

**File** 1009npshr21_seg2biol.ai wgab

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# Normandy Park Shoreline Characterization Report


Map 22

## Segment 3

Segment 3

Associated Wetland

Single Family Residential Parcel

Vacant Parcel

Undivided Interest Parcel

Park

Incorporated Area Boundary

Stream

**Public Access**

Known Upland

Known Water Only

Potential

N

0 200 400 Feet

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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets

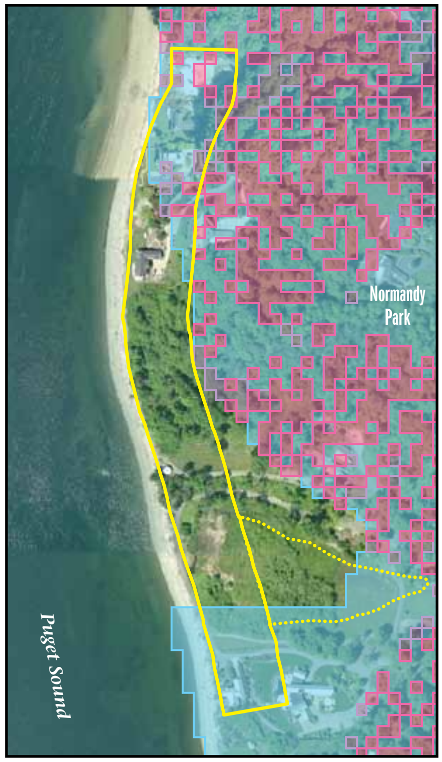
**File** 1009npshr22_seg3.ai wgab

# Normandy Park Shoreline Characterization Report

Maps 23a-d

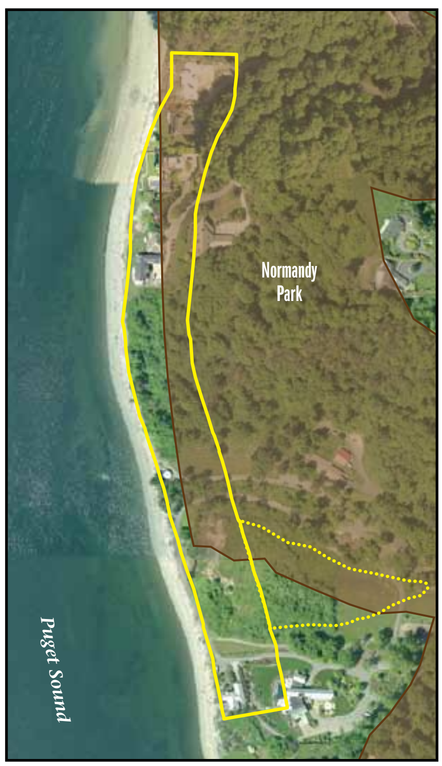
**Segment 3 Geologic Features**


23a. Liquifaction Susceptibilty




23b. Landslide Hazards


23c. Slopes 25% and Greater




23d. Erosion Hazards

**23a. Liquifaction Susceptibilty**

- Moderate to High
- Low to Moderate
- Very Low

**23b. Landslide Hazards**

Potential for Rapid Shallow Landslides

- High
- Moderate
- Low
- Landslides Mapped in 2005

**23c. Slopes 25% and Greater**

- Slopes ≥ 25%

**23d. Erosion Hazards**

- Erosion Hazard Areas

- Segment
- Associated Wetland
- Incorporated Area Boundary
- Stream

N

0 800 1600 Feet

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**Data** King County Datasets; Liquefaction – WADNR 2004; Landslides – Johannessen et al 2005; Predictive Shallow-Rapid Slope Stability – WADNR 2000; Erosion Hazards – King County 1990; 25% Slopes or greater – unpublished KC data, created 2010

**File** 1009npshr23_seg3geol.ai wgab



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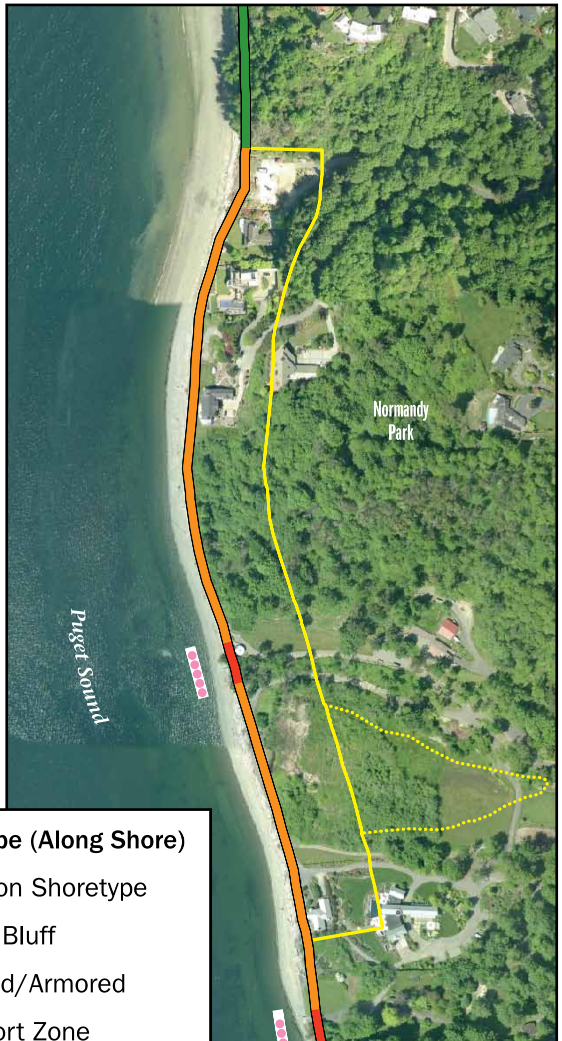
# Normandy Park Shoreline Characterization Report

Maps 24a-b

**Segment 3**
**Coastal Features**




**Current Shoretype (Along Shore)**

- Accretion Shoretype
- Feeder Bluff
- Modified/Armored
- Transport Zone

**Historic Shoretype (Offset)**

- Feeder Bluff
- Feeder Bluff Exceptional
- Potential Feeder Bluff
- Not Feeder Bluff

**24a. Current and Historic Shoretype**

**Map created by** DNRP GIS/ Visual Communications/Web Unit

**Data** King County Datasets; Current Shoretypes and Historic Shoretypes (Johannessen et al 2005);Groins (Anchor Environmental 2004);Boat Ramps (Anchor Environmental 2004); Overwater Structures (Anchor Environmental 2004); Shoreline Armoring (Johannessen et al 2005); Shoreline Armoring At, above or below OHWM (Anchor Environmental 2006)

**File** 1009npshr24_seg3coast.ai wgab


**Shoreline Armoring**

- Armor Above Ordinary High Water (OHW)
- Armor at OHW
- Armor Below OHW
- Groin
- Dock
- Ramp

**24b. Coastal Features**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- Segment
- Associated Wetland
- Incorporated Area Boundary
- Stream

N

0 200 400 Feet

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# Normandy Park Shoreline Characterization Report


Map 25

**Segment 3**
**Hydrologic Features**

**National Wetland Inventory Wetland**

**1874 Wooded Marsh Location**

**Salt-tolerant Vegetation**

**Other Salt-tolerant Vegetation**

**Stream**

**Stream Mouth**

**Segment**

**Associated Wetland**

**Incorporated Area Boundary**

N

0 200 400 Feet

September 2010



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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Streams-King County 2009; Wetlands-National Wetlands Inventory--WDFW 2010; Marsh-Anchor 2004; Floodplain–King County 2006

**File** 1009npshr25_seg3hydro.ai wgab

# Normandy Park Shoreline Characterization Report

Maps 26a-d

## Segment 3 Biological Features


26a. Forage Fish Spawning Areas


26b. Eelgrass Distribution


26c. Riparian Vegetation


26d. Drift Log/Large Woody Debris

### 26a. Forage Fish Spawning Areas

**Spawning Habitat**

- Pacific Sand Lance
- Surf Smelt
- Forage Fish Survey Location

### 26b. Eelgrass Distribution

- Continuous
- Patchy

### 26c. Riparian Vegetation

**Trees**

- Dense Overhanging
- Patchy Overhanging
- Dense Not Overhanging
- Patchy Not Overhanging
- Grass

### 26d. Drift Log/Large Woody Debris

- Drift Log Accumulations
- Large Woody Debris

- Segment
- Associated Wetland
- Incorporated Area Boundary
- Stream

N

0 800 1600 Feet

September 2010



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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Forage Fish Spawning Surveys-WDFW 2010; Eelgrass and Kelp-WADNR: Shorezone 2001; Marine Riparian Vegetation–Anchor 2004; Drift Log/LWD–Anchor 2004

**File** 1009npshr26_seg3biol.ai wgab



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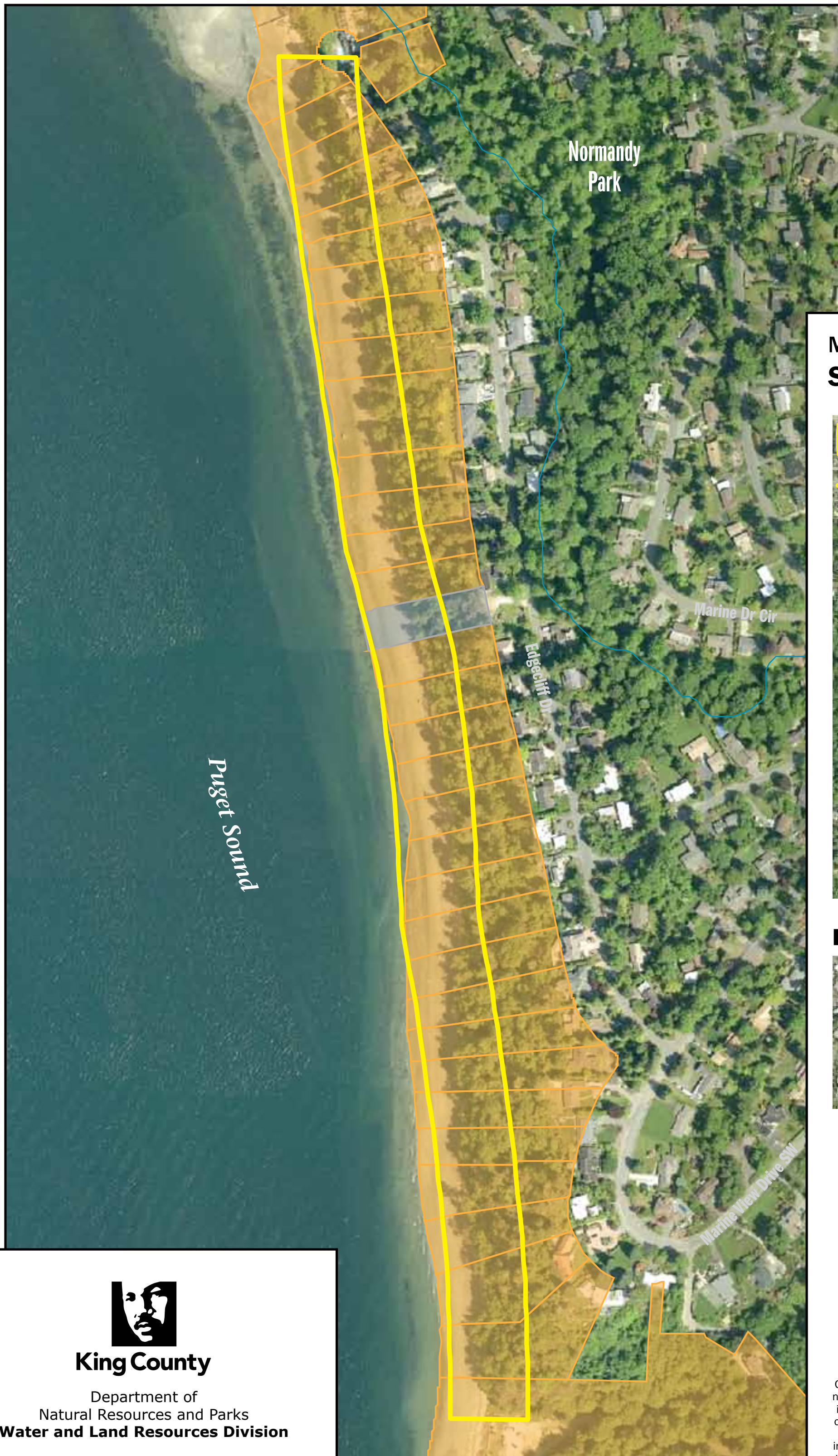
# Normandy Park Shoreline Characterization Report




Map 27

**Segment 4**

- **Segment 4**
- **Associated Wetland**
- **Single Family Residential Parcel**
- **Vacant Parcel**
- **Undivided Interest Parcel**
- **Park**
- **Incorporated Area Boundary**
- **Stream**

**Public Access**

- **Known Upland**
- **Known Water Only**
- **Potential**

N

0 200 400 Feet

September 2010



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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets

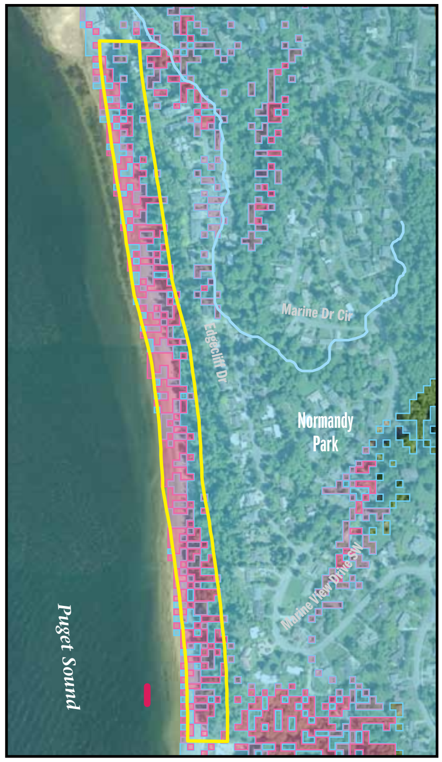
**File** 1009npshr27_seg4.ai wgab

# Normandy Park Shoreline Characterization Report

**Maps 28a-d**

## Segment 4 Geologic Features


28a. Liquifaction Susceptibilty




28b. Landslide Hazards


28c. Slopes 25% and Greater


28d. Erosion Hazards

**28a. Liquifaction Susceptibilty**

- Moderate to High
- Low to Moderate
- Very Low

**28b. Landslide Hazards**

Potential for Rapid Shallow Landslides

- High
- Moderate
- Low
- Landslides Mapped in 2005

**28c. Slopes 25% and Greater**

- Slopes ≥ 25%

**28d. Erosion Hazards**

- Erosion Hazard Areas

- Segment
- Associated Wetland
- Incorporated Area Boundary
- Stream

N

0 400 800 Feet

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**Data** King County Datasets; Liquefaction – WADNR 2004; Landslides – Johannessen et al 2005; Predictive Shallow-Rapid Slope Stability – WADNR 2000; Erosion Hazards – King County 1990; 25% Slopes or greater – unpublished KC data, created 2010

**File** 1009npshr28_seg4geol.ai wgab

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# Normandy Park Shoreline Characterization Report

Maps 29a-b

**Segment 4**
**Coastal Features**

Segment

Associated Wetland

Incorporated Area Boundary

Stream


**Current Shoretype (Along Shore)**

Accretion Shoretype

Feeder Bluff

Modified/Armored

Transport Zone

**Historic Shoretype (Offset)**

Feeder Bluff

Feeder Bluff Exceptional

Potential Feeder Bluff

Not Feeder Bluff

**29a. Current and Historic Shoretype**


**Shoreline Armoring**

Armor Above Ordinary High Water (OHW)

Armor at OHW

Armor Below OHW

Groin

Dock

Ramp

**29b. Coastal Features**

N

0 400 800 Feet

September 2010

**Map created by** DNRP GIS/ Visual Communications/Web Unit

**Data** King County Datasets; Current Shoretypes and Historic Shoretypes (Johannessen et al 2005);Groins (Anchor Environmental 2004);Boat Ramps (Anchor Environmental 2004); Overwater Structures (Anchor Environmental 2004); Shoreline Armoring (Johannessen et al 2005); Shoreline Armoring At, above or below OHWM (Anchor Environmental 2006)

**File** 1009npshr29_seg4coast.ai wgab


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# Normandy Park Shoreline Characterization Report


30a. Forage Fish Spawning Areas


30b. Eelgrass Distribution


30c. Riparian Vegetation


30d. Drift Log/Large Woody Debris

Maps 30a-d

**Segment 4 Biological Features**

**30a. Forage Fish Spawning Areas**

**Spawning Habitat**

Pacific Sand Lance
Surf Smelt
Forage Fish Survey Location

**30b. Eelgrass Distribution**

Continuous
Patchy

**30c. Riparian Vegetation**

**Trees**

Dense Overhanging
Patchy Overhanging
Dense Not Overhanging
Patchy Not Overhanging
Grass

**30d. Drift Log/Large Woody Debris**

Drift Log Accumulations
Large Woody Debris

Segment
Associated Wetland
Incorporated Area Boundary
Stream

N

0 400 800 Feet

September 2010



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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Forage Fish Spawning Surveys-WDFW 2010; Eelgrass and Kelp-WADNR: Shorezone 2001; Marine Riparian Vegetation–Anchor 2004; Drift Log/LWD–Anchor 2004

**File** 1009npshr30_seg4biol.ai wgab



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# Normandy Park Shoreline Characterization Report


Map 31

**Segment 5**

**Segment 5**

**Associated Wetland**

**Single Family Residential Parcel**

**Vacant Parcel**

**Undivided Interest Parcel**

**Park**

**Incorporated Area Boundary**

**Stream**

**Public Access**

**Known Upland**

**Known Water Only**

**Potential**

N

0 200 400 Feet

September 2010

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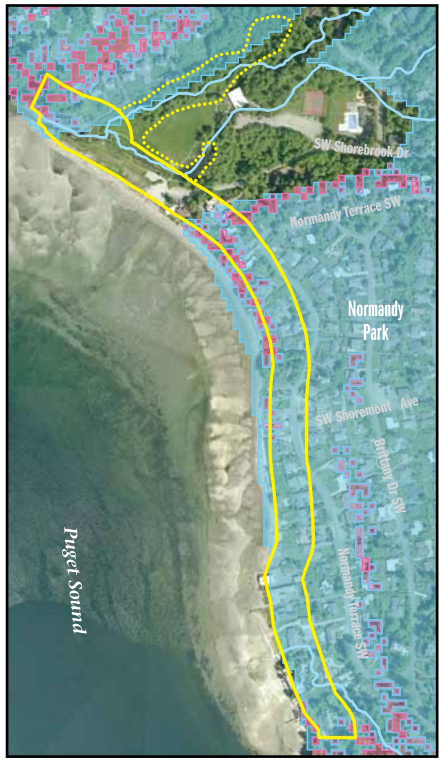
**Map created by** DNRP GIS/Visual Communications/Web Unit
**Data** King County Datasets
**File** 1009npshr31_seg5.ai wgab

# Normandy Park Shoreline Characterization Report

Maps 32a-d

**Segment 5 Geologic Features**


32a. Liquifaction Susceptibilty




32b. Landslide Hazards


32c. Slopes 25% and Greater


32d. Erosion Hazards

**32a. Liquifaction Susceptibilty**

Moderate to High

Low to Moderate

Very Low

**32b. Landslide Hazards**

Potential for Rapid Shallow Landslides

High

Moderate

Low

Landslides Mapped in 2005

**32c. Slopes 25% and Greater**

Slopes ≥ 25%

**32d. Erosion Hazards**

Erosion Hazard Areas

Segment

Associated Wetland

Incorporated Area Boundary

Stream

N

0 400 800 Feet

September 2010



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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Liquefaction – WADNR 2004; Landslides – Johannessen et al 2005; Predictive Shallow-Rapid Slope Stability – WADNR 2000; Erosion Hazards – King County 1990; 25% Slopes or greater – unpublished KC data, created 2010

**File** 1009npshr32_seg5geol.ai wgab

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# Normandy Park Shoreline Characterization Report

Maps 33a-b

**Segment 5**
**Coastal Features**

Segment
Associated Wetland
Incorporated Area Boundary
Stream


**Current Shoretype (Along Shore)**

Accretion Shoretype
Feeder Bluff
Modified/Armored
Transport Zone

**Historic Shoretype (Offset)**

Feeder Bluff
Feeder Bluff Exceptional
Potential Feeder Bluff
Not Feeder Bluff

**33a. Current and Historic Shoretype**

**Map created by** DNRP GIS/ Visual Communications/Web Unit

**Data** King County Datasets; Current Shoretypes and Historic Shoretypes (Johannessen et al 2005);Groins (Anchor Environmental 2004);Boat Ramps (Anchor Environmental 2004); Overwater Structures (Anchor Environmental 2004); Shoreline Armoring (Johannessen et al 2005); Shoreline Armoring At, above or below OHWM (Anchor Environmental 2006)

**File** 1009npshr33_seg5coast.ai wgab


**Shoreline Armoring**

Armor Above Ordinary High Water (OHW)
Armor at OHW
Armor Below OHW

Groin
Dock
Ramp

**33b. Coastal Features**

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N

0 400 800 Feet

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# Normandy Park Shoreline Characterization Report


Map 34

**Segment 5**
**Hydrologic Features**

**National Wetland Inventory Wetland**

**1874 Wooded Marsh Location**

**Salt-tolerant Vegetation**

**Other Salt-tolerant Vegetation**

**Stream**

**Stream Mouth**

**Segment**

**Associated Wetland**

**Incorporated Area Boundary**

N

0 200 400 Feet

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**Data** King County Datasets; Streams-King County 2009; Wetlands-National Wetlands Inventory--WDFW 2010; Marsh-Anchor 2004; Floodplain–King County 2006

**File** 1009npshr34_seg5hydro.ai wgab

# Normandy Park Shoreline Characterization Report


35a. Forage Fish Spawning Areas


35b. Eelgrass Distribution


35c. Riparian Vegetation


35d. Drift Log/Large Woody Debris

Maps 35a-d

**Segment 5 Biological Features**

**35a. Forage Fish Spawning Areas**

**Spawning Habitat**

Pacific Sand Lance

Surf Smelt

Forage Fish Survey Location

**35b. Eelgrass Distribution**

Continuous

Patchy

**35c. Riparian Vegetation**

**Trees**

Dense Overhanging

Patchy Overhanging

Dense Not Overhanging

Patchy Not Overhanging

Grass

**35d. Drift Log/Large Woody Debris**

Drift Log Accumulations

Large Woody Debris

Segment

Associated Wetland

Incorporated Area Boundary

Stream

N

0 400 800 Feet

September 2010

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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Forage Fish Spawning Surveys-WDFW 2010; Eelgrass and Kelp-WADNR: Shorezone 2001; Marine Riparian Vegetation–Anchor 2004; Drift Log/LWD–Anchor 2004

**File** 1009npshr35_seg5biol.ai wgab



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# Normandy Park Shoreline Characterization Report


Map 36
**Segment 6**

**Segment 6**
**Associated Wetland**
**Single Family Residential Parcel**
**Vacant Parcel**
**Undivided Interest Parcel**
**Park**
**Incorporated Area Boundary**
**Stream**

**Public Access**

**Known Upland**
**Known Water Only**
**Potential**

N

0 100 200 Feet

September 2010



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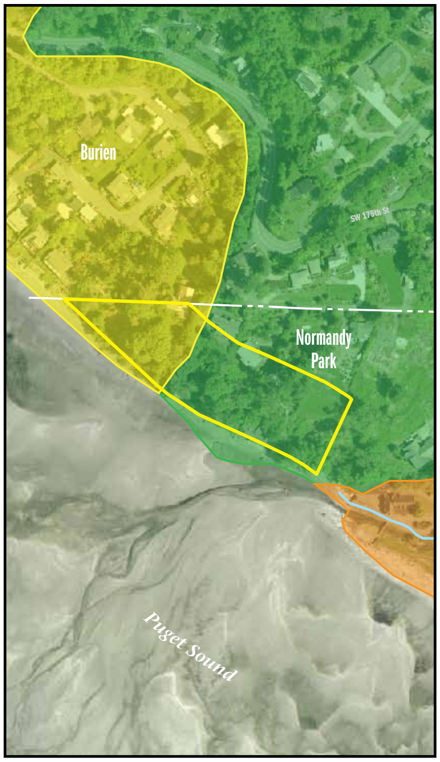
**Map created by** DNRP GIS/Visual Communications/Web Unit
**Data** King County Datasets
**File** 1009npshr36_seg6.ai wgab

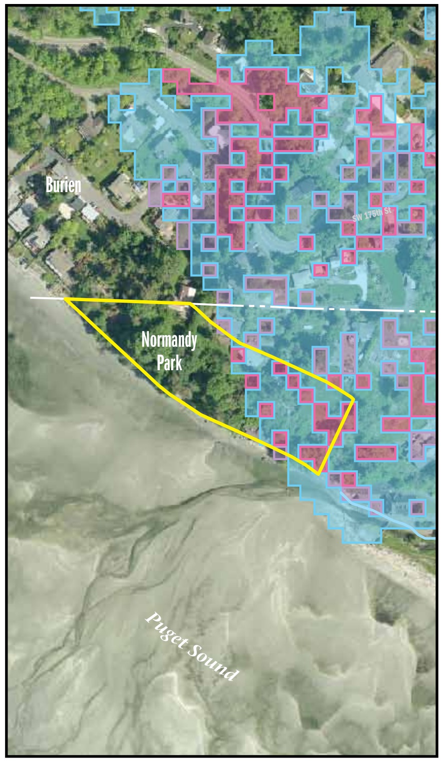
# Normandy Park Shoreline Characterization Report

Maps 37a-d

**Segment 6 Geologic Features**




37a. Liquifaction Susceptibilty




37b. Landslide Hazards


37c. Slopes 25% and Greater


37d. Erosion Hazards

**37a. Liquifaction Susceptibilty**

- Moderate to High
- Low to Moderate
- Very Low

**37b. Landslide Hazards**

Potential for Rapid Shallow Landslides

- High
- Moderate
- Low
- Landslides Mapped in 2005

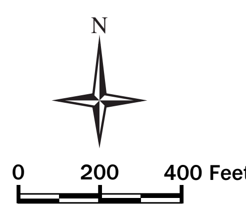
**37c. Slopes 25% and Greater**

- Slopes ≥ 25%

**37d. Erosion Hazards**

- Erosion Hazard Areas

- Segment
- Associated Wetland
- Incorporated Area Boundary
- Stream




September 2010



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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Liquefaction – WADNR 2004; Landslides – Johannessen et al 2005; Predictive Shallow-Rapid Slope Stability – WADNR 2000; Erosion Hazards – King County 1990; 25% Slopes or greater – unpublished KC data, created 2010

**File** 1009npshr37_seg6geol.ai wgab

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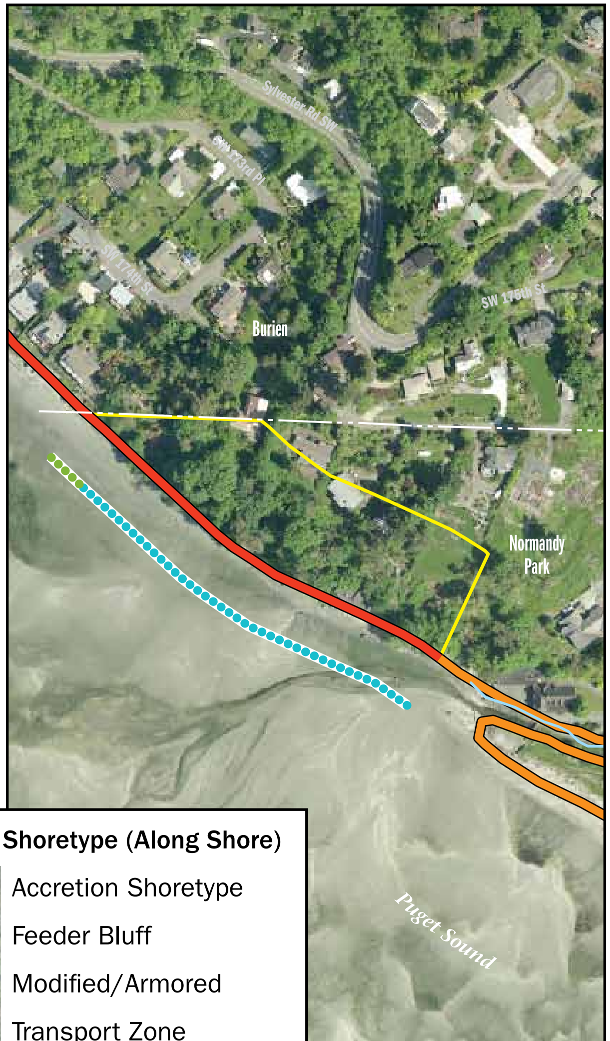
# Normandy Park Shoreline Characterization Report

Maps 38a-b

**Segment 6**
**Coastal Features**

- Segment
- Associated Wetland
- Incorporated Area Boundary
- Stream




**Current Shoretype (Along Shore)**

- Accretion Shoretype
- Feeder Bluff
- Modified/Armored
- Transport Zone

**Historic Shoretype (Offset)**

- Feeder Bluff
- Feeder Bluff Exceptional
- Potential Feeder Bluff
- Not Feeder Bluff

**38a. Current and Historic Shoretype**

**Map created by** DNRP GIS/ Visual Communications/Web Unit

**Data** King County Datasets; Current Shoretypes and Historic Shoretypes (Johannessen et al 2005);Groins (Anchor Environmental 2004);Boat Ramps (Anchor Environmental 2004); Overwater Structures (Anchor Environmental 2004); Shoreline Armoring (Johannessen et al 2005); Shoreline Armoring At, above or below OHWM (Anchor Environmental 2006)

**File** 1009npshr38_seg6coast.ai wgab


**Shoreline Armoring**

- Armor Above Ordinary High Water (OHW)
- Armor at OHW
- Armor Below OHW
- Groin
- Dock
- Ramp

**38b. Coastal Features**

N

0 200 400 Feet

September 2010

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**The shoreline jurisdiction boundaries shown on this map are only an approximation. The Ordinary High Water Mark has not been precisely mapped.**

# Normandy Park Shoreline Characterization Report


39a. Forage Fish Spawning Areas


39b. Eelgrass Distribution


39c. Riparian Vegetation


39d. Drift Log/Large Woody Debris

Maps 39a-d

## Segment 6 Biological Features

### 39a. Forage Fish Spawning Areas

**Spawning Habitat**

- Pacific Sand Lance
- Surf Smelt
- Forage Fish Survey Location

### 39b. Eelgrass Distribution

- Continuous
- Patchy

### 39c. Riparian Vegetation

**Trees**

- Dense Overhanging
- Patchy Overhanging
- Dense Not Overhanging
- Patchy Not Overhanging
- Grass

### 39d. Drift Log/Large Woody Debris

- Drift Log Accumulations
- Large Woody Debris

- Segment
- Associated Wetland
- Incorporated Area Boundary
- Stream

N

0 200 400 Feet

September 2010



**The shoreline jurisdiction boundaries shown on this map are only an approximation. The Ordinary High Water Mark has not been precisely mapped.**


**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets; Forage Fish Spawning Surveys-WDFW 2010; Eelgrass and Kelp-WADNR: Shorezone 2001; Marine Riparian Vegetation–Anchor 2004; Drift Log/LWD–Anchor 2004

**File** 1009npshr39_seg6biol.ai wgab



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# Normandy Park Shoreline Characterization Report


Map 40

## Potential Restoration and Preservation Areas

- Restoration Potential
- Preservation Potential
- Segment 1 — Segment and Number
- Associated Wetland
- Incorporated Area
- Puget Sound/Lake
- Stream
- Major Road

N

0 1/4 1/2 Miles

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**Map created by** DNRP GIS/Visual Communications/Web Unit

**Data** King County Datasets

**File** 1009npshr40_rest_preserv.ai wgab