

KING COUNTY SHORELINE CUMULATIVE IMPACTS ASSESSMENT

September 2010

1. Purpose and General Description

This report assesses the potential for cumulative impacts of reasonably foreseeable future development in the shoreline jurisdiction that could result from development and activities over time under the King County Shoreline Master Program. The Department of Ecology's shoreline guidelines require local governments to evaluate and consider the cumulative impacts of reasonably foreseeable future development on the shorelines of the state (WAC 17-26-186(8)(d)).

Ecology's Guidelines require a local government's Shoreline Master Program (SMP) to result in "... no net loss of ecological functions and protection of other shoreline functions and/or uses." Master programs must contain policies, programs, and regulations that address adverse cumulative impacts and fairly allocate the burden of addressing cumulative impacts among development opportunities. The State's objective in directing local governments to evaluate potential cumulative impacts is to ensure that, when implemented over time, the proposed Shoreline Master Program goals, policies and regulations will achieve this no net loss standard.

Evaluation of such cumulative impacts should consider:

- Current conditions affecting the shorelines and relevant natural processes;
- Reasonably foreseeable future development and use of the shoreline; and
- Beneficial effects of any established regulatory programs under other local, state, and federal laws." (WAC 173-26-186(8)(d))

The King County Shorelines Cumulative Impacts Assessment uses these three considerations as a framework for evaluating the potential impacts to shoreline ecological functions and processes that may result from implementation of the proposed Shoreline Master Program over time.

In King County, current conditions are identified and described in the King County Shorelines Technical Appendix (May 2007). The King County Shoreline Master Program establishes standards for allowed uses and procedures to evaluate individual actions for their potential to impact shoreline resources on a case-by-case basis. This assessment analyzes the future development that is expected to result from allowed development and the cumulative impacts of that development on the shoreline.

2. Methods and Assumptions

Existing Shoreline Conditions

Existing shoreline conditions, based on the characterization of ecological process integrity in King County Shorelines Technical Appendix, are summarized to provide context for the impervious surface area discussion in this cumulative impacts assessment.

Shoreline Land Use and Permit Trends

Existing shoreline land use is evaluated through shoreline permit trends (dating back to 1990) and provides the basis for discussing historic versus expected future shoreline development. Shoreline permits are also included as part of the land use characterization in King County Shorelines Technical Appendix.

Overview of Key Shoreline Protection Standards

Allowable activities and protection requirements under current and proposed shoreline management regulations are summarized and compared. This analysis provides the basis for determining how proposed regulations influence potential cumulative impacts. Key regulations are discussed.

King County proposes to use eight designations to regulate uses and modifications within the shoreline zones: High Intensity, Residential, Rural, Conservancy, Resource, Forestry, Natural, and Aquatic. The King County Shoreline Master Plan defines the criteria for assigning these designations. The quantitative element of this cumulative impacts assessment focuses on landward designations. Potential cumulative impacts to the Aquatic designation are qualitatively discussed in this analysis. The amount of shoreline (in terms of shoreline miles, acres and parcels) is defined to provide context for the results of the landscape analysis.

Review of Best Available Science Analysis and Results

The results of the risk assessment conducted as part of King County's critical areas¹ regulatory update (adopted in 2004) are reviewed. This work is included as part of the shoreline cumulative impact assessment because the County proposes to rely on critical areas regulations to protect existing shoreline ecological functions.

Landscape Analysis: Impervious Surface Area in Shoreline Jurisdiction

An analysis was conducted to describe the existing conditions in shoreline zones within the County. Seven designations, all except the Aquatic, were coupled with the shoreline type (i.e. lake, marine, or stream) to generate 18 possible shoreline categories that defined the spatial extent of the analysis. Cumulative impacts were then analyzed for each shoreline category using a generalized estimate of new impervious surface that could occur in the shoreline zone under proposed regulations. Current conditions were compared to a hypothesized worst case scenario of possible future impacts (the maximum potential increase in impervious surface within the shoreline jurisdiction). This worst case scenario is discussed in terms of expected shoreline development.

Because more than 1,900 miles of stream and lake shorelines and 51 miles of marine shorelines within King County's Shoreline Master Program jurisdiction are evaluated, the quantitative analyses are statistically robust according to Osenberg (1994). By being comprehensive, this analysis takes into consideration the issues of ecological scale, process and function.

¹ Critical areas include: wetlands; fish and wildlife habitat conservation areas, including shorelines of the state and other aquatic areas; geologically hazardous areas, such as steep slopes and channel migration hazard areas; frequently flooded areas; and critical aquifer recharge areas.

It is assumed that development effects accrue in a cumulative fashion and that artificial impervious land covers are a good indicator of the level and potential degree of effect of development that occurs in proximity to shorelines of the county. To this end, the County's high-resolution GIS layer (4 feet on-a-side grid cells) of impervious areas (Marshall 2000) was used to create a quantifiable indicator of potential cumulative impacts within shoreline areas.

There are other obvious landcover alterations that are correlated with impervious surfaces and that affect ecological process and function (e.g. loss of natural vegetation and soil compaction associated with land clearing, riparian encroachment, and other direct hydrologic modifications). For this analysis, however, it was assumed that impervious surfaces are a suitable indicator of cumulative impacts of land use as indicated by other research (May 1997; Wissmar 2000). Additionally, following methods of Stanley et al (2005), impervious surface data was a major factor in determining the degree of alteration of ecological processes (see King County Shorelines Technical Appendix, May 2007).

King County's critical area regulations require all new development within aquatic area and wetland buffers to fully mitigate for the impacts on aquatic area or wetland functions. Mitigation that includes buffer enhancement is expected to be effective at achieving the shoreline management goal of no net loss of ecological function (Figure 1). Mitigation requirements are discussed further in the description of the proposed Shoreline Master Program below and in Attachment 1.

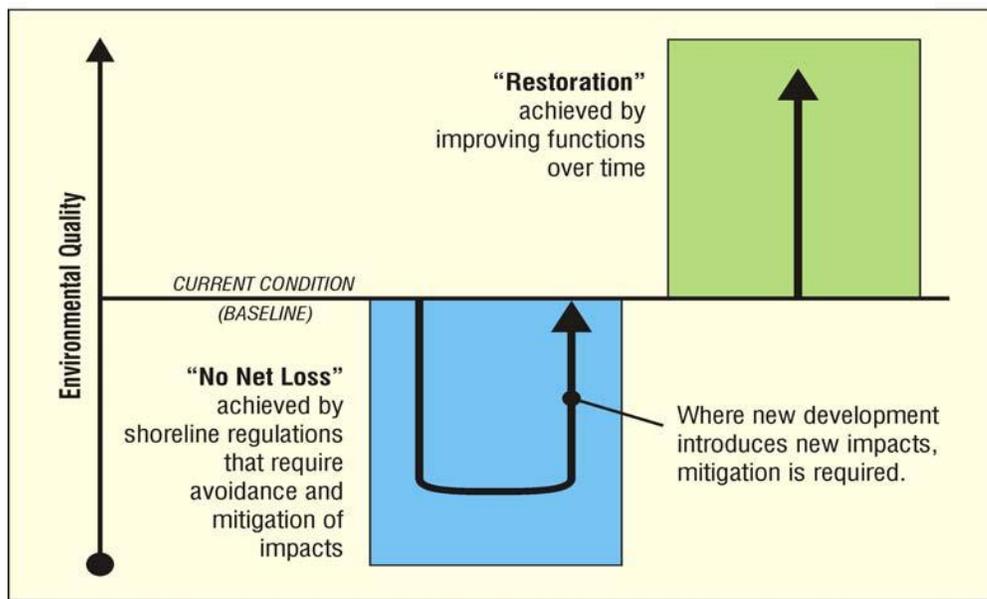


Figure 1. Environmental condition relative to disturbance. The blue square represents a disturbance and decreased environmental condition at the bottom of the arrow followed by mitigation of the impacts that returns the system's ecological function to its pre-disturbance condition. The green square represents improved environmental function following restoration actions. (Source: Department of Ecology)

In order to evaluate the cumulative impact of the proposed Shoreline Master Program, cumulative impacts analysis started with an estimate of the current and potential future impervious surface for property located within the shoreline jurisdiction. The potential future

cumulative impacts were estimated by increasing buffer impervious surface coverage on parcels in the shoreline jurisdiction by the amount that would be allowed under proposed shoreline regulations. Estimates of impervious area (i.e. potential cumulative impacts) were then averaged by shoreline type and designation.

To measure the differences between current and possible future conditions, a comparison of mean impervious surface percentages was performed. To further evaluate potential areas of concern, maps showing developable parcels were reviewed to assess localized changes and consistency with designation and reach and drift cell characterization scores (pixel and summarized reach/drift cell scores).

3. Shoreline Land Use and Permit Trends

The 2007 King County Buildable Lands Report states that the urban area of King County contains almost 22,000 net acres of vacant or potentially redevelopable residential land. However, future development on 25% of the countywide land supply in single-family zones and 10% of the land in multifamily and mixed use zones would be restricted due to critical areas. Until the recent economic downturn, the County had been issuing approximately 7,000 residential permits per year for development throughout the unincorporated area. Approximately 1,000 of those permits are reviewed with regards to critical areas (Bottheim pers. comm. 2008). Rural unincorporated King County, where the vast majority of the County's shoreline jurisdiction is located, has grown relatively slowly since the Growth Management Act took effect in the mid-1990s. According to the 2006 King County Annual Growth Report, less than five percent of countywide new residential construction and population growth occurred in the rural unincorporated area.

Analysis of development permits and approvals issued from 1990 to 2004 within the shorelands of King County indicates that King County issued approximately 2,250 development permits or approvals in the County's shoreline jurisdiction from 1990 through 2004. These include shoreline substantial development permits, shoreline variances, shoreline conditional uses, and shoreline exemptions. Many of these permits were issued for areas that are now incorporated and are no longer subject to King County's Shoreline Master Program. Approximately 1650 of these properties are still subject to King County's jurisdiction.

About half (1,013) of these approvals or permits were for maintenance or repair of existing structures or for timber harvest or stormwater management and did not result in new impervious areas. While there may have been some short-term impacts associated with these activities, they are not likely to have resulted in a net loss of ecological function along King County shorelines. Of the remaining development permits or approvals, 562 (28%) were for new single family residences and 355 (17%) were for a variety of other types of shoreline development, such as trails, utilities, docks, and other miscellaneous structures. Table 1 shows the number of development approvals from 1990 through 2004 by proposed shoreline environment

Table 1. Numbers of Shoreline permits or approvals issued by proposed designation during 1990-2004.

Proposed Designation	Shoreline Development Activity 1990-2004
High Intensity	24
Residential	43
Rural	382
Conservancy	540
Resource	155
Forestry	91
Natural	97

King County's critical area regulations, which are being incorporated by reference into the Shoreline Master Program, allow expansion by up to 1,000 square feet of an existing residential structure located in a wetland or aquatic area buffer. Any impacts from the expansion must be mitigated. In recent years, approximately 60 permits per year have allowed this type expansion (Bottheim pers. comm. 2008). A small percentage of these expansions have involved structures located within the shoreline jurisdiction.

Regarding in-water development trends, King County compiled new data on the location of shoreline docks as part of the inventory and characterization (King County Shorelines Technical Appendix, May 2007). The vast majority of docks are located in the Conservancy, Rural, and Residential environments. The density of docks in these designations ranges from about 1 dock per conservancy shoreline mile to 4 docks per rural shoreline mile to 16 docks per residential shoreline mile (Table 2). Under the proposed regulations, new docks will need to demonstrate that there are no other available options and any new docks in the Conservancy environment for a commercial or manufacturing use would have to be located at least 250 feet from another dock (see discussion under Shoreline Master Program in this document).

Table 2. Number of existing docks by proposed shoreline designation and water type.

Proposed Designation	Freshwater Docks	Marine Docks	Estimated New Freshwater Docks 2010 - 2030
High Intensity	0	5	0
Residential	438	0	8
Rural	242	84	5
Conservancy	379	12	5
Resource	0	1	0
Forestry	11	0	0
Natural	0	10	0

Major existing land uses and land use patterns along King County shorelines are summarized and in the King County Shorelines Technical Appendix.

4. Overview of Key Shoreline Protection Standards

State and Federal Regulations

In addition to local regulations, a number of state and federal agencies have regulatory jurisdiction over resources in the shoreline jurisdiction. As with local requirements, state and federal regulations apply throughout the County and significantly reduce the potential for

cumulative impacts to shorelines. The major state and federal regulations affecting shoreline-related resources include, but are not limited to:

- **Endangered Species Act (ESA):** The federal ESA addresses the protection and recovery of federally listed species. Depending on the listed species, the ESA is administered by either the National Oceanic and Atmospheric Administration Fisheries or the United States Fish and Wildlife Service.
- **Clean Water Act (CWA):** The federal CWA requires states to set standards for the protection of water quality. It also regulates excavation and dredging in waters of the U.S., including wetlands. Certain activities affecting wetlands in the County's shoreline jurisdiction or work in the 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 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 County could require an HPA. 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 one or more acres, and municipal stormwater systems that serve populations of 100,000 or more.

King County Plans and Regulations Relevant to Shoreline Protection

The following is a general discussion of plans and regulations that apply in the King County shoreline jurisdiction.

King County Comprehensive Plan

The King County Comprehensive Plan seeks to balance social, environmental, and economic goals through land use and zoning regulations, critical areas regulations using best available science, and other development standards. Updated shoreline management goals and policies are adopted as Chapter 5 in the King County Comprehensive Plan. King County shoreline goals and policies are consistent with the State's goal to prevent a net loss of shoreline ecological processes and functions and to restore shorelines over time.

King County Code Title 21A: Zoning

The King County Code establishes land use zones that implement the Comprehensive Plan's vision for future land use. Zones near shorelines include agriculture, mining, forestry, open space, residential, office, commercial and industrial. King County zoning was developed in part with consideration of the results of basin plans that were developed to protect water resources and habitat.

King County Code, Chapter 21A.24: Critical Areas

King County first adopted comprehensive regulations to protect environmentally sensitive areas in 1990. Those regulations were significantly amended in 2004. The critical area regulations are designed to protect critical areas from adverse impacts of development and to protect public safety. The regulations establish development standards, buffers and allowed alterations in critical areas as well as ensure that the critical area impacts of any permitted development is fully mitigated. The regulations also require that mitigation sequencing: that impacts to the critical area must first be avoided, then minimized and finally mitigated. King County's Critical Area Regulations are found in K.C.C. Chapter 21A.24.

The Shoreline Master Program relies on the critical areas regulations to protect critical areas within the shoreline jurisdiction, ensuring that there will be a consistent set of standards both within and outside of the shoreline jurisdiction.

For aquatic areas that are also shorelines of the state, the regulations establish a buffer of 115 feet for aquatic areas inside the urban growth area and 165 feet for aquatic areas outside the urban growth area. The regulations also require a 15 foot building setback from the buffer. Alterations to the aquatic area and buffer are limited. A critical areas report is generally required prior to making alterations. The report must include an analysis of the impact of the activity on the aquatic area and its buffer.

King County's regulations do allow existing, legal residential structures located in aquatic area and wetland buffers to be expanded by up to 1,000 square feet. This expansion may be allowed within the aquatic area buffer provided it is in the area of least adverse impact. Mitigation for the impacts resulting from the expansion is required. This mitigation usually consists of enhancing or restoring an equivalent area of buffer between the area of impact and the aquatic area or wetland with native trees and shrubs.

Compensatory mitigation is also required for other types of shoreline modifications. New, expanded, replacement or repaired docks, piers, moorage piles or buoys, floats and launching facilities must meet location, size and construction criteria, and mitigate through retention of woody debris and removal of invasive weeds. New or expanded moorage facilities must plant site a ten-foot wide buffer of native trees and shrubs on the adjacent upland parcel. Shoreline stabilization must evaluate non-structural alternatives that would avoiding an adverse impact, and comply with the Integrated Streambank Protection Guidelines.

When it adopted its Critical Area Regulations, King County conducted a risk assessment of the regulations, considering best available science, as required by the Growth Management Act. See Best Available Science Volume II: Assessment of Proposed Ordinances (February 2004 available at <http://www.kingcounty.gov/property/permits/codes/CAO.aspx#best>). The conclusion of the analysis for aquatic areas, which includes the shoreline jurisdiction, was that the critical areas standards – in combination with all other programmatic, capital, stewardship and incentive programs – are highly consistent with aquatic area protection best available science. The only departure from best available science relevant to the Shoreline Master Program is that buffers may not adequately address microclimate control.

King County Code, Chapter 9.04: Surface Water Management

King County reviews development proposals to ensure that surface water management standards are met. The County also promotes the preservation of natural drainage systems, protection of fishery resources, and wildlife habitat.

The County's Capital Improvement Program also identifies, funds, and implements site-specific projects intended to provide flood control or alleviation, improve and enhance riparian habitat, replace culverts to improve fish passage, and improve water quality from stormwater runoff.

The main objective of surface water management requirements is to promote public health, safety and welfare by establishing and operating a comprehensive approach to surface and storm water problems in order to: reduce flooding, erosion and sedimentation; prevent and mitigate habitat loss; enhance groundwater recharge; and prevent water quality degradation. This comprehensive approach includes the following elements: basin planning; land use regulation; construction and maintenance of facilities; public education; and provision of surface and storm water management services. The County imposes limits on the maximum amount of impervious surface that is allowed and requires all new development to control and treat runoff.

King County Code, Chapter 16.82: Clearing and Grading Standards

This Code chapter defines the Clearing and Grading Standards for development within the County. The code regulates clearing and removal of vegetation, excavation, grading and earthwork construction including cuts and fills, gravel pits, dumping, quarrying and mining operations within King County in order to protect public health, safety and welfare by:

1. Minimizing adverse stormwater impacts generated by the removal of vegetation and alteration of landforms;
2. Protecting water quality from the adverse impacts associated with erosion and sedimentation;
3. Minimizing aquatic and terrestrial wildlife habitat loss and impacts to other riparian functions, such as microclimate, caused by the removal of surrounding vegetation;
4. Protecting sensitive areas from adverse clearing and grading activities;
5. Facilitating and encouraging long term forest practice and agricultural production operations where appropriate;
6. Minimizing the adverse impacts associated with quarrying and mining operations; and
7. Preventing damage to property and harm to persons caused by excavations and fills.

Shoreline Master Program

King County adopted its Shoreline Master Program in 1978 and has not significantly amended it since then. The County's existing Shoreline Master Program goals and policies are an independent document that is not directly integrated into the King County Comprehensive Plan . King County's existing shoreline development regulations and permitting procedures are codified as a separate title – Title 25 of the King County Code. The existing Shoreline Master Program established a system of shoreline environment designations that provide a uniform basis for applying policies and use regulations within distinctly different shoreline areas. Generally, the environment designations adopted in 1978 were based on the then existing and planned development patterns, biological and physical capabilities and limitations of the shoreline, and King County's vision and objectives for its future development. The 1978 Shoreline Master Program uses four shoreline environment designations: Urban, Conservancy, Rural, and Natural.

The proposed Shoreline Master Program (September 2010) updates the King County's program to bring it into compliance with Ecology's guidelines. The updated Shoreline Master Program establishes a new system of environment designations, in compliance with Ecology's guidelines (WAC 173-26-211). The new system applies designation criteria and management policies consistently across areas with similar current and planned land uses and ecological characteristics. The proposed environment designations are: High Intensity, Residential, Rural, Conservancy, Resource, Forestry, Natural and Aquatic (Table 3). The criteria for these shoreline designations are described in detail in Chapter 5 of the King County Comprehensive Plan.

Table 3. Proposed shoreline designation miles, acres and parcels.

Part A.

Current Program		
Current Designation	Miles	Acres
Conservancy	897	21,755
Natural	109	2,640
Rural	108	2,620
Urban	13	324

Part B.

Proposed Program				
Proposed Designation	Miles	Acres (% of total)	Shoreline Type	Parcels*
Conservancy	313	11,001 (18.2%)	Lake	775
			Marine	434
			Stream	2,897
Resource	127	16,160 (26.7%)	Marine	5
			Stream	695
Forestry	921	21,569 (35.6%)	Lake	49
			Stream	710
Natural	304	7,230 (11.9%)	Lake	14
			Marine	422
			Stream	215
Rural	73	3,064 (5.1%)	Lake	614
			Marine	1,507
			Stream	857
Residential	23	1,127 (1.9%)	Lake	968
			Stream	357
High Intensity	5	446 (0.7%)	Lake	3
			Marine	24
			Stream	105

*Due to spatial inconsistencies among data layers, there is some error in determining the exact number of parcels in each designation.

The proposed Shoreline Master Program adopts requirements that new development in the shoreline jurisdiction must avoid and then minimize and mitigate for the adverse impacts of proposed development activities. After avoidance and minimization, mitigation of impacts generally includes replacement or enhancement of buffers and affected critical areas. Key changes include: incorporation of critical areas protections into the shoreline regulations, and updated standards for shoreline stabilization, docks and piers, and trails in shorelines. The proposed changes to development standards and use regulations are more protective than the existing Shoreline Master Program in large part due to formal inclusion of critical areas protections into the shoreline regulations. Attachment 1, Summary of Potential Cumulative Impacts Associated with Proposed Shoreline Master Program, qualitatively assesses how cumulative impacts may occur per designation and how those impacts would be offset by the requirements of the proposed Shoreline Master Program, other local, State and Federal regulations and non-regulatory actions.

Consistent with state guidelines (WAC 173-26-186), the proposed Shoreline Master Program includes new goals and policies addressing shoreline restoration within King County. The goals and policies for restoration establish the County's intent to achieve no net loss of shoreline ecological functions, and to also see an overall improvement to the condition of habitat and resources within the shoreline jurisdiction. The Shoreline Protection and Restoration Plan (September 2010) identifies restoration opportunities that include capital and programmatic restoration opportunities identified in salmon recovery and flood hazard management plans, and potential funding and partnership opportunities. The Plan acknowledges areas where shoreline functions have been degraded by past development activities and flood hazard reduction efforts (e.g. bank armoring and levee building) and recommends actions appropriate for existing conditions and constraints to ecological processes. Implementation of the Protection and Restoration Plan is expected to guide improvement of shoreline ecological functions within the County over time.

5. Existing Shoreline Conditions

As part of the County's Shoreline Master Program update process, the County conducted a shoreline inventory and characterization (King County Shorelines Technical Appendix, May 2007) that assessed the degree to which ecological functions and processes in the shoreline jurisdiction have been altered by existing development. The result of the characterization was a rating for each shoreline reach based on the degree to which its shoreline functions had been altered. A summary of the process alteration ratings by shoreline type and reach and broad geographic area (i.e., Vashon-Maury Island, lowlands, and federal and non-federal forest production areas) is provided in Table 4. Shoreline geographic areas include the unincorporated lowland (western third) of the County that primarily supports residential, commercial, and agricultural use; the privately managed Forest Production District (FPD Non-Federal Lands); and the state and federal forest lands and wilderness areas (FPD Federal Lands). In general, the analysis indicates that the majority of King County shorelines are in medium to high condition (relatively unaltered).

Table 4. Degree of Ecological Process Integrity. Average Reach Ratings by ecological process and shoreline type for unincorporated King County. Scores are based on the Characterization described in the Comprehensive Plan Appendix M. For each process, the average rating for all reaches within a location is reported. Potential ratings range from high (H), meaning ecological processes relatively unaltered to Low (L), meaning processes are highly altered by existing development. A summary of the percent of reaches for each rating categories is also presented.

Ecological Process	Marine	Lake scores by geographic location			River scores by geographic location		
	Vashon/Maury	Lowland	*FPD Federal lands	FPD Non-Federal Lands	Lowland	*FPD Federal lands	FPD Non-Federal Lands
Light	M	MH	H	H	MH	H	H
LWD	M	MH	MH	MH	M	MH	M
Nitrogen	MH	H	H	H	MH	H	H
Phosphorus	MH	MH	H	H	MH	H	H
Pathogens	MH	MH	H	H	MH	H	H
Toxins	M	MH	H	H	MH	H	H
Sediment	ML	MH	MH	MH	M	H	MH
Water cycle	M	M	H	MH	M	H	MH
Wave energy	M	MH	H	H	N/A	N/A	N/A
Tidal influences	MH	N/A	N/A	N/A	N/A	N/A	N/A
OVERALL	M	MH	H	H	MH	H	H

Percentage of reaches in each rating category:

Ecological Process	Marine	Lake scores by geographic location			River scores by geographic location		
	Vashon/Maury	Lowland	*FPD Federal lands	FPD Non-Federal Lands	Lowland	*FPD Federal lands	FPD Non-Federal Lands
Low	2.9	0.0	0.0	0.0	0.0	0.0	0.0
Medium Low	23.7	1.0	0.0	0.0	2.2	0.0	0.0
Medium	31.7	1.1	0.0	0.0	34.6	0.0	0.1
Medium High	15.6	78.9	9.5	3.1	45.7	2.0	11.1
High	26.1	19.1	90.5	96.9	17.6	98.0	88.8

*FPD = Forest Production District.

Impervious surfaces, among other data, is used to evaluate the degree of alteration of all of the ecological processes listed in Table 4, with the exception of wave energy. Discussion in the shoreline characterization analysis recognizes the direct relationship between impervious surface and the status of ecological processes (King County Shorelines Technical Appendix, May 2007)).

6. Landscape Analysis: Impervious Surface in Shoreline Jurisdiction

The landscape analysis was developed to generally identify the extent to which shoreline designations may be at risk from future development, to assist in refining the proposed Shoreline Master Program, and to help guide protection and restoration efforts. It estimated there will be a potential increase in buffer impervious surfaces in the shoreline jurisdiction, assuming that 1,000 square feet of new impervious surface is built on every developable shoreline parcel. For purposes of this analysis, developable parcels include private parcels that currently have impervious surface located within the 165-foot critical area buffer. Some designations (Forest, Resource, and High Intensity) are excluded from the analysis as there is minimal or no existing single family development in those areas. As additional areas are incorporated in the coming years, the vast majority of King County's development will be residential, mostly single family detached residences. Areas where non-residential development are allowed will be limited and is mostly located outside the shoreline jurisdiction.

This analysis assumes that: (1) any impervious surface in the buffer is a single family residence, which is the criteria for allowing expansion; (2) there is an existing single family residence in the buffer on every parcel where there is current impervious surface; (3) new impervious surface is not sited outside of the shoreline jurisdiction where it could be on large rural parcels and as required by the mitigation sequence; and (4) all property owners will choose to expand single family residences on developable parcels. Therefore, this is a conservative worst case scenario.

This scenario shows a potential increase in the percent impervious for shoreline buffer areas. Overall, the total current percent impervious surface for all shoreline parcel buffers is 8.0% (Attachment 2). Given assumptions described above, the potential future impervious surface would be 9.4% for a net overall increase of 1.4%. While a seemingly small potential change, clearly some areas have much more potential for change than others. The most dramatic potential change in buffer imperviousness is for Residential lakes and Rural marine where percent buffer impervious surface could change from current 12.5% and 5.1% to potential future 35.9% and 29.6%, respectively (Table 5). A more moderate degree of change could occur for Rural lake and Rural stream, where percent buffer impervious could change from 10.7% and 0.1% currently to 22.3% and 13.6%, respectively for the future. Conditions for these shorelines generally range from low to medium/high; areas of high condition are generally not present in these areas and therefore had very little potential for change. Additionally, the Rural and Residential shorelines make up 7.0% of the total shoreline area (Table 3).

In contrast, most areas representing the highest conditions could experience no to relatively small increases in impervious surface in the buffer. For the Natural designation (11.9% of the total shoreline area) impervious surface is expected to change by less than 2%. This area is in high condition for the most part. Buffer impervious surfaces along Forestry, Resource and High Intensity shorelines would not be expected to increase at all as there are very few single family uses. Ultimately, 92.3% of King County's shorelines – including most shorelines that are in the highest ecological condition – would not likely experience a large change in impervious surface.

In addition to being mostly confined to a relatively small percentage of the shoreline buffer area, the effect of increased impervious surface in the buffer would be mitigated. As stated previously, it is estimated that this provision to allow expansion of single family residences by 1,000 square feet has been used in about 60 permits per year (less than 1% of about 7,000 total residential permits and about 1,000 permits that get detailed critical areas review per year). Furthermore, there are specific conditions under which this expansion is allowed within the shoreline jurisdiction, including:

- A mitigation sequence that requires avoidance, minimization and mitigation of shoreline ecological resources is applied (as discussed previously).
- Mitigation requirements specify that a comparable area of degraded buffer area must be enhanced (nonnative plants removed and replaced with native vegetation per an approved landscaping plan). For example, in shoreline areas where existing conditions are poor, such as in Quartermaster Harbor where water quality is low and where there may be a concentration of new impervious surface in the shoreline buffer, enhancement as a mitigation requirement may result in an improvement in ecological function over existing conditions. In other instances where conditions are currently moderate to high and on-site opportunities to restore degraded conditions are limited, such as along middle reaches of Bear Creek, Issaquah Creek, Raging River and the Cedar River, off-site mitigation may be required to offset impacts. Off-site mitigation would be guided by the Shoreline Protection and Restoration Plan priorities.
- A shoreline conditional use permit is required if expansion occurs in the Conservancy, Resource, Forestry or Natural shoreline environment. A conditional use permit is not required in the High Intensity, Residential and Rural shoreline environments. These 3 designations make up 7.7% of the shoreline jurisdiction.
- If an expansion is greater than 1,000 sf, a shoreline variance is required.
- A 3-year bond and monitoring is required to ensure at least 80% survival of native plants.
- A cumulative total of up to 1,000 sf expansion is allowed per parcel.
- 1,000 sf expansion is not allowed on parcels that were previously developed via a Rural Stewardship Planning permit.

Table 5. Potential Change in Buffer Imperviousness of King County shorelines. Percent impervious areas are estimated from averages of all developable parcels within each designation. Forestry, High Intensity, and Resource designations; these designations are excluded from the analysis.

Designation*	Shoreline Type	Average Existing Shoreline Buffer % Impervious, including hazard areas	Potential Future Average Buffer % Impervious, including hazard areas	Difference between Existing and Potential Future Average Buffer % Impervious
Conservancy	Lake	16.9	21.7	4.8
	Marine	8.2	11.8	3.6
	Stream	9.8	11.5	1.8
Natural	Lake	0.0	0.0	0.0
	Marine	4.7	6.5	1.8
	Stream	1.6	3.0	1.4
Residential	Lake	12.5	35.9	23.4
	Stream	20.6	25.6	5.1
Rural	Lake	10.7	22.3	11.6
	Marine	5.1	29.6	24.5
	Stream	0.1	13.6	13.5
Forestry	Lake	3.4		
	Stream	3.3		

Designation*	Shoreline Type	Average Existing Shoreline Buffer % Impervious, including hazard areas	Potential Future Average Buffer % Impervious, including hazard areas	Difference between Existing and Potential Future Average Buffer % Impervious
High Intensity	Lake	63.5		
	Marine	31.3		
	Stream	62.0		
Resource	Marine	6.8		
	Stream	0.5		

Conclusion

Consistent with the Shoreline Management Act goals, King County's Shoreline Master Program adopts new shoreline environment designations, updated development standards and regulations for shoreline modifications and uses and better protection for shoreline processes. The updated standards and regulations are generally more protective of the shoreline environment and are largely consistent with best available science in protecting aquatic areas.

As discussed in this analysis and summarized in Attachment 1, proposed development and mitigation standards help to ensure that new residential structures do not cumulatively affect shoreline ecology. The Shoreline Protection and Restoration Plan identifies opportunities to improve or restore ecological functions that have been impaired as a result of past development activities. In addition, the proposed Shoreline Master Program augments several County, state and federal regulations that also protect shoreline functions and values for a variety of goals, including the recovery of threatened salmon and Puget Sound restoration.

The King County shoreline is in generally good condition while including a variety of existing land uses. There are opportunities for new shoreline development on vacant lots or by expanding existing structures. However, it is reasonable to conclude that less than the estimated development or expansion will actually occur, given shoreline development trends since 1990.

The cumulative actions (protection, restoration, regulations, and stewardship) taken over time in accordance with the provisions of the updated Shoreline Master Program are not likely to result in a net loss of shoreline ecological functions from existing baseline conditions, and may result in an increase in shoreline ecological functions.

References

- Allen, T. F. H. 1998. The Landscape "Level" is Dead: Persuading the Family to Take it off the Respirator. Pages 615 in D. L. P. a. V. T. Parker, editor. *Ecological Scale: Theory and Applications*. Columbia University Press, New York.
- Forman, R. T. T., and M. Godron. 1986. *Landscape Ecology*. John Wiley & Sons, New York.
- Frissell, C. A., W.J. Liss, C.E. Warren, and M.D. Hurley. 1986. A heirarchical framework for stream habitat classification: viewing streams in a watershed context. *Environmental Management* 10:199-214.

- Gardner, R. H. 1998. Pattern, process, and the analysis of spatial scales. Pages 17-34 *in* a. V. T. T. P. D.L. Peterson, editor. *Ecological Scale: Theory and Applications*. Columbia University Press, New York.
- Li, H. W., G.A. Lamberti, T.N. Pearsons, C.K. Tait, and J.L. Li. 1994. Cumulative effects of riparian disturbances along high desert trout streams of the John Day basin, Oregon. *Transactions of the American Fisheries Society* 123(4):627-640.
- Marshall and Associates. 2000. Anthropogenic impervious surface data in 4x4 grid cells derived from aerial photo analysis.
- May, C. W., R.R. Horner, J.R. Karr, B.W. Mar, E.B. Welch. 1997. Effects Of Urbanization On Small Streams in the Puget Sound Ecoregion. *Watershed Protection Techniques* 2(4):483-494.
- Naiman, R. J., H. Decamps, and M. E. McClain. 2005. *Riparian*. Elsevier Academic Press, Amsterdam.
- Osenberg, C. W., R.J. Schmitt, S.J. Holbrook, K.E. Abu-Saba, and A.R. Flegal. 1994. Detection of environmental impacts: natural variability, effect size, and power analysis. *Ecological Applications* 4(1):16-30.
- Timm, R. K., R.C. Wissmar, J.W. Small, T.M. Leschine, and G. Lucchetti. 2004. A Screening Procedure for Prioritizing Riparian Management. *Environmental Management* 33:151-161.
- Watson, M. K. 1978. The scale problem in human geography. *Geogr. Ann.* 60B:36-47.
- Wiens, J. A. 1976. Population responses to patchy environments. *Annual Review of Ecology and Systematics* 7:81-120.
- Wiens, J. A. 1989. Spatial scaling in ecology. *Functional Ecology* 3:385-397.
- Wiens, J. A., J.F. Addicott, T.J. Case, and J. Diamond. 1986. Overview: the importance of spatial and temporal scales in ecological investigations. Pages 145-153 *in* J. D. a. T. J. Case, editor. *Community Ecology*. Harper and Row, New York.
- Wissmar, R. C., D.C. Pflugh, and R.K. Timm. 2000. Changes in developed land cover (1991–1998): Cedar River, Washington. Pages 616 *in* a. R. L. B. P. J. Wigington, editor. *Riparian ecology and management in multi-land use watersheds*. American Water Resources Association, Middlesburg, Virginia.

Attachment 1. Summary of Potential Cumulative Impacts Associated with Proposed Shoreline Master Program

Proposed Shoreline Designation	Length (miles), area (acres) and Proportional Area (%) of Designation	Potential Change in Buffer (165-ft wide) Impervious Surface (see Table 5)	Major Types of Foreseeable Future Development Likely to Affect Shoreline Condition	Potential Impacts to Shoreline Ecological Processes	Proposed SMP and Other Regulatory Offsets (Regulatory Citation)	Non-Regulatory Offsets
Natural	304 mi., 7,230 acres (11.9%)	<p>Potential change in % buffer impervious surface ranges from 0% (lakes), 1.4% (rivers) to 1.8% (marine).</p> <p>On freshwater shorelines, no concentration of developable parcels in high quality areas. On marine shorelines, a small high density clump of developable parcels in Quartermaster Harbor and sporadic distribution of parcels along outer edge of Maury Island – along medium to high quality shorelines.</p>	No major changes expected due to predominance of public lands managed for wilderness and natural resource condition	None or slight improvement over time where historic land uses are removed and restoration occurs	<ul style="list-style-type: none"> • KC CAO (buffers, clearing limits, mitigation for all impacts, and roads and other infrastructure follow low impact design) and FHMP (zero-rise), • WDNR FPA rules (ESA HCP applies), WDFW HPA • US Federal Land Policy and Management Act, Northwest Forest Act, ESA, CWA, Federal Wilderness Act and Mt. Baker-Snoqualmie National Forest Plan. • Conditional Use Permit (with Ecology review) required for 1,000 sf expansion in buffer 	Forestry and rural stewardship programs, tax incentive and TDR programs
Forestry	921 mi., 21,569 acres (35.6%)	There is little potential change as there are very few developable parcels in this designation.	<ul style="list-style-type: none"> • No or only minimal changes expected due to predominance of lands in forestry and municipal uses. • Parcels are generally required to be at least 80 acres and limited non-forest related development is allowed • Very limited amount of new roads and other supporting infrastructure for residential development may occur 	<ul style="list-style-type: none"> • None or, at worst, very limited, infrequent and localized impact primarily to riparian vegetation and associated LWD and sediment processes caused by allowable development not able to be sited outside of regulatory buffer. • Limited construction of access roads and associated stream crossings 	<ul style="list-style-type: none"> • KC CAO (buffers, clearing limits, mitigation for all impacts, and roads and other infrastructure follow low impact design) and FHMP (zero-rise), • WDNR FPA rules (ESA HCP applies), WDFW HPA US Federal Land Policy and Management Act, Northwest Forest Act, ESA, CWA, Federal Wilderness Act and Mt. Baker-Snoqualmie National Forest Plan. • Conditional Use Permit (with Ecology review) required for 1,000 sf expansion in buffer 	Forestry and rural stewardship programs, tax incentive and TDR programs

Proposed Shoreline Designation	Length (miles), area (acres) and Proportional Area (%) of Designation	Potential Change in Buffer (165-ft wide) Impervious Surface (see Table 5)	Major Types of Foreseeable Future Development Likely to Affect Shoreline Condition	Potential Impacts to Shoreline Ecological Processes	Proposed SMP and Other Regulatory Offsets (Regulatory Citation)	Non-Regulatory Offsets
Resource	127 mi., 16,160 acres (26.7%)	There is little potential change as there are very few developable parcels in this designation.	<ul style="list-style-type: none"> Minimal to moderate changes possible due to potential for new mining and agriculture. Limited number of new roads and other supporting infrastructure for mining and agriculture activities may occur 	Agriculture and mineral activities may impact vegetation and soils, modifying hydrology, sediment, LWD and nutrient processes and creating new sources for pathogens and toxics	<ul style="list-style-type: none"> KC CAO (buffers, clearing limits, mitigation for all impacts, and roads and other infrastructure follow low impact design) and FHMP (zero-rise), WDNR FPA rules (ESA HCP applies), WDFW HPA WDNR Surface Mining Act Mitigation required for all impacts and roads and other infrastructure must follow low impact design. Conditional Use Permit (with Ecology review) required for 1,000 sf expansion in buffer 	Agricultural stewardship (farm plans) WDNR Surface Mining Act requires reclamation for all but a very limited set of mining activities
Conservancy	313 mi., 11,001 acres (18.2%)	<p>Potential change in % buffer impervious surface ranges from 4.8 (lakes), 1.8% (rivers) to 3.6% (marine).</p> <p>On rural lakes and streams, high concentrations of developable parcels in medium/high to high quality areas. On marine shorelines, low density and broad distribution of developable parcels along medium to high quality shorelines.</p>	<ul style="list-style-type: none"> No or only minimal changes expected due to predominance of lands in hazardous, ecologically or culturally significant condition. <p>Parcels with development potential are generally of sufficient size to be able to locate new development outside of shoreline and are required to remain in largely forested condition Limited number of new roads and other infrastructure for septic and water to supply residential development may occur</p>	Relatively limited, infrequent and localized impact primarily to riparian vegetation and associated LWD and sediment processes caused by allowable development not able to be sited elsewhere and limited construction of access roads and associated stream crossings. Agriculture and mineral activities may impact water quality	<ul style="list-style-type: none"> KC CAO (buffers, clearing limits, mitigation for all impacts, and roads and other infrastructure follow low impact design) and FHMP (zero-rise), WDNR FPA rules (ESA HCP applies), WDFW HPA Conditional Use Permit (with Ecology review) required for 1,000 sf expansion in buffer 	<p>Forestry and rural stewardship programs</p> <p>tax incentive and TDR programs</p> <p>FHMP and Salmon Recovery CIPs</p>
Rural	73 mi., 3,064 acres (5.1%)	<p>Potential change in % buffer impervious surface ranges from 11.6% for (lakes), 13.5 % (rivers) to 24.5 % (marine).</p> <p>On rural lakes and streams, high concentration of developable parcels in medium/low to medium/high condition. On marine shorelines, high concentration of parcels in Quartermaster Harbor and several clumps of parcels throughout marine shoreline – along low to medium/low condition drift cells.</p>	<ul style="list-style-type: none"> Minimal to moderate changes possible due to potential for: new residences, some of which may qualify for shoreline variance and be built in buffers, and expansion of up to 1,000 sq. ft for existing single family residential structures Limited number of new roads and other supporting infrastructure to accommodate new or expanded development 	New or expanded development may impact vegetation, LWD, sediment, hydrology, water quality, and light energy.	<ul style="list-style-type: none"> KC CAO (buffers, clearing limits, mitigation for all impacts, and roads and other infrastructure follow low impact design) and FHMP (zero-rise), WDNR FPA rules (ESA HCP applies), WDFW HPA. 	<ul style="list-style-type: none"> Rural stewardship programs tax incentive and TDR programs, Public involvement and education Open space acquisition, restoration and stormwater retrofit programs FHMP and Salmon Recovery CIPs

Proposed Shoreline Designation	Length (miles), area (acres) and Proportional Area (%) of Designation	Potential Change in Buffer (165-ft wide) Impervious Surface (see Table 5)	Major Types of Foreseeable Future Development Likely to Affect Shoreline Condition	Potential Impacts to Shoreline Ecological Processes	Proposed SMP and Other Regulatory Offsets (Regulatory Citation)	Non-Regulatory Offsets
Residential	23 mi., 1,127 acres (1.9%)	Potential change in % buffer impervious surface ranges from 23.4 (lakes) to 5.1 % (rivers). There is no marine Residential shoreline. On rural lakes and streams, high concentration of developable parcels along medium/low to medium/high condition shorelines. No developable parcels on marine shoreline.	<ul style="list-style-type: none"> Minimal to moderate changes possible due to potential for: new residences, some of which may qualify for shoreline variance and be built in buffers, and expansion of up to 1,000 sq. ft for existing single family residential structures Limited number of new roads and other infrastructure will be built to accommodate new or expanded development 	New or expanded development may impact vegetation, LWD, sediment, hydrology, water quality, and light energy.	<ul style="list-style-type: none"> KC CAO (buffers, clearing limits, mitigation for all impacts, and roads and other infrastructure follow low impact design) and FHMP (zero-rise), WDFW HPA 	<ul style="list-style-type: none"> Rural stewardship programs tax incentive and TDR programs, Public involvement and education Open space acquisition, restoration and stormwater retrofit programs FHMP and Salmon Recovery CIPs
High Intensity	5 mi., 446 acres (0.7%)	There is little potential change as there are very few developable parcels in this designation.	<ul style="list-style-type: none"> Minimal changes expected due to high level of existing development. Limited potential for: new residences, some of which may qualify for shoreline variance and be built in buffers, and expansion of up to 1,000 sq. ft for existing single family residential structures Small amount of new roads and other infrastructure expected because most are already in place. 	Conditions expected to stay the same or improve somewhat over the existing baseline because new development or redevelopment will have to follow higher standards for environmental protection than was required of the older, existing development.	<ul style="list-style-type: none"> KC CAO (buffers, clearing limits, mitigation for all impacts, and roads and other infrastructure follow low impact design) and FHMP (zero-rise), WDFW HPA 	<ul style="list-style-type: none"> Public involvement and education Open space acquisition, restoration and stormwater retrofit programs FHMP and Salmon Recovery CIPs

Proposed Shoreline Designation	Length (miles), area (acres) and Proportional Area (%) of Designation	Potential Change in Buffer (165-ft wide) Impervious Surface (see Table 5)	Major Types of Foreseeable Future Development Likely to Affect Shoreline Condition	Potential Impacts to Shoreline Ecological Processes	Proposed SMP and Other Regulatory Offsets (Regulatory Citation)	Non-Regulatory Offsets
Aquatic	N/A	N/A	<ul style="list-style-type: none"> • Minor change (positive and negative) possible due to implementation of the FHMP (a positive) but off-set by limited number of new docks and localized, limited use of dredging and bank armoring for emergency, private residence and critical facility protections • Piers and Docks Expect few proposals for new marine docks on Vashon. Some new docks will be proposed on freshwater lakes. • Bulkheads Expect some requests for new bulkheads or other shoreline stabilization, especially after winter storm events. • Aquaculture Rarely proposed. • Live aboards None are allowed under current shoreline regulations; as proposed will be limited to marinas. • Ditch maintenance Few new proposals not covered by agricultural drainage assistance program or roads maintenance programmatic shoreline exemption. • Marinas Limited to Vashon Island, and there are few suitable locations. 	<ul style="list-style-type: none"> • Future conditions always difficult to predict --- may stay the same or decline somewhat over the existing baseline because some new development in or along water is expected. • Alternatively, implementation of the FHMP could provide net improvement in river shoreline conditions due to construction of flood hazard reduction projects that remove, set-back or modify existing flood control structures and floodplain development. • Construction of docks and piers could adversely impact shoreline processes and fish and wildlife habitat. • New bulkheads or other shoreline stabilization could adversely impact shoreline processes. • Aquaculture can adversely affect critical saltwater habitat and shoreline processes. • Live-aboards could contaminate water quality and adversely impact habitat. • Ditch maintenance can adversely impact wetlands and habitat. • Marinas may contaminate water quality, and adversely affect water quality and shoreline processes. 	<ul style="list-style-type: none"> • KC CAO (buffers, clearing limits, mitigation for most impacts, and roads and other infrastructure follow low impact design 21A.24) and FHMP (zero-rise), • Piers and Docks - Conditional Use Permit required for new docks and piers in Conservancy, ForestryResource shorelines, not allowed in Natural shorelines. Marine docks only allowed where no feasible alternative exists, including moorage buoys. Freshwater docks limited in CAO by presence of wetland vegetation. New criteria for size, location, construction methods, New compensatory mitigation requirement. • Bulkheads and other shoreline stabilization – strict criteria for new shoreline stabilization, including imminent hazard, and evaluation of nonstructural alternatives. • Aquaculture – Strict new criteria to protect critical saltwater habitat, water quality, substrate, and shoreline processes. • Marinas and Live-Aboards – Live-aboards only within marinas, with no sewage discharge to the water. Marinas limited to High Intensity, Residential, Rural and Aquatic shorelines with Conditional Use Permit. • Ditch Maintenance – Allowed subject to Best Management Practices under CAO. No shoreline exemption required for agricultural ditch maintenance within the agricultural production district with an HPA and in compliance with the County's Agricultural Drainage Assistance Program. Conditional Use Permit required for disposal of dredged material in shorelands. 	<ul style="list-style-type: none"> • Public involvement and education • Open space acquisition, restoration and stormwater retrofit programs • FHMP and Salmon Recovery CIPs

Attachment 2. Summary of Potential Change in Buffer Impervious Surface on Developable Parcels

Designation*	Shoreline Type	Existing Conditions				Potential Future Conditions (1,000 sf added to the buffer of each developable parcel)**						
		Average Shoreline Parcel % Impervious	Acres of Existing Impervious Surface in Buffer including hazard areas	Average Shoreline Buffer % Impervious including hazard areas	# Parcels with Existing Impervious in Buffer	# of Parcels with Existing Impervious in Buffer outside of Hazard areas	Acres of Potential Future Impervious Surface in Buffer, including hazard areas	Potential Future Average Buffer % Impervious, excluding hazard areas	Potential Future Average Buffer % Impervious, including hazard areas	Potential Future Average Parcel % Impervious including hazard areas	% of Total Parcels Potentially Affected	Total Parcels in Each Designation and Type
Conservancy	Lake	13.0	45.6	16.9	564	510	58.6	21.5	21.7	15.1	65.8	775
	Marine	7.4	14.2	8.2	274	74	20.5	9.6	11.8	10.2	17.1	434
	Stream	9.2	212.9	9.8	1,685	1,496	251.7	11.8	11.5	10.0	51.6	2,897
Natural	Lake	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0.0	0.0	14
	Marine	4.9	12.2	4.7	196	57	16.7	5.2	6.5	6.3	13.5	422
	Stream	1.5	0.9	1.6	34	21	1.6	2.2	3.0	1.9	9.8	215
Residential	Lake	25.8	56.4	12.5	779	708	74.3	34.6	35.9	31.6	73.1	968
	Stream	23.2	22.2	20.6	238	233	27.7	27.2	25.6	25.1	65.3	357
Rural	Lake	14.6	21.6	10.7	379	373	30.4	22.1	22.3	18.5	60.7	614
	Marine	21.3	93.5	5.1	1,312	624	123.7	33.4	29.6	27.1	41.4	1,507
	Stream	11.8	54.4	0.1	428	404	64.2	14.2	13.6	12.7	47.1	857
Forestry	Lake	3.5	6.5	3.4	12		6.5					49
	Stream	3.4	137.2	3.3	263		137.2					710
High Intensity	Lake	85.0	1.5	63.5	3		1.5					3
	Marine	27.3	1.0	31.3	22		1.0					24
	Stream	70.7	48.7	62.0	78		48.7					105
Resource	Marine	6.1	1.4	6.8	4		1.4					5
	Stream	7.2	94.4	0.5	361		94.4					695
Total Acreage			824.4				959.8					
Overall Buffer % Impervious***				8.0				9.4				

* There is minimal opportunity for use of the 1,000 sf expansion standard in the Forestry, High Intensity and Resource designations; these designations are excluded from the analysis.

**Exclude publicly-owned parcels and parcels that are in landslide hazard areas or severe channel migration zone.

***There are 10,258 total acres in the 165-foot buffer in King County's shoreline jurisdiction.