Steep Slope Hazard Areas

What are steep slope hazard areas?

King County Code (KCC) defines steep slope hazard areas as slopes that exceed 40 percent inclination (about 21 degrees) and have a vertical elevation change of at least 10 feet (see KCC 21A.06.1230). This equals any ground surface with at least 10 feet in vertical rise over 25 horizontal feet. In unincorporated King County, most steep slopes are made of soils deposited by ice and water during previous glacial cycles of the ice age, or Pleistocene period, more than 10,000 years ago. These areas have greater potential risks resulting from slope instability, landsliding, or erosion.

The Department of Local Services, Permitting Division (Permitting) is responsible for determining the existence, location, and classification of critical areas including steep slope hazard areas during review of a permit application or Critical Area Designation. Permitting is also responsible for determining whether a permit application complies with the standards and regulations in KCC 21A.24.

What development standards apply to steep slope hazard areas?

Development proposals and alterations on sites containing steep slope hazard areas are subject to development standards in KCC 21A.24.310.B. Those standards can be summarized as follows:

1. **A buffer is required from all edges of a steep slope hazard area**. The buffer is the preferred regulatory tool to eliminate or minimize the risk of property damage or injury resulting from the steep slope hazard area. Permitting is responsible for determining the width of the buffer, based on the data and recommendations given in a geological critical area report. Several factors influence the buffer width required for a steep slope hazard, including but not limited to the overall height of the slope, steepness, soil or rock types, groundwater, drainage, vegetation, erosion, building loads, and earthquake forces.

   In most cases, the minimum buffer allowed without a geological critical area report is 50 feet. Consequently, if development is located outside the buffer and critical area setback is more than 65 feet from a steep slope hazard area, a geological critical areas report is not required.

   For most coastal bluffs that qualify as steep slope hazard areas, the toe of the slope is in the sea level rise risk area, and the minimum buffer allowed without a geological critical area report increases to 75 feet.

2. **Removal of any vegetation from a steep slope hazard area or associated buffer is generally prohibited**. Specific exceptions for allowed alterations to steep slope hazard areas are given in KCC 21A.24.045.

3. **The risk of property damage or injury resulting from slope instability shall be eliminated or minimized**. For most developments, the risks are minimized by avoiding the hazard area by means of a steep slope hazard buffer. The buffer must be wide enough to locate development outside the area which could decrease stability or otherwise be threatened by the steep slope. How to evaluate slope instability is discussed in more detail, below.

   For development allowed within the steep slope hazard area and buffer (see KCC 21A.24.045), a permit application still must demonstrate that the proposal—including construction methods—will minimize risks and not destabilize the steep slope. Geotechnical engineering such as retaining walls or deep foundation elements may be necessary as mitigation to minimize impacts in these circumstances.

4. **Development is required to comply with the recommendations given in a geological critical area report.** A geological professional may give specific conditions necessary to minimize risks. If Permitting geological review agrees that the recommendations meet critical area standards and regulations, those requirements and recommendations must be implemented in a development proposal.

How to assess slope instability and landsliding?

A steep slope hazard area is a balancing act of competing forces. Slopes are subject to many destabilizing forces—scour from wind and water, hydrostatic pressure from groundwater, intermittent seismic shaking, and most importantly, gravity. Conversely, slopes must internally resist these forces—the resisting forces are commonly expressed as friction and cohesion (stickiness). Where the disturbing forces are greater than the resisting forces, the slope is considered unstable and at risk of failure.

Slope failure, or landsliding, comes in a variety of forms including shallow instability where the weathered ground surface slides off of more competent unweathered soils as well as deep-seated instability where large blocks of earth can move downhill. Both forms are hazardous; on average, local soils weigh about 130 pounds per cubic foot, so you can imagine it does not take a large volume of moving soil to threaten people or property.

Permitting geological review regularly requests that quantitative slope stability analyses be provided in the geological critical area report to evaluate slope stability. The standard method of quantitative slope stability analysis is a “limit equilibrium analysis” and multiple software programs have been developed to run these analyses. The output of a limit equilibrium analysis is the ratio of resisting forces to disturbing forces, which is called the factor of safety (FS). The boundary condition between

stability and instability is where the resisting forces are equal to the disturbing forces; this condition is known as the limit equilibrium state and is expressed as FS=1.0.

For purposes of design, KCC 21A.24.310.B.3 follows the regional industry standard and specifies that:

> *The risk of slope instability shall be considered to be minimized where a slope stability analysis demonstrates the factor of safety to exceed 1.5 for static conditions and 1.1 for seismic conditions. […]*
>
> *seismicity shall be modeled as a horizontal force equal to one half the peak ground acceleration adjusted for site class effects, or PGA_m, as given for the site in the International Building Code and American Society of Civil Engineers 7 standard*

The design FS is higher than the limit equilibrium state of FS=1.0 to account for and mitigate potential uncertainties between the model (both input parameters and shortcomings of the methodology) and the reality the built-out condition will have to withstand. Applying factors of safety for design that are more conservative than our best estimate of reality is a fundamental engineering practice.

King County Code does provide an exception to the standard criteria for a slope stability analysis for when a more detailed deformation analysis is conducted. Geological professionals that are considering a more detailed analysis are recommended to contact Permitting geological staff prior to permit submittal.

Permitting geological staff do not require quantitative slope stability analysis for all steep slope hazard areas. In some cases, a buffer reduction can be justified based on alternative qualitative reasoning such as the geometry of smaller steep slopes or steep slopes formed of more stable materials like bedrock.

How to assess erosion?

Erosion is also a hazardous aspect of steep slope hazard areas. Erosion of soil on or near slopes can steepen slopes and worsen slope instability risks or contribute debris to potential landslides. Over time, erosion rates may cause steep slope hazard areas to retreat towards developed areas. Steep slopes also provide a natural ecological function of contributing sediment and woody material to aquatic habitats that provides spawning habitat for fish and regulates stream flow.

King County recognizes that in most cases, the best way to balance public safety with environmental functions and values is to allow steep slope hazard areas to erode naturally. The use of buffers from all sides of the steep slope hazard area both preserves native trees and vegetation that stabilize the soil and isolates steep slope from the effects of nearby development. The buffer also protects proposed development from risks associated with continued erosion over time.

When proposing a reduced steep slope buffer to accommodate a development proposal, geologic professionals must factor in erosion rates over time and minimize impacts to native vegetation on a slope in addition to slope stability analysis.

What alterations are allowed in steep slope hazard areas and buffers?

In general, development is generally restricted within steep slope hazard areas and buffers to minimize impacts to stability and conserve native vegetation. However, exceptions for some specific types of development, or alterations, are given in KCC 21A.24.310.A.

Any alteration may be “exempted” and allowed within steep slope hazard areas that are under 20 feet in height. Similarly, alterations to steep slope hazard areas created by previous legal grading may be allowed. To qualify for either exception, Permitting geological reviewers must agree with a geological critical area report which has analyzed the slope and demonstrated that there is no impact. In many cases, engineering may be proposed as mitigation to eliminate any potential impact.

For all other steep slope hazard areas and buffers, allowed alterations are listed by category in a table found in KCC 21A.24.045.C. These categories include allowances for certain projects involving structures, grading, utilities, roads, recreation, and agriculture. If an alteration is allowed, specific conditions are given in KCC 21A.24.045.D. Each of the applicable conditions must be met in addition to the steep slope development standards, the proposed alteration to be allowed within a steep slope hazard area or buffer.

Any allowed alteration must meet the development standards for steep slopes, specifically demonstrating that risk of property damage or injury resulting from slope instability shall be eliminated or minimized for the proposal. The allowed alteration must also apply the avoidance and mitigation sequencing in KCC 21A.24.125 as well as any other applicable standards and regulations of KCC 21A.24 to be allowable.

Where can I find more information?

More information regarding critical areas is available on our website.

- Geological Critical Area Report Requirements

For most areas in unincorporated King County, the iMap GIS webpage contains a mapping layer of areas likely to qualify as steep slope hazard areas.

For more information, visit our customer service page.

For complex projects or projects potentially constrained by steep slope hazard areas or buffers, we strongly recommend you apply for a **voluntary pre-application meeting** and submit a geological critical area report for feedback from Permitting geological review staff. It’s often valuable to present your conceptual development proposal and receive comments during the preliminary design phase to gain a better understanding of regulations that will impact project design and feasibility. This

information early in a project can reduce the time and expense of redesigns or infeasibility later in the permitting process. An applicant may also choose to receive comments from additional review staff if related to their proposal.

- Pre-application Meeting Information