SLOPE STABILIZATION

The extensive shoreline, mild maritime climate and diversity of landscape make western Washington an attractive place to live and work. However, increasing human habitation in an area with high precipitation can create problems. In an undisturbed state, the soils of western Washington are light and permeable to water; however, as people move into formerly undisturbed areas and start developing them, soils are often compacted by use of machinery, stripped away so as to provide a stable base for construction, or covered over with blacktop, cement or buildings. Any of these activities can increase surface runoff of water ("overland flow"), which flows towards water bodies such as lakes, rivers or the ocean. Owners of water-front properties are therefore impacted by accumulated runoff from upland properties as well as from their own property. After a heavy rainfall this can be a considerable amount of water, which can increase the likelihood of soil erosion and landslides ("mass movement"); these events can cause property damage and even loss of life. Owners of property on bluffs, slopes or cliffs can reduce the likelihood of erosion or mass movement if they understand the role played by plants in maintaining slope stability, and manage their vegetation accordingly. In order to understand this role we will need to briefly examine some geology and hydrology, then return to plants.

GEOLOGY

Our region is geologically young and most of our soils are underlain with glacial till (often referred to as "hardpan"), which was deposited about 13,000 years ago when the last glaciers retreated. This somewhat impermeable layer is overlain with a layer of weathered material, of varying thickness, which was formed mainly by the biological action of plants breaking up the till and depositing organic material, forming soil. This upper layer, in an undisturbed state, is quite permeable to water.

HYDROLOGY

Water enters our ecosystems as precipitation (rain, snow, hail or fog). After water lands on a hill slope it moves downhill and eventually enters the ocean. From there it is evaporated into the atmosphere, eventually it becomes precipitation, and the cycle starts over again. There are several pathways by which water can move down slopes, and the pathway taken is dependent on two things: intensity of rainfall and infiltration capacity, or the rate at which water is absorbed by the soil. If rainfall intensity exceeds infiltration capacity, the water will flow downhill on the surface, as overland flow. If the infiltration capacity exceeds the rainfall intensity, the water will flow downhill underground, either as shallow subsurface flow, or as groundwater. If the ground becomes saturated, this subsurface flow can reappear further down the slope as a seep or spring, known as "saturation return flow." Overland flow is responsible for erosion of slopes and subsurface flow can cause mass movement such as landslides. We will look at each of these processes in more detail.

Erosion

As each raindrop strikes the earth's surface, a few grains of soil are displaced on all sides; those which are displaced on the downhill side move further, because of gravitational force. This starts the process of erosion, which is continued when water runs down a hillside, carrying soil particles with it. Because ground varies in its erodibility and because water takes the path of least resistance, rills and gullies form. In a rill or a gully erosion takes place on three sides, so the formation of them increases the amount of soil being eroded.

Mass Movement

Mass movement is defined as the downslope movement of soil under its own weight. Subsurface water can be a factor in this process, partly because it increases the weight of the soil mantle. It also gives the soil lift and buoyancy, reducing contact with the underlying matter and thus enabling it to move downhill more easily.

These two processes are connected, because surface erosion can concentrate surface water, creating steeper slopes which are more prone to mass movement. Reducing erosion may also reduce the likelihood of mass movement.

VEGETATION

Vegetation modifies the simple form of the hydrologic cycle which was presented above. It does this in several ways, all of which reduce the amount of water actually present on a slope at any time. Firstly, in a vegetated area the plants intercept some of the precipitation before it reaches the soil. Often a considerable amount of water can be stored on the surface of leaves and stems, as anyone who has walked through a forest in western Washington after a rainstorm can testify. Some of this water will eventually drip from the vegetation and reach the ground, but it may do so after the peak of the storm has passed. Some of it will be evaporated from the leaves or stems and return to the atmosphere without reaching the ground.

Plants transpire through their stems and leaves; the water lost through transpiration is replaced by water obtained from the soil by capillary action. Hence the amount of surface water and, in the case of deep-rooted plants, the groundwater is reduced.

As well as reducing the amount of water present on a slope, vegetation can increase the stability of the slope because large plants can act as a physical barrier, slowing the rate of overland flow or buttressing a slope and possibly reducing the extent of mass movement. More significantly, roots bind the soil together; fine roots near the surface can reduce the likelihood of surface erosion, and deeper root networks can bind together different soil layers into a larger unit which can increase strength and reduce potential for failure. Contrary to what many people believe, the roots of large trees spread far beyond the dripl ine (an imaginary line under the edge of the canopy). In fact, fine

feeder roots, which are normally in the upper twelve inches of the soil, can spread two or three times as far as the drip line, and roots of different trees of the same species can graft together forming a strong lattice with great soil-holding capability.

MANAGEMENT OF VEGETATION

Property owners sometimes cut down trees on slopes, under the belief that reducing the weight on the slope will increase its stability. There is also a belief that tall trees can act as levers in windstorms, transferring the wind energy to the soil, causing the tree to uproot and possibly precipitate a land movement. Whilst this situation can occur, empirical evidence has shown that the overall benefit of trees on slopes exceeds the problems they can create. It is not usually good practice to remove a healthy tree from a slope, and concerned property owners should consult a qualified arborist or environmental expert before taking any such action.

Trees are also sometimes removed from slopes by property owners in order to enhance the view. In general, when trees are removed their roots will die after a few years and the soil-holding capacity will be lost. There are however some broad-leafed tree species, which can be cut down close to the ground without killing the tree; the stump will sprout and the root system will stay intact, continuing to bind the soil together. This ability can be utilized in some areas, but the work should be done by a qualified person.

In cases where erosion or mass movements have stripped vegetation from a slope, it can be replanted. If this is done well, preferably using native plant species, the aesthetic appeal and the stability of the slope can be improved. There are many factors to consider when undertaking this type of work, and it should be done by professionals.

Relationships between plants, soils, water and climate are complex. When water front property is in jeopardy, the stakes are sometimes very high and the more information an individual has, the better able he or she is to make a wise decision. Those desiring more information should consult the three excellent booklets put out by the Washington State Department of Ecology. Their titles are:

Surface Water and Groundwater on Coastal Bluffs:
A Guide for Puget Sound Property Owners.

Slope Stabilization and Erosion Control Using Vegetation:
A Manual of Practice for Coastal Property Owners.

Vegetation Management:
A Guide for Puget Sound Bluff Property Owners.

http://www.northwestarborist.com/