**Overall Relief Classes**

**Hills and Valleys:**

**Hills** [Landscape Term] A natural elevation of the land surface, rising rather prominently above the surrounding land, usually of limited extent and having a well-defined outline (rounded rather than peaked or rugged), and generally considered to be less than 300 m from base to summit; the distinction between a hill and a mountain is arbitrary and dependent on local usage. (Bates and Jackson, 1995)

**Valley** [Landscape Term] (a) Any low-lying land bordered by higher ground; esp. an elongate, relatively large, gently sloping depression of the Earth's surface, commonly situated between two mountains or between ranges of hills or mountains, and often containing a stream with an outlet. It is usually developed by stream erosion, but may be formed by faulting. (b) A broad area of generally flat land extending inland for a considerable distance, drained or watered by a large river and its tributaries; a river basin. (Bates and Jackson, 1995)

**Lowland:**

**Lowland** [Common Landform and Landscape Term] (a) A general term for low-lying land or an extensive region of low land, esp. near the coast and including the extended plains or country lying not far above tide level. (b) The low and relatively level ground of a region, in contrast with the adjacent, higher country; e.g. a vale between two cuestas. (c) A low or level tract of land along a watercourse; a bottom. (Bates and Jackson, 1995)

**Mountains:**

**Mountain(s)** [Common Landform (singular), Landscape Term (plural)] (a) Any part of the Earth's crust higher than a hill, sufficiently elevated above the surrounding land surface of which it forms a part to be considered worthy of a distinctive name, characterized by a restricted summit area (as distinguished from a plateau), and generally having comparatively steep sides and considerable bare-rock surface; it can occur as a single, isolated eminence, or in a group forming a long chain or range, and it may form by earth movements, erosion, or volcanic action. Generally, a mountain is considered to project at least 300 m above the surrounding land. (b) Any conspicuous or prominent elevation in an area of low relief, esp. one rising abruptly from the surrounding land and having a rounded base. (c) A region characterized by mountains; term usually used in the plural. (Bates and Jackson, 1995)

**Plains:**

**Plain** [Landscape Term] A general term referring to an extensive, lowland area that ranges from level to gently sloping or undulating. A plain has few or no prominent hills or valleys, and usually occurs at low elevation relative to surrounding areas. (Bates and Jackson, 1980)

**Plateau:**

**Plateau** [Landscape Term] Any comparatively flat area of great extent and elevation; specifically an extensive land region considerably elevated (more than 150-300 m in altitude) above the adjacent country or above sea level; it is commonly limited on at least one side by an abrupt descent, has a flat or nearly smooth surface but is often dissected by deep valleys and surmounted by high hills or mountains, and has a large part of its total surface at or near the summit level. A plateau is usually higher and has more noticeable relief than a plain (it often represents an elevated plain), and is usually higher and more extensive than a mesa; it may be tectonic, residual, or volcanic in origin. (Bates and Jackson, 1995)

**Volcanoes:**

**Volcano** – (a) A vent in the surface of the Earth through which magma and associated gases and ash erupt; also, the form or structure, usually conical, that is produced by the ejected material. (b) Any eruption of material, e.g., mud, sand, etc. that resembles a magmatic volcano. NRCS

**PLATEAU LANDFORMS ASSOCIATIONS**

**Angulate Plateaus** are characterized by having a strong prominent system of joints and faults at other than a right angles. Typically these are normal faults with small amounts of lateral displacement. The faulting has created positive (uplands) and negative (drainages) patterns with repeating topographic elements. These plateaus are characterized by numerous faults over a broad area up to several kilometers in extent.

Angulate plateaus have a high drainage density with many ephemeral channels. Streams are captured and redirected by displacement of the faults blocks. The rearrangement and redirection of precipitation runoff by the fault blocks gives a zig-zag appearance to catchment channels. The faults are zones of weakness and set up water flows along these zones. Angulate Plateaus are more highly weathered than faulted incised plateaus. Slopes are developed by degradation and erosion of the plateau. Deeper canyons develop than would be expected because of the captured discharge. Sediment is sometimes impounded by fault scarps, in closed depressions, and at locations with lower slope angle. In these pockets of sediment accumulation there is increased soil development.

**Collapsed Plateaus** consists of plateaus that are dominated by landslides, with hummocky poorly-drained, chaotic fallen bedrock blocks that divert the main-axis river channel. Collapse of plateaus lowers their overall slope. Landslide areas can cover many miles and may be from the pre-historic past or a recent and current development. Water routing through this landscape may be irregular due to recent and on-going slope failure with its accompanying surface and subsurface drainage diversions and impoundments. Sediment recruitment by streams is significant along the margins of collapsed plateaus. Sediment and water storage (such as a lake, meadow and or plain - current or historic) is locally significant upstream of collapsed landslide toes. Because of irregular slopes and varied surface water availability, this LfA has a most diverse upland habitat. The slide areas can hold deep soils, retain moisture and provide micro-climates that offer a variety of excellent resources for numerous floral and faunal communities.

**Faulted Incised Plateaus** are narrow and elongate plains cut by parallel and sub-parallel faults. Typically these are normal faults with small amounts of lateral displacement. The faulting has created positive (uplands) and negative (drainages) patterns with repeating topographic elements. These plateaus are characterized by numerous parallel faults over a broad area up to several kilometers in extent.

The drainages in the faulted incised plateaus are captured and redirected by displacement of the faults blocks. The rearrangement and redirection of precipitation runoff by the fault blocks gives a zig-zag appearance to catchment channels. The faults are zones of weakness and set up water flows along these zones. Slopes are developed by degradation and erosion of the plateau. Deeper canyons develop than would be expected because of the captured discharge. Sediment is impounded by fault scarps, in closed depressions, and at locations with lower slope angle. In these pockets of sediment accumulation there is increased soil development.

There are bedrock slopes that have appeared because of tectonic activity not erosion. These slopes have little if any soil mantle developed. The tectonic created slopes are steeper than the angle of repose of slopes created by erosion. The slopes in this landform are a mix of steep (tectonic) and not so steep (erosion processes) slope. There are valleys with flows that have been diverted or captured flow by other drainages. These captured or diverted drainages are essentially “hanging valleys”. These hanging valleys have sheet flow at a reduced rate and sediment transport is reduced.

**Incised Plateaus:** The Columbia River and associated basalt flows constitute one of the largest flood basalt flows in the world. The basalt flows emanated from a series of fractures in the earth surface. Initially they created a broad, nearly level plateau up to 8000 to 9000 feet thick that covered an area of 77,000 square miles across eastern Oregon and southwest Washington (Orr and Orr, 2012). Much of the plateau is without a perennial sources of water.

Incised refers to landscapes and landforms that retain their outlines and the majority of their mass but are experiencing and initial alteration of form due to weathering. Depending on stage of erosion, plateaus will manifest varying degrees of incision. Initially water is transmitted directly below ground through a series of fractures in the flow. As the original basalt flows weather, surface runoff increases. Fluvial erosion processes intiate incision and ephemeral stream channel formation. With increased weathering and erosion, runoff of snowment and precipitation dominates and deep incisions occur at weak points in the basalt flows. The plateau becomes highly incised, eventually giving way to deep incision of canyons which headcut back into the plateaus over time.

Figure XX: Noller depiction of landform relationships based on degree of weathering and erosion and runoff from the landscape.

**Verrucated Plateaus** have a hummocky, warty morphology, including common hillocks and poorly organized to tortuous drainages, but cannot be definitely ascribed to mass failure as the dominant surface process. Origins for this type of LfA include ancient landslides that have been eroded, such as exhumed deep-marine landslides incorporated in a bedrock formation, or exhumed ancient volcanic flows in bedrock strata. As such, the hummocky terrain is associated with eroded portions of the landscape. Verrucated plateaus include portions of incised or angulate plateaus where the underlying strata have not been exposed or reactivated. In this map unit, drainages are poorly integrated, leading to variable routing of surface water through this type of landscape, seeps and springs occur as a result. Because of irregular slopes and aspects, as well as varied surface water availability, this LfA has a diverse upland habit.

HILLS AND VALLEYS

**Canyonlands** are an extensive landform north of the Wallowa Mountains. They are low linear concave features that at the base have a fluvial channel that may or may not be active. The active process that is visible may not be the original process that formed the feature. The magnitude at present may not be representative of the magnitude in the past. A central active channel is cutting a narrow slot that erodes or causes the collapse and mass movement of material to the channel where water flow removes it. Rock removal occurs because of slope mass collapse or movement. Recognition of the different processes occurring along the walls of the feature parallel to the current river or stream is what differentiates these features from one another.

In the Blue Mountains, canyonlands have repeating elements from river to terraces to hill-slopes up to a ridge and then downslope in reverse in the next catchment. These repeating elements continue across the landscape for hundreds and sometimes thousands of acres. The thin bedded Columbia River Basalts give a horizontal to sub horizontal ridge swale going down a steep rocky slope. The benched landscape is cut by small drainages or gullies so that much of the canyonlands are dominated by right angles in the drainages. Limited by the rate the resistant basalt bedrock is decomposed very thin soil if any soil at all is present as a result, sediment supply is limited from this LfA. The horizontal strata intercepts what sediments and thin soils form in wedges on some of the benches. These increase in thickness as you move downslope. Canyonlands have predominantly droughty soil conditions. However, the colluvial soil in lower landscape positions trap water and sediments. This can result in well-developed soils that hold moisture and facilitate better vegetation, timber and habitat. In this colluvial terrain positive landforms have developed overtime changing from concave to convex. This colluvial terrain is often neglected and is a source of excellent habitat . Soils found on hilltops are deep and those by depressions or ponds are thin, counter to expectation. On the project scale these are areas with great heterogeneity so planning and review needs to be site specific and site verified.

**Coastal Fluvial Valleys**- located in a region of tidal influence, the tidewater area. Tides may have no influence or affect the fluvial processes for many miles upstream depending on stream gradient in relation to sea level. Coastal Fluvial valleys within the diurnal tide cycles have attenuated hypoheriec flow and the daily ingress and egress of the tide intensify the moisture effect in soils and soil development. Estuaries with wide low-lying channels and terraces, within the tidal range develop a sinuous character and are richer in organic material from the twice-daily influx of nutrients from the ocean. Soil pores aerate and flood with each change in the tide. The Coastal Fluvial Valleys fade or die as they merge with the bay or estuary.

**Coastal Hills** - the term Coastal refers to features and landforms adjacent to the modern coast, slopes, hills and mountains facing or having a general aspect toward the ocean. The ocean acts as a moderating factor on temperature and temperature fluctuations. These landforms are within the “fog belt” and the marine influence of moisture and moderate temperatures enhances soil development. These landforms drain to the ocean and are parallel or sub-parallel to the coast. The general aspect of coastal landforms faces prevailing winds, are moisture blocking and combined with a moderate temperature regime enhances weathering and creates an environment with high forest productivity and biodiversity. The weathering leads to landforms with steep relief, instability, and dense vegetation. The soils are isomesic in Oregon and isofrigid in Washington. Spodosols, Ultisols and Andisols dominate along the coastal terrain of the Pacific Northwest. Bioturbation, wind-throw churning and salt fluxes all contribute to the hastening of soil development in coastal landforms.

**Fluvial Valley** - Characterized by a broad valley floor, a plain related to a watercourse with broad terraces and parallel or sub parallel boundaries. The width of the feature is at 60 meters or more. The valley is mostly contiguous with a direct relation between the flowing water and the plain.

Soil will have redox features from numerous wet/dry cycles, high primary productivity due to low slope angle, sufficient moisture, and well-developed soils with generous amounts of organic matter. In and near the channel sandy well-drained soil expedites hypoheriec flow. The dynamic nature of the channel and water level fluctuation creates lakes, sloughs as well as seasonal and permanent wetlands adjacent to the stream and in currently abandoned streambeds. Mollisols, Inceptisols, are common as well as Andisols and Alfisols depending on parent material and elevation above the valley floor.

**Fluvial Terraces -**  A step-like surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, lake or sea shore. The term is usually applied to both the relatively flat summit surface (tread), cut or built by stream or wave action, and the steeper descending slope (scarp, riser) graded to a lower base level of erosion.

**Fluviolacustrine Deltas** form where river systems deposit into a lake. They are complex landforms due to the varying lake levels into which they are deposited. The particle size deposited varies by what the river system is transporting. Once in the lake sediments are sorted with the coarser particles in the channels and the finer particles in the levees. These sediments mix with the diatomateous earth and fine paticles that form the lake substrates.

A **Glacial Valley** includes both the glacial valley bottom and sideslopes of the glacial valley wall. Often the landform is too narrow to be characterized solely as a Glacial Valley Bottom.

The sideslopes accumulate the basal and lateral till of the valley glacier. The area experienced immediate post glacial redistribution of valley side till through colluvial deposition, debris flows, and sheet flow with deposition onto the valley floor. Many areas of the valley walls are exposed to bedrock as a result. There are pockets of lateral moraines with fluvial deposits between them. Seeps and springs emerge in the colluvial material and associated with till deposits.

Glacial Valley Bottoms are those fluvial valleys that are found upstream of paleo-glacial moraines. Glacial Valley Bottoms are fluvial valleys with areas of glacially deposited sediments and scours mixed in with fluvial aggradation and erosion. This mélange makes discerning what is fluvial and what is glacial difficult. The glacial influence predates that fluvial in most locales. A meander plain that varies with watercourse sinuosity dominates the landform. Remnant moraines can detour or dam the stream channel creating valley lakes. In a Glacial Valley Bottoms where drainages meet, stream confluence is often downstream of what topography would indicate due to the presence of ancient medial moraines acting as a barrier. The confluence of waters is delayed for yards or sometimes miles. Heterogeneity of sedimentation is common rather than unusual with the glacial scouring and deposition intermingled with fluvial aggradation and degradation along the valley floor. These are droughty soils, quickly draining; in a climate with sufficient moisture they can be relatively productive.

**Gorges** are deep, box-shaped valleys created by higher than normal discharges. These gorge-forming discharges are the result of a restriction or stoppage of normal flows upstream of this landform that upon release create a catastrophic flood. The gorge-forming flows originate from a landslide formed lake, which was catastrophically breached, or a glacier dammed lake breaching the restricting ice, as in the Missoula Floods. A gorge is identified by its vertical or overhanging walls, narrow slotted shape and higher relief slopes than the canyon or valley adjoining or bounding it. Gorges are spatially shorter along a channel reach than a canyon or valley. More??

**Hills and Valleys** - In a broad plain a prominence is most likely a hill. In some cases these hills may have been mountains that due to weathering, an adjacent uplift or surrounding deposition have a reduced prominence and are now hills. In glacial valley bottoms more resistant portions of the bedrock that the ice rose over will leave behind a hill or series of hills. Hills are associated with valleys and a series of hills will have saddles joining them. Hills offer a vantage point for predators and shelter for prey. They can be islands of biodiversity in a landscape where areas of lower relief have been extensively modified.

**Meander Belt -**  The meander zone is that area along a valley floor across which a meandering stream shifts its channel from time to time, specifically the area of the flood plain included between two lines drawn tangentially to the extreme limits of all fully developed meander. It may be from 15 to 18 times the width of the stream (BJ 1995, FS Geomorph). A meander belt is a deep to very deeply incised meander plain; it contains similar landforms to a meander plain except most are greatly exaggerated in relief and underlain by bedrock. Meander belts developed during previous geologic episodes when streams flowed in a sinuous pattern across a plain; however subsequent geologic events caused an uplift of the plain. The river continued to downcut at a rate similar to the uplift resulting in an incised meander belt. The current stream channel at the base of the Meander Belt is undersized in relation to the valley form. During the downcutting process, slopes were scoured, terraces and other stream geomorphic features, now elevated in the landscape, were deposited. The landscape within the Meander Belt is quite complex, resembling the elements of a current floodplain although they are found high on the valley walls above the current floodplain level.

**Washboard Canyons** arean extensive landform north of the Wallowa Mountains. This is a subset of the Canyonlands Landform Associations. Washboard Canyons are long, linear concave features with a river or an intermittent stream along their central axis. The valley walls of these fluvial channels have a repeating pattern of ridges arrayed perpendicular to the streamcourse, giving the walls a washboard appearance. Rock removal out of this part of the landscape occurs because of mass collapse or creep down slope, that feeds the central active stream. Side channels and swales of the stream network locally have debris flow deposits that spread out along the stream channel, diverting its course. Erosion of the channel with the supplied rock leads to a rejuvenation of the cycle of slope instability and fresh rock supply for transport out of the canyons.

In the Blue Mountains, Washboard Canyons have repeating elements from river to “washboard” hill-slopes up to a ridge and then downslope in reverse in the next catchment. These repeating elements continue across the landscape for hundreds and locally thousands of acres. As with the nearby Canyonlands, hill slopes exhibit a layering pattern due to the underlying Columbia River Basalts. Deep, V-shaped channel erosion of the thin-bedded basalts yield a stepped morphology away from the stream and up the steep rocky slope. The benched landscape is cut by small drainages or gullies so that much of the Washboard Canyons are dominated by right angle (trellis) pattern of the streams.

Limited by the rate the resistant basalt bedrock is decomposed very thin soil if any soil at all is present as a result, sediment supply is limited from this LfA. The horizontal strata intercepts what sediments and thin soils form in wedges on some of the benches. These increase in thickness as you move downslope. Soils are typically droughty. Locally, however, northeast-facing slopes have accumulated volcanic ash that results in well-developed soils that hold moisture and facilitate better vegetation, timber and habitat.