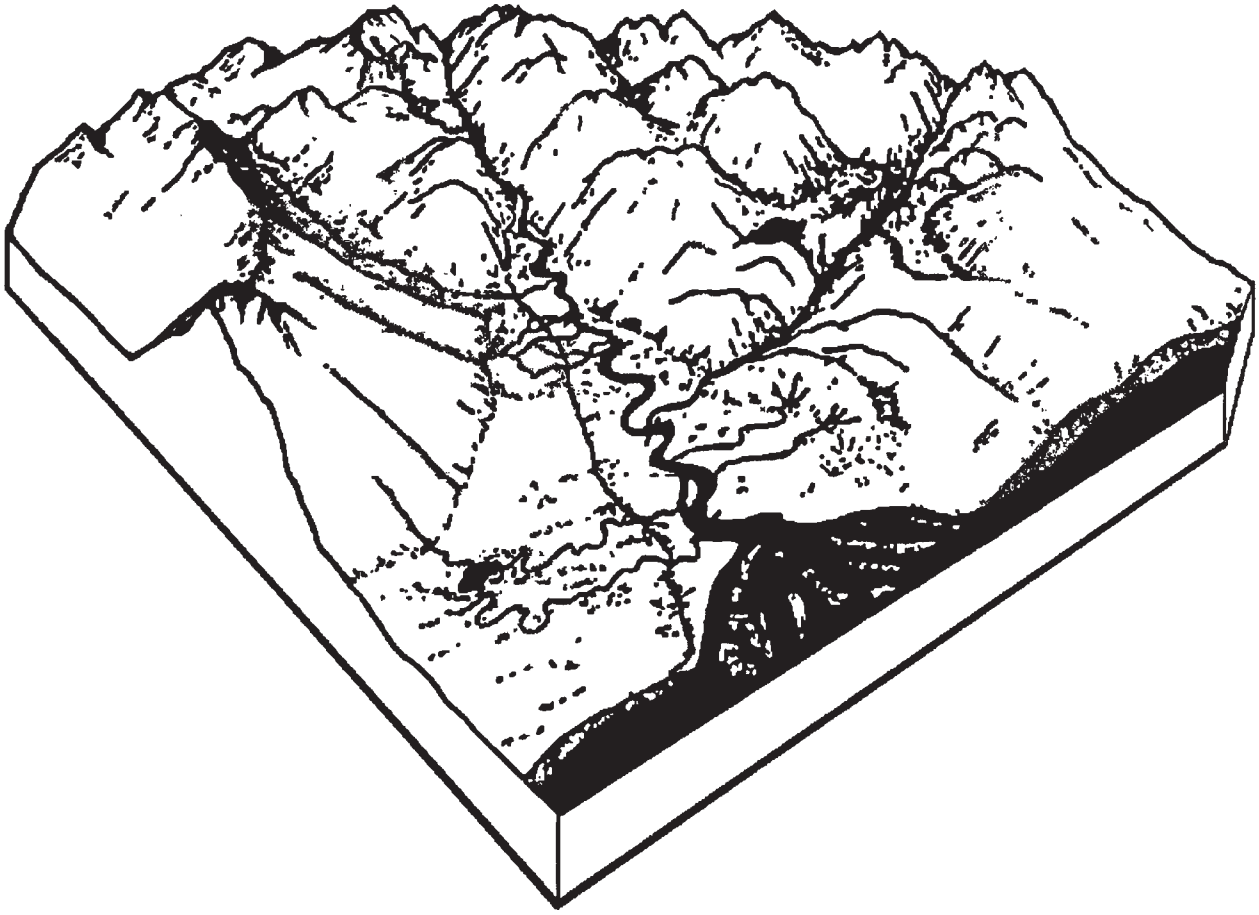
Landforms of the Alaska Region
Classification Guide



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DEDICATED TO

James M. Downs was a Soil Scientist with the Chatham Area Supervisor's Office of the Tongass National Forest. James was killed in a helicopter accident in the performance of his duties with the Forest Service March 6, 1987. James' insights to the functional processes in landform associations and landform characteristics are the foundation for this guide. He left a legacy of respect and understanding for the land and its many valuable characteristics. We miss Jim very much.

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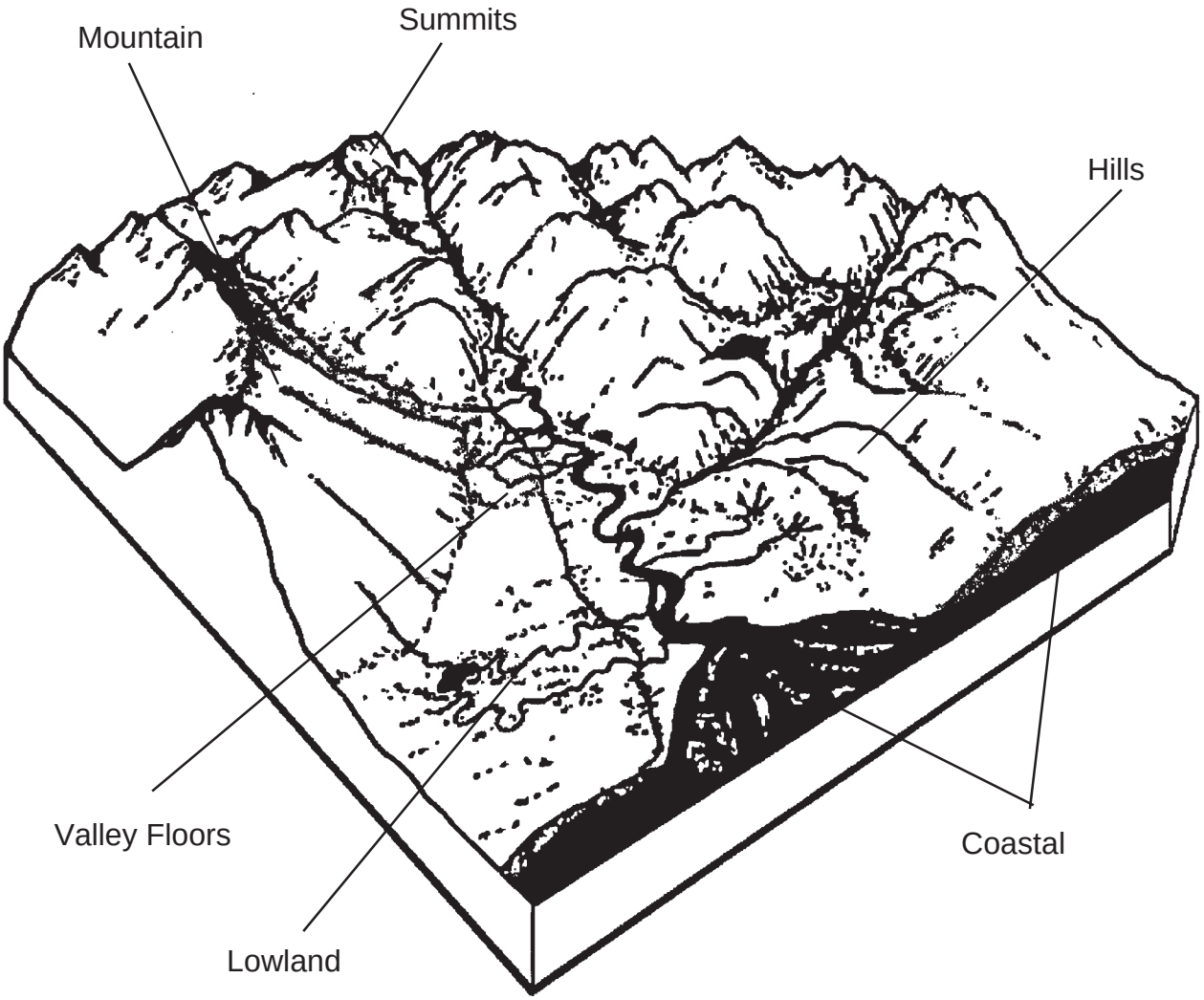
TYPICAL DISTRIBUTION OF LANDFORMS ACROSS A LANDSCAPE



INTRODUCTION

Guide Purpose

This guide is intended for resource managers, soil scientists, hydrologists, ecologists, or anyone involved with natural resource management on the Alaska Region of the USDA Forest Service. It describes a landform classification system used in the Ecological Unit Inventory (EUI) project but can be used by anyone wanting to delineate landforms. Landform is the initial, large scale delineation stratifying the mapped landscape into segments having similar climate, physiography, geomorphology, and parent materials. From this, highly predictable delineations of geology, soils, plant associations or community types, and channel types are possible.

Principal mapping components for the *Ecologic Unit Inventory of Alaska* are landform, surficial geology or parent material, soils, vegetation, and slope gradient, integrating the relationships between geologic and climatic history, soils, and plant ecology. As used for inventory, the landform classification system is a procedure for collecting, storing, and interpreting land base information. It contains a landform identification legend, landform descriptions, and differentia for classifying and mapping landforms.

Landform Definition

A landform is defined as "one of the multitudinous features that when taken together make up the surface of the earth. It includes all broad features, such as plain, plateau, and mountain, and also all the minor features, such as hill, valley, slope, canyon, arroyo, and alluvial fan." (American Geological Institute, 1976). Landforms are geometric features, expressing geomorphic processes over time, and can be described by their surface characteristics.

In the *Integrated Resource Inventory*, landform dimensions (such as length, width, and elevation range), internal characteristics (such as stream channels and soil parent materials), and other quantifiable aspects are emphasized because of their value to classification and management interpretation. Geomorphic processes play a secondary role in this guide in favor of these quantifiable properties.

Landform Associations --Components of the Alaska Region Landform Classification Guide are defined within the context of seven basic landform associations. Landform associations are used in this guide to group like landforms and to describe dominant processes which influence their management.

Landform associations represent the broadest level in this system where the elements of physiography, climate, drainage characteristics, and erosional mechanisms (geomorphology) become controlling. Associations are named and defined according to the criteria for their delineation: external relief, slope gradient, topographic sequence, geomorphic process, and physiography. They often encompass two or more landforms, although the association may be represented by a single landform. Associations are areas of land that can be mapped at the reconnaissance level and, as such, identify areas for which zoning and resource allocation decisions can be made.

Landforms--Below the association level, individual landforms are defined primarily by physical attributes, such as external relief, frequency or depth of drainage dissection, slope gradient, and juxtaposition to other landform associations; and secondarily, by geomorphic process. Thus mountain slopes, hills, valley floors, and lowlands landforms are defined and classified principally by morphology and appear in a topographic sequence within watersheds.

Landforms help define the parts of a drainage basin and, as such, are tools intended to complement a holistic watershed management approach. They allow us to describe the flux of energy and materials and to predict, with a high degree of accuracy, general responses to natural and human influences. Landforms can be managed as isolated segments, however, cumulative effects in one part of a watershed can affect activities taking place in a different part of the watershed, either upstream, downstream, or on adjacent landforms. It is important to remember this concept when using this guide.

Landform units are named according to the dominant association and drainage dissection or shape. Geomorphic processes have been used to aid naming in the cases of glaciation, freezing, and thawing. Limited use will be made of geomorphic or chronologic properties in classification. Valley floor, flood plain, coastal, and volcanic landforms have geomorphic implications by name, but are also readily defined and classified by their morphology and position.

Landform is a valuable component for making an inventory of land potential in steeply forested, mountainous terrain, providing a maximum of land information with a minimum of investment (Wertz and Arnold, 1972). It facilitates mapping large areas of land using photo interpretation with a minimum of field checking while improving predictability. An understanding of landform extent and distribution within watersheds gives resource managers additional tools for managing forest resources.

Landforms define the way water and materials translocate through watersheds, greatly influencing watershed storm precipitation response, water budget, sediment routing, erosion rates and volumes, as well as, groundwater recharge and discharge function.

Landform dictates exposure to solar energy, via variations in elevation, aspect and slope inclination to ground surface (Bailey 1980).

Landforms stratify soils, vegetation, and streams into similar groups, creating map units having high predictability. Since other landform-dependent characteristics of elevation, climate, slope gradient, and drainage are delineated as part of the map unit, resource managers are able to develop interpretations for timber layout, harvest design, accessibility, and other activities dictated by physiography and active geomorphology.

Landform Classification

Nationally accepted classification systems for the soil and vegetative components exist for the Integrated Resource Inventory and are used in its application (National Soils Guide, 1993; Soil Taxonomy, 1975; Daubenmire, 1968; Pfister, 1977). The Alaska Region Landform Classification has been developed, because no national landform classification system is currently in existence.

The intent of this classification is to provide landform mappers and map users with a clear record of observable properties used to delineate landforms of differing physical qualities in order to independently evaluate their significance for management.

In any classification, clarity of the system depends on the confines of language. A consensus on definitions used in this classification eliminates confusion due to the semantic variation inherent in language.

These characteristics and definitions make it possible to classify segments of the landscape into discrete landforms. Geomorphology terms throughout this text are defined in the Glossary of Geology, of the American Geological Institute (McGary, 1957). New landforms may later be identified during field mapping and should be documented for Regional review before adding to the legend or to this guide.

Landform Mapping

This guide defines the criteria used to classify and map a specific landform. Landform classification criteria are either observed in the field or inferred through aerial photography interpretation. The use of landform criteria to initially define mapping units has several advantages in soil surveys of forested lands:

1. It results in maps of landform polygons which determine consistent groupings of soils, plant associations/communities, and slope gradients.

2. It uniformly interprets properties, such as hydrologic behavior, slope stability, and sediment storage, for assessing land use potential and hazards to land use.

3. It documents the basis for interpretations in which landform properties are a factor in land management. It forces the mapper to form a hypothesis of how the landscape was formed. If the hypothesis is correct, landform delineation greatly facilitate soil mapping by aerial photo interpretation.

Once identified by photo interpretation, landforms are then premapped directly onto the aerial photograph prior to field investigation. By delineating landform polygons prior to field survey, the mapper documents his/her hypothesis that the landform meets criteria for its classification. The mapper then locates field traverses which cross representative areas of each mapping unit. Data which document the properties of the landform are taken during the field traverse. Patterns of soils and climax vegetation within each representative delineation are also described. If the hypothesis of landform formation is correct, differentiating criteria will be met and recurring patterns of soils and climax plant communities will be observed. Once described and established, these patterns and the associated landform classification are further stratified into an ecological unit which includes soil and potential natural vegetation. This process makes it possible to quickly map large areas of land, and permits intensive study of representative areas.

Landform mapping symbols are numeric. Note that numbers in the *Landform Identification Legend* do not always follow sequentially. For example, in the *Mountain Slopes Landform Association*, numbers 33 and 34 are missing. During the development of landforms in the Alaska Region these tentative landforms were later encompassed as typical components of Landform 32, "Frequently dissected, shallowly incised mountain slopes," or Landform 35, "Infrequently dissected, smooth mountain slopes." Mapping criteria were consolidated in order to maintain a classification that was meaningful for management. The convenience of sequential numbering was forfeited in deference to the large number of map symbols that would otherwise need correcting.

To achieve greater uniformity in using landform criteria as a basis for defining mapping units, and to facilitate communication about landform properties, the primary classes of landforms recognized in the Alaska Region are defined in this guide. In ecological unit mapping, additional landform, soil, geologic, and vegetation properties are used to further subdivide these classes to produce mapping units with uniformity in both ecological integrity and management properties.

Corollary landform inventory databases which include morphology data, geology and soil data, and vegetation composition data are maintained by the Watershed and Fisheries Staff Groups in the Forest Supervisor's Offices on the Chatham, Stikine, and Ketchikan Areas of the Tongass National Forest and the Chugach National Forest.

Things To Be Aware Of

The information contained in this guide is intentionally brief. The purpose is to give a picture of landform characteristics and management concerns. Anyone seeking additional information should consult with Forest Soil Scientists or Hydrologists, as well as the sources listed in the *Literature Cited.* Every attempt has been made to simplify technical terms to make this guide useful to a variety of people. Further definitions can be found in the National Soils Handbook and various other sources.

Although landform characteristics are relatively consistent, a degree of variability is inherent in these map units. Therefore, caution should be used in relying solely upon this information for site-specific project decisions. The classifica-

tion of an individual landform is not necessarily invalid if actual physiographic characteristics, such as channel dissection frequency, are outside the range of values reported in this guide. Site-specific channel characteristics and management interpretations should be verified in the field, as necessary, for project planning.

Landform mapping should play a prominent role in setting priorities for any field verification. Users should refer to soils or ecological mapping unit descriptions for detailed information on the distribution and frequency of the soils and vegetation in a given geographic area. Where apparent mapping discrepancies occur, users are requested to consult with Forest Soil Scientists or Hydrologists.

The landform information contained in this guide is the result of many years of development, modification, and validation. Nevertheless, the *Landform Classification Guide* will continue to evolve as new applications are developed and as additional resource data is compiled. The Alaska Regional Soil Scientist, in a coordinated effort with the Forests, will issue updates to this guide whenever the need arises.

To help understand the different terms used in this guide, we have included the following definitions.

Position *refers to the place on the landscape or relative elevation the landform is found.*

Slope shape *is described by the convexity, linearity, or concavity of the slope and pattern. Broken and undulating are slope characteristics used to modify shape.*

Slope gradient *is described by percent.*

External relief *is the elevation difference between the lowest and highest points of the landforms.*

Internal relief *is the elevation difference between component features within the landform.*

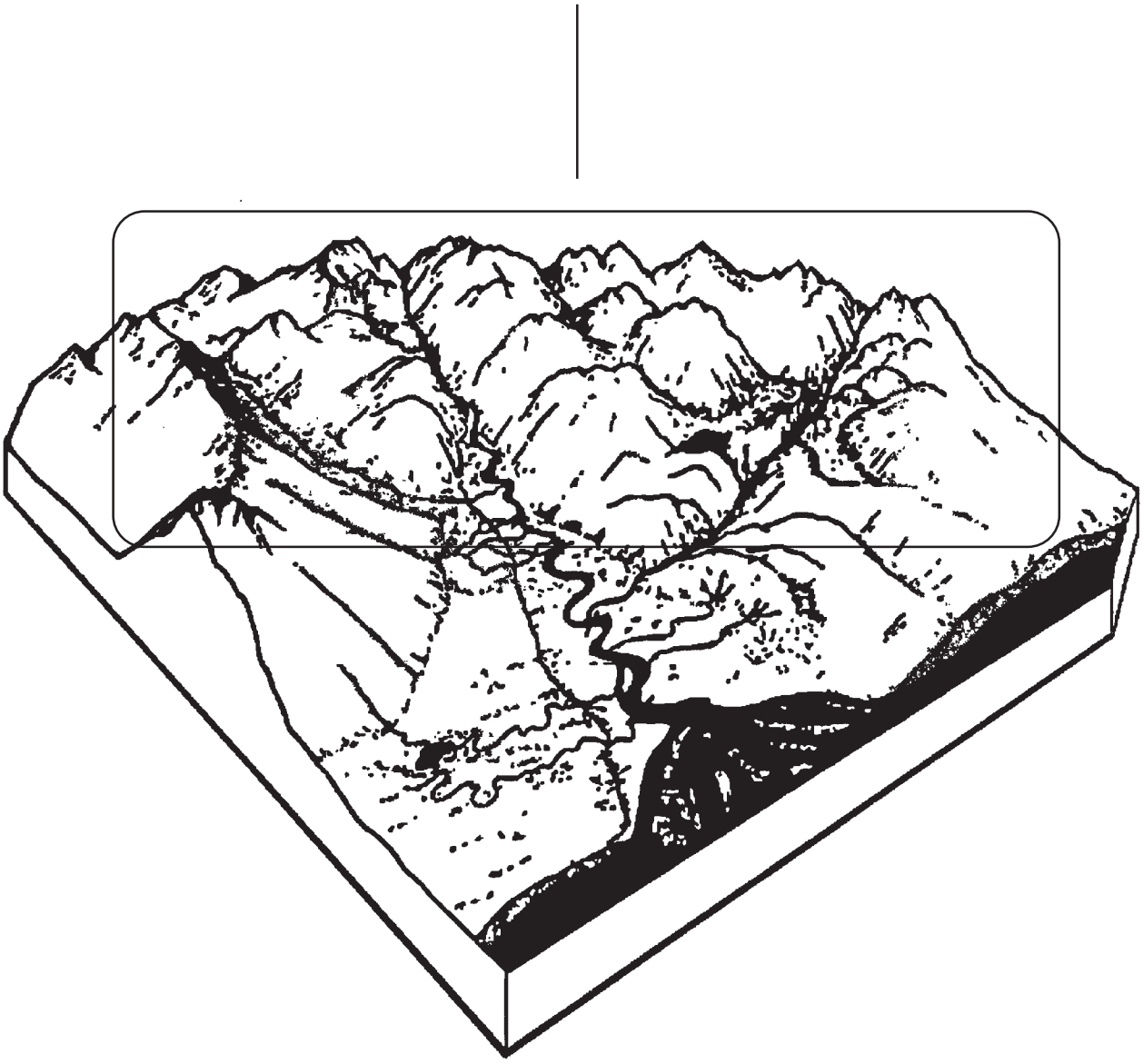
Drainage pattern *is described by stream order and type of stream network.*

Stream frequency *is given by the number of streams per mile.*
Premapping *units are delineated through interpretation of 1:15840 (4 in. = 1 mi) aerial photographs.*

Low level air reconnaissance *and on-the-ground spot checks are used to field verify the landform mapping units.*

Finally, *photo mapping is transferred to mylar topographic base maps (usually 2 in. = 1 mi scale) and digitized for incorporation into the Geographic Information System (GIS).*

10 - MOUNTAIN SUMMITS LANDFORM ASSOCIATION



10 - MOUNTAIN SUMMITS LANDFORM ASSOCIATION

General Description

The mountain summits landform association occupy high elevation (alpine) positions and includes subordinate high elevation shoulders and sideslopes. These ridgetops are formed as part of mountain building plate tectonic processes, and later sculpted by glaciation or mass wasting. Rugged mountain summits, rounded mountain summits, and glacier landforms comprise the association.

Landmass transfer processes dominate these landforms of the mountain summits association. These landforms influence landscape hydrologic function by their capacity for storm precipitation reception. Rain or snow storage from the build up of snow precipitation over the winter months commonly occurs on leeward edges and many sheltered pockets of these landforms. Snow persists into the summer months, providing snowmelt runoff to adjacent landscapes lower in the watershed. The slow release of this reserved precipitation influences the timing of peak stream flows and maintenance of wetland hydrology and downstream flow levels into the summer months.

The mountain summits, as well as mountain slopes association, receive substantial precipitation from orographic storm events that pass over low elevations. This influences stream response due to the additional precipitation volume collected and routed through these associations.

Severe winds and cold climates with high precipitation in the form of rain and snow, and frost action in conjunction with often rugged and steep topography, leave this landform association dominated by exposed bedrock, small areas of tundra vegetation underlain by thin soil mantles, and unvegetated talus. Soils that form here are slow to warm up in the summer, having to wait for snowpack to melt and drain off the slopes before solar radiation can penetrate the saturated soil. The very short growing season is ideal for low-growing shrubs, forbs, and sedges and most are mat-forming species. Vegetative diversity is often very high in this landform association. Wetland plant species (typically of the heath family) dominate the alpine tundra (Cowardin et. al. 1979).

Channel types are of the high gradient contained process group (Paustian et al. 1992). Stream channels are typically incipient first order and second order, and are commonly located along fault and joint bedrock fractures. They are primary sediment source zones, characterized by high water velocities during spring and fall freshets and late winter and spring snow avalanching, and serve as erosional transport zones.

Differentia

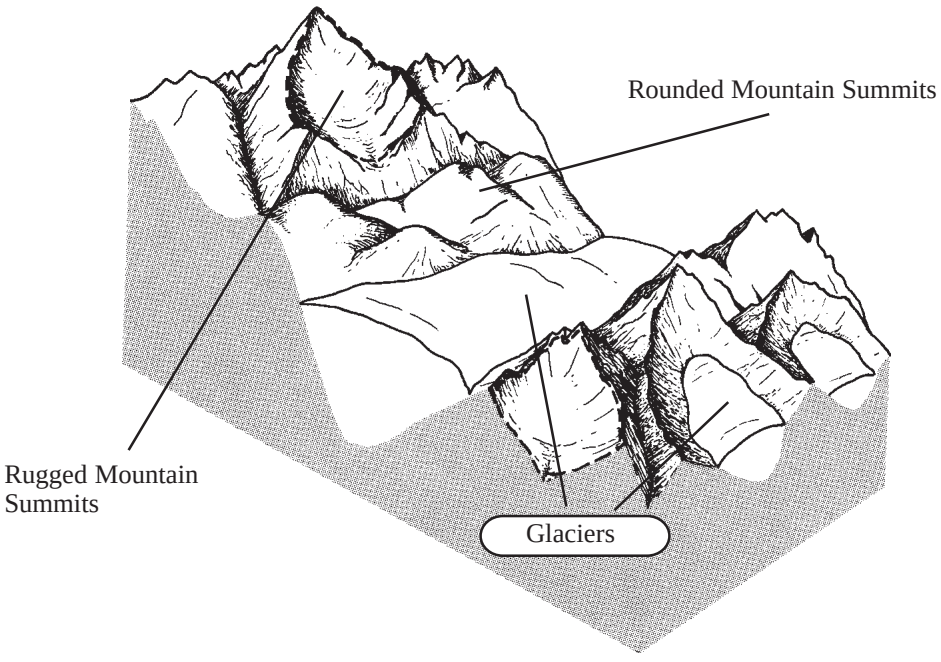
1. Highest landscape positions of the watershed.

2. Includes mountain summits, adjacent shoulder slopes, and alpine sideslopes (could include subalpine slopes if not delineated as such).

3. Elevation is at or above subalpine climatic zone.

4. Any homogeneous tract larger than 40 acres and wider than 500 feet.

5. Surface dominated by bedrock, thin soils, ice, and snow.



11 - Rugged Mountain Summits

General Description

The rugged mountain summits are comprised of a diverse group of high elevation features which form a very steep and rugged topography, dominated by exposed bedrock. The main feature consists of a jagged mountain summit, but adjacent cirque headwalls and snow avalanche slopes, if exposed bedrock is dominant, are also included. Rock outcrop, talus, snow, and ice predominate. Stream development is weak to absent.

Landscape Position *- These are high elevation mountain landforms that constitute the highest landscape position. Units are large and contain greater than 50 percent exposed bedrock. They include mountain summits, alpine shoulder slopes, and adjacent alpine and subalpine sideslopes.*

Landform Features *- Horns, aretes, nunataks, talus cones, sols, cirques, snow avalanche slopes, and truncated spurs associated with extensive exposed bedrock, steep gradients, and harsh alpine climate are the dominant features. Permanent snowfields and glaciers, if present, are smaller than 40 acres and comprise less than 40 percent of the mapping unit.*

Slope Shape *- Slopes are straight or broken. Summits are sharp, angular, and jagged, forming an extensive complex of ridges, peaks, navigational sideslopes, and cirque headwalls.*

Relief *- External relief ranges from 1,000 to several thousand feet, extending from upper erosional sideslopes to mountain peaks. Internal relief is high, ranging from 100 to 1,000 feet along rock faces, cliffs, cirque headwalls, knobs, and ridges.*

Slope Gradient *- Average slope gradient is about 100 percent with a dominant range of 75 to 150 percent. Vertical faces are common. Narrow ridgetops can be more gently sloping (30-50 percent), but short, steep pitches are common.*

Drainage Dissection *- Either undeveloped or weakly developed first order streams grade into second order parallel ravines along snow avalanche slopes.*

Mapping Unit Differentia

Any homogeneous tract larger than 40 acres which has the following criteria:

1. Encompasses, at least in part, a mountain summit position (external relief of associated mountain system exceeds 1,000 feet).

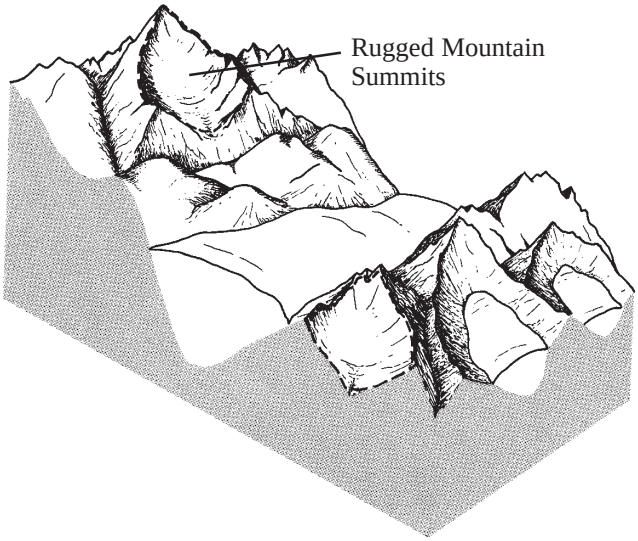
2. Does not include glaciers larger than 40 acres.

3. Internal relief is higher than 100 feet.

4. Overall dominant slope class is greater than 75 percent.

5. Exposed bedrock and unvegetated talus comprise greater than 50 percent of the area.

Mountain summit positions are differentiated by evaluating homogeneous 40 acre tracts for all criteria. Cirque basins and snow avalanche slopes located adjacent to them are also included, but only if they meet criteria 2, 4, and 5.



Hydrologic Function

Stream channels are associated with cirque basins, hanging valleys, or snow avalanche chutes, or emanate from the terminus of steep valley glaciers or perched alpine glaciers. Stream flows are derived from snow and glacier melt and respond quickly to rainfall events. These are sediment transport systems. Channel sideslopes are variably stable to unstable depending on the degree of bedrock control shaping the channel. Very high gradient, or steep channel gradients rapidly deliver sediment to downstream reaches. Channel gradient is highly variable due to frequent occurrence of falls and cascades, making streams within this landform inaccessible to anadromous or resident fish species. These landforms donate water from high levels of snowmelt to the sloping areas below.

Engineering

The extreme frequency of cliffs, ravines, and oversteepened slopes generally precludes engineering projects typical to forest management. Due to the high frequency of associated snow avalanche and snow storage zones, management of juxtaposed lower landscape positions needs to consider alternative harvest systems, and road designs and drainage structures to mitigate potential impacts from avalanching, mass wasting, and increased water runoff.

Vegetation and Timber

This landform supports nonforest vegetation consisting mainly of scatted lichen and bryophyte communities with occasional pockets of forbs, low shrubs, and sedges where soils are deeper.

12 - Rounded Mountain Summits

General Description

Rounded mountain summits include rounded, high elevation mountain peaks and ridgetops which exhibit characteristics of being overridden by large, continental ice sheets. Terrain is gentle, compared to rugged mountain summits (11), and the unit is restricted to summits and shoulder slopes. Other high elevation features, such as cirque basins, snowfields, glaciers, and snow avalanche slopes, can occur, but only as small inclusions. Stream development is weak to absent.

Landscape Position *- These are high elevation landforms found on summit positions. They are associated with other high elevation features which are influenced by a harsh alpine climate. Low elevation ridgetops are not included. Shape is typically oblong, with the long axis oriented along a ridgetop and the short axis breaking along shoulder slopes.*

Landform Features *- Ice-scoured ridgetops, mountain peaks, truncated spurs, and broad saddles associated with gentle gradients and a harsh alpine climate are dominant. Permanent snow and ice fields occur only as minor inclusions.*

Slope Shape *- Slopes are generally convex and gently broken, forming a complex of broad (500 feet) ridges and peaks. Slopes are compound on the long axis and convex on the short axis.*

Relief *- External relief extends from shoulder slopes to broad mountain summits. Internal relief is moderate, ranging from 50 to 100 feet along knobs and rock faces.*

Slope Gradient *- Average slope gradient is 30 percent, with a dominant range of 15 to 55 percent. Broad ridgetop positions are gently sloping (20 to 45 percent) with steeper slopes occurring on small knobs and cliffs, on short pitches near drainage dissections, or where landforms break to avalanche slopes and mountain sideslopes. The zone where shoulder slopes break into mountain sideslopes determines the lower boundary of the unit.*

Drainage Dissection *- Essentially undeveloped. Small rills sometimes occur in depressional areas.*

Mapping Unit Differentia

Any homogeneous tract larger than 40 acres and wider than 300 feet which has all of the following criteria:

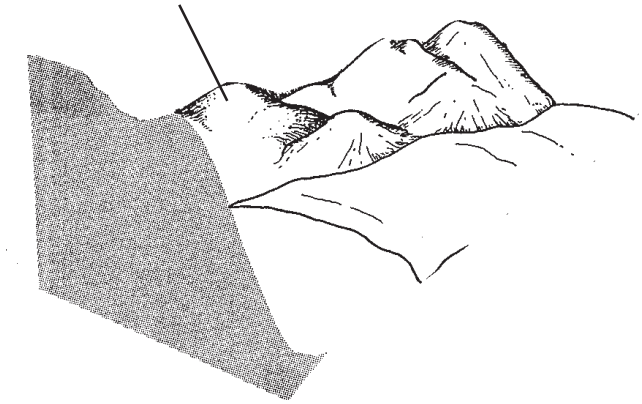
1. Encompasses a mountain summit position which is found in association with other high elevation features influenced by a harsh alpine climate.

2. Does not include glaciers larger than 40 acres.

3. Internal relief is low to moderate (50 to 100 feet).

4. Overall dominant slope class is less than 55 percent.

Rounded Mountain Summits



Hydrologic Function

Stream channels are associated with cirque basins, hanging valleys, and snow avalanche chutes. Stream flows are derived from snow and glacier melt and respond quickly to rainfall events. These are sediment transport systems (Paustian et al. 1992). Channel sideslopes are variably stable to unstable depending on the degree of bedrock control shaping the channel. Very high gradient or steep channel gradients rapidly deliver sediment produced by mass wasting and hillslope processes to downstream reaches. Channel gradient is highly variable due to frequent occurrence of falls and cascades, making streams within this landform inaccessible to anadromous or resident fish species. These landforms donate water from high levels of snowmelt to the sloping areas below.

Engineering

These rounded mountain summits provide roading opportunities if access to summits can be obtained.

Vegetation and Timber

This landform may support stands of the mountain hemlock plant association series or other subalpine timber species. Trees are very slow growing due to harsh climate and short growing season. They are frequently found in krummholz form. Shrubs, especially those in the heath family, are common and may carpet extensive areas of the landform. Alpine meadows may occur in protected areas, often with high species diversity. Forbs and sedges are common.

13 - Glaciers

General Description

These are ice fields, perennial snowfields, and glaciers larger than 40 acres. Exposed bedrock and surficial deposits comprise less than 40 percent of the unit.

Landscape Position *- Ice fields, perennial snowfields, and alpine glaciers usually occur at high elevations. Mainland glaciers can extend down deep valley troughs to saltwater.*

Landform Features *- Ice fields, perennial snowfields, alpine glaciers, and valley glaciers dominate. Nunataks, moraines, and talus cones are inclusions smaller than 40 acres and comprise less than 40 percent of the unit.*

Slope Shape *- Slope shapes are variable, but tend to be compound and convex both horizontally and vertically.*

Relief *- External relief on the islands ranges from 200 to 1,000 feet. Relief on the mainland is much greater, ranging from 1,000 to several thousand feet. Internal relief is low on the snow and ice fields, as well as on glaciers during winter and spring, with undulating ogives extending up to 100 feet in height. In summer, when the surface-snow melts, crevasses are exposed and internal relief increases to 300 feet. Internal relief caused by nunatak inclusions can be very high, extending up to 1,000 feet or more.*

Slope Gradient *- Slope gradients are extremely variable, ranging from near level on snowfields to greater than 100 percent on icefalls and nunataks.*

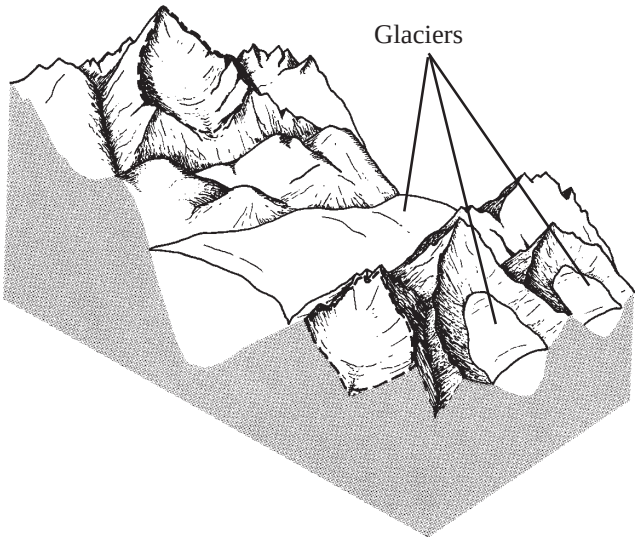
Drainage Dissection *- Meltwater channels are poorly developed, highly braided, and englacial. Deeply incised ravines often drain nunataks and hanging valleys.*

Mapping Unit Differentia

Any homogeneous tract greater than 40 acres which has the following criteria:

1. Dominated by permanent snow and ice features; vegetated or unvegetated bedrock and unconsolidated deposits occupy less than 40 percent of the unit

2. Does not include tracts of bedrock or unconsolidated deposits larger than 40 acres



Hydrologic Function

Channel types consist of narrow, high gradient, shallow to moderately incised streams, which are well contained and usually controlled by bedrock. Channels are sediment transport systems, receiving material from headwater mass wasting and hillslope erosion processes. Stream banks and sideslopes are typically quite stable, so only minor amounts of sediment and debris are introduced locally. Steep gradients and moderate stream power result in little in-channel sediment storage.

Engineering

Glaciers are highly unstable which precludes engineering projects typical to forest management.

Vegetation and Timber

This landform is primarily unvegetated. Exposed rock areas may include lichen and bryophyte communities.

14 - Subalpine Summits and Ridges

General Description

Rounded subalpine summits and ridges include rounded, moderate elevation summits and ridges which exhibit characteristics of being overridden by large, continental ice sheets. The terrain is relatively gentle and restricted to moderate elevation plateaus, ridges, and summits.

Landscape Position *- These are moderate elevation landforms in a marine climate found on ridge or hill summit positions. They are normally at timberline, but are not high enough to receive the harsh alpine climate associated with higher elevations.*

Landform Features *- Ridgetops, low mountain peaks, broad saddles, and rolling plateaus associated with mid elevation climates.*

Slope Shape *- Slopes are generally convex and gently broken, forming a complex of broad ridges and peaks.*

Relief *- External relief extends from shoulder slopes to the ridge summits. Internal relief ranges from 50 to 100 feet along the knobs and rock faces.*

Slope Gradient *- Slope gradient ranges from 15 to 35 percent. Steeper slopes occur on small knobs, peaks, and cliffs, on short pitches near drainage dissections, or where landform breaks into sideslopes.*

Drainage Dissection *- Essentially undeveloped. Small rills sometimes occur in depressional areas*

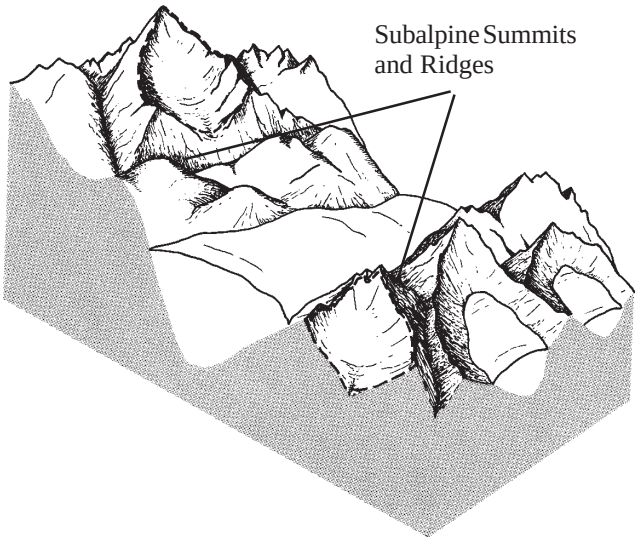
Mapping Unit Differentia

1. Encompasses moderate elevation board ridges and ridge summits.

2. Does not include perennial snowfields or glaciers.

3. Internal relief is less than 100 feet.

4. Overall slope gradient is less than 45 percent.



Hydrologic Function

Stream flows are derived from and respond quickly to snowmelt and rainstroms. These are sediment transport systems. Channel sideslopes are normally stable and are almost exclusively bedrock controlled. Streams will commonly dry up during short droughts. Small depressions will act as minor buffers in stream flow. These landforms donate water from high levels of snowmelt to the sloping areas below.

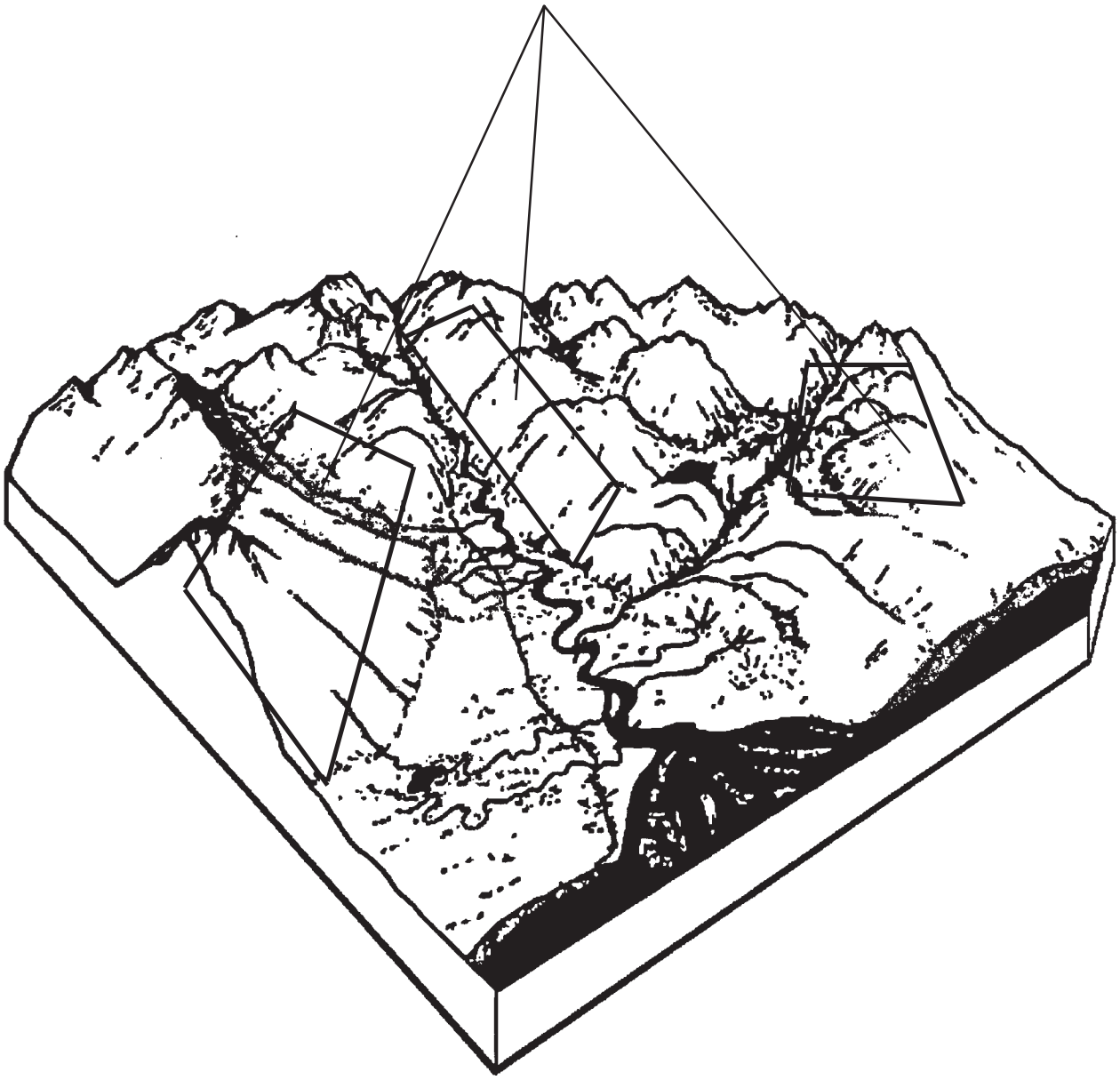
Engineering

These subalpine summits and ridges offer few roading opportunities.

Vegetation and Timber

This landform may support stands of the mountain hemlock plant association series or other subalpine timber species. Trees are very slow growing due to harsh climate and short growing season. They are frequently found in krummholz form. Shrubs, especially those in the heath family, are common and may carpet extensive areas of the landform. Alpine meadows may occur in protected areas, often with high species diversity. Forbs and sedges are common.

30 - MOUNTAIN SLOPES LANDFORM ASSOCIATION



30 - MOUNTAIN SLOPES LANDFORM ASSOCIATION

General Description

The mountain slopes landform association occupy subordinate elevations, in excess of 1,000 feet, and below the mountain summits landform association. Characterized by long slope lengths and high external relief, they were formed as part of mountain building processes and were sculpted by glaciers. Once glaciers cease as the dominant land shaping tool, erosional processes, primarily mass wasting, further sculpt the landform. Continual weathering by water, freezing, and thawing, provides more (earthen) materials for transport.

These landforms are able to intercept orographic storm events and receive additional precipitation as runoff from the adjacent mountain summits. The hydrologic inputs of rain and snow, and more importantly, the indirect inputs of rain, snow, and summer snowmelt runoff from the mountain summits landform association, add a tremendous volume of water. Watersheds with a high percentage of their land mass occupied by mountain slopes will have larger water budgets than watersheds without a mountain slopes landform. The mountain slopes landform association has the capacity to deliver larger volumes of water from storm events and more water throughout the year through ground water, rainfall and snowmelt runoff than the lower elevation hills landform association.

Channel types occurring within the mountain slopes association are of the high gradient contained process group (Paustian et. al. 1992). Streams are typically ephemeral, first and second order channels of steep channel gradient. Channels are typically narrow with steep sideslopes well suited for receiving and routing sediment from the surrounding landscape. These channels are locally referred to as V-notches or ravines. The relative frequency of ravines occurring on slopes determines mass failure rates and intensities of the various mountain slopes landforms and their ability to route sediment to larger order streams (Swanston 1990).

The majority of these landforms are mantled with colluvium or till within three feet to bedrock. They are erosional sideslopes with soil mass wasting, colluvial creep, and subsurface and overland water runoff being the dominant erosional transport mechanisms. Soils are poorly sorted, with various sizes of rock fragments common throughout the soil profiles. They are mineral soils, generally well drained to somewhat poorly drained, shallow to deep, and underlain by bedrock. Glacial till commonly occurs as a subsurface layer, mantling the bedrock. Some soils support western hemlock forests with varying amounts of Sitka spruce, mountain hemlock, and/or Alaska yellow-cedar, depending on elevation, soil drainage, soil depth, and disturbance history (Martin 1989). Other soils, in areas of snow storage and avalanche slopes support shrubs and krummholz, or if on gentler slopes, i.e. alpine meadow, support heath.

Differentia

1. External relief from footslope to mountain shoulder slopes is at least 1,000 feet.

2. Dominant slope gradient is greater than 35 percent.

3. Source waters for streams dissecting the association originate in the mountain summits landform association.

4. Major portions of the landform are erosional transport slopes.

31 - Frequently Dissected, Deeply Incised Smooth Mountain Slopes

General Description

These are frequently dissected, smooth mountain slopes with more than three deep ravines (greater than 50-feet deep) per linear mile.

Landscape Position *- Mid to upper mountain sideslopes (excludes footslopes).*

Landform Features *- Deeply dissected erosional mountain sideslopes (includes shoulders and backslopes).*

Slope Shape *- Vertically, slopes are smooth and linear to concave. Horizontally, slopes are smooth, slightly convex and concave, and slightly undulating in the interfluve areas (between ravines).*

Relief *- External relief is greater than 1,000 feet, extending from valley footslopes to mountain shoulder slopes. Internal relief in larger ravines ranges from 50 to 100 feet. Internal relief between knobs and benches is subdued, less than 50 feet.*

Slope Gradient *- Average slope gradient exceeds 35 percent. Ravine sideslopes range from 65 to 100 percent with vertical faces being common.*

Drainage Dissection *- A series of deeply incised (greater than 50 feet), parallel, first and second order streams runs perpendicular to slope contours (ravines). Typically, the landform contains greater than three deep ravines per mile and may contain three to ten shallow (10- to 50-feet deep) ravines per mile. Streams originate in alpine areas with a deep winter snowpack.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria:

1. Restricted to mountain sideslopes with an external relief greater than 1,000 feet.

2. Frequently dissected (greater than three per mile) by well developed, deeply incised (greater than 50 feet), second order streams with a parallel pattern and V-shaped morphology. Spacing is less than 1,500 feet between ravines.

3. Each ravine is deeply incised, but its area does not exceed 20 acres.

4. Has minimum horizontal width of 500 feet and vertical length of 1,200 feet.

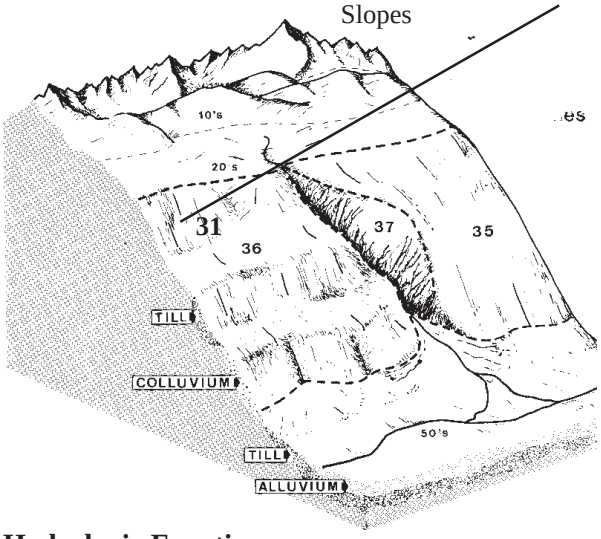
5. Severe and continuous erosional activity (indicated by dense thickets of pioneer brush species) is restricted to ravine sideslopes.

6. Has a smooth vertical slope shape. Internal relief of knobs and benches is less than 50 feet.

7. Stream dissection originates in alpine areas with a deep winter snowpack.

8. Average slope gradient exceeds 35 percent (footslopes are less than 35 percent).

Frequently Dissected, Deeply Incised Smooth Mountain Slopes



Hydrologic Function

Surface erosion and mountain slope mass wasting are the principal sources of stream sediment load. Stream flow responds quickly to intense rainfall and rain-on-snow events. Steep channel gradients and high stream power limit sediment storage, therefore sediment is rapidly delivered to downstream channels, affecting downstream anadromous fish habitat through transport of sediment, large woody debris, nutrients, and aquatic insects. Wetlands are not common and most slopes just convey water.

Engineering

High frequency of deep ravines generally precludes midslope road construction due to bridging requirement. High incidence of debris torrents requires consideration in placement of downslope drainage and crossing structures. Frequent use of oversized culverts is needed to offset large volume, flash flooding events. For road construction, full bench with end haul and cut and fill techniques are commonly used.

Vegetation and Timber

This landform has a moderate and highly productive commercial forest zone. Typical overstory species are western hemlock and Sitka spruce. Yellow-cedar may occur in areas with poor soil drainage. Mountain hemlock is common above 1,500 feet. Typical understory species include menziesia, blueberry, five-leaf bramble, shield fern, and bunchberry with shrubs especially common on ravine sideslopes.

Relatively steep slopes require cable logging systems. Long slope lengths provide skyline or intermediate support logging systems opportunities. The high frequency of deep ravines may allow settings between ravines. Frequent split yarding away from ravines is often required to reduce channel sideslope soil degradation and sediment production.

Sideslope sensitivity and erosion potential are high. Stream bank and sideslope disturbance associated with road cuts and timber yarding may result in mass wasting and significant sediment delivery to downslope stream systems.

32 - Frequently Dissected, Shallowly Incised Smooth Mountain Slopes

General Description

This landform has frequently dissected smooth mountain slopes with more than ten shallow (10- to 50-feet deep) ravines per linear mile.

Landscape Position *- Mid to upper mountain sideslopes (excludes footslopes).*

Landform Features *- Shallowly dissected erosional mountain sideslopes.*

Slope Shape *- Vertically, slopes are smooth and linear to concave. Horizontally, slopes are slightly convex and concave, and slightly undulating in the interfluves (between ravines).*

Relief *- External relief is greater than 1,000 feet, extending from mountain shoulder slopes to footslopes. Internal relief within ravines ranges from 10 to 50 feet. Internal relief between knobs and benches is subdued, less than 50 feet.*

Slope Gradient *- Average slope gradient exceeds 35 percent. Ravine sideslopes dominantly range from 45 to 80 percent.*

Drainage Dissection *- A series of shallowly incised (less than 50-feet deep), parallel, first and second order streams runs perpendicular to slope contours (ravines). The landform contains greater than ten shallow ravines per linear mile, but fewer than three deep (greater than 50 feet) ravines. Streams are slightly convergent along concave slopes. Streams originate in alpine areas with a deep winter snowpack.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria:

1. Restricted to mountain sideslopes with an external relief greater than 1,000 feet.

2. Frequently dissected (greater than ten per mile) by well developed, shallowly incised (10 to 50 feet), second order streams having a parallel pattern and a V-shaped morphology, which are discernible on aerial photographs.

3. Does not contain deeply incised ravines (greater than 50 feet) less than 1,500 feet apart.

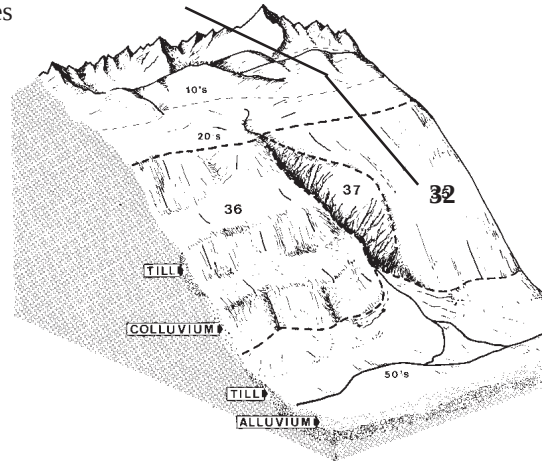
4. Has minimum horizontal widths of 500 feet and vertical lengths of 1,200 feet.

5. Does not contain extensive areas (larger than 20 acres) of severe, continuous erosional activity (snow avalanche paths) as indicated by dense thickets of pioneer shrub species.

6. Stream dissection originates in alpine areas with a deep winter snowpack.

7. Has a smooth vertical slope shape. Internal relief of knobs and benches is subdued, less than 50 feet.

Frequently Dissected, Shallowly Incised Smooth Mountain Slopes



Hydrologic Function

Surface erosion and mountain slope mass wasting are the principal sources of stream sediment load. Stream flow responds quickly to intense rainfall and rain-on-snow events. Steep channel gradients and high stream power limit sediment storage, therefore sediment is rapidly delivered to downstream channels, affecting downstream anadromous fish habitat through transport of sediment, large woody debris, nutrients, and aquatic insects. Wetlands are not common and most slopes just convey water.

Engineering

High frequency of shallow ravines generally requires an increased frequency of culverts for midslope road construction. High incidence of debris torrents requires consideration in placement of downslope drainage and crossing structures. Frequent use of oversized culverts may be needed to offset large volume and flash flooding events. For road construction, full bench with end haul and cut and fill techniques are commonly used.

Vegetation and Timber

This landform has a moderate and highly productive commercial forest. Typical overstory species are western hemlock and Sitka spruce. Yellow-cedar may occur in more gentle areas with poor soil drainage. Mountain hemlock is common above 1,500 feet. Typical understory species include menziesia, blueberry, five-leaf bramble, shield fern, and bunchberry with shrubs especially common on ravine sideslopes.

Relative steep slopes require cable logging systems. Long slope lengths provide skyline or intermediate support logging systems opportunities. High frequency of ravines may allow settings between ravines. Frequent split yarding away from ravines is often required to reduce channel sideslope soil degradation and sediment production.

Sideslope sensitivity and erosion potential are high. Stream bank and sideslope disturbance associated with road cuts and timber yarding may result in mass wasting and significant sediment delivery to downslope stream systems.

35 - Infrequently Dissected, Smooth Mountain Slopes

General Description

These landforms have smooth, continuous mountain slopes with infrequent (less than 10 per mile) dissection by ravines. They occur at mid to upper elevations below timberline.

Landscape Position *- Mid to upper mountain sideslopes (excludes footslopes).*

Landform Features *- Infrequently dissected erosional mountain sideslopes.*

Slope Shape *- Both horizontally and vertically, slopes are smooth and linear to convex or slightly undulating. Small knobs and benches are smaller than five acres in size.*

Relief *- External relief is greater than 1,000 feet. Extends from mountain shoulder slopes to footslopes. Internal relief between knobs, benches, and ravines is subdued, less than 50 feet.*

Slope Gradient *- Average slope gradient exceeds 35 percent.*

Drainage Dissection *- An infrequent series of shallowly incised (less than 50-feet deep), parallel, first and second order streams runs perpendicular to slope contours (ravines). The landform contains less than three deep (greater than 50 feet) ravines and less than ten shallow ravines per linear mile. Deep ravines are mapped separately as mountain slope ravines (37) when they occur incidentally with smooth mountain slopes. Stream channels are slightly divergent along convex slopes. Streams originate in alpine areas with a deep winter snowpack.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria:

1. Restricted to mountain sideslopes with an external relief greater than 1,000 feet.

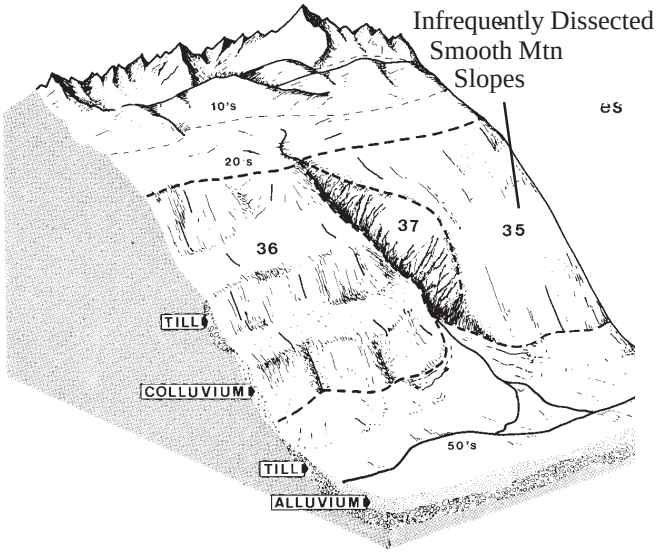
2. Infrequently or undissected (less than ten ravines per mile) by well developed, shallowly incised, second order streams having a parallel pattern and a V-shaped morphology, which are discernible on aerial photographs.

3. If associated with isolated deeply incised ravines (greater than 1,500 feet apart) the ravines are mapped as mountain slope ravines landform if greater than 20 acres.

4. Has minimum horizontal width of 500 feet and vertical length of 1,200 feet.

5. Does not contain extensive areas (larger than 40 acres) of severe and continuous erosional (snow avalanche) activity as indicated by dense thickets of pioneer shrub species.

6. Has a smooth vertical slope shape. Internal relief of knobs and benches is subdued, less than 50 feet and their size is less than five acres.



Hydrologic Function

Surface erosion and mountain slope mass wasting are the principal sources of stream sediment load. Stream flow responds quickly to intense rainfall and rain-on-snow events. Steep channel gradients and high stream power limit sediment storage, therefore sediment is rapidly delivered to downstream channels, affecting downstream anadromous fish habitat through transport of sediment, large woody debris, nutrients, and aquatic insects. Snow avalanche chutes, cascades, low vertical falls, and bedrock knickpoints are common features. Wetlands are not common on these conveyor slopes.

Engineering

This landform provides an adequate roading surface for midslope road construction. Cut and fill, and full bench road construction techniques are commonly used. Landslides are common.

Vegetation and Timber

This landform has a moderate and highly productive commercial forest zone. Typical overstory species are western hemlock and Sitka spruce. Yellow-cedar may occur in areas with restricted soil drainage. Mountain hemlock is common above 1,500 feet. Typical understory species include menziesia, blueberry, five-leaf bramble, shield fern, and bunchberry with shrubs especially common on ravine sideslopes.

Relatively steep slopes require cable logging systems. Long slope lengths provide skyline or intermediate support logging systems opportunities.

Sideslope sensitivity and erosion potential are moderate. Stream bank and sideslope disturbance associated with road cuts and timber yarding may result in mass wasting and significant sediment delivery to downslope stream systems.

36 - Broken Mountain Slopes

General Description

This landform is composed of mountain slopes broken by benches and plateaus into discontinuous slopes. Ravine dissection is usually infrequent.

Landscape Position *- Broken mountain slopes, including summits and high elevation plateaus.*

Landform Features *- Broken sideslopes, benches, high elevation plateaus, and low elevation summits.*

Slope Shape *- Vertically, slopes are broken. Horizontally, slopes are highly variable. They contain numerous knobs or benches larger than five acres.*

Relief *- Located on mountain slopes with an external relief greater than 200 feet, extending from mountain shoulder slopes to footslopes. Internal relief is high, exceeding 50 feet on knobs and benches.*

Slope Gradient *- Slope gradients are bimodal, ranging from 45 to 100 percent on sideslopes, and 10 to 30 percent on plateaus, benches, and summits.*

Drainage Dissection *- Infrequent dissection occurs by first and second order stream channels (ravines) which follow structural disconformities.*

Mapping Unit Differentia

Any homogeneous tract larger than 20 acres which has all of the following criteria:

1. Restricted to landscapes similar to the mountain and hill landform associations with an external relief greater than 200 feet.

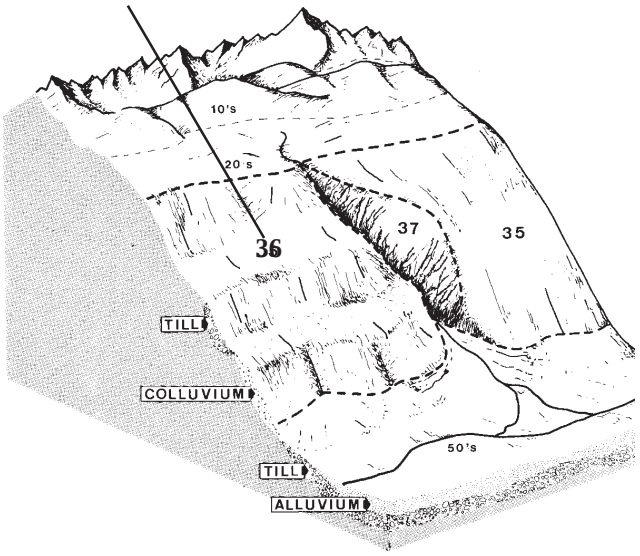
2. Does not contain extensive areas (larger than 20 acres) of severe and continuous erosional (snow avalanche) activity indicated by dense thickets of pioneer brush.

3. Has a broken vertical slope shape. Internal relief of knobs and benches is greater than 50 feet and their size is greater than five acres.

4. Does not occupy high elevation summits which are influenced by a harsh alpine climate.

5. Look for the mosaic of open areas - scrubby forest right next to larger dense forest stands. These edges reflect soil drainage changes and can be used to demark boundaries.

Broken Mountain Slopes



Hydrologic Function

Surface erosion and mountain slope mass wasting are the principal sources of stream sediment load. Stream flow is slowed by benches between short slopes and disconformity of stream reaches. Bimodal channel gradients limit stream power, therefore sediment is slowly delivered to downstream channels. Ground water discharge zones are common on these conveyor and receptor slopes.

Engineering

Wetlands are frequent on these benches and low gradient slopes. Road location is a challenge to insure the hydrologic function is not impaired. On steep slopes cut and fill and full bench road construction techniques are commonly used.

Vegetation and Timber

This landform typically supports a mosaic of productive hemlock forest and less well drained cedar and mixed coniferous forested wetlands. Shrubs and forbs are common, especially in the mixed conifer stands. Many of the plateaus and benches support peatlands and forested wetlands.

Steep slopes require cable logging systems. Benches and low gradient slopes may provide shovel yarding opportunities.

37 - Mountain Slope Ravines

General Description

Mountain slope ravines are steep walled, deeply incised ravines, larger than 20 acres, which occur either alone or in tight clusters on mountain slopes. Channel gradients are very high.

Landscape Position *- Mountain sideslopes.*

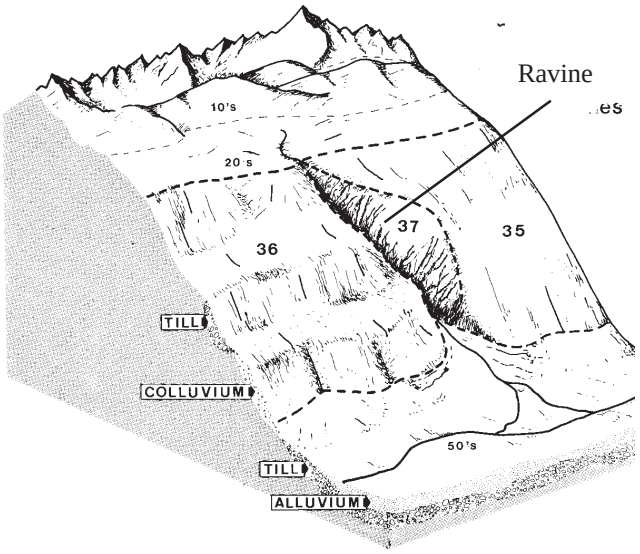
Landform Features *- Large ravines.*

Slope Shape *- Vertically, ravines are straight, either smooth or broken. Horizontally, ravines are V-shaped.*

Relief *- External relief is variable. Internal relief is high, with ravine incisions exceeding 50 feet.*

Slope Gradient *- Ravine sidewalls are very steep and vertical bedrock outcrops are common (dominant slope range of 75 to 150 percent).*

Drainage Dissection *- Deeply incised (greater than 50-feet deep), second order streams run perpendicular to slope contours and have a V-shaped morphology. Channel gradient exceeds 10 percent.*



Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria:

1. Restricted to mountain sideslopes.

2. Consists of one or several tightly clustered ravines which are deeply incised (deeper than 50 feet).

3. If clustered, greater than 50 percent of the area is occupied by ravine sideslopes and channels.

4. Stream gradient exceeds 10 percent.

Hydrologic Function

Surface erosion and mountain slope mass wasting are the principal sources of stream sediment load. Stream flow responds quickly to intense rainfall and rain-on-snow events. Steep channel gradients and high stream power limit sediment storage, therefore sediment is rapidly delivered to downstream channels, affecting downstream anadromous fish habitat through transport of sediment, large woody debris, nutrients, and aquatic insects. Snow avalanche chutes, cascades, low vertical falls, and bedrock knickpoints are common features.

Engineering

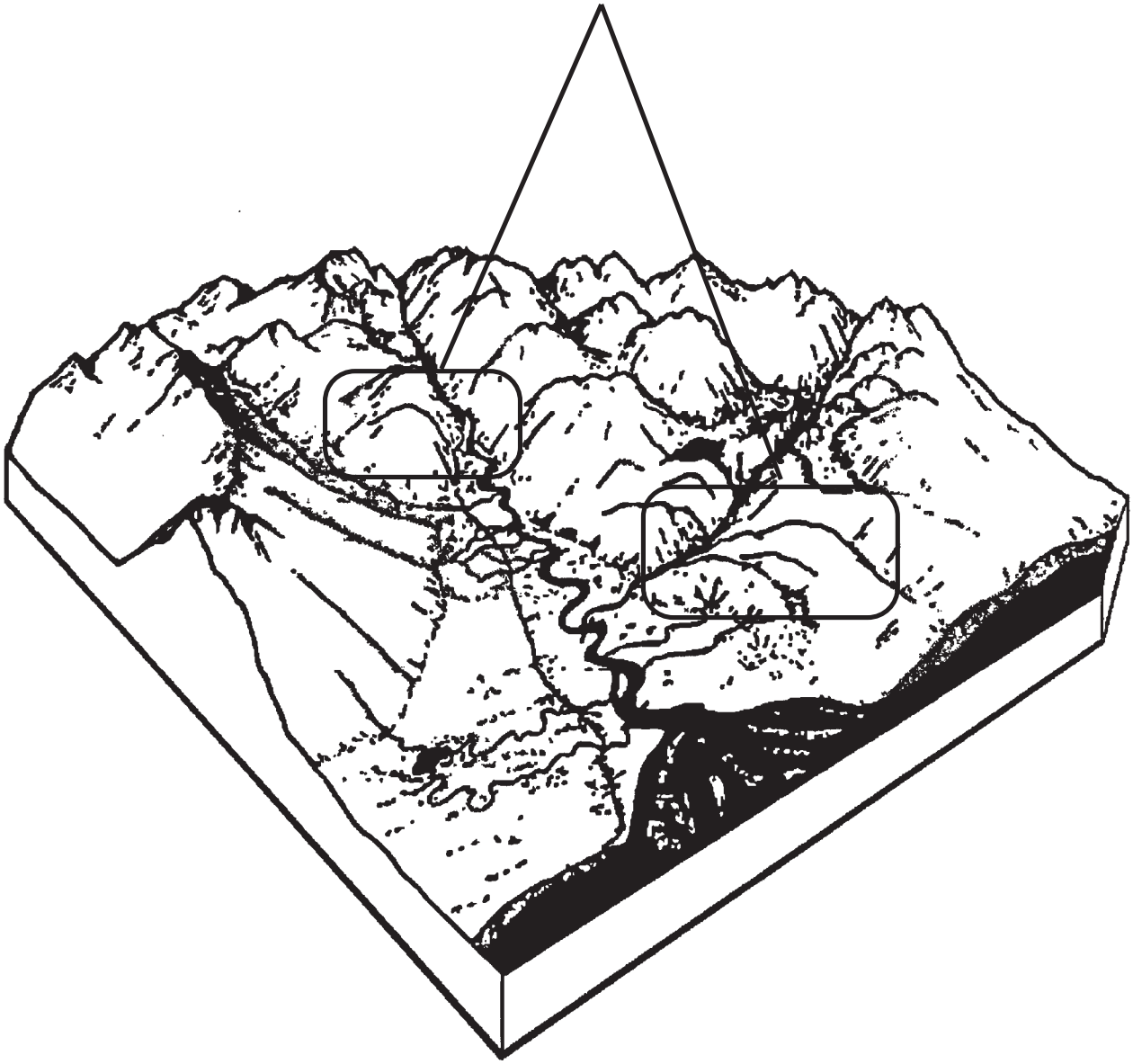
Mountain slope ravines generally block access for roading or require extensive bridge design.

Vegetation and Timber

Ravine sides are typically vegetated by shrubs such as oplhor, ribbra and rubspe. Ferns are common. Forest may occur on sideslopes, typically conifers in the overstory series.

Extremely unstable sideslopes and sediment routing potential preclude timber harvest. Harvesting on adjacent interfluve areas should not include yarding across the ravines.

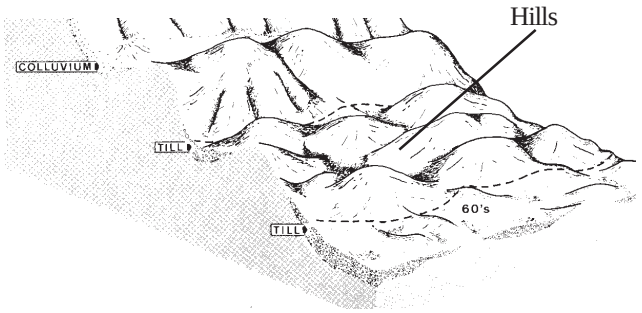
40 - HILLS LANDFORM ASSOCIATION



40 - HILLS LANDFORM ASSOCIATION

General Description

Landforms of the hills association are not influenced by alpine climates or frost churning processes. They are usually just above to valley floors, lowlands, and/or coastal landform associations. They are physically separated by ravines or low elevation landform associations (valley floors or lowlands) from the mountain summits and mountain slopes landform associations; and therefore, do not receive input from summer snowmelt or high elevation (orographic) storm runoff common to mountain slopes landforms. They do not have the capacity to collect and carry the large volumes of runoff associated with mountain slopes landform association, due to their shorter slope lengths and smaller total area encompassed. Landforms of the hills association have been formed by mountain building and/or glaciation processes.



The density (miles/acre) of stream channels is low in the hills association. The most common channel type process groups are high gradient contained (39 percent) and moderate gradient contained (35 percent) (Paustian et al. 1992). Inclusions of the flood plain, alluvial fan, and moderate gradient mixed control channel type process groups occur along transition boundaries between the hills and the valley floor landform associations.

Streams are typically ephemeral, first and second order channels of steep channel gradient. Stream channels are typically narrow with steep sideslopes well suited for receiving and routing sediment from the surrounding landscape. The relative frequency of ravines occurring on slopes determines mass failure rates and intensities of the various hills landforms and their ability to route sediment to larger order streams.

The hills association has low risk for significant impacts from mass wasting and sediment delivery to streams, due to short slope lengths, small areas, and less water inputs to the hydrologic system relative to the mountain slopes landform association.

These landforms are erosional sideslopes with soil mass wasting, colluvial creep, subsurface, and overland water runoff being the dominant transport mechanisms. Primary parent materials for soil development are colluvium and residuum from till and bedrock. Soils are poorly sorted with various sizes of rock fragments common throughout soil profiles. They are generally well drained to somewhat poorly drained, shallow and deep soils underlain by bedrock. Glaciation has been a dominant land shaping process, resulting in dense till substrates overlying the bedrock which yield soil systems that are more poorly drained than those of the mountain slopes association. Therefore, they have lower productive commercial forest potential and greater proportions of mixed conifer forested wetlands and peatlands. Organic and mineral soils support mixed conifer and western hemlock forests with varying amounts of Sitka spruce, mountain hemlock, and/or Alaska yellow-cedar, depending on elevation, soil drainage, depth, and disturbance history (Martin 1989).

Differentia

1. Comprised of one or more distinctly separate hills of an elevation range from 50 feet to the lower boundary of the subalpine climatic zone (less than 1,000 feet elevation rise).

2. Sideslope gradient is greater than 35 percent.

3. Hills do not have frost churning processes or harsh alpine climates.

4. Hills do not receive rainfall runoff or summer snowmelt from mountain summits or mountain slopes landform associations, either by overland flow or subsurface (lateral) water movement.

42 - Rolling Hills

General Description

Rolling hills are a series of distinctly separate but adjoining hills which have an external relief of 50 to 200 feet. Hills have distinct summits, are infrequently dissected by streams, and occur at low elevations below timberline.

Landscape Position *- Low elevation (less than 1,000 feet), foothills within valley floors or on coastal lowlands.*

Landform Features *- Groups of foothills, hills, moraines, ridges, summits, and sideslopes.*

Slope Shape *- Undulating groups of smooth to broken convex hills. Hillslopes comprise greater than 50 percent of the area, when compared to summits, and depressions between the hills comprise less than 50 percent of the area.*

Relief *- External and internal relief is moderate (ranges from 50 to 200 feet), extending from summits to depressions. Relief on specific hillslopes is subdued, ranging from 10 to 50 feet along bedrock controlled knobs and benches.*

Slope Gradient *- Gradients are bimodal, with a dominant range of 35 to 55 percent on hillslopes and 10 to 25 percent on summits or depressions between the hills.*

Drainage Dissection *- Weakly developed first and second order streams occur on hillslopes with a dendritic or parallel drainage pattern. They have a low frequency, less than three channels per linear mile. Moderately developed third and fourth order streams flow between the foothills with a dendritic, rectangular, or deranged pattern.*

Mapping Unit Differentia

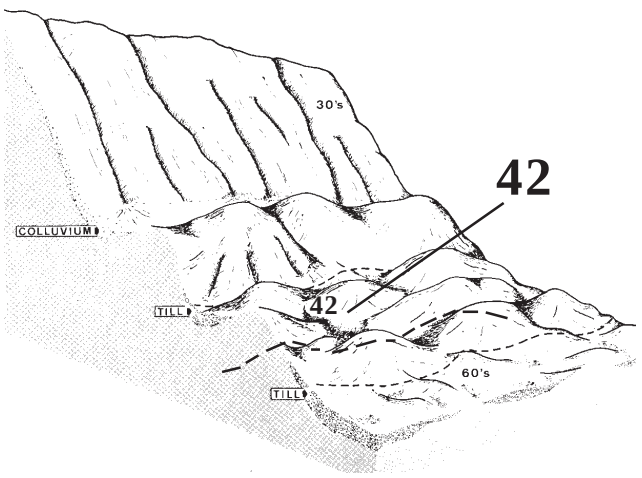
Any homogeneous tract of land larger than 20 acres which has all of the following criteria:

1. Comprises a series of two or more distinctly separate hills. Hills have summits and are separated by interconnected narrow depressions.

2. The hillslopes form a major component, greater than 50 percent of the area; consequently, summits and depressions between the hills comprise less than 50 percent of the area.

3. Relief is 50 to 200 feet, extending from summits to depressions.

4. Hill sideslope gradients exceed 35 percent.



Hydrologic Function

Bedrock control is prevalent. Stream energy is high on the hillsides due to moderate channel gradient and high flow containment. Stream flow responses to intense rainfall or rain-on-snow events are usually rapid from hill to depression. Shallow mass wasting of weathered bedrock and poorly consolidated glacial till on channel sideslopes is a primary source of sediment and debris which is quickly transported downslope. In-channel storage of fine sediment is minor on the hillside but significant once on the depressions (or flats) between hills. Depressions generally have high water tables, recieve waters from upslope and have various wetlands present.

Engineering

Road access through rolling hills is generally achieved by routing road systems along valleys between hills using overlay construction techniques.

Vegetation and Timber

Moderately and highly productive forests are commonly interspersed with lower productive and non productive forested wetlands and peatlands. The overstory is commonly mixed conifers with a shrubby understory. In the more open types, forb diversity is often high.

Short cable systems are commonly used for harvest. Shovel yarding opportunities may exist.

43 - Frequently Dissected Smooth Hillslopes

General Description

Frequently dissected smooth hillslopes with more than ten stream channels per mile occur at low elevations below timberline.

Landscape Position *- All slope positions of hillslopes. Elevation does not rise to the alpine or subalpine climatic zone.*

Landform Features *- Dissected hillslopes.*

Slope Shape *- Vertically, slopes are concave and smooth. Horizontally, slopes are slightly convex and concave, and slightly undulating in the interfluves (between ravines).*

Relief *- External relief ranges between 200 and 1,000 feet, extending from summits to depressional bottomlands. Internal relief between knobs and benches is subdued, less than 50 feet.*

Slope Gradient *- Average slope gradient exceeds 35 percent. Ravine sideslopes range from 45 to 80 percent.*

Drainage Dissection *- This landform includes a frequent series (greater than ten per mile) of shallowly incised (less than 50 feet) first and second order streams with a V-shaped morphology. The drainage pattern is either dendritic or parallel, both running perpendicular to slope contour. Occasionally deeply incised ravines (greater than 50 feet) occur. Streams are slightly convergent along concave slopes and do not originate in alpine areas with a deep winter snowpack.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria:

1. Restricted to hillslopes with an external relief ranging from 200 to 1,000 feet, and elevation does not rise to alpine or subalpine climatic zones.

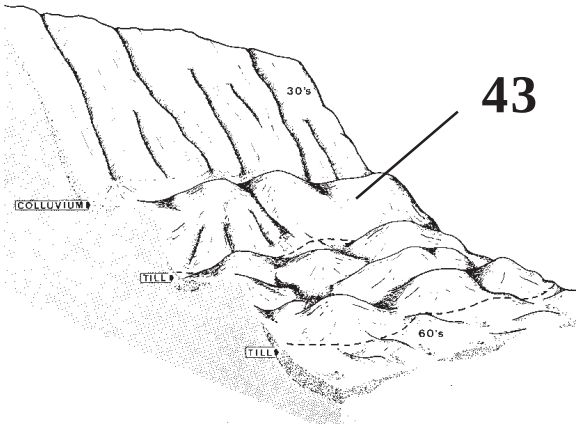
2. Frequently dissected (greater than ten per mile) by well developed, first and second order streams which are discernible on aerial photographs.

3. Has a dominant slope class exceeding 35 percent.

4. Stream dissection does not originate in alpine areas with a deep winter snowpack.

Hydrologic Function

Surface erosion and hillslope mass wasting are the principal sources of stream sediment load. Stream flow responds quickly to intense rainfall and rain-on-snow events. Short slope lengths minimize area for sediment production. Steep channel gradients and high stream power limit sediment storage. Sediment production is much less than on dissected mountain slopes landform. Sediment is rapidly delivered to downstream channels, affecting downstream anadromous fish habitat through transport of sediment, large woody debris, nutrients, and aquatic insects. Depressions generally have high water tables, recieve waters from upslope and have various wetlands present.



Engineering

Midslope roads are seldom required to access timber due to short slope lengths. Midslope roads commonly require cut and fill road construction design. Full bench construction design may be required on steep slope gradients. High frequency of shallow ravines require an increased frequency of culverts in midslope roading. Potential for debris torrents is low to moderate due to the absence of snowmelt or rainfall runoff interception from mountain slopes or mountain summits landform associations.

Vegetation and Timber

Moderate and highly productive forests are commonly interspersed with lower productive and non productive forests, forested wetlands and peatlands. The overstory is commonly mixed conifers with a shrubby understory. In the more open types, forb diversity is often high.

Relative steep slopes require cable logging systems. Short-slope lengths generally preclude the need for skyline or intermediate support logging systems. Frequent split yarding away from ravines is often required to reduce channel sideslope soil degradation and sediment production.

Sideslope sensitivity and erosion potential are high. Stream bank and sideslope disturbance associated with road cuts and timber yarding may result in mass wasting and sediment delivery to stream systems. Wetlands are common.

44 - Infrequently Dissected, Smooth Hillslopes

General Description

This landform consists of infrequently dissected, smooth hillslopes with less than ten ravines per mile. They occur at low elevations below timberline.

Landscape Position *- All slope positions on hillslopes. Elevation is less than 1,500 feet.*

Landscape Features *- Infrequently dissected hillslopes.*

Slope Shape *- Smooth and linear to convex, both horizontally and vertically. Knobs and benches are uncommon.*

Relief *- External relief ranges from 200 to 1,000 feet, extending from summits to depressional bottom lands. Internal relief between knobs and benches is subdued, less than 50 feet.*

Slope Gradient *- Average slope gradient exceeds 35 percent. More gently sloping benches of 20 to 35 percent occasionally occur.*

Drainage Dissection *- This landform includes an infrequent series (less than ten per mile) of shallowly incised (less than 50 feet) first and second order streams with a V-shaped morphology. The drainage pattern is either dendritic or parallel, running perpendicular to the slope contour. Streams are slightly divergent along convex slopes and do not originate in alpine areas with a deep winter snowpack.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria:

1. Restricted to hillslopes with an external relief ranging from 200 to 1,000 feet. Elevation does not rise to alpine or subalpine climatic zone.

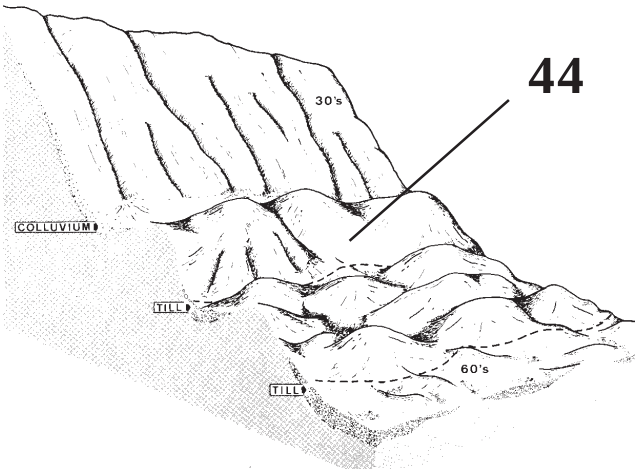
2. Infrequently dissected (less than ten per mile) by well developed first and second order streams which are discernible on aerial photos.

3. Stream dissection does not originate in alpine areas with a deep winter snowpack.

4. Has a smooth slope shape. Internal relief of knobs and benches is less than 50 feet, with size less than five acres.

Hydrologic Function

Surface erosion and hillslope mass wasting are the principal sources of stream sediment load. Stream flow responds rapidly to intense rainfall and rain-on-snow events. Mass wasting and hillslope processes occurring in headwater areas produce the sediment and debris that is quickly transported downstream. Short slope lengths minimize collection area for sediment production. Steep channel gradients and high stream power limit sediment storage, therefore, sediment is rapidly delivered to downstream channels, affecting downstream anadromous fish habitat through transport of sediment, large woody debris, nutrients, and aquatic insects. Depressions generally have high water tables, recieve waters from upslope and have various wetlands present.



Engineering

Due to short slope lengths, midslope roads are seldom required to access timber. Midslope roads commonly require cut and fill road construction design. Full bench road construction may be required on steep slope gradients. Debris torrents and other landslide potential is low due to lack of ravines, short slope lengths, and absence of snowmelt or rainfall runoff interception from mountain summits or mountain slopes landform associations.

Vegetation and Timber

Moderate and highly productive forests are commonly interspersed with lower productive forests, non productive forested wetlands and peatlands. The overstory is commonly mixed conifers wih shrubby understory. In the more open types, forb diversity is often high.

Relative steep slopes require cable logging systems. Short slope lengths generally preclude this need for skyline or intermediate support logging systems. Sideslope sensitivity and erosion potential are low to moderate. Low frequency of ravines minimizes soil disturbance and sediment routing.

46 - Broken Hillslopes

General Description

Broken hillslopes have numerous continuous or discontinuous benches that transect the sideslopes and that break up the normal drainage pattern. They normally occur from sea level up to the timberline. These landforms are commonly found on more weather resistant geological rock types such as those of granitic or volcanic origin and metamorphosed sandstones.

Landscape Position *- All slope positions are on hill sideslope positions. Elevations are under 1,500 feet.*

Landscape Features *- Broken sideslopes, benches, low to moderate elevation plateaus, and low elevation summits.*

Slope Shape *- Broken with numerous continuous and discontinuous benches and knobs.*

Relief *- External relief ranges from 200 to 1,000 feet. Internal relief between benches is usually from 50 to 200 feet.*

Slope Gradient *- Average slope gradient of the sideslopes is greater than 35 percent. Gradient of the benches is usually less than 15 percent.*

Drainage Dissection *- Infrequent dissection by firs and second order stream channels which follow structural disconformities.*

Mapping Unit Differentia

1. Restricted to landscapes similar to the hills landform association with an external relief ranging from 200 to 1,000 feet.

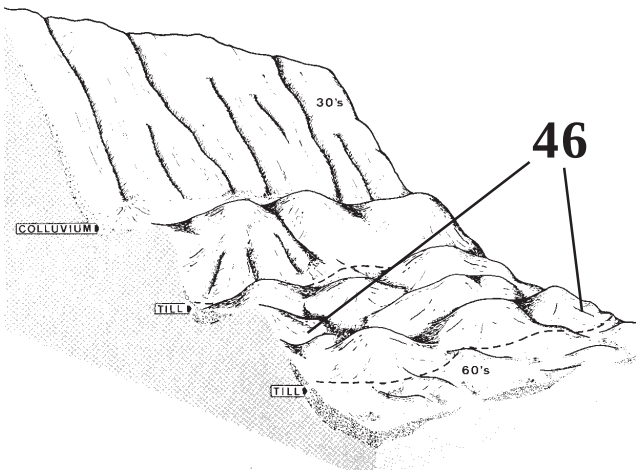
2. Does not contain extensive areas larger than 20 acres of severe and continuous erosion (snow avalanche) activity indicated by dense thickest of pioneer brush.

3. Has a broken vertical slope shape and an internal relief of knobs and benches which are greater than 50 feet.

4. Does not occupy high elevation summits which are influenced by a harsh alpine climate.

Hydrologic Function

Bedrock is prevalent and plays a strong role in slope shape and function. Stream energy is slowed by benches or knobs between short slopes and disconformities of stream reaches. Bimodal channel gradients limit stream power, therefore sediment is slowly delivered to downstream channels. Stream flow responds to intense rainfall or rapid snowmelt events. In-channel storage of fine sediments is minor on the hillside but significant in depressions or on benches. Depressions generally have high water tables, recieve waters from upslope and have various wetlands present.



Engineering

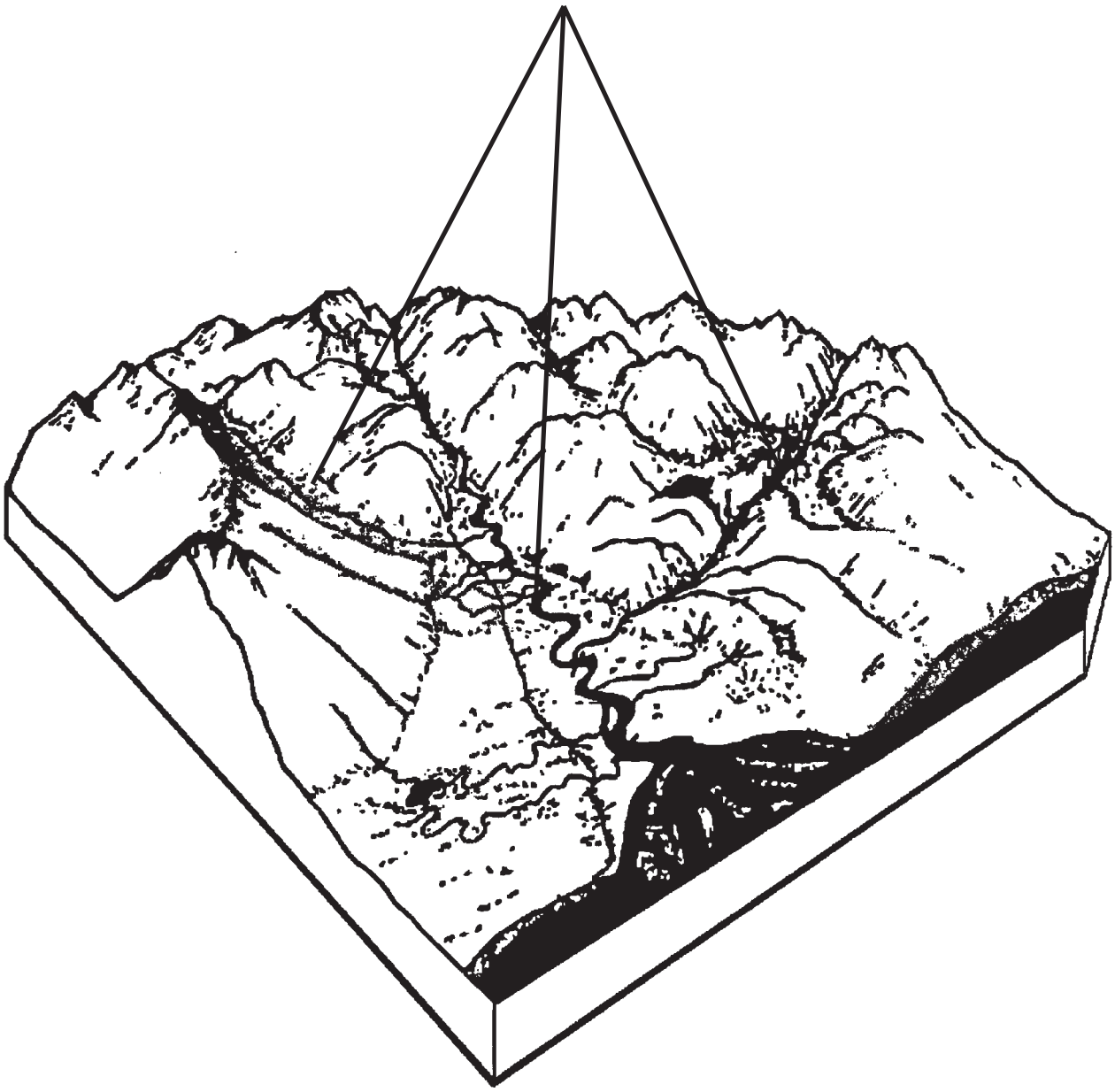
Due to short slope lengths, midslope roads are seldom required to access timber. Midslope roads commonly require cut and fill road construction design. Full bench road construction may be required on steep slope gradients. Debris torrents and other landslide potential is low due to lack of ravines, short slope lengths, and absence of snowmelt or rainfall runoff interception from mountain summits or mountain slopes landform associations.

Vegetation and Timber

Moderate and highly productive forests are commonly interspersed with lower productive and non productive forests and peatlands. The overstory is commonly mixed conifers with shrubby understory. In the more open types, forb diversity is often high.

Relative steep slopes require cable logging systems. Short slope lengths generally preclude this need for skyline or intermediate support logging systems. Sideslope sensitivity and erosion potential are low to moderate. Low frequency of ravines minimizes soil disturbance and sediment routing.

50 - VALLEY FLOOR LANDFORM ASSOCIATION



50 - VALLEY FLOOR LANDFORM ASSOCIATION

General Description

Valley floor landform associations have slope gradients from 0 to 35 percent, and are found at the base of mountain slopes and hills landform associations, receiving both hydrologic and material inputs from the higher elevation, juxtaposed landform. They are composed of surficial deposits of either colluvium, alluvium, or till, resulting in large accumulations of soil materials. The valley floor landform association is formed by depositional processes originating from fluvial, glacial, or colluvial activity, or an admixture of these. The valley floor landform association is comprised of colluvial and colluvial/fluvial footslopes, lateral moraines, singular or coalescing alluvial fans, glacial-fluvial fans, deltas, estuaries, and flood plains.

In general, stream channels are moderate to low gradient and are transitional from mountain streams, which have confined sidewalls due to bedrock control, to uncontained channels of the flood plains landform of the valley floor association. Channel bedloads are often deep and commonly range from cobbles to silt.

The valley floor association has the highest density of streams of all landform associations. Many channel type process groups are represented. The flood plain process group, comprised of low gradient, valley floor streams and rivers, represents 28 percent of all streams occurring in valley floors. High gradient contained channel types represent 19 percent of streams and are comprised mostly of stream channels of the footslopes and alluvial fans. These are steep, incised, first and second order channel types. The glacial outwash process group, low gradient channels, fed by glacier meltwaters, represents 14 percent of streams. The alluvial fan process group and moderate gradient mixed control process group (streams with limited lateral channel and boulder bedloads) each occupy 12 percent of all streams in the valley floor landform association (Paustian et al. 1992).

Soils are deep to very deep in these landforms. As slope gradients rapidly decrease from steeper adjacent landforms, water velocity declines, reducing its ability to transport sediment, and deposition occurs. Although these depositional landforms appear stable, they store tremendous amounts of sediment which can be mobilized and routed to nearby stream systems during unusually high storm precipitation events. Natural surface disturbance increases with increased frequency and intensity of fluvial activity.

The greater the role that water plays in transportation and deposition in these zones, the more likely fine soil particles are to be washed away, leaving stratified sediments. Landforms in the valley floor association receiving cyclic fluvial disturbance tend to drain easily and are commonly subirrigated. Sitka spruce forests dominate. Valley floors with little fluvial activity tend to be dominated by western hemlock. Soils of landforms influenced by glaciation remain poorly sorted; if underlain by compact till, they are densely packed, and imperfectly drained. They support mixed conifer woodland and peatlands.

Differentia

1. Restricted to footslope positions at the base of mountain slopes and/or hills landform associations; or, in the case of flood plains, border third or fourth order stream systems.

2. Average slope gradient is less than 35 percent.

3. Composed of deep surficial deposits resulting from glacial, fluvial, or colluvial processes, or frequently scoured by flooding.

4. Not inundated by saltwater during tidal fluctuations.

51 - Infrequently Dissected Footslopes and Alluvial Fans

General Description

Infrequently dissected footslopes and alluvial fans are located at the base of infrequently dissected mountain slopes or hillslopes. They are composed of surficial deposits; colluvium from normal slope movements and when below active mass wasting, till when associated with lateral moraines. Slope gradients are less than 35 percent.

Landscape Position *- Lower depositional slopes located at the base of erosional sideslopes and above the valley floor.*

Landform Features *- Colluvial footslopes, colluvial toeslopes, landslide debris slopes, talus slopes, and lateral moraines.*

Slope Shape *- Vertically, they are usually concave, but fan or cone shapes can sometimes be found below active mass wasting areas. Horizontally, they are either linear, or in the case of unusually active cones, convex and undulating.*

Relief *- External relief is low, generally ranging from 5 to 100 feet. Internal relief is associated with either large debris boulders or stream dissection, and is usually very low (less than 10 feet).*

Slope Gradient *- Average gradients range from 5 to 35 percent.*

Drainage Dissection *- A series of aggrading, moderately developed, second order streams, flows perpendicular to slope contours. Stream dissection is infrequent, less than ten per mile (interfluve spacing greater than 500 feet). Channel incision is very low, except when dissecting lateral moraines. Drainage pattern is parallel to distributary.*

Mapping Unit Differentia

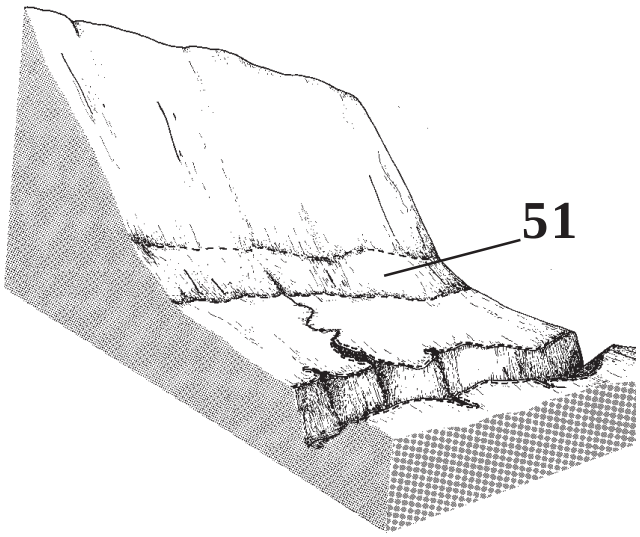
Any homogeneous tract of land larger than 20 acres and wider than 300 feet which has all of the following criteria:

1. Restricted to footslope positions at the base of infrequently dissected erosional sideslopes.

2. Average slope gradient is less than 35 percent.

3. Stream frequency is less than ten per mile and the interfluve spacing is greater than 500 feet; the frequency of stream dissection is measured along the upper boundary of the unit before the channels split into a distributary pattern, and it can be estimated by observing the frequency of a ravine dissection on the upper hill or mountain sideslopes.

4. Composed of deep surficial deposits, with colluvium or glacial till predominant.



Hydrologic Function

Deposition of eroded materials from upslope (or by glaciation) is the primary geomorphic process. Moderate gradients, resulting in moderate stream power, result in sediment storage. Sediment may be delivered to downstream channels, affecting downstream anadromous fish habitat. Large woody debris accumulations are extensive and help retain coarse gravel. Wetlands are not common and most slopes just convey water via open channels.

Engineering

Overlay roads are most commonly designed for this landform. Occasionally, finer textured soils require full bench road construction and improved drainage due to their instability.

Vegetation and Timber

Generally, highly and moderately productive timber of the western hemlock and Sitka spruce plant associations occupy these sites. However, mixed conifer plant associations commonly occur where soil drainage is slowed.

On well drained lower slope gradients (0-20) shovel yarding is the preferred logging system. Short cable systems access steeper slope gradients.

52 - Frequently Dissected Footslopes and Alluvial Fans

General Description

Frequently dissected footslopes and alluvial fans are located at the base of frequently dissected hillslopes and mountain slopes. They are composed of stratified alluvial deposits and are dominated by aggrading stream channels. Slope gradients are less than 35 percent.

Landscape Position *- Lower depositional slopes located at the base of erosional sideslopes and above the valley floor.*

Landform Features *- Alluvial footslopes, alluvial fans, coalesced alluvial fans, and alluvial-colluvial footslopes.*

Slope Shape *- Vertically, they are convex and smooth. Horizontally, they form large convex alluvial fans or an undulating series of coalesced alluvial fans.*

Relief *- External relief is low, ranging from 5 to 100 feet. Internal relief is very low (usually less than 10 feet) and is associated with stream dissection.*

Slope Gradient *- Average gradients range from 5 to 35 percent.*

Drainage Dissection *- A series of aggrading, moderately developed, second order streams flows perpendicular to slope contours. Stream dissection is frequent (greater than ten channels per mile), and interfluve spacing is less than 500 feet. Channel incision is very low to nonexistent. The drainage pattern is distributary.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres and wider than 300 feet which has all of the following criteria:

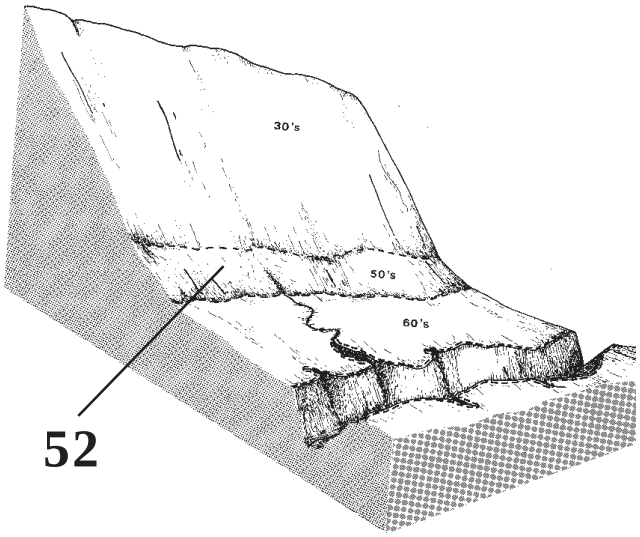
1. Restricted to footslope positions dominated by aggrading stream channels.

2. Average slope gradient is less than 35 percent.

3. Stream frequency exceeds 10 channels per mile (interfluve spacing is less than 500 feet) and is measured along the upper boundary of the unit before the channels split into a distributary pattern, and it can be estimated by observing the frequency of ravine dissection on the upper mountain or hill sideslopes.

4. Composed of deep surficial deposits, with alluvium and, occasionally, glacial till being predominant.

5. Not inundated by saltwater during tidal fluctuations.



Hydrologic Function

Surface erosion and hillslope mass wasting on above landforms are the principal sources of stream sediment load. Storage of sediment is temporary. Moderate to steep channel gradients, resulting in moderate to high stream power, limit sediment storage. Sediment is rapidly delivered to downstream channels, affecting downstream anadromous fish habitat. Large woody debris accumulations are extensive and help retain coarse gravel. Wetlands are not common and most slopes just convey water via open channels.

Channels on alluvial cones flow over and actively rework the deposited material that has formed the landform. Small accumulations of fine sediment may be stored in pools associated with large boulders.

Engineering

Overlay roads with an increased frequency of culverts per mile are most commonly designed for this landform. Occasionally, finer textured soils require full bench road construction and improved drainage due to their instability.

Vegetation and Timber

Highly productive timber of the Sitka spruce and western hemlock plant associations occupy these sites.

On well drained lower slope gradients (0-20 percent) shovel yarding can be used if stream side channels are marked and carefully avoided. Short cable systems access steeper slope gradients. Split yarding may be required to avoid disturbing stream channels and ravines.

53 - Flood Plains

General Description

Flood plains are nearly level alluvial or glacio-fluvial plains and deltas. They occupy valley floors which are associated with periodic flooding by large third and fourth order streams.

Landscape Position *- Found usually below 300 feet in elevation in valley floors and lowlands. Unit has a long linear shape with the long axis along a major stream channel.*

Landform Features *- Alluvial flood plains, oxbow lakes, meander scars, river levees, braided channels, lower stream terraces, and deltas (where not delineated as an estuary component; otherwise see estuary landform).*

Slope Shape *- Linear and smooth, both vertically and horizontally.*

Relief *- External relief is 0 to 100 feet. Internal relief is subdued (less than 20 feet) and is associated with stream bank cutting.*

Slope Gradient *- Average gradient of 2 percent with a dominant range of 0 to 5 percent.*

Drainage Dissection *- Well developed third and fourth order streams may have braided or meandering channels and a stream gradient less than 3 percent. Drainage pattern is anastomotic.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres and wider than 300 feet which meets all of the following criteria:

1. Restricted to valley floors and lowlands (does not occur on footslopes).

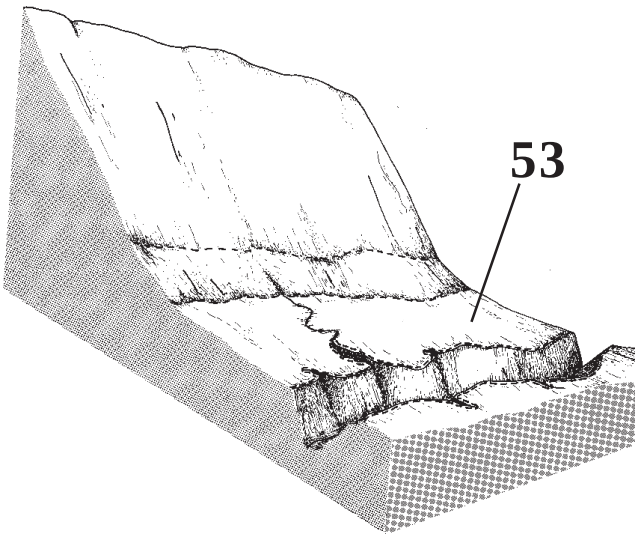
2. Has a dominant slope range of 0 to 5 percent.

3. Dissected by a third order or larger stream system with an anastomotic drainage pattern.

4. The dissecting stream channel has a low gradient (less than 3 percent), braided or meandering channels, and little incision (less than 10 meters).

5. Dominated by deep, well-stratified alluvial deposits.

6. Not inundated by saltwater during tidal fluctuations.



Hydrologic Function

Channels are typically sinuous, with extensive gravel bars, multiple channelways, alluvial terraces, large log jams, and extensive flood plains. Sand and fine gravel constitute a large percentage of the substrate material, deposited and stored in pools, point bars, and on flood plains, which is typically mobilized during high flow events. Bank erosion and bank building processes result in very dynamic and diverse channel morphology. Channel gradient is low and flow containment is poor, resulting in relatively low stream power. Most of these areas recieve waters from upslope and transmit it to adjacent channels.

Engineering

Stream crossings require bridge construction. Overlay road construction on stable upper terraces out of the flood zone are permissible.

Vegetation and Timber

Highly productive Sitka spruce plant associations dominate this landform.

Outside of the active flood plain, on well drained soils, shovel yarding is the preferred method of timber harvest. Skunk cabbage indicates poor soil bearing strength and these stands should be cable yarded.

54 - Valley Floor Gorges

General Description

Valley floor gorges are deeply incised third and fourth order streams which occupy valley floors. Sideslopes are very steep (greater than 75 percent) and stream gradients are moderate (3 to 10 percent). Gorge floors often contain narrow flood plains.

Landscape Position *- Found in valley floors and lowlands landform associations. Unit has a long linear shape with the long axis along a major stream channel.*

Landform Features *- Deeply incised gorges and canyons.*

Slope Shape *- Straight or broken along the long axis which parallels the stream channel. The short axis has straight sidewalls with a V-shaped or truncated V-shaped morphology.*

Relief *- External relief is 50 to 500 feet. Internal relief is high, exceeding 50 feet along gorge sidewalls.*

Slope Gradient *- Gorge sidewalls, which dominate the unit, are very steep (exceed 75 percent) and vertical rock outcrops are common.*

Drainage Dissection *- One deeply incised (greater than 50 feet), third or fourth order stream runs parallel with the valley floor. It has a V-shaped or truncated V-shaped morphology, and stream gradients are 3 to 10 percent.*

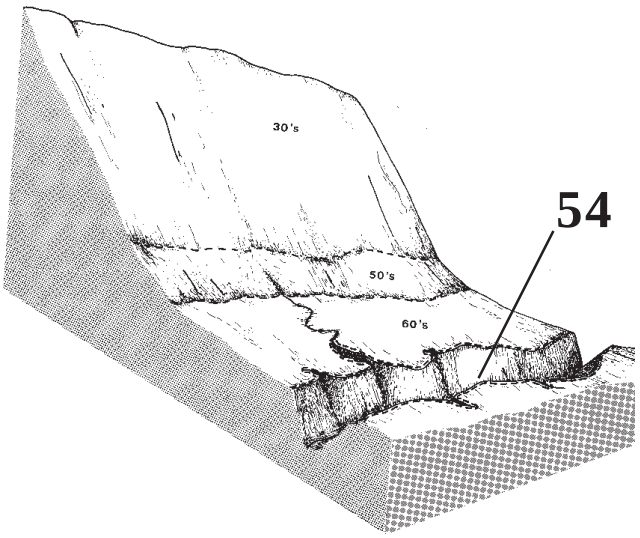
Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres and wider than 300 feet which has all of the following criteria:

1. Restricted to valley floors and lowlands landform associations.

2. Dissected by and is parallel to a third order or larger stream system.

3. The dissecting stream channel has a moderate gradient (3 to 10 percent) and is deeply incised (greater than 50 feet).



Hydrologic Function

Bedrock falls, boulder strewn cascades, and steep gradient chutes are common channel features. Mass wasting from steep mountain slopes and along channel sideslopes is a major on-site contributor of sediment. High stream energy results in efficient transport of both coarse bedload sediment and fine sediment. Flow containment is excellent.

Engineering

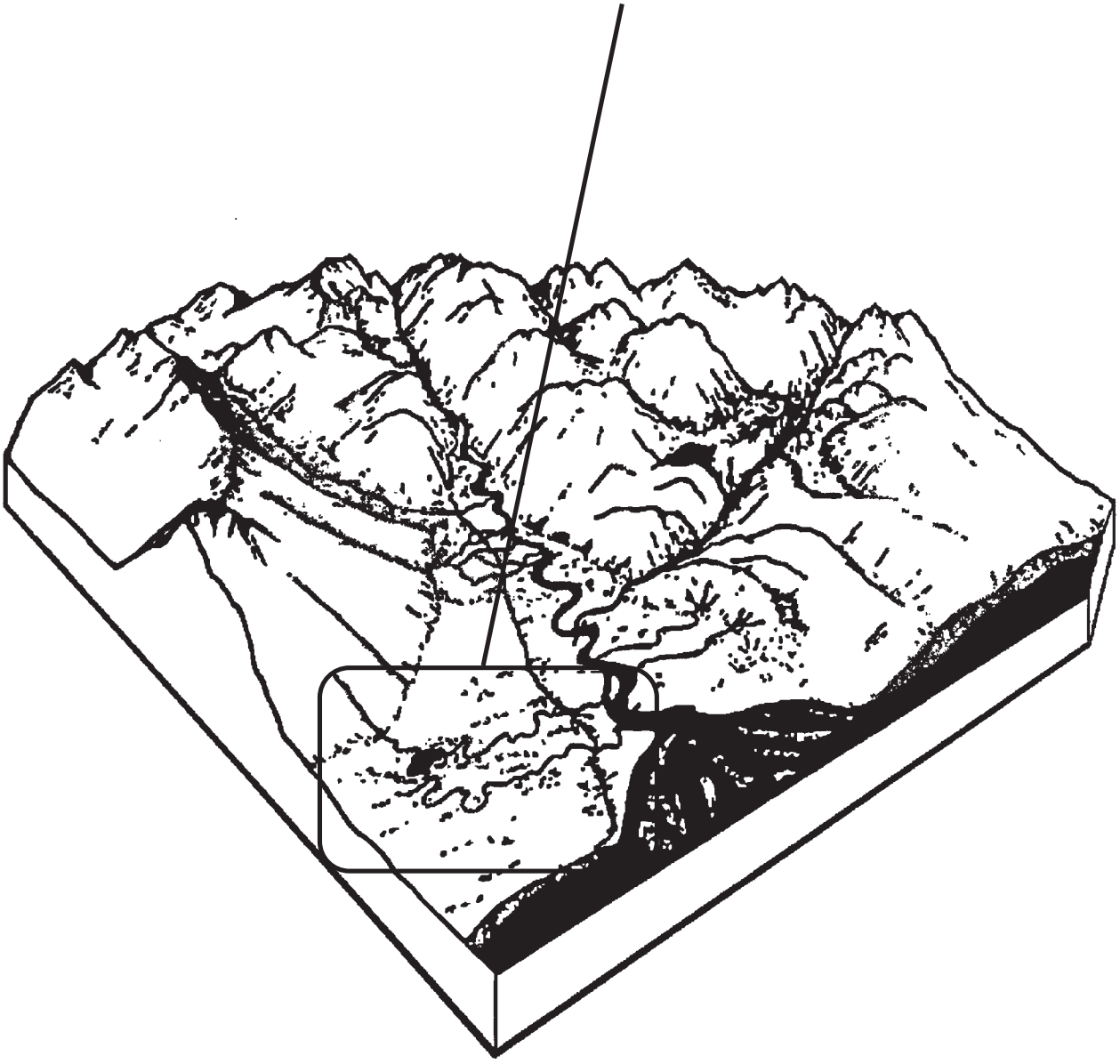
Valley floor gorges generally block access for roading.

Vegetation and Timber

Moderately productive forests may occupy valley floor gorges along with alder and salmonberry plant communities.

Extremely unstable sideslopes and high sediment routing potential preclude timber harvest.

60 - LOWLANDS LANDFORM ASSOCIATION



60 - LOWLANDS LANDFORM ASSOCIATION

General Description

Landforms of the lowlands association are comprised of nearly level to gently sloping or undulating historic planar land surfaces of glacial, alluvial, or marine origin. Elevation may range from 0 to several thousand feet above sea level. These are extensive, broad areas of very low relief and gentle slope gradient located on forelands, till plains, cirque floors, and valley floors.

Streams are of very low gradient and low velocity, represented by palustrine (38 percent) and flood plain (33 percent) channel type process groups (Paustian et al. 1992). Water movement is slow with low sediment transport. These are highly stable landforms and commonly act as long term material and groundwater storage zones.

Unconsolidated surficial deposits are often overlain by deep accumulations of sphagnum or sedge peat. Organic soils, composed of partially decomposed and undecomposed sedges and sphagnum, are very deep and poorly drained. Sedge and sphagnum peatlands are the dominant habitats of these landforms, although open woodlands of shore pine or mixed conifer plant associations are common (Martin 1989).

Differentia

1. Average slope gradient is from 0 to 35 percent.

2. Relief is low, less than 50 feet between hill or knob summits and depressions.

3. If topography is undulating, the knob hillslopes and bench faces are a minor component, occupying less than 50 percent of the area.

4. Do not occupy pleistocene or holocene footslopes at the base of erosional sideslopes. Do not occupy a series of curvilinear mounds located adjacent to coastline (uplifted beaches). Are restricted to cirque bottom, plateau, valley, till plain, outwash plain, uplifted tide mudflats and coastal plain landform features.

5. Not inundated with saltwater tidal fluctuations.

61 - Gently Sloping Lowlands

General Description

Gently sloping lowlands are broad extensive areas of low relief and gentle gradients which are located on coastal lowlands, till plains, cirque floors, and valley floors. Slope shapes are either smooth or gently undulating. The unconsolidated surficial deposits are often overlain by deep accumulations of sedge peat.

Landscape Position *- Associated with a broad elevation range, but are restricted to cirque floors, valley floors, till plains, outwash plains, and coastal plains.*

Landform Features *- Cirque basin floors, valley floors, till plains, outwash plains, and coastal plains.*

Slope Shape *- Till plains and coastal plains are flat to undulating. Valley floors are generally concave with a smooth or undulating topography. In undulating or broken topography, knob hillslopes and bench faces form a minor component (less than 50 percent of the area).*

Relief *- Relief is very low, usually less than 50 feet, being comprised of rock knobs and bench faces.*

Slope Gradient *- Average gradient ranges from 5 to 35 percent. On broken and undulating topography, the gradient is bimodal, ranging from 20 to 55 percent on knob hillslopes and bench faces, and 0 to 20 percent on terraces and depressions.*

Drainage Dissection *- Weakly developed first and second order streams occur in a deranged or dendritic pattern, with a occasional dissection by a third or fourth order stream. Sheet surface flow occurs during periods of heavy precipitation due to characteristic very slow subsurface drainage.*

Mapping Unit Differentia

Any homogeneous tract of land greater than 20 acres which has all of the following criteria:

1. Average slope gradient ranges between 5 and 35 percent.

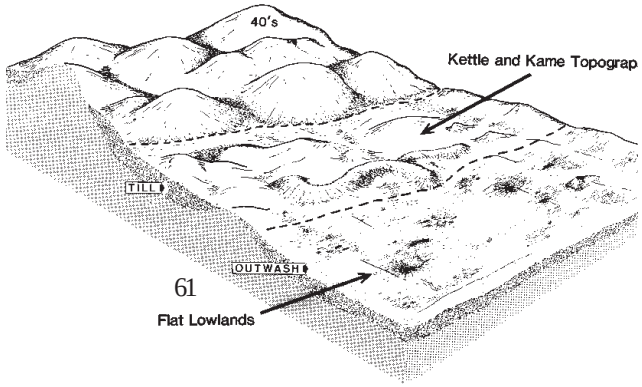
2. Relief is very low, less than 50 feet between knob summits and depressions.

3. If the topography is undulating, the knob hillslopes and bench faces are a minor component (less than 50 percent of the area); conversely, bench terraces and depressions comprise greater than 50 percent of the area.

4. Restricted to cirque floor, valley floor, till plain, outwash plain, and coastal plain landform features; does not occupy footslopes at the base of erosional sideslopes, except as inclusions, and does not occupy a series of curvilinear mounds, located adjacent to the coastline (uplifted beaches).

5. Not inundated by saltwater.

6. If the topography is undulating, the depressions are not filled with numerous ponds and small lakes.



Hydrologic Function

Bedrock control of channel banks and stream bed is prevalent. Stream energy is high due to moderate channel gradient and high flow containment. Cascades, low vertical falls, and bedrock knickpoints are common features. In-channel sediment storage is low. Fine sediment is easily flushed through these channels. Shallow mass wasting of weathered bedrock on steep mountain slopes and poorly consolidated glacial till on channel sideslopes are primary sources of sediment.

Channels on low gradient flood plains function as temporary storage systems. Large woody debris accumulations are frequent and retain significant volumes of coarse to fine sediment, which is mobilized only during peak flow events due to low stream power. Receiptor wetlands are common.

Engineering

Overlay road construction will require rock fill where organic deposits are deep.

Vegetation and Timber

This landform is dominated by peatland bogs and fens. Marginally and non productive shore pine or mixed conifer forested wetlands can also occupy this landform.

62 - Flat Lowlands and Plateaus

General Description

Flat lowlands and plateaus are smooth, flat topography found on valley floors or coastal plains. They are stable landforms composed of glacial outwash or fine textured sediments which are often overlain by deep accumulations of sedge or sphagnum peat.

Landscape Position *- Found in valley floors or broad outwash plains, on dried-up lake beds, on broad coastal plains, or on broad plateaus.*

Landform Features *- Outwash plains, till plains, stabilized upper alluvial terraces, lacustrine basins, and uplifted tidal flats.*

Slope Shape *- Flat and smooth, both vertically and horizontally, with the exception of terraced landforms which are interrupted by short, abrupt scarps.*

Slope Gradient *- Gradients are very low, less than 5 percent.*

Drainage Dissection *- Weakly developed first order streams dominate and have a deranged drainage pattern. The landform is characterized by very slow subsurface drainage or by sheet surface flow during periods of heavy precipitation. The unit is commonly dissected by a moderately developed third or fourth order stream.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria:

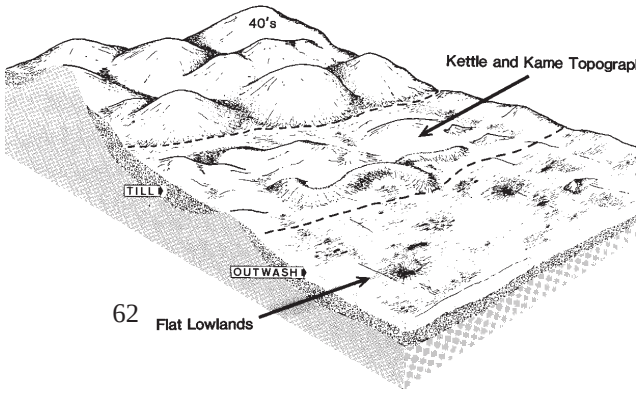
1. Restricted to lowland, valley floor positions and plateaus or coastal plains.

2. Dominant slope gradient is below 5 percent.

3. External and internal relief are very low, less than 5 feet.

4. Stable landforms which may be influenced by ponding, but are not eroded by flooding and are not dissected by numerous stream channels.

5. Not inundated by saltwater.



Hydrologic Function

Channel pattern may be highly sinuous, and streams are commonly associated with ponds and small lakes. Stream energy is low, retaining organic laden silt, sand, and very fine gravel, which is mobilized only during peak flow events. Stream flow may be influenced by runoff from peat bogs. Sediment routed from high and moderate gradient sediment transport channels is temporarily stored in channels or on the adjacent flood plain. Large woody debris accumulations are frequent and retain significant volumes of fine sediment. Receiptor wetlands are common.

Engineering

Overlay road construction often requires rock fill, or fabric and corduroy underlayment when crossing deep organic soil deposits.

Vegetation and Timber

This landform is imperfectly drained and generally dominated by peatland bogs, fens and marginally productive mixed conifer forested wetlands

63 - Glacial Topography

General Description

This landform includes extensive undulating glacial moraines with low relief and gentle slope gradients. Kames are ridges or mounds up to 100 feet in relief. Kettles are ponds and small lakes that occur in the depressions left by melting glacial ice.

Landscape Position *- Till plains.*

Landform Features *- Terminal moraines, ground moraines, lateral moraines, kettles, kames, roche monotonies, etc.*

Slope Shape *- Gently undulating.*

Relief *- Relief is low, usually less than 100 feet, and is comprised of small hills and water filled depressions.*

Slope Gradient *- Gradient is bimodal, ranging from 20 to 55 percent on moraine and kame slopes, and 5 to 15 percent on moraine and kame summits and depressions.*

Drainage Dissection *- Infrequent dissection by weakly developed first order streams occurs in a deranged pattern. The landform is usually dissected by a third or fourth order stream.*

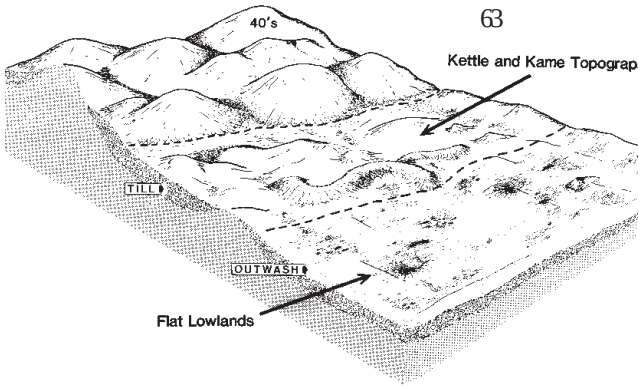
Mapping Differentia

Any homogeneous tract of land greater than 20 acres which has all of the following criteria:

1. Average slope gradient ranges between 5 and 55 percent.

2. Relief is low, less than 100 feet between summits and depressions.

3. Topography is undulating, being composed of numerous knobs and water filled depressions.



Hydrologic Function

Moderate to low gradients and flow containment result in moderate to low stream energy. In-channel storage of fine sediment is minor in narrow shallow contained channels, however, organic laden silt, sand, and very fine gravel are retained in the narrow placid flow channels. Stream flow may be influenced by runoff from extensive peatlands. This landform has extensive kettle (pit) and kame (mound) features that control the hydrology and plant ecology. The kettles are depressional wetlands are seasonally flooded and wetland plants are common. The kames are usually considered uplands and have a prevalance of non-wetland plant species.

Engineering

Road access is achieved by routing the road system along the breaks in slope but skirting the lowlying areas where practicable. Most crossings of wetlands require overlay road construction techniques.

Vegetation and Timber

Areas of low slope gradient with imperfect drainage are dominated by peatlands, such as tufted clubrush, bog kalmina, etc. On kame and moraine sideslopes mixed conifer forest-types occur. Where moderately productive forests occur, short cable systems may be used for harvest.

64 - Outburst Flood Plains

General Description

Outburst flood plains are flat outwash plains formed by previous, catastrophic flooding events, and which are highly dissected by abandoned stream channels.

Landscape Position *- A low elevation flood plain occurring immediately below an active glacier or glacial lake and adjacent to an outwash plain.*

Landform Features *- Dissected outwash plains and remnant outburst flood plains.*

Slope Shape *- Basically flat, but, to some degree, broken by frequent alluvial terraces.*

Relief *- Relief is very low, less than three feet between alluvial terraces.*

Slope Gradient *- Gradients are low, less than 5 percent.*

Drainage Dissection *- Frequent dissection occurs by stream channels formed under catastrophic flooding events which occurred during glacial recession. Most channels are now either abandoned or carry slowly moving water during periods associated with a high water table.*

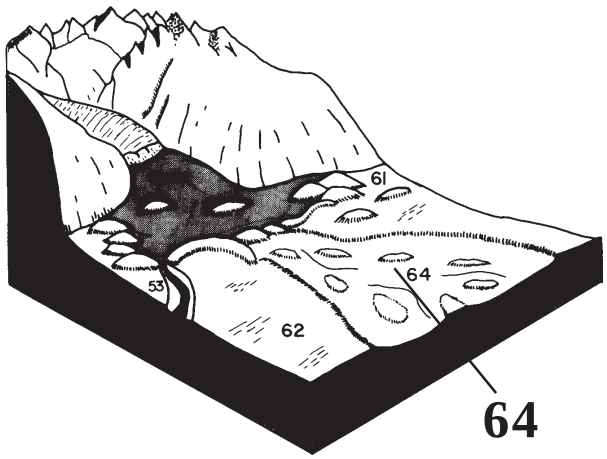
Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria:

1. Restricted to outwash plains.

2. Dissected by numerous (greater than ten per mile) stream channels which were formed historically, but which are no longer associated with erosive flooding events.

3. Dominant slope gradient is less than 5 percent.



Hydrologic Function

Sediment routed from high and moderate gradient channels is temporarily stored in stream channels and on the adjacent flood plain. Sand and fine gravel deposits in point bars and pools are dominant streambed features. Large woody debris accumulations are frequent and retain significant volumes of fine sediment, which are only mobilized during peak flow events, due to low stream power. Wetlands are common where groundwater tables are high. Most of these landscapes convey water.

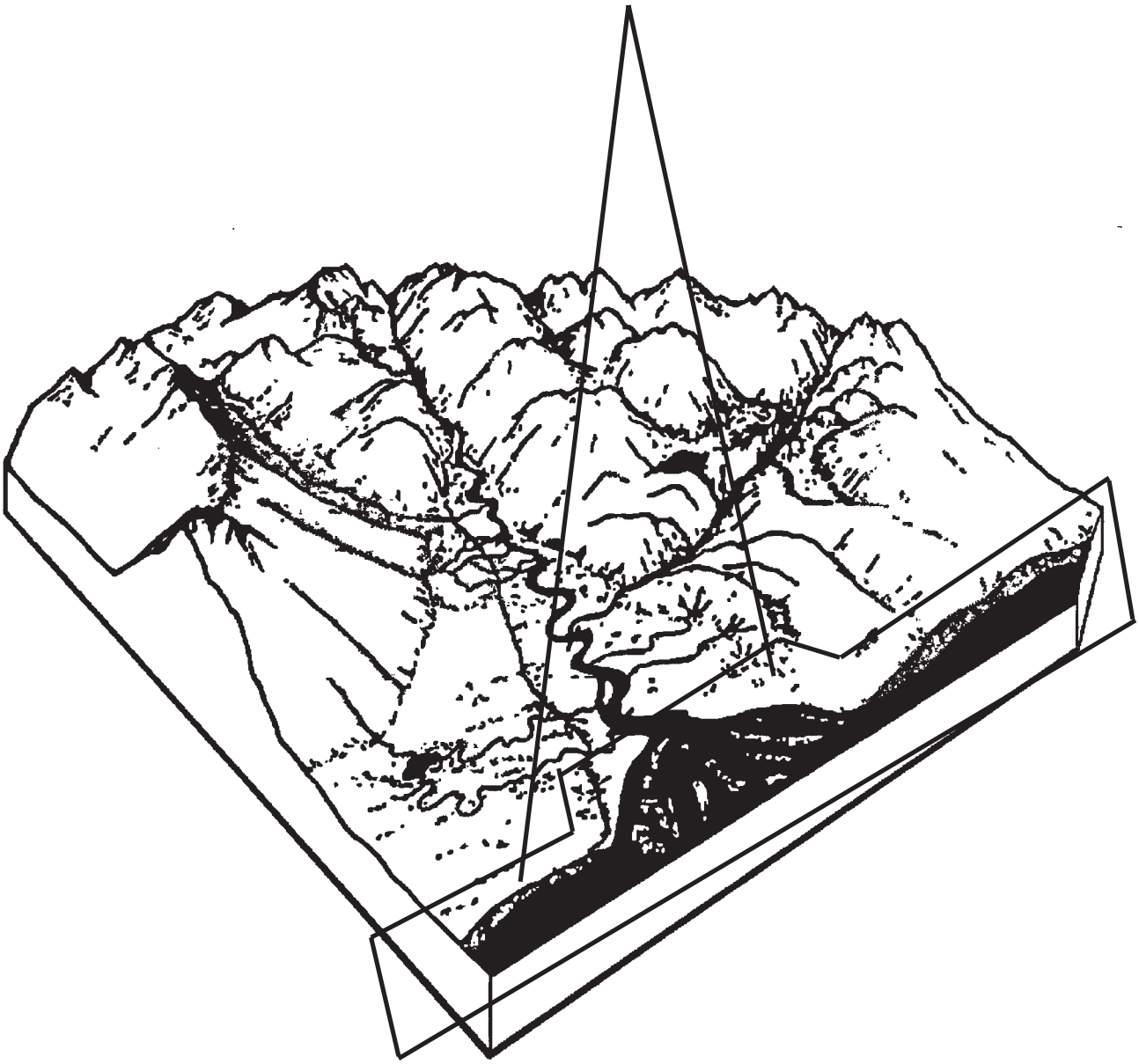
Engineering

Road construction requires a large number of culverts per mile of construction due to the many streams dissecting the landform.

Vegetation and Timber

Highly variable productivity depending on location. Shovel yarding is generally adequate for timber harvest on this landform. Compaction of the soil as a result of machinery operation is a concern for long term site productivity.

70 - COASTAL LANDFORM ASSOCIATION



70 - COASTAL LANDFORM ASSOCIATION

General Description

The coastal landform association defines the terrestrial boundary as mean low tide and is comprised of estuaries, wave front beaches and dunes, wave cut scarps and platforms, rock headlands, and uplifted (elevated) beaches and uplifted estuary mudflats. The morphology of these landforms is the result of marine influences, such as daily tidal fluctuations, maritime storms, wave splash, periodic saltwater inundation, wave or surf carving, and dune building. In many cases, the formation of these coastal landforms is aided by isostatic rebound (general land mass uplift after glacial recession), tectonics (e.g. tectonic uplift), and longshore transport.

Coastal landforms, in general, are composed of either clean or washed sands (beaches and dunes), mudflats (estuarine landform), or bedrock (rock headlands). Slope gradients range from 0 to 35 percent, except for the rock headlands which often occur with slope gradients greater than 75 percent on the wave cut scarp. Streams of this association are the channel types of the Estuarine Process Group (Paustian et al. 1992).

Differentia

1. One major border of the landform is, or has been, defined by a seawater margin.

2. Is or has been shaped by contact with tide waters which may or may not include surf action.

3. Most channel locations were generated by tidal scour processes.

71 - Estuaries

General Description

Estuaries are flat, highly dissected deltas located where major stream systems enter saltwater. Includes intertidal mud flats and saltwater marshes which are inundated by high tides

Landscape Position *- Coastal areas at the mouth of major stream systems within protected bays and inlets.*

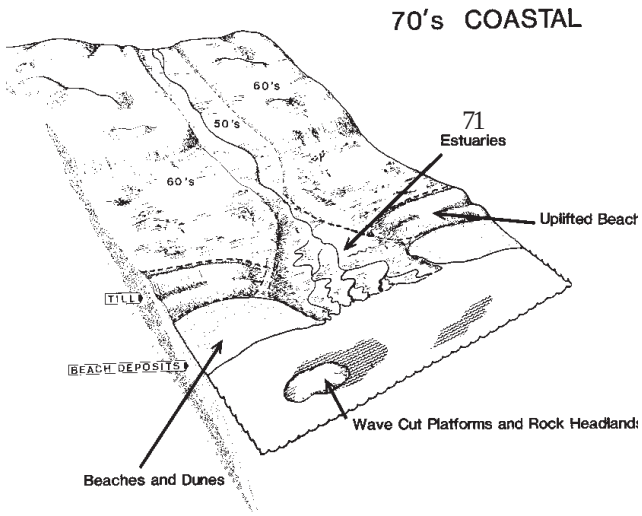
Landform Features *- Tide flats, salt marshes, mud flats, salt chucks (lochs), and river deltas.*

Slope Shape *- Flat and smooth.*

Relief *- External and internal relief is very low (less than 15 feet).*

Slope Gradient *- Almost level, ranging from 0 to 5 percent.*

Drainage Dissection *- Highly braided, third and fourth order streams characterized by meandering channels or a radiating drainage pattern occur.*



Mapping Unit Differentia

Any tract of land larger than 20 acres and wider than 300 feet which has all of the following criteria:

1. Contains the mouth of a highly braided third or fourth order stream which enters saltwater.

2. Inundated by saltwater during tidal fluctuations.

3. Contains very low relief (less than 15 feet) and very low slope gradients (less than 5 percent).

4. Exposed at mean low tide (see USGS topography map for delineations).

Hydrologic Function

Low gradient channels, functioning as depositional channels, are subject to tidal influences. Bank erosion is influenced more by ocean erosion processes than by stream discharge events. Gravel and sand bars tend to be stable bed features, except during extreme flow events. Large woody debris significantly influences channel structure, and accumulations are important in forming pool habitat (Paustian et al. 1992).

Engineering

Difficult road construction because of poor bearing strength sediments and tidal concerns. Large embankments are required to cross these landforms and considerations must be given to the ebb and flow of the tides to insure estuary function is not impaired.

Vegetation and Timber

The landform is dominated by halophytes. In the frequently inundated areas, sedges such as Carex lyngbye are common. In higher landward areas, forbs particularly umbels and grasses such as Deschampha and Testuca dominate. Wetlands are common.

72 - Beaches and Dunes

General Description

Beaches and dunes are gently sloping shores currently exposed to wind and waves. These are restricted to sparsely vegetated sandy beaches and dunes.

Landscape Position *- Exposed, normally west or south facing, coastal margins.*

Landform Features *- Sand beaches, sand dunes, spits, bars, and barrier islands.*

Slope Shape *- Beaches are both terraced and concave vertically, and are curvilinear horizontally. Dunes form convex knobs, spits, and bars. They are convex vertically, but curvilinear horizontally.*

Relief *- Beaches, spits, and bars have very low relief, both externally and internally. Dunes have moderate external relief (up to 100 feet), but very low internal relief (less than 10 feet).*

Slope Gradient *- Beaches, spits, and bars have gradients less than 10 percent and are often nearly level. Dunes average 40 percent with a dominant range of 10 to 50 percent.*

Drainage Dissection *- Undeveloped: the stream channels are frequently eroded by wave action.*

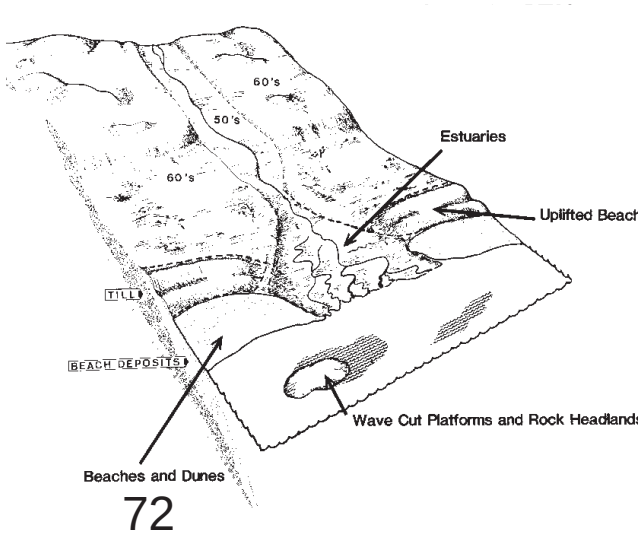
Mapping Unit Differentia

Any tract of land larger than 20 acres and wider than 300 feet which has all of the following characteristics:

1. Composed of sandy or gravelly beaches and dunes along exposed outer coasts.

2. Inundated by tidal fluctuations and wave splash, or influenced by wind blown sands or wave splash; therefore, rarely vegetated by trees.

3. Relief is low to moderate (less than 100 feet) and slope gradients are gentle (less than 50 percent).



Hydrologic Function

Wide, low gradient channels, functioning as depositional channels, are subject to tidal influences. Bank erosion is influenced more by ocean erosion processes than by stream discharge events. Gravel and sand bars tend to be stable bed features, except during extreme flow events. Large woody debris significantly influences channel structure, and accumulations are important in forming pool habitat.

Engineering

Generally inadequate for road construction due to sandy soils.

Vegetation and Timber

Beaches and dunes are typically sparsely vegetated, with forb and grass communities beyond direct tidal influence. Elymus niellos frequently forms a beach fringe. Herbs such as lupine, strawberry, calcic, honkenya, and Carex macrocephala are common. Successional stands of noncommercial timber at a variety of ages may occupy this landform beyond the reach of wave splash.

73 - Wave Cut Platforms and Rock Headlands

General Description

Wave cut platforms and rock headlands are wave-worked rocky cliffs, scarps, headlands, and reefs extending into or adjacent to the sea.

Landscape Positions *- Exposed, usually south or west facing, coastal margins.*

Landform Features *- Wave cut platforms, rock headlands, sea cliffs, marine terrace scarps, reefs, shoals, and islets.*

Slope Shape *- Headlands are straight vertically and straight to convex horizontally. They are usually very broken and discontinuous. Islets are convex vertically and horizontally, either smooth or broken. Wave cut platforms form a narrow band along coastal margins and are composed of a flat bench which abruptly breaks to saltwater along a steep linear scarp.*

Relief *- External relief is 30 to 200 feet. Internal relief is very high, often exceeding 100 feet.*

Slope Gradient *- Wave cut platforms are bimodal with the upper terrace (greater aerial extent) being nearly level (0 to 5 percent) and the lower scarp (lesser aerial extent) being very steep (greater than 55 percent).*

Drainage *- Undeveloped: streams develop inland and enter saltwater in deep, wave-cut ravines along fault and joint cracks.*

Mapping Unit Differentia

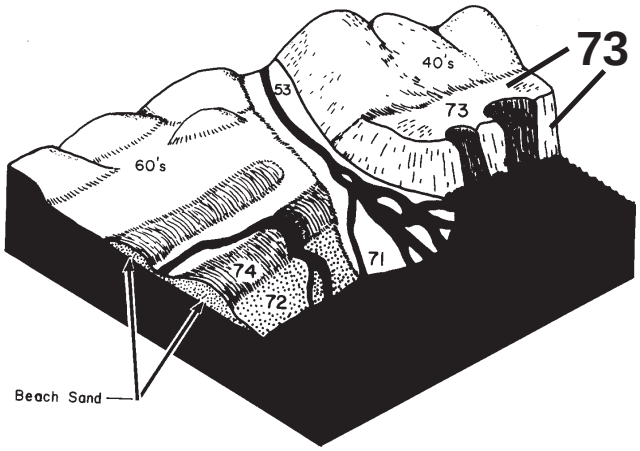
Any tract of land larger than 40 acres and wider than 300 feet which has all of the following criteria:

1. Dominated by exposed bedrock, often only exposed on scarp, which has less aerial extent than top.

2. Restricted to steep coastal margins with high relief (greater than 30 feet).

3. Headlands have slope gradients exceeding 55 percent.

4. Wave cut scarps have a flat upper bench which breaks abruptly down a very steep (greater than 55 percent) linear scarp.



Hydrologic Function

Well contained channels are confined by adjacent landforms. Bedrock control of channel banks and stream bed is prevalent. Stream energy is high due to moderate channel gradient and high flow containment, resulting in sediment transport systems. Shallow mass wasting of weathered bedrock on channel sideslopes is a primary source of sediment that is quickly transported downstream. Fine sediment may be stored in pools associated with large boulders. Stream flow responses to intense rainfall or rain-on-snow events are usually rapid.

Engineering

Difficult for road construction.

Vegetation and Timber

Summits of headlands often forested, typically spruce or spruce-western hemlock. Stands are often quite productive with shrub and forb understories. Scarp sideslopes often shrublands-alder, devil's club, or grasses, especially Calamagrostis nukalnisis on outer coast.

Generally inaccessible to timber harvest. Oversteepened slopes preclude timber harvest.

74 - Uplifted Beaches

General Description

Uplifted beaches are coastal beaches which are not presently being eroded or deposited by wave action.

Landscape Position *- Inland areas adjacent to exposed, normally west or south facing, coastal margins.*

Landform Features *- Uplifted beaches, inland beach ridges, and stabilized dunes.*

Slope Shape *- Uplifted beaches form a series of long, narrow curvilinear mounds along coastal margins. They are convex along the short axis and curvilinear along the long axis.*

Relief *- External and internal relief is very low to moderate (less than 50 feet).*

Slope Gradient *- Beach mounds have gentle slope gradients (less than 35 percent).*

Drainage Dissection *- Poorly developed third and fourth order streams often dam up behind or run parallel to the landward edge of an uplifted beach until an eroded breakout point is reached. Overflow channels often flow between beach ridges.*

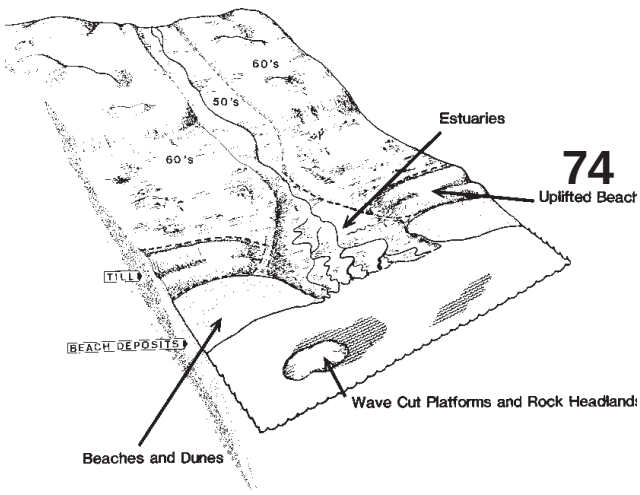
Mapping Unit Differentia

Any continuous tract of land larger than 20 acres and wider than 300 feet which has all of the following criteria:

1. Composed of a series of curvilinear mounds with low to moderate relief (less than 50 feet) and gentle slope gradients (less than 35 percent).

2. Overlain by marine deposits; stabilized dunes have been reworked by wind erosion.

3. No longer inundated by saltwater or wave splash (due to isostatic rebound or tectonic uplift) and the presence of woody species is used as an indicator.



Hydrologic Function

Sediment routed from high and moderate gradient channels is temporarily stored in stream channels and on the adjacent flood plain. Sand and fine gravel deposits in point bars and pools are dominant streambed features. Large woody debris accumulations are frequent and retain significant volumes of fine sediment, which are only mobilized during peak flow events. Stream energy is low due to wide, low gradient channels. Large estuarine channels are subject to tidal influences. Most of these donate water to the adjacent landforms. Wetlands are not common.

Engineering

Overlay road construction in common on the lower slope gradients.

Vegetation and Timber

Moderately and highly productive spruce forests commonly occupy the beach ridge systems of this landform. Typically, the understory is devil's club, blueberry, various forbs, and mosses. Shovel yarding is generally adequate for timber harvest of theses moderate to highly productive forests.

76 - Uplifted Estuaries and Tidal Flats

General Description

Uplifted estuaries and tidal flats are flat or nearly flat, uplifted tide flats, salt marshes, mud flats, salt chucks (lochs), and river deltas, once influenced and inundated by high tides. They have been uplifted by isostatic rebound or tectonic movement and are not influenced by tidal action.

Landscape Position *- Coastal margins elevated from present sea level. Delta shaped areas adjacent to current estuaries and stream systems; also occurring between uplifted beach ridges.*

Landform Features *- Uplifted tide flats, salt marshes, mud flats, salt chucks, and river deltas.*

Slope Shape *- Flat or nearly flat and smooth.*

Relief *- External relief (maximum elevation from saltwater) is less than 100 feet and internal relief is less than 15 feet.*

Slope Gradient *- Slope gradient ranges from 0 to 5 percent.*

Drainage Dissection *- Highly braided, third and fourth order streams characterized by meandering channels or a radiating drainage pattern occur in the uplifted delta areas. Other uplifted features include small palustrine drainages, 1 to 4 feet wide and less than 2 feet deep that drain into the third and fourth order streams of the uplifted or current deltas.*

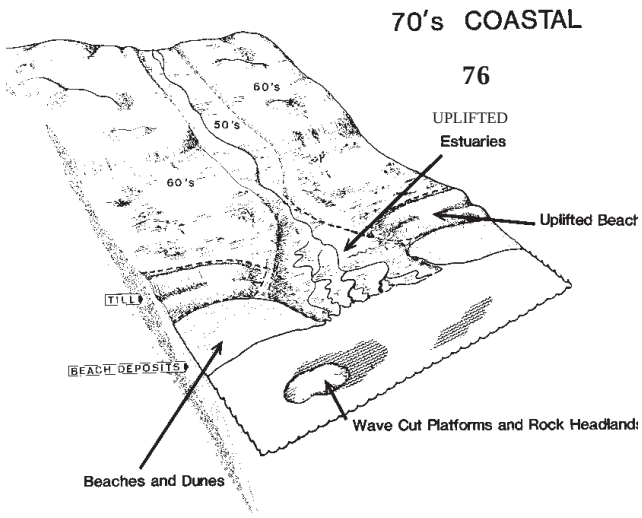
Mapping Unit Differentia

Any tract of land larger that 20 acres and wider than 300 feet which has all of the following criteria:

1. Restricted to large marine deltas that are abnormally characterized by incised slough channels and shallow ponds.

2. Are relatively level.

3. Contain incised slough channels with a cut bank relief of up to 10 feet.



Hydrologic Function

Water on the land surface is derived mainly from precipitation on soils with very low infiltration silts and clays. Overflow from ponds drains into channels that will be intertidal where they are closer to the ocean. There are also a combination of single incised channels from rivers that originate outside of the map unit and cut through the map unit. If the rivers are of glacial origin they will likely have a braided pattern. Many channels are remanent of tidal scour and are underfit.

Engineering

Difficult road construction because of poor bearing strength silts and sand sediments and super saturated soils. Many stream crossings will be required.

Vegetation and Timber

Vary from early successional wetland communities to old growth spruce and hemlock forest. In recent uplifted areas, vegetation varies from marsh to alder shrublands. On older areas, conifer vegetation has developed and a pit and mound nature of the forest floor has developed. In areas that are poorly drained, forested wetlands dominate the landscape and peatlands slowly develop. Soil compaction and puddling can become a problem where equipment is allowed to break through the litter and duff cover.

80 - VOLCANIC LANDFORM ASSOCIATION

General Description

The volcanic landform association is comprised of volcanic cones, lava plateaus, basaltic domes, lava scarps, and lava plains. Surficial deposits include volcanic ash, cinders, breccia, tuff, and lava. Slope gradients range from 0 to 75 percent. Except for lava flows, volcanic landforms are relatively unstable when compared to other landform associations and can potentially be high sediment sources should destabilization occur.

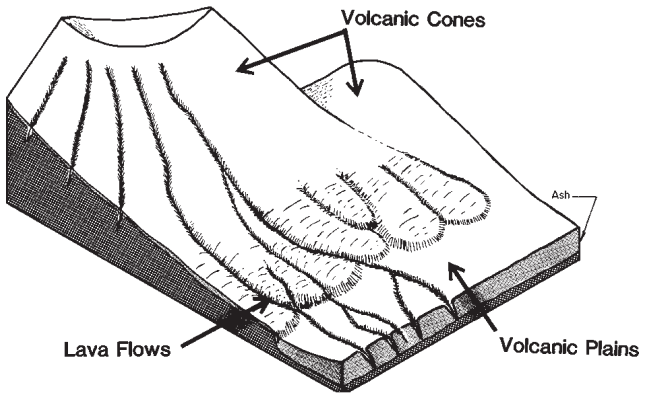
Differentia

1. Landform has been shaped by volcanic eruption, lava flow, and/or other processes of volcanism.

2. Surficial ash and cinder materials occur as plumes and are generally widespread.

3. Lava flows consists of basalt or rhyolite and occur as benchy topography.

4. Pyroclastic mudflows deposits occur near vent areas.



82 - Frequently Dissected Volcanic Cones

General Description

Sideslopes of volcanic cones which are frequently dissected by more than ten ravines per linear mile.

Landscape Position *- All slope positions of volcanic cone sideslopes. Elevation ranges from 500 to several thousand feet.*

Landform Features *- Frequently dissected volcanic cone sideslopes and ravine sidelopes and channels.*

Slope Shape *- Vertically, slopes are straight. Horizontally, slopes are convex.*

Relief *- External relief rises to alpine or subalpine climate, extending from cone shoulder slopes to footslopes or plateaus. Internal relief within ravines ranges from 10 to 75 feet. Internal relief between knobs and benches is subdued, less than 30 feet.*

Slope Gradient *- Average slope gradient usually exceeds 35 percent. Ravine sideslopes dominantly range from 55 to 100 percent.*

Drainage Dissection *- A series of radiating first and second order streams runs perpendicular to slope contours (ravines). More than ten ravines occur per linear mile, with an average spacing between channels of less than 500 feet.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria.

1. Restricted to sideslopes of a volcanic cone with external relief rising to alpine or subalpine climate.

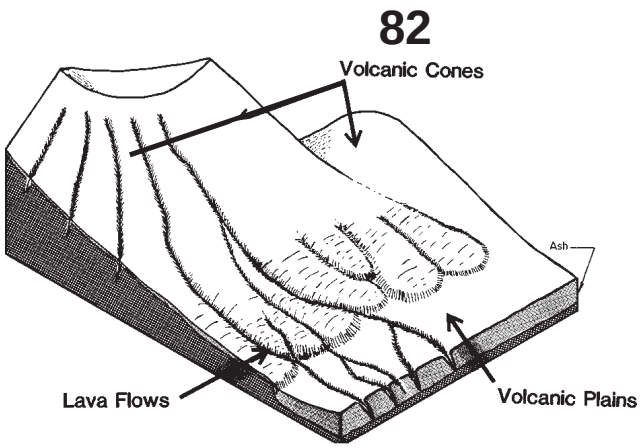
2. Frequently dissected (greater than ten per mile) by well developed, second order streams which are discernible on aerial photographs (deeper than 10 feet). The streams have a radiating pattern and a V-shaped morphology.

Hydrologic Function

The radial stream drainage pattern is a distinctive feature associated with the Edgecumbe and Crater Ridge cones. A relatively dense stream drainage network with small elongated watersheds occur on the south, east, and west slopes of these cones.

Streams associated with this landform are primarily in the high gradient contained channel process group. These are high energy erosional channels with cobble/boulder size bed materials. Erosion from steep cannel sideslopes contributes large sediment loads to these streams.

Runoff from this landform is very flashy due to steep slopes, shallow soil, mantles, and relatively high precipitation. Snow melt is an important runoff component during winter and spring.



Engineering

Unstable volcanic ash soils generally require full bench road construction design. An increased frequency of culverts per mile of road construction is required due to ravines.

Vegetation and Timber

Medium-size cones and lower slopes of large cones are usually forested in mixed conifer vegetation types. More productive hemlock and hemlock-cedar vegetation types also occur where drainage is better. Stands may be fairly open with dense shrub and forb understories. Upper slopes of large cones are typically shrub-covered, alpine plant communities, or bare soil/rock.

Moderately productive commercial forests occupy this landform. Steep slopes require cable logging systems. Full or one end log suspension is required to avoid disturbing volcanic ash soils. The high frequency of ravines requires split yarding away from ravines to reduce channel sideslope soil disturbance and sediment production.

Sideslope sensitivity and soil erosion potential are extremely high. Soil disturbance associated with road cuts and timber yarding will result in mass wasting.

83 - Infrequently Dissected Volcanic Cones

General Description

Sideslopes of volcanic cones which are infrequently dissected by less than ten ravines per linear mile.

Landscape Position *- All slope positions of volcanic cone sideslopes. Elevation ranges from 500 to several thousand feet.*

Landform Features *- Infrequently dissected volcanic cone sideslopes and ravine sideslopes and channels.*

Slope Shape *- Vertically, slopes are straight. Horizontally, slopes are convex.*

Relief *- External relief is greater than 1,000 feet, extending from cone shoulder slopes to footslopes or plateaus. Internal relief between knobs and benches is subdued, less than 30 feet.*

Slope Gradient *- Average slope gradient usually exceeds 35 percent.*

Drainage Dissection *- If dissection occurs, the streams are widely spaced, greater than 500 feet between channels (less than ten per linear mile). The first and second order streams (ravines) run perpendicular to slope contours.*

Mapping Unit Differentia

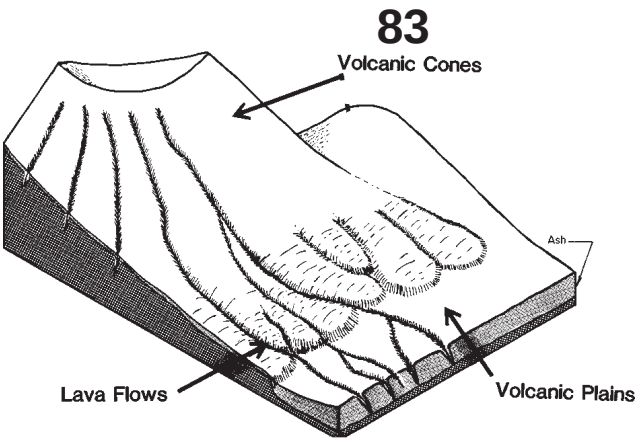
Any homogeneous tract of land larger than 20 acres which has all of the following criteria.

1. Restricted to sideslopes of volcanic cones with an external relief rising to alpine or subalpine climate.

2. Undissected or infrequently dissected (less than ten per linear mile) by well developed, second order streams which are discernible on aerial photographs (deeper than 10 feet).

Hydrologic Function

Runoff from this landform is very flashy due to steep slopes, shallow soil mantles, and relatively high precipitation. Snow melt is an important runoff component during winter and spring.



Engineering

Unstable volcanic ash soils generally require full bench road construction design.

Vegetation and Timber

Medium-size cones and lower slopes of large cones are usually forested in mixed conifer vegetation types. More productive hemlock or hemlock-cedar vegetation types also occur where drainage is better. Stands may be fairly open with dense shrub and forb understories. Upper slopes of large cones are typically shrub-covered, alpine plant community, or bare soil/rock.

Moderately productive commercial forests occupy this landform. Steep slopes require cable logging systems. Full or one end log suspension is required to avoid disturbing volcanic ash soils.

Sideslope sensitivity and soil erosion potential are extremely high. Soil disturbance associated with road cuts and timber yarding will result in mass wasting.

84 - Small Volcanic Cones

General Description

Small cone shaped volcanic hills with an external relief limited to below subalpine climate.

Landscape Position *- All slope positions of cone shaped, volcanic hills.*

Landform Features *- Volcanic hill summits and sideslopes.*

Slope Shape *- Vertically, slopes are smooth or straight. Horizontally, slopes are convex.*

Relief *- External relief ranges between 200 and elevation of the predominate local subalpine climatic zone, extending from cone hilltops to footslopes or lowland volcanic plateaus. Internal relief between knobs and benches is subdued (less than 30 feet).*

Slope Gradient *- Average slope gradient ranges from 35 to 75 percent.*

Drainage Dissection *- Weakly developed first and second order streams occur on hillslopes with a radiating drainage pattern. They have a low frequency, less than three channels per mile.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria:

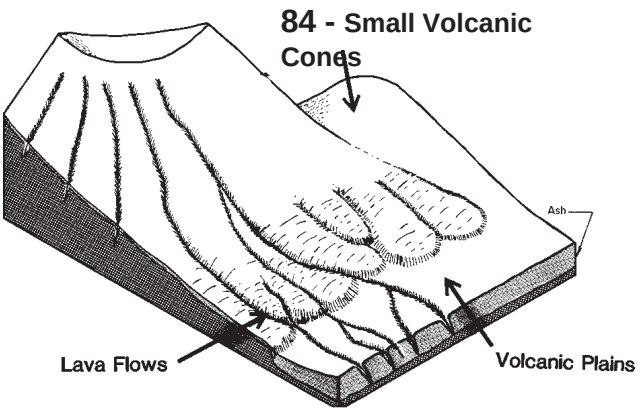
1. Restricted to volcanic cones with an external relief ranging from 200 to 1,000 feet. Elevation does not rise to alpine or subalpine climatic zone.

2. Stream dissection does not originate in alpine areas with a deep winter snowpack.

3. Has a smooth slope shape. Internal relief of knobs and benches is less than 30 feet with size less than five acres.

Hydrologic Function

Numerous small pyroclastic cones are found on South Kruzof island. These features do not have major drainways due to limited runoff source area and highly permeable pyroclastic deposits.



Engineering

Overlay roads generally are routed along the base of the cone. Normally midslope roads are not required. Unstable volcanic ash soils generally require full bench road construction design on midslope roads.

Vegetation and Timber

These cones are usually forested in hemlock, hemlock-cedar, or mixed conifer plant community types. Shrub and forb understories may be extensive. Productivity and drainage are quite variable.

Moderately productive commercial forests occupy this landform. Steep slopes require cable logging systems. Full or one end log suspension is required to avoid disturbing volcanic ash soils.

Sideslope sensitivity and soil erosion potential are moderate to high. Soil disturbance associated with road cuts and timber yarding may result in mass wasting and sediment delivery to streams.

85 - Frequently Dissected Volcanic Plateaus

General Description

Highly broken lava flows which are frequently dissected by deeply incised stream channels. Internal relief is high and the spacing between incised channels is less than 500 feet.

Landscape Position *- Low to mid elevation lava flows located at the base of volcanic cones.*

Landform Features *- Highly broken lava plateaus, basaltic domes, lava scarps, cone footslopes, and drainage sideslopes and channels.*

Slope Shape *- Both vertically and horizontally, the lava flows are convex and highly broken.*

Relief *- External relief is highly variable, extending from plateau and dome summits to lowland plains or ocean coasts. Internal relief is very high. Knobs, cinder cones, and lava scarps average up to 1,500 feet high.*

Slope Gradient *- Slope gradients are bimodal and range from 55 to 100 percent on lava scarps, ravine sideslopes, and scoria mounds. Gradients on plateau summits and benches range from 25 to 40 percent.*

Drainage Dissection *- Frequent dissection occurs by deeply incised stream channels which have a dendritic drainage pattern. Spacing between channels is less than 500 feet and incision ranges from 20 to 75 feet.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria.

1. Composed of lava flows which have formed broad, extensive plateaus and domes.

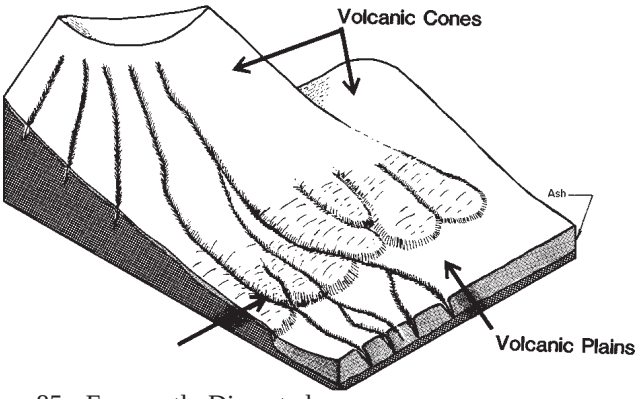
2. Internal relief is very high. The height of knobs, mounds, and scarps exceeds 50 feet.

3. Frequently dissected by deeply incised stream channels. Average spacing between channels is less than 500 feet.

Hydrologic Function

These landforms are moderate to gently sloping and have uniformly thick deposits of highly erosive volcanic ash. As a result, a dense dendritic drainage pattern has developed.

Streams associated with this landform are in the high gradient contained and moderate gradient contained channel process groups. These streams can be characterized as erosional channels. Channel profiles have a marked stair-step form



85 - Frequently Dissected Volcanic Plateaus

caused by scarps formed at the terminus of lava flows. Channels are very deeply incised (over 50 feet) in unconsolidated pyroclastic deposits. Large scale mass wasting from steep sideslopes are locally significant sediment and debris sources.

Surface runoff is relatively rapid due to moderate slopes and limited soil water holding capacity. Some surface runoff storage capacity is associated with bog ponds on gentle slopes and benchlands. Some deep groundwater recharge may occur through fissure in basalt flows or lava tubes.

Engineering

This landform presents extreme challenges to transportation corridor design. Road access is severely limited by many scarps, deep ravines, and abrupt and extreme changes in internal relief.

Vegetation and Timber

This landform, with restricted drainage, typically supports low productive mixed conifer and hemlock-cedar plant communities. These forests often occur as stripes along drainages or on steeper slopes, while the bulk of the plateau is peatland.

Marginally productive for commercial harvest. Ravines and internal relief features generally limit logging.

86 - Infrequently Dissected Volcanic Plateaus

General Description

Highly broken lava flows which are undissected or infrequently dissected by stream channels. Internal relief is high and the spacing between incised channels is greater than 500 feet.

Landscape Position *- Low to mid elevation lava flows located at the base of volcanic cones.*

Landform Features *- Lava plateaus, basaltic domes, lava scarps, cone footslopes, and drainage sideslopes and channels.*

Slope Shape *- Both vertically and horizontally, the lava flows are convex and highly broken.*

Relief *- External relief is 500 to 1,500 feet, extending from plateau and dome summits to lowland plains or ocean coasts. Internal relief is very high. Knobs, cinder cones, and lava scarps average up to 1,500 feet high.*

Slope Gradient *- Slope gradients are bimodal, and range from 55 to 100 percent on lava scarps, and scoria mounds. Gradients on plateau summits and benches range from 25 to 40 percent.*

Drainage Dissection *- If dissection occurs, the streams are widely spaced and deeply incised, with a dendritic drainage pattern. The average spacing between channels is greater than 500 feet (less than ten per linear mile).*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria.

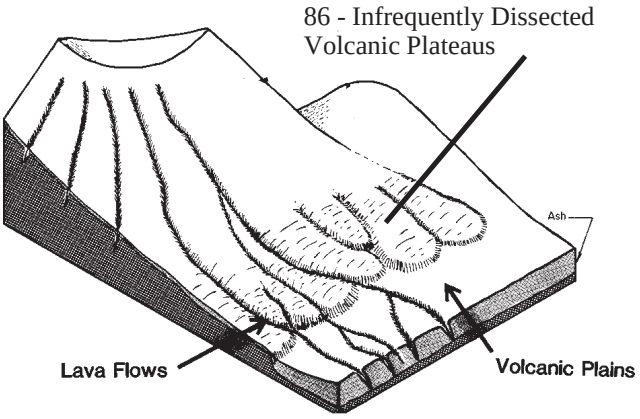
1. Composed of lava flows which have formed broad, extensive plateaus and domes.

2. Internal relief is very high. The height of knobs, mounds, and scarps exceeds 50 feet.

3. Infrequently dissected or undissected by deeply incised stream channels. Average spacing between channels is greater than 500 feet.

Hydrologic Functions

These landforms are associated with the saddle between the large Edgecumbe and Crater Ridge cones, small lava flows from secondary vents, and the margins of large overlapping lava flows. Consequently, these landform units have minimal upslope runoff source areas and surface drainage development.



Surface runoff is relatively rapid due to moderate slopes and limited soil water holding capacity. Some surface runoff storage capacity is associated with bog ponds on gentle slopes and benchlands. Some deep groundwater recharge may occur through fissures in basalt flows or lava tubes.

Engineering

This landform presents extreme challenges to transportation corridor design. Road access is severely limited by many scarps and abrupt and extreme changes in internal relief.

Vegetation and Timber

This landform with restricted drainage, typically supports low productive mixed conifer and hemlock-cedar plant communities. These forests often occur as strips along drainages or on steeper slopes, while the bulk of the plateau is peatland.

Marginally productive for commercial harvest. Extremes in internal relief may limit logging.

87 - Frequently Dissected Volcanic Plains

General Description

Smooth, almost flat, lava flows which are frequently dissected by stream channels. Internal relief is very low, and the spacing between incised channels is less than 500 feet.

Landscape Position *- Low elevation lava flows that are located between coastal margins and more inland volcanic plateaus.*

Landform Features *- Smooth, unbroken lava plains, and drainage sideslopes and channels.*

Slope Shape *- Flat and smooth, both vertically and horizontally.*

Slope Gradient *- Gradients are predominantly very low (less than 5 percent). Deeply incised stream sideslopes are much steeper, averaging 60 to 100 percent.*

Drainage Dissection *- Frequent dissection occurs by deeply incised stream channels which have a dendritic drainage pattern. Spacing between channels averages less than 500 feet and incision ranges from 20 to 75 feet.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria.

1. Is composed of lava flows which have formed broad, extensive plains.

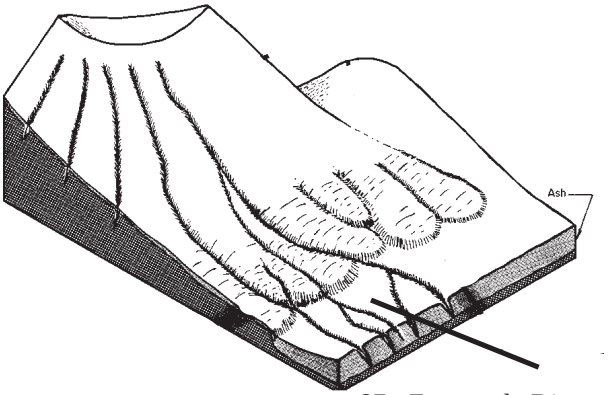
2. Has a very low internal relief. Knobs, mounds, and scarps are uncommon.

3. Is frequently dissected by deeply incised stream channels. Average spacing between channels is less than 500 feet.

Hydrologic Function

These landforms are moderate to gently sloping and have uniformly thick deposits of highly erosive volcanic ash. As a result, a dense dendritic drainage pattern has developed.

Streams associated with this landform are primarily in the moderate gradient contained channel process group. Low gradient large contained and flood plain process group streams also are common on more gently sloping lands near the coast. Flood plains are typically very narrow stream corridors that are moderately incised (10 to 50 feet) into the ash deposits. Channel substrates have an abundance of finer particles (sands and very fine gravel) from sediment eroded from adjacent ash deposits. Mass wasting of inner gorge sideslopes can have locally significant influence on stream channel morphology. Channel type map units are denoted with a volcanic ash modifier to highlight these unique characteristics.



87 - Frequently Dissected Volcanic Plains

Large expanses of gently sloping peatlands tend to attenuate runoff from precipitation in this landform., However, once bog ponds and rill channels reach capacity, storm flow runoff to adjacent streams is very rapid. Groundwater influences are fairly minor due to impermeable soil horizons that develop in ash parent material. Deep alluvial deposits adjacent to major streams are very limited, but can be locally important for maintaining baseflow in streams. Due to the predominance of peatlands in these watersheds, streams are highly colored and slightly acidic.

Engineering

Road access may be limited by ravine dissection. An increased frequency of culverts over the average will be required in road design.

Vegetation and Timber

This landform typically supports extensive peatlands dominated by sedges and low shrubs with scattered shore pines. Stronger, low productive forests occur where drainage is improved, such as on stream sideslopes or steeper slopes.

This landform supports marginally productive commercial forest land.

88 - Infrequently Dissected Volcanic Plains

General Description

Smooth, almost flat, lava flows which are undissected or infrequently dissected by stream channels. Internal relief is very low, and the spacing between incised channels is greater than 500 feet.

Landscape Position *- Low elevation lava flows that are located between coastal margins and more inland volcanic plateaus.*

Landform Features *- Smooth, unbroken lava plains, and drainage sideslopes and channels.*

Slope Shape *- Flat and smooth, both vertically and horizontally.*

Slope Gradient *- Gradients are usually very low (less than 5 percent). Deeply incised stream sideslopes are much steeper, averaging 60 to 100 percent.*

Drainage Dissection *- This landform is undissected or infrequently dissected by deeply incised stream channels which have a dendritic drainage pattern. Spacing between channels averages greater than 500 feet and incision ranges from 10 to 75 feet.*

Mapping Unit Differentia

Any homogeneous tract of land larger than 20 acres which has all of the following criteria.

1. Composed of lava flows which have formed broad extensive plains.

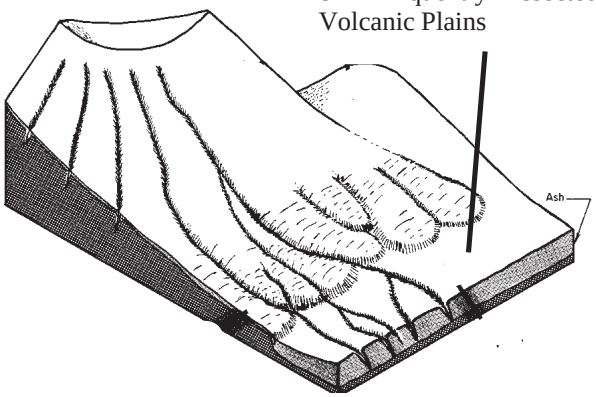
2. Internal relief is very low. Knobs, mounds, and scarps are uncommon.

3. Infrequently dissected by deeply incised stream channels. Average spacing between channels is greater than 500 feet.

Hydrologic Function

These landforms are associated with the saddle between the large Edgecumbe and Crater Ridge cones, small lava flows from secondary vents, and the margins of large overlapping lava flows. Consequently, these landform units have minimal upslope runoff source areas and surface drainage development.

87 - Infrquently Dissected Volcanic Plains



Large expanses of gently sloping peatlands tend to attenuate runoff from precipitation in this landform. However, once bog ponds and rill channels reach capacity, storm flow runoff to adjacent streams is very rapid. Groundwater influences are fairly minor due to impermeable soil horizons that develop in ash parent material. Deep alluvial deposits adjacent to major streams are very limited but can be locally important for maintaining baseflow in streams. Due to the predominance of peatlands in these watersheds, streams are highly colored and slightly acidic.

Engineering

Overlay roads are generally adequate to access this landform.

Vegetation and Timber

This landform typically supports extensive peatlands dominated by sedges and low shrubs with scattered shore pines. Stronger, low productive forests occur where drainage is improved, such as on stream sideslopes or steeper slopes.

This landform supports marginally productive commercial forest land.

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