

Defining Active Fluvial Units



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Active fluvial units include alluvial streams and their associated active floodplains and active fans. These features are considered active fluvial units as their behaviour or character might well be changed through harvesting. The critical deposits are those where erosion within the rooting depth is likely if the trees are removed; or in the case of active fans, where removal of trees can allow increased spread of sediment and debris deposition on the fan surface.

Along streams where erosive action is focussed several metres below the rooting zone, (as can be the case with glaciofluvial escarpments or terraces), tree roots do not provide resistance to stream bank erosion, and the removal of trees does not affect channel stability. There may be stability implications to logging of escarpments; however, terrain stability management is the subject of another document.

Whether a fluvial unit is "active" or not, often needs to be determined AT THE SITE LEVEL. It is therefore important that the final determination on areas to be protected from harvest is not made from inventory-level mapping, and in particular, not from provincial surficial geology mapping. The scale of this mapping varies but is often at 1:50,000 or higher. Many of the coastal areas have no BC government surficial geology mapping.

Alluvial Streams

Alluvial streams are considered active fluvial units due to their unconfined nature. See Table 1 for a detailed description of stream channel type.

Active Floodplains

The active floodplain is the area of a floodplain that floods frequently, typically within 5 years. This is determined by visible evidence of water flow or inundation. The active floodplain includes terraces adjacent to the stream and flood channels where this evidence is apparent; and may include terraces described as "mid-level benches". Mid-level benches are often not continuous or well defined; terraces may be discontinuous, or with varying stepped surface elevations. Because of this it is important to delineate the active floodplain by visible evidence such as vegetative indicators and/or water-borne sediment or wood debris. Where a stream has one confined bank the floodplain may be on only one side of the stream.

Dry floodplains or inactive floodplains flood less frequently and may include glaciofluvial or till terraces that are 2 m or more above the channel, as well as rarely-inundated alluvial terraces. Tributary streams crossing these units to join the main channel may be alluvial/active fluvial.

When defining the floodplain at an airphoto or inventory mapping exercise (1:20,000 or similar), mapped polygons typically include all fluvial terraces. If there is uncertainty as to whether a terrace is active, it should be included with the clearly active floodplain.

It is often quite apparent on airphotos what the active channel migration zone is. If the active floodplain cannot be determined with certainty at the inventory level because of canopy closure, small stream size, or the character of the terraces (low fluvial terraces or rarely-inundated fluvial terraces), provide for final determination of at the site level when laying out cutblocks.

Table 1: Stream Channel Types

Alluvial Channel	Alluvial channels are active fluvial units. They have at least one unconfined erodible bank in alluvial deposits. Alluvial deposits are material that was deposited by the stream under the contemporary flow regime. The stream has an identifiable floodplain (channel migration zone) and a riffle-pool or cascade-pool channel bed with a channel gradient $\leq 5\%$. The stream can erode its bank(s) and widen its channel. Riparian vegetation is critical to limit bank erosion. If there is a significant channel migration zone, stream position may change within this zone, triggered by disturbance or a large flood event. Abandoned channels or flood channels may be present. LWD is important for channel structure and habitat features. Alluvial channels are often reaches of highly productive fish habitat and are highly sensitive to disturbance such as logging of riparian forest, removal of LWD from the channel, or loss of LWD supply.
Semi-alluvial Channel	Semi-alluvial channels are not active fluvial units. The channel has confining banks in non-alluvial material. Channel position is stable; the stream cannot move laterally beyond its active channel. The stream has a riffle-pool channel bed and gradients $\leq 5\%$. LWD varies from important in small channels to absent or non-functional in large channels. Quality of habitat may be affected by aggradation or scour, removal of LWD, or loss of LWD supply.
Non-alluvial Channel	Non-alluvial channels are not active fluvial units. They are typically confined to entrenched channels with a stable position, although some non-alluvial channels flowing over rock or boulders may have limited lateral confinement. Banks are resistant to erosion (such as till, colluvium, rock). Non-alluvial channels are less sensitive to disturbance than semi-alluvial or alluvial channels. Banks in non-rock material may experience minor local widening or undercutting from erosion if vegetation is removed or in extreme storm events; and may experience minor bed or bank scour. Non-alluvial channels are typically transport zones. LWD function depends on stream energy and channel character. LWD is non-functional in high energy non-alluvial streams, but may function in small streams to trap sediment, limit scour, and control sediment transport. Channel bed is typically cascade-pool, step-pool or rock-dominated.

Fans

Background

- This landform is a cone- or fan-shaped deposition area where a confined tributary enters a larger valley and becomes unconfined. The fan limits may extend to a half circle, or may be limited by topography or cutting by the main valley stream to a narrow arc.
- Fans can have surface slopes up to 20° (38%). Landforms steeper than this are considered cones.
- Alluvial processes dominate where the slope on the fan surface $< 4^\circ$ (7%). Fans may be transitional – predominantly colluvial processes (debris flows) on the upper part of the fan, and alluvial processes on the lower fan. Between major colluvial events it is common for alluvial process to modify colluvial fans. For the purpose of defining “active fluvial units”, no distinction is made between these processes.
- Fan sediments are typically coarsest at the apex, becoming finer downstream, although boulders can be scattered across the full length of debris flow fans, and entrenched streams can transport coarse material farther down the fan.

- The natural stability of a fan is related to the relative ratio of sediment and water being delivered from a watershed. Many of the fans in BC were essentially formed during deglaciation, and contemporary fan-building or fan-eroding activity is frequently limited to only a portion of the fan surface.
- Active deposition processes that originate from sources in the drainage area above the fan may be from:
 - Natural landslides – either chronic or infrequent, or
 - Land use effects such as slides from roads or cutblocks.
- A watershed that is producing more sediment relative to water usually has a shallow, poorly confined channel, with evidence of water flows and sediment accumulation on the fan surface laterally beyond the stream channel.
- A watershed that is producing more water relative to sediment usually has a channel that is entrenched. However, an entrenched channel does not always indicate a naturally stable fan. Periodic debris flows can fill a 4 m deep, entrenched channel in one event, leading to broadcasting of water and sediment.
- Debris flow levees, either recent or historic, can be features that “entrench” a channel.
- Multiple channels may be present on fan. It is common for these channels to be established historically, with water flow in any channel being the result of localized sediment accumulations (frequently associated with debris jams) that partially or totally block off flow in other channel(s).
- Consequences of logging a fan can be:
 - Nil on stable fan with stable watershed upslope and appropriate engineering and harvesting prescriptions; or
 - Destabilisation of channels because of loss of root reinforcement along channel banks, increased sediment broadcasting, or stream diversion from wood debris, inadequate drainage structures, and inappropriate road construction; and/or
 - Difficulty of reforestation due to ongoing sediment deposition.

Destabilised fans can take decades to recover and restoration is rarely feasible.

Definition: Fans as active fluvial units

Determination of fan characteristics and assessment of fan activity follow the hydrogeomorphic criteria from Land Management Handbook 57 (Wilford et al, 2005)¹.

Based on field evidence, individual fans can be stratified into two components: in-active and active units. The “active fluvial unit” is the active component of the fan (described below).

¹ Wilford, D.J., M.E. Sakals, and J.L. Innes. 2005. Forest management on fans; hydrogeomorphic hazards and general prescriptions. B.C. Min. For., Res. Br., Victoria, B.C. Land Management Handbook No. 57. Available: <http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh57.htm>

All or parts of fan surfaces with stands 200 years and older undisturbed by visible hydrogeomorphic processes, are considered stable within the timeframe of forest management and are not "active fluvial units".

If no hydrogeomorphic processes are evident, the stream channel position is stable, and the fan is forested with stands 50 -200 years because of disturbances other than hydrogeomorphic processes such as fire, disease, or insects, then the fan is not an active fluvial unit.

If no hydrogeomorphic processes are evident, the stream channel position is stable, and the fan has been previously harvested more than 50 years ago with no evidence of post-harvesting disturbance, then the fan is not an active fluvial unit.

The active fluvial unit (rarely the whole fan surface) is defined as the "hydrogeomorphic riparian zone". This is the zone where the forest stores sediment, maintains the stream location, and reinforces the soil mass.

Identification of hydrogeomorphic riparian zone

Indicators of hydrogeomorphic processes are:

Airphoto evidence

- Visible sediment sources such as landslides in the watershed upstream of the fan indicate potentially high sediment loads are being delivered to the fan.
- Variations in forest canopy on the fan surface linked to stream channels, such as deciduous bands or bands of younger stands than the surrounding forest (cohorts) indicate either multiple channels or land-clearing by debris flows or floods.
- Multiple channels which may appear as streams radiating out from the fan apex; may be inferred by the abrupt disappearance of the main channel from the airphoto view (smaller channels under the forest canopy); or may be visible as multiple points of discharge at the lower margin of the fan.
- Visible sediment accumulation in the channels or on the fan surface.
- Visible increase in gravel bars in the main stream immediately downstream of the confluence of the fan with a larger stream.
- Abrupt angles in the stream channel on the fan indicate a high potential for channel straightening.

Field evidence

- Unconfined stream channels with evidence of periodic flow on the fan surface outside the channels.
- Recent sediment distributed through the trees. "Recent" is defined as unvegetated or with limited accumulation of organic matter.

- Log steps storing sediment and debris.
- Visible channel diversions caused by jams of wood and sediment.
- Visible channel avulsions caused by sediment infilling or by erosion of the channel banks.
- Trees with partially buried boles (as evident from lack of butt flare).
- Scars on trees from impacts by transported sediment or wood.
- Levees of sediment and/or wood debris along the channel sides.
- Wood debris in jams, dikes along the channel sides, log walls piled against trees, or on the fan surface but recently water or debris flow transported.
- Root reinforcement along channel sides or across the fan surface which may appear as a network with minor erosion behind or below the roots.

(For more detailed descriptions of the hydrogeomorphic riparian zone, refer to Land Management Handbook 57).

The limits of the hydrogeomorphic riparian zone are defined by delineating the zone from the apex down where these processes occur. The top of the zone is the upstream point at which it is possible for the stream to be diverted from its present channel and re-occupy an older channel on the fan surface; or to flood the fan surface; or to establish a new channel in the event of a debris flow/debris flood/ flood event. This point may be at the fan apex, or if the stream is well entrenched in the upper part of the fan (such as in a complex fan where the contemporary stream has downcut through an earlier fan formed during deglaciation), at the lower limit of entrenchment.

If no clear margins are evident (such as topographic changes) the limit of the active fluvial unit is at the transition to undisturbed forest stands 200 years or older.