GUIDELINES FOR TREATING HIGH ERODING STREAMBANKS (GREATER THAN EIGHT FEET)

High streambanks are generally unstable. At eight feet or higher, the critical height of the bank is often exceeded. The critical height is the height of bank that is stable for the soil types and moisture conditions occurring in that bank. Slope failure is the typical erosion process for banks that exceed critical height. Slab failures are common in silty or coarser textured soils while rotational slumps are more typical for banks with more heavy textured (clayey) soils. See Companion Document 11 for diagrams and further information on failure mechanics.

High streambanks continue to fail until the soil materials in the bank reach a stable angle of repose. This channel widening process is driven by the combination of slope failure processes and stream flows. Sloughed materials are washed away by stream flows which prevents the redistribution of loads on the bank. The toe of the bank may be eroded, or even undercut, which also helps maintain critical loads on the bank. These processes will continue until the channel is wide enough so a small capacity, bankfull channel can form with an adjacent floodplain.

Slope failure problems are typically solved by unloading the top of the bank by excavation, loading the toe of the slope or doing a combination of both. This is not always a viable approach for streambanks. Adjacent land use may limit or prohibit excavation. Placing fill, gabions, rock, or other loading materials at the toe of the bank requires large volumes of material which usually encroach on the stream's cross-section. The stream will tend to attack the toe material or blow out the opposite bank to acquire the cross-section it needs to maintain channel stability. Also, the costs of excavation, or for materials for loading the toe, may be prohibitive if the unstable bank is extremely high.

One alternative solution for stabilizing high streambanks is to construct a bench at the toe of the bank (toe bench) and excavate the opposite bank to maintain a stable channel cross-section (Figure 1). The face of the toe bench is armored if it is to be maintained as the outside boundary of a meander. The surface of the toe bench is vegetated to slow flood flows so deposition occurs on the toe bench in place of scouring of sloughed bank materials. Over time, the bank will continue to slough until the accumulated materials at the toe of the bank counter the weight at the top of the bank or until the roots of woody vegetation mature to the point that they reinforce the strength of the soils in the bank.

The elevation of the toe bench, its width and the dimensions of the stable channel cross-section are based on fluvial geomorphology principles used in the Rosgen stream classification system. Toe benches are recommended for "C", "D", or "E" stream types. These streams are "slightly entrenched" in Flosgen's classification system. This means that flows greater than the bankfull discharge flow onto a floodplain that is at least 2.2 times the width of the stream cross-section at the bankfull discharge.

Flows greater than the bankfull discharge must be able to access the floodplain for a toe bench to work. Generally, high banks are formed in "C", "D", or "E" stream types when the stream laterally migrates into a higher terrace, or the wall of the valley it lies in, In these situations, a floodplain is still accessible on the side of the stream opposite the high bank.

Toe benches are not recommended for "entrenched" stream types ("A", "G", or "F"). These streams have little or no floodplain at the elevation of the bankfull discharge. Rosgen's floodplain width for these stream types is 1.4 (or less) times the width of the stream cross-section at the bankfull discharge. These three stream types typically occur when a channel is downcutting.

Rosgen's "B" stream types are "moderately" entrenched. They fall between the 1 .4 and 2.2 figures for floodplain width. Toe benches may work in these stream types but the risk of failure is higher than for slightly entrenched streams.

The elevation of the surface of the toe bench should be the elevation of the bankfull discharge. The toe bench should be wide enough to maintain a flat, depositional surface adjacent to the stream after the high bank has sloughed to a more stable angle. In other words, the sloughed materials should remain at the

toe of the bank and not extend to the outside edge of the toe bench. Site conditions and the channel alignment must be considered when establishing the toe bench width. Excavation on the bank opposite the toe bench should be done to maintain both the appropriate width/depth ratio for the bankfull channel cross-section and a stable meander pattern. The length of the toe bench is determined by the length of the high bank requiring protection. Construction should begin and end at stable points such as riffles.

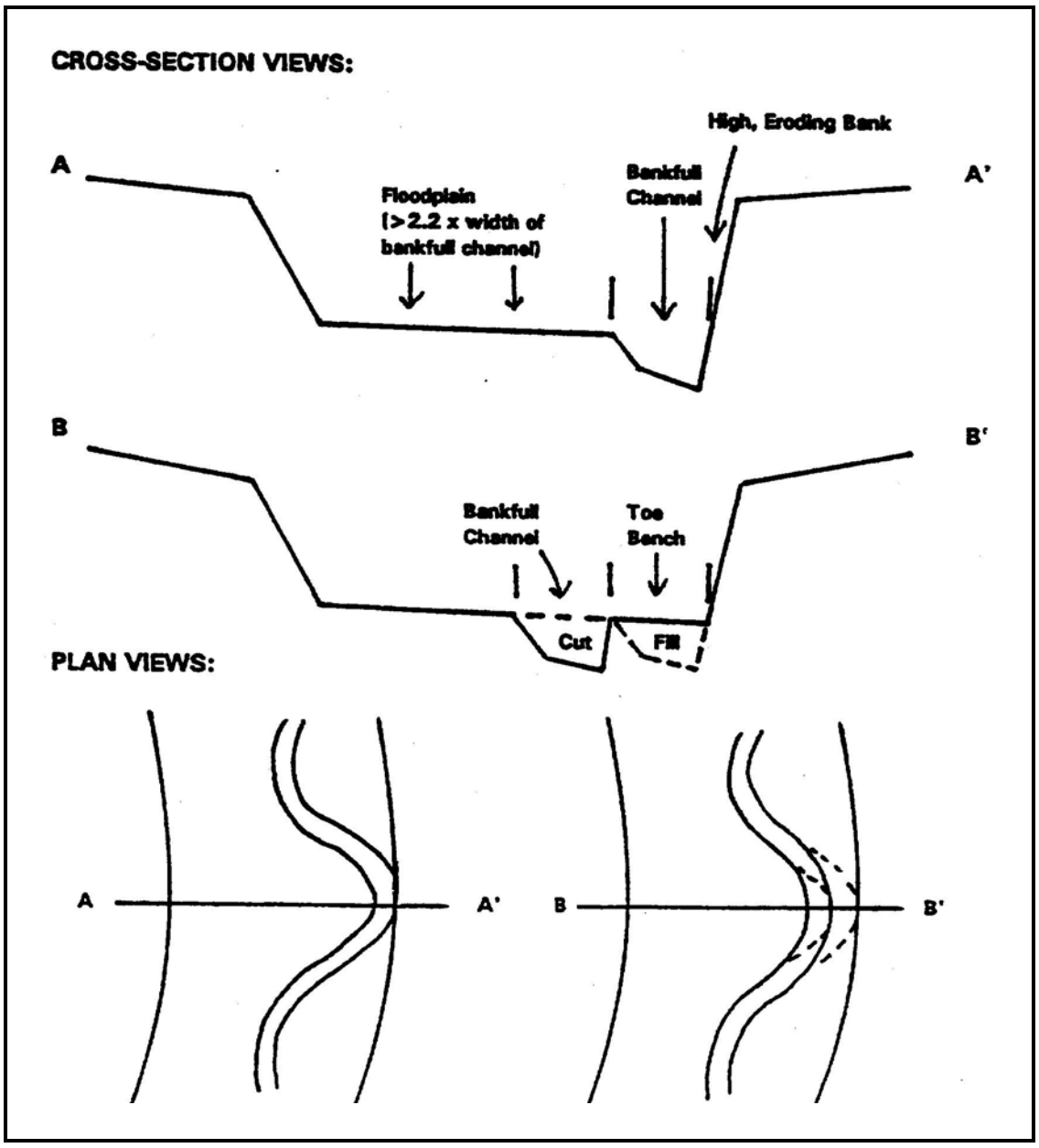

Figure 1. Treating high, unstable streambanks using a toe bench.

Source: Lyle J. Steffen, Geologist, Retired, USDA-NRCS, Lincoln, NE (11/16/95).