DETERMINING SAFE CLEARING LIMITS FOR SKID ROAD/TRAIL CONSTRUCTION

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ABSTRACT.—Most of the timber harvested in the United States is extracted by ground-based skidders and crawler/dozer systems. Ground-based systems require a primary transportation network (skid trails/roads) throughout the area being harvested. Following cutting, logs are skidded or dragged along these surfaces to the landing, where they are loaded onto trucks and transported to processing plants. The degree of excavation/construction on these skid roads/trails varies with the steepness of the terrain and the size of logs/logging vehicles. Excavation/construction creates certain hazards that could damage property and threaten human lives. In one incident that led to a court case, excavation undercut the lateral support of a tree that was left on a vertical (vs. backsloped) cutbank. The tree later fell, severely injuring a logger. We provide a decision algorithm for determining practical clearing limits/guidelines for the proper construction of skid roads/trails.

Society is increasingly asking more of the nation's forests with respect to wood products (veneer, sawlogs, pulpwood, fuelwood, etc.) and recreational opportunities (hiking, biking, horseback riding, snowmobiling, etc.). Increased access to and use of our forest resources requires a network of haul roads and skid roads/trails (Skelton 1949; Meyer 1970). Haul roads generally are permanent and well designed, and receive heavy vehicle use. Most skid roads/trails are temporary and often poorly designed, but vehicle traffic on these roads is light once harvested timber has been extracted. However, skid roads/trails (hereafter called trails) continue to be used for recreation activities such as hiking, hunting, and horseback riding even after many of them have been gated or otherwise blocked off.

Most of the timber harvested in the United States is extracted by ground-based skidders and crawler/dozer systems. Ground-based systems require a primary transportation network throughout the area being harvested (Wackerman et al 1966; Pearce and Stenzel 1972). Following cutting, logs are skidded or dragged along these trails to the landing, where they are loaded onto trucks for transport to sawmills, paper mills, OSB plants, veneer mills, etc. (Conway 1976). The degree of construction/excavation required on these trails varies with the steepness of the terrain and the size of logs/logging vehicles (Wenger 1984). Excavation/construction can create certain hazards that if not eliminated can damage property and threaten human lives. In one incident that led to a court case (Melvin Willard White vs. Wenturine Brothers Lumber, Inc., ICI Explosives, U.S.A., and American Forestry Consultants, vs. John Bouch Logging, In the Court of Common Pleas of Westmoreland County, Pennsylvania, Civil Division No. G.D. 382-2000, 2003), excavation undercut the lateral support of a tree that was left on a vertical (vs. backsloped) cutbank. The tree later fell, severely injuring a logger. In this article we review current trail construction methods, review safety regulations, and provide practical clearing limits/safety guidelines for trail construction.

Current Construction Methods

The construction of trails on flat or gentle terrain requires little excavation. Trees, vegetation, or other obstacles are simply pushed out of the way with a bulldozer to create a trail that can be negotiated with a skidder, crawler tractor, farm tractor, or forwarder. Construction on steep terrain requires considerable excavation and movement of earth. On such terrain, the trail must be carved out of the hillside, which moves or otherwise displaces obstacles such as soil, rocks, and trees. Most of this material is deposited on the downhill side of the road and the bulk sometimes is buried in the fill or used as a barrier to hold the fill in place (Wenger 1984).

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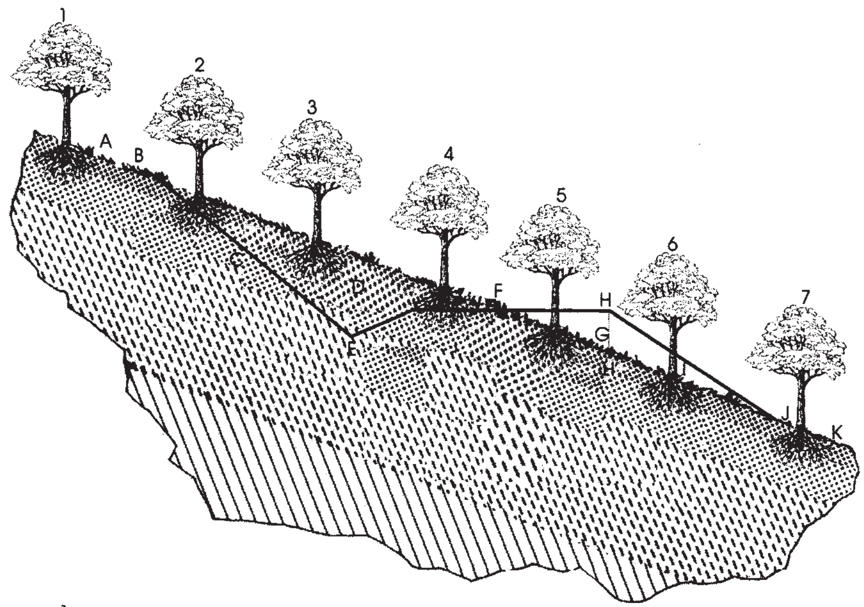

Figure 1.—Cut and fill cross-section of a skid road/trail on a moderate slope: (A): clearing limit; (B): top of backsloped cutbank; (C): cut slope; (D): cut section; (E): ditch; (F): centerline; (G): fill section; (H-H'); outer edge and height of fill; (I): fill slope; (J): toe of fill; (K): downhill clearing limit.

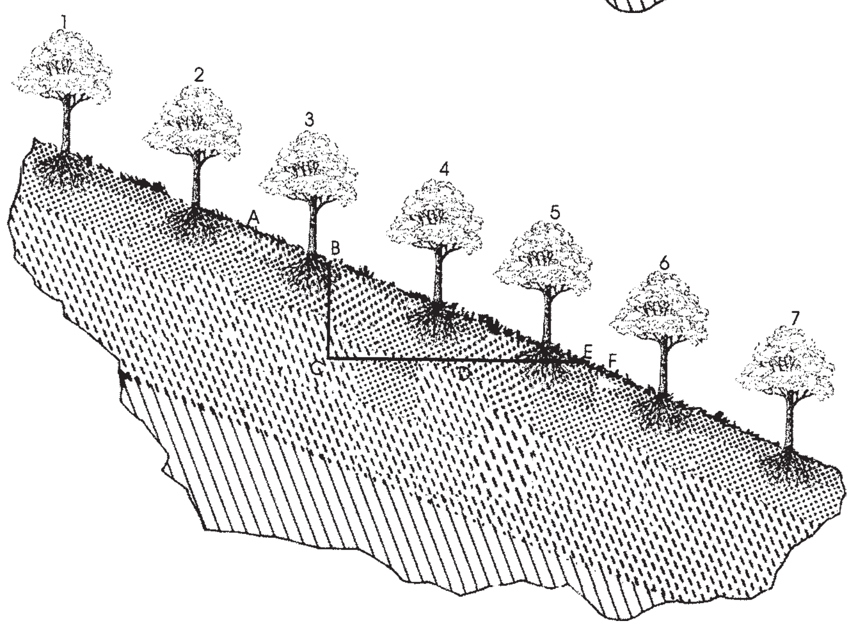

Figure 2.—Vertical cut cross-section of a skid road/trail on a moderate slope: (A): uphill clearing limit; (B): top of vertical cutbank; (C): bottom of vertical cut; (B-C): height of vertical cut; (D): centerline; (E): downhill edge of skid road/trail; (F): downhill clearing limit.

The cut and fill method (Fig. 1, D and G) is used occasionally to minimize the amount of excavation on the uphill side and the movement of soil. Ideally, the volume of earth excavated on the uphill side is used on the downhill side (the fill) to create the running surface of the trail. Balancing the cut and fill reduces the amount of excavation on the uphill side and minimizes the movement of earth, which, in turn, reduces the construction costs. The earth on the fill side must be compacted and free of woody material, e.g., such as stumps, root wads, and other vegetation. This process increases construction costs.

An alternative to cut and fill on low-volume, and low-use skid trails is using vertical cuts to carve the entire running surface of the trail from the uphill side (Fig. 2). The vertical cut method speeds construction, reduces costs, and eliminates the need for back sloping and fill compaction.

Whichever construction method is used, it is imperative that safe clearing limits be set (Fig. 3) as both practices create safety hazards, i.e., trees, vegetation, and other obstacles on the uphill side of the trail (Anonymous 1983; OSHA 2000, 2001). Trees with excavated or disturbed root systems are likely to fall onto the trail and must be removed. These stems can be grubbed out (including the root ball) or felled

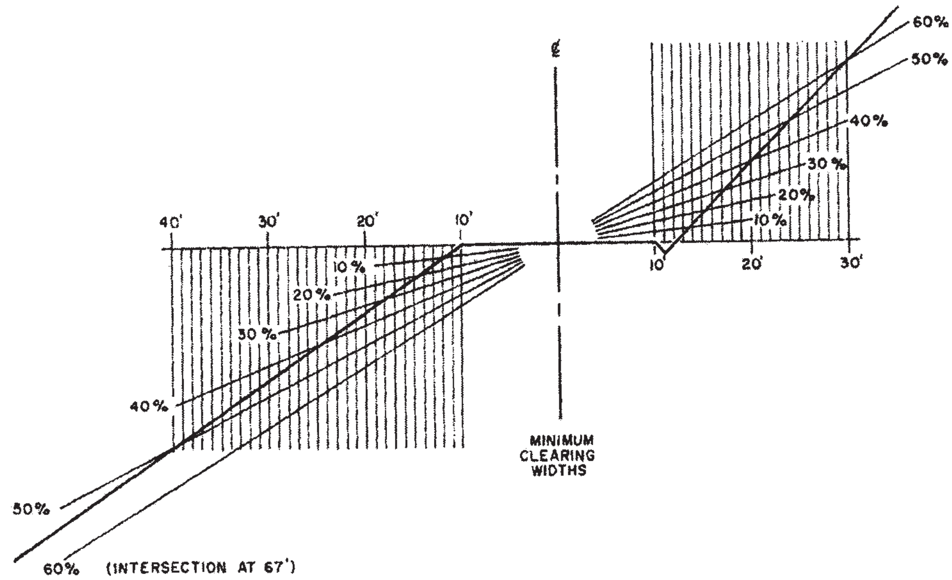

Figure 3.—Cut and fill cross-section of haul road on moderate slope showing uphill and downhill minimum clearing limits for alternative side slopes (from Wenger 1984).

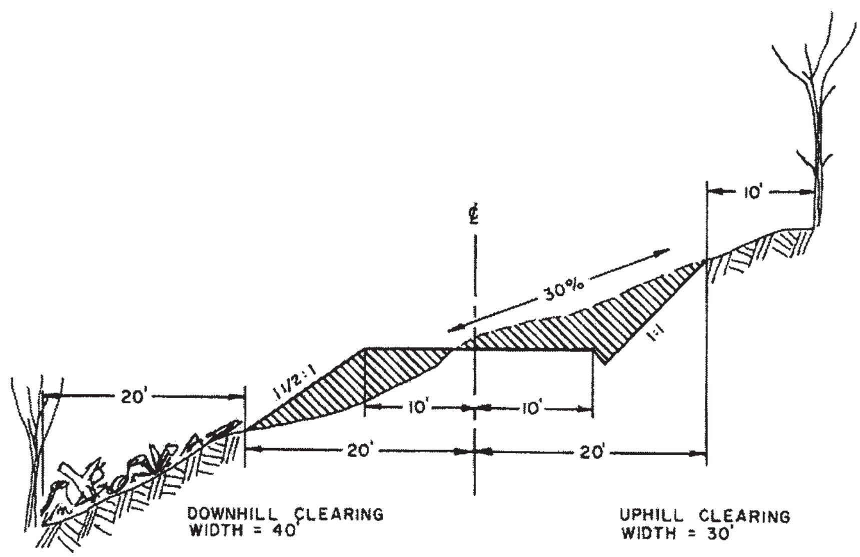

Figure 4.—Cross-section of haul road on moderate slope showing cut and fill areas and clearing limits for cut and fill banks (from Wegner 1984).

depending on their location relative to the uphill side of the cutbank. If circumstances do not allow timely removal, the tree(s) should be flagged and the OSHA Two Tree Length Rule observed until removal.

Practical and Safe Clearing Limits

Few guidelines on clearing limits for forest haul roads (Anonymous 1983; Wenger 1984; OSHA 2001, 2002) are applicable to trails. The general recommendation is that "all snags, danger trees, loose rocks, stumps or other unstable material shall be removed or cleared for a safe distance back from roadsides or roadside banks when they present a hazard to users of roadways", and that "brush foliage or debris which would obstruct the view of a vehicle operator on roadway intersections or on sharp curves shall be

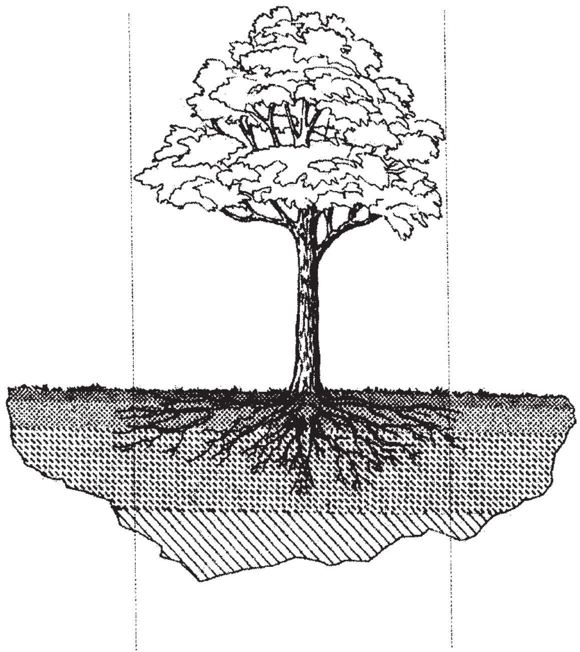

Figure 5.—Isometric scaling proportions of a tree's leaf and stem biomass area to the root biomass area.

cleared and all possible precautions shall be taken to relieve the hazard of such conditions" (Anonymous 1983).

A convenient way to determine minimum clearing limits for haul roads is to plot sideslopes on graph paper and then superimpose the road standards on them (Fig. 3). In most cases, clearing above the centerline should extend at least 10 feet beyond the cut stake position; clearing below the centerline should extend at least 20 feet below the fill stake to allow stumps and other debris to be deposited (Fig. 4). On steep to moderate sideslopes, trees with roots that were undercut during excavation and that are located adjacent to the upper clearing limit or vertical cut should be grubbed out or felled (Pearce and Stenzel 1972).

The following should be considered in judging whether to remove a tree or other obstacle from a cutbank during or following trail excavation:

- Sideslope (%). Steep slopes (≥ 25%) are unstable and require more excavation on the uphill side and more fill on the downhill side. Very steep slopes require full bench roads.
- Soil, solid/loose. Loose rock, etc. moves easily.
- Distance from cutbank edge. The closer the tree/obstacle is to the cut edge, the more likely it will fall.
- Moisture/aspect. Once soils reach the plastic limit, they are nearly liquid in consistency.
- Size of tree/obstacle. The larger the tree/obstacle, the greater amount of mass is on the cutbank.
- Undercut roots/soil. These remove a tree's attachment to the ground, undermining stability.
- Species of tree. Certain species are shallow rooted while others have deep taproots.
- Tree health/vigor. A sound, healthy tree with a full crown always has a strong anchoring mechanism (root system).
- Clearing limits. Should be set and maintained where applicable.

With respect to tree health/soundness and determining clearing limits, Enquist and Niklas (2002) found that a tree's above-ground biomass relative to the leaf and stem area scales nearly isometrically to the root biomass area (Fig. 5). Thus, the outer diameter of the crown also defines the outer diameter of the majority of the root system. This concept is important in creating safe clearing limits for trails. Although some small feeder roots will extend beyond the crown diameter/drip edge (Gilman 1988; Tubbs 1977) and some of these feeder roots may become damaged or disturbed during excavation

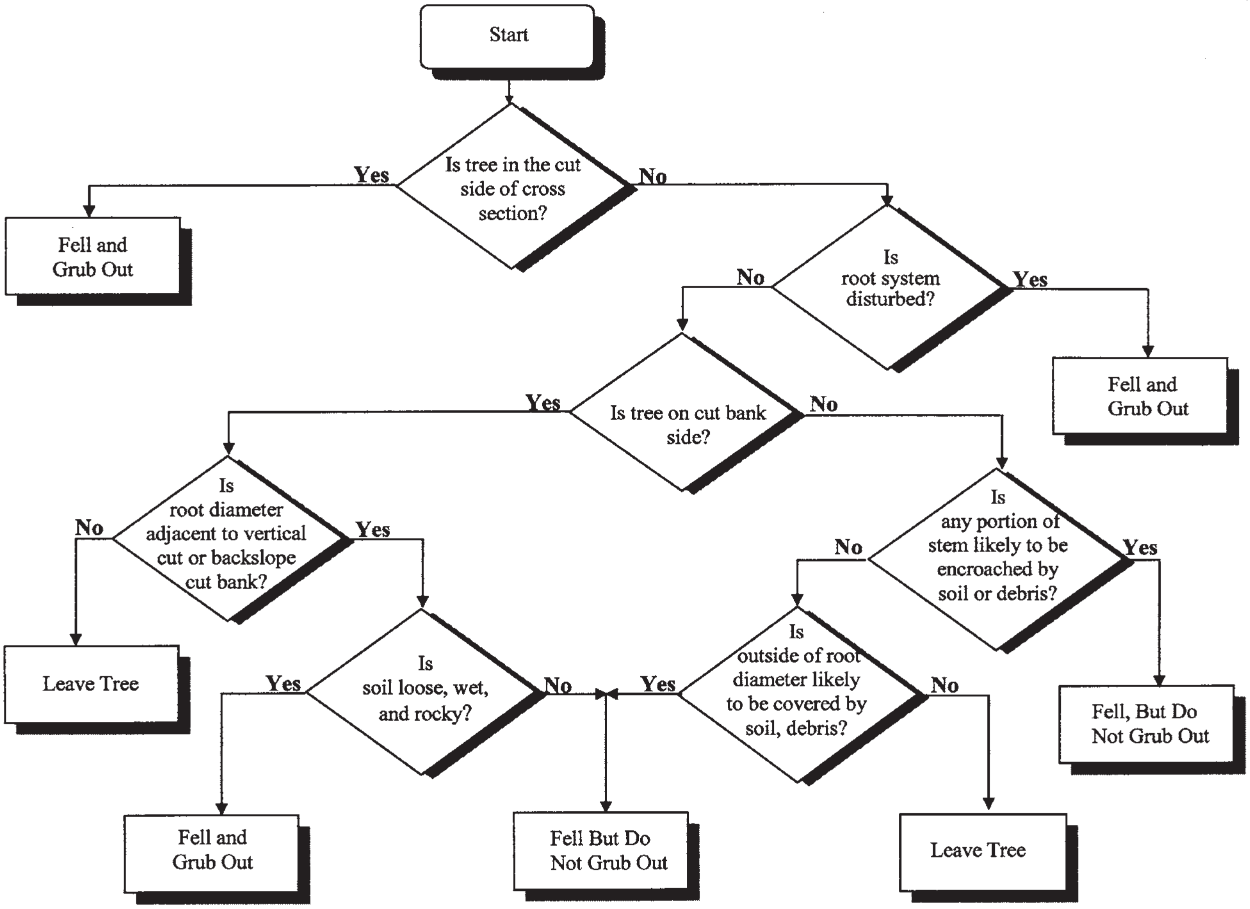

Figure 6.—Decision chart for determining practical and safe clearing limits for skid road/trails with backsloped or vertical cutbanks and fill slopes.

(Stout 1957), the lateral support of the tree will not be affected unless roots well within the crown diameter are damaged/disturbed.

Figure 6 is useful for setting practical and safe clearing limits for trail construction as it addresses decisions on removing trees within and adjacent to the cross section for trails with vertical or backsloped cutbanks. For a cut and fill cross section with the cutbank backsloped (Fig. 1), trees 2, 3 and 4 should be felled and the stump/root wad grubbed out. Trees 5 and 6 should be felled close to the ground and the stump/root wad left in place. Tree 7 should be felled as the toe of the fill will encroach on the root system (see Figure 5) and also might be covered by the stumps and materials from the uphill trees that were grubbed. Tree 1 is safe to leave since its entire root system has not been disturbed during the excavation or backsloping.

For a vertical cut cross-section (Fig. 2), trees 4 and 5 should be felled and the stump/root wad grubbed out. Tree 6 should be felled and the stump/root wad left in place. Tree 3 should be felled because its root system has been disturbed/excavated/exposed and the stump/root wad removed. Some applications may not require that the stump/root wad be removed. For example, the stump/root wad would not be grubbed if the forester/manager in charge determines that felling the tree eliminates the potential hazard and that site conditions (soil type, moisture, height of cutbank, etc) are sufficiently stable to keep the stump/root wad from falling into the trail. Tree 7 should be felled if the earth from the vertical cut excavation would bury any point of the stem or the outside root diameter. Tree 2 is safe as its entire root system is undisturbed (see Figure 5).

Considerations for Managers

The construction/excavation of skid roads/trails creates certain safety hazards that can be eliminated and/or mitigated by observing practical and safe clearing limits during and after trail construction/excavation. The decision chart included in this article should be helpful in determining guidelines that will result in a safer workplace. On a practical level, if there are doubts about a tree's stability, that tree should be removed.

Literature Cited

Anonymous. 1983. **Ground skidding handbook.** 1st ed. Richmond, BC: Worker's Compensation Board of British Columbia.

Conway, S. 1976. **Logging practices—principles of timber harvesting systems.** San Francisco, CA: Miller Freeman Publications.

Enquist, B.J.; Niklas, K.J. 2002. **Global allocation rules for patterns of biomass partitioning in seed plants**. Science. 295: 1517-1520.

Gilman, E.F. 1988. **Predicting root spread from trunk diameter and branch spread**. Journal of Arboriculture. 14(4):85-98.

Meyer, C.F. 1970. **Route surveying and design.** 4th ed. Scranton, PA: International Textbook Co.

OSHA 2000. **OSHA preambles—logging.** Washington, DC: U.S. Department of Labor, Occupational Safety & Health Administration. Available: http://www.osha.gov/PREAMBLE/ Logging_toc/ logging_toc_by_sect.html.

OSHA 2001. **Logging advisor.** Washington, DC: U.S. Department of Labor, Occupational Safety & Health Administration. Available: http://www.osha.-slc.gov/SLTC/logging_advisor/ mainpage.

Pearce, J.K.; Stenzel, G. 1972. **Logging and pulpwood production.** New York, NY: Ronald Press.

Skelton, R.R. 1949. **Route surveys.** 1st ed. New York, NY: McGraw Hill Book Co.

Stout, B.B. 1957. **Studies of the root systems of deciduous trees.** Black Rock Forest Bulletin 15. Cornwall on the Hudson, NY: 45 p.

Tubbs, C.H. 1977. **Root-crown relations of young sugar maple and yellow birch.** Res. Note NC-225. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 4 p.

Wenger, K.F. 1984. **Forestry handbook. 2nd ed.** New York, NY: John Wiley and Sons.

Wackerman, A.E.; Hagenstein, W.D.; Michell, A.S. 1966. **Harvesting timber crops**. New York, NY: McGraw Hill Book Co.