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# WINCH-ASSIST FORWARDER:

## BEST PRACTICE MANUAL

**SPECIAL PUBLICATION SP-535**

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# INTRODUCTION TO:
## WINCH-ASSIST FORWARDER BEST PRACTICES

Machines and equipment are constantly evolving and technology is improving. Using best practices to perform duties at work is the future in all businesses around the world, and logging is no different. As technologies change, our best practices must evolve to facilitate the changes and improvements that are being made.

For many years, we have used various equipment to bring wood to the road, such as cable yarders, hoe chuckers, and even forwarders on semi-steep ground without the assistance of cable winches. However, there is an increasing need for forwarders to follow harvesters on steeper ground with short pitches, which is not economical for large cable yarders and is too steep for conventional forwarders. The need for conventional forwarders that can work steeper ground with shorter slopes became evident.

Logging on steeper ground with shorter slopes using winch-assist harvester/forwarder tandems has been taking place in several European countries, Australia, and South America for a number of years; initially implemented with harvesters, similar winch mechanisms were soon developed for forwarders to allow them to follow the harvesters. Thanks to the overseas experiences and the growing need for this advanced equipment, many manufacturers from around the world have or are developing machines with computerized, on-board cable winches that work with existing conventional forwarders in such a way that they can safely perform on steeper ground. Because of their better contact with the ground, wheeled machines are well suited for integration with cable-assist winches. They also tend to burn less fuel, are lighter (and will, thus, result in less ground disturbance if operated properly), quieter and smaller than some of the current equipment (which is favourable with the public), are best for both commercial thinning and clear-cut applications, and so on. The key to making wheeled machines productive and ensure that the cost stays low is using the best known operating techniques available and performing detailed service and daily maintenance on the equipment. The best practices that you will read about in this manual involve the most up-to-date techniques available to facilitate high production and ensure that the cost of operation stays as low as possible.

In forwarding wood, as in many similar occupations, one can often quickly form habits based on experience. This manual contains techniques and procedures that will take you through every stage of the forwarding process, including planning, loading, travelling, handling the boom, and unloading. These practices were developed by some of the best operators in the world.

You may find that there will be times when you cannot follow one of the steps in this manual because of the variables in our forests. However, any process is considered successful if it can be used at least 80% of the time. Some operators find that skipping steps or changing the process makes them feel more comfortable, but this often leads to damaging the machine, decreasing production, and reducing contractor success.

The best practices presented here are designed for success, and practicing them will help make operators more confident and productive. If you have difficulty following any of these best practices, talk with your contractor about your concerns. Sometimes all it takes is a bit of coaching to become comfortable with all of the steps of the forwarding process.

## IN SUMMARY,
### HERE ARE A FEW THINGS TO REMEMBER:

- Machines are always evolving.
- Constantly be thinking about how to keep the cost low.
- Use best practices and follow recommendations.
- Continually be improving operating skills and paying attention to preventative maintenance.
- Practice efficient techniques to improve your bottom line.

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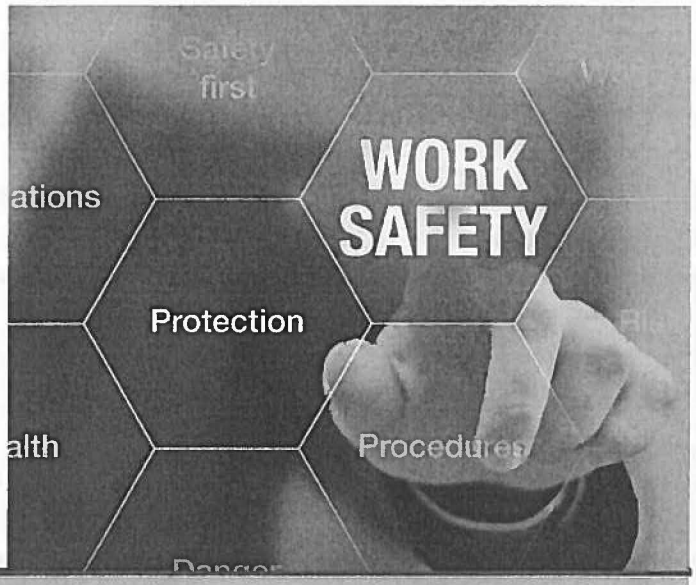
# 01.
# SAFETY




**WorkSafeBC REQUIREMENTS**

There are several WorkSafeBC regulations that are applicable to winch-assist systems. These include:

1. Planning and documentation: OHSR 26.2(1), 26.2(3)(a), 26.2(3)(b)(c), WCAct 119(b)
2. Prime contractor responsibilities: OHSR-26.2(2), 26.2(3)(a), 26.2(3)(b)(c), WCAct 118(2)(a)(b)
3. Employer responsibilities: OHSR 26.16(4)(a)(b), WCAct 115.1(a), 115.2(a)-(f), OHSR 26.16(2-4)
4. ERP (Emergency response plan): OHSR 4.13(1-3), 4.14(1-4)
5. Supervisor responsibilities: OHSR 26.3(1), 16.4, 16.6, WCAct 115(2)(e), 117(1)(2)6
6. Operator/worker responsibilities: OHSR 3.12(1), 16.5, WCAct 116(2)(a)(e)
7. Supplier responsibilities: OHSR 4.4, WCAct 120
8. FOPS: OHSR 16.21
9. ROPS: OHSR 16.22
10. Cab guarding:
    - Cab G602
    - Roof G608 or SAE231
    - Boom side G604 or SAE J1084
    - Front G603 and G604
    - Door and door side windows G603 and G604
    - Back window G603 and G604
11. Emergency escape: OHSR 16.17
12. Slope limitations: OHSR 26.12.1, 26.16. Exceeding slope limitations requires:
    - risk assessment
    - site-specific written safe work practices
    - must not be operated in a particular location or manner if its stability cannot be assured
13. Worker training: WCAct 115, 26.3, 3.23, 16.4
14. Cranes and hoists: OHSR 14 with 14.9 (14.5 to 14.8) exception for logging
15. Rigging: OHSR 15, including section 3.5 on cable inspection

16. Planning:
    OHSR 26.2

17. Radio-controlled equipment:
    OHSR 26.12.2 must be equipped with a fail-safe or stop mechanism that becomes operational if the remote control device fails.

18. In addition, WorkSafeBC's document *Understanding the Requirements for Mobile Logging Equipment in British Columbia* (2016) identifies the following areas of concern that may be dealt with by manufacturer's instructions or written safe work procedures under "Safe work procedures and manufacturer instructions specific to winch-assist equipment" (Figure 1).

19. Snubbing loads on steep grades:
    OHSR 16.38

## OPERATOR CONSIDERATIONS

- The operator must be skilled and competent at working on steep slopes.
- Have an operator fatigue plan in place and follow it as necessary.
- See the BC Forest Safety Council's *Steep Slope Logging Resource Package* (2015) for more information on operator considerations.

## TRAINING

- Anyone operating machinery on steep ground must receive the appropriate training and be competent to perform the required tasks safely and productively.
- New operators must start on lesser slopes and transition to steeper slopes.
- Best progression for new operators is
  1. Start on forwarder, no winch
  2. Progress to forwarder, with winch
  3. Then start on harvester, no winch, slopes up to 50%
  4. Progress to harvester with a winch
  5. Bigger wood – this is more difficult than learning to work with the winch

**Safe work procedures and manufacturer instructions specific to winch-assist equipment**

Several additional areas of concern have been identified and may be dealt with in the manufacturer's instructions or written safe work procedures. These concerns are as follows:

- Stump selection and method of securement, as well as frequency of inspection to ensure worker safety and machine stability.
- Winch and cable inspection — how often and to what standard?
- Potential to damage or sever cable with head, boom, or logs.
- Abrasion of cable on rock outcrops and other obstacles.
- Safe work area around machine and cable. Area of no entry may be different than in regular mechanized falling.
- Rescue procedure in the event of breakdown or misadventure. How do you right a machine if it flops on its side?
- Worker training.
- Lockout and de-energization procedures.
- Winch capacity/load rating and safety systems. Failsafes?
- Cable size and strength.

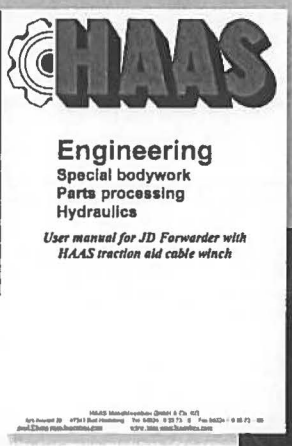
FIGURE 1. *From WorkSafeBC document* Understanding the Requirements for Mobile Logging Equipment in British Columbia (2015).

## RISK ASSESSMENT

A risk assessment is an essential component of any steep-slope harvesting operation. Use the manufacturer's manual (Figure 2) as part of your risk assessment to help identify the controls to put in place when operating machinery on steep or difficult ground in the forest.

- The first step for new operators or operators who are about to run a model of a machine that is new to them should be to read the owner's manual for that machine.
- Reading the safety and operating instructions for a machine can be extremely important to an operator's health and safety.
- Operator's manuals provide information about areas to be aware of and areas to avoid during the operation of a machine.
- The operator's manual should remain in the machine at all times to serve as a guide for any operator to follow in case an issue with the machine arises that the operator is not familiar with. These issues could relate to personal safety.

FIGURE 2.
*Always refer to the winch manufacturer's operator manual for recommendations. (Images courtesy of Haas Automation, Inc. and Ponsse Plc.)*




**WorkSafeBC's regulation 26.16 for slope limitation states:**

1. Repealed. [B.C. Reg. 312/2003, effective October 29, 2003.]
2. If the manufacturer's maximum slope operating stability limit for logging equipment is known, the equipment must be operated within that limit.
3. If the manufacturer's maximum slope operating stability limit for logging equipment is not known, the equipment must be operated within the following limits:
   a. a rubber tired skidder must not be operated on a slope which exceeds 35%;
   b. a crawler tractor, feller buncher, excavator and other similar equipment not be operated on a slope which exceeds 40%;
   c. any other forestry equipment specifically designed for use on a steep slope must not be operated on a slope which exceeds 50%.
4. Despite subsections (2) and (3) but subject to subsection (5), logging equipment may be operated beyond the maximum slope operating stability limits specified in those subsections if
   a. a qualified person conducts a risk assessment of that operation, and
   b. written safe work practices acceptable to the Board are developed and implemented to ensure the equipment's stability during operation.
5. Despite anything in this section, logging equipment must not be operated in a particular location or manner if its stability cannot be assured during that operation.

[Amended by B.C. Reg. 312/2003, effective October 29, 2003.]
[Amended by B.C. Reg. 20/2008, effective May 1, 2008.]

The key point is that if the manufacturer's maximum slope-operating stability limit for harvesting is not known, then WorkSafeBC's slope limit for rubber-tired machines is 35% and exceeding these limits requires: a risk assessment, written safe work practices, and no operation in a location or manner where stability cannot be assured.

An increase in slope will mean that you need to plan carefully how the work will be done:

- Choose which machine to use.
- Decide who will be operating the machines.
- Decide how to supervise the work and take account of changing conditions.
- To work safely on steep ground, you must take into consideration the entire harvesting operation, not just one machine. Everyone involved must communicate their work plan and be in regular contact with each other.
- Record how the execution will be planned in the risk assessment and site safety rules.
- Each operation will be different and will need to be assessed to control the site-specific conditions and variables.

An example of a risk assessment form is shown in Figure 3.

**Steep Slope Logging – Risk Assessment and Site Pre-Work**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | | | | Licensee/Owner | | | |
| Cutting Permit | | | | Contractor | | | |
| Block | | Steep Slope % (range) | | | Location within Block | | |
| Machine | | Max Slope % allowed | | Operator | | Estimate of hours to do work | |
| Machine | | Max Slope % allowed | | Operator | | Estimate of hours to do work | |

| | | |
|---|---|---|
| Appropriate Information Supplied by Owner (map, slope %, hazards) | Yes ☐ | |
| Assessor Qualified to Conduct Steep Slope Assessment | Yes ☐ | |

| Risk Assessment of Steep Slope | | | Site Specific Procedures (Refer to Part 2 – Safe Work Practices for Steep Slope Operations) |
|---|---|---|---|
| **Note: Site specific procedures must be developed for each type of machine that is operating on the steep slope.** | | | |
| Slopes greater than 35% for wheeled machines | Yes ☐ | N/A ☐ | |
| Slopes greater than 40% for tracked machines | Yes ☐ | N/A ☐ | |
| Unstable Ground (slumps, Terrain Stability Field Assessment, talus) | Yes ☐ | N/A ☐ | |
| Ground Roughness (boulders, rock outcrops, hummocks, gulleys) | Yes ☐ | N/A ☐ | |
| Unsafe slopes below operating area | Yes ☐ | N/A ☐ | |
| Shallow Soil Depth over Bedrock | Yes ☐ | N/A ☐ | |
| Soil conditions (sandy or saturated organic soils, consider how logging may affect water flow and soils on site) | Yes ☐ | N/A ☐ | |
| Poor winter ground conditions (poor snow, minimal frost depth on site) | Yes ☐ | N/A ☐ | |
| Slash (amount, elevated, size) | Yes ☐ | N/A ☐ | |
| Poor visibility (snow, fog, night shift) | Yes ☐ | N/A ☐ | |
| Harvest Plan Requirements (reserve areas, leave trees, planned skid trails) | Yes ☐ | N/A ☐ | |
| Oversized Trees (size, weight and species) | Yes ☐ | N/A ☐ | |
| High Stumps (what is the allowable stump height) | Yes ☐ | N/A ☐ | |

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| | | | |
|---|---|---|---|
| Isolated Work (how close is machine assistance to overcome a difficulty) | Yes ☐ | N/A ☐ | |
| Other | Yes ☐ | N/A ☐ | |

| Steep Slope Pre-Work | | | Check that the following requirements are in place and communicated with all workers on site. |
|---|---|---|---|
| Steep slopes and No Go areas are easily identified, mapped and map provided to workers. | Yes ☐ | N/A ☐ | |
| Manual Tree Falling Required | Yes ☐ | N/A ☐ | |
| Duration of Exposure minimized (consider shift length, # of breaks, # of consecutive days on shift) | Yes ☐ | N/A ☐ | |
| Machine capabilities appropriate for timber type (tree size and weight) | Yes ☐ | N/A ☐ | |
| Confirm good working condition of machine(s) (hydraulics, tires/tracks, ROPS, guarding, seatbelts, escape hatches) | Yes ☐ | N/A ☐ | |
| Operator Competency (check experience and training) | Yes ☐ | N/A ☐ | |
| Operator State of Mind – alertness, understanding of plan – Avoid fatigue, rushing, complacency | Yes ☐ | N/A ☐ | |
| Operator – can measure slope % stop operations if unsure/uncomfortable and contact supervisor | Yes ☐ | N/A ☐ | |
| Skid trail construction (locations and specs discussed) | Yes ☐ | N/A ☐ | |
| Supervision and Man-check frequency | Yes ☐ | N/A ☐ | Who<br>How Often |
| Emergency Response Plan in place | Yes ☐ | | |

| Reassessment Date and Update to Site Specific Procedures: | |
|---|---|
| Date: | Updates: |
| | |
| Date: | Updates: |
| | |

| Signatures: | |
|---|---|
| Operators | |
| | |
| Qualified Assessor | |
| Supervisor | |

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FIGURE 3.
*Sample risk assessment form (from BC Forest Safety Council, 2015).*

## GENERAL SAFETY

- Safety is always the number one priority when on a work site.
- Winch-assist harvested sites are located on wet, rough, and steep land. This terrain brings a higher risk of machine instability and even possible machine overturning.
- Experience can significantly lower the risk because experienced operators often know how to handle different situations based on former experience. Learning and understanding the contents of this manual will help manage these challenging conditions.
- Any operator not comfortable with the slope that the machine is working on must stop immediately.
- Machines should be operated straight up and down the hill whenever possible, and never across the slope.
- Wheeled forwarders should be equipped with ring chains or wheel tracks on the single axles, and bogie assemblies should have wheel tracks. All tires must be in good condition, with the recommended tire pressure and chains and tracks properly adjusted.
- If you are working on rocky or broken terrain, be very cautious of dropping over rock faces or large single rocks.
- Wear a safety belt at all times to reduce the risk of injury if a machine overturns.
- Know where the escape hatches are in your machine and check them on a regular basis to make sure they are working properly. This may save your life in a rollover situation.
- All tools and other heavy objects should be stored in secure tool boxes or somewhere on the machine other than in the cab. Many times in a rollover, the loose objects flying around inside the cab are the most dangerous and can cause the most injury.
- Read and follow the operator's manual.
- Avoid crossing active roads with the cable. If necessary, clearly indicate the cable location (Figure 4).
- Protect the cable from abrasion, infiltration by soil, and sharp bends by placing a brow log at ground breaks (Figure 5).

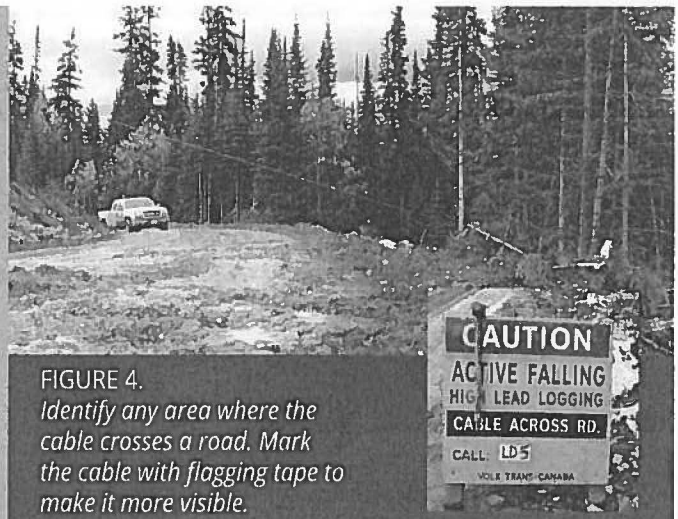



FIGURE 4.
*Identify any area where the cable crosses a road. Mark the cable with flagging tape to make it more visible.*

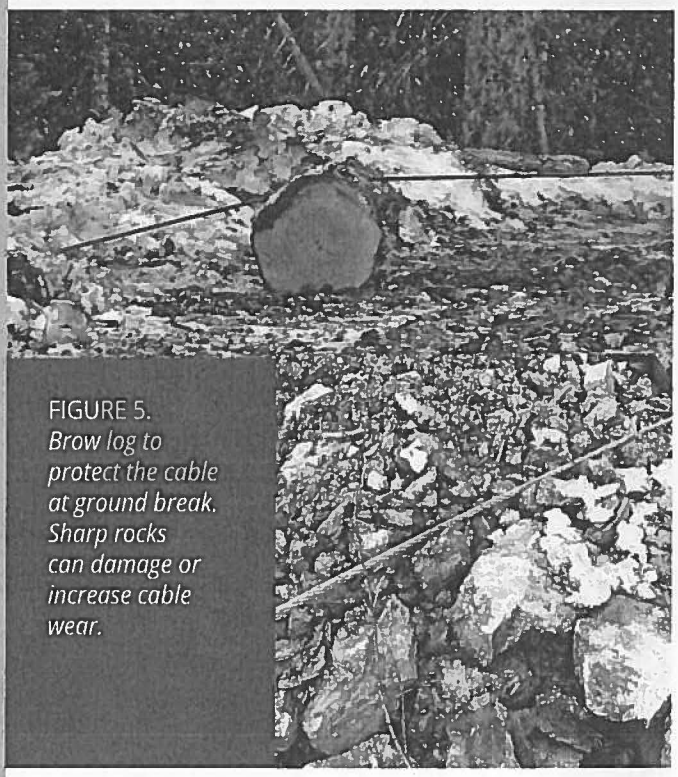


FIGURE 5.
*Brow log to protect the cable at ground break. Sharp rocks can damage or increase cable wear.*

## BACKING UP SAFELY

- In winch-assist forwarding, the winch is mounted at the rear of the machine. This allows anchoring to a stump at the top of a hill and loading downward toward the road.
- When the trails are downhill from the road, the forwarder must drive down the hill cab-first and load backward up the hill, which can make it difficult for the operator to see where the machine is travelling on the trail.
- To address this lack of visibility, manufacturers now offer integrated cameras as an optional feature.
- For safe operation of the forwarder, machines working on steep ground must be equipped with one of these cameras.
- The camera should be cleaned as often as necessary, as the operator must always be able to see clearly where the machine is travelling. Figure 6 shows the camera screen as seen by the operator in the cab. Because the camera is mounted low in the rear frame, the operator has a good view of the trail behind the machine.

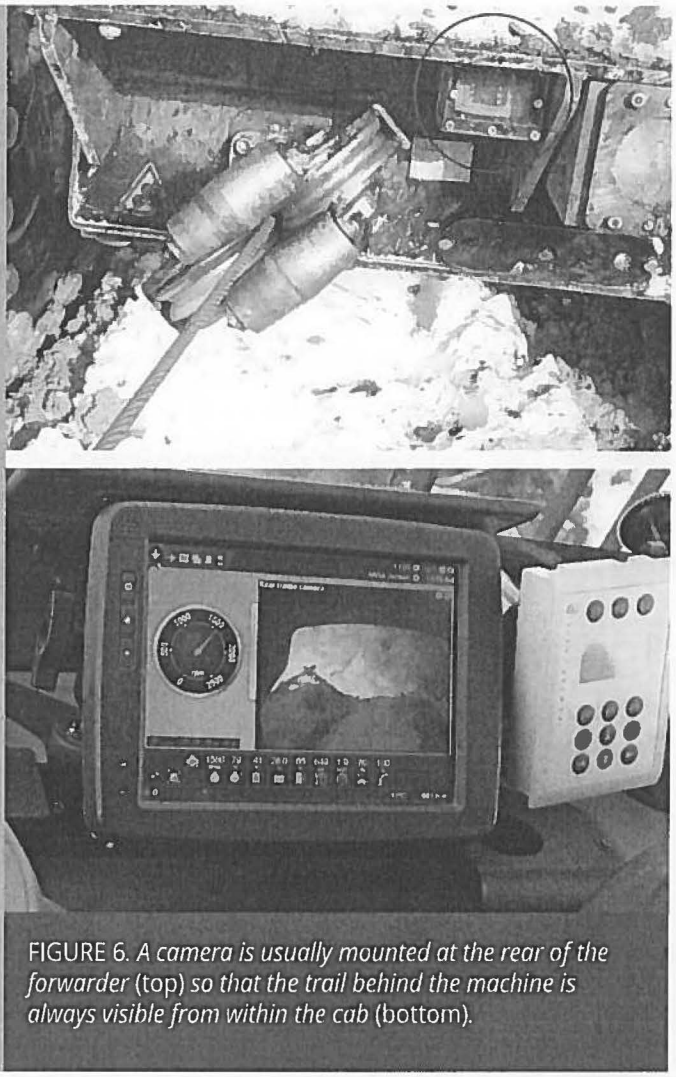


FIGURE 6. *A camera is usually mounted at the rear of the forwarder* (top) *so that the trail behind the machine is always visible from within the cab* (bottom).

## EMERGENCY PROCEDURES

Follow any emergency procedures provided by the manufacturer in the event of an incident. Additionally, the following procedures are recommended:

- In the event of cable system failure (may include machine attachment point, connectors, chain, wire rope, and/or anchor[s]):
  - Activate the blade braking device on the assisted machine if available.
  - Activate the wheel brakes on the assisted machine.
  - Use the head's grapple to hold on a tree/stump or set the head or heel rack (if available) into the ground to provide further braking resistance.
  - Exit the cab only if safe to do so once the assisted machine is fully immobilized.
- In the event of communication failure between the assisted machine and winch anchor:
  - Follow the manufacturer's operating procedures. With a constant tension system, the winch is generally set up to continue to maintain the tension preset before the communication failure.

## SAFETY ZONES

- Always recognize and abide by the manufacturer's safe work zones and warnings.
- Operators and other workers should establish and respect a large safety zone around a tethered forwarder whenever it is operating or if the anchor is under tension (Figure 7).
- New machines have safety decals to warn against dangerous areas, but these decals can become worn. Know and follow the manufacturer's requirements for safe work zones.
- New operators should be given a full orientation of the machine and made aware of all safety zones, safety mechanisms, and lockout procedures.

## WIRE ROPE AND RIGGING

Follow any recommended wire rope and rigging specifications and procedures provided by the manufacturer. Additionally, the guide entitled *Wire Rope Integrity in Winch-Assisted Harvesting Operations: A Guide to Wire Rope Handling and Inspection for Machine Operators* (FPInnovations, 2016) describes accepted best practices on this topic and is recommended as an information source. Some general recommendations include, as a minimum:

- Develop and keep written records of formal, periodic, and thorough inspections, and maintenance and replacement schedules of the wire rope as well as all rigging and winch components. These can vary based on the winch type and size, wire rope type, rigging components, terrain, and weather conditions. Keep a log, noting dates and details of cable use hours, cable inspections, any cable damage, any shock loading incidents, any cable sections cut out, splices, and end connectors.
- On a daily basis:
  - The first 20–30 m section (used most often) of the wire rope should be carefully and thoroughly inspected.
  - Any events of traction loss or tensions exceeding safe working load must be recorded.
- On a weekly basis:
  - Open all lids, and check the winch drum and tensioning disks (if applicable), guide rollers, fairlead rollers, and connectors for signs of wear.
  - Unspool entire length of wire rope and inspect for signs of damage.
  - Test tensioning and remote control devices.
- On a monthly basis:
  - Remove the first 3–5 m of the wire rope as it is used the most and is exposed to abrasion and tension. It is at risk of internal damage from bending and fatigue.
  - Dismount and flip the tensioning disk (if applicable) to prevent uneven wear of the disk gouges that may lead to subsequent rope damage. Check the bearings of the pressure rollers and holder for deformations or other damage that would prevent them from functioning properly.
- On a semi-annual or annual basis (depending on the size of rope and conditions):
  - Replace the whole length of the wire rope. If no external damage is noted, electromagnetic testing is recommended to ensure wire rope integrity and suitability for further use.
  - Replace the tensioning disk.
  - Check all other rigging components and replace if necessary.

# 02.
# ENVIRONMENT

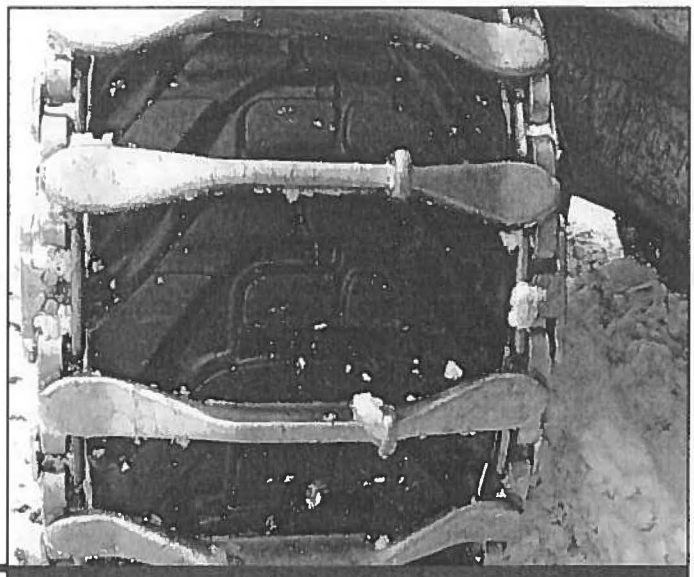


FIGURE 8.
*Use wheel tracks to prevent wheel spin in slippery conditions.*

## ENVIRONMENTAL CONSIDERATIONS

Ground-based equipment can potentially damage soils through excessive disturbance, primarily by causing rutting or compaction, which can reduce future tree growth. Rutting on steep slopes may also cause water redirection or concentration and result in erosion and mass wasting.

Best practices to limit environmental impacts include the following:

- Use wheel tracks for better traction to help prevent wheel spin (Figure 8).
- Distribute slash and drive forwarder over it in soft ground conditions and rehabilitate afterwards with excavator if necessary (Figure 9).
- Prevent ruts by placing brush where the machine will travel.
- Align logs and slash so water flow is not concentrated.
- Minimize the slipping of wheels, especially when using wheel tracks.
- Closely monitor operations where track or wheel spin is damaging soils and cease or move operations if necessary.
- Minimize repeated machine passes over the same trail.
- Avoid turning the tracks when working on sensitive soil types as this may create ruts which could direct and concentrate water flow onto slopes.

- Use the winch system wherever an untethered operation would cause soil damage.
- Maintain sufficient and constant tension so the machine does not slip or slide and to prevent wheel spin.
- Be aware of any track or tire spin due to malfunction, unsuitable conditions, or exceeding the limits of the system, and stop before damage is done to the soils.
- Cease operations in very wet conditions. Refer to local wet weather safety shutdown guidelines and procedures, such as those provided in BC Timber Sales (2006).
- Recognize that winch assist may not be suitable everywhere and an alternative forward system, such as hand felling or cable yarding, may still be necessary in some areas. Stop operation if the environmental limits of the system are reached.

## TECHNIQUES FOR PREVENTING DAMAGE

- Wherever possible, plan the routes in such a way that forwarders avoid climbing steep slopes.
- Haul horizontally along the graded section of the slope or on established trails.
- The harvester should clear the trails for the forwarders to limit soil exposure and obstruction of the natural drainage systems.
- Once the wood has been hauled, all diversionary water systems must be cleared (trenches, raised berms) to divert water flowing along the trails toward surrounding vegetation and to slow water flow and filter water before it returns to waterways. Do so at regular intervals along the trail.
- Reduce forwarder loads using the multi-stage method and avoid making sharp turns.
- Spread woody debris across the site. Piles of debris may be used to stabilize ruts and paths that are at risk of eroding, as well as small ravines.
- Before cutting, wetlands must be clearly located so that operators can avoid disturbing the soil.
- Mark hauling trails before cutting to facilitate the operators' work.
- When building a bladed skid road, always ensure that the route allows for regular water drainage.
- Avoid harvesting on this type of slope during periods when soil moisture is high (consecutive days of rainfall, etc.).
- Carefully map slopes that can be harvested and include paths, bladed skid roads, hauling trails, streams, and soft ground.
- Walk the entire cutblock to check that the information on the map is correct.
- Use forwarders with tracks on both bogies.

**FIGURE 9.**
*Use slash and debris to protect the soil and prevent ruts on soft ground.*

## ENVIRONMENTAL PROTECTION
### Planning considerations

- Proper planning allows the operator to make full use of harvesting measures to reduce environmental impact.
- Steep slopes are prone to erosion, mass movement, and sinking during harvesting.
- Risks increase with the degree of soil exposure, the severity of the angle of the slope, and fine-textured soil.
- The risk of erosion is greatest on long slopes, regardless of soil texture.
- Forest operations on steep slopes can result in:
    - surface erosion
    - loss of forest floor, linked to deep exposure of mineral soil
- When the gradient of the slope is greater than 35% or the soil condition is poor, a logging trail must be built at the bottom of the slope or harvested block. The trail must not interfere with natural water flow or exceed a 25% gradient. A steeper slope will limit the forwarder's efficiency and ability to haul logs. Gather low-quality logs a few at a time to limit return trips to the trail. Use the forwarder's maximum load capacity whenever possible but always consider the terrain surface quality.
- Supervisors must ensure that hauling trails are built with care. Large forwarders cannot perform sharp-angled turns so harvesting trails must be built with exits that access hauling trails.

### Following the logging plan

- The logging plan is created to enhance the operator's ability to work the cutblock. There are many different challenges and variables throughout a steep-ground operation.
- It is important that operators follow the logging plan, having the most efficient trails for the forwarder in accordance with the terrain and making turns wide enough to accommodate the forwarder.
- When working on steep ground, it is critical for the harvester to make the trails as straight as possible.
- As a result, the contractor/operator must plan and execute the cutting of trails so they run straight up and down the slope, with a maximum of 5% side slope.
- The GPS unit can help maintain straight trails and plot or identify problem areas and should be used as a guide. If this tool is not available, then simply walking the trails and using ribbon to mark the problem or potential problem areas is another option.
- This can be challenging, so good planning and communication between the contractor, operator, and supervisor is important to make the best plan to accommodate both the harvester and forwarder.
- Rehabilitation of disturbed areas should be undertaken as soon as it is practical to do so.

## BEFORE STARTING TO FORWARD WOOD

### Operator considerations

- New operators or operators who are about to drive a model of machine that is new to them should always learn and understand the features and limitations of the machine.
- Forwarders can have varying characteristics, from length of reach and stability to the height, size, and weight of load.
- The operator's manual offers operating information on features, but only experienced operators or trainers can help an operator learn about a forwarder's limitations.
- The operator's manual should remain in the machine at all times to serve as a guide for any operator to follow.

### Planning the forwarding of wood

Before starting a steep-ground logging operation (i.e., a forward block that is on a slope of 25% or greater), make sure that the operational logging plan addresses the following considerations:

- terrain (e.g., slope measurements [Figure 10], soil/ground condition, moisture content, ground roughness, erodible soils, boulders)
- size and type of wood products produced
- amount of brush that will be produced and a record of how it has been handled
- weather conditions
- water on site, the possibility of flash floods
- siltation
- visibility
- the possibility that the block needs to be walked and trails designated for day and night operation
- the possibility of modifying the site by constructing trails or ramps
- recovery arrangements, including dealing with oil spills

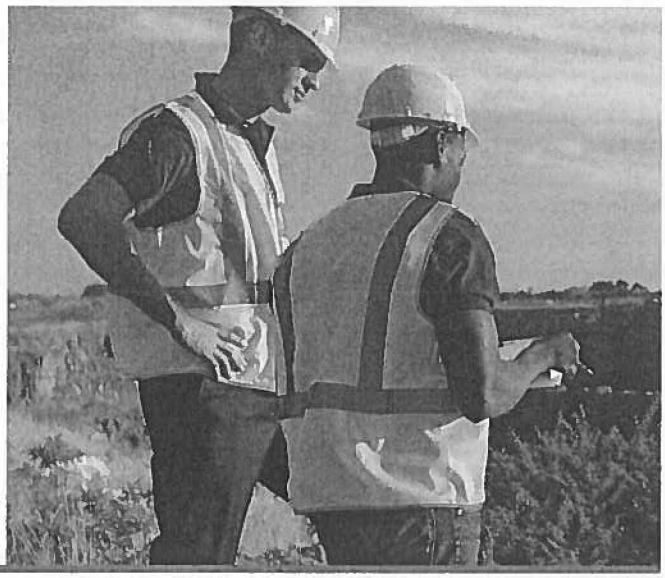
**FIGURE 10.**
*Working on an excessive side slope is dangerous.*

- Exercise caution when driving the machine near ruts or trails, which may force it to change direction and follow the contour of the terrain. This is a very dangerous situation and could result in a machine rollover. The operator must use graded trail sections or a trail built for this purpose (Figure 11).
- To minimize the cost of harvesting on steep slopes, logging contractors must use forwarders with a large loading capacity (18 to 19 tonnes) and high tractive effort.
- Consider adding non-standard components, such as a bunk behind the forwarder (Figure 12), a rotating cab, a winch, an aggressive set of forest tracks (Figure 8), and posts for the rear cargo.

FIGURE 11.
*When driving a forwarder near ruts or trails, use either built trails/roads at the top or bottom of a cut strip* (top) *or prepared trails* (bottom).

- If the slope is too steep, the terrain unstable, or there is limited traction, plan or build a logging trail to the top of the slope from the road down to the forest floor below the road so that the forwarder can access the cutblock (Figure 11).
- If a logging trail must be used, the forwarder will access the trail by moving forward and will load up when descending from the road. With this type of slope, it is crucial that the operator respects the loading zone, as the weight of the logs and the nature of the slope will increase the amount of effort required to lift the wood.

**FIGURE 12.**
*For working on steep ground, consider adding a bunk, rotating cab, and factory-installed winch system.*



# 03.
# PLANNING

## OPERATIONAL PHASE PLANNING

Operational phase planning is very important in any operation but becomes much more so in a winch-assist operation. In this type of operation, the winch-assisted machines must be able to work on tethered cables without disruption from the other activities on the operation, such as trucks, pickups, and other machines that may need to pass on a road where the forwarder is tethered across that road. Therefore, when the initial planning for the cutblock is taking place, the logistics of when and where the machines, trucks, and pickups will be must be considered and planned so that each phase of the operation can work properly without interruption.

There are some rules of thumb that you can follow that will help you make the best decisions:

- A new cutblock/area should be planned well in advance when doing winch-assist logging. Things such as weather and seasons will have an effect, so where the cutblock is located is important.
- Things like where and when to plan anchors, hill access ramps, and forwarder piling areas are important, especially going into a different season.
- Layout must be detailed and the plan should establish which machines are cutting where and if there are conflicts with any other phases of the operation (see Figure 13).
- Areas that are designated for winch-assist machines should be earmarked to be cut as early as possible in the cutblock/area plan.
- These areas should get cut and forwarded before trucking occurs beyond that point on the road.
- Normally, this would mean that designated areas near the front of the block would be cut first and areas near the back of the cutblock or on branch roads would be cut last.
- This would reduce the need for most vehicles to pass the active tethered forwarder during its operation.

If the above criteria can be met, the forwarder will not be disturbed, thus allowing for good performance and productivity during the work shift. The better the plan is, then the higher the chance of having good execution of the plan. However, good plans do not necessarily result in good execution. It is just as important that there is good communication between everyone involved in the operation. Everyone is a part of the planning process, everyone understands the plan, and everyone agrees to execute the plan as it was designed.

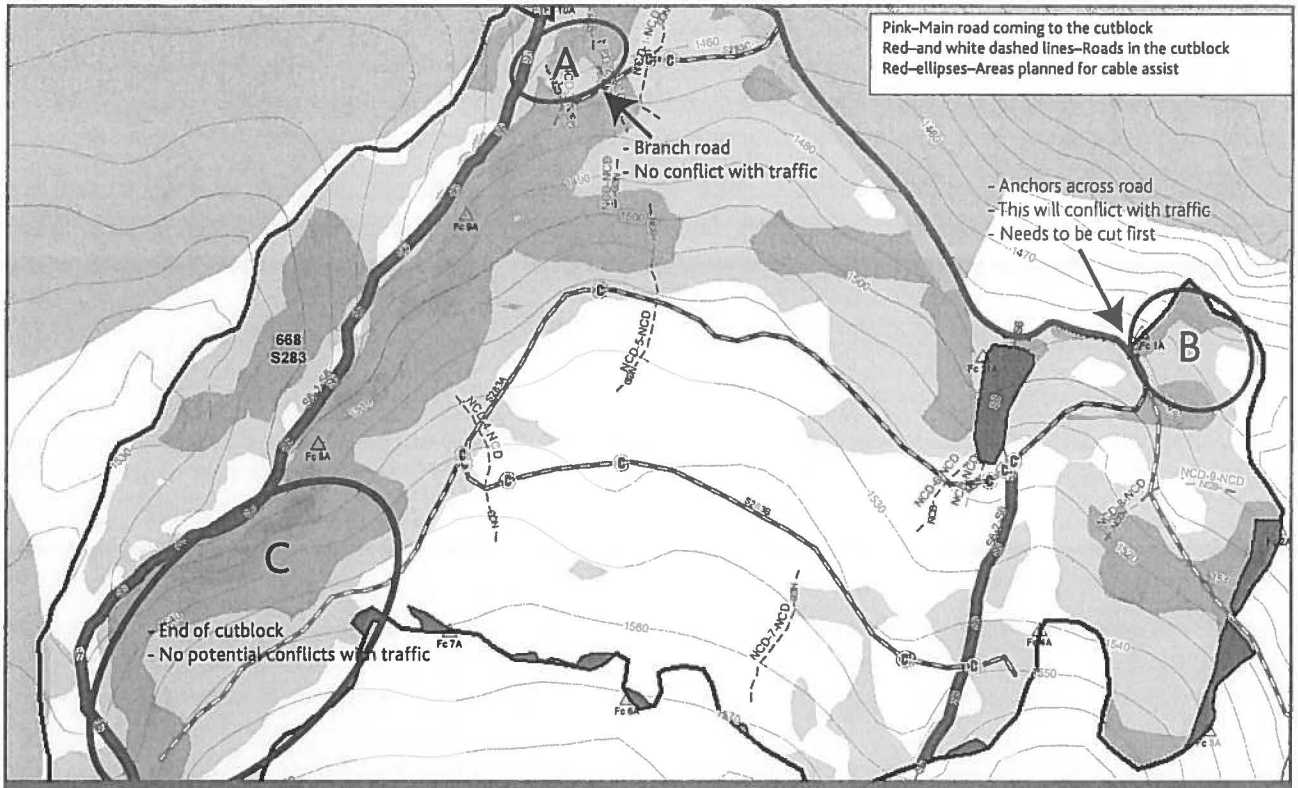



FIGURE 13. *Planning sections of the block on the map.*

## Road planning within the cutblock

Roads are a significant part of harvesting every cutblock and even more so when harvesting steep ground. First of all, many mountain or hillside sites will have rock formations. This can add another dimension to harvesting slopes. The ability to access and forward depends on where the roads are placed. Well-planned roads can make a considerable difference to the ability of trucks and loaders to maneuver without incidents of becoming stuck or not being able to access wood on the cutblock. Road planning and forward cutblock planning should be done as a joint effort to plan and forward the cutblock in the safest and most efficient manner. This would include proper truck turnarounds and wide out areas placed at strategic locations that will facilitate good traffic flow on the cutblock.

## On-site shop or service facility

There are many other things to take into consideration with a winch-assist operation. Make sure there is an on-site service facility (service truck or trailer; Figure 14). Along with the normal service tooling required to keep your operation running, a small kit of things such as extra cable, wedge sockets, cable clamps, shackles, and hooks will be required. All of these items are essential to carry out winch-assist logging and if one piece is damaged or broken, the whole operation may be forced to a halt. For more information, see Chapter 5, "Beginning to forward wood with a winch-assist machine."

## Preparation for other seasons

As mentioned earlier, planning of future cut areas is critical for winch-assist logging. If the cutblock/area will be harvested during late fall or winter, snow has to be the first consideration. Winch-assist logging works best up to 1 m of snow. If a future cutblock/area is located at a higher elevation, it may need to be harvested in the summer season. If this future cutblock/area is designated to be cut during cold weather months and is in a suitable location, then it will be important to dig and prepare deadman anchors, access ramps on the downhill side of the road, and any landings for the forwarder to place piles of wood. For more information, see the "Planning a new cutblock/area" section in this chapter.

**FIGURE 14.** *On-site shop and service facility.*

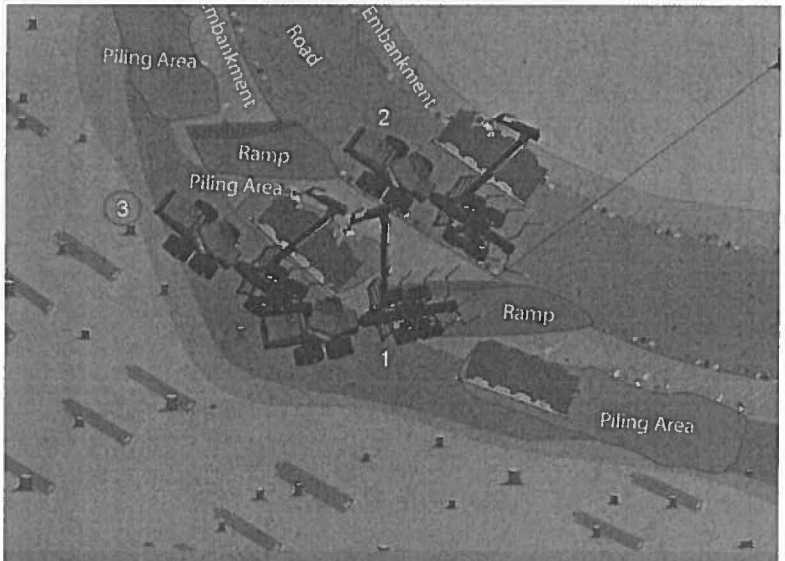



**FIGURE 15.** *Access ramps and three possible piling configurations.*

## PLANNING A NEW CUTBLOCK/AREA

When planning a new cutblock/area, trails need to be planned with anchors, ramps, and piling areas. Anchors will be discussed in Chapter 4, "Anchors and catch stumps."

This section discusses building ramps and piling areas for future cutblocks/areas.

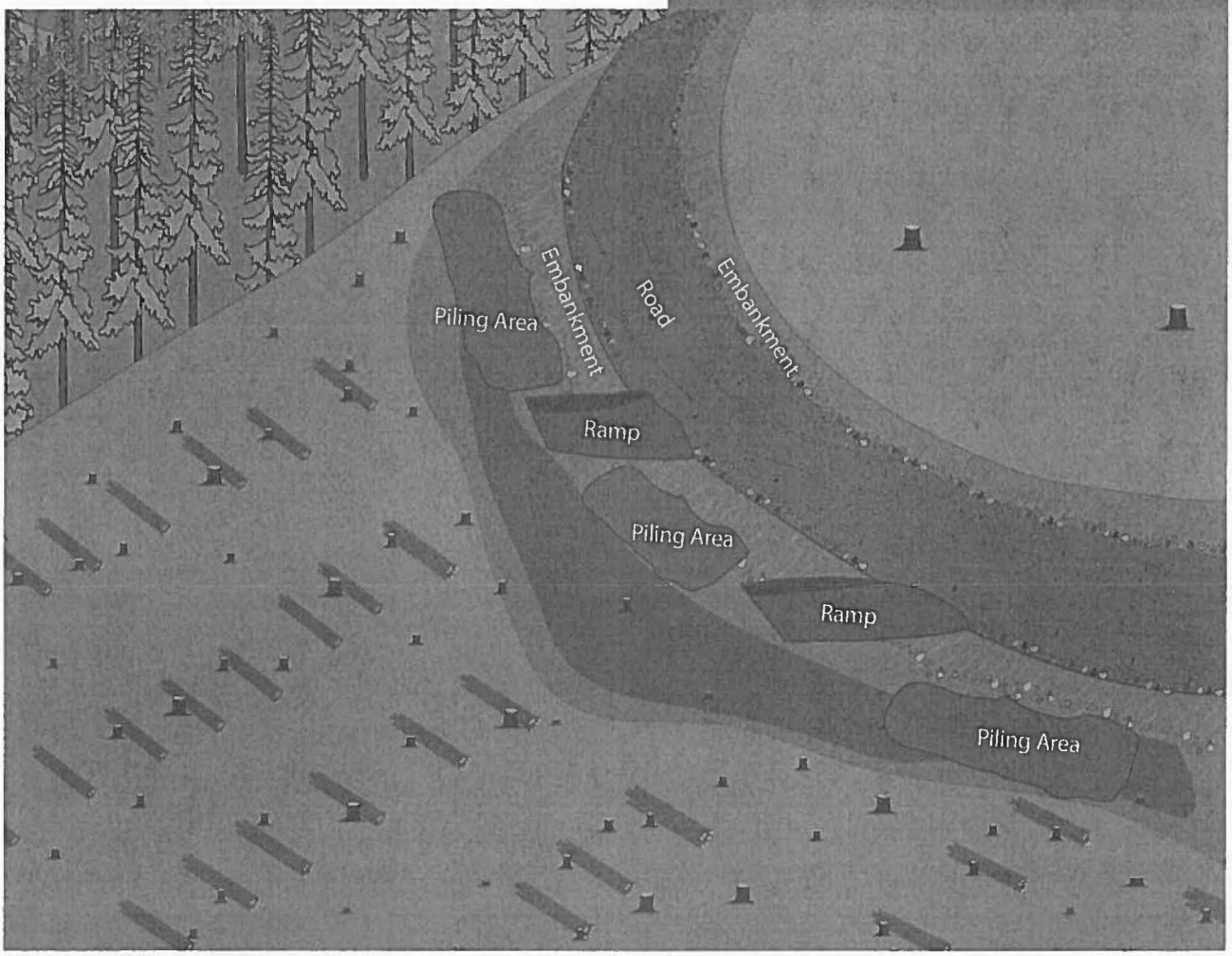
### Access ramps

- Ramps are small, 45° trails that are opened up on the downhill edge of the cutblock road to allow both the harvester and forwarder to access the trails below the road. These access points are designed to be small and not cause any loss of integrity of the cutblock haul road.
- Because of the 45° design, the width can be minimal yet accessible for the machines.
- Ramps must be designed as short as possible to minimize the amount of erosion that can take place. By building these ramps short and facing back into the forest floor, any erosion will end here.
- Figure 15 shows an example of ramps and piling areas that were planned and installed before the harvesting crew arrived. The drawing also shows three possible piling configurations that the forwarder can use as wood is extracted from the cutblock:
  1. The most limited situation: Because of the slope, the forwarder is forced to off-load on either side of the machine on one of the two available piling areas. This is limited because the operator can only pile as far as the boom can reach.
  2. One of the best scenarios: The forwarder is on stable footing and can pile on either side of the road, allowing for the best pile configurations. Care must be taken not to catch the cable in the tracks when backing up and maneuvering on the road, especially during dark hours.
  3. Slightly limited scenario: This scenario offers better piling flexibility than option 1 as the operator can utilize the whole length of the piling area while maneuvering parallel to it and without being limited to boom reach. Care must also be taken in this situation not to catch the cable in the tracks when backing up and maneuvering.

## PILING AREAS

- Piling areas require some planning and are not necessarily consistent due to varying terrain and road systems.
- A piling area may be near the bottom of one of the ramp areas just where the forward trail will meet the ramp. This is the most ideal location because it allows the forwarder to place wood near the road for loading and reduces the need to go onto the ramp and road, which may lead to damage that could increase road maintenance costs.
- Figure 16 shows a piling area that has been made near the ramp areas.
- Piling space is normally limited in situations where steep ground is being logged. If there is either not enough piling space or no piling space due to terrain issues, then piling locations may be required either at the edge of the road surface or across the road in some cases.
- Where the road has been recessed into the side of a steep hill, the terrain may be steep on either side of the road. This often limits the area where the forwarder can pile wood, so planning must go into how and when trucking will take place to allow for an uninterrupted flow of wood.

FIGURE 16.
*Placement of the ramps and piling areas.*



# 04.

# ANCHORS AND CATCH STUMPS

## TYPES OF ANCHORS AND CATCH STUMPS

There are several types of anchors that can be safely used to assist with the machine's integrated traction winch or the autonomous stationary winch systems in a variety of situations:

- single tree/stump anchors – normal straight slope with single or double cable strap anchor is the simplest and most commonly used
- multiple anchor trees and/or stumps
- deadman anchors
- rock anchors
- machine anchors

Safety should always come first; gloves should be worn any time you are working with steel cable. This section looks at the main types of anchors and uses photos or drawings to help explain how to set them up and use them properly.

### Stump and tree anchors

Stumps and trees are most commonly used to anchor winch-assist rubber-tired forwarders. Deadman anchors, rock anchors, and machine anchors may be used in locations where there are no suitable trees or stumps. Follow these best practices when planning:

- Plan trails with consideration of the location of the best stump anchors.
- Anchor straps and rigging must match or exceed the safe working load of the wire rope in use.
- Rig anchors about 18 m (60 ft.) apart, adjusting for boom reach and inaccessible areas.
- Pre-tension the anchor to 5 or 6 tonnes to test it before beginning work. Re-tension the anchor from a safe position using the forwarder winch remote control and without an operator in the machine.
- Pre-plan anchors in the daylight for night operations. Use headlamps to aid in setting up anchors in the dark.

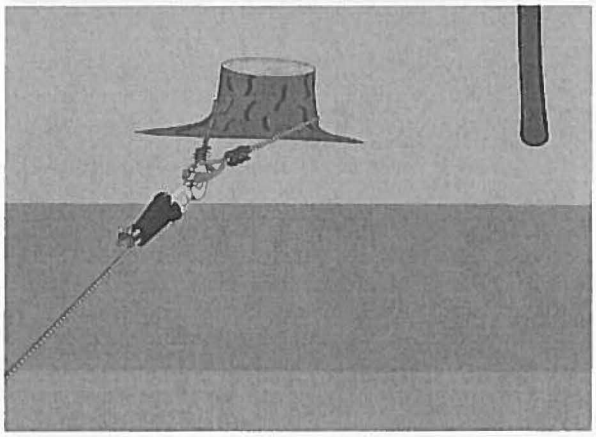
### Selecting the tree/stump anchor:

- Use appropriately sized stumps (Figure 17) and trees. See cable yarding literature for recommendations on selecting a good anchor stump or anchor tree (WorkSafeBC, 1993).
- Choose sound trees or stumps that are in good health and well-rooted, without exposed roots or rocks (Figure 18).
- Choose trees with a healthy treetop.
- Size:
  - larger than 45 cm (>18 in.) diameter – a single tree or stump is okay (Figure 18)

- 30 to 45 cm (12 to 18 in.) diameter – use two trees or stumps
- 20 to 30 cm (8 to 12 in.) diameter – use three trees or stumps
- less than 20 cm (8 in.) diameter – install multi-tree anchor with supervisor or use alternative anchor system

- Species: Douglas-fir is preferred; pine, cedar, and spruce are okay (Figure 18); hemlock should be avoided; balsam fir is not suitable.
- Firm and stable old-growth stumps can still be good as anchors.
- Consider the fact that stumps have limited holding capacity in saturated conditions.
- Ensure anchor stumps are tall enough to prevent the strap from slipping off (Figure 19). Notch the stump if necessary to ensure the strap is secure.
- Avoid stump or trees:
  - with exposed roots
  - on rock or stones (Figure 20)
  - with rot

FIGURE 17.
*Single-tree and single-stump anchor placements.*



## The most common single-stump or tree-anchor rigging and setup

- This can have one or two cable loop straps or one large synthetic woven strap, depending on the manufacturer's recommendations for the particular brand of winch being used.
- It is fairly simple to install and secure. Place the cable or woven strap as low as possible on the stump while ensuring there are no obstacles that come into contact with the strap, such as rocks, wood debris, or buildup of snow that could cause the strap to slip or break.
- While standing in the designated safe zone (see "Anchor test" in this chapter), use the winch remote control to apply the amount of pull recommended by the winch manufacturer to secure the strap (see Figure 18).

FIGURE 18.
*Examples of good anchor stumps.*

FIGURE 19.
*Example of an anchor stump that is too short.*


FIGURE 20.
*Avoid anchor stumps that are perched on rock outcrops.*

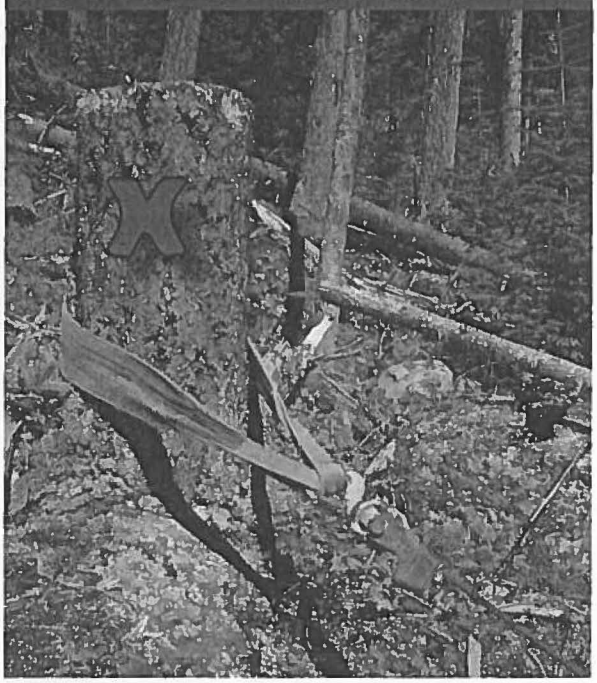



FIGURE 21.
*Pre-rigged anchor tree with an extension strap.*

- Pre-rig anchor trees (Figure 21) with extension straps or wire rope in areas where suitable anchors are located considerable distances from the road or in difficult spots.
- When pre-rigging anchors, it is wise to paint attach points (loops at the end of the anchor) and ribbon high enough near the anchor so it is possible to find should there be snow on the ground when the timber is actually harvested (Figure 21).

FIGURE 22.
*Multiple-tree anchor.*

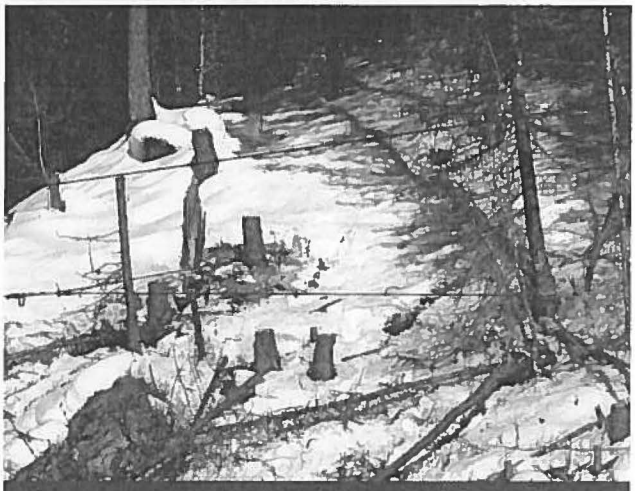


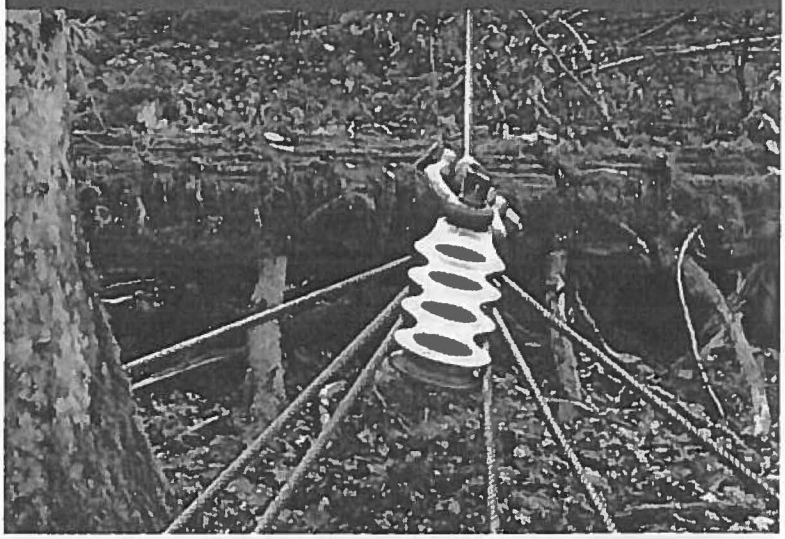
FIGURE 23.
*One-stump and one tree combined with an equalizer block for an anchor in small trees for a small cable-logging system.*

### Multiple stump/tree anchors or combinations

This is more complicated than a single tree or stump but is still fairly simple to set up. Testing is very important and the use of a monitor can reduce the risk. Always follow the winch manufacturer's recommendations.

- It is important in multiple tree setups to have the primary anchor tree take the highest percentage of the pull, but use trees in close proximity to take a smaller percentage of the pulling tension.
- For instance, if two trees were used, the pulling tension should be approximately 60% on the primary and 40% on the secondary (Figure 22).
- For three trees, it may be 60% on the primary and 20% equally on the other two.
- You should always refer to the recommendations of the manufacturer before performing any of these configurations.
- When setting this type of anchor, try to find a larger tree that will take most of the pull, even if it is not directly in line with where you want the cable to run, but use one or more other trees to help direct the cable to where you do want it positioned for the best trail coverage by the forwarder.
- Use multiple stumps or trees (Figures 23 and 24) as necessary, using accepted rigging and tie-back procedures. Refer to the *Cable Yarding Systems Handbook* (WorkSafeBC, 1993).

FIGURE 24.
*Multi-stump/multi-tree anchors used with winch-assist systems.*



- Where necessary, notch stumps following standard cable-logging methods.
- Use caution if rigging a block to redirect the rope as forces on the anchor can become large, depending on the angles (e.g., the force on the anchor can become doubled).
- If rigging standing tree anchors, rig with "deflection" stumps/trees so the direction of force will not pull the tree toward the machine.
- Tie back tree anchors (Figure 25) if they may fall into the working area or if required by regulation.
- A stump monitor to notify the operator notification of stump movement is recommended (Figure 26).

FIGURE 25.
*Anchor tree (bottom) and tie-back tree (top) with synthetic tie-back strap.*

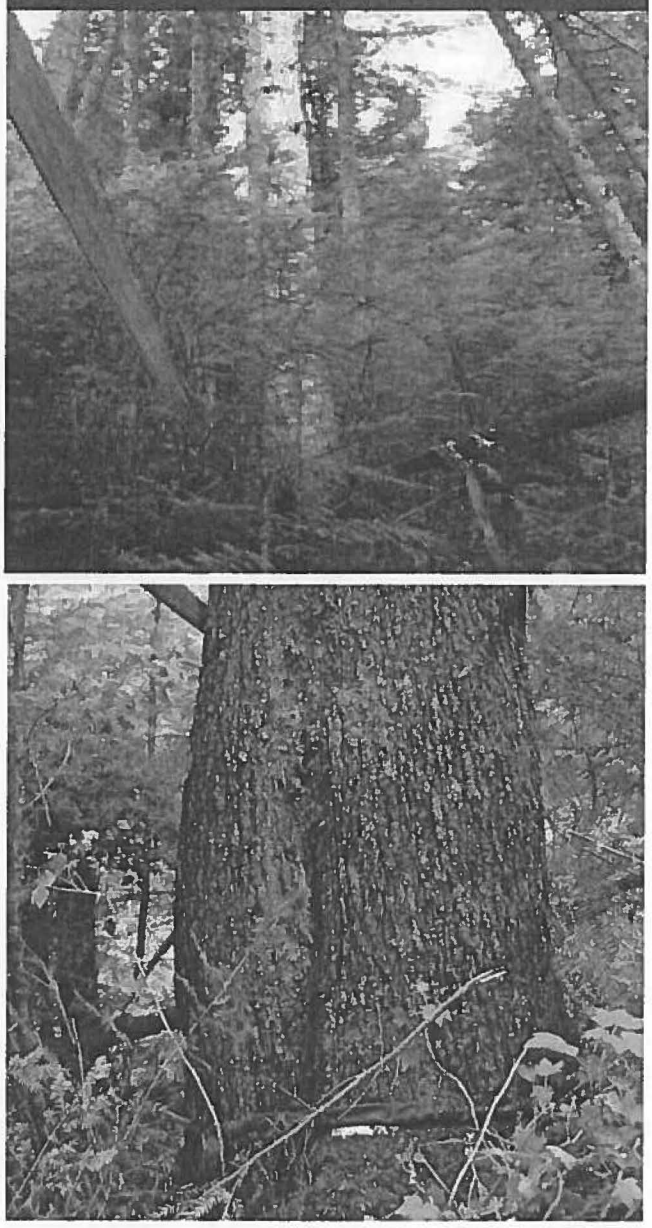
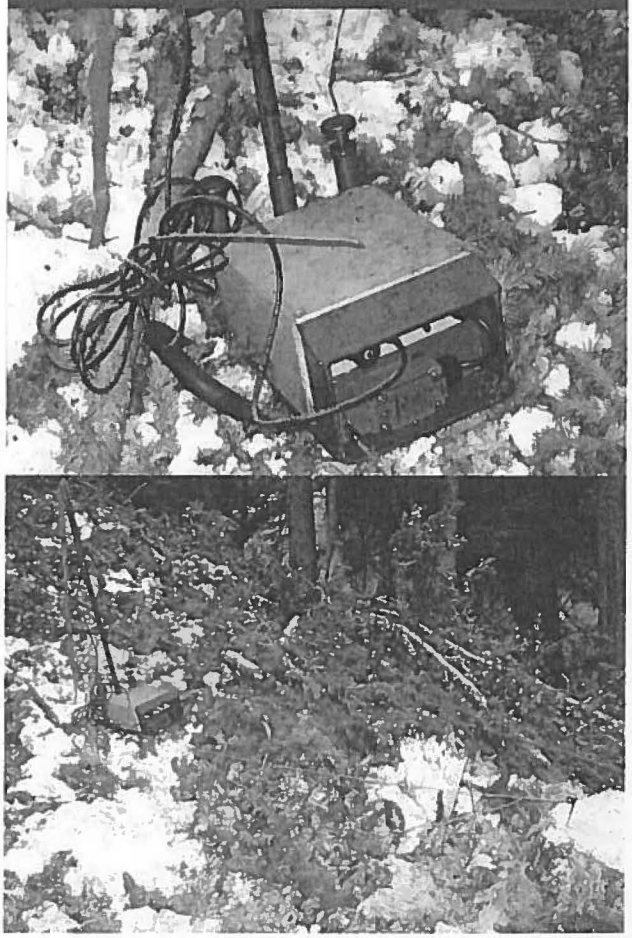


FIGURE 26.
*Device to detect stump movement.*

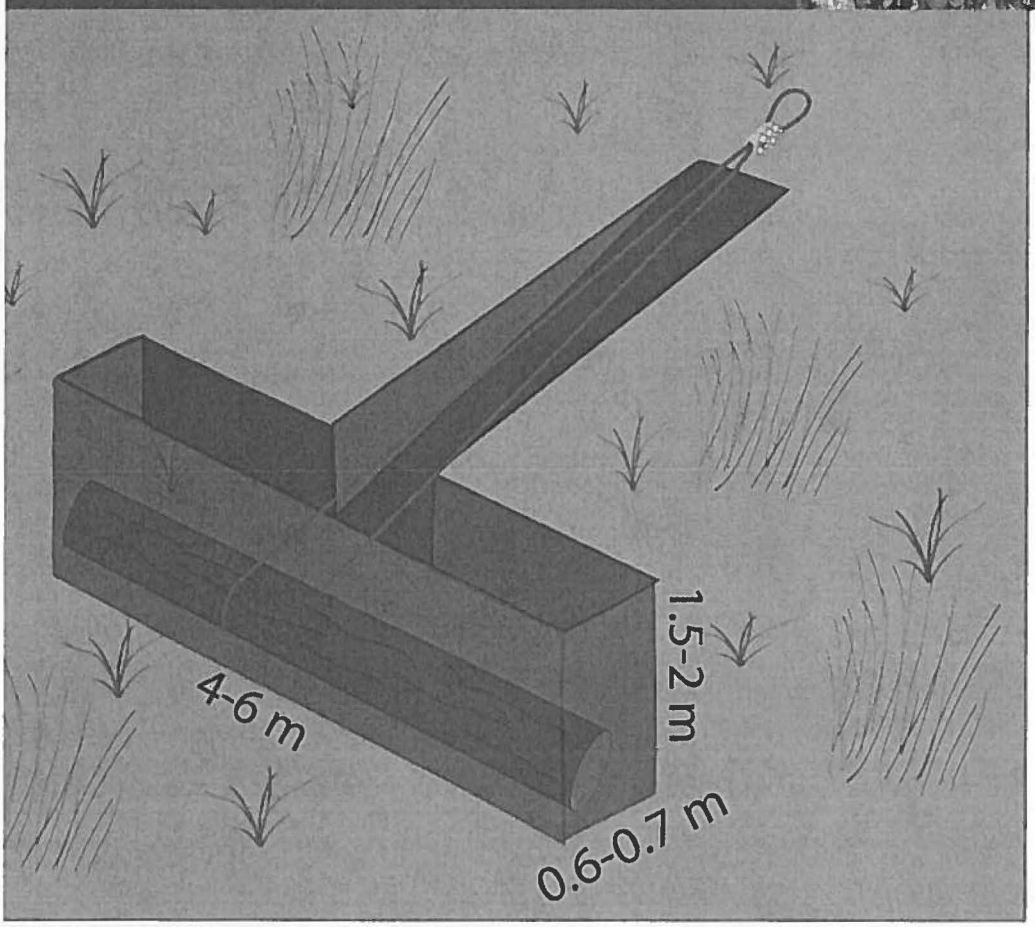


## Deadman anchors

Deadman anchors may be used where adequate stumps, trees, or equipment anchors are not available. Additional instructions for selecting and installing deadman anchors can be found in the *Cable Yarding Systems Handbook* (WorkSafeBC, 1993).

- A deadman anchor can be made by digging a 6 m long trench.
- Bury deadmen 1.5 to 2 m deep.
- Bury a large, sound 5.0 m long log placed lengthways in the trench with a cable wrapped around the log's mid-point.
- Bury the log with the cable end extending above the ground for attachment to the winch wire rope (Figure 27).

FIGURE 27.
*Completed deadman hook-up with strap.*



## Rock anchors

Rock anchors (Figure 28) have had some, but limited, use in cable logging.

- They have strong tensile strength but weak shear strength.
- Drill access to site or portable drill is required.
- Untrue drillholes or non-cylindrical holes will reduce holding power.
- Avoid fractured rock, or drill beyond the fractures or grout them.
- The number of bolts required depends on the load.
- Use equalizer blocks or turnbuckles for multiple bolts.
- Bolt should point in the direction of pull.
- Torque and test before use.
- A safety factor of 3 is recommended.

Different types (expansion bolts, grouted steel pins, unwedged, or ungrouted steel pins) have different advantages and disadvantages that should be considered.

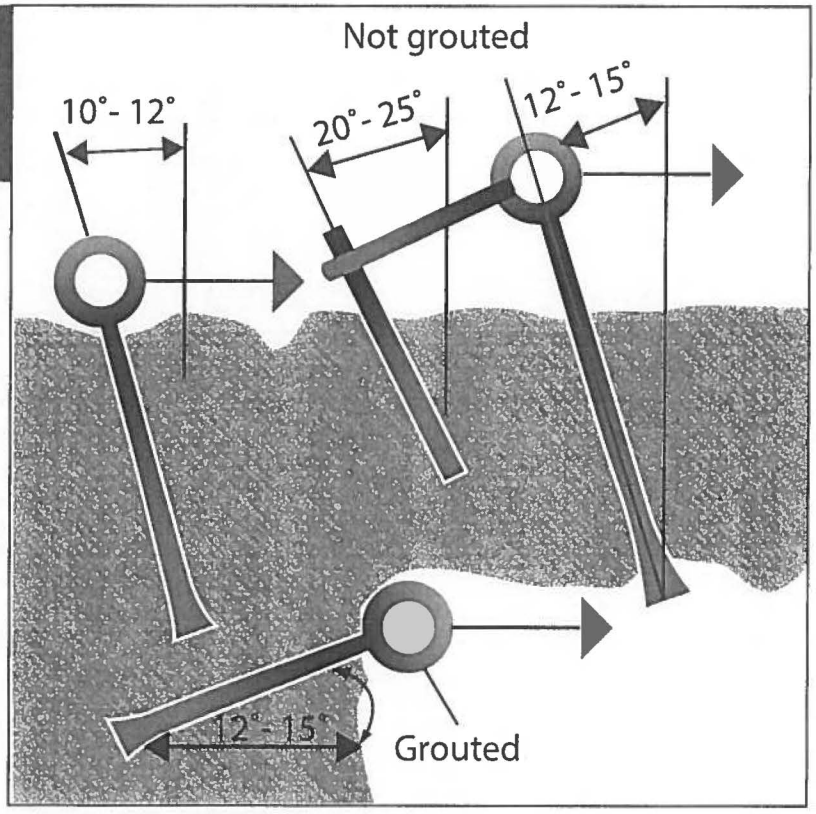



**FIGURE 28.**
*Rock anchor example.*

## Machine anchors

Typically, an excavator or bulldozer is modified to act as a machine anchor (Figure 29). Use a machine with a low centre of gravity and attach the cable to a low point on the anchor machine to prevent it from overturning. Ensure the attachment point is engineered to support the expected load. These setups should be certified by a manufacturer.

Smaller, low centre of gravity, remote-controlled units like the T-winch are starting to emerge (Figure 29). These machines are typically easier to move around, have a very low centre of gravity, and are easy to set up. They are typically designed to work with smaller machines like rubber-tired harvesters.

- Position the anchor machine on level or upsloping ground whenever possible. For downsloping ground, place the anchor machine in the least downsloping position and secure it using one of the methods below.
- Position and secure the anchor machine to prevent any sideways rotation or downslope movement.
- Always position the anchor machine with the forwarder to prevent overturning.
- Apply the anchor machine's track brakes.
- Use the anchor machine's blade or bucket to secure the machine by placing the blade or bucket against a stump or tree, or dig it into the ground, as necessary. For bulldozer-style blades, force the anchor machine's blade at least half-way into the soil. For excavator-style anchor machines, reversing the bucket can improve its purchase in the soil.
- Guy the anchor machine to one or more stumps, trees, or other suitable objects on the machine's uphill side with one or more guylines as necessary to prevent anchor movement. Ensure guyline(s) are tight and the forces are equal (if using more than one guyline) before operating the forwarder.
- Install and use anchor movement alarm (break-away switch) that signals the operator if the anchor machine moves.
- Take extra care to secure the anchor machine adequately on frozen ground.

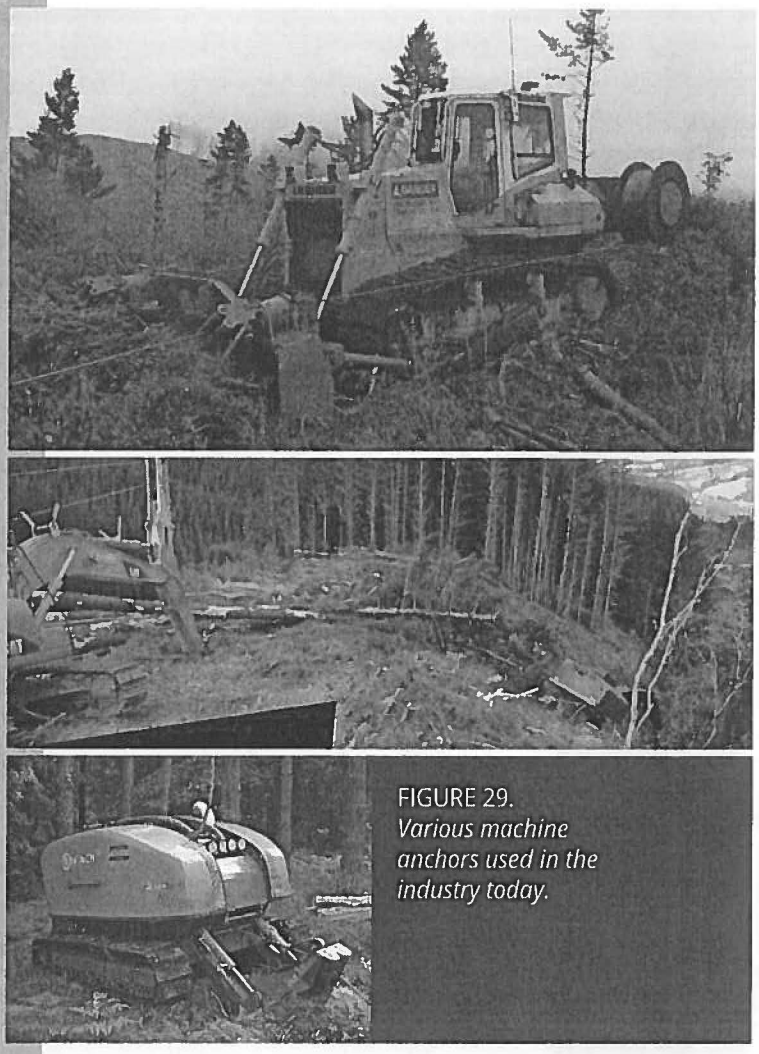


FIGURE 29.
*Various machine anchors used in the industry today.*

## GETTING ANCHORED

Because of the synchronized pull of both the winch and the transmission of the assisted machine, proper traction and stability are achieved within the recommended degree of slope the machine is working. Various techniques can be applied to winch-assist logging to further increase the benefits over conventional steep-ground logging.

The steps to using the winch assist for the forwarder are as follows:

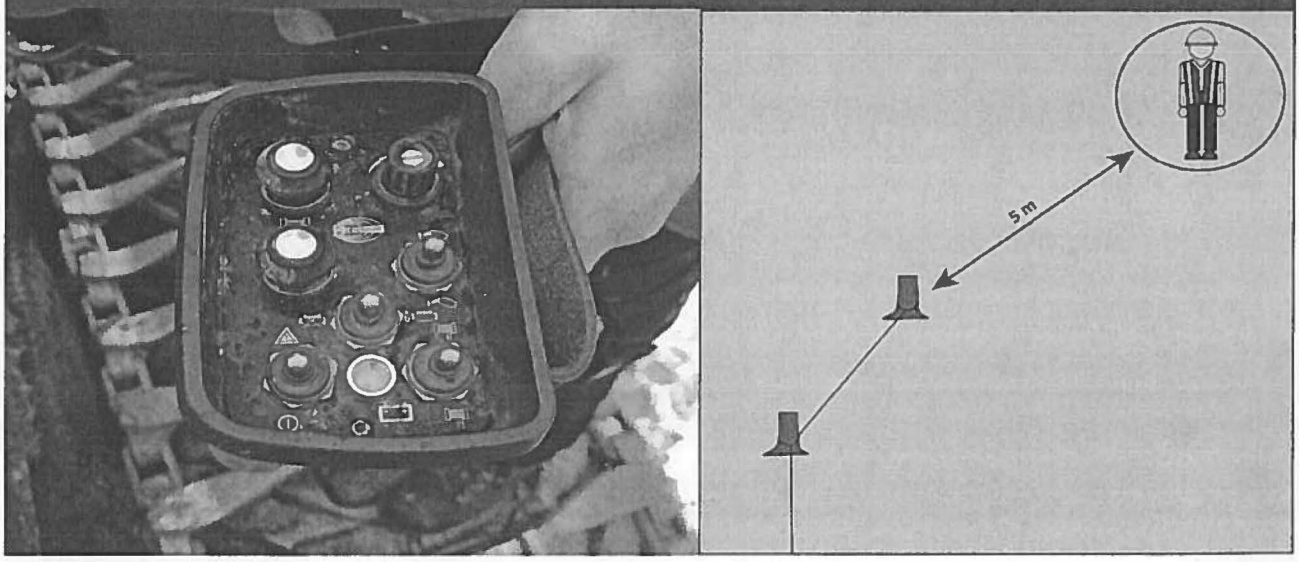
1. Find a proper anchor for the current trail before starting. It is smart especially in the beginning that the contractor/operator plan these anchor points in advance. The earlier you can find and mark these anchor points, the less time will be wasted looking for and deciding on anchors later when the machine may get held up due to no anchors being available.

2. Once you know your anchor point, the cable loop strap or synthetic strap will be placed around the anchor point by the operator. Using the remote control as shown in Figure 30, the operator will stand in the safe zone (check winch manufacturer's operator manual) and tighten the cable to the recommended test pressure. Always wear gloves when handling steel cable. It has a tendency to have steel wire fragments protruding from it as it wears.
3. If the anchor is safe and fully secured, the operator can now go to the machine and start working.
4. When walking to the machine along the route that the cable lies, it is best to check that the cable will have a clear path back to the machine.
5. The cable can be used as a support mechanism to assist the operator back to the machine when the ground is steep and/or rough. Always use gloves.
6. Once in the machine, the operator will set the winch using the manufacturer's recommendations, and then start working.
7. See the following section, "Anchor test," for the exact steps in testing the anchor.

## Anchor test

1. Stand outside the machine, 5 m away from an anchor tree, and at a 45° angle above and behind the uppermost stump or tree in the anchor system.
2. Use the remote control to engage the winch on the forwarder and pull on the anchor with a maximum force of 3 tonnes.
3. Watch the upper part of the root for movement during the test.
4. If there is movement in the ground, stop and find another anchor tree or stump.
5. If there is no movement, increase the winch force to 6 tonnes.
6. If there is no movement, then the forwarder can be operated using a maximum winch force of 5 tonnes.
7. If greater tensions are expected due to insufficient traction, increase the winch force to 9 tonnes.
8. If there is no movement, then the forwarder can be operated using a maximum winch force of 7 tonnes.
9. Always maintain a 5 m safety zone around the anchor when it is under tension. Do not stand below the anchor (Figure 30).

FIGURE 30.
*Example of remote-control device for testing the anchor* (left). *Example of safety zone when testing anchor* (right).



### Catch stumps (also referred to as redirects)

To harvest and forward wood on steep ground where the slope may change incline as well as direction, several techniques may need to be employed. One of these is working with catch stumps where an operator can safely and successfully harvest and forward slopes within the safety criteria laid out in earlier sections of this manual. Please also refer to recommendations regarding rope management when catching around stumps, described in FPInnovations (2017):

- one catch stump part way down the hill for a redirect (shown in Figure 31)
- multiple catch stumps for multiple angles of slope
- a valley in a slope with one or two ridge slopes that require multiple short trails from each ridge (shown in Figure 32)

### Single catch stump

One catch stump part way down can allow the machine to redirect for the following situation:

- This type of anchoring is used when you find that part way down the hill, the slope of the hill changes direction slightly so that the machine must change course.
- In this case, a high stump can be left at or near the breaking point of the angle change that will allow the cable to be placed around this stump to make a straight line in that direction, as shown in Figure 31.
- This can only be used to change the angle a few degrees so the harvester and forwarder will be able to work on the face of the slope with no side slope.
- If the stump is prepared to the right height, the operator can use the lift of the winch enclosure to place the cable around the stump and get it off the stump when coming back up the hill.
- This is a safer option because the operator does not have to leave the cab in order to place the cable.

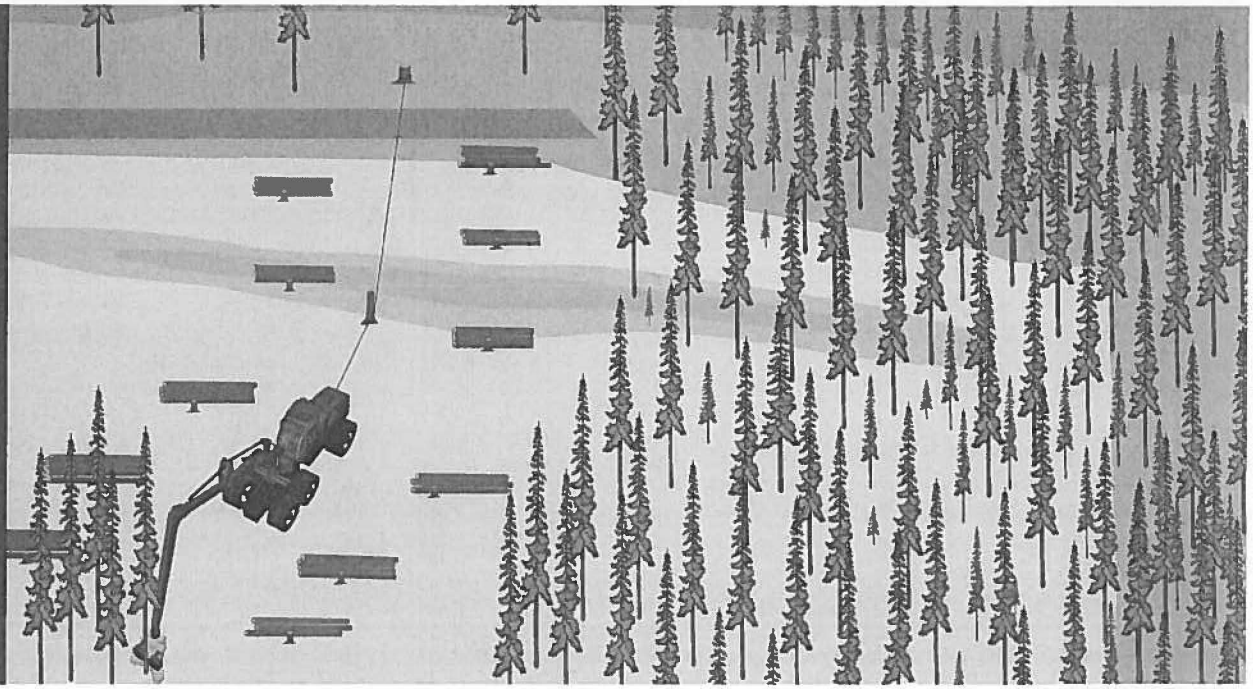


FIGURE 31. *Single catch stump part way down the hill.*

### Catch stumps on secondary slopes

A valley in a slope with one or two ridge slopes that require multiple short trails (see Figure 32):

- This scenario is slightly more complex in that it is used not to make a trail redirect but only to redirect the forwarder a short distance to reach wood from small ridges within the hill.
- In this case, the forwarder operator would leave a high stump on the opposite side of the trail to allow the forwarder to redirect down the slope of the ridge and either place the wood at the bottom to a trail or feed it back to the main trail that the operator was working on.
- If the required deflection angle is smaller than recommended by the manufacturer, associated hazards such as abrasion, high temperatures, tension differences, and catch stump failure could lead to unsafe consequences. For such situations, installing a block for running line configurations is recommended.
- The process is to cut the full length of the trail but leave openings on the side to be cut every 16–18 m, depending on the distance you normally leave between cut strips.
- Across from each one of these trails, you will need to leave a high stump that you will later use to redirect.
- Once the main trail is cut, then you will use the high stumps you left on the way in to redirect down the hill to cut the small section between the trails.
- This is a necessary method any time there are ridges that protrude out of the hill going in the same direction as the main slope.
- Remember that none of the wood cut on this redirect should be left on the redirect trail because the forwarder cannot reach or drive to this wood.
- This method is only for the forwarder to be able to place wood it cannot normally reach and place it to either of the two adjacent trails.

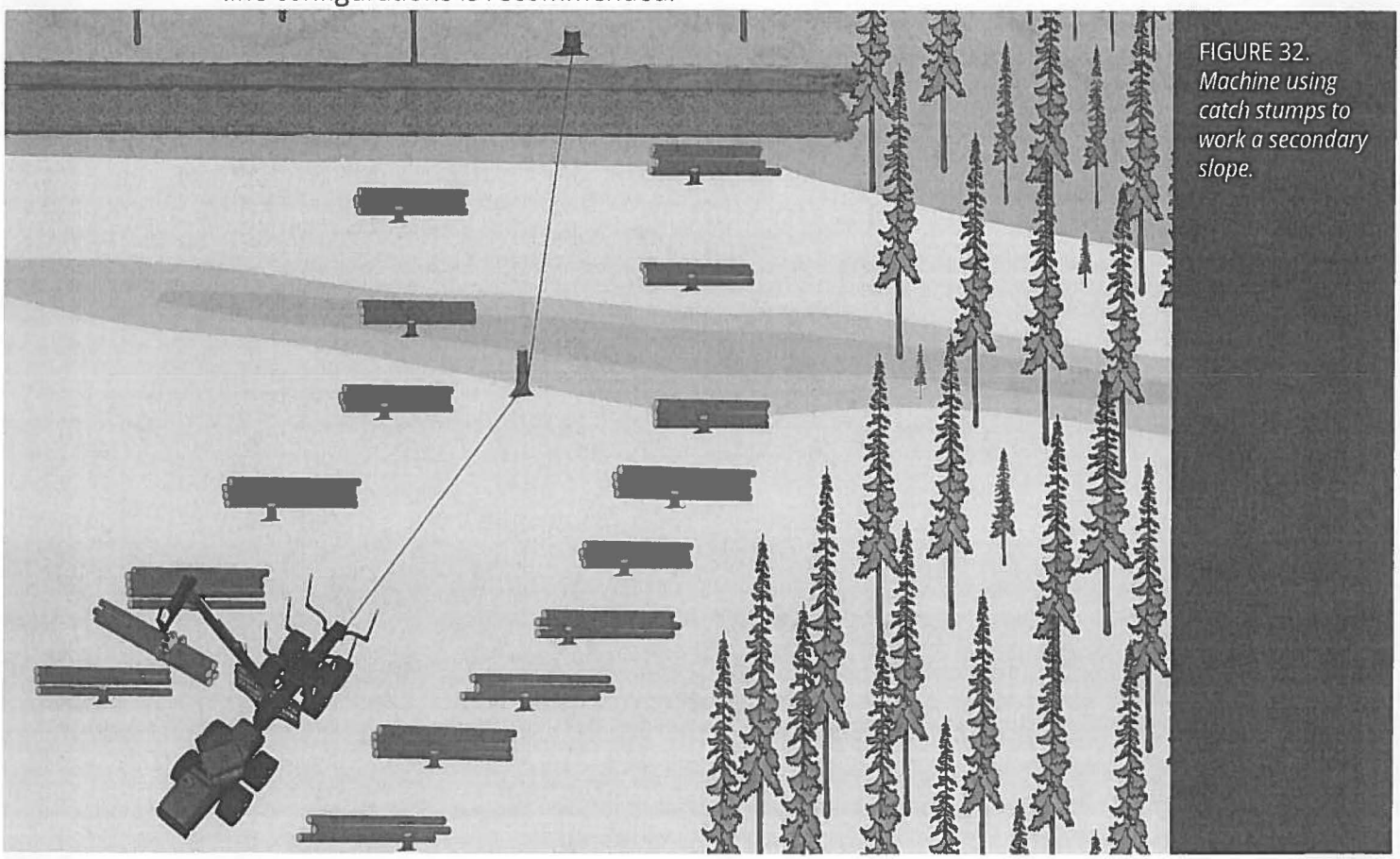


FIGURE 32. *Machine using catch stumps to work a secondary slope.*

## Secondary slopes

- A valley in a slope with one or two ridge slopes is very different for the forwarder than the harvester.
- This scenario is slightly more complex for the harvester than the forwarder in that catching redirect stumps (shown in Figure 33) is used not to make a purpose-built extraction trail redirect, but only to redirect the harvester a short distance to reach wood from small ridges along the hill and place the wood on either of the adjacent trails for the forwarder.
- This allows the forwarder to work straight down the ridge on one trail and along the valley on the other trail using the same anchor point (two scenarios are shown on Figure 33).
- Figure 33 shows a fairly large pie-shaped area between the two trails where the harvester placed the wood on the trails using several short trails from catch stumps on the ridge.
- The wood inside the pie shape at the beginning of the trail (circled in Figure 33) may need to be picked up or moved going in to allow a straighter pull to the anchor.

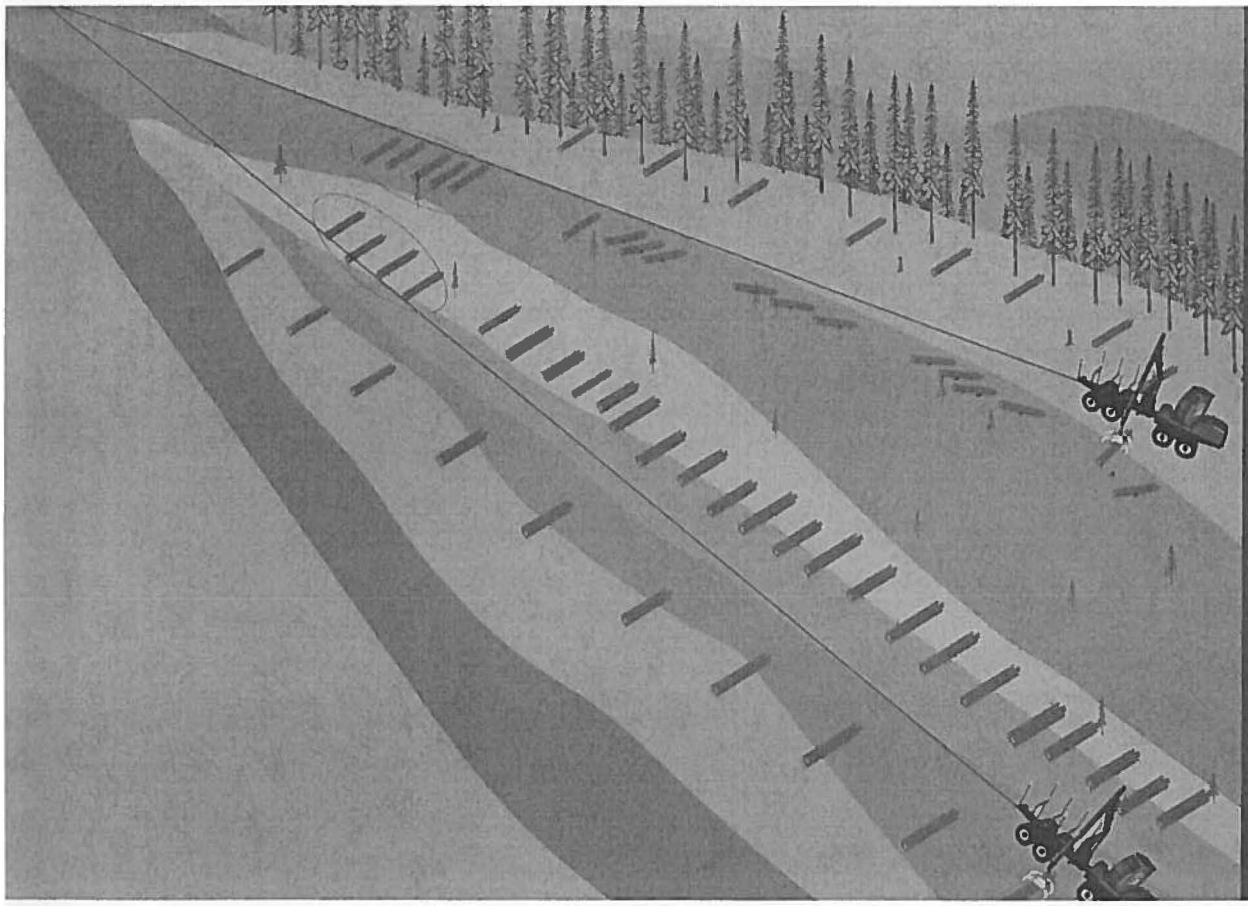


FIGURE 33. *Proper trail directions for a forwarder working a secondary slope.*

# 05.

# BEGINNING TO FORWARD WOOD WITH A WINCH-ASSIST MACHINE

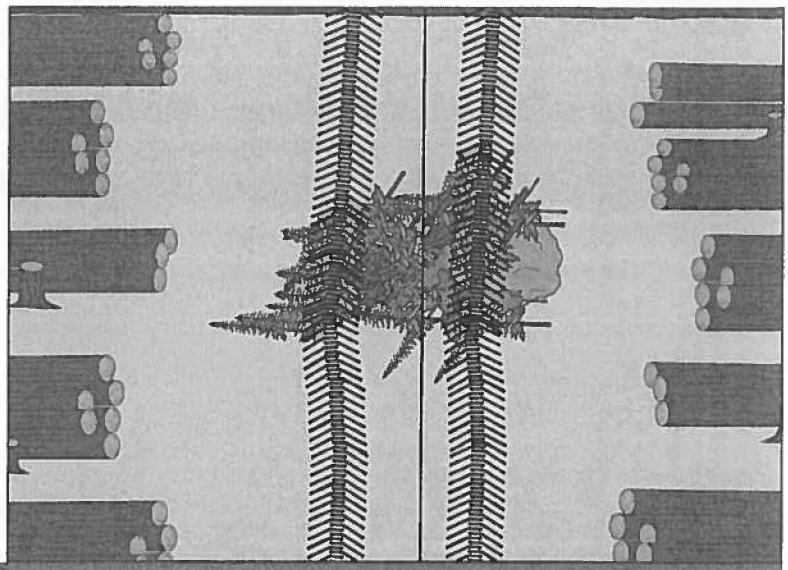


FIGURE 34.
*Brushing around rocks, stumps, or difficult terrain on a trail.*

## WINCH-ASSIST FORWARDER CONSIDERATIONS

Before operating a winch-assist machine, an operator must complete training on the proper operation, anchoring, safety measures, and features to competently run the machine.

- Working down the hill empty, the operator of the forwarder should watch carefully for high stumps and large rocks that the machine might get caught on when coming back up the hill loaded. Anything that the operator believes might have touched the belly or centre joint of the machine going down the hill should be addressed right away on the way down.
- If the operator encounters high stumps or rocks, there are two options for preventing problems on the way back up loaded:
  1. Brush and small woody debris can be piled around a rock or stump to build up the base and allow the machine to go over the obstruction. This will work only if the obstacles are relatively small or short and if their impact would be significantly reduced by brushing (Figure 34). If the obstacle can be seen far enough in advance, the forwarder may be able to move over slightly to avoid it.
  2. If there is a risk of problems, abandon the trail until the contractor does an assessment and makes a plan to cut the stump manually or, in the case of a large rock, the lower part of the trail is cleared using an adjacent trail; in the worst-case scenario, the contractor may need to bring in an excavator to fix the trail.
- Any time an operator steps out of the cab onto steep ground, the risk of injury from slips or falls increases.
- Experience will greatly expand an operator's ability to manage obstacles, such as high stumps or rocks, but beginners may need to avoid some areas altogether on closer inspection. These areas should be left for the more experienced operator or contractor to deal with.
- It is normally best that the most experienced operator works the tougher terrain until the less experienced operator has gained the confidence and experience required.
- As in any forest operation, it is recommended that if a machine is going to work two or more shifts, the operator working during the dark hours works on the best ground.
- If an operator comes to uncertain or challenging areas during a night shift, it is recommended that work in those areas is ceased and resumed during daylight hours.
- Trails requiring a redirect (catch stump) should be planned for daylight hours as well. Planning and executing a redirect in the dark is not practical or efficient.

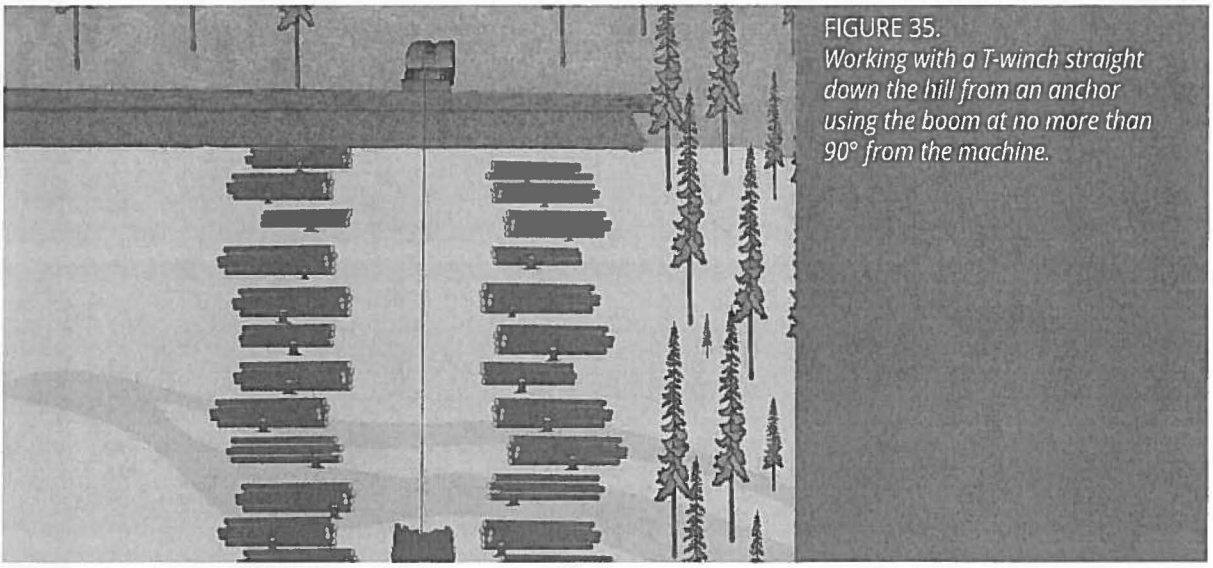


FIGURE 35.
*Working with a T-winch straight down the hill from an anchor using the boom at no more than 90° from the machine.*

## FORWARDING WITH A WINCH-ASSIST MACHINE

Now that you have made a plan and decided how you will safely set your anchors, you can start the forwarding process. Here are some forwarding steps that are specific to winch-assist logging:

- Regardless of the type of anchor being used, forwarding is done in the same manner.
- The forwarder drives down the hill to the end of the trail and picks up wood as it comes back up the hill toward the road.
- The loader should always be placed in the transport position when travelling down the hill to the back of the trail.
- The operator has several choices for how the load is structured as far as product size and length dictates and where and when to load it. We will expand on some specific techniques further in this manual.
- **The forwarder should always be able to sit stable on a hill without the support of a winch.**
- A longer trail requires a dedicated anchor, especially if an anchored winch is used, such as the T-winch shown in Figure 35.
- When forwarding on steeper parts of a slope, the operator must be careful not to move products or disturb piles that are not currently being loaded; the wood must remain at or near 90° to the trail so that logs do not slide or move. It is important that the boom is used at no more than 90° to the machine to avoid disturbing piles (Figure 35).
- Wood is usually placed in piles on both sides of a machine, so the operator must make sure that the machine is travelling at a sufficient distance between the piles to avoid running over them.
- Erosion can be an issue anywhere the machine comes in contact with the soil, so it is extremely important to manage the brush so that it is located under the machine, with the smaller woody debris under the track area. Any large woody debris should be removed from the trail area to reduce the chance of sliding or creating an unbalanced trail. This process comes with experience. Newer operators should not start on a challenging trail until they have mastered this procedure.

## TRAIL ORIENTATION IS CRUCIAL WHEN STEEP-GROUND/WINCH-ASSIST LOGGING

There are some rules of thumb that you can follow that will help you make the best decisions:

- The anchor stump/tree/deadman anchor should be located in a centred position if using the anchor for multiple trails.
- Trails must follow the terrain to reduce the amount of side slope for the machine. The forwarder is much more sensitive to this since the centre of gravity is higher on a loaded forwarder than on a harvester.
- In the past, many cutblocks were planned on longer, more continuous slopes. Many of these shorter slope cutblocks can either be broken or changed in direction for short distances. When the side angle of the slope changes, catch stumps should be left just before the side angle changes. Catch stumps, as they have become known, are stumps that are left about 1 m high where the cable can be placed with the machine to redirect it on a different angle from the anchor, as shown in Figure 36. These stumps must be large enough to support the machine while it is working on the changed angle.
- Remember that the higher the cable lies on the stump and the greater the angle of redirection, the larger the stump must be to support the machine. The location of the catch stump is critical to getting the cable as low as possible on the stump.
- Care must be taken to orient the trails from a common anchor so the distance between the trails does not become wider than the machine has the ability to cut.

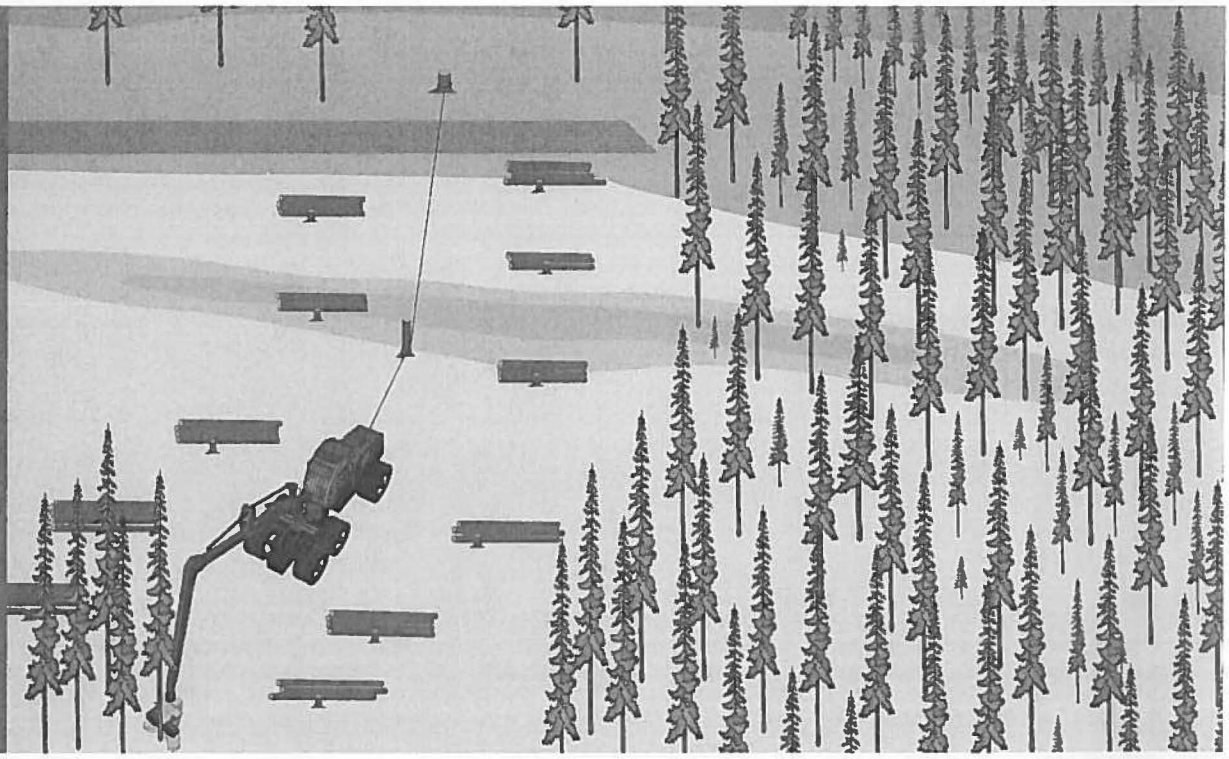


FIGURE 36. *Machine using catch stumps to work a secondary slope.*

# 06.
# PLANNING

FIGURE 37.
*Machine that failed to regard the side slope safety recommendation of 5%.*

## PLANNING THE FORWARDING OF A TRAIL

- Never operate a forwarder on side slopes greater than 5% (see Figure 37). It is unsafe and can be costly, as major structural problems can result from turning while loaded within a cut strip.
- Avoid tight-radius turns while driving with a full load, as this can overstress frame components, mid-joints, bogies, and tires.
- Arrive at the road with a full load and travel the shortest distance possible. Pick up wood from the back of the trail first, working toward the road, and clean each trail completely.
- When backing or driving into the trail for the next load, ensure that no wood was dropped during the previous load and that no scattered pieces were missed.
- When working on steep ground, other factors come into play that add another dimension to forwarding. When backing into a cut strip that is uphill from the road, newer machines with balanced bogies can climb fairly steep slopes without losing traction. However, if you apply the forwarder's on-board winch tension just enough to get the traction required for the machine to navigate up the slope, you can reduce the amount of fuel required and the wear to the driveline that might occur in a non-tethered machine.
- Because a forwarder is designed so that the ground pressure at the wheels is optimal for achieving maximum traction when the forwarder is about one-half to two-thirds loaded, the machine will not produce the traction required if too little wood is loaded. Use good judgment in determining how much wood to load.
- With about a third of a load in the bottom of the bunk, however, a forwarder will normally have the traction it needs. If the hill or a portion of the hill appears difficult, ensure that the machine is straight and engage the locking differential (diff-locks) to prevent the wheels from spinning.
- When ascending or descending a hill driving backward, pay strict attention to the rear mounted camera.

**Never turn a machine on a side slope that exceeds 3%.**

## PLANNING AS YOU NAVIGATE THE TRAIL

- Travelling empty before starting the next load is a good time to plan a loading sequence.
  1. Load the sort with the largest piece size first (Figure 38).This will enable you to better estimate the remaining volume and help with optimizing the load sequence for subsequent loads.
  2. Consider loading logs on the uphill side of a pile first to prevent them from rolling when logs are loaded below them.
  3. Consider placing small volumes of scattered products (shown in green rectangles in Figure 38) that amount to less than half a bunk in the centre of the bottom area of the bunk, between the wheels, and loading another product in the reminder of the bunk.
  4. Alternatively, load half a bunk of a smaller product (green rectangles), top-loaded with sawlogs (blue rectangles) that would be easy to remove without spending unnecessary time at the roadside pile.
- With experience, and based on what products are on the trail, it is possible to develop many combinations of loads if there is an opportunity to plan them.
- Continually plan to optimize forwarder productivity by ensuring large-volume loads and fast cycle times.
- Pick up any logs that protrude onto the trail first. Do not run over them with the forwarder as the bogie tracks will damage them.
- In summary, take a full load of logs of larger size and volume (blue rectangles in Figure 38) first. This will expose piles of random pulp products (red rectangles). Next, load more large pieces (blue), or load the scattered products (red or green) on the bottom, and top off with the products from the back of the strip (red). As you can see, there are numerous possibilities; choose the order that is the most practical and efficient.

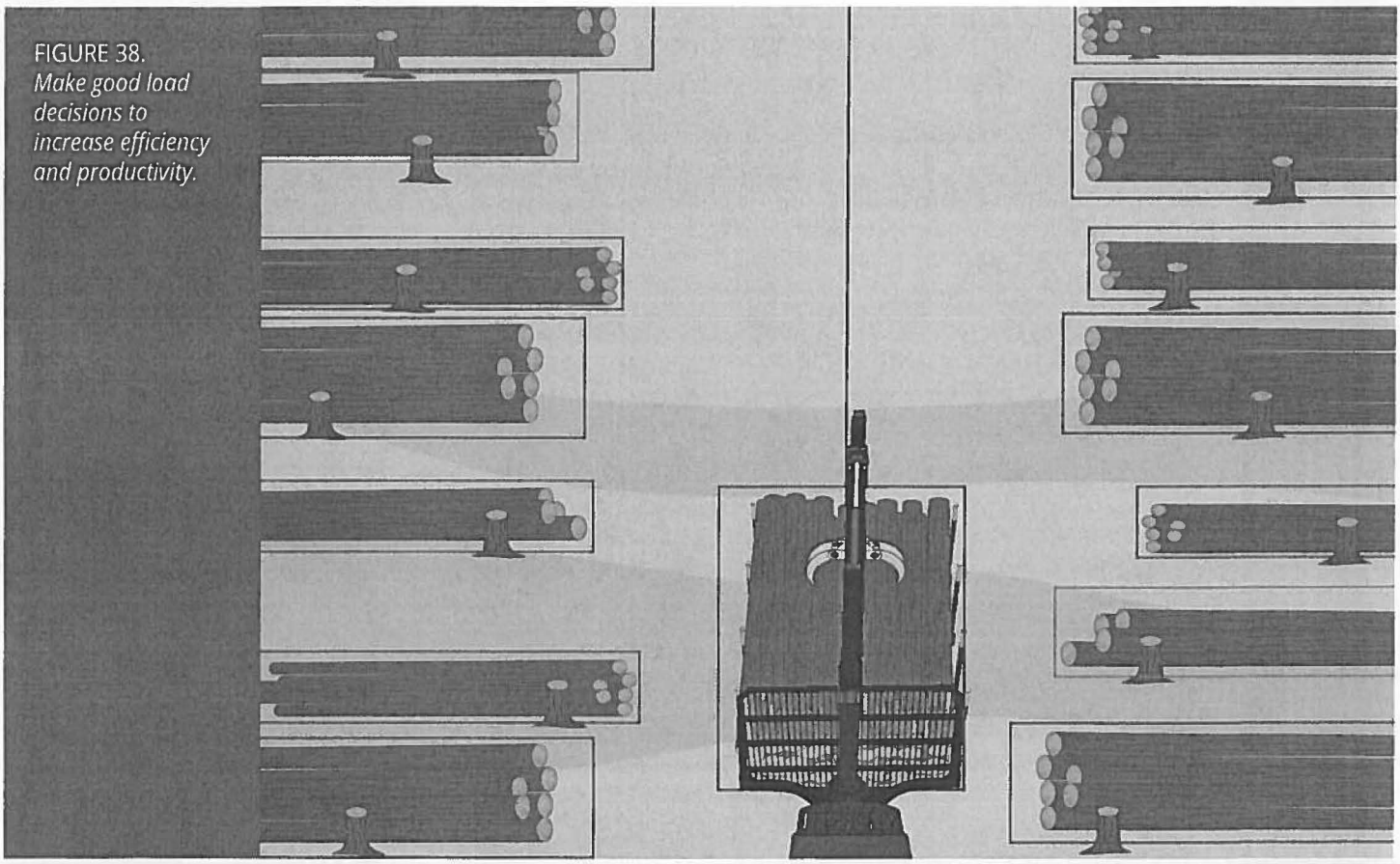
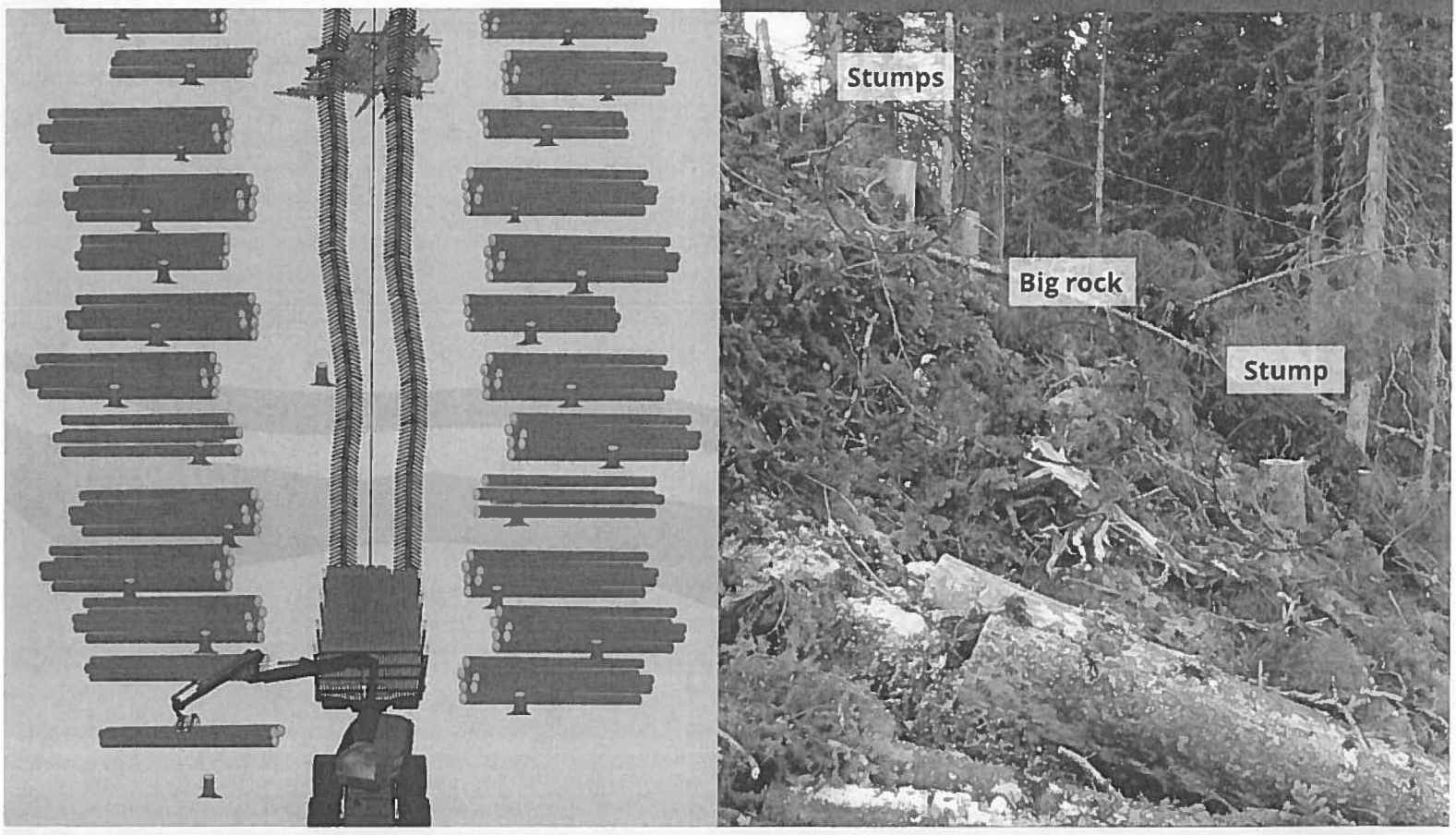


FIGURE 38.
*Make good load decisions to increase efficiency and productivity.*

## AVOIDING OBSTACLES AND TRAVELLING AT AN APPROPRIATE SPEED

- If you are working in an area with difficult terrain, walk the area first or have a supervisor do it. Difficult terrain should be identified on the map before forwarding begins.
- Ensure that the harvester has cut stumps low and that all windfall and other woody debris larger than 15 cm (6 in.) in diameter is removed from the trail. If any of these are found during the trail survey, they should be reported to the contractor/ foreman and corrected.
- Place a brush mat around obstacles, such as large rocks or stumps, to aid in maintaining stability when travelling over them (Figure 39).
- Be aware that obstacles such as large stumps or boulders may require planning to avoid them.
- Keep the forwarder travelling at a maximum constant speed to maintain traction and stability. Avoid excessive stopping and starting. By making slow and steady movement on the first trip to the back of the trail, you will know where and when to adjust your speed while continuously moving to maintain traction.

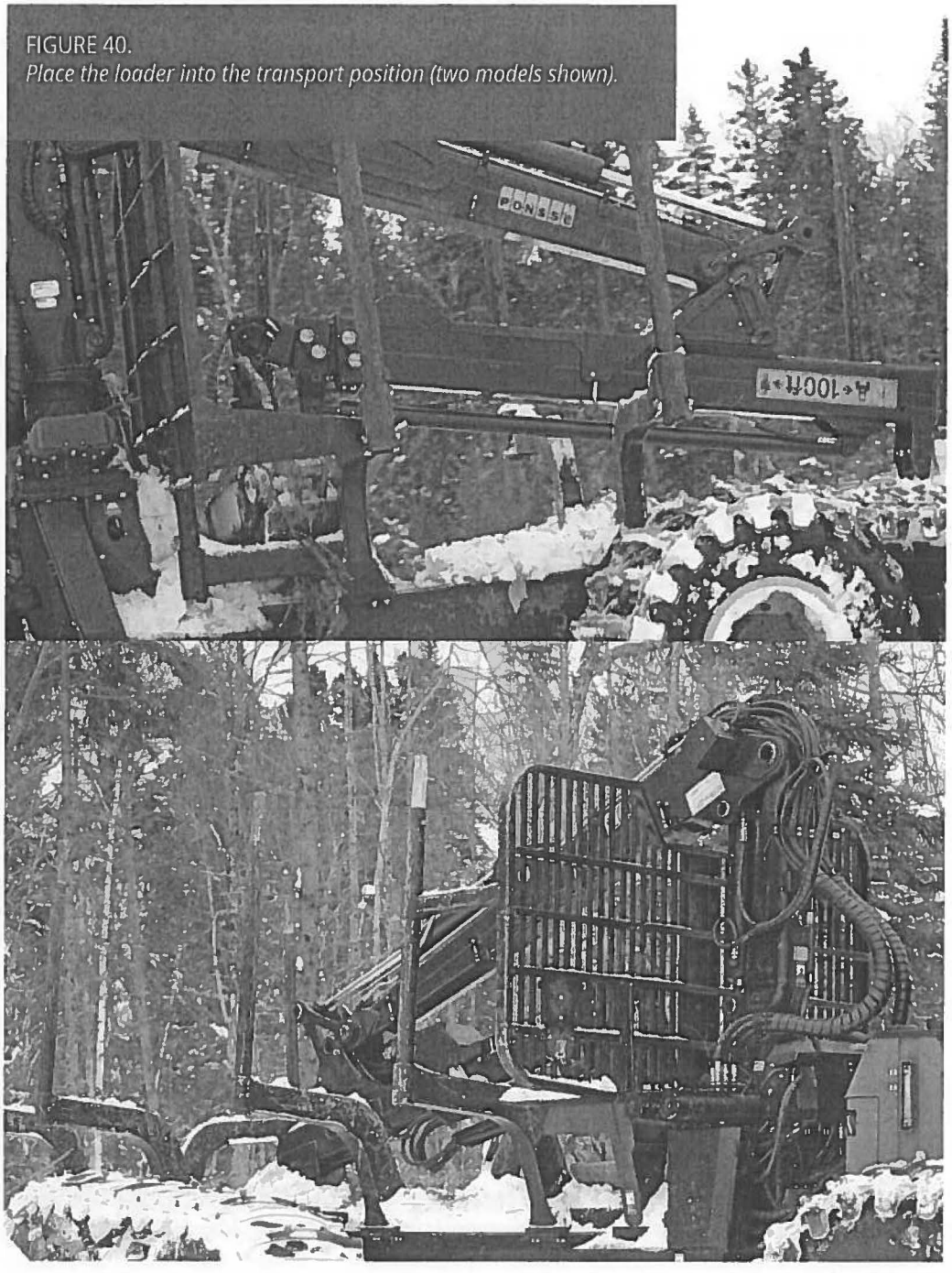
FIGURE 39.
*Place a brush mat around obstacles on the trail.*



**POSITIONING THE LOADER WHEN TRAVELLING EMPTY**

- Most forwarders are designed to allow the loader to be easily placed into the transport position on the loader rest (Figure 40).
- Loaders should be positioned when the bunk is empty as this allows better visibility when driving in reverse, reduces wear on boom components (including boom pins, bushings, and rotator links), and eliminates boom movement during travel.
- If you have difficulty positioning the loader, ask a co-worker or the machine dealer how to do it properly.

FIGURE 40.
*Place the loader into the transport position (two models shown).*



# 07.
# LOADING

FIGURE 41.
*Keep the forwarder close to the pile and the stick boom 90° to the logs that will be loaded.*

### MACHINE LOADING ZONE

- On steep ground, the loading zone extends from the rear of the front bogie tire to the rear of the back bogie tire (Figure 41).
- Keep the forwarder close to the pile and the stick boom perpendicular (90°) to the logs that will be loaded. This promotes efficient loading as only the main boom and swing functions are needed.
- When picking up logs that are beyond the load gate, use an extension boom to prevent hitting the gate and stakes beneath the main boom.

### POSITIONING THE MACHINE

- It is important not only to be at the right distance from the wood, but also to load only in the area where the wood can be seen from the operator's seat. This will serve as a guide to avoid over-reaching and loading outside the loading zone. With hydrostatic transmissions, it is no longer necessary to reach ahead of or behind the machine's visible loading area.
- Such positioning not only allows the operator the best view, it also lowers operator fatigue, especially during night-time operating, as it is easier to see sorts and to drive the machine while loading wood.
- Maintaining a stick boom as close as possible to 90° to the ground is the most efficient method of loading. This is possible only if the operator is working within the loading zone.
- If the loader is being used outside the loading zone, the stick boom must move farther to reach the pile, and it takes longer to bring wood to the bunk. Because of the longer reach of the boom, it takes more effort to lift the wood, which also increases fuel consumption and wear on the components.
- When working behind the back bogie, it is important to use the extension boom, depending on whether the machine has one, as the main boom can hit the load gate or stakes. This can damage the bottom of the boom and the bunk components.

## BUILDING THE LOAD

- When building a load, it is important that the operator can see as much of the surface of the load as possible.
- To make sure that the top of the load is level, place logs so that the butt ends alternate between facing forward and backward. When the forwarder is three-quarters full, place the logs so that the butt ends face the rear of the machine. Loading this way helps keep the front of the load below the top of the load gate.
- To maximize the payload, place logs in the forwarder bunk so that they are parallel with one another.
- Building the load on the bunk is similar to building a pile at the roadside, except it is in a much more confined area.
- As at the roadside, the valleys formed during loading are important for managing wood as it is placed in the bunk.
- Start loading the forwarder by placing logs in the centre of the bunk. Figure 42 shows the steps in building a good load of wood.
- Once the first few grapples of wood are placed in the lowest area of the bottom of the bunk, a hump will start to form near the centre of the bunk (indicated by circle #1 on the bottom layer of wood in Figure 42). At this point, the operator starts to build in the valleys by placing a grapple of wood on each side of circle #1 (indicated by circle #2 on either side of circle #1), and then against the stakes on each side (indicated by circle #3).
- The load can be built using this pattern all the way to the top.
- Whenever possible, place the better formed grapples of wood next to the stakes to help align the wood on the outer side of the load. The grapples of wood that are not as well formed can go into the valley for adjusting the rest of the load.
- When loading longer logs, pick up the logs at 2–3 ft. off the centre so that they dangle, but not more than 2 ft. below the bottom of the grapple. This enables you to use the dangle to assist with steering while being able to get the grapple over the stakes.
- Typically, it is best that the grapple dangles forward toward the load gate when loading and outward, or away, when unloading.

FIGURE 42.
*Place wood in the correct order to build a good load of wood.*

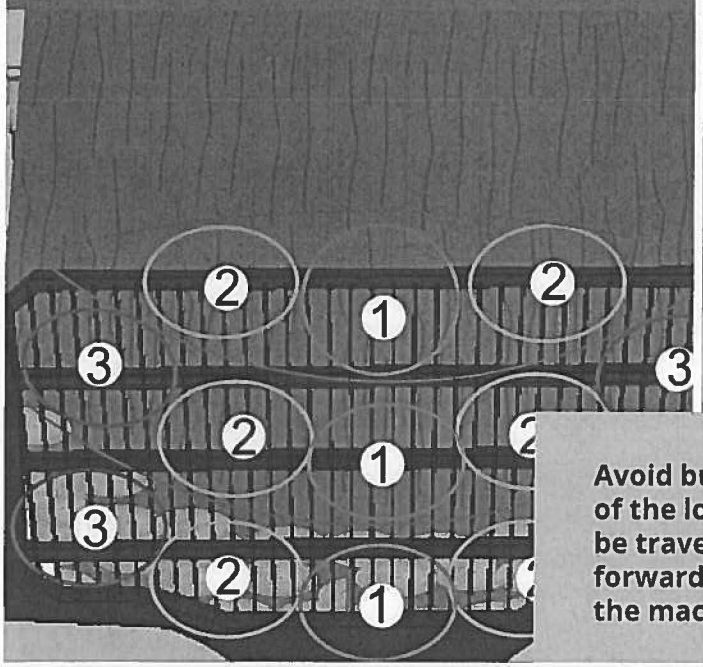
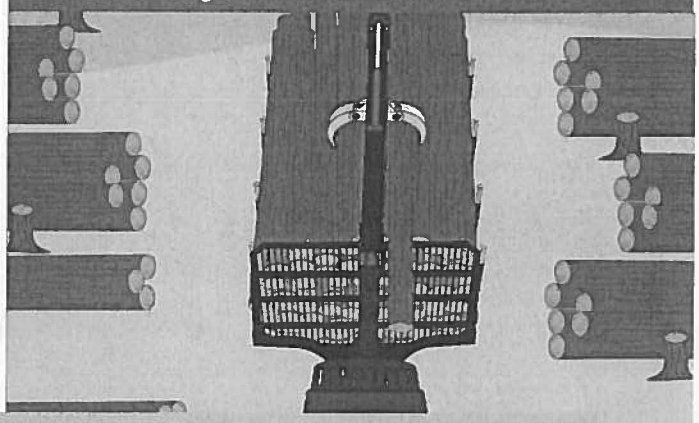



FIGURE 43.
*Avoid building the load above the load gate so that logs do not slide over the gate and toward machine.*



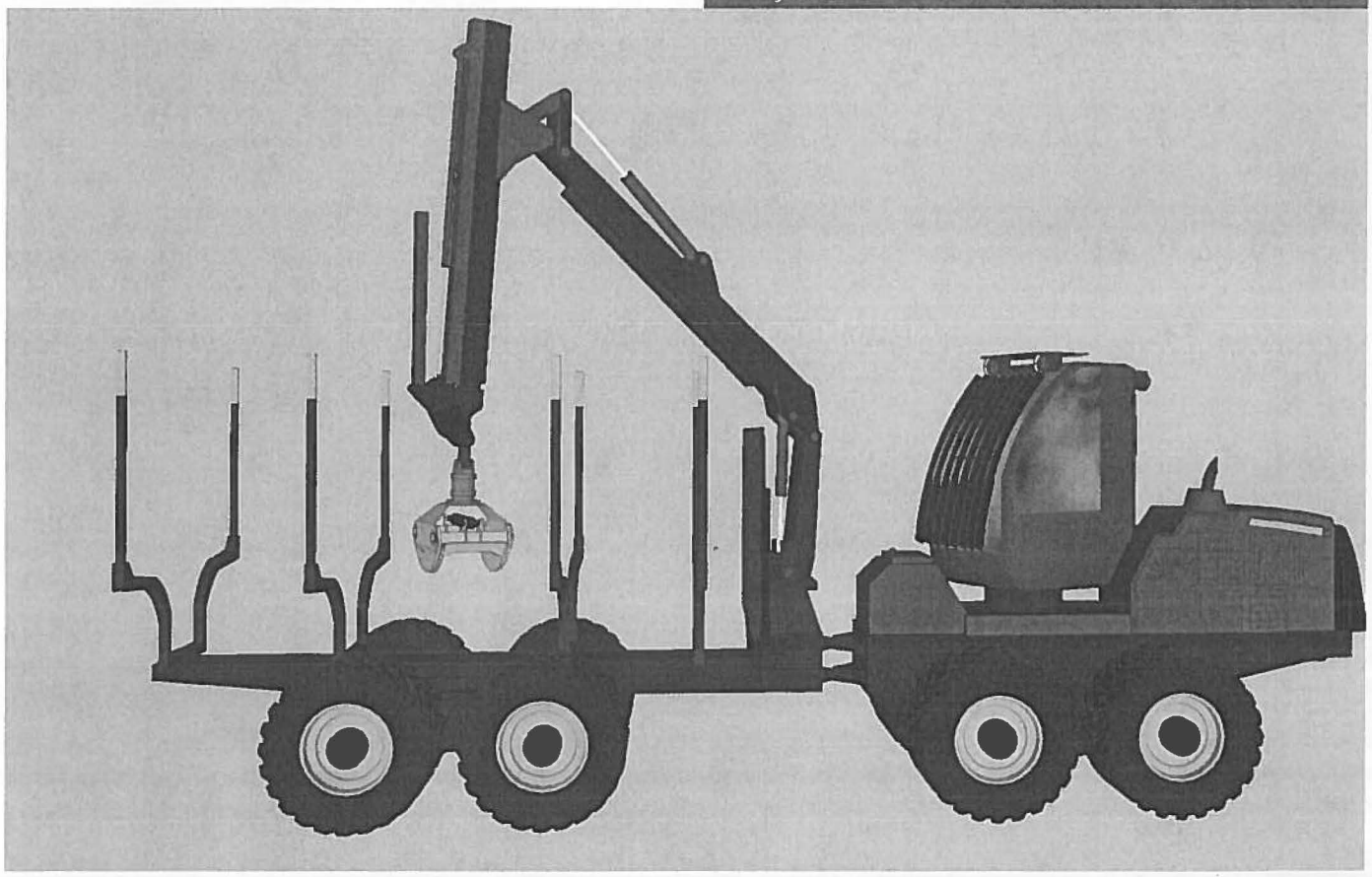
**Avoid building a load above the height of the load gate if the forwarder will be travelling downhill, as logs can slide forward and injure you and or damage the machine (Figure 43).**

### WORKING THROUGH THE STAKES

When loading or unloading wood, productivity depends on the cycle time of the grapples placing wood on the machine.

- A good operator can complete a cycle every 30 seconds or less while being smooth and in full control of the loader.
- Many operators think this cycle time fully depends on how fast the loader is moving. We will discuss loader movement in the Chapter 8, "Controlling the boom."
- Other techniques can help speed up the cycle, and going through the stakes with an empty grapple has to be one of the best (Figure 44).
- When loading, keep the grapple as low as possible while passing wood over the stakes. After placing the wood on the load, simply move the grapple out between the stakes to the pile to pick up more wood instead of lifting the grapple up and over the stakes.
- This technique may seem tricky at the beginning, but it only takes a few days to get comfortable with it. Remember that this is all about having smooth control.

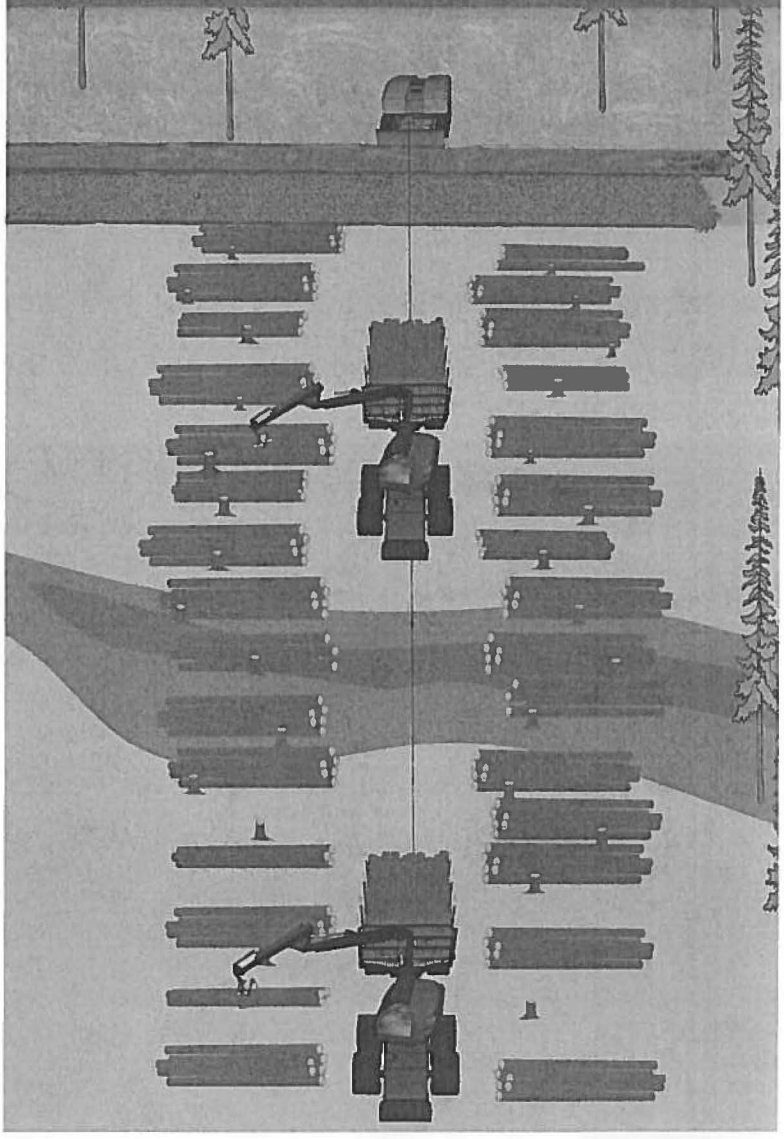
FIGURE 44.
*Swing the grapple through the stakes to speed up the cycle.*



## MULTI-STAGE LOADING

- Multi-stage loading is a technique used while working on challenging or environmentally sensitive terrain (i.e., soft ground). The forwarder is loaded only partially on this terrain, and the load is finished in a location where conditions are favourable. Figure 45 shows a forwarder using multi-staging to avoid travelling fully loaded over a steep section of trail.
- Multi-staging helps reduce the risk of the machine losing traction or stability, or becoming stuck. A reduced load results in lower ground pressure, which helps prevent damage to sensitive soil and reduces wear and tear on the machine's power train, final drives, tires, winch cable, and cable attachments.
- Multi-stage loading involves using two or more loading areas where an operator can decrease cycle time, and reduce the risk of getting stuck or rolling over, or anything else that may reduce or halt production.

FIGURE 45.
*Use multi-stage loading when working on challenging or environmentally sensitive terrain.*



# 08.
# CONTROLLING THE BOOM

**RUNNING THE LOADER AT AN APPROPRIATE SPEED**

- What constitutes an appropriate speed depends on the operator's skill level. The goal should be to operate the machine as quickly as possible while maintaining control at all times.
- If you are making mistakes, chances are good that you are working too fast for your ability. Indicators that an operator is working too quickly usually show on the machine as bent stakes, a bent load gate, scarring on the grapple, etc.
- Keep in mind that the setup of the controls can also partly determine the speed that is appropriate.
- There is a fine line between working the machine too fast and too slow. Working it too slow can result in low productivity, with potentially higher quality. Too fast can result in lower quality, damage to the machine, and often the development of bad habits – but potentially higher productivity.
- The key is to find a good balance that results in a high level of accuracy and control with good boom efficiency. A good balance will always produce more volume with less wear and tear to the machine than high speed alone. With time, practice, and coaching, your speed and control of the machine will continue to increase.
- Sometimes, newer operators or operators using machines with loader controls set up improperly for their level of skill tend to develop bad habits and unintentionally bottom out cylinders. (Bottoming out a cylinder refers to pushing a boom function to the end of the cylinder, where it mechanically stops).
- Many newer machines have built-in sensors or a hydraulic means of cushioning as the rod comes close to the end of the cylinder, but not all do.
- Extending the boom functions to their maximum on a machine that does not have cylinder dampening can be very damaging to boom cylinders, pins, and bushings.
- If the cylinders have sensor or hydraulic dampening, the loader can become very slow when in this area of the cylinder. A choppy effect can result from going in and out of this zone.
- Getting into the habit of working in the mid-range of the boom reach will help reduce the risk of the boom working at its maximum reach on any one function, which can bottom out the lift, stick, and extension boom cylinders.
- The main goal is to complete the required task without ever bottoming out cylinders. Understanding the reach capabilities will help you attain smooth loader function and extend the life of the boom components.

## MAINTAINING CONTROL OF THE BOOM

- As we mentioned, running the loader at an appropriate speed is the most effective way of avoiding contact with the forwarder, trees, rocks, ground, wood, etc.
- Here are a few tips to help avoid clashes:
  1. Always position the machine as straight as possible.
  2. Work only within the loading zone.
  3. Avoid placing the grapple where you cannot see it.
  4. Avoid working within 0.9 m (3 ft.) of the load gate.
  5. Allow a full open grapple span between the pile and the machine when using the grapple to align wood.

## MULTI-FUNCTIONING OF THE BOOM

- Modern forwarders are designed to work well when using multiple functions at the same time.
- Adjusting the loader functions so that movements are smooth is the first step to learning to use multiple functions of the boom simultaneously.
- By having good control, you can use the main, stick, and extension boom functions at the same time to go smoothly to the pile and back to the load.
- Good multi-functioning of the boom will allow you to gain control and speed to load a greater amount of wood more easily and efficiently, and at a lower cost, than having a fast, jerky boom.

## MOVING THE LOADER WHILE DRIVING

- When operating on steep ground, never move the loader at the same time as when the forwarder is moving.
- Positioning the loader while moving the forwarder can be done on flat ground under favourable conditions. However, never pick up logs until the machine comes to a complete stop and the centre joint and work brakes engage.
- Moving the loader and forwarder simultaneously can help improve productivity, but it should only be performed by an experienced operator. For example, after loading from one pile and while driving to the next, the operator can position the loader for picking up logs from the next pile.

## USING THE EXTENSION BOOM

- Use the extension boom to increase efficiency of loading and unloading:
  1. When loading or unloading logs positioned low in the front bunk, use the extension to quickly move the grapple down to the logs. This avoids having to tightly "knuckle" the main boom, which is difficult as it requires precise control of both booms.
  2. You can also use the extension as a simple and fast function when grappling wood outside the bunk. Again, to use the extension to place the grapple over the wood, while moving the extension boom, reach outward toward the wood. This helps to speed up the loading process and minimizes other boom movements.
  3. Maintain the boom in an A shape as it helps you maintain efficiency (Figure 46).
  4. When using the boom extension to reach for logs, retract the extension before lifting the loaded grapple. This practice reduces wear and tear on the extension boom, cylinder, and slides.
  5. Remember that the extension boom is designed for use in a vertical position to control the boom and increase efficiency.

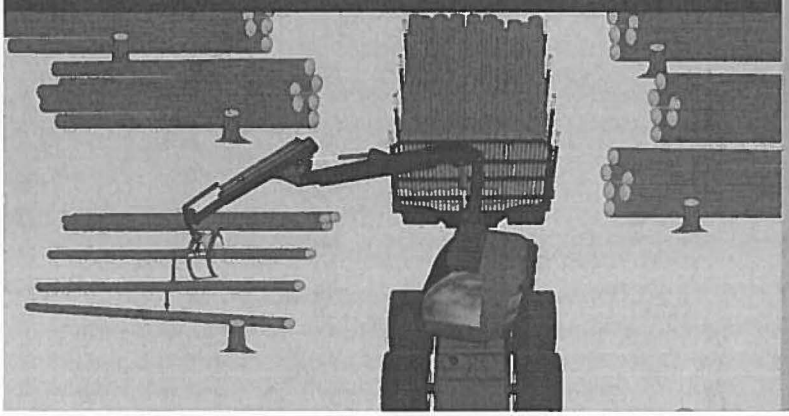
FIGURE 46.
*Use the extension boom to move the boom quickly, and maintain the boom in an A shape for efficiency.*

# 09.
# CONTROLLING THE GRAPPLE

### LOADING THE GRAPPLE

- Follow the manufacturer's recommendations for maximum grapple load whenever possible.
- Always try to fill the grapple to its maximum capacity.
- Move any single logs to build a pile first. Bunch up any smaller piles of the same product to get a reasonably sized grapple load, as shown in Figure 47.
- An experienced operator can complete a grapple cycle (to the machine loaded and back to the pile) in 30 seconds or less. If it takes 3–5 seconds to accumulate small grapples, bunching up smaller piles of wood first would result in a huge cost savings.
- Fewer grapple cycles, coupled with full grapples, is the most efficient in terms of time, fuel, and production.
- If there are two small pieces of product on one side of the machine and a pile of same product on the other side, it is more productive to grab the two sticks and go across the trail to the other pile than taking the two sticks to the load.

FIGURE 47.
*Bunch wood first before filling the grapple.*



### PLANNING THE GRAPPLING OF WOOD

- The most productive operators are those who try to have a full grapple of wood each time the loader goes from the pile to the machine.
- Plan before removing wood from the pile to get the most efficient and productive cycles.

- In Figure 48, the operator is planning to take five logs in the first grapple (red circle), four logs in the second (cyan circle), and five in the last (blue circle). This will ensure that the grapple is full, but not overfilled, in each cycle, and that the process does not result in two overfilled grapples and one log left on the ground.
- Forwarder grapples have rounded jaws designed to facilitate rolling wood inward, forming a well-aligned, full grapple load; however, wood may not be well aligned either in the pile or on the load, so operators must use certain techniques to aid in forming a secure, well-aligned load.
- Often, if the grapple is simply dropped over the top of the wood and closed, it will result in an unstable grapple of wood. Sometimes if the amount of wood is too small, too large, or if the load has an open bottom and crossed sticks, wood may drop out.
- When closing the grapple, it is best to roll the grapple slightly so that the wood has a chance to move around and become aligned.
- This technique is done by swinging the boom slowly over a short distance when closing the grapple or by lowering one jaw of the grapple to one side of the pile before closing it.
- One of the most costly actions while operating a forwarder is losing wood while loading or unloading. Cleaning up this wood usually involves picking up one stick at a time and requires moving the machine or risking damage to it.

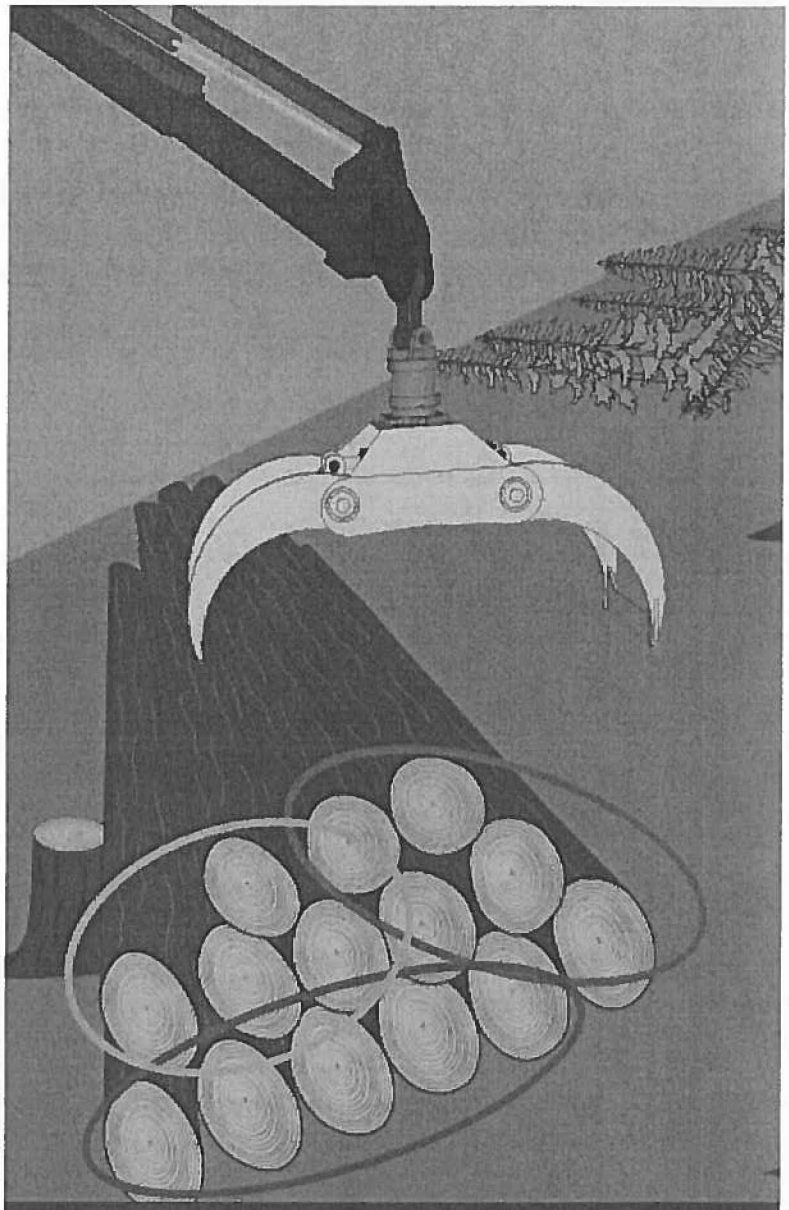


FIGURE 48.
*Plan grapples of wood before picking them up.*

- On steep ground, it is even more important to have secure grapples of wood. If wood drops out of the grapple, it may create a situation where the machine becomes unstable, which can put both the machine and the operator in jeopardy.

## LOADING AND UNLOADING THE GRAPPLE

- There is certainly some technique involved when loading and unloading the grapple that is acquired through experience.
- When loading a grapple from a trail-side pile, if the pile contains less than a full grapple of wood, maintain a grapple width that is slightly larger than the width of the targeted pile. This will help save time and reduce the amount of brush and debris that is grabbed as the grapple is closed.
- As the grapple is approximately half-closed, begin to lift the boom slightly while continuing to close the grapple. Doing this will help the wood roll into the grapple and further reduce the amount of debris that is grabbed.
- When loading piles that have more wood than a grapple can hold, it is important to take the wood from one side of the pile. This allows you to stabilize one jaw of the grapple on the ground beside the pile and then adjust the other jaw to take an appropriate amount of wood to form a secure but full grapple (Figure 49). Using this method, the single-jaw action tends to roll the wood, assisting with alignment of the wood within the grapple.
- This technique can also be used to pick up a single stick from a pile or to avoid picking up brush.
- When unloading the forwarder, lower one jaw of the grapple over the outside of the bunk, close the grapple slowly, swing it slightly toward the centre of the load, and lift the boom at the same time. This, again, aids in rolling the wood tightly to form a secure and full grapple of wood.

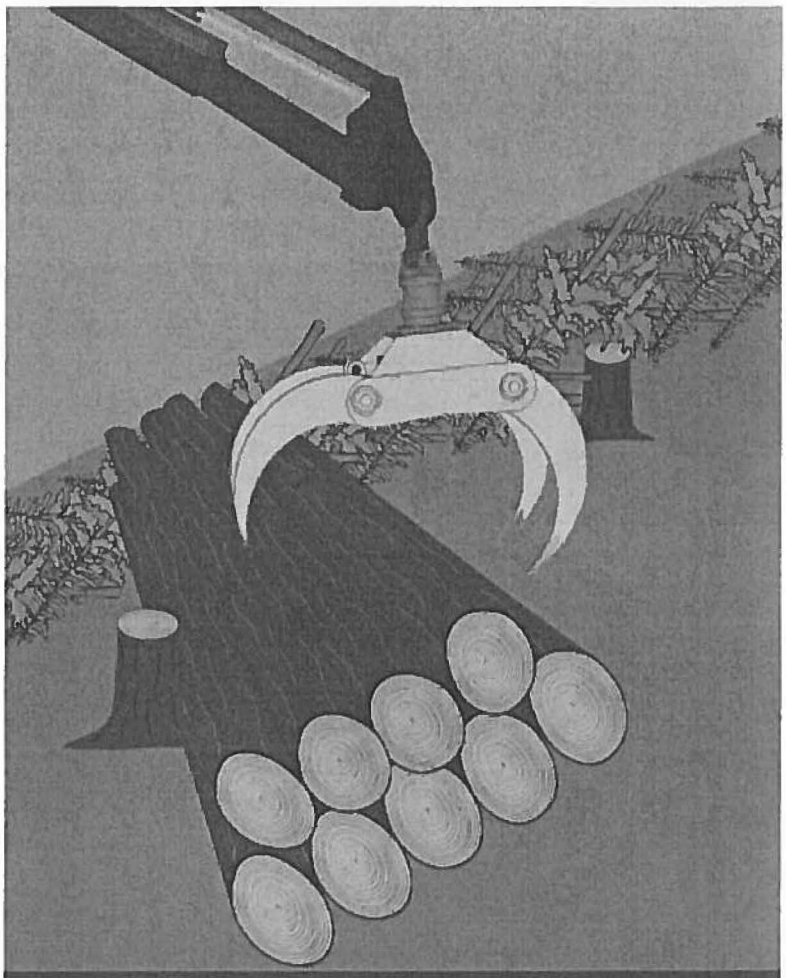


FIGURE 49.
*Lightly stabilize one jaw while maneuvering the other jaw to pick up wood.*

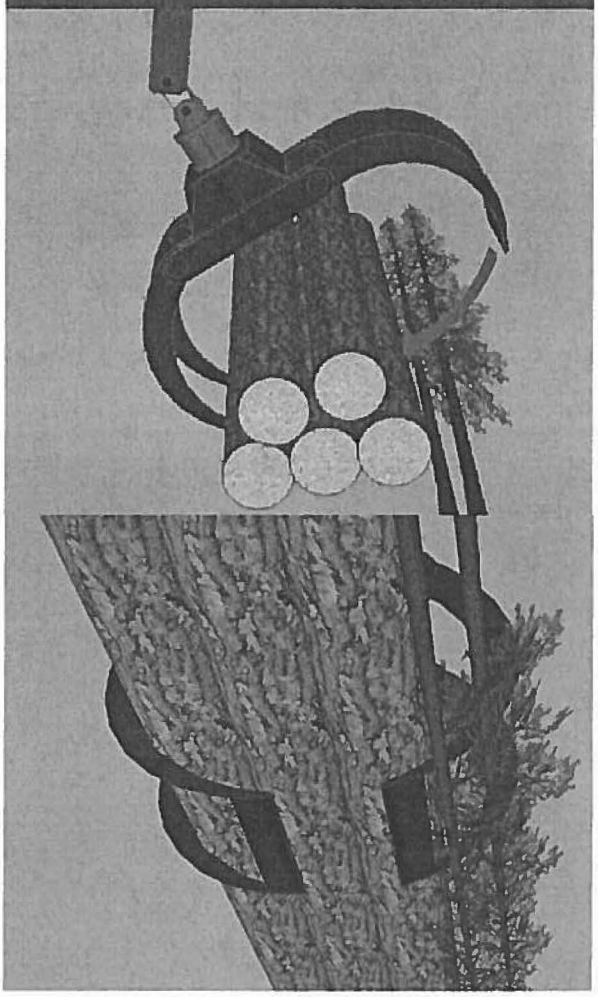
- When unloading the grapple on a load or pile, lift the boom slightly while opening the grapple. This helps to prevent the grapple from coming into contact with the wood on the load, in turn making the unloading of the grapple much smoother and improving the pile quality. With some practice of lifting and opening at the right pace, you will place the wood perfectly without disturbing any of the wood on the load.

## USING THE GRAPPLE TO MINIMIZE BRUSH IN THE WOOD

- It is better to prevent brush from getting in the load during loading instead of removing it during unloading or when loading a truck.
- Try this technique to prevent brush from being loaded with logs:

1. Lift the boom while closing the grapple to maneuver the jaw edges just above the brush while grappling the wood (this is called the sweeping method). It takes a bit of practice, but it is one of the most effective techniques.
2. Stabilize one grapple jaw on the ground or on a log, then swing the boom slightly while closing the grapple to maneuver the other jaw into position to grapple the wood (Figure 50).
3. If the wood is piled over lumps of brush and it looks very irregular under the pile, stabilize one grapple jaw on the cleaner side and use the technique of swinging and closing the grapple to split the pile or grab the wood that is most isolated from the brush.

FIGURE 50.
*Stabilize one jaw of the grapple to avoid brush.*

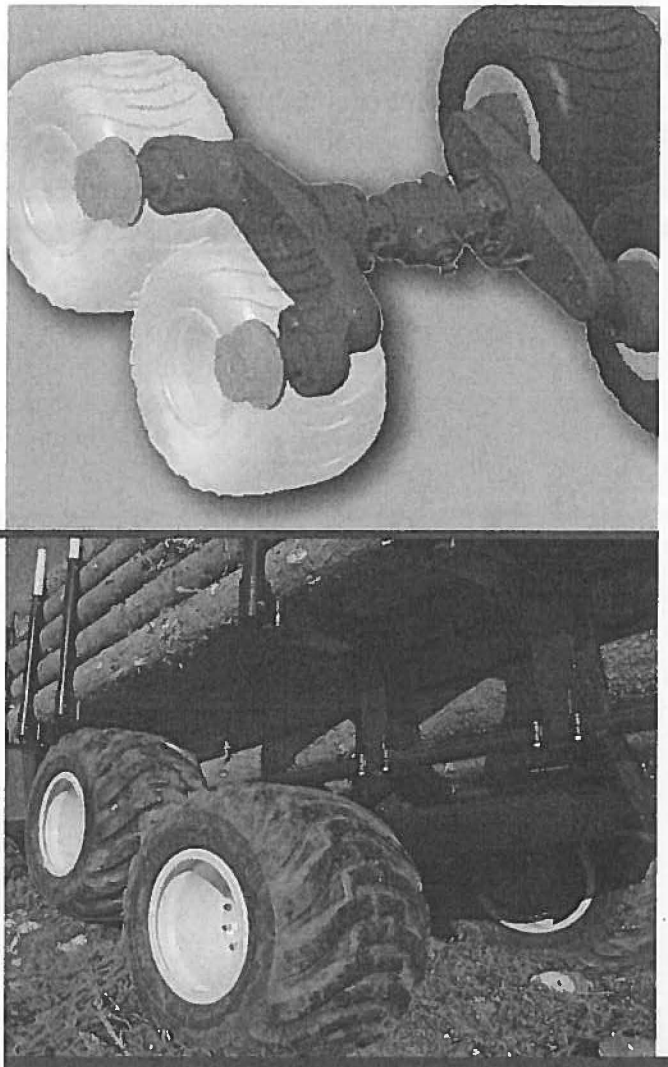


**TRANSITIONING FROM PILE TO PILE**

- A great way to save cycle time when loading the last grapple of wood before moving to the next pile is to hold the last grapple of wood in the grapple and rest it on the load while moving (Figure 51, left).
- Many operators place wood in the bunk and then reach elsewhere on the load to stabilize the grapple, all while the machine is sitting in one place (Figure 51, right). Doing this may only take a few extra seconds, but remember that a full cycle should take 30 seconds or less. If you lose 3–5 seconds emptying and then stabilizing the grapple and another few seconds to swing it over the stakes instead of through them, this lost time can add up fast.
- Letting the grapple of wood come to a rest in the general area where it will be emptied allows you to move the machine to the next pile right away.
- When the machine arrives at the next pile, place the wood just before swinging the grapple through the stakes to reach for the next amount of wood.

FIGURE 51.
*When loading the last grapple of wood, let the full grapple rest on the load* (left) *while moving to the next pile, instead of spending time emptying the grapple and then stabilizing it before moving* (right).

# 10.
# DRIVING A LOADED MACHINE



### KEEPING THE MACHINE STRAIGHT

- When working on steep ground, it is important to keep the machine wheels as straight as possible while driving up and down the hill.
- Over-steering or maneuvering can place the machine in an unbalanced state, which could decrease stability and would most certainly burn more fuel and cause more wear and tear on the machine.
- Keeping the machine as straight as possible also reduces ground disturbance and therefore minimizes erosion.
- Using balanced bogies on a forest machine improves operational efficiency and comfort on demanding terrain (Figure 52).
- Balanced bogies are a standard feature on many forwarders and are optional on most. By optimizing the weight distribution on all the bogie wheels, the balancing unit ensures the best stability, grip, and traction. This allows you to maneuver the machine more easily and safely on rough or steep terrain while minimizing ground disturbance.

FIGURE 52.
*Use balanced bogies to hold all the wheels on the ground on steep terrain.*

- A balanced bogie also minimizes the swaying of a loaded machine by maintaining support and contact with the ground under most conditions. This enables a higher driving speed on level ground when the machine is loaded and results in higher productivity.

### MINIMIZING IMPACT ON THE TERRAIN

- Because the balancing units in the bogie axle distribute the total weight optimally to all bogie wheels, they also allow all the wheels to transfer their fair share of the traction force to the ground (Figure 52).

With an unbalanced bogie, it is possible that only one bogie wheel has contact with the ground and does all the work on its own. Distributing the weight and traction force evenly over a larger area minimizes ground disturbance by decreasing ground pressure and tearing force from each wheel.

- Some balanced bogies are streamlined by placing portals inside the wheel rims. This makes the bogie ends smaller and widens the ground clearance between the bogie beams. Wider ground clearance reduces the need to steer the machine to avoid contact with rocks and stumps. The main benefits of this feature are lower fuel consumption, higher driving speed, and less risk of getting stuck on obstacles.

**LOADING THE RIGHT AMOUNT OF WOOD**

- Overloading the forwarder can cause instability and excessive wear and tear on the machine.
- Know the load capacity (in tonnes) of your machine. Obtain an estimate of the weight of a full load by:
  1. Unloading it on a truck and weighing it on the on-board truck scale.
  2. Obtaining an estimate of the load volume and converting it to tonnes.
- Remember that different tree species have different densities, which will affect load weight. Also, longer logs will produce a larger load and a heavier weight.

FIGURE 53.
*Always keep the load lower than the load gate.*

- Figure 53 shows a load that does not go over the load gate. Note that the operator is using an extra-wide bunk to keep a low centre of gravity, which is the best bunk configuration for steep-ground forwarding.
- The operator in this photo also has the loader in a very flat position, with the grapple over the back of the load. This further keeps the centre of gravity low for working on steep ground.

## GROUND DISTURBANCE AND BRUSHING

- Excessive ground disturbance is unacceptable, especially on steep ground.
- Minimize ground disturbance by:
  1. Ensuring that an ample amount of brush is placed in potential problem areas.
  2. Minimizing load size when crossing wet/soft and exposed areas in the block.
  3. Straddling the tracks or using a different trail if evidence of ground disturbance develops.
- This normally is not an issue on steep ground, but often wet/soft areas can be found at the base of a hill, where topsoil collects over time. Sometimes dips or plateaus in a steep-ground setting can also have wet/soft areas.
- Obstacles such as rocks, stumps, or fallen trees will always be evident throughout a cutblock (Figure 54, left).
- On steep ground, obstacles can present a potential safety hazard and can increase wear on the driving components, such as tracks, tires, and bogies.
- Avoid obstacles, if possible, or move them if they are unavoidable but movable.
- Avoid driving the machine over or into obstacles, as this can lower productivity (due to decreased speed), and on steep ground it can create an unstable situation for the machine.
- Brush and smaller woody debris can be spread over some obstacles to effectively lower stumps and rocks to make the trail passable (Figure 54, right).
- If the machine starts to lean to a point where you feel uneasy, reach with a grapple full of wood to the opposite side and keep it low to the ground to balance the machine as you proceed carefully.
- Avoid issues by moving very slowly over such areas of the trail. After you pass the potentially unsafe area, mark the location with GPS, or use a landmark to make a mental note if GPS is not available on the machine. When you enter the trail for the next load, fix the area with brush and small debris so that it will not be a problem in the future.

FIGURE 54.
*High stumps and rocks in the trail can be dangerous* (left). *Fill in the areas around obstacles with brush and small woody debris to make the trail passable* (right).

### LOCKING THE DIFFERENTIAL

- It is important to lock the differential before driving into an obvious problem area, especially when ascending steep ground (empty or loaded).
- An operator will often continue to travel uphill until the machine spins and then will need to back down partially to engage the diff-locks.
- It is best to get the machine as straight as possible, engage the diff-locks before reaching the potentially difficult area, and then continue on up the hill. When you pass the area, release the diff-locks.
- Never operate the machine with diff-locks engaged all the time, and avoid steering as much as possible when they are engaged.
- Reducing the accelerator pedal pressure while maintaining a high rpm will help increase traction. Greater pedal pressure will create more flow and, thus, more speed, but it will also decrease power to the wheels.

### KEEPING THE LOADER LOW ON THE LOAD

- Place the loader as low as possible on the load when driving a loaded machine.
- When working on steep ground, it is critical to have the grapple open, placed far back on the rear bunk of wood, with a small amount of downward pressure (this would most likely come from the weight of the loader, since most manufacturers do not include downward pressure on the main boom function) to help secure the load.
- Figure 55 shows a loader down flat on a load, with the grapple placed properly over the back of the load. Be aware that if this is not done carefully, hose damage can result. You should always ask your dealer's or manufacturer's recommendations for the specific type of machine you are using.

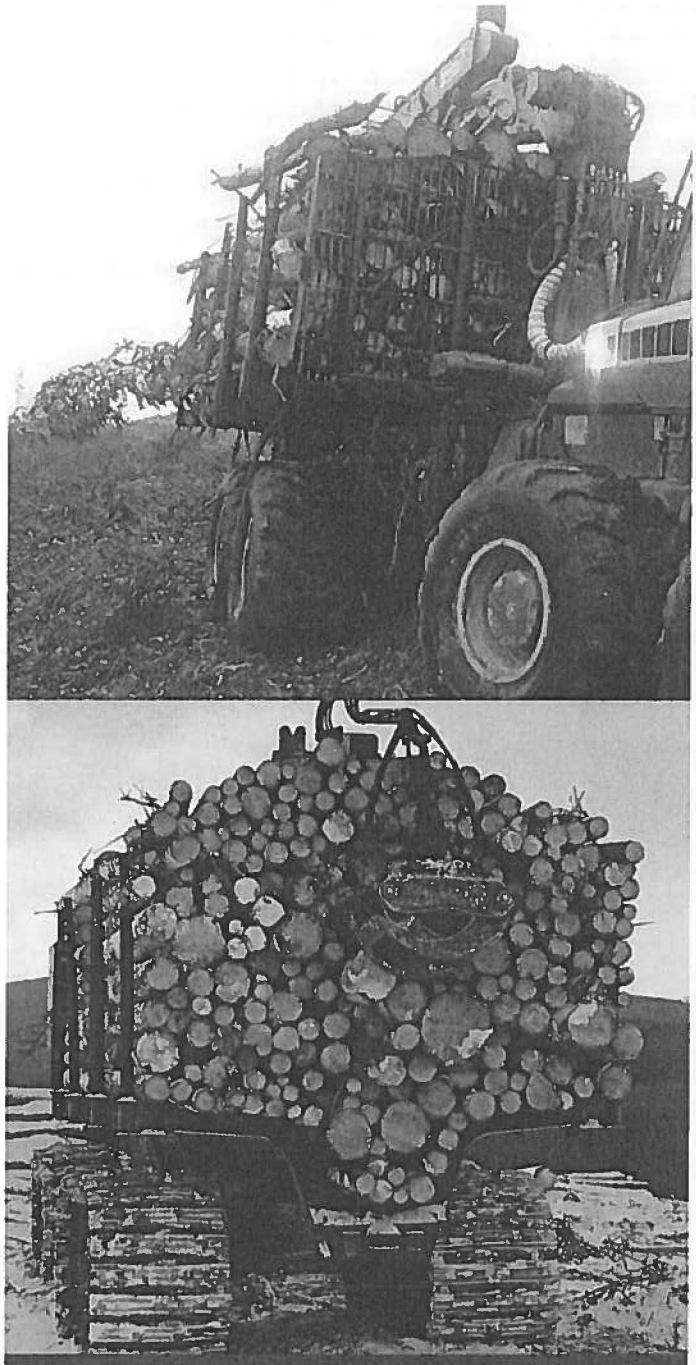


FIGURE 55.
*Keep the loader low on the load while driving a loaded machine.*

- The lower the loader is, the better, because this greatly reduces the movement of the loader components and lowers the centre of gravity, which is most important on steep ground.

# 11.
# UNLOADING

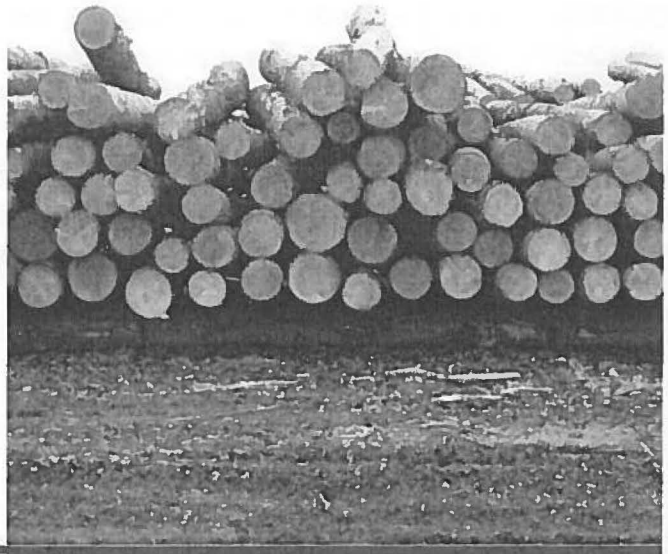


FIGURE 56.
*Build a straight and long pile base before building the pile high.*

FIGURE 57.
*Create natural hills and valleys to promote better pile quality.*

**BUILDING A ROADSIDE LOG DECK**

- When starting a pile on the roadside, build the pile long before trying to build it high. This will help you form a plan for the length of the pile and allows you to build a very straight pile base (Figure 56).
- When building the pile long, there is more opportunity to create hills and valleys throughout the pile. These are the natural ups and downs within a pile that help contain grapples of wood to build a strong and well-aligned pile structure (Figure 57).
- Piling into the valleys minimizes rolling of logs, decreases unloading time, and helps form a neat pile.
- If the pile is built correctly, every grapple of wood will create more valleys as the pile is built to the recommended height of 4 m (12 ft.). It is possible to build piles higher, but this can become inefficient for the loader. Higher piles should only be built if there is limited piling space.
- When wood is placed into a valley, any loose wood will roll to the bottom and will stay aligned with the rest of the pile. The valley becomes somewhat of a container for the wood. On the other hand, if wood is placed on a flat surface, a hill, or on the face of the pile, wood tends to roll around or down the face of the pile, which requires spending time cleaning up the spilled wood.

**POSITIONING THE MACHINE**

- As with loading, it is important to position the machine properly when unloading. Understanding the recommended distance can be challenging, especially for new operators. Figure 58 (left) shows an operator reaching to the full length of the boom plus the extension to reach the pile. This practice adds a lot of wear on the loader and reduces production through lost time due to the extra-long reach.
- When unloading long logs, such as logs 500 cm (16 ft. 4 in.) or longer, position the machine as close as possible to the roadside pile to minimize the reach required to place the wood down (Figure 58, right). Minimizing reach is vital to saving time and reducing the amount of strain on the boom.
- Make sure the stick (outer) boom is always working at or near 90° to the machine. This is the sweet spot. This position of the boom allows for the most power and maneuverability when loading or unloading wood, which also increases time, fuel efficiency, and productivity.

FIGURE 58.
*A fully extended reach is inefficient and causes wear on the loader* (left). *Position the machine as close to the pile as possible to minimize reach* (right).

## MINIMIZING BRUSH IN THE PILE

- Minimizing the amount of brush in the pile is part of the quality standard that most companies expect.
- Brush in the pile decreases a truck's payload while it hauls wood to the mill, which can directly impact the company's bottom line (Figure 59).
- Excessive brush also results in lost production at the mill as the brush or debris must be removed before it enters the mill.
- Using good grapple control can help reduce the amount of brush that ends up in the roadside pile. The best time for managing the amount of brush that ends up in the load is when wood is being loaded onto the forwarder.
- Brush in the forwarder load also decreases the machine's payload, so waiting until the wood arrives at the roadside before managing the brush directly impacts the contractor's cost versus tonnes delivered.

## UNLOADING AT THE ROADSIDE

- Longer logs tend to be much easier and faster to unload. They are even easier to load if the forwarder is positioned close to the pile to reduce stick boom movement and if the wood is grabbed in a way that allows a natural dangle of +/–1 m (3–4 ft.) (Figure 60).
- This amount of dangle toward one end assists with steering while piling wood into the valleys on the pile. Drop the low end of the grapple of wood into the valley, swing to centre it, and then drop the wood into the valley.
- When working with logs 4 m or longer, it is better if the logs dangle away from you. This allows for better control and easier engagement with the pile valley.
- As with loading wood, avoid overloading the grapple while unloading to prevent losing wood. Overloading is time-consuming and needless, and it decreases production and increases the cost per tonne to the contractor.

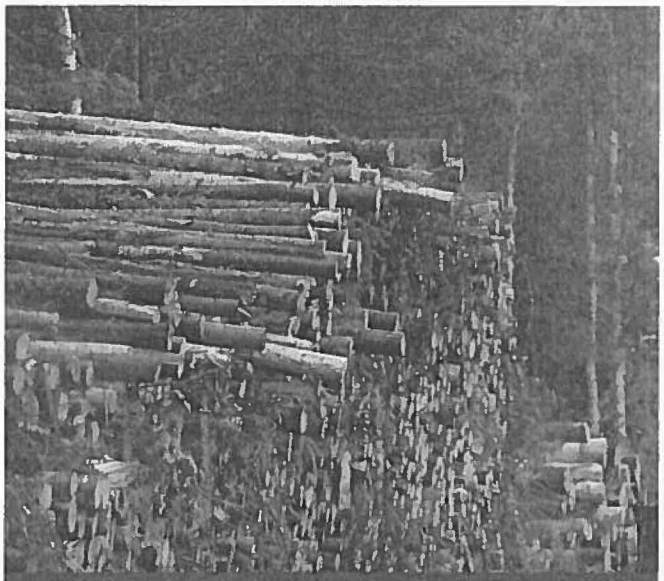


FIGURE 59.
*This is far too much brush in the pile.*

FIGURE 60.
*A dangle of +/– 1 m helps control wood.*

- Swinging the empty grapple through the stakes minimizes boom movement and increases production. It might seem tricky at the beginning, but as with any skill, only practice will help improve your ability.

**FILLING THE GRAPPLE WITH WOOD WITHOUT OVERLOADING IT**

- When grappling wood from the load, it can be difficult to fill the grapple properly. If the open grapple is placed on the wood and is closed, logs often cross or jam against each other, causing a gap to form in the bottom of the wood in the grapple.
- This situation usually results in an unstable grapple of wood. Anytime there is a large open space or crossed logs within the grapple jaws, wood can slide toward the pile while the grapple swings.
- To fill the grapple with wood, place it so that one jaw goes down over the outside of the load, and close the grapple slowly while swinging the boom toward the centre of the load and lifting it at the same time (Figure 61). The wood will roll into the grapple and fill it perfectly.
- This process works on all lengths and types of wood, but you will need to adjust the opening of the grapple on long and/or large logs to keep within the limit of the machine's capacity.
- Use a similar technique to off-load, but in the opposite order: take the first grapple full from one side of the pile and then the other, and the last one from the middle.
- Following this sequence all the way down the pile helps increase the number of well-filled grapples of wood while reducing the amount of rolling and movement of wood on the load.

FIGURE 61.
*Place the grapple on the wood properly.*

**KEEPING THE WOOD IN THE PILE ALIGNED TO THE STANDARD**

- When building a pile, always consider the hand-off to the next operation in line, which is the fleet loader and trucks.
- Poorly piled wood increases loading time, which can dramatically reduce production of the trucking fleet. However, keep in mind that trying to align wood perfectly costs a lot of time.
- Always follow the standard, which is for the log ends to be +/– 15 cm (6 in.) (Figure 62).
- The optimal time for achieving the standard is when the forwarder is being loaded. Learning good loading techniques and taking the time to build a proper load can save a great deal of time at the roadside and can increase the payload on the forwarder, as there will be less open space (or wasted space) within the load.
- Even if wood is loaded and unloaded carefully, a few sticks can become misaligned on the pile at the roadside (see Figure 61, on the left of the pile). These misaligned pieces can be managed to adhere to the piling standard, but, again, be aware that continuous management can lead to lost time, and to the failure of hose and grapple components. The best way to minimize the need for aligning wood on the roadside pile is to maintain good alignment in the forwarder load and use the valleys properly.

FIGURE 62.
*Align wood to the standard of +/– 15 cm.*

# 12.
# PILING TO THE STANDARD

**SQUARING ALL ASPECTS OF THE PILE**

- The first step to building a good pile base is starting the pile with a good square base so that the wood runs at 90° to the length of the pile (Figure 63).
- The second step is building the pile so that it is parallel to the road. This will maintain a set distance from the side of the road that will allow road graders to grade properly, snow plows to plow properly, and trucks to load without issue.
- Use skids (normally an unmerchantable product) to lay a straight design for the start of the pile.
- Using good loading techniques, loading wood into the valleys, and using the dangle technique during unloading will help you build a pile that is well aligned and indexed.

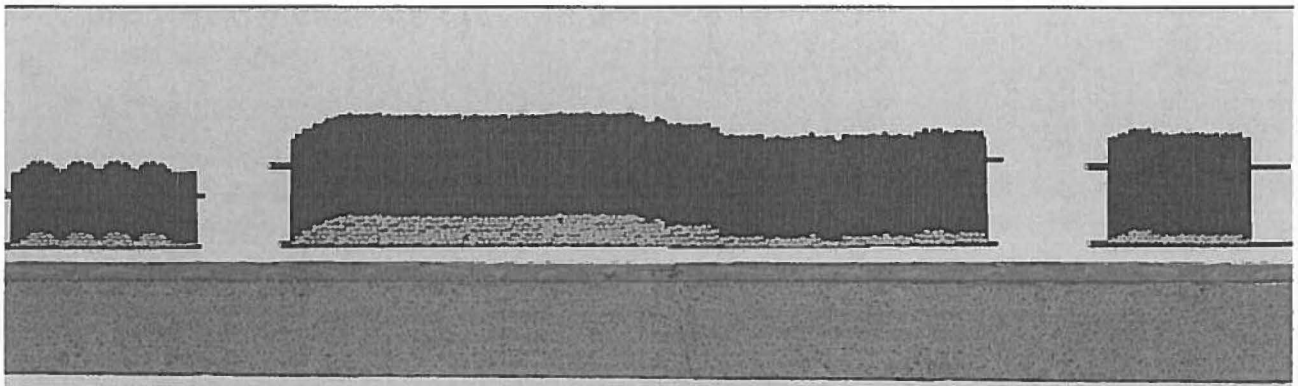
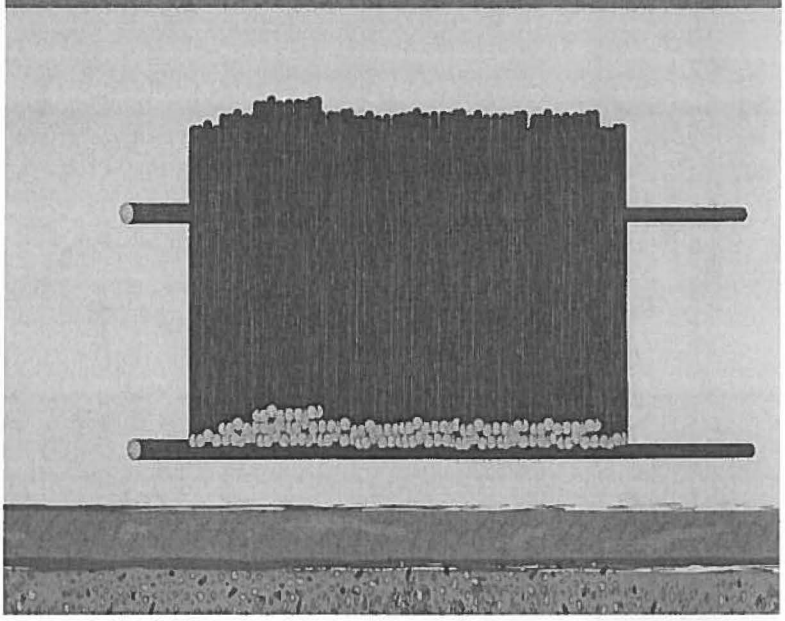


FIGURE 63.
*Use skids and build piles long to help align them squarely with the road.*

## USING UNMERCHANTABLE WOOD AS A PILE BASE

- Unmerchantable normally refers to an undersized tree with no usable wood fibre as it does not meet product specifications. It may also include deadwood, undesired species, or skids.
- Always place a skid or unmerchantable wood on the ground under the piling area (Figure 64) before starting to unload because it:
  1. Acts as a frame that helps to build a good and stable pile.
  2. Prevents wood from lying directly on mud or snow.
  3. Allows you to start the pile square and level, which is necessary for building a good pile.
- Using unmerchantable material such as dead trees is the best solution as it can stay in the mud without affecting the operation.
- Skids tend to be longer than deadwood, which can save time by requiring less material.
- Poorly built piles without skids can often become unstable and fall over, causing an expensive cleanup. Wood piled directly on mud or snow can be lost or damaged.

FIGURE 64.
*Always use skids or an unmerchantable product as a base for the pile.*



## PLACING WOOD THE RIGHT DISTANCE FROM THE ROAD

- It is important to know how far from the road wood should be placed and to have something to use as a guide to maintain that distance throughout the whole length of the pile.
- Some operators use the grapple closed half-way to where the jaws meet as a guide, which for many grapples is 0.9–1.2 m (3–4 ft.) at the centre point. This falls within the normal distance parameters of 0.6–1.2 m (2–4 ft.) that the pile should be placed from the bottom of the road slope.
- When planning the location of a roadside pile, make sure to plan the distance from the road to the pile. Wood piled on a freshly plowed snow bank can limit the plow if it snows again before the wood is trucked away. Wood piled too close to the shoulder can restrict summer road grading; not only does it prohibit the grader from doing its job, it also often causes issues for trucks and other traffic using the road. Sometimes such proximity can also contribute to other issues, such as the bottom of a pile becoming damaged or frozen down.
- Two reasons for planning a minimum and maximum distance from the road:
  1. Placing piles within the spec minimizes the reach of the forwarder during unloading and of trucks during loading.
  2. It also allows snow removal equipment to work during the winter and the grader to work during all seasons.

## DETERMINING PILE LOCATION

- Finding sufficient space for piling is one of a forwarder operator's biggest dilemmas. There are often tight quarters on steeper ground, so there is not a lot of piling space for wood.
- Selecting the proper roadside location for piles is essential to forwarder and truck efficiency.
- We talked about piling areas when we discussed planning of the cutblock, but here we will focus more on being efficient with the space you have available.
- First, always come up with a game plan with your contractor to move to an adjacent area if the current one is becoming full.
- This will allow you to have at least one other plan and perhaps a second plan if there are areas available on both sides of the current forwarding area within the cutblock.
- There are many considerations in starting a new cutblock or pile location:

    1. First and foremost, you must be aware of and adhere to the standard operating procedures of the company you are doing the work for when it comes to certain things, such as how far wood should be piled from running water, the distance from the road, and so on. (For more information about standard operating procedures, talk to your contractor.)
    2. The next considerations relate to the shape of the block, how long the trails are, and what the estimated volume is of the products from each trail. If this information is not available, an estimate can be made after the first trail is forwarded.
    3. You also need to know whether there is enough area along the roadside that is eligible for piling wood. If there is not, ask your contractor to organize trucks to move enough of the wood to at least allow additional wood to be piled at roadside.

- Based on the information gathered, now it is time to do the actual planning long before piling the first grapple of wood:

    1. If the main product is 20-ft. logs, plan to make this pile the largest and centred on 3 or 4 trails (depending on volume), so that the forwarder does not have far to travel at the road.
    2. Pile any small-volume products from the bottom of the loads (such as random-length pulp) somewhere near one of the ends of the big piles so that wood can be off-loaded on the way toward the trails being forwarded. This will reduce the amount of time for forwarding this product because the forwarder will already be passing the location during its normal cycle.
    3. Other sorts of larger sawlogs are often piled on top of loads, so a location near the ends of the major piles is also helpful so that the product can be off-loaded on the way to the pile from the trails being forwarded.
    4. Any very minor-volume sorts (no more than a half load per shift) can be off-loaded near the major piles and moved to a more remote location at the end of the shift (during fuelling time, greasing time, etc.).
    5. Be careful not to make too many piles, which can result in a loss of space.

- This may all sound complicated, and it can be. This is why it is extremely important to know how much product is on the cutblock and where it is located, how much area is available at the roadside for piling wood, and what the availability is of trucks to remove products from the roadside. Some software companies have developed calculation apps that can help plan the amount of road frontage required to pile wood at the roadside. Some apps can also estimate the volume of wood within a cutblock.
- Piling as close as possible to where the wood is coming from is the most efficient. Therefore, you must also consider whether the wood is coming from one side of the road, both sides of

the road, or some from the side and the rest from the end of the road.

- The rule of thumb is to make piles large, but typically not more than 30–60 m (100–200 ft.) long. If the pile is too long, you will need to drive too far to the next pile of product. On the other hand, if the pile is too small, it will take up too much space and often there will not be enough space for all of the products. Small piles also cause trucks to be less efficient because of the large amount of movement needed to gather a full load.
- Place minor products so that they can be unloaded on the way to or from the location where the main products are unloaded.
- Pile from the back of the pile to the front to avoid going onto the road surface wherever possible. This helps to reduce damage to the road, avoids blocking roads for trucks and other traffic, and saves road costs and overall operation costs such as limiting truck flow and other work traffic.

### DETERMINING WHERE TO PLACE WOOD SORTS

- Figure 65 shows the largest sort volume near the centre of four fairly long trails. This placement allows the operator to pile in either direction and provides options for smaller volumes to be piled on the opposite side of the road or at the ends.
- Placement of piles will depend on whether the machine is allowed on the road in that particular area. Sometimes wood can be piled from the back of the pile or only over the side, but it all depends on the space available and any company regulations you must follow.
- Sometimes short sections of road are accessible, but not always. In the scenario in Figure 65, the piles can be accessed from behind them, providing the terrain is flat enough.
- A mistake that many operators make early on in their career is making too many piles, which can result in a lot of lost space. Figure 66 demonstrates such a case. The blue line represents a straight line along the tops of the piles and the red valley areas below the blue line show the volume of wood that is being lost as a result of the small size of the piles.

FIGURE 65.
*Make a long pile for the highest-volume product to help increase pile volume.*

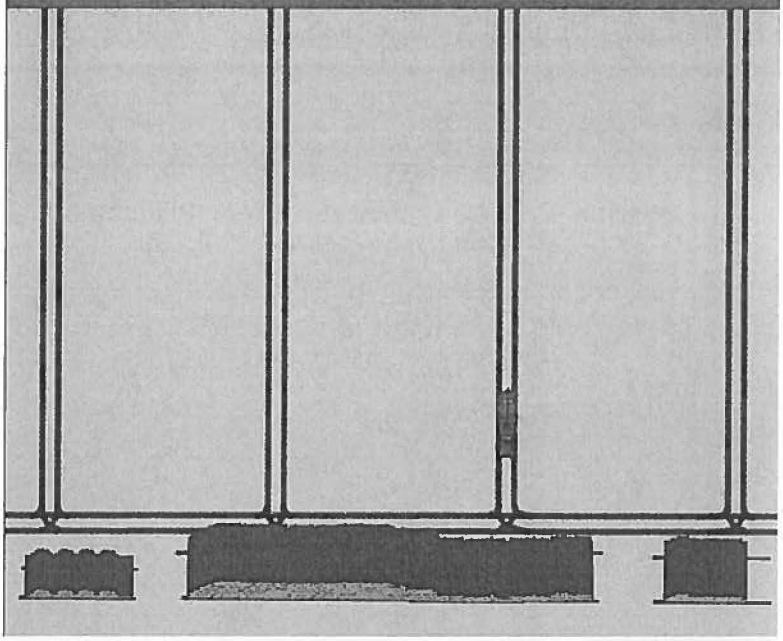
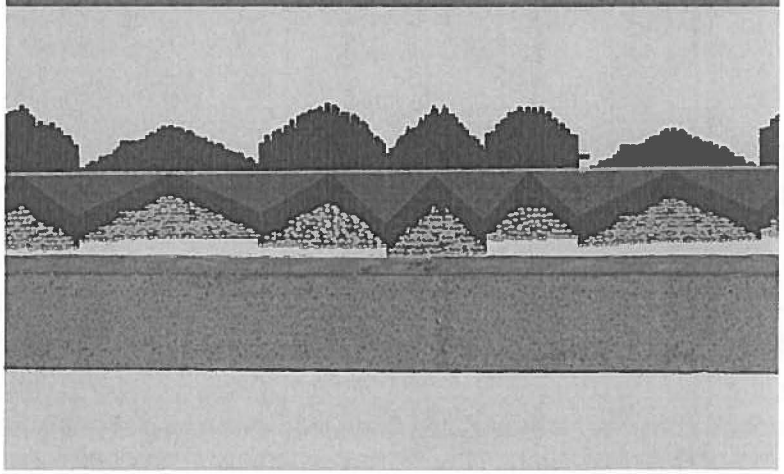


FIGURE 66.
*Making many small piles uses up piling space and reduces roadside volume per linear metre of space available.*



# 13.
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