Vision, knowledge, performance

Best practice guidelines for
Land Preparation

This Best Practice Guide is being reviewed.

The future of Best Practice Guides will be decided during 2015.
He Mihi

Nga pakiaka ki te Rawhiti. Roots to the East.
Nga pakiaka ki te Rakī Roots to the North.
Nga pakiaka ki te Uru Roots to the West.
Nga pakiaka ki te Tonga. Roots to the South.

Nau mai, Haere mai We greet you and welcome you.
ki te Wāonui o Tane To the forest world of Tane.
Whaia te huarahi, Pursue the path,
o te Aka Matua, of the climbing vine,
i runga, I te poutama on the stairway,
o te mātauranga. of learning.
Kia rongo ai koe So that you will feel,
te mahana o te rangimārie. the inner warmth of peace.
Ka kaha ai koe, Then you will be able,
ki te tū whakaiti, to stand humbler,
ki te tū whakahī. Yet stand proud.

Kia Kaha, kia manawānui Be strong, be steadfast.

Tena koutou katoa.
First edition December 2002
Revised edition January 2005

This Best Practice Guideline is to be used as a guide to certain land preparation procedures and techniques. It does not supersede legislation in any jurisdiction or the recommendations of equipment manufacturers.

FITEC believes that the information in the guideline is accurate and reliable; however, FITEC notes that conditions vary greatly from one geographical area to another; that a greater variety of equipment and techniques are currently in use; and other (or additional) measures may be appropriate in a given situation.

Other Best Practice Guidelines included in the series:

• Cable Logging
• Chainsaw Use
• Fire Fighting and Controlled Burnoffs
• Ground-based Logging
• Loading
• Maintenance inspections of Yarder Towers
• Manual Log-making
• Mechanised Harvesting and Processing
• Mobile Plant
• Personal Protective Equipment
• Road and Landing Construction
• Silvicultural Pruning
• Transport
• Tree Felling
• Tree Planting
• Working with Helicopters

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Land Preparation
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Introduction

Purpose of these guidelines

The Best Practice Guidelines for Land Preparation have been designed by FITEC to improve worker safety and performance. They combine industry training standards and best practice information to provide a valuable reference manual for people involved in land preparation.

These guidelines should be read in conjunction with:

- the Approved Code of Practice for Safety and Health in Forest Operations. In particular, these guidelines provide direct support for Part 3 - Section 12 (Land Preparation and Establishment) of the code.
- New Zealand Standards Code of Practice for Management of Agrichemicals.

These Best Practice Guidelines are also a valuable reference document for the following Unit Standards registered on the NZQA framework.

- 1221 - Demonstrate knowledge of job prescriptions for forest operations
- 1232 - Demonstrate knowledge of forest planting site quality
- 3285 - Demonstrate knowledge of personal safety at vegetation fires
- 6935 - Operate an excavator type tracked machine in a forestry situation
- 6936 - Operate a tracked machine in a forestry situation
- 6966 - Apply environmental management to mechanised land preparation operations
- 17761 - Demonstrate knowledge of quality determining factors in commercial plantation forestry
- 17772 - Demonstrate knowledge of environmetal requirements in forest operations
- 19955 - Prepare land for forest establishment using gravity roller crushing
- 19956 - Prepare land for forest establishment using a V-blade
- 19957 - Prepare land for forest establishment using towed roller and blade crushing
- 19958 - Prepare land for forest establishment using spot cultivation techniques
- 19959 - Prepare land for forest establishment using root and line rakes
- 19960 - Prepare land for forest establishment using cultivations methods
- 19961 - Prepare land for forest establishment using mulching
- 19962 - Prepare steep terrain for forest establishment using excavator windrowing
- 19767 - Clear vegetation for forest establishment using motor manual means

How to use these Guidelines

These guidelines have been arranged in six main sections:

- Land preparation basics
- Motor-manual land clearing
- Agrichemical application
- Manual land clearing
- Mechanical site preparation
- Controlled burnoffs.

The Glossary of Terms gives the meaning of terms used throughout these guidelines.

The Index to Unit Standards allows the reader to locate information specific to each of the Unit Standards listed above.
Acknowledgements

FITEC acknowledges the assistance of the Occupational Safety and Health and Service, Liro Forestry Solutions, and numerous forest industry trainers, forestry contractors, and forest company staff in the development of these Best Practice Guidelines.

About best practice training material

FITEC has developed the material in this publication. It has been reviewed by representatives of the forest industry. At the time of publication, FITEC considers the practices and approaches in this publication to exceed accepted industry standards with regard to production and business management. In addition, the practices recommended in the publication exceed all the New Zealand regulatory standards, in particular those related to health and safety, environmental management, and human resources / employment as applicable.

This material is reviewed and reprinted regularly by FITEC.
Land preparation basics

What is land preparation?
The objective of land (site) preparation is to improve potential tree growth, survival, and uniformity of a crop about to be established (planted).
Through appropriate land preparation, factors that limit tree growth are reduced. These factors include:
- Poor drainage
- Weed competition
- Compacted or naturally dense soils.

Site preparation improves site conditions in one or more of the following ways:
- Reducing weed competition for light, nutrients and water
- Improving soil, water, and air conditions through cultivation
- Loosening tight or compacted soils to allow roots to grow through them
- Reducing frost susceptibility through mounding.

The need for land preparation generally occurs on two different types of land:
- Previously unforested land currently occupied with grass or woody scrub vegetation
- Harvested forest cutover.

Correctly performed, land preparation creates enough disturbance to reduce the limiting site factors without causing excessive soil disturbance or degradation.
While the issues and problems faced in preparing these sites can be quite different, many of the machines and techniques described here are applicable to both.

Types of land preparation operations
There is a range of operations used, which improve the physical characteristics of a site. Broadly, land preparation operations can be divided into the following:

<table>
<thead>
<tr>
<th>Desired site effect</th>
<th>Land preparation operation</th>
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<tr>
<td>Reduced vegetation (weeds) competition</td>
<td>Manual land clearing</td>
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<td></td>
<td>Motor-manual land clearing</td>
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<td></td>
<td>Crushing</td>
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<td></td>
<td>Agrichemical application</td>
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<td>Oversowing</td>
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<tr>
<td>Improved access to planting spots</td>
<td>Mechanical raking, mulching and blading</td>
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<tr>
<td></td>
<td>Windrowing</td>
</tr>
<tr>
<td></td>
<td>Crushing</td>
</tr>
<tr>
<td></td>
<td>Controlled burning</td>
</tr>
<tr>
<td>Improved soil physical conditions</td>
<td>Mechanical cultivation (ripping) and/or mounding</td>
</tr>
<tr>
<td></td>
<td>Drainage, V-blading</td>
</tr>
<tr>
<td>Reduced frost risk</td>
<td>Mounding</td>
</tr>
<tr>
<td>Reduced erosion risk</td>
<td>Oversowing</td>
</tr>
<tr>
<td></td>
<td>Spot cultivation or spot agrichemical application</td>
</tr>
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<td></td>
<td>Stabilisation</td>
</tr>
</tbody>
</table>
These Best Practice Guidelines provide further knowledge and procedural information on the following land preparation operations:

- Manual land clearing
- Mechanical land preparation
- Motor-manual land clearing
- Agrichemical application

In addition, the use of controlled burns for land preparation is briefly described here. A complete description of equipment and procedures is presented in the Best Practice Guidelines for Fire Fighting and Controlled Burnoffs.

Environmental considerations

Land preparation operations will have an impact on the environment. Through appropriate planning and application, potential adverse impacts can be avoided, remedied, or mitigated.

The following section describes the management of environmental values, including cultural, soil, and water values.

Cultural sites

There are three main types of cultural sites. These are:

- *Archaeological sites* - are sites that show evidence of human activity of an age greater than 100 years. These sites are automatically protected whether or not the site has been recorded under the Historic Places Act (1980). This Act makes it an offence to interfere with the site without consent from the Historic Places Trust.

Examples of archaeological sites are:

- Maori burial sites (urupa)
- Pa sites (waahi tapu)
- Kumara pits (rua)
- Old roads and goldmining sites

- *Traditional sites* - are places or sites that are important for reasons of historical significance, or spiritual and emotional association with Maori people. They frequently have no physical remnants of human activity and they may be protected under the Historic Places Act (1980).

Examples of such sites are canoe landing points (e.g., the landing point of the Te Arawa canoe at Maketu) or sacred mountains (e.g., Putauaki/Mt Edgecumbe).

- *Historic sites and buildings* — have protection orders issued by the Minister of Conservation if they have the appropriate Historic Places Trust classification. Forestry areas are unlikely to contain such sites. However, examples include:

  - Kauri dams
  - Ruined buildings/sites
  - Gold field remains.
Cultural sites may be already marked on maps. Forest planners should incorporate a search for cultural sites into their planning process. An archaeologist may be employed to search formal records, interview connected local people, and survey the site of the proposed operation.

Cultural sites may also be discovered during the land preparation operation. This is most likely where new sites are being cleared for planting. If found, such sites should be marked and isolated to ensure they are not interfered with. The contractor and/or landowner should be contacted as soon as possible. They will then have the site assessed to determine cultural significance and any legal obligations.

**Adverse environmental impacts**

Operations that involve soil disturbance and/or vegetation removal may cause adverse environmental impacts. This is especially so when the operation is up-slope of, or near a waterway.

There may be a requirement by the local Regional Council to manage the land preparation operation to avoid, remedy, or mitigate such impacts. If so, the landowner will need consent from the council. This consent will specify agreed management practices that must be followed. These conditions are usually specified in the job prescription.

Disturbance caused by tracking, cultivation, and mounding, and desiccation or clearing of vegetation may result in the following adverse impacts:

- Erosion of tracks and fill slopes
- Reduction in water quality, and sediment build-up
- Reduced slope stability
- Visual impacts, especially if on steep slopes.

Methods for reducing adverse impacts associated with soil disturbance and vegetation removal include:

- Identify unstable areas
- Locate access tracks on terraces, ridges, and away from waterways and unstable areas where appropriate
- Work around the contour where possible
- Avoid working in wet conditions
- Form water tables and install sufficient culverts, flumes, and cut-offs to control run-off on to stable ground
- Use excavator-based machines rather than tractor or skidders
- Install sediment traps and soak-holes

The storage, handling, and application of agrichemicals near waterways may increase the risk of contamination of the water (this is in addition to potential impacts on stock and people).

Methods for reducing adverse impacts associated with agrichemical application include:

- Comply with the Code of Practice for Management of Agrichemicals
- Use only licensed operators
- Choose the correct chemical and application rate
- Store and handle chemicals away from waterways
- Advise the public, neighbours, and other workers of the application operation.
- Spray in appropriate weather conditions
- Use effective, well-maintained equipment

**Job prescription**

A job prescription is a written instruction from the forest owner detailing the requirements for the land preparation operation. It may include:

- Type of land preparation operation
- Map showing the location and boundaries of the site to be treated and any special features of the site (e.g., protected or hazardous areas)
- Anticipated timing of the operation
- Any legal requirements or rules affecting the operation (e.g., Resource Management Act or Historic Places Act)
• Quality requirements, including intensity/depth of treatment, agrichemical application rates
• Safety requirements including a list of hazards identified by the forest owner or their representative.

It is important that all workers are briefed on the content of the job prescription and if possible they have a copy.

Having no job prescription or an inadequate job prescription may result in poor land preparation and conflict over the actual standards required. This can lead to:
• The forest owner may end up with a lower value forest, re-assessment costs, and extra supervision costs.
• Individual operators and crews may lose income.

Training and supervision
Accidents and incidents can result in injury or death. Employers may incur added costs through increased accident insurance levies, potential loss of jobs, and loss of contracts.
The Approved Code of Practice for Safety and Health in Forest Operations requires that new employees be supervised by a competent person until the employer is sure the employee can work safely and is not likely to harm themselves or anyone else.
All operators should be under a documented training programme and should be aiming to pass the relevant NZQA Units that apply to land preparation.

Knowledge of hazards
Before starting in a new area all operators must be involved in identifying any significant hazards on the site and the way those hazards will be controlled. There must be documented evidence on site listing the hazards and controls, and showing that all operators have been run through those hazards and controls.
The two main hazard categories are Health Hazards and Operational Hazards.
• Health Hazards and control measures will be discussed below.
• Operational Hazards will be specific to each operation being performed. Thus, operational hazards and control measures are listed in subsequent sections of these guidelines.

Health hazards
Land preparation (particularly manual land preparation) can be a physically demanding job. To maintain peak performance and prevent accidents through fatigue, you must take special care of your body. This includes your physical fitness, diet, water intake, personal hygiene, sleep, and how you treat your body away from work.
## Health hazards

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of rest/sleep</td>
<td>• Build short frequent rest breaks into your work routine.</td>
</tr>
<tr>
<td></td>
<td>• Take at least two evenly spaced 30 minute rest breaks during the working day.</td>
</tr>
<tr>
<td>Early starts</td>
<td>• Go to bed earlier to replace the sleep you lose in the morning.</td>
</tr>
<tr>
<td></td>
<td>• Once early starts have finished allow time for your body to recover.</td>
</tr>
<tr>
<td>Alcohol abuse</td>
<td>• Avoid drinking alcohol at least 24 hours before carrying out any hard physical work.</td>
</tr>
<tr>
<td>Poor nutrition</td>
<td>• Start each day with a high carbohydrate breakfast like porridge, cereal, toast, bananas, pasta, or potatoes.</td>
</tr>
<tr>
<td></td>
<td>• Eat high protein foods like lean meat, chicken, eggs, milk and cheese at night.</td>
</tr>
<tr>
<td></td>
<td>• Eat at the start of a break and rest to allow digestion.</td>
</tr>
<tr>
<td></td>
<td>• Always eat a high carbohydrate snack straight after work.</td>
</tr>
<tr>
<td>Drugs</td>
<td>• Avoid all non-prescription drugs as they seriously affect both your mental and physical ability to work.</td>
</tr>
<tr>
<td></td>
<td>• Inform the boss if you are on any medication that may affect your work. Stay home if necessary.</td>
</tr>
<tr>
<td></td>
<td>• Before receiving any medication, tell your doctor what you do for a living.</td>
</tr>
<tr>
<td></td>
<td>• If you are on long-term medication for a serious health complaint inform the boss or crew of your condition in case you are involved in an emergency at work.</td>
</tr>
<tr>
<td>Over-exertion/sprains and strains</td>
<td>• Start each day with a 10–15 minute warm-up and then a few stretches.</td>
</tr>
<tr>
<td></td>
<td>• Start the day slowly until muscles are warmed up properly.</td>
</tr>
<tr>
<td></td>
<td>• Do some stretches at the end of the day.</td>
</tr>
<tr>
<td></td>
<td>• Take particular care when starting back at work after the holidays.</td>
</tr>
<tr>
<td>Hypothermia/chills (shivering, coldness, numbness of extremities, pale skin colour, clumsiness and irrational behaviour)</td>
<td>• Wear rain wear to protect yourself from rain/water (be careful not to overheat).</td>
</tr>
<tr>
<td></td>
<td>• Put on warm clothes when you stop for a break.</td>
</tr>
<tr>
<td></td>
<td>• Carry spare dry clothing even on fine days. The weather can turn bad very quickly.</td>
</tr>
<tr>
<td></td>
<td>• If anyone shows signs of hypothermia, they must be removed from the operational area and warmed.</td>
</tr>
</tbody>
</table>
### Health hazards (cont...)

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
</table>
| **Lack of hygiene/infection**               | • Clean and dress any cuts or scratches received on the job as soon as possible and keep them covered.  
• Make sure the first aid kit is kept fully stocked.  
• Carry water and soap on the job to wash hands before smokos.  
• Bath or shower every night.  
• Eat a balanced diet to keep your body healthy.  
• Wear clean clothes against the skin every day. |
| **Exposure to sun**                          | • Wear sun block.  
• Wear a light shirt on hot days.  
• Wear a hat or helmet with a flap to cover your neck.  
• Carry out regular health checks of moles, freckles, etc. |
| **Occupational Overuse Syndrome (OOS)**      | • Use the correct operating techniques.  
• Maintain hand and power tools in good working order, with sharp blades/chains.  
• Use pre-work warm up and stretching techniques throughout the day. |
| **Heat stress (flushed face, sweating, weakness, tiredness, dizziness, nausea)** | • Dress appropriately to the level of physical activity you are doing.  
• Wear loose fitting clothing that allows air circulation (open trouser legs and wrist cuffs).  
• Move to the shade until body temperature drops and stabilises. |
| **Dehydration**                              | • Regularly drink fluids at a rate of 0.5 litres per hour and up to 1 litre per hour in hot conditions.  
• Drink before you feel thirsty.  
• Do not drink fluids, like soft drinks and cordials that have more than 8% carbohydrate content.  
• Drink high carbohydrate drinks after work to replace energy levels.  
• Drink plenty of water at night to recharge the body.  
• Drink a couple of glasses of water before leaving for work. |
Manual land clearing

Types of operation

The use of hand tools is a very labour-intensive way of clearing a site. Generally, manual methods are used only on small areas where it is not practical, environmentally acceptable, or safe to use a machine.

These operations may include land clearing by scrub cutting or preparation by line cutting or spot clearing/releasing.

These operations are typically carried out by groups of workers using slashers, but they may also use spades or mattocks.

Operational hazards

Manual land preparation can be physically demanding. The use of cutting tools, such as a slasher, and the working environment will pose operational hazards for workers. These may be worsened if there are additional health hazards (Health Hazards, page 6).
## Operational hazards

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ineffective personal protective equipment (PPE)</strong></td>
<td>• Do not perform operation if PPE is ineffective.</td>
</tr>
<tr>
<td></td>
<td>• Clean dirty hi-vis garments and oil-soaked protective legwear.</td>
</tr>
<tr>
<td></td>
<td>• Replace any worn, damaged, or expired PPE.</td>
</tr>
<tr>
<td></td>
<td>• Routinely check the condition of your PPE.</td>
</tr>
<tr>
<td><strong>Slasher, spade, or mattock blade</strong></td>
<td>• Wear safety work boots.</td>
</tr>
<tr>
<td></td>
<td>• Ensure you have a stable stance before using your slasher, etc.</td>
</tr>
<tr>
<td><strong>Fragments of dirt/wood in eyes</strong></td>
<td>• Wear safety glasses.</td>
</tr>
<tr>
<td><strong>Other slasher operators</strong></td>
<td>• Work at least 3 m away from other workers, or if in scrub over 2 m tall work at least two times the height of the scrub away from other workers.</td>
</tr>
<tr>
<td></td>
<td>• Wear hi-vis clothing.</td>
</tr>
<tr>
<td><strong>Cuts to hands when sharpening</strong></td>
<td>• Always have a handle on the file or wear protective leather gloves.</td>
</tr>
<tr>
<td></td>
<td>• File away from the cutting edge.</td>
</tr>
<tr>
<td></td>
<td>• Clamp the slasher firmly when sharpening.</td>
</tr>
<tr>
<td></td>
<td>• Use a draw file.</td>
</tr>
<tr>
<td><strong>Defective tools</strong></td>
<td>• Replace or repair defective or damaged tools before using them.</td>
</tr>
<tr>
<td></td>
<td>• Have spare tools available.</td>
</tr>
<tr>
<td></td>
<td>• Do not use blunt tools.</td>
</tr>
<tr>
<td><strong>Slips and falls</strong></td>
<td>• Take care to find firm footing before cutting.</td>
</tr>
<tr>
<td></td>
<td>• Wear spiked soled boots.</td>
</tr>
<tr>
<td></td>
<td>• Work uphill or across the slope to avoid overbalancing when slashing.</td>
</tr>
<tr>
<td></td>
<td>• Carry hand tools in such a way that they can be thrown clear if necessary during a fall.</td>
</tr>
</tbody>
</table>
Personal protective equipment

The approved Code of Practice for Safety and Health in Forest Operations requires operators to have and use the following protective equipment.

- Hi-vis helmet
- Protective eyewear, unless it creates a greater hazard
- Hi-vis shirt, vest, or coat
- Safety footwear providing ankle support.

In addition, workers or crews should have available:

- Means of communication in an emergency (such as RT, cell phone, whistle).
- First Aid kit

Equipment requirements

A **Slasher** is a simple tool with a wooden handle and a sharp metal blade, which may be hooked or straight.

Hooked blades are best suited to light vegetation such as grass, bracken, and blackberry.

Slashers with straight blades are best suited to scrub such as gorse, broom, and manuka.

When using a slasher for land clearing, the workers must wear safety boots with steel toecaps. Spiked soles improve footing. It is also a good idea to wear eye protection (safety glasses). If the scrub being cut is over 2 m tall, a hard hat should be worn. A hi-vis shirt or vest should be worn at all times.

Maintenance of equipment

- The cutting edge of the slasher should be kept sharp and in serviceable condition.
- The handle should be free of splits and splinters and the head should be firmly fixed to the handle by a bolt or pin.
- A small tool kit consisting of files (with handles) and spare bolts should be available.
- The slasher blade should be sharpened on the away stroke of the file.

General land clearing procedure

- Walk into the designated work area. Take water, First Aid kit, and file with you.
- Maintain secure footing at all times.
- Decide on your plan of work.
- Cut scrub and slash with controlled blows.
- Maintain communication with other crew members
- Tools should be carried in one hand, below shoulder level.
- If tree releasing, cut away from the tree.
- Use a wrist action rather than a stiff arm action.
- Avoid leaving sharp stakes.
Motor-manual land clearing

Types of operation

The most common method of motor-manual land clearing involves the use of brush-cutters or chainsaws. Brush-cutters can be used for light and medium vegetation, up to a maximum diameter of approximately 10 cm. Chainsaws are suited to larger woody vegetation.

Operational hazards

Motor-manual land preparation can be physically demanding. The use of motorised cutting tools and the working environment will pose operational hazards for workers.

Presented below are operational hazards related to motor-manual land preparation. These hazards are in addition to operator Health Hazards covered previously (Health Hazards, page 6).

For further details on chainsaw hazards, maintenance and operation refer to the Best Practice Guidelines for Chainsaw Use and Best Practice Guidelines for Tree Felling.

Using a brush-cutter (top) and a chainsaw (bottom) to clear vegetation
## Operational hazards

<table>
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</tr>
<tr>
<td></td>
<td>• Routinely check the condition of your PPE.</td>
</tr>
<tr>
<td><strong>Carrying a chainsaw</strong></td>
<td>• Carry the chainsaw in both hands in a position where it can be thrown clear if you slip.</td>
</tr>
<tr>
<td></td>
<td>• Turn the saw off or activate chain brake when walking any distance or over obstacles.</td>
</tr>
<tr>
<td><strong>Carrying a brush-cutter</strong></td>
<td>• Carry the brush-cutter in a position where it can be thrown clear if you slip.</td>
</tr>
<tr>
<td><strong>Starting chainsaws/brush cutters</strong></td>
<td>• If cold starting, place saw/cutter on ground, have left arm straight and in mitt, right foot in rear handle or knee on handle.</td>
</tr>
<tr>
<td></td>
<td>• If warm starting, use step-over method with the bar to your left (not in front in case of kickback).</td>
</tr>
<tr>
<td><strong>Cuts when sharpening chain or blade</strong></td>
<td>• Work on a firm base.</td>
</tr>
<tr>
<td></td>
<td>• Use file handle and file guide.</td>
</tr>
<tr>
<td></td>
<td>• Replace file(s) if worn.</td>
</tr>
<tr>
<td></td>
<td>• Always rotate chainsaw chain towards the tip of the bar.</td>
</tr>
<tr>
<td></td>
<td>• File brush-cutter blades in the direction away from you.</td>
</tr>
<tr>
<td><strong>Moving chainsaw chain or brush-cutter blade</strong></td>
<td>• Wear all required PPE, and ensure it is in good condition.</td>
</tr>
<tr>
<td></td>
<td>• Use correct stance and work techniques.</td>
</tr>
<tr>
<td></td>
<td>• Make sure you hold the chainsaw or brush-cutter with both hands.</td>
</tr>
<tr>
<td></td>
<td>• Take appropriate action if low in energy, dehydrated, or fatigued.</td>
</tr>
<tr>
<td><strong>Chainsaw kickback</strong></td>
<td>• Hold the saw firmly with two hands.</td>
</tr>
<tr>
<td></td>
<td>• Make sure your left hand is wrapped around the front handle and in the mitt.</td>
</tr>
<tr>
<td></td>
<td>• Be aware of the guide bar nose at all times.</td>
</tr>
<tr>
<td></td>
<td>• Do not let the guide bar nose come into contact with any object.</td>
</tr>
<tr>
<td></td>
<td>• Be especially careful when cutting small or light material that may catch in the chain.</td>
</tr>
<tr>
<td></td>
<td>• Do not over-reach or cut above shoulder height.</td>
</tr>
<tr>
<td></td>
<td>• Correctly maintain your chainsaw.</td>
</tr>
</tbody>
</table>
## Operational hazards

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chainsaw kickback (cont...)</strong></td>
<td>• Ensure that all safety devices are operable.</td>
</tr>
<tr>
<td></td>
<td>• Make sure the chain is correctly tensioned and sharpened.</td>
</tr>
<tr>
<td><strong>Burns from exhaust/muffler</strong></td>
<td>• Keep bare skin away from exhaust and muffler.</td>
</tr>
<tr>
<td><strong>Engine exhaust fumes</strong></td>
<td>• Do not operate saw in poorly ventilated or confined areas.</td>
</tr>
<tr>
<td><strong>Vibration injuries</strong></td>
<td>• Ensure the vibration damping mounts on the brush-cutter are in good condition.</td>
</tr>
<tr>
<td><strong>Fires</strong></td>
<td>• Carry a fire extinguisher.</td>
</tr>
<tr>
<td></td>
<td>• Ensure the motor is fitted with a spark arrester.</td>
</tr>
<tr>
<td></td>
<td>• Do not leave a hot motor in contact with dry litter.</td>
</tr>
<tr>
<td></td>
<td>• Do not smoke when refuelling.</td>
</tr>
<tr>
<td></td>
<td>• Clean up or cover any fuel spills.</td>
</tr>
<tr>
<td></td>
<td>• Move at least 3 m away from refuelling area before restarting.</td>
</tr>
<tr>
<td><strong>A poorly maintained chainsaw or brush cutter</strong></td>
<td>• If any part of the chainsaw or brush-cutter is not working correctly due to damage or wear it should be repaired, replaced, or sharpened.</td>
</tr>
<tr>
<td><strong>Other operators</strong></td>
<td>• You need to be aware of where the other people are and what they are doing.</td>
</tr>
<tr>
<td></td>
<td>• Work at a distance away from other operators equal to at least two times the height of the vegetation being cut.</td>
</tr>
<tr>
<td></td>
<td>• If two operators are working together, only one may make chainsaw cuts at a time.</td>
</tr>
</tbody>
</table>
Personal protective equipment

The approved Code of Practice for Safety and Health in Forest Operations requires operators to have and use the following protective equipment:

- Hi-vis helmet fitted with Grade 4 (or higher) earmuffs
- Hi-vis shirt, vest, or coat
- Protective legwear, chainsaw chaps, or trousers
- Protective eyewear, unless it creates a greater hazard
- Safety footwear providing ankle support
- First Aid kit with at least two large sterile wound dressings.

In addition, each operator should:

- Carry a fire extinguisher
- Carry a means of communication (such as radio, pager, or whistle) and/or have arranged for regular communication with other workers on site (such as a regular a 2-hourly visit)

Chainsaw operators felling trees over 20 cm in diameter must carry at least three wedges and a driving tool.

Equipment and accessories

- Chainsaw or brush cutter of suitable size in good working order, sharp chain or blade.
- Adequate fuel and oil supply in appropriate containers.
- Water bottle - for drinking water to keep operator’s fluid level up.

<table>
<thead>
<tr>
<th>Method</th>
<th>Suggested tools</th>
<th>Suggested spare parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chainsaw</td>
<td>• bar wrench, combination spanner</td>
<td>• sharp chain</td>
</tr>
<tr>
<td></td>
<td>• round file and flat file (including file handles)</td>
<td>• starter cord</td>
</tr>
<tr>
<td></td>
<td>• file guide with depth gauge setter</td>
<td>• starter spring</td>
</tr>
<tr>
<td></td>
<td>• sprocket and clutch grease gun</td>
<td>• air and fuel filters, spark plug</td>
</tr>
<tr>
<td></td>
<td>• tuning screw driver</td>
<td>• chain breaking/joining tool and spare links</td>
</tr>
<tr>
<td></td>
<td>• cleaning cloth</td>
<td>• casing and cover screws</td>
</tr>
<tr>
<td></td>
<td>• operators’ manual</td>
<td>• side cover nuts</td>
</tr>
<tr>
<td></td>
<td>• feeler gauge</td>
<td></td>
</tr>
<tr>
<td>Brush-cutter</td>
<td>• spanners</td>
<td>• spare blades</td>
</tr>
<tr>
<td></td>
<td>• screw drivers</td>
<td>• spark plug</td>
</tr>
<tr>
<td></td>
<td>• allen keys</td>
<td>• starter cord</td>
</tr>
<tr>
<td></td>
<td>• round file and holder</td>
<td>• nuts, bolts, and screws</td>
</tr>
<tr>
<td></td>
<td>• flat file</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• setting gauge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• lubricant</td>
<td></td>
</tr>
</tbody>
</table>
Brush-cutters can be fitted with a range of blade types according to the material being cut. The two main types are:

- Circular saw blades designed for heavy scrub and small trees
- 3- or 4-blade brush blades designed for light to moderate scrub and grass.

### Chainsaw-clearing procedures

For details on use and maintenance of chainsaws see the [Best Practice Guidelines for Chainsaw Use](#) and [Best Practice Guidelines for Tree Felling](#).

- On sloping ground it is easier to start work at the bottom of the hill and work up. As scrub typically leans downhill it will fall that way when cut from the stump.
- When working in small-diameter material, the chain can drag the material towards the operator after it is cut. This can be a hazard, especially if the scrub is a spiny plant such as gorse.

  This can be overcome by:
  - Using a high chain speed
  - Cutting the material close to the ground
  - Using the upper part of the cutter bar, so that the chain pushes the material away from the operator

- When cutting small-diameter scrub it is often tempting to try to cut several stems at once, using the saw in a sweeping motion. If this technique is used, care must be taken to ensure the tip of the bar does not strike:

  - Other stems, causing kickback
  - The ground, blunting the chain
  - Other stems, causing pinching of the bar in partly cut stems
  - Exposed rocks, which can blunt or break the partly cut stems

- The operator should always be aware of the position of the tip of the bar in relation to obstacles.
- Unit standards 6916, 6917 and 43 are prerequisites for chainsaw use.

### Brush-cutter procedures

**General**

- Brush-cutters can be used for both grass and fern, or for clearing woody scrub.
- The blade should be at maximum speed before it is used to cut anything.

  - All of the unguarded part of the blade can be used.
  - Try to cut several stems in one pass. Swinging the brush-cutter from side to side is possible in light material.
  - Cutting with the left-hand half of the blade tends to pull the brush-cutter towards the stem and away from the operator.
  - Cutting with the right-hand half tends to push the blade away from the stem, towards the operator.
  - When cutting larger diameter stems (>3 cm), think of the circular blade as a clock face. Use the section between 10 o’clock and 11 o’clock as it gives most control over the blade.
Brush-cutter safety

- Harnesses for supporting the brush-cutter need to be fitted and used according to the manufacturer’s recommendations.
- The emergency release system for the harness must work effectively.
- The operator shall make sure that no other person comes closer than 3 m (or twice the height of material being cut) whilst he is operating the brush-cutter. When working in heavy and/or difficult scrub or on slopes, this distance will need to increase.
- Only blades designed for the brush-cutter may be used.
- The blade must be properly secured to the head.
- The blade must be kept properly sharpened.
- The blade must not be sharpened while the engine is running.
- The blade must be inspected regularly during the day for cracks.
- The brush-cutter must not be used without a blade guard.
- The brush-cutter must not be used if the silencer is damaged or emitting sparks.
- When refuelling:
  - Do not smoke
  - Make sure the engine is switched off
  - Move 3 m from the refuelling site before restarting the motor.

Sharpening the blade

A correctly sharpened blade is essential for effective use. It avoids wear on the blade, drive mechanism, and engine. It also reduces operator effort and fatigue.

The type of file and the filing action used will depend on the blade being used. Round files are used to sharpen circular saw blades; a flat file is used on the brush blade. For both sorts of blades, follow the sharpening instructions specified by the manufacturer.

Circular saw blades can be easily sharpened without removing the blade from the head.

Make sure the head of the cutter is firmly supported when sharpening. One means of doing this is to cut a small tree at about waist height. Cut a notch in the top of the severed tree to support the bar. Lean the brush-cutter against the support and hold it in position by trailing one leg over the motor and handles, and applying weight on the cutter head.
Three- or four-blade brush blades should be removed or the blade secured from spinning when being sharpened.

**Maintenance**

**Daily**
- Clean the exterior of the saw and check for loose nuts and bolts.
- Clean the air filter.
- Check the blade and blade guard - replace if they are cracked or damaged.

**Weekly**
- Lubricate the linkages and bearing points of the throttle control with thin lubricant.
- Check the starter mechanism.
- Clean the cylinder cooling fins and cooling air intake.
- Check that the blade drive gear is well lubricated.

**Monthly**
- Clean the fuel tank.
- Clean the cooling air fan.
- Clean around the carburettor.
Mechanical site preparation

Types of operations
There are a variety of machines and attachments available for mechanical site preparation. The decision as to which one to use will depend on the type of operation being undertaken. There are two types of operation:

- Slash management
- Soil cultivation and/or mounding.

Slash management
Mechanical slash management may be accomplished by:

- Windrowing
- Mulching
- Line blading.

- Crushing
- Line raking

Windrowing (bulldozer and excavator)
- Windrowing clears the majority of the heavy slash from the area to be planted, leaving it piled in rows. This allows planters and spot sprayers to traverse the site without having to climb over the logging debris.
- It does not have to be absolutely free of slash. If done poorly, this operation can cause the loss of litter layer and topsoil.
- The piles of windrowed material should be kept as narrow as possible, preferably less than 4 m wide.
- Windrowing can occur up and down, or across slope.
- When creating windrows that are orientated up and down the slope, strips of slash should be placed across the windrow every 100 m to control water run-off.
- Working along or around the contour is recommended where this is possible.
- The excavator tracks can be rested on the top of the windrow to reduce the working angle of the machine.
- The windrows should not be formed up to the edge of waterways, and an undisturbed strip should be left next to streams to trap sediment.

Roller crushing (towed and gravity -bulldozer)
- Roller crushing is used both on standing scrub and on the cutover.
- It can be used as a pre-burn preparation (for standing scrub) or as a site preparation treatment on its own.
- It can be used on flat to rolling terrain (towed rolling) or on steep terrain (gravity rolling).
- The aim is to crush the scrub or slash into a compact layer and break the material into smaller pieces to accelerate drying.
- When gravity rollers are being used, the roller weight must not exceed half the weight of the tractor or excavator operating it.
Mulching (slash - bulldozer or excavator)

- On some sites, removing slash by windrowing or burning is undesirable. On these sites, mulchers attached to excavators or tractors can break the slash into a coarse chip-like mulch.
- They can also be used to treat live vegetation as an alternative to spraying.

Line raking (bulldozer or excavator) and line blading (bulldozer)

- Line raking and line blading operations are very similar to each other and are intended to clear lines through sites covered in heavy slash or scrub.
- They are typically carried out by bulldozers, fitted with a slash rake (see photo) or angle-blade.
- The machine pushes a clear lane through the slash.
- Soil disturbance should be kept to a minimum and the aim should be to leave the topsoil layer intact with a minimum amount of disturbance to the litter layer.
- Lines should not be orientated directly down hill if it can be avoided safely.

Soil cultivation and/or mounding

Soil cultivation may be accomplished by a number of means. These include:
- Continuous ripping-mounding
- Spot mounding
- Continuous ripping-mounding (bulldozer)
- Spot ripping-mounding
- V-blading.

- Ripping and mounding are used to cultivate soils where the soil density or drainage is limiting to early tree growth. These machines work best on clear sites. If working on cutover with logging residues, a path needs to be cleared through the slash prior to the cultivation pass.
- The cultivation should be carried out when the soils are dry as this gives the best result for the ripping and sub-surface shatter.
- The equipment used should be matched to the cultivation prescription for the site.
• Operators should stop the machine occasionally and check that they are achieving the prescribed distance between rows (typically 3.5 to 5 m).

• Continuous rip lines should not be orientated up and down the slope as this can lead to erosion. They should be put in following the contours of the slopes.

• Where downhill ripping is being carried out, the ripper should be lifted completely clear of the ground for a distance of 5 m for every 20 m ripped.

**Spot ripping-mounding (excavator) and spot mounding (excavator)**

• Spot mounding and spot ripping-mounding are very similar operations.

• They are typically carried out with cultivation tools mounted on an excavator.

• One of the common tools used is the Wilco spot cultivator. The cultivator head is used first as a rake to push the slash off the spot. Then the head is pulled towards the machine to do the cultivation.

• Excavators can create from one to five rows per pass across the site depending on the size of the base machine, the row spacing, and the site conditions. Typically they do three rows per pass.

**Skidder-based spot mounding**

• There are a number of skidder- or tractor-based intermittent spot mounders available.

• These are mounted on the rear of the skidder and towed across the site. They are often computer controlled and can create planting spots at a predetermined spacing.

**V-blading**

• V-blading is a bulldozer-based operation for creating high continuous mounds.

• It is severe treatment and is only used on sites that are swampy or have a severe frost problem.

• The bulldozer has a V-shaped blade mounted on the front; this is pushed down and into the soil as the tractor drives forward.

• It creates a clear lane between two continuous mounds.

• The height of the mounds depends on the width of the blade, the number of passes and how deep the blade is pushed into the ground. Typically the mounds are 40 to 50 cm high.

• V-blade mounds should be angled across slope and have intermittent drains to control water run-off.
### Summary of operation capabilities

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Description</th>
<th>Slope limits</th>
<th>Production rates</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twin-rope gravity roller</td>
<td>150 kW bulldozer or 40T excavator, 2 winch drums, 6 to 8 tonne roller</td>
<td>&gt; 15°</td>
<td>0.5–2.0 ha PMH</td>
<td>Well-shattered slash, minimal soil disturbance</td>
</tr>
<tr>
<td>Single-rope gravity roller</td>
<td>120 kW bulldozer, 1 winch drum, 2 to 6 tonne roller</td>
<td>&gt; 15°</td>
<td>0.5–1.0 ha PMH</td>
<td>As above</td>
</tr>
<tr>
<td>Towed roller</td>
<td>120 kW bulldozer, 2 to 10 tonne roller</td>
<td>&lt; 20°</td>
<td>0.5–2.5 ha PMH</td>
<td>As above</td>
</tr>
<tr>
<td>Root rake bulldozer</td>
<td>120 kW bulldozer with root rake</td>
<td>&lt; 22°</td>
<td>0.1–0.6 ha PMH</td>
<td>Line raking is cheaper than windrowing with less soil disturbance</td>
</tr>
<tr>
<td>Root rake excavator</td>
<td>20 tonne excavator, root rake</td>
<td>&lt; 22°</td>
<td>0.4–0.6 ha PMH</td>
<td>Better slope ability than bulldozers, with less soil disturbance</td>
</tr>
<tr>
<td>V-rake</td>
<td>120 kW bulldozer V-shaped root rake</td>
<td>&lt; 22°</td>
<td>0.2–0.9 ha PMH</td>
<td>Line raking only</td>
</tr>
<tr>
<td>V-blade</td>
<td>120 kW bulldozer</td>
<td>&lt; 20°</td>
<td>1.1–0.6 ha PMH</td>
<td>Creates severe soil disturbance</td>
</tr>
<tr>
<td>Rippers</td>
<td>120 to 150 kW bulldozer, tool bar, winged ripper</td>
<td>&lt; 20°</td>
<td>0.5–1.5 ha PMH</td>
<td>Requires clear site, preferably dry soil, aim 60 to 70 cm deep</td>
</tr>
<tr>
<td>Ripper mounders</td>
<td>150 kW bulldozer, tool bar, winged ripper, offset discs</td>
<td>&lt; 20°</td>
<td>0.5–1.0 ha PMH</td>
<td>Produces a raised cultivated bed</td>
</tr>
<tr>
<td>Spot mounders</td>
<td>20 tonne excavator, mounding rake or bucket</td>
<td>&lt; 22°</td>
<td>0.2–0.4 ha PMH</td>
<td>Less impact than V-blading</td>
</tr>
<tr>
<td>Spot ripper mounders</td>
<td>20 tonne excavator, winged ripper tine, mounding rake</td>
<td>&lt; 22°</td>
<td>0.2–0.4 ha PMH</td>
<td>More flexible than bulldozer operations</td>
</tr>
</tbody>
</table>

PMH = productive machine hour (delay-free)

### Operational hazards

Mechanical site preparation relies on the safe operation of mobile plant. Specifics of the operation and maintenance of Mobile Plant are covered in the *Best Practice Guidelines for Mobile Plant*.

Presented below are operational hazards related to mechanical site preparation equipment and its use. These hazards are in addition to operator Health Hazards covered previously (*Health Hazards*, page 6).
## Operational hazards

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vibration</strong></td>
<td>• Avoid sudden impacts.</td>
</tr>
<tr>
<td></td>
<td>• Reduce the time your back is exposed to vibration by getting off the machine at least once every hour.</td>
</tr>
<tr>
<td></td>
<td>• Make sure your seat is adjusted properly.</td>
</tr>
<tr>
<td></td>
<td>• Do exercises while seated to even out pressure on spinal discs.</td>
</tr>
<tr>
<td></td>
<td>• Control breathing and relax muscles.</td>
</tr>
<tr>
<td></td>
<td>• Keep a good posture.</td>
</tr>
<tr>
<td></td>
<td>• Keep fit - strengthen abdominal muscles.</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td>• Use hearing protection inside a cab if noise levels are above 85 dB.</td>
</tr>
<tr>
<td></td>
<td>• Reduce noise exposure by keeping doors and windows shut while working.</td>
</tr>
<tr>
<td><strong>Solvents</strong></td>
<td>• Read safety information regarding the solvents being used.</td>
</tr>
<tr>
<td></td>
<td>• Do not get solvents on your skin (wear gloves).</td>
</tr>
<tr>
<td></td>
<td>• Wash hands after use and before eating.</td>
</tr>
<tr>
<td></td>
<td>• Avoid breathing in solvent fumes, ensure there is plenty of ventilation in the work area.</td>
</tr>
<tr>
<td><strong>Diesel fuel or hydraulic fluid under pressure</strong></td>
<td>• Install cylinder rod support struts, or block cylinders and equipment before working on the hydraulic system.</td>
</tr>
<tr>
<td></td>
<td>• Cycle all hydraulic controls after shut down to relieve system pressure. Follow the manufacturer's instructions.</td>
</tr>
<tr>
<td></td>
<td>• When venting or filling the hydraulic system, loosen the filler cap slowly and remove it gradually.</td>
</tr>
<tr>
<td></td>
<td>• Use a piece of cardboard or wood when looking for leaks.</td>
</tr>
<tr>
<td></td>
<td>• Wear a face shield or goggles for protection.</td>
</tr>
<tr>
<td></td>
<td>• Wipe up any spills of oil or diesel on the machine, especially if they are in areas that are used for footing.</td>
</tr>
<tr>
<td><strong>Other vehicles on roads during transportation</strong></td>
<td>• Make sure all flags, lights, and warning signs are in place and visible.</td>
</tr>
<tr>
<td></td>
<td>• Use hazard-warning lights.</td>
</tr>
<tr>
<td></td>
<td>• Use a pilot vehicle if required.</td>
</tr>
<tr>
<td></td>
<td>• Secure all accessory equipment or attachments.</td>
</tr>
<tr>
<td><strong>Climbing in/out of cabs</strong></td>
<td>• Maintain three points of contact while climbing.</td>
</tr>
<tr>
<td></td>
<td>• Face the machine when climbing or dismounting.</td>
</tr>
<tr>
<td></td>
<td>• Be aware of the state of the ladder (ice, water, mud, and oil) and clean if necessary.</td>
</tr>
</tbody>
</table>
### Operational hazards (cont...)

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climbing in/out of cabs (cont...)</td>
<td>• Don’t jump from the machine.</td>
</tr>
<tr>
<td></td>
<td>• Don’t climb off a moving machine.</td>
</tr>
<tr>
<td></td>
<td>• Don’t use either the steering wheel or control levers as handholds when entering or leaving the cab.</td>
</tr>
<tr>
<td>Fire or explosion</td>
<td>• Never fill the fuel tank with the engine running, while smoking, or near a naked flame.</td>
</tr>
<tr>
<td></td>
<td>• Ground the fuel funnel or nozzle against the filler neck to prevent sparking.</td>
</tr>
<tr>
<td></td>
<td>• Do not cut or weld on fuel lines, tanks, or containers.</td>
</tr>
<tr>
<td></td>
<td>• Make sure that all oily rags and other flammable materials are removed from the machine.</td>
</tr>
<tr>
<td></td>
<td>• Check for and repair fuel, oil, and hydraulic leaks before operating the machine.</td>
</tr>
<tr>
<td></td>
<td>• Use non-flammable solvents for cleaning.</td>
</tr>
<tr>
<td></td>
<td>• Store all flammable fluids and materials away from the work area.</td>
</tr>
<tr>
<td></td>
<td>• Check the readiness of fire extinguishers or suppression systems.</td>
</tr>
<tr>
<td></td>
<td>• Clean the machine daily to remove vegetation and oil likely to cause or fuel a fire.</td>
</tr>
<tr>
<td></td>
<td>• Maintain and service machinery according to manufacturer specifications.</td>
</tr>
<tr>
<td></td>
<td>• Ensure that modifications to the machine do not compromise fire safety.</td>
</tr>
<tr>
<td></td>
<td>• Do not operate machinery if it is in a condition that may cause a fire.</td>
</tr>
<tr>
<td></td>
<td>• At the end of the day, park the machine in a clear space (landing or roadside), with access maintained at all times.</td>
</tr>
<tr>
<td>Exhaust fumes</td>
<td>• Ensure that exhaust is not leaking fumes into cab.</td>
</tr>
<tr>
<td></td>
<td>• Ensure there is adequate ventilation for exhaust fumes to escape if working in confined areas.</td>
</tr>
<tr>
<td>Maintenance hazards</td>
<td>• Read the manufacturer’s service and operating manuals.</td>
</tr>
<tr>
<td></td>
<td>• Ensure that you have the necessary information and tools.</td>
</tr>
<tr>
<td></td>
<td>• Stop the engine and remove the key when working on the machine.</td>
</tr>
<tr>
<td></td>
<td>• Check that the work space has adequate clearance, light, and ventilation.</td>
</tr>
<tr>
<td></td>
<td>• Wear PPE (eye protection, gloves, and overalls).</td>
</tr>
<tr>
<td></td>
<td>• Keep clear of moving parts (fans, belts, etc.).</td>
</tr>
</tbody>
</table>
## Operational hazards (cont...)

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
</table>
| **Maintenance hazards (cont...)** | • Start the engine only from the operator’s seat.  
• Make sure the machine is on a level surface with the brakes on.  
• Block the tracks before releasing brakes.  
• Lock or block any hydraulic rams, hoses, or attachments being worked on.  
• Disconnect the battery before working on the electrical system.  
• Remove the ground cable first; connect this cable last.  
• When using gas or electrical welding equipment, use a welding helmet and mask, gloves, and overalls, and clean grease and oil from around work area.  
• When using grinding equipment wear gloves and goggles; make sure grinder guards are in place. |
| **Track hazards** | • Wear gloves if handling recently used pins and bushings from dry joints.  
• Never hit a track tension spring (they could shatter explosively if under compression). |
| **Tyre hazards** | • Follow supplier’s recommendations.  
• Don’t exceed correct tyre pressures.  
• Inspect wheels and tyres daily.  
• Don’t operate on low pressures, cuts, bubbles, and damaged rims or with missing lug bolts or nuts.  
• When adjusting tyre pressure, use a long hose with a self-adjusting chuck. Always stand behind the tread when doing this. Ensure the area to the side of the tyre is clear of other people. |
| **Asbestos** (some older machines may have components containing asbestos in brake linings and gaskets) | • Never use compressed air for cleaning.  
• Avoid brushing or grinding.  
• Use wet methods for cleaning.  
• Wear an approved respirator.  
• Avoid areas where particles may be in the air.  
• Shower after contact.  
• Store food and drink and personal belongings away from the work area.  
• Never eat, drink, or smoke where asbestos is present. |
| **Lifting heavy items** | • Have good footing.  
• Stand close to the item being lifted. |
### Operational hazards (cont...)

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lifting heavy items (cont...)</strong></td>
<td>- Squat with your knees bent.</td>
</tr>
<tr>
<td></td>
<td>- Lift with your legs, keeping your back straight.</td>
</tr>
<tr>
<td></td>
<td>- Whilst carrying the load, hold it close to you.</td>
</tr>
<tr>
<td></td>
<td>- Obtain assistance with lifting large or bulky items.</td>
</tr>
<tr>
<td><strong>Terrain</strong></td>
<td>- Check the plan and the site for holes, bluffs, steep slopes, gullies,</td>
</tr>
<tr>
<td></td>
<td>and high stumps.</td>
</tr>
<tr>
<td></td>
<td>- Do not exceed the manufacturer’s slope limit for the machine.</td>
</tr>
<tr>
<td><strong>Waterways</strong></td>
<td>- Check the plan and the site for wet areas and streams.</td>
</tr>
<tr>
<td><strong>Transmission lines (power)</strong></td>
<td>- Check the plan and the site for power lines. The upper part of the</td>
</tr>
<tr>
<td></td>
<td>machine must stay at least 5 m away from power lines.</td>
</tr>
<tr>
<td><strong>Pipelines (gas)</strong></td>
<td>- Check the plan and the site for water and gas pipelines. Do not</td>
</tr>
<tr>
<td></td>
<td>dig or cultivate near them.</td>
</tr>
<tr>
<td><strong>Other operations</strong></td>
<td>- Check with the supervisor for location of other operations. Stay two</td>
</tr>
<tr>
<td></td>
<td>tree lengths clear of any felling operation and a safe working</td>
</tr>
<tr>
<td></td>
<td>distance from other operations.</td>
</tr>
<tr>
<td><strong>Roads</strong></td>
<td>- Be aware of the impact of your operation on roads.</td>
</tr>
<tr>
<td></td>
<td>- Do not work out on to roads or leave debris on roads unless it is</td>
</tr>
<tr>
<td></td>
<td>unavoidable. If your operation is going to affect a road, then</td>
</tr>
<tr>
<td></td>
<td>warning signs must be placed on the road either side of the affected</td>
</tr>
<tr>
<td></td>
<td>area.</td>
</tr>
<tr>
<td><strong>Heavy slash or stems under tension</strong></td>
<td>- Keep a lookout for large pieces of slash under tension.</td>
</tr>
<tr>
<td></td>
<td>- Be careful with windthrown stems.</td>
</tr>
<tr>
<td></td>
<td>- Position the base of machine behind the rake when releasing tension</td>
</tr>
<tr>
<td></td>
<td>so that flick backs cannot reach the cab.</td>
</tr>
</tbody>
</table>
Personal protective equipment

The personal protective equipment required by machine operators includes:

- Safety helmet (must be worn outside a protected cab)
- Hi-vis garment
- Protective eyewear, if not in an enclosed cab
- Earmuffs or ear plugs if noise levels are likely to exceed 85dB
- Safety footwear (non-spiked)
- Properly fitting clothes or overalls.

In addition, each machine should be equipped with a fire extinguisher, First Aid kit, and a means of communication in the event of an emergency.

Equipment requirements

The specific requirements for attachments and the prime mover are related to the type of operation being performed and the prescription set for the site. It is important for safety and productivity that the machine be fit for task, both in specification and working condition.

Machines working in forest establishment operations must meet the appropriate OPS, FOPS, and COPS or ROPS standards as specified in the Approved Code of Practice for Safety and Health in Forest Operations (Part 3, Section 4).

Where applicable, mobile plant must have a valid warrant or certificate of fitness and an operator’s licence.

Specific details on the requirements of mobile plant are presented in the Best Practice Guidelines for Mobile Plant.

Other safety features and issues

Different machines will have safety features that ensure operators do not come to harm in the course of their duties. To comply with the machine manufacturer’s operator safety manual, relevant parts of the operation and maintenance manual should be read and understood by anyone intending to use the machine.

General

All machines must be fitted with a radio or have other means of communication. A cell phone may be sufficient, if the area being worked has adequate cell phone coverage.

All machines must be maintained according to the manufacturer’s requirements. Each day the machine must be checked to ensure that it is working correctly. The operator or the person in charge of the operation should do this check. Anyone else noticing a defect should inform the operator.

Seat belts

Mobile plant fitted with ROPS or COPS must be fitted with a seat belt or safety restraint complying with AS 2664:1983 or similar standard.

Night work

Machines required to work at night must be fitted with lights adequate to light up the work area. Some operations are not suited to operating at night for safety reasons.

Brakes

A machine must be fitted with brakes capable of holding the machine and its load on any slope that it is working on.
Noise
If operating noise levels might cause hearing damage (greater than 85dB), a warning sign must be displayed. Operators must wear suitable hearing protection.

Operating parts of machine
Pulleys, shafts, belts, and fanbelts must be securely guarded. Winches must have warning signs.

Operating machinery
Where the stability of the machine may be compromised by the slope, weather, or ground conditions, specific hazard control measures shall be put in place.

Equipment shall not be operated on slopes that exceed the maximum specified by the manufacturer. As a guide, subject to weather and ground conditions:

- Rubber-tyred machines should not operate on slopes that exceed 30% (18°)
- Crawler tractors and other similar machines should not operate on slopes that exceed 40% (22°)
- Excavators should not operate on slopes that exceed 40% (22°).

Tracks must be kept in good condition. When working on slopes, a thrown track presents a hazard when it comes off (loss of machine stability) and when it is being put back on.

Safety features, which will require a check daily (or before starting a shift), include:

- Seat belt
- Warning devices
- Safety signs
- Reverse or travel alarms and beepers
- Fire extinguishers
- First Aid kit
- Screens and doors
- Guards, lights
- Horns
- Mirrors
- Fire suppression system
- Radio (RT) or cell phone.

Environmental considerations
It is possible for heavy machines to cause considerable damage to the environment if they are used in an inappropriate way or place.

Potential impacts include:

- Soil erosion
- Reduced slope stability
- Sedimentation in waterways affecting water quality
- Soil compaction
- Visual impacts

Means to reduce or mitigate potential adverse impacts include:

- Leave an undisturbed strip beside waterways and wetlands
- Avoid use on steep slopes
- Keep length of runs (especially downhill) to a limited length
- Fuel supplies should be located at the point where, if spills or leaks occur, fuel cannot enter a waterway.
- Keep the machine and debris away from waterways
- Work around contours where possible
- Avoid oil or fuel spills, and ensure all waste material and fluids are removed from the site.
Use of agrichemicals

The application of agrichemicals is intended to kill and control weed species that will compete with the planted crop.

Careful planning of agrichemical application operations is required to ensure that risks to workers, neighbours, and the environment are avoided.

Agrichemical applications are managed under the Resource Management Act 1991. Therefore, environmental considerations and planning processes may need to be followed before an operation begins.

Any agrichemical will only ever have a temporary effect on the site vegetation. It is important to consider long-term effects. Removing the existing vegetation may allow other weeds to become established and these may be a more serious problem than the vegetation removed. The history of the site should give an indication of what seeds are likely to be present in the soil.

Everyone involved in the operation should understand the objectives, the methods to be employed, the hazards involved, and the procedures to be followed to avoid personal and environmental contamination.

Workers undergoing training in Agrichemical application are required to have an understanding of the New Zealand Standards Code of Practice for the Management of Agrichemicals. This code sets out standards for agrichemical safety during transport, handling, application, clean up, and storage. This agrichemical code is available from Standards New Zealand, Wellington.

This section of the Best Practice Guidelines does not attempt to repeat the content of the agrichemical code. The following sections provide an overview of agrichemical application techniques and should be read in association with the agrichemical code.

Application methods

The application method will depend on whether you are preparing individual planting spots, rows, or entire sites.

Weed-a-metre

- The Weed-a-metre is a handheld device for spot application of granular herbicides for tree releasing.
• The application rate is accurately controlled so there is no need to mix chemicals. The herbicide is applied dry, and so does not have to be mixed with water.
• There is little risk of applying an incorrect dose unless the Weed-a-metre is operated twice on tree or held too low to the ground.
• A spreader cone is used to disperse the granules over the spot.
• The applicator holds a relatively small amount of granules (enough for 70 to 100 trees). An additional supply of granules can be carried on a belt or in a backpack.
• The Weed-a-metre can apply varying doses according to the size of trigger fitted, and is suitable for applying Velpar 20G or Prefix D.

**Spot gun**

• The spot gun is a handheld combination pump and spray nozzle attached to a backpack spray reservoir (5 to 12 litres) for applying liquid herbicides.
• It is suitable for spot releasing with many herbicides.
• It can be fitted with either a solid cone nozzle for circular spots or a fan nozzle for square spots.
• Prescribed spot sizes are typically from 1.5 to 2 m in diameter.
• The spot gun delivers an accurately metered dose.

**Knapsack sprayer**

• The knapsack sprayer is useful for spot or row spraying.
• It consists of a 15- to 20-litre backpack tank to which a handheld lance is attached by a flexible hose.
• A trigger mechanism on the lance controls the spray flow. The lance is pressurised by a hand pump built into the backpack.
• Pressure control is essential as pressure affects flow rate. Some units have a pressure release valve; this limits maximum but not minimum operating pressure.

- Flow control valves are available which control pressure within close limits.
- Two types of nozzle are generally used - the solid cone and the flat fan. A different method of application is required for each nozzle.
  - The solid cone is held above the vegetation at a specified height for a specified time, producing a circular spot.
  - When the fan spray is used, strips of spray are applied either side of the tree being released to achieve a uniform dose of agrichemical over a square or rectangular area. It is important to hold the nozzle at the correct height above the vegetation.
Brush guns

- Brush guns are used to apply large volumes of dilute agrichemical to control vegetation along roadsides, firebreaks, forest boundaries, and isolated patches of weeds.
- They consist of a vehicle-mounted tank (typically on a 4WD utility), a high-pressure pump, and a spray gun on the end of variable-length hose and reel.
- Pressure is controlled by a relief valve that bypasses excess spray back into the tank when the gun is not being operated.
- Spray is applied at between 1000 and 2000 litres per hectare, to thoroughly wet the vegetation.
- The spraying pattern and droplet size can be controlled during spraying by adjusting the gun rather than the nozzle. A jet produces larger droplets with less risk of drift than a hollow cone nozzle.
- Use of clean water is important. If the tank is filled from ponds and streams, the intake should have a filter fitted.

Aerial Application by Helicopters

- Helicopter spraying is the most common form of broadcast agrichemical application.
- Helicopters can rapidly cover large areas of difficult terrain with dense weed growth.
- The boom on a helicopter should be no longer than 80% of the rotor diameter. If the boom is longer, spray from the outer nozzles can be caught in the rotor vortex, increasing the risk of spray drift and reducing spray deposition on the target weeds.
- A variety of nozzles can be fitted to the boom to suit specific needs. In general, the larger nozzles produce larger drop sizes and fewer fine droplets. There is less drift with the larger droplet sizes.

Other application options

- Weed wipers
- MeterJet spray gun
- Mistblowers

Operational hazards

Working with agrichemicals poses the threat of internal or external exposure to chemicals.

Always read the label before opening any chemical container.

In aerial operations, workers must be aware of the hazards associated with working with helicopters (see Best Practice Guidelines for Working with Helicopters).

Presented below are operational hazards related to agrichemical application. These hazards are in addition to operator Health Hazards covered previously (Health Hazards, page 6).
## Operational hazards

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
</table>
| Poisoning from contact with chemicals | • Treat all agrichemicals as poisons.  
• Read the label.  
• Wear personal protective clothing.  
• Handle with care and avoid spills and direct skin contact with chemicals.  
• Wash hands before eating or drinking.  
• Wash clothes and equipment daily.  
• Shower at the end of each working day.  
• Do not rub face or eyes whilst working with chemicals.  
• Avoid spray drift contact.  
• Have the relevant Material Safety Data Sheet on site.  
• Be aware of appropriate First Aid treatment.  
• Do not store or transport chemicals in the passenger compartment of a vehicle. |
| Spray drift into non-target areas | • Avoid spraying in unsuitable conditions (excessive wind, high temperature, and low humidity).  
• Use appropriate techniques and equipment.  
• Be aware of boundaries and sensitive areas. |
| Slips and falls while spraying   | • Take care to find firm footing before moving and spraying.  
• Wear spiked soled boots. |

## Personal protective equipment

The required personal protective equipment will vary with the type and form of the chemicals being used and the method of application. It is important to remember the toxicity is related to dose, and dose is related to concentration.

At the mixing stage, chemicals are highly concentrated and a very small amount can be toxic. A high standard of protective equipment is necessary as well as care to avoid spills and direct contact with the chemical.

Once the chemicals have been mixed with the carrier (water) they are diluted and the amount needed to make a toxic dose is greater. However, the period of exposure to mixed chemicals tends to be much greater and so protective equipment and vigilance are still necessary.
**Protective clothing**
- Safety boots (waterproof)
- Overalls
- Chemical-resistant apron (some chemicals)
- Gloves (waterproof or chemical-proof)
- Goggles or safety glasses
- Hat
- Face mask or respirator.

**Operator requirements**
Spraying operators should be:
- Fit for the task
- Literate or have an understanding of labelling
- Responsible
- Fully trained or undergoing training - including First Aid for poisoning.

Agrichemicals can enter the body by inhaling, swallowing, or skin contact. Anyone involved with the use of agrichemicals should be able to recognise the symptoms of poisoning (nausea, headaches, skin or eye irritations, and abnormal or erratic behaviour).

Always seek medical attention as soon as possible if poisoning is suspected.
If seeking medical treatment, take the label or a container with a readable label with you. The Materials Safety Data Sheet will provide information on First Aid treatment should chemical poisoning be suspected.

**Spray additives**

**Surfactants (wetting agents)**
Surfactants may be added to the mix for application. Surfactants are chemicals added to the water to reduce its surface tension. This increases its ability to stick to and spread across the surface of the weed leaves, and improves its absorption into the plant. This is important where the weed has a waxy leaf surface, such as broom.

Some sprays come with surfactants already in the mix and putting in more may decrease the effectiveness of the spray. Always read the label and follow the recommendations. Failure to add a surfactant when needed may result in a failure to control the target weeds.

**Dyes**
Dyes are sometimes added to the mix in spot spraying so that operators can see which spots have been treated after the spray has dried. They can also be used in pre-plant spraying to indicate where the treated spot is before the vegetation begins to die off. It is important to use a dye that is safe and does not affect the chemical composition of the agrichemical. Read the label. Use dyes that are registered as food additives.

**Thickeners**
Spray thickeners are sometimes added to reduce the amount of spray that goes into fine droplets, therefore reducing the amount or risk of spray drift. They will not, however, eliminate fine droplets.

If used inappropriately they can cause an increase in fine droplets, reduce coverage and increase flow rate through the nozzles.

These additives should be used with caution, and only after testing.
Environmental considerations

- It is essential that the spray hits only the target area, especially if the boundary indicates a land ownership change.
- Contamination of streams or standing water must be avoided.
- Ensure dosage rates are appropriate for the target weeds; over-concentration can adversely affect the environment.
- Spills should be avoided, or contained, and cleaned up.
- All empty containers must be removed from the site and disposed of in an appropriate manner.
- Do not mix or load any chemicals within 20 m of a waterway, or at a point where spills may flow into a waterway.

Handling procedures

- There are three main forms in which agrichemicals are available:
  - Liquids
  - Granules
  - Powders.
- If you are using wettable powders take care when handling and mixing that you do not inhale any of the powder. They are often very fine powders and easily disturbed.
- Wear approved protective clothing and equipment (including facemask or respirator).
- Work in a well-ventilated area.

- Stay upwind of any chemical while mixing or pouring.
- When mixing chemicals, make sure you are on a flat clear site and have all the necessary equipment, including measuring cylinders, funnels, mixing paddles, and protective equipment. Clean up any spills and have a spill kit appropriate to the chemical being used.
- Dispose of empty containers, residual chemical, and contaminated material in an approved manner.
- Wash up after handling chemicals, and before eating/drinking. Washing facilities must be provided where chemicals are being mixed, handled, or applied.
- Supplies of drinking water must be clearly labelled.
- Smoking is prohibited while spraying, mixing, or handling chemicals.

Storage procedures

- Ensure containers are stored upright, properly sealed in a secure area, out of reach of children and pets.
- Always store agrichemicals in their original containers with the labels on. Keep the containers clean and free of spills.
- Check for and dispose of any leaking or damaged containers.
- Keep agrichemicals away from food and drink.
- Have smoko away from the storage site.
- Store away from waterways, ponds, and other sensitive areas.
- Children and unauthorised persons are not allowed access to the chemicals.
- Measuring and mixing equipment shall be stored with the agrichemicals.
**Weed-a-metre procedure**

**Application**
The Weed-a-metre is held over the tree to be treated. The trigger is activated to apply a single dose of agrichemical.

**Care and maintenance**
At the end of each day’s use the weed-a-metre should be emptied, and any granules returned to their original container.
The trigger mechanism should be dismantled and cleaned with a dry cloth. **Do not** blow on it.

**Spot gun spraying procedure**

**Calibration**
Calibration is the process of managing the volume of active ingredient applied to the target vegetation, to ensure that the proper (prescribed or recommended) amount of chemical is applied per hectare.
The principles of calibration are basically the same regardless of the method of application.

1. Read the product label for handling and mixing instructions.
2. Read the job prescription for specifications, including application rate of active ingredient, spot size and shape, and any other requirements (surfactant, dye etc).
3. Select a nozzle that will cover the prescribed spot, and gives good even coverage, and measure the radius of the the spot sprayed.
4. Calculate the area of the treated spot, using the formula $A = \pi r^2$.
5. Check the volume of spray required for coverage of a spot (from the spot gun).
6. Calculate the volume of spray required per hectare.
7. From the prescribed application rate of active ingredient, calculate the volume of water required per hectare.
8. Pour half of the water into the mixing tank and add the chemical.
9. Mix thoroughly, add the remaining water and mix again.

<table>
<thead>
<tr>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>If the nozzle sprays a spot with a radius of 0.7 metres (as prescribed), then the area sprayed per spot is: $3.142 \times 0.7 \text{ m}^2 = 1.54 \text{ m}^2$</td>
</tr>
<tr>
<td>And if the average volume of spray is 5 millilitres per spot, then the application rate in litres per hectare is: $\frac{5 \times 10000}{1000 \times 1.54} = 32.5 \text{ litres per hectare}$</td>
</tr>
<tr>
<td>(Litres per spot to make up a hectare)</td>
</tr>
</tbody>
</table>

If then the required application rate of active ingredient is:
4 Kg (of for example Atrazine) per hectare, and Gesaprine is 50% active ingredient (Atrazine)

Then the 32.5 litres of spray per hectare will require 8 litres of Gesaprine and 24.5 litres of water.

<table>
<thead>
<tr>
<th>Care and maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>After use, the tank and plastic hose should be thoroughly rinsed and the nozzle removed and washed.</td>
</tr>
<tr>
<td>The gun should be stripped and cleaned to remove all traces of chemical.</td>
</tr>
<tr>
<td>When reassembling, apply a thin film of castor oil to all moving parts and O-rings.</td>
</tr>
<tr>
<td>Blocked nozzles should be cleaned with a stiff nylon bristle. They should not be cleaned with wire, pins, or other metal objects as these can damage the nozzle and alter the flow and spray pattern, <strong>Do not</strong> blow on nozzles to clear them.</td>
</tr>
<tr>
<td>Always use clean water when spraying. Water from ponds and streams may contain grit or weed that can block nozzles.</td>
</tr>
</tbody>
</table>
**Knapsack spraying procedure**

**Calibration**

1. Read the product label for handling and mixing instructions.
2. Read the job prescription for specifications, including application rate of active ingredient, spraying pattern, and any other requirements (surfactant, dye etc).
3. Select the type of nozzle for the spraying pattern or other requirements.
4. Measure the average time to spray a single spot, or set area of strip (e.g. 2 metres x 10 metres).
5. Spray into a measuring cylinder (or similar vessel) for a minute or other set time, and measure the volume of spray delivered.

(6) Calculate the volume of spray per spot, or set area of strip, as follows:

\[
\text{Volume delivered per minute} \times \frac{60}{\text{time per spot or strip in seconds}} = \text{Volume of spray per spot or strip}
\]

(7) Convert the area of the spot or strip to hectares, to calculate the application rate of spray per hectare.

\[
\frac{\text{Volume per spot or strip (mL)}}{1000} \times \frac{10000}{\text{Average area per spot of strip (m2)}} = \text{Average rate of spray per hectare}
\]

(8) Check the prescribed application rate of active ingredient per hectare from the job prescription or product label.

**Mixing to required rate**

Mix the chemicals and water as for the spot gun.

**Spraying**

- Locate the tree carefully.
- Position the applicator at the right height, allowing for vegetation height and ground slope.
- Use the correct application method, as specified in the job prescription.
- Ensure the area to be treated is fully covered and use a work pattern that is efficient.
- If spraying around trees sensitive to the agrichemical, use a protective cone or shield to keep the spray off the tree.
- Do not spray foliar-active agrichemicals if rain is expected. Heavy rain within 4 to 6 hours of application will reduce the effect of some agrichemicals.

**Care and maintenance**

- After use, the sprayer must be washed thoroughly with a mild detergent and flushed with clean water.
- Seals and gaskets must be checked for wear and leaks regularly.
- Do not allow water used for flushing or washing to contaminate standing or running water, and do not spill on ground used for growing trees.

**Brush gun spraying procedure**

**Calibration**

Read the product label, and the job description. The volume of spray required depends on the nature of the

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*Agrichemical application*
vegetation (it must be wetted). It is useful, however, to know at least approximately the volume applied as this will enable the operator to calculate the quantity of chemical and water volume required to complete the job.

Accurately measure an area to be treated and determine the volume of spray (litres) to be applied.

Calculate the application rate using: \[
\frac{\text{Active ingredient (litres)}}{\text{Area sprayed (hectares)}}
\]

**Spraying**

- Work in a consistent pattern, moving the nozzle in a zigzag pattern back and forth so that all the target weeds are covered.
- Do not work in strong winds.
- Spray with the wind, not into or across the wind as this will lead to drift, hitting of non-target areas, and blow back towards the operator.
- Do not spray foliar active agrichemicals if rain is expected. Heavy rain within 4 to 6 hours of application will reduce the effect of some agrichemicals.

**Care and maintenance**

- Clean water is important. If the tank is being filled from a stream or pond, a filter should be fitted to the intake to keep out unwanted particles. Particles can damage the pump and block the nozzle.
- A pressure gauge should be fitted to the nozzle so the operator can monitor pressure. A drop in pressure can affect the droplet size, spray output rate, and spray distance. Pressure drops are often due to blocked filters.
- Spare filters should be carried to reduce downtime and maximise use of good spraying conditions.
- Do not clear blocked nozzles by blowing into them; use a nylon brush or bristle.
- After use the sprayer should be thoroughly washed and flushed if different chemicals are to be used. This is especially relevant if hormone sprays (Tordon, Grazon) have been used. Do not allow the flushing or washing water to contaminate standing or running water, and do not allow it to spill on to ground used for growing crops.

**Helicopter spraying procedure**

**Calibration**

The spray emission rate must be adjusted to ensure the specified application volume per hectare is achieved, at the flying speed and swath width being used.

The required spray output can be calculated from the following formula:

\[
\text{Volume output (litres/min)} = \frac{\text{Speed (km/hr) \times Swath width (m) \times Application rate (litres/ha)}}{600}
\]

**Note:** This formula also covers spraying using a vehicle mounted spray boom.

**Speed**

Aircraft airspeed indicators are graduated in knots. The formula above requires speed to be expressed as kilometres per hour. To convert knots to kilometres per hour, multiply by 1.852.

It is usual to accept the reading from the airspeed indicator. Should there be any doubt about its accuracy, timing the aircraft over a measured distance of at least 1 kilometre and averaging several runs can be used to check speed.

\[
\text{Speed (km/hr)} = \frac{\text{Distance flown (km) \times 3600}}{\text{Time taken (seconds)}}
\]

Ground speed can also be obtained as a Global Positioning System (GPS) output.
Swath width

This is the distance in metres between two adjacent flight lines.

For single-pass spraying, the swath width equals the effective swath width. For half-overlap spraying, it equals half the effective swath width.

If the swath width is entered in the above equation, there will be no confusion when calculating the output for half-overlap or single-pass spraying. It is usual to accept the value for the effective swath width quoted by the pilot.

If you have measured it previously, it is unlikely to have changed unless the length or configuration of the boom has been altered.

Effective swath width

Measurement of the effective swath width is difficult and the results can be confusing. It should only be attempted when the wind speed is less than 5 knots and its direction is constant.

1. Select a flat open area, ideally an airstrip.
2. Place a line of spray traps (paper sheets stapled to squares of card) on the ground at 1-m spacings, at right angles to the wind direction. The line should be about 40 m long.
3. Mark the centre with a flag and locate two flags at about 20 m on either side of the line so that all three flags form a line that cuts the centre of the trap line at right angles.
4. Fill the tank with a dye solution and spray on to the ground until solution is emitted from the outer nozzles.
5. Ask the pilot to make a spray run at operational height and speed along the flagline, at a right angle to the trapline.
6. The spray should be switched on at least 50 m before, and switched off 50 m after the line.
7. Watch the flags to accurately record the wind direction as the aircraft passes upwind over the trapline.
8. Examine the dye deposit on the traps. The effective swath is the distance between the points at each end of the line where the deposit falls at a concentration equal to half the average deposit found in the middle of the line.

For a general estimate of spray coverage, the paper traps are quite satisfactory. However, be aware that different droplet sizes tend to diffuse into the paper, making it difficult to visually assess the quantity of spray deposited. As droplet diameter doubles, volume increases eightfold, and this makes it difficult to estimate the effective swath.

If more detailed information is required, paper can be replaced with Mylar (the transparent material used for displaying through an overhead projector).

1. After spraying, the dye-covered Mylar sheets can be carefully removed from the cards and placed individually into translucent plastic cups that have been numbered to correspond with the line of traps (e.g., 1 to 40).
2. Add a measured quantity of water and shake. This will colour the solution in proportion to the amount of dye deposit.
3. For accurate swath width determinations, the patterns from three runs should be averaged.

There is likely to be considerable variation between spray patterns. At least three runs are necessary to determine how the nozzle arrangement should be altered.

Spray output

As the spray pump of a helicopter is driven either from the main engine through a hydraulic or belt coupling, or by an electric or petrol auxiliary motor, the spray gear can be fully pressurised and the spray output measured while the helicopter is on the ground.

1. Fill the tank with water, and ask the pilot to spray until all the air has been expelled from the boom.
2. Check that the nozzles are working correctly and that there are no leaks in the system.
3. Turn off the spray, refill the tank, and mark the water level in the sight gauge.
4. Spray for 1 minute.
If the volumes indicated on the tank have not already been checked, determine the spray output by measuring the volume that needs to be added to bring the liquid in the tank back to its original level. Changing the boom pressure can make small adjustments to output, but major changes require the addition or removal of nozzles. The output should be within 5% of the calculated value.

**Example:**
Calculate the spray output required to apply 150 litres/ha from a helicopter flying at 40 knots, with a swath width of 10 m.

Output (litres/min)  
= \frac{\text{Speed (km/hr)} \times \text{Swath width (m)} \times \text{Application rate (litres/ha)}}{\text{600}}  
= \frac{(40 \times 1.852) \times 10 \times 150}{600}  
= 185.2 \text{ litres/minute}

If the helicopter has a capacity of 400 litres, the composition of a load can be calculated as follows:

\[ \text{Area sprayed per load (ha)} = \frac{\text{Size of load (litres)}}{\text{Application rate (litres/ha)}} \]

Each helicopter load must contain the amount of product/ha x number of hectares sprayed per load. To apply 4 kg active ingredient (terbuthylazine) per hectare, 8 litres of product (50% a.i.) are required. Therefore each load of 400 litres must contain 8 x 2.7 = 21.6 litres of product, e.g., Gardoprim. Part fill the mixing tank, add 21.6 litres of Gardoprim, and top up with water to bring the volume up to 400 litres.

**Spraying**
- The pilot is always in control of the operation.
- He/she should make a preliminary check of the area, preferably with the ground controller, to identify boundaries and obstacles.
- A map and aerial photos should be available.
- Some form of swath marking, mapping, or control should be used to ensure complete coverage without unnecessary overlap or double passes (GPS is commonly used).
- The helipad should be located as close as possible to the spray block. Preferably it should be close to a water supply, but if this is not possible good road access will be required for bringing in water.
- To minimise drift in sensitive areas, the helicopter should fly at an altitude of not more than 10 m above the target and cease spraying when the wind exceeds 10 km/hour.
- Target blocks near sensitive areas should be sprayed with the wind blowing away from the sensitive area.
- Drift also increases when the temperature is above 20 degrees or humidity falls below 80%.
- If the spray release height is greater than 10 m, then lowering the air speed to 25 knots can reduce drift.
- Still conditions are not suitable for spraying near sensitive areas as fine droplets will disperse in all directions.
- Do not spray in fog or inversion layers as spray may drift long distances off target.
- Drift can be controlled by:
  - Using large droplet sizes and high water rates
  - Removing swirl plates from the nozzles
  - Angling nozzles towards the rear of the aircraft to reduce wind shear
  - Using drift-reducing additives.
Effects of fire

A high degree of skill and planning is needed to use fire safely and effectively.

Fire can be used on its own. Alternatively, some pre-treatment of the site may be necessary to kill or crush vegetation.

In the past, fire was a popular method of land preparation. However, the area treated with planned burn-offs is currently around only 1500 ha/year.

The effects of a fire are directly related to how well it is planned and managed. The aims are to safely and effectively remove the unwanted vegetation, scrub, and slash. There should be no threat or damage to life or surrounding areas.

An effective fire removes the unwanted material cleanly in a controlled manner.

An ineffective fire may be one that;

• does not burn well and leaves material partly burnt or unburnt
• burns too hot and intensely, removing too much of the litter and topsoil
• burns out of control into areas that were not part of the planned burn.

Controlled burnoffs can be expensive and risky, and create large clouds of smoke that can cause irritation to neighbours. Some fires can cause loss of vital nutrients from the site.

Despite these reservations there are instances where fire is the preferable option for clearing a site. The use of controlled burns also gives the opportunity to train staff in preparation for fighting wild fires.

The following sections provide an overview of safety issues associated with controlled burnoffs. For more detailed information on fire behaviour, tools, and procedures refer to the Best Practice Guidelines for Fire Fighting and Controlled Burnoffs.

Operational hazards

Hazards at fires include burns, smoke inhalation, heavy machinery, and helicopters.

Presented below are an Operational Hazards related to fires. These hazards are in addition to operator Health Hazards covered previously (Health Hazards, page 6).

Note that further detail on fire fighting is presented in Best Practice Guidelines for Fire Fighting and Controlled Burnoffs. Also, further details on helicopter hazards are presented in Best Practice Guidelines for Working with Helicopters.
## Operational hazards

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ineffective personal protective equipment (PPE)</strong></td>
<td>- Do not perform operation if PPE is ineffective.</td>
</tr>
<tr>
<td></td>
<td>- Replace any worn, damaged or expired PPE.</td>
</tr>
<tr>
<td></td>
<td>- Routinely check the condition of your PPE.</td>
</tr>
<tr>
<td><strong>Heat stress</strong> (flushed face, sweating, weakness, tiredness, dizziness, nausea)</td>
<td>- Dress appropriately to the level of physical activity you are doing.</td>
</tr>
<tr>
<td></td>
<td>- Wear loose fitting clothing that allows air circulation (open trouser legs and wrist cuffs).</td>
</tr>
<tr>
<td></td>
<td>- Move to a cooler area until body temperature drops and stabilises.</td>
</tr>
<tr>
<td><strong>Heat exhaustion</strong> (weak pulse, shallow breathing, clammy skin, pale face, slow reactions)</td>
<td>- Remove person from the fire area until they have recovered.</td>
</tr>
<tr>
<td></td>
<td>- Contact medical personnel/Crew Boss.</td>
</tr>
<tr>
<td><strong>Heat stroke</strong> (increased heart beat, hot dry skin, high body temperature, flushed face, headaches &amp; dizziness, patient is irritable and confused)</td>
<td>- Urgent medical attention is required.</td>
</tr>
<tr>
<td></td>
<td>- Loosen clothing and cool with water.</td>
</tr>
<tr>
<td></td>
<td>- Evacuate the patient.</td>
</tr>
<tr>
<td><strong>Changes in fire behaviour and getting trapped by fire</strong></td>
<td>- Have an escape route.</td>
</tr>
<tr>
<td></td>
<td>- Be alert to changes in the fire movement.</td>
</tr>
<tr>
<td></td>
<td>- Do not go into unburnt areas uphill or downwind of the fire.</td>
</tr>
<tr>
<td></td>
<td>- Do not run through flames unless you can see clear ground beyond them.</td>
</tr>
<tr>
<td></td>
<td>- If trapped in a vehicle, do not get out until the fire has passed.</td>
</tr>
<tr>
<td></td>
<td>- Watch for wind changes and whirlwinds.</td>
</tr>
<tr>
<td><strong>Noise (from pumps, aircraft, or machinery)</strong></td>
<td>- Wear appropriate hearing protection.</td>
</tr>
<tr>
<td></td>
<td>- Move away from the noise zone if not required to be there.</td>
</tr>
<tr>
<td><strong>Radiant heat (from fire) and embers</strong></td>
<td>- Wear protective clothing.</td>
</tr>
<tr>
<td></td>
<td>- Stay back from the fire edge, away from radiant heat.</td>
</tr>
<tr>
<td></td>
<td>- Have an escape route planned.</td>
</tr>
<tr>
<td></td>
<td>- If you are getting too hot, move away from the heat source into a cooler position.</td>
</tr>
<tr>
<td></td>
<td>- <strong>If someone receives a burn:</strong></td>
</tr>
<tr>
<td></td>
<td>☐ cool the burn with water for 10 minutes</td>
</tr>
<tr>
<td></td>
<td>☐ seek immediate medical help</td>
</tr>
<tr>
<td></td>
<td>☐ watch for and treat for shock.</td>
</tr>
</tbody>
</table>
### Operational hazards (cont...)

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
</table>
| **Smoke inhalation** | • Stay on the upwind edge of the fire.  
• Move to a safe area to recover.  
• Have a smoke mask available.  
• Stay close to the ground if in smoke. |
| **Heavy machinery** | • Be familiar with the plan and where the machines are.  
• Stay clear of any machines that are operating.  
• Do not approach the machine until the operator indicates that it is safe to do so.  
• Be aware that smoke limits visibility - the operator may not be able to see. |
| **Other workers** | • When using hand tools work at least 3 m away from other workers, or if felling in tall scrub work at least two times the height of the scrub away from other workers. |
| **Hand tools** | • Use the right tool for the job.  
• Ensure tools are in good condition - do not use damaged tools.  
• Use a file with a handle to sharpen tools.  
• Carry tools in one hand at the balance point, blade forward.  
• Pass tools to others handle first.  
• Don’t leave hand tools lying around on the ground - prop them up against something.  
• Secure tools when transporting them. |
| **Out of planned area burning** | • Install adequate firebreaks.  
• Have an observer looking for spot fires from a vantage point.  
• Have the fire perimeter manned by trained and equipped staff to stop the spread of fire.  
• Light the fire in a controlled manner. |
| **Helicopters (see Best Practice Guidelines for working with helicopters for more details)** | • Observe all the rules and procedures described in [Best Practice Guidelines for Working with Helicopters](#).  
• Conduct a safety briefing before starting a helicopter operation.  
• The pilot is in charge.  
• Approach the machine from the front, never from the rear.  
• Only approach when pilot indicates that it is safe to do so.  
• Approach from the downhill side on sloping terrain. |
## Operational hazards (cont...)

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Helicopters (cont...)</strong></td>
<td>• Observe all the rules and procedures described in <em>Best Practice Guidelines for Working with Helicopters</em>.</td>
</tr>
<tr>
<td></td>
<td>• Conduct a safety briefing before starting a helicopter operation.</td>
</tr>
<tr>
<td></td>
<td>• The pilot is in charge.</td>
</tr>
<tr>
<td></td>
<td>• Approach the machine from the front, never from the rear.</td>
</tr>
<tr>
<td></td>
<td>• Only approach when pilot indicates that it is safe to do so.</td>
</tr>
<tr>
<td></td>
<td>• Approach from the downhill side on sloping terrain.</td>
</tr>
<tr>
<td></td>
<td>• Hold any long items (shovels) level below the waist.</td>
</tr>
<tr>
<td></td>
<td>• Make sure there are no loose items in the landing area.</td>
</tr>
<tr>
<td></td>
<td>• Stay clear of any sling loads until they are landed.</td>
</tr>
<tr>
<td></td>
<td>• Keep the crew together on one side of the landing zone.</td>
</tr>
<tr>
<td></td>
<td>• Do not approach any slung equipment unless you are involved in its operation (monsoon buckets / fire lighters).</td>
</tr>
<tr>
<td><strong>Foam (if handling concentrate or)</strong>*</td>
<td>• Wear appropriate protective clothing (waterproof coat and trousers, gloves, boots, goggles).</td>
</tr>
<tr>
<td><strong>Powerlines</strong></td>
<td>• Look for fallen lines in the burnt area.</td>
</tr>
<tr>
<td></td>
<td>• Do not spray water near powerlines or electrified railway lines.</td>
</tr>
<tr>
<td></td>
<td>• Confirm lines are dead before attempting to extinguish burning power poles.</td>
</tr>
<tr>
<td><strong>Fixed-wing aircraft</strong></td>
<td>• Conduct a safety briefing before starting a fixed-wing aircraft operation.</td>
</tr>
<tr>
<td></td>
<td>• Beware of moving propellers.</td>
</tr>
<tr>
<td></td>
<td>• Only approach a fixed-wing aircraft from behind the wings.</td>
</tr>
<tr>
<td></td>
<td>• The pilot is in charge. Follow his/her instructions.</td>
</tr>
</tbody>
</table>
Personal protective equipment

All personnel attending a controlled burnoff are required to wear approved personal protective equipment meeting the requirements of the National Rural Fire Authority, Rural Fire Management Code of Practice, Forest & Rural Fires Act 1977.

The minimum requirements are:

- Leather work boots (woollen socks)
- Ankle to wrist outer clothing (wool or fire-resistant), loose to allow air flow and cooling
- Cotton or woollen undergarments (no polypropylene)
- Approved fire control or forestry helmet
- Safety goggles
- Earmuffs (at least Grade 4), or other hearing protection, if working around pumps or machinery.

In addition, the following items should be considered:

- Balaclava and gloves to protect against radiant heat
- Dust mask to protect against ash and dust
- A small pack to carry extra clothing and some food.
- Water bottles to allow water to be carried
- Clothing which restricts normal movement
- Protective clothing or equipment which may restrict vision.

You should not wear the following items:

- Shorts and short-sleeved shirt
- Synthetic clothing (including chainsaw chaps/trousers)
- Clothing which restricts normal movement
- Protective clothing or equipment which may restrict vision.

Worker requirements

All staff attending a controlled burnoff should be:

- Physically fit and unaffected by drugs or illness
- Fully briefed on the plan for lighting and managing the fire, and what to do in case of break-outs or other emergencies
- Adequately clothed
- Trained in the use of all equipment they are using and safety procedures.

Controlled burnoff procedures

For information on the tools, techniques, and procedures to be used for controlled burning refer to the Best Practice Guidelines for Fire Fighting and Controlled Burnoffs.
# Glossary of terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos</td>
<td>Material used in brakes and clutches on older machines; the powder from this material can cause health problems if inhaled.</td>
</tr>
<tr>
<td>Batter slopes</td>
<td>The cut edge of roads and banks above the road where the road is on or around a hill.</td>
</tr>
<tr>
<td>Calibration</td>
<td>Measurements made to check accuracy or determine rate of application.</td>
</tr>
<tr>
<td>COPS</td>
<td>Cabin Operator Protective Structure.</td>
</tr>
<tr>
<td>Cutover</td>
<td>Area of forest which has been recently harvested.</td>
</tr>
<tr>
<td>Cultivation</td>
<td>Loosening of soil to improve root development and tree growth.</td>
</tr>
<tr>
<td>Culvert</td>
<td>Pipe under a road or track to allow water to cross under.</td>
</tr>
<tr>
<td>Cut-offs</td>
<td>Small earthworks across tracks which divert water off the track.</td>
</tr>
<tr>
<td>dB</td>
<td>Decibels, a measurement of how loud a noise is.</td>
</tr>
<tr>
<td>Duff</td>
<td>Layer of decaying needles and small branches on the ground.</td>
</tr>
<tr>
<td>End-haul</td>
<td>Road-making operation where loose material cut out of the hill to create the road is trucked away rather than pushed over the edge.</td>
</tr>
<tr>
<td>Erosion</td>
<td>Movement of soil downhill through natural processes.</td>
</tr>
<tr>
<td>Fire break</td>
<td>Strip of cleared land kept free of slash and vegetation.</td>
</tr>
<tr>
<td>Flume</td>
<td>Trough attached to a culvert to carry water away from any loose soil or fill.</td>
</tr>
<tr>
<td>FOPS</td>
<td>Falling Object Protective Structure.</td>
</tr>
<tr>
<td>Grade</td>
<td>Measurement of slope as a ratio of distance up and distance forward.</td>
</tr>
<tr>
<td>Granular agrichemicals</td>
<td>Weed-killing chemicals manufactured as small grains.</td>
</tr>
<tr>
<td>Gravity roller</td>
<td>Machine for crushing scrub that rolls down a hill under its own weight and is then winched back up.</td>
</tr>
<tr>
<td>Agrichemicals</td>
<td>Chemicals used to control vegetation.</td>
</tr>
<tr>
<td>Hi-vis</td>
<td>High-visibility clothing or helmets, usually a bright fluorescent colour.</td>
</tr>
<tr>
<td>Hydro-seeding</td>
<td>Applying seed, fertiliser, and sticking agent to slopes in order to speed up grass colonisation of bare ground.</td>
</tr>
<tr>
<td>Iwi</td>
<td>Maori tribal groups.</td>
</tr>
<tr>
<td>Job prescription</td>
<td>Detailed specification for a job, covering what is to be done where and to what standard.</td>
</tr>
<tr>
<td>Knapsack sprayer</td>
<td>Sprayer used to apply chemicals to individual tree spots.</td>
</tr>
<tr>
<td>Land preparation</td>
<td>Operations preceding planting used to modify land to enhance tree growth.</td>
</tr>
<tr>
<td>Glossary of terms (cont...)</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Mitigate</strong></td>
<td>To remove the effect of, to alleviate.</td>
</tr>
<tr>
<td><strong>Monsoon bucket</strong></td>
<td>Large bucket for carrying water under a helicopter used to drop large amounts of water directly on top of a fire.</td>
</tr>
<tr>
<td><strong>Motor manual</strong></td>
<td>Operations where power tools carried by hand are used (chainsaws).</td>
</tr>
<tr>
<td><strong>Mounding</strong></td>
<td>Creation of small heaps of soil on which trees are to be planted.</td>
</tr>
<tr>
<td><strong>Mulching</strong></td>
<td>Breaking slash and vegetation into small chip-like chunks.</td>
</tr>
<tr>
<td><strong>OPS</strong></td>
<td>Operator Protective Structure prevents objects entering the cab.</td>
</tr>
<tr>
<td><strong>Prescription</strong></td>
<td>See Job prescription</td>
</tr>
<tr>
<td><strong>Prime-mover</strong></td>
<td>Machine to which different attachments can be added for cultivation or slash preparation.</td>
</tr>
<tr>
<td><strong>Releasing</strong></td>
<td>Manual or chemical operations to remove competing vegetation from around young trees.</td>
</tr>
<tr>
<td><strong>Remedy</strong></td>
<td>To put right or fix after an impact has occurred.</td>
</tr>
<tr>
<td><strong>Ripping</strong></td>
<td>Pulling a steel tine through the soil to cultivate it.</td>
</tr>
<tr>
<td><strong>Ripping-mounding</strong></td>
<td>A combination of ripping and mounding to create a mound of loose soil over a rip line; can be a continuous line or in spots.</td>
</tr>
<tr>
<td><strong>ROPS</strong></td>
<td>Roll-over Protective Structure.</td>
</tr>
<tr>
<td><strong>Running surface</strong></td>
<td>The part of a track or road which vehicles travel on.</td>
</tr>
<tr>
<td><strong>Ruts</strong></td>
<td>Tracks left in the soil by harvesting machinery. The soil is compacted and disturbed.</td>
</tr>
<tr>
<td><strong>Sediment</strong></td>
<td>Fine soil that ends up in water.</td>
</tr>
<tr>
<td><strong>Sediment traps</strong></td>
<td>Holes or other structures designed to capture water and allow sediment to settle out before the run-off reaches a stream.</td>
</tr>
<tr>
<td><strong>Slash</strong></td>
<td>Layer of logging residue (branches, etc.) left on the cutover after logging.</td>
</tr>
<tr>
<td><strong>Slasher</strong></td>
<td>Hand tool for cutting grass and scrub.</td>
</tr>
<tr>
<td><strong>Soak hole</strong></td>
<td>Hole in the ground dug to trap water and allow it to soak into the ground (common in areas with pumice soils).</td>
</tr>
<tr>
<td><strong>Soil compaction</strong></td>
<td>Compression of soil can inhibit root growth.</td>
</tr>
<tr>
<td><strong>Spot gun</strong></td>
<td>Sprayer used to apply chemicals to individual tree spots.</td>
</tr>
<tr>
<td><strong>Survival rate</strong></td>
<td>Percentage of the planted trees alive at the time of assessment.</td>
</tr>
<tr>
<td><strong>Topography</strong></td>
<td>The shape of the ground, whether it is steep or flat.</td>
</tr>
<tr>
<td><strong>Topsoil</strong></td>
<td>The first layer of soil under the needles. It is rich in nutrients and organic matter.</td>
</tr>
</tbody>
</table>
Glossary of terms (cont...)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urupa</td>
<td>Maori burial sites.</td>
</tr>
<tr>
<td>Visual impacts</td>
<td>Whether the operation and its effects can be seen, and how much this changes the public perception of the forest.</td>
</tr>
<tr>
<td>Water table</td>
<td>Gutter along the edge of a road to collect water.</td>
</tr>
<tr>
<td>Waahi tapu</td>
<td>Sites of significance to Maori, including those of sacred and cultural significance.</td>
</tr>
<tr>
<td>Windrowing</td>
<td>Moving the slash on the cutover into long parallel piles.</td>
</tr>
</tbody>
</table>
Index of unit standards

The following provides an index to NZQA Unit Standards directly linked to the content of these Best Practice Guidelines.

Unit

1221 Demonstrate knowledge of job prescriptions for forest operations
1232 Demonstrate knowledge of forest planting site quality
3285 Demonstrate knowledge of personal safety at vegetation fires
6935 Operate an excavator type tracked machine in a forestry situation
6936 Operate a tracked machine in a forestry situation
6966 Apply environmental management to mechanised land preparation operations
17761 Demonstrate knowledge of quality determining factors in commercial plantation forestry
17772 Demonstrate knowledge of environmental requirements in forest operations
19955 Prepare land for forest establishment using gravity roller crushing
19956 Prepare land for forest establishment using a V-blade
19957 Prepare land for forest establishment using towed roller and blade crushing
19958 Prepare land for forest establishment using spot cultivation techniques
19959 Prepare land for forest establishment using root and line rakes
19960 Prepare land for forest establishment using cultivations methods
19961 Prepare land for forest establishment using mulching
19962 Prepare steep terrain for forest establishment using excavator windrowing
19767 Clear vegetation for forest establishment using motor manual means
Poroporoaki

Whaia te huarahi o te mātauranga
Pursue the path of learning.

Ka piki ake koe, ka whānui atu nga pae.
The higher you climb, the wider the horizons.

Rapuhia nga pae i roto, I tōu nei ngakau.
Seek also the horizons within your self.

E tipu, e awhi, e tū.
Grow, embrace, stand tall.
Vision, knowledge, performance