PART C — APPLICATION OF EROSION AND SEDIMENT CONTROL PRACTICES

9.0 SPECIFIC FORESTRY ACTIVITIES – EROSION & SEDIMENT CONTROL

This section outlines commonly undertaken forestry activities, how they might be undertaken from an erosion and sediment control perspective and the types of control measures that can be used to minimise potential effects on the receiving environment. Each activity is described, relevant considerations discussed, and an erosion and sediment control toolbox portrayed.

The activities discussed in this section include:

- Roading
- Landing Sites
- Haul Tracks and Firebreaks
- Land Preparation
- Harvesting
- Post Harvesting Management

The development of roads, landings and haul tracks are essentially earthwork activities and Sections 6 & 7 have outlined a number of commonly implemented erosion and sediment control methodologies for these activities.

A table outlined in Figure 9.4 provides a summary of the operating thresholds based on a catchment size of all of the erosion and sediment controls mentioned in the previous section.

9.1 Access Roading

Construction of roads can be a major contributor of sediment. Forward planning can reduce this risk by locating roads away from vulnerable areas, carrying out the work during fine weather in summer etc. Progressive stabilisation e.g. by progressively laying aggregate on completed sections of road, will further reduce the risk of erosion and sediment generation.

During construction, erosion and sediment control measures will generally be required, particularly where an overland flow path or a watercourse crosses the earthwork area, and at discharge points. These erosion and sediment control systems are generally temporary as, when completed, the road carriageway should be stabilised and not require further sediment control.

At the completion of construction, all bare areas should be stabilised. In roading terms this usually means that the road surface will have a cover of aggregate, that watertables are stabilised such as by lining with suitably sized aggregate, and that cut and fill batters have been hydroseeded or sown with grass seed.

Where the road is to be constructed on ridge tops with minimal cut and fills, aggregate can be progressively placed on completed portions of the road and often no or only minimal sediment controls are required. Controls become necessary when a disturbed area cannot be stabilised within one working day. Effectively this means that work may proceed without sediment controls while the weather window is clear, however when work stops for a weekend and/or rain is forecast, then treatment and control measures, such as those detailed in this guideline, should be installed[1].

9.1.1 Roading Considerations

- Construct roads on, or as near as possible, to ridge tops, natural benches and flatter slopes. Where possible, steep slopes should be avoided, particularly where watercourses are close by.
- Minimise clearing and keep the road width to the minimum necessary to operate safely and effectively.
- Where possible, do not construct roads in the floor of gullies, and minimise gully crossings as much as possible.
- Do not discharge runoff directly to a watercourse. Where possible, discharge runoff from unstabilised areas through a sediment control measure (*e.g.* decanting earth bunds) and then to stable outfalls.
- Where steep side cuts cannot be avoided, ensure adequate cross-formation drainage is installed and that these channels flow onto stable or erosion proof areas such as spurs. Ensure they do not discharge onto areas of fill. End hauling of soil may be necessary on steeper slopes to prevent side cast material slipping into watercourses.

[1] Note that there is considerable risk in relying on favourable weather to complete earthworks or to harvest an area via haul tracks without erosion and sediment control measures in place. While there are some small scale operations that can be carried out without specific controls installed because immediate stabilisation can be achieved, most require some control measures to be installed and maintained during the works.

- Sediment control measures are required to treat runoff from all bare areas during construction where the road cannot be progressively stabilised before forecast rain. Areas can be stabilised with, for example, grass, aggregate, slash or mulch.
- Complete cut faces by leaving a rough surface with small benches to help grass seed and or hydro-seed to establish. Operate the machine parallel to the cut or at right angles to water flow direction, leaving small ledges as often as is practicable. This can also be achieved by dragging the teeth of an excavator bucket horizontally across the cut.
- Compact road fills to appropriate engineering standards. Failed fills can cause significant environmental damage and be expensive to repair.

9.1.2 Roading - Erosion & Sediment Control Toolbox

Erosion Control

Recommended erosion control methods for roading include (specific details are contained in Section 6).

- Stabilise bare road surfaces (e.g. with aggregate) and batters (e.g. hydroseed) as soon as practical.
- Culvert pipe sizes should be a minimum of 300mm diameter to minimise blocking. Note the general pipe sizing in Table 8 (section 8.3.3)
- Stabilised inlets and outlets for culverts should be installed. Discharged flows must not be discharged directly onto or over fill, or erosion-prone areas. In those situations, runoff should be piped or flumed to an erosion proof area, and suitable energy dissipation provided in the form of rock rip-rap or stable areas of slash.
- Stabilise watertables with aggregate or other approved methods as soon as practicable once the gradient exceeds 2% (see section 6.4.3). This is because water table velocities can become high and erosive on bare slopes and particularly as slope grades increase (see Table 6 below).
- Install rock lining and/or check dams in the water table drains when the slope and distance increases the erosion risk (e.g. rock, sandbags – section 6.3.6).
- Hydroseed or apply grass seed and mulch to bare areas as soon as possible.

Sediment Control

Common sediment control methods used for roading include: (specific details are contained in Section 7):

- Silt Traps and Decanting Earth Bunds to be installed during the construction phase and retained until the area has been stabilised against erosion. These are appropriate for areas of less than 3,000m^2 to 5,000m^2 (note that the catchment area refers to all of the catchment, not just the bare area alone).
- Silt Fences can also be used for disturbed areas of less than 3,000m^2 in area (although they are less robust).
- Sediment Retention Ponds for areas exceeding 5,000m^2

Table 9 Watertable velocities on different grades and surfaces [2]

Slope of Site (%)	Velocity – bare clay surface (m/s)	Velocity – rock lined (100 to 150mm) (m/s)
2	3.2	1.6
5	5.1	2.6
10	7.2	3.7

[2] A drain 0.5 m deep, 1:1 sides and 0.5 m wide channel base has been assumed.

9.2 Landing Sites

Landings may be permanent or temporary formations. They are generally constructed 12 to 18 months prior to harvesting and must be well drained and stable with appropriate erosion and sediment controls in place.

The construction of landings can require significant earthworking with the potential to generate large volumes of sediment from rainfall events. Therefore, all sediment-laden flows should be directed to sediment treatment measures prior to discharge from the landing. The site may require shaping or a diversion channel/bund installed to direct the flows to one or more control systems. Furthermore, the cumulative impacts of many landing sites within a single forest, if constructed without appropriate erosion and sediment control, can potentially create a significant adverse effect on watercourses.

Hard, compacted surfaces such as landings can be left unstabilised for varying timeframes provided the appropriate erosion and sediment controls are installed and any necessary approval (resource consent and/or winter works extension) from the ARC has been obtained. Any loose soil should be stabilised with grass seed, mulch, slash etc. An example of a landing site that was constructed during the earthworks season and not used for harvesting immediately after construction is outlined in Photo 9.2.

Photo 9.1 Landing Site with bunded edges to direct water flow into decanting earth bund prior to discharge. Slash & offcuts used as stabilisation of embankments. Decanting earth bund located at upper point of landing. Landing area less than 3,000m^2.

In practice, the disturbed areas over the landing tend to become progressively become smaller during harvesting operations due to the coverage of slash and mulch, generally leaving only that area where logs are being processed requiring sediment control. In these circumstances it is still essential that the exposed areas and any contributing catchment are identified and that treatment measures are installed and fully maintained. If the entire landing including 'stabilised' areas of log stockpiles all discharge to one discharge point, then the treatment measures must be sized accordingly.

9.2.1 Landing Site Considerations

- Where possible locate landings outside riparian corridors and away from perennial (Category 1) watercourses and overland flow paths to minimise upper catchment flows onto the landing and associated tracks.
- Construct landings with a slight slope or crown to promote efficient drainage in the required direction.
- Ensure landings are constructed providing sufficient space for sediment control measures such as silt traps and decanting earth bunds to be formed for the treatment of flows off the landing. Control measures should be located away from the main harvesting action to avoid damage or sited such that they remain intact until the landing has been stabilised.
- Take care in constructing erosion and sediment control measures as the concentrated water flows can create their own problems if discharged to unstable areas (e.g. see Silt Traps and Decanting Earth Bund details in section 7.6 and 7.7).
- Compact any fills associated with landings to appropriate engineering standards.
- Ensure exposed ground is stabilised as soon as practicable following completion of the earthworks, using sowing of grass seed, hydroseeding or mulching as necessary.
- Ensure slash is disposed to a stable part of the landing, or plans are put in place to either pull it back at the end of harvesting, or to burn it.
- Many problems at landings occur after the completion of logging and are due to failure of runoff control measures. Maintenance may be necessary for a number of years after logging has been completed.

Photo 9.2 Landing site that has been hydroseeded on the batters and margins as erosion control. Decanting earth bunds although not seen in this photograph, were installed during the construction of the landing. Landing has been left in this state during the winter period to enable harvesting operations to occur some seasons later.

9.22 Landing Sites - Erosion & Sediment Control Toolbox

Erosion Control

Recommended erosion control methods for landings include (specific details are contained in Section 6).

- Divert any upper catchment clean water flows from the landing surface.
- Install Diversion Channels, Diversion Bunds and Cut-off Drains to break up overland flow paths.
- Undertake interim stabilisation with grassing, hydroseeding, mulching, placement of aggregate, slash, etc following construction of the landing and prior to use (particularly on fill embankments).
- Following the use of the landing, stabilise remaining areas that pose an erosion and sedimentation risk. This may include runoff diversion measures such as Piping and Fluming to remove surface water down any unstable landing batters. Hydroseed or apply grass seed and mulch to bare areas.
- Monitor the site and remedy as required.

Sediment Control

- Common sediment control methods used for landings include Silt Traps, Decanting Earth Bunds, and Silt Fences. Specific details are contained in Section 7

Outlined in Figures 9.1 to 9.3 is a spectrum of different erosion and sediment control devices suitable for use on landing sites. These scenarios are not considered exhaustive but provide some examples of the different toolbox of controls available. The configuration and type of control used along with the location of these devices may have some influence on the operating radius of any hauling and therefore some careful planning is required to ensure these controls operate at peak efficiencies whilst hauling operations are occurring.

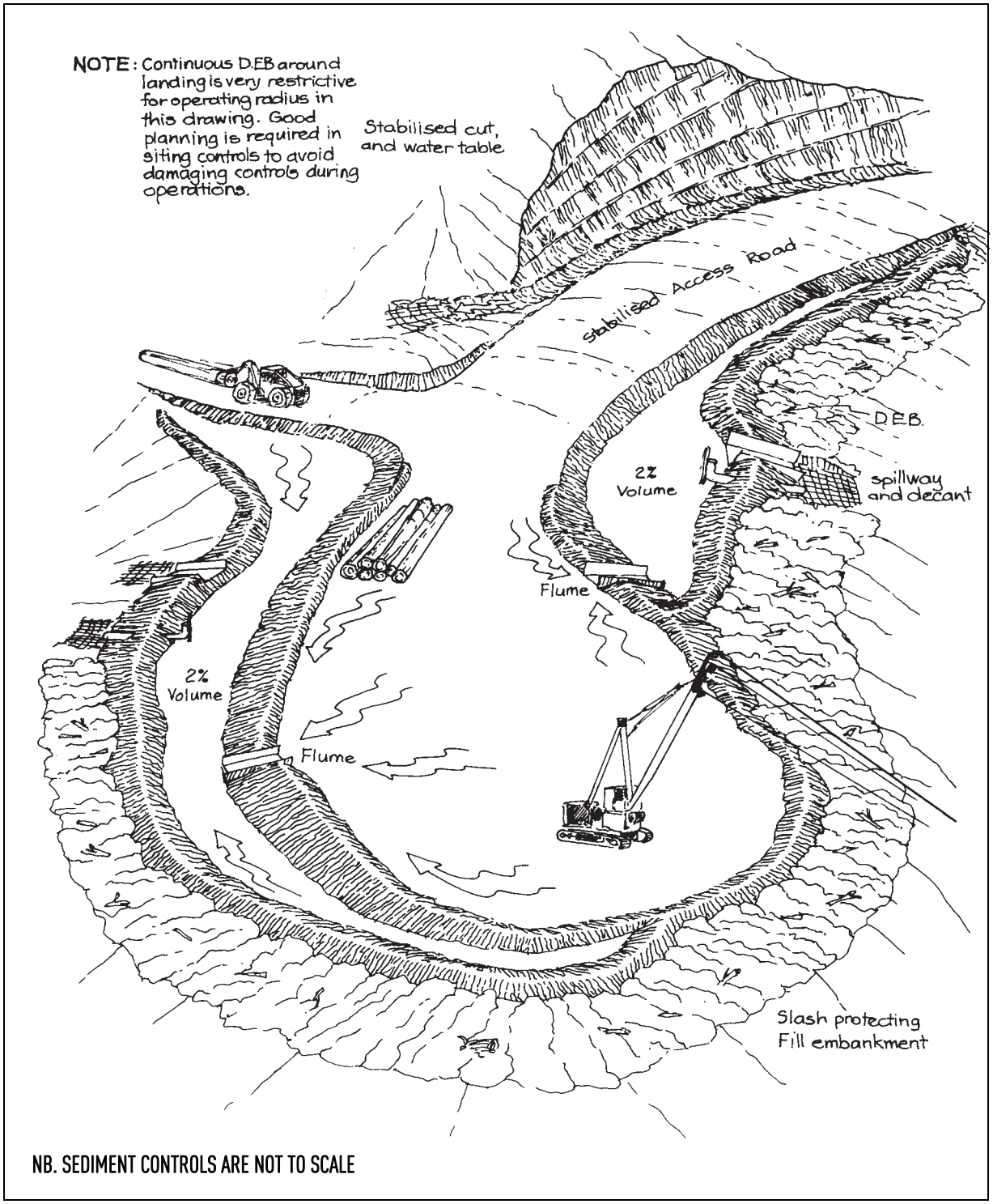

Figure 9.1 **Scenario1 (90 degree Operating Radius):** --Toolbox of erosion and sediment controls used on a landing site and accessway. The prime treatment devices are continuous decanting earth bunds with flumes conveying the flows from the processing area. Note that that the cut batter and watertable have been stabilised and therefore require no treatment. *Note: not to scale.*

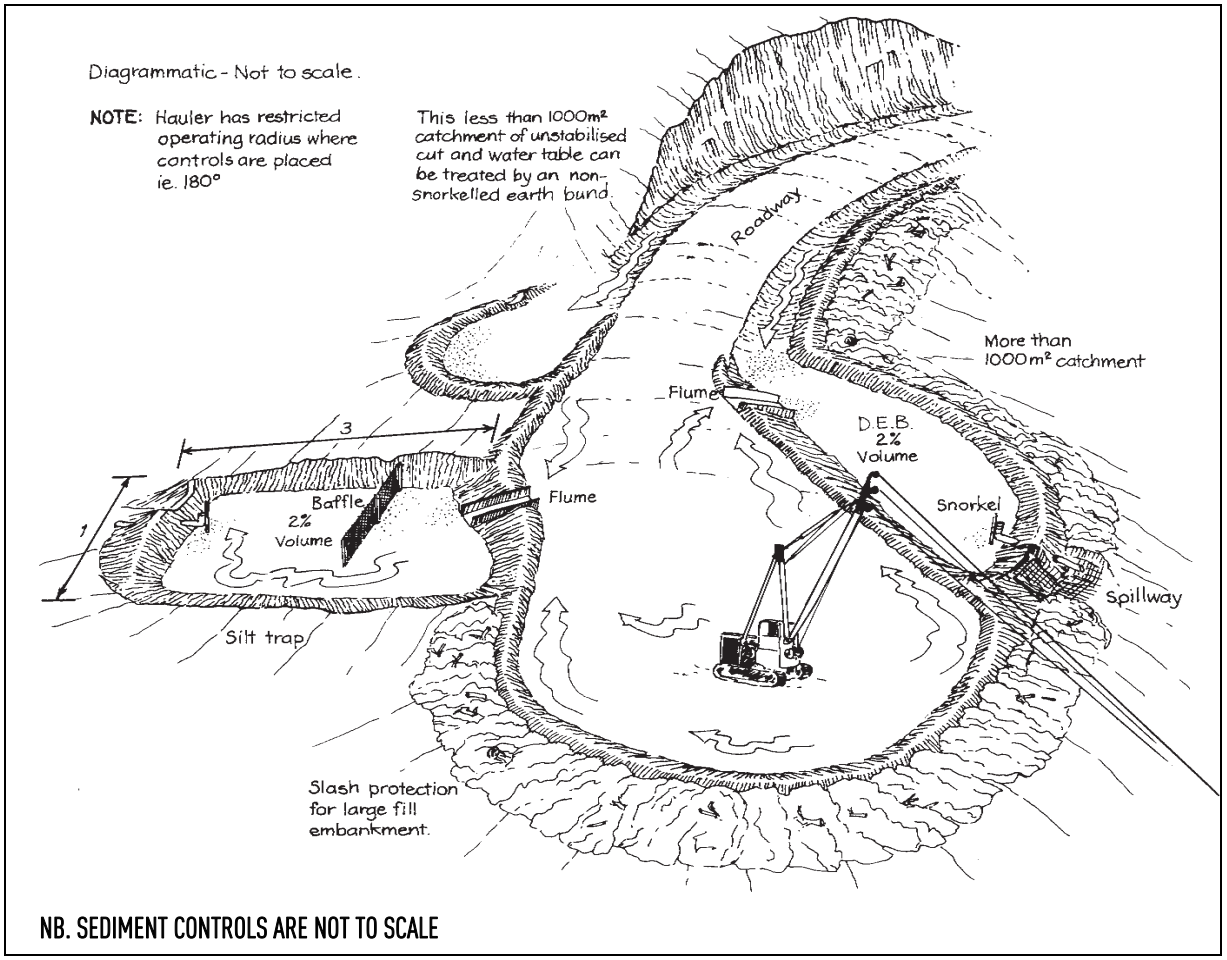

Figure 9.2 **Scenario2 (180 degree Operating Radius):** --Toolbox of erosion and sediment controls used on a landing site and accessway. The prime treatment devices used in this example are a continuous decanting earth bund and silt trap with flumes conveying the flows from the processing area. Note that that the cut batter and watertable which have not been stabilised, have a catchment of less than 1,000m^2 and therefore runoff is treated via an earth bund (horseshoe –shaped) with no decant installed. *Note: not to scale.*

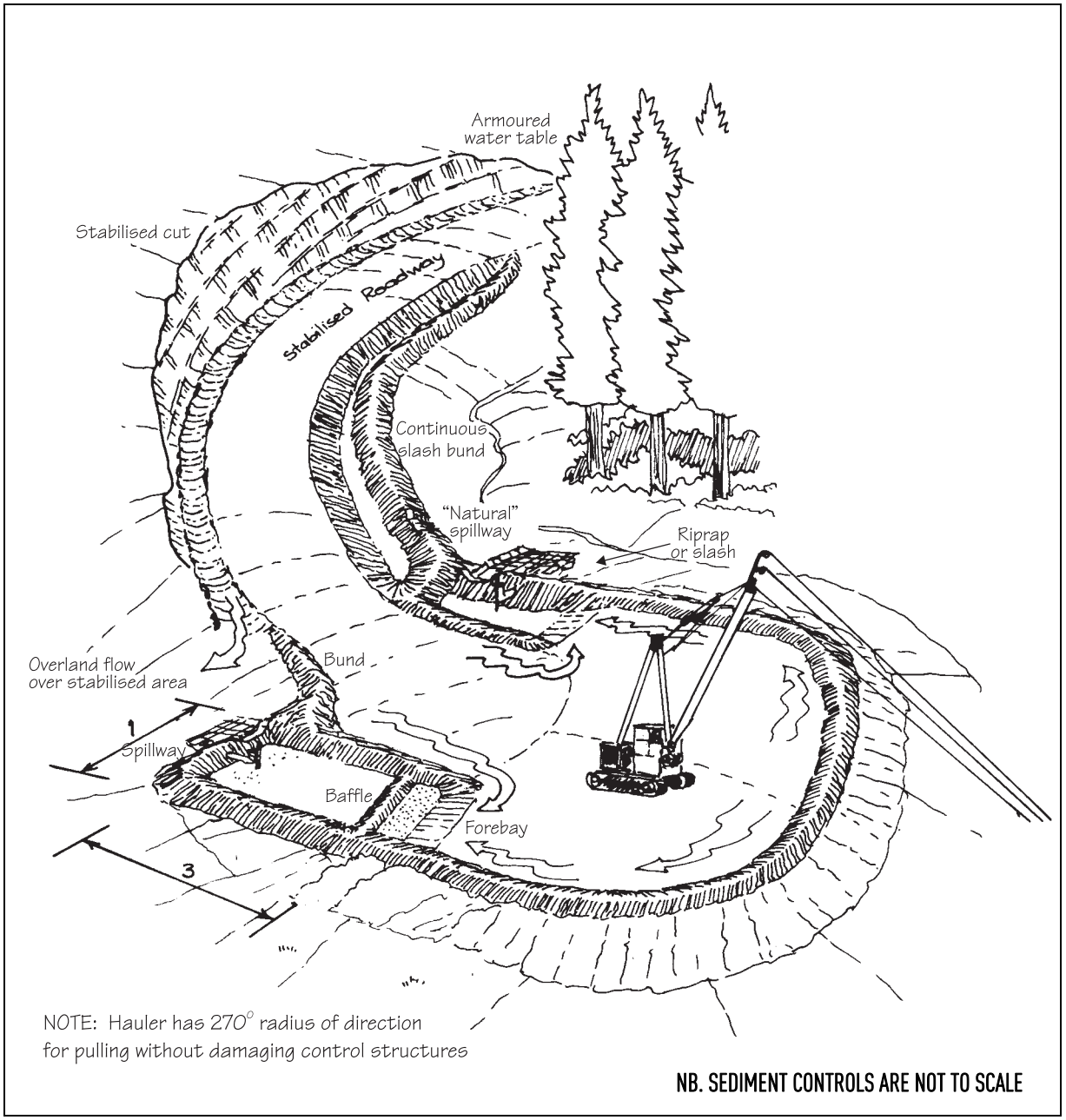

Figure 9.3 **Scenario3 (270 degree Operating Radius):** –Toolbox of erosion and sediment controls used on a landing site and accessway. The prime treatment devices (two silt traps) have been located away from the hauler enabling a clearer operating radius. *Note: not to scale.*

9.3 Haul Tracks and Firebreaks

Haul tracks and firebreaks often cut through or across overland flow paths and ephemeral watercourses, and their construction has the potential to generate large volumes of sediment. Maintaining sediment control measures on these tracks and firebreaks is problematic, particularly for tracks that are in constant use, as the logs being hauled often block control measures such as cut-off drains installed to intercept and deflect flows. Sediment laden flows should be directed to a control system in places where the water naturally flows, to be less reliant on physically maintaining cut-offs with machinery. These treatment systems should be operational until the tracks are stabilised by oversowing or placing of slash when no longer required.

9.3.1 Haul Track Considerations

- Tracks and firebreaks should be located to minimise the likelihood of debris and/or soil entering watercourses.
- Tracking results in the concentration of runoff and consequently an increase in erosion. Minimise erosion by tracking across contours and where possible locate tracks on ridges rather than gullies.
- Make sure extraction tracks do not lead directly to watercourses.

Photo 9.3 An example of a poorly designed and constructed haul track with no erosion or sediment controls allowing sediment to discharge directly into adjacent watercourse

9.3.2 Firebreak Considerations

- Do not undertake firebreak formation (by earthworks construction) on steep slopes that fall directly to watercourses. If fire breaking is necessary in these locations, the firebreak should be formed without soil disturbance (e.g. hand cut vegetation, then apply herbicide/fire retardant).

9.3.3 Haul Track and Firebreaks - Erosion & Sediment Control Toolbox

Erosion Control

- Recommended erosion control methods for haul track and firebreaks include diversion channels/bunds, cut-offs/contour drains to shorten overland flow distances and to direct flow to stable disposal areas. Specific details are contained in Section 6.
- Stabilisation of these areas is best achieved by the progressive application of a layer compressed slash to a thickness of 300mm before machinery is tracked over. If this method is applied, then sediment controls may not be required.

Sediment Control

- Common sediment control methods used for haul tracks and firebreaks include Silt Traps, Decanting Earth Bunds and Silt Fences. Specific details are contained in Section 7. Note for maintenance purposes, it is recommended that these areas are stabilised with the methods outlined in Section 6 (*eg* slash) as continual repair of these sediment controls after harvesting may be difficult.

9.4 Land Preparation

Land preparation may include disturbance of the ground surface, desiccation or removal of existing vegetation or a combination of both. In doing so, these activities expose bare land and therefore increase the risk of soil erosion. They may be subject to the rules contained in the Auckland Regional Plan: Sediment Control (Nov 2001).

Mechanical land preparation should be carried out on the contour as much as possible to minimise runoff being concentrated down the cultivated lines. Where downhill runs are unavoidable, limit them to 50 metres (approximate) maximum length. Do not attempt these runs on slopes that are too steep for the tractor to reverse back up. Blade or rake at least one line on the contour along the lower boundary of downhill operations. This will help prevent runoff concentration at low points or gullies. Finish downhill runs well before any fill batter slopes e.g. landings or access roads. Always leave an undisturbed strip beside watercourses.

If carrying out cultivation on landings, cultivate or rip the landings across their general slope. Repair or reinstate drainage channels and cutoffs after any mechanical preparation. Be particularly careful near roadside edges.

Do not push slash from windrows or firebreaks into watercourses. Align windrows of compacted slash along the contour of sloping land. This will help form a barrier and filter for trapping sediment (although note that slash bunds are not a recognised sediment control measure in the Auckland region).

When working near watercourses, gullies or steep areas, work along the contour. Always inspect the site at the completion of operations for areas that will potentially erode and implement remedial action.

9.5 Harvesting Operations

9.5.1 Planning

The need to carry out planning prior to harvesting is vital. If harvesting is well planned, any potential adverse effects to the receiving environment will be minimised. A harvest plan (see section 5) should include the location of proposed roading and stream crossings (including standards and pipe sizes), landing locations, recommended haul tracks, hauler settings and any special precautions required for sensitive areas. All watercourses, historic sites and other features that will need to be considered (such as wetlands, electric powerlines, gas lines, waahi tapu sites etc) should be identified. Earthworks & harvest planning should involve the proposed contractors if possible, and the preliminary work should include a thorough site inspection. Aerial photos, contour maps and clear indications of property boundaries, will assist in the harvest planning process.

Photo 9.4 A practice to be avoided. Blind hauling 'sweeping' sediment into watercourses as well as unnecessarily exposing earth.

9.5.2 Extraction

In general, hauler settings and landings should be located so that extraction is away from watercourses and sensitive areas.

(a) Ground-based systems

Keep tracking and stumping to a practical minimum. Where soil conditions and the terrain allow, use a few carefully chosen tracks and stay on these, rather than taking shortcuts that may cause unnecessary ground disturbance.

Carry the butts of logs off the ground, or on the machine wherever possible. Keep the machine blade up, and do not bulldoze soil and stumps needlessly.

Do not haul through or along streams. However, if the operation necessitates the extraction of logs across a stream, and there is no alternative route, then use a permanent or temporary crossing (See section 8.2).

(b) Cable systems

If cable systems are used in environmentally sensitive areas, wherever practical, keep the settings small, the haul distance short, and the hauling direction uphill.

Where possible, minimise cross-slope haul-lines that damage areas of protective vegetation or sweep slash and soil into watercourses. Where possible, lift logs clear of these areas, and always use the appropriate machine with the required tower height and carriage system to suit the site. Don't form log channels or furrows that direct and concentrate runoff towards a watercourse.

9.5.3 Slash and Residue Management

Prior to harvesting operations commencing, there should be some assessment of whether large volumes of slash and residue will be produced, following on-site processing. Where possible, dispose of the slash to a stable area, bearing in mind that the slash is an excellent resource for stabilisation material. If large amounts of slash and residue will be produced, then contingency measures to deal with the volume of material will need to be put in place.

Slash and residue from processing operations can cause problem "bird nests", if not managed in a proper manner. With all slash and residue disposal, the overburden material will collapse over time, as the woody debris rots down. Disposal sites for slash and debris should be carefully located in designated areas, and marked on site for clear identification. These areas should be on stable land, well away from steep slopes, fill material, slips, gully heads, and riparian areas. This will reduce the likelihood of adverse off-site effects. In this instance post operation water control is critical to ensure the slash and slope on which it sits does not become waterlogged and aid slope instability.

Photo 9.5 A practice to be avoided. An example of offcuts and slash providing a physical barrier to flows within a Category 1 (Perennial) watercourse.

9.6 Post Operational Management/Maintenance

9.6.1 Management

On completion of harvesting operations, ensure that the following matters (where appropriate) are addressed:

- Remove any logging debris from within the 1:100 year (1%AEP) flowpath of Category 1 watercourses that may provide significant barriers to waterflow and/or of fish passage; either by hand, or with appropriate machinery, whilst avoiding bank disturbance and/or deepening of the stream channel.
- Remove and rehabilitate all temporary crossings in a manner that minimises sediment being discharged into the watercourse.
- Construct cut-off drains on extraction tracks, haul paths[3] and firebreaks (refer Table 1 of Section 6.3.2) until adequate stabilisation has been achieved.
- Ensure there is adequate drainage provided on landings and that slash and logging residue is in a stable position to minimise the potential to collapse.
- Slash and logging residue should be placed in a stable position to minimise the potential to collapse and adversely affect watercourses.
- Vegetate and/or stabilise any exposed sidecast material, or fill batters on earthworks sites except where approved at the time of site monitoring by the ARC.
- Ensure that runoff is channelled safely over batter slopes and onto stable areas.

[3] Haulpaths in this context, are defined as linear tracks or pathways where repeated use of machinery has disturbed the ground and exposed bare earth. Typically used for log hauling.

9.6.2 Maintenance

Post operational maintenance of earthworks is very important. A regular maintenance program should be put in place, to ensure that erosion and sediment controls continue to function properly. This maintenance program should be established at the onset of earthworking and continue until the earthworks have been stabilised and/or the erosion and sediment controls no longer required. The development of a formalised schedule may assist in this regard.

Ensure that stormwater runoff is managed appropriately, and that the systems are capable of working well between inspections. In some instances it may be preferable to over design the systems that have been constructed in areas of difficult access and therefore may be checked less often. To achieve this may require for example, larger control measures, deeper cut-offs, *etc*.

When undertaking grading of roads, ensure that control measures, flumes and drainage channels are not blocked by the grader. Inspect after grading to ensure that all systems are working. Check that culverts and bridges are not blocked or scoured out. Landings, haul paths, tracks and fire breaks can become problem areas, because they are seldom used again after an operation is completed. In some instances, ongoing maintenance of earthworks may be required until the earthworks areas are stabilised. In general, areas at greater risk should be inspected more frequently.