Stable roads and tracks

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Construction and maintenance of on-farm roads and tracks are high erosion risk activities. Roads and tracks can erode badly in heavy rains and quickly become untrafficable or unsafe. The erosion is usually due to poor design or lack of maintenance. If the track becomes a drain, it will quickly scour, with the soil ending up as sediment in drains and waterways. Eroding tracks can be a significant contributor to soil loss.

Track design

Lack of drainage and use in wet conditions have eroded this track.

Good track design minimises erosion potential. The first step is to consider all possible routes. Topographic maps and aerial photographs are useful, but it is essential to inspect potential routes and walk along them. A track on gentle terrain is usually more stable and requires less maintenance than a track with high steep batters that are difficult to stabilise. The design should be based around the limitations of the soil rather than the vehicle as the limits of stable track design are much lower than four wheel drive vehicle capability.

A well-designed track:

- lies above flood level
- follows the contour of the land as much as possible
- uses ridge tops and north and west facing slopes where possible
- involves minimal cutting and filling
- has a slight grade to stop water ponding on the track and creating boggy areas
- has a slight cross-slope to encourage drainage
- is separated from streams by vegetation buffers to trap any eroding soil
- has effective outlets for drains and culverts to minimise erosion.

Areas to avoid when designing a new track include:

- natural waterways
- low-lying wet areas and soaks on hillsides
- actively eroding or historically eroded areas, especially areas where mass movement has occurred
- native vegetation
- cultural heritage sites.

Track grade

The grade is the slope running along the length of the track (not across the track). The greater the slope the faster water will flow along it, increasing the risk of erosion, so the aim is to keep the grade as low as possible. Steep track sections require careful design and usually mean more drainage works and higher maintenance costs. Grades of 10° (18%) slope should be the maximum as steeper grades need special drainage works, and may need hard surfaces.

Use the worksheet for estimating slope (page 175) to work out the grades for sections of the track.

Track construction

Construct and maintain tracks in low rainfall periods (see page 144 for rainfall information) and use an excavator rather than a bulldozer on steep slopes. Book contractors well in advance to ensure construction happens when erosion risk is low. Earthmoving equipment can spread weeds and soil-borne diseases so ask contractors to clean their machinery before it comes onto the property or hose it down at a secure point before starting work. Aim to get vegetation established on any disturbed ground as quickly as possible after construction or maintenance work.

Clearing

Before construction, clear the track area of trees and woody shrubs to avoid having them incorporated into fill batters. Try to limit clearing to 0.5 m on either side of the track. If trees have to be removed outside this area, cut them rather than bulldoze to minimise soil disturbance. Land clearing for routine agricultural management activities (RAMAs) is permitted without approval under the Native Vegetation Act 2003, provided that it is kept to a minimum and within specified distance limitations.

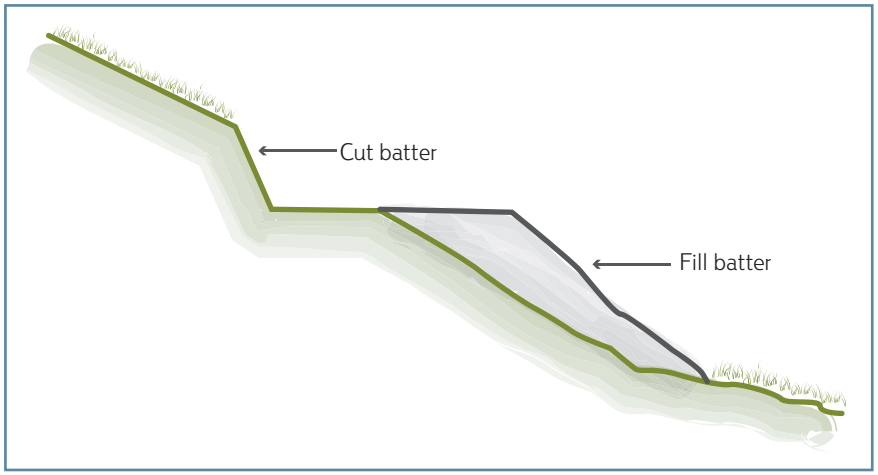
For tracks on rural zoned properties the maximum clearing width allowed is 6 m (4 m on rural residential zoned properties), with stricter conditions on protected riparian zones next to waterways.

For more information on land clearing regulations see http://www.nativevegetation.nsw.gov.au/fs/fs_06.shtml

Road batters

A road batter is a constructed earth slope cut into the hillside or made of fill material. A track running across a slope will often have a cut batter on the upslope and a fill batter on the down slope.

Typical profile of a track constructed across a slope with cut and fill.
Adapted from: Earthmovers Training Course, Soil Conservation Service of NSW, 1992



Cut batters

Cut batters should be close to vertical for heights up to 1.5 m. These batters may suffer from slumping initially, but will usually stabilise with follow-up maintenance. Cut batters higher than 1.5 m, or persistently collapsing batters, require stabilising with laying back, retaining walls or diverting run-on water around the batter.

Fill batters

Fill batters should be no steeper than 1:2 m, and flatter where possible. Disturbed fill is much less stable than a cut batter so rapid establishment of vegetation cover is essential to stabilise them. Where practicable stockpile topsoil and leaf litter to respread over areas to be revegetated.

Track drainage

Rain falling on a compacted track quickly concentrates into erosive streams that scour soil and make the track difficult to negotiate. The track surface needs to be shaped so that water runs across rather than along the track and doesn't pond on the surface.

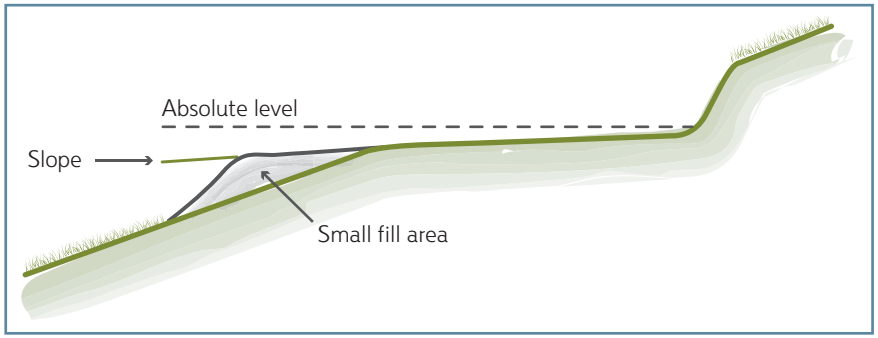
Crossfall drainage

The purpose of crossfall drainage is to take water across the track and off to the side, but where water does not drain quickly enough, regular drainage structures will be needed as well. There are three types of crossfall drainage.

Outfall drainage

Outfall drainage directs water from the track to the outside edge. The track is shaped so that the inside edge of the track is higher than the outside edge. Water flows across and off the track to the downslope side. Outfall drainage is used when the track's fill batters are small and not likely to erode. Earth windrows formed on the outside edge of the track during construction or grading need to be removed because they redirect water along the track.

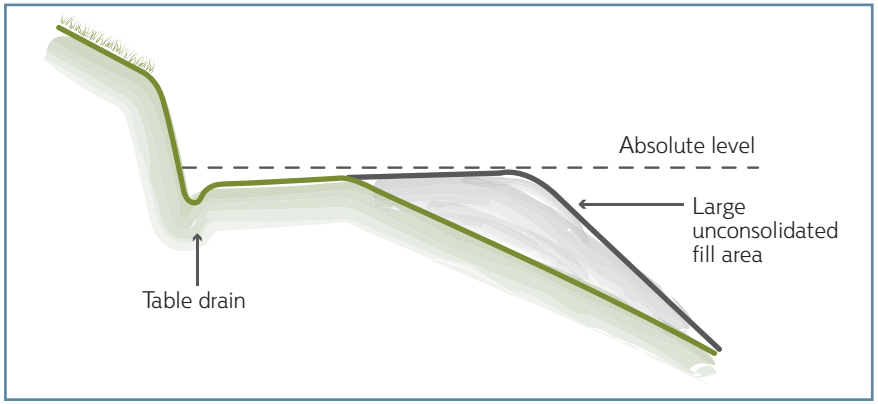
Outfall drainage takes water across the track to the outside slope.
Adapted from: Earthmovers Training Course, Soil Conservation Service of NSW, 1992



Infall drainage

Infall drainage directs water to the inside edge where table drains carry it to drainage structures that cross the track. Infall drainage is used when the track is constructed on large or erodible fill batters, or the outside bank is more than a metre high.

Infall drainage carries water to the inside of the track.
Adapted from: Earthmovers Training Course, Soil Conservation Service of NSW, 1992



Crown drains

These drains are used for tracks on ridges or gentle slopes.

Crown drains shed water to both sides of the track from the high point in the centre of the track.
Adapted from: Earthmovers Training Course, Soil Conservation Service of NSW, 1992

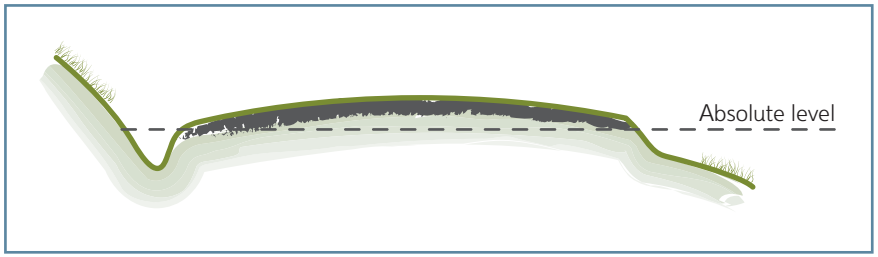


Table drains

Table drains run alongside the track and carry water from the track to disposal areas via culverts, cross banks or mitre drains.

Culverts

Culverts are pipes buried below the track surface to carry water under the track. They need to be large enough to carry major flows from the catchment above the inlet. They are laid as close as possible to the natural drainage line down the slope to avoid turbulence and scouring at the inlet and outlet. The water emerging from the pipe needs to be discharged safely (see page 100).

Rock protects the batter where this culvert emerges.
Source: Tim Duckett IECA

Batter dropdowns

Where a culvert pipe emerges above the foot of a downhill fill batter the water path needs to be stabilised to prevent undercutting of the track. Batter dropdowns are drain channels stabilised with rock or concrete to carry water down past the foot of the batter without eroding the soil.

Cross banks

Cross banks are earth banks across the road (also known as 'whoa-boys'), to intercept water running down the track and divert it off to the side. Cross banks need to be located at points where there are stable areas to receive the drain water (see page 100).

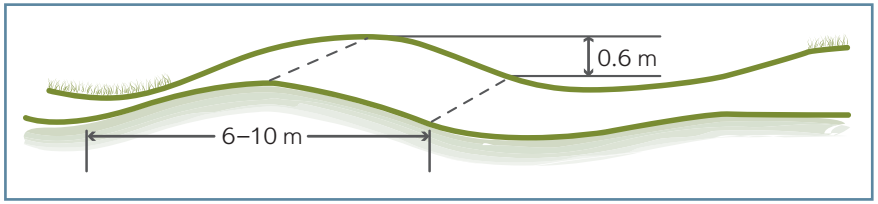
A cross bank stops water running down the track slope.
Source: Michael Frankcombe IECA

Cross banks work best when constructed at a slight angle to the track with a grade of approximately 1:20 to prevent water ponding on the road in the cross bank drainage channel.

Dimensions

Dimensions of cross banks need to be tailored to the types of vehicles that will use the track. Easily trafficable cross banks can only be constructed on slopes of less than 12° (21%) because of the increase in grade on the approach and descent from the bank. The diagram below shows dimensions for a cross bank that can be negotiated by most vehicles.

Typical dimensions for an easily trafficable cross bank.
Adapted from: Earthmovers Training Course, Soil Conservation Service of NSW, 1992



Construction

Earth required to construct cross banks is usually borrowed from the track on the upslope side of the bank. Sufficient earth must be used to give the required dimensions after compaction. A long shallow excavation is better than a short deep one.

Typically, a bulldozer rips the road to a depth of 20–30 cm for 15–20 m back from the chosen drainage line. The loose earth is pushed down the road line to form a bank, starting from the uphill side of the track, then shaped and compacted to form the finished bank.

Cross bank drains must be big enough to carry the maximum flow without overtopping. If the bank overtops it needs to be made higher, or other cross banks need to be built along the track.

Enough cross banks need to be constructed to prevent rills from developing in the track surface. The table below shows recommended spacings for different slopes and soil categories. On an existing track a good rule of thumb is to put in a cross bank at the top of a rilled section.

Recommended maximum spacing for cross banks.
Source: Earthmovers training course – Soil Conservation Service of NSW, 1992

Track grade (%)	Slope degrees	Low soil erodibility	High soil erodibility	Very high soil erodibility
		Brown and red soils derived from fine-grained sediments	Red soils on fine-granites, fine-grained sandstones and basalt	Grey and yellow soils derived from granites, or sedimentary deposition, especially coarse-grained types
Up to 14	0–8	70–90 m	60–70 m	20–30 m
14–21	8–12	60–70 m	50–60 m	*
21–28	12–16	40–60 m	*	*
28–36	16–20	30–40 m	*	*
36–40	20–22	20–30 m	*	*

Note: * indicates tracks should not be constructed on these soil types within the given slope range.

Spoon drains

Spoon drains have a similar function to cross banks, but are constructed by excavating a wide shallow depression across the track and spreading the earth thinly along the track surface. They are used mostly on tracks with very low grade.

A recessed pipe set into a steep gravel track.

Recessed pipes

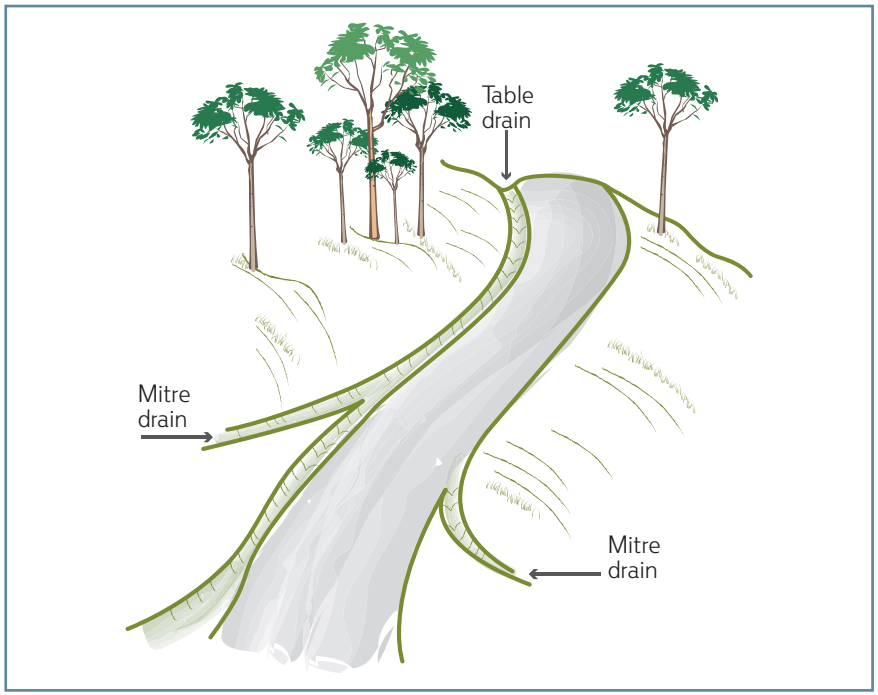
Where slopes are too steep to allow trafficable cross banks, hardened spoon drains can be constructed by recessing a half steel or concrete pipe into the track surface. This allows for a deeper, narrower channel that can drain fast flowing water and allow vehicle traffic. The recessed pipe crosses the track at a more oblique angle and a steeper grade than an earth cross bank. The faster flow of water will help to keep the pipe clean. If the grade is too flat, the pipe will fill with sediment and water will flow onto the track. Recessed pipes are likely to need more frequent maintenance than earth banks. The drain outlet must be stable and robust due to the concentrated flow of water discharged.

Mitre drains

Mitre drains are surface channels that take water from the track shoulder, table drains or cross banks to safe disposal areas. They angle away from the track, and are spaced as close together as practicable.

Ideally, mitre drains are less than 50 m apart, and much closer on steep slopes or in erodible soils. The slope of the mitre drain needs to be less than 5° (9%) to avoid scouring and needs to discharge to a stable area.

A track should have frequent mitre drains to direct water away from the track and its table drains.
Adapted from: Earthmovers Training Course, Soil Conservation Service of NSW, 1992



Drain outlets

Water draining off tracks needs to be discharged onto dense vegetation such as grass to filter sediment and hold underlying soil in place. Where there is enough space, give the drain outlet a broad edge so that water spreads rather than concentrates. If this is not possible place rocks at the drain outlet to dissipate the energy of fast flowing water. Avoid discharging drains directly into waterways.

Sediment traps

Once track construction starts soil will inevitably erode from the site during rain. To stop this soil entering waterways install sediment traps such as silt fences or hay bales at all drain outlets.

Track crossings

Where tracks cross a watercourse or drainage line they are vulnerable to erosion. Water needs to be directed across or under the track so that the track remains passable. The amount of work needed to maintain crossings depends on the topography and the volume of water in the watercourse or drainage line. Where the track has to cross a natural watercourse, approaches need to be as flat as possible. Steep approaches usually form rills and gullies, or wash out in floods, and require frequent maintenance.

Fords

Fords are preferable to culverts or bridges as they occur naturally or can be constructed with minimal disturbance to the streambed and banks. If the crossing site is not naturally rocky, a stable crossing can be built with well-compacted rock or hard fill brought to the site. Rock fill needs to be extended up the banks to the flood flow height of the stream, and hard fill should sit no higher than the bed of the stream. Do not push soil into a ford to make the grade easier for vehicles. Rather than reshaping the approaches to a crossing, consider constructing a bridge or culvert.

A natural rock platform used as a crossing point.

Shallow depressions or swampy areas can be paved with stones or logs placed across the track. Do not use logs to ford a flowing stream as they are often dislodged in flood events.

Culverts

Culverts are suitable for crossings in small upslope catchments or over streams that do not carry much debris as debris can quickly block the culvert and make it ineffective. The culvert must be large enough to accommodate peak flows or be designed as a concrete causeway. It is important that the culvert design allows fish to move freely up and down the stream.

For more information on fish friendly road crossings go to the NSW DPI website http://www.dpi.nsw.gov.au/fisheries/habitat/rehablitating/road-crossings

This older style culvert crossing is designed to function as a causeway in high flows.

This modern box culvert causeway is more 'fish-friendly' than the older style.

Bridges

Bridges are required where the drainage line is a deep gully, or likely to carry large debris. Bridge design is beyond the scope of this handbook, but for safety a bridge must be designed to support at least its own weight and the weight of the heaviest vehicle that will cross it. In fast-flowing streams bridge supports may need to be protected by concrete, rocks or timber to protect against washing out in floods.

A timber bridge spans a deeply incised stream channel.

Track surface

Concrete can be used to stabilise steep, high use tracks.

The choice of surface depends on the type and volume of traffic that will use the track. Bare soil is not usually a stable surface for a track because it is vulnerable to erosion and may become slippery and boggy when wet. Grass cover is best for low use tracks, with gravelling where ruts develop. Frequently-used tracks may require gravelling. Steep sections of high traffic roads where gravel washes away may need a hardened surface such as bitumen or concrete.

Maintenance

Maintenance is usually most necessary and required more frequently in the early years following construction, until soils consolidate and vegetation becomes established. Most damage to roads and tracks occurs when a drain fails through filling in, blockages or banks wearing down.

Regular maintenance can help avoid costly large-scale repairs.

Basic track management principles are outlined below.

- Don't drive in the same wheel tracks all the time and use lighter vehicles where possible.
- If possible, avoid driving on the track when soil is wet. This will help stop wheel ruts forming and reducing the effectiveness of the cross drains.
- Inspect the track after heavy vehicle use or rainfall and repair any damage as soon as possible.
- Check all drains at least once a year, and repair and clear where necessary.
- If surface drains are in order, but erosion of the track is still occurring, install a new cross bank or spoon drain at the top of rilled sections.
- Leave material that slumps from cut batters untouched unless it restricts the width of the track or blocks a table drain. If necessary, remove spoil carefully without undercutting the toe of the batter.
- When working on a track, minimise soil disturbance. Avoid blading soil except where necessary to form the surface.
- Remove any windrows formed through grading or reshaping that might prevent water draining off the track.
- Revegetate immediately after soil disturbance while the soil is soft, regardless of the season.
- Do not remove more timber than is necessary to maintain access along the tracks and to maintain drains.
- Where necessary cut timber rather than bulldoze it, especially above cut batters or within drainage lines.