

Construction Access Roads

GENERAL CONSTRUCTION PRACTICE



Photo 1 – Permanent construction and maintenance access road



Photo 2 – Temporary construction access road through parkland

This fact sheet provides general information on how the principles of erosion and sediment control apply to temporary, unsealed construction access roads.

1. Planning Issues

Access roads are used to provide temporary access into and through construction sites, as well as permanent, low-traffic access for ongoing maintenance activities.

Ideally, these access roads should be located to minimise vegetation disturbance, while giving appropriate consideration to the intended purpose of the road. In many cases a temporary access road will follow proposed permanent transport corridors; however, in cases where the pathway must deviate from a permanent road corridor, the following issues should be considered when planning the road location.

- Unsealed roadways should ideally follow the land contour with a gentle gradient of between 1 and 4%.
- Avoid locating unsealed roads down the centre of a valley or along the centre of an overland flow path where it can be difficult to control drainage on the roadway.
- Avoid long, sustained grades where stormwater cannot be regularly removed from the road and its associated side drains.
- Avoid steep grades, areas of dense timber, and any other location where it may be difficult to control drainage.
- Where practical, allow the road to follow an undulating pathway that allows stormwater to leave the road at regular intervals.
- Aim to minimise the number of gully and stream crossings, and place any such crossings at locations where there are stable bed and banks.
- Wherever practical, locate the road above the 1 in 1 year ARI flood level, and at least above the 'low bank' of streams, i.e. the stream bank below the lowest floodplain terrace.
- Avoid any unnecessary disturbance to the riparian zone of streams, and where possible, utilise this vegetation as a buffer zone to separate the road from the stream. Ideally, the minimum width of this buffer zone should be at least the width of the stream (measured at the top of the low bank) or 30m whichever is the lesser.
- Avoid areas of potential mass movement, such as shallow soils resting on a rock outcrop.

- Avoid crossing long, steep, unstable slopes, especially where the bedrock is highly weathered.
- Avoid opening up moisture-laden foot-slopes.
- If a permanent maintenance access track follows a fence line on a long, steep slope, consider deviating the track away from the fence line every 60 to 80m to help shed runoff from the track at regular intervals (Figure 1).

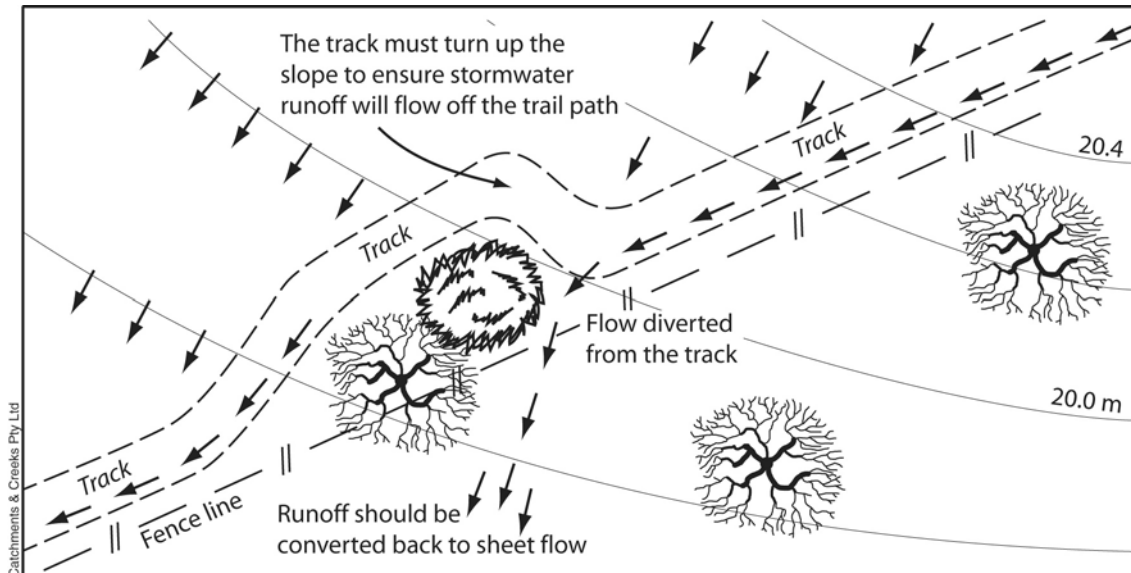


Figure 1 – Control of drainage along fence-line tracks

- Where access is required across a slope, and infall drainage can be achieved (Photo 5), the roadway should be sited slightly off the land contour. This allows controlled flow velocities within the hillside table drain.
- Where access is required across a slope, and outfall drainage can be achieved (Photo 6), the roadway should be sited as close as possible to the contour of the land. This allows up-slope stormwater runoff to pass evenly across the road, thus avoiding flow concentration.
- Ridges often provide an excellent location for unsealed roadways because runoff can discharge each side of the road. Valleys and concave areas, however, make the shedding of runoff difficult because the runoff usually gravitates back towards the roadway.
- Always obtain expert soils advice before designing or constructing roads through dispersive or acid sulfate soils.



Photo 3 – Access roads cut into dispersive soil can experience severe erosion



Photo 4 – Table drains cut into dispersive soil need to be treated and/or sealed with non-dispersive soil

2. Road Alignment, Gradient and Surfacing

There are basically three types of roadway cross sections: sub-surface, ground level, and formed roads (Figure 2). Sub-surface tracks are generally not recommended—they can collect large quantities of up-slope runoff effectively turning the track into a drainage channel.

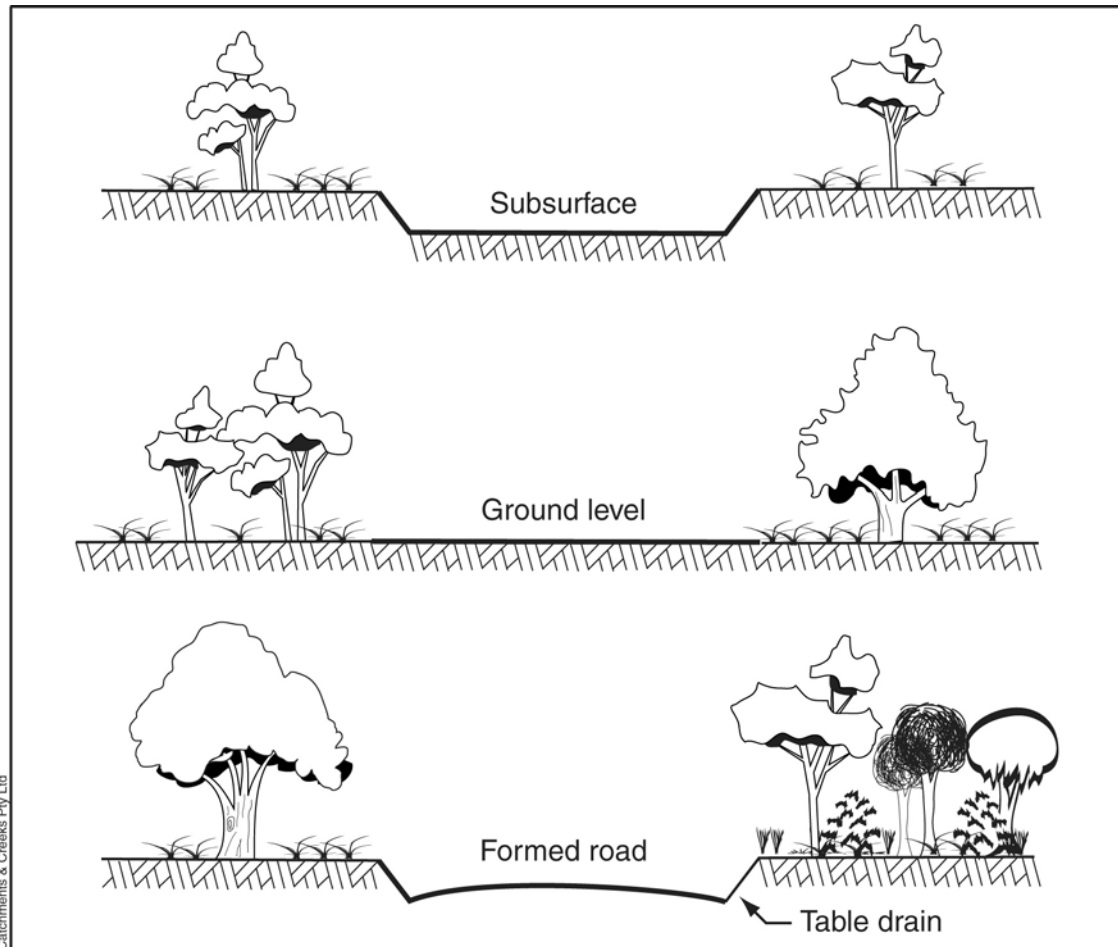


Figure 2 – Typical track cross sections (after Carey, 1992)

Ground level roads are formed by slashing or blading the surface vegetation. Low cost, low traffic temporary access tracks are best constructed at ground level. Access tracks for heavy construction vehicles may require 'gravelling' to reduce sediment-laden runoff.

Formed roads should be used where an access pathway is likely to become permanent (e.g for ongoing maintenance access), or if it is likely to carry significant volumes of traffic.

In locations where sediment runoff from an unsealed roadway is likely to cause environmental problems, the road may need to be covered with gravel to reduce runoff turbidity caused by raindrop impact erosion.

A trafficable lane width of 3 to 4m is generally required, with a maximum desirable cleared width of 5m. Haul roads may require much wider widths to allow passing and to provide safe sight lines. Land clearing for construction of the roadway should be reduced to the minimum practicable, especially if located within 30m of any watercourse.

Unsealed roads should have at least a slight longitudinal grade to allow free surface drainage and to avoid excessive ponding within wheel tracks. Generally the grade of a track should be less than 10° (17.5%). Short lengths of steeper grades may be needed to negotiate difficult sections. Such sections may need to be sealed with bitumen or concrete, or otherwise stabilised (e.g. timber sleepers, soil-cement treatment, gravel).

If it is necessary to design road sections with grades exceeding 10°, then it should be noted that trafficable drainage cross-banks are generally limited to a maximum grade of approximately 12° (1 in 4.7 or 21%).

The sealing of earth tracks can greatly reduce soil erosion resulting from vehicular traffic, stormwater runoff, raindrop impact erosion, and wind erosion. Table 1 provides suggested surface treatments that may assist in the reduction of sediment-laden runoff from long-term, low to medium traffic access roads. These recommendations are only a general guide—appropriate consideration should always be given to past experiences gained from within similar regions.

Table 1 – General guide to the surface treatment of low to medium traffic areas

Road Grade	Option	Road Finish
< 5%	1st option	Compacted crushed rock
	2nd option	Resin-impregnated for added wear
	3rd option	Bitumen
5 to 10%	1st option	Hot-rolled bituminous surface over compacted sub-base
	2nd option	Resin-impregnated soil
	3rd option	Bitumen
10 to 20%	1st option	Asphaltic AC10 concrete over compacted sub-base
	2nd option	Resin-impregnated soil
	3rd option	Bitumen
> 20%	1st option	Mesh-reinforced concrete (40MPa) over compacted sub-base

3. Road Drainage

There are three forms of road crossfall: outfall, infall and crowned (i.e. formed road). Roads constructed on a ridge or gentler slope should be crowned; however, minor access tracks may not have sufficient width to make a crowned profile practicable. Crowning can ease drainage problems by allowing water to be shed from both sides of the road.



Photo 5 – Example of 'infall' road crossfall



Photo 6 – Example of 'outfall' road crossfall

Outfall drainage (i.e. drainage directed away from the hillside) allows stormwater to discharge from the road as sheet flow. If outfall drainage is installed, then any 'windrows' that develop along the down-slope side of the road during the construction, operational or maintenance phase need to be removed. Outfall drainage should not be used when any of the following conditions exist (in which case infall drainage is usually preferred):

- down-slope fill batters are unconsolidated and likely to erode;
- down-slope fill batters exceed 1.5m in height;
- sediment-laden runoff needs to be directed to a sediment trap;
- the road is subject to rutting causing stormwater to be redirected down the road rather than across the road;
- maintenance procedures are likely to result in the formation of an earth windrow along the outside edge of the road. Such windrows can cause stormwater to pond on the track and to eventually discharge as concentrated flow at breach points.



Photo 7 – Boggy ground formed on the edge of a road with outfall drainage



Photo 8 – Rehabilitation of eroded earth batter caused by unstable outfall drainage

When using infall drainage, the formed table drains should represent the primary drainage path within road reserves. Stormwater should be removed from the trafficable road surface as soon as practicable. The crossfall required to achieve effective drainage is generally 4% (1 in 25). For safety reasons, the maximum crossfall should not exceed 10%.

To ensure stormwater sheets off the road into the table drain it may be necessary to construct either infall or outfall cross-banks (known as 'whoa-boys') at selected locations. (A table drain is the side drain of a road adjacent to the shoulders, and comprising part of the road formation.)

Outfall cross-banks (Figure 3) or outfall drains (e.g. culverts) are used to remove water from the table drain at appropriate outfall locations. Infall cross banks (Figure 4) are used at locations where a cross-bank is required to direct water off the road surface (as per the recommended drainage spacing presented in Table 2), but it is inappropriate to direct this water off the side of the road.

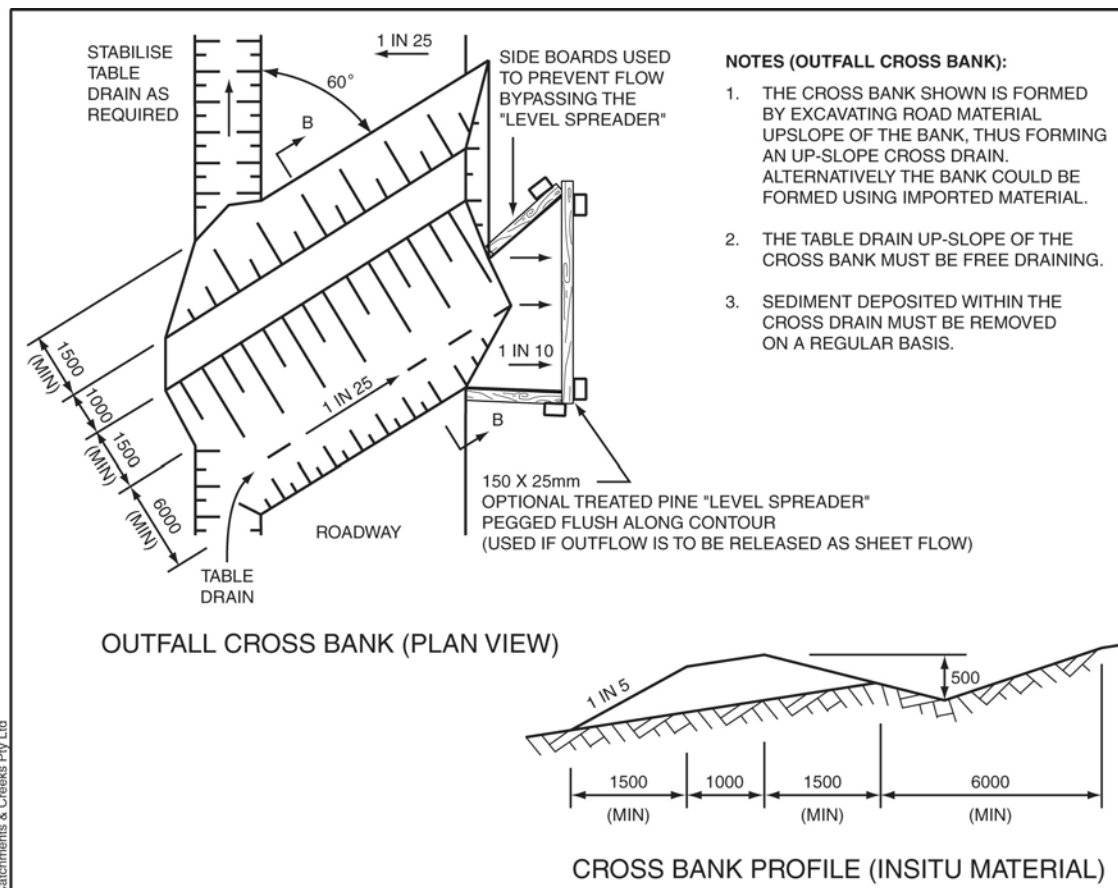


Figure 3 – Outfall cross-bank for low speed tracks

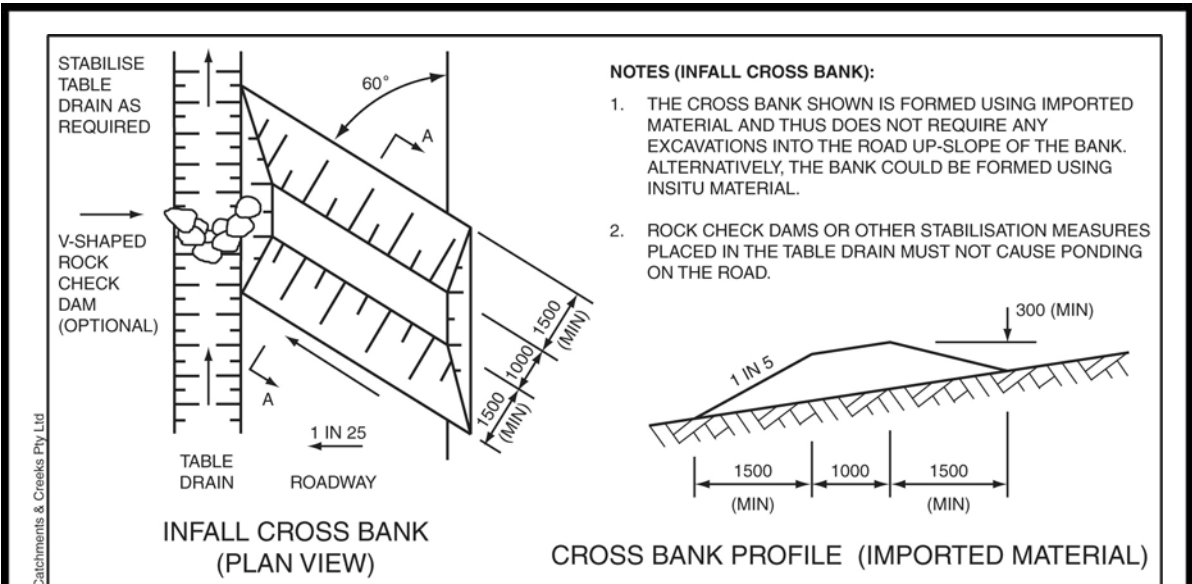


Figure 4 – Infall cross-bank for low speed tracks



Photo 9 – Cross-bank (whoa-boy)



Photo 10 – Outfall cross-bank



Photo 11 – Cross-bank showing discharge structure (foreground)



Photo 12 – Cross-bank discharge structure releasing flow down a steep slope

Cross-banks consist of a trafficable earth mound (whoa-boy) constructed across a road to collect and divert runoff. Cross-banks are used in low speed areas and can be used as speed control devices (hence the term 'whoa-boy'). In medium or high-speed areas, sub-surface cross drainage (i.e. culverts) should be used.

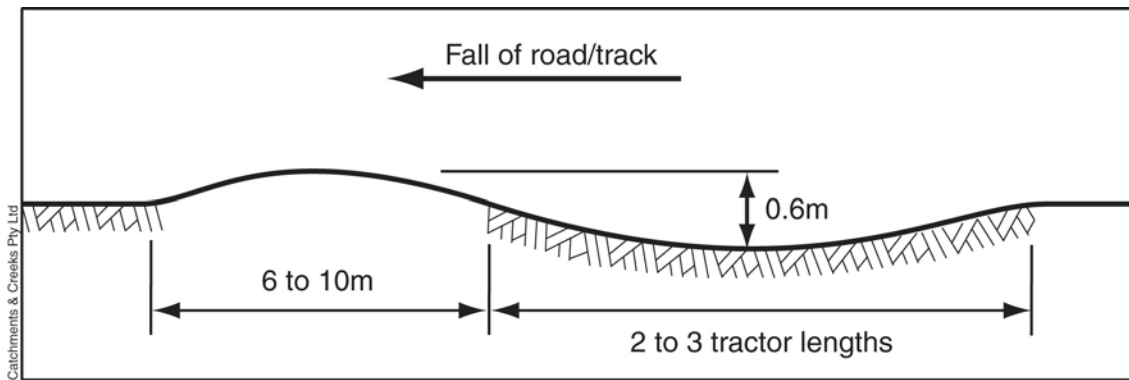


Figure 5 – Typical cross bank profile for low to medium speed traffic areas

The profile of the cross-bank should be of sufficient length to ensure comfortable vehicle passage. The height of the cross-bank should be sufficient to allow adequate drainage taking into account slope and soil type. The preferred dimensions of a cross-bank (Figures 3 to 5) will depend on the type, speed and frequency of construction traffic.



Photo 13 – Cross-bank



Photo 14 – Rubber strips used to direct stormwater of an outfall fire trail

The drainage outlet of the cross-bank should allow water to escape rapidly from the roadway. Ideally this water should be converted back to sheet flow using a suitable *level spreader*. Level spreaders are only used when it is desirable to release the water as sheet flow. Level spreaders can be formed from earth or solid materials such as treated timber (as shown in Figure 3).

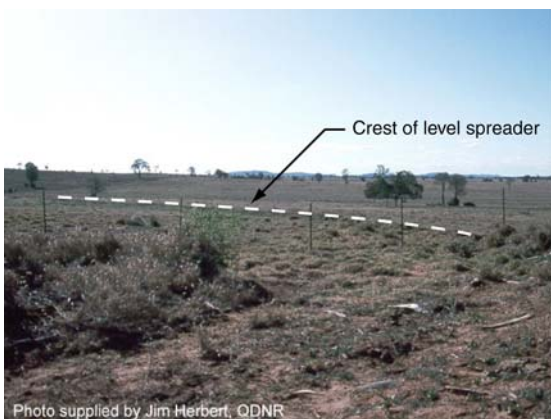


Photo 15 – Level spreader in a rural setting



Photo 16 – Timber flow spreader

If the road runs parallel to a watercourse, then every effort should be made to sheet water off the road surface, discharging it as sheet flow through the adjoining riparian zone. Maximum use should be made of this riparian zone to filter sediment from stormwater runoff before it enters a watercourse.

If the road runs along a ridge, then ideally, stormwater runoff should be discharged evenly off each side of the ridge. Figure 6 provides examples of possible drainage for ridge tracks. For the unformed road example provided in Figure 6, if a 'ground level' road profile is used, then the cross-banks may alternate to discharge water each side of the ridge.

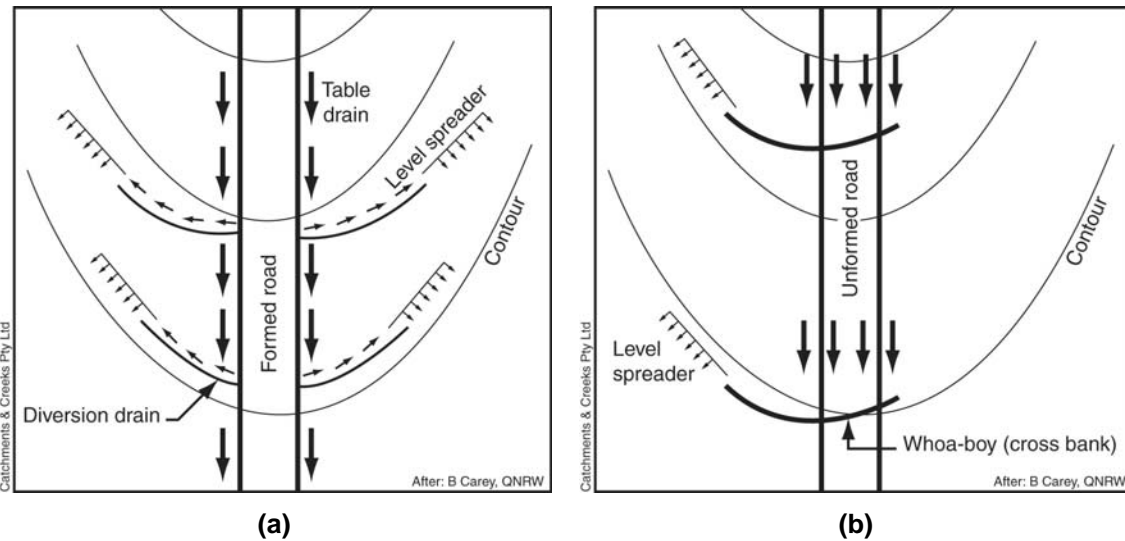


Figure 6 – Drainage of formed and unformed roads on a ridge (Carey, 1992)

In the absence of locally accepted guidelines, cross-banks should be constructed at the spacing presented in Table 2.

Table 2 – Maximum spacing of cross drains^[1]

Grade of track	Maximum spacing of cross drains (m)			
	Low hazard ^[2]		Moderate and high hazard ^[2]	
	North of Rockhampton ^[3]	Other areas	North of Rockhampton ^[3]	Other areas
< 9% (5°)	60	80	30	40
9–27% (5–15°)	40	50	20	30
27–47% (15–25°)	20	30	10	20
> 47% (25°) ^[4]	10	20	10 ^[4]	10 ^[4]

[1] Sourced from Department of Primary Industries, Queensland – Forest Service, 1988.

[2] Soil erodibility may be recognised by the soil descriptions provided in Table 3.

[3] Only applicable in areas north and/or east of the 1000mm isohyet.

[4] Cover crop establishment of all drains is recommended on slopes exceeding 47%. Gradients of this magnitude are only recommended for short distances on these soil types.

Notwithstanding the recommendations of Table 2, the following points should be considered when locating cross-bank drainage:

- any spacing recommendations contained in regional guidelines, with appropriate adjustments made based on past experience and existing track conditions;
- location of concentrated stormwater inflow and preferred points of discharge;
- location of short sections of flatter track grade within a length of steep track that would facilitate the construction of a cross bank.

Whoa-boys cannot be used on slopes steeper than 20% (11.3°) because the back batter becomes too steep to be negotiated by a vehicle.

The consolidated bank should be shaped with batters no steeper than 5:1(H:V) in relation to the road grade. The bank can be shaped with the tractor blade, and the entire length of the bank should be track or wheel rolled to obtain maximum compaction and a smooth even bank.

If it is necessary to fill an eroded table drain in order to form the cross-bank, then the bank should be compacted at this point with extra earth to allow for slumping and to cope with concentrated runoff within the drain.

Table 3 – Soil erodibility classification ^[1]

Erosion hazard rating	Soil type		Parent material ^[2]
	Surface texture and subsoil colour	Soil groups	
High	Shallow gravelly soils	Lithosols	Coarse textured igneous rocks, (granites, granodiorite, diorite, gabbro)
	Sands or sandy loams with yellow, pale grey or black subsoils (or derived from granitic material)	Alluvials, podzols, siliceous sands	
	Loams or clay loams with pale grey or black subsoils	Soloths, solodized solonetz, grey podzolics	Deeply weathered sandstones
Moderate	Sands or sandy loams with red subsoils (except on granitic material, then erosion hazard rating is high)	Red earths, red podzolics	Sedimentary rocks (shales, mudstones, conglomerates, lightly weathered sandstones)
	Loams or clay loams with red or yellow subsoils	Red or yellow podzolics	
	Clays with yellow, grey or black colours	Black earths, grey or brown clays, prairie soils	Moderately hard metamorphics
Low	Clay with yellow subsoils	Xanthozem, euchrozem	Fine textured igneous rocks (basalt, andesite, rhyolite, trachyte)
	Clay with red subsoils	Krasnozem	Hard metamorphics

[1] Sourced from Department of Primary Industries, Queensland – Forest Service, 1988.

[2] Refers to the erosion hazard of exposed weathered material other than true soil. It is not implied that the above soils are derived directly from the rocks in the adjoining column.

Following construction, a small, temporary *U-shaped sediment trap* may need to be constructed at the drainage outlet to collect sediment. These traps should only be constructed if they do not promote down-slope erosion or ponding on the track.

If the soil up-slope of the bank is likely to be saturated on a regular basis, and if past experience has shown that this soil will eventually turn into a 'bog', then it may be necessary to embed a sheet of synthetic earth reinforcing mesh (Photo 27) into the soil (Figure 7). This reinforcing mesh will reduce the risk of track damage by pedestrian and vehicular traffic.

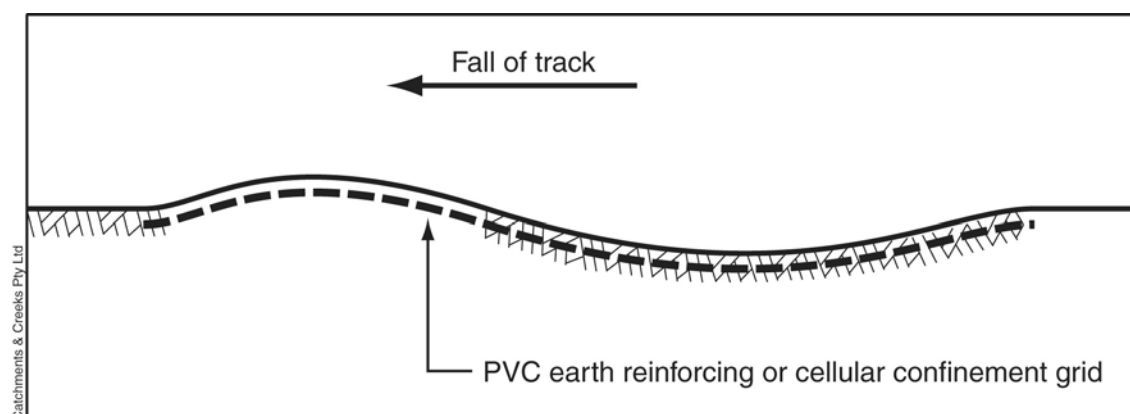


Figure 7 – Cross-bank reinforced with sheet of synthetic earth reinforcing mesh

4. Diversion Drains

Diversion drains are the constructed drainage channels that collect water from the table drain and direct it to a suitable disposal area. Wherever practical, these drains should be flat-bottomed, not V-shaped, and should have an excavated cross-sectional area at least equal to that of the upstream table drain.

The initial grade ('kick out' grade) in the diversion drain should approximate the grade of the table drain to avoid energy loss, and hence sedimentation and bank failure. As the drain increases in length, the grade in the channel should progressively decrease. Ideally, diversion drains should have a surveyed grade of 0.2% for the final 30m (i.e. 6cm fall in 30m).

Herbert and Evans (1992) provides the following recommended spacing for diversion drain outlets along table drains (always consult local guidelines).

Table 4 – Recommended spacing of diversion drains along table drains ^[1]

Road grade %	Road grade (degrees)	Spacing (m)
< 2%	< 1.15°	120
2 to 4%	1.15 to 2.3°	60
4 to 8%	2.3 to 4.6°	30
> 8%	> 4.6°	15

[1] Sourced from Herbert and Evans, 1992

In rural areas, road runoff can be an important resource for neighbouring properties. Discharge from a diversion drain can be spread over a pasture to ensure grass growth through the use of a level spreader.

If the diversion drain is built through a property fence, a suitable floodgate needs to be constructed (in cooperation with the landowner) so the fence can be opened during drain maintenance.

In areas with known dispersive subsoils (Photo 4), the use of *flow diversion banks* rather than excavated diversion drains may be preferred to control surface runoff.



Photo 17 – Diversion drain on an unsealed rural road



Photo 18 – Several diversion drains on a sealed roadway

5. Watercourse Crossings

Where possible, crossings of streams should be constructed at right angles to the stream, and in locations where the stream channel is straight with well-defined banks.

When suitable materials are available, approaches to crossings should be covered with non-erodible materials such as rock or gravel. Otherwise, road layout and drainage measures should be designed to prevent sediment-laden runoff from these approach roads discharging directly into the stream as shown in Figure 8.

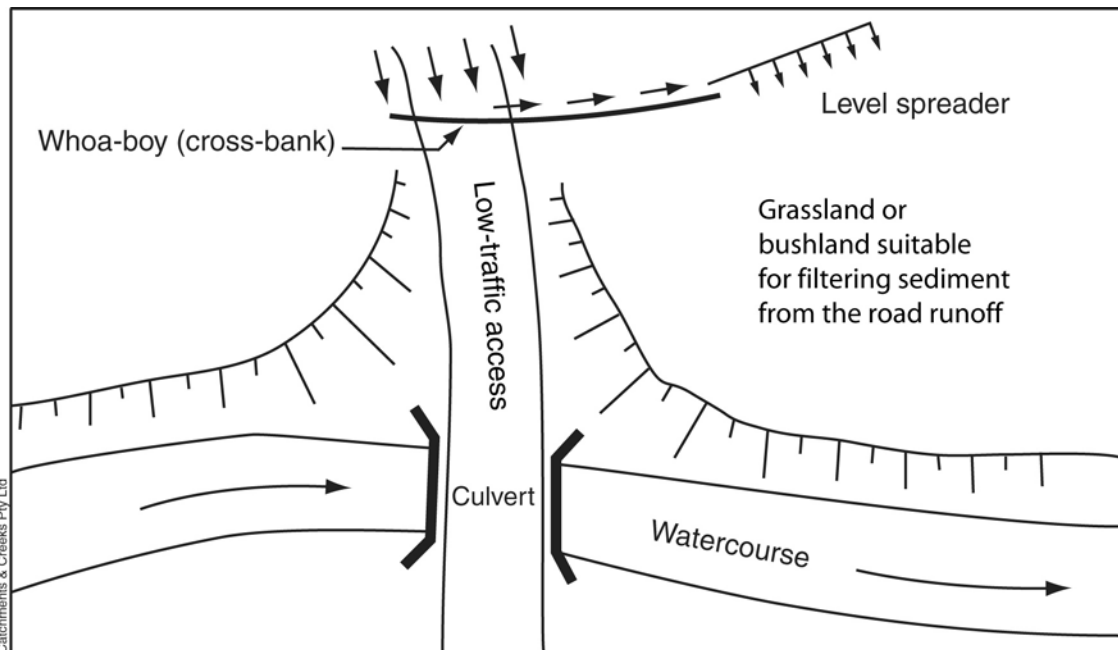


Figure 8 – Track drainage control adjacent stream crossings

Where practical, a cross-bank should be used to shed water from an approach road prior to it descending a steep grade, such as the approaches to a gully or watercourse crossing (Photo 20). If the access ramp is longer than 15m, it may be necessary to construct additional flow diversions down the cutting.



Photo 19 – Flow diversion bank (cross bank) at the crest of a descending road



Photo 20 – Flow diversion cross bank (difficult to see in photo) just prior to the road falling to a creek crossing

Cleared vegetation and other debris should be removed from the floodplain if there is the potential for this material to cause damage to downstream structures during floods.

Watercourse crossings may consist of fords, culverts or bridges (Photos 21 to 24). Log dam crossings are generally not recommended because they can obstruct stream flows, and create excessive turbulence and erosion.

Temporary bridge crossings may be formed from felled timber, or a culvert bridging-slab (SLBC) suspended between well-anchored logs (Photo 21).

Culvert designs should always consider the effects of debris blockages and potential erosive forces caused by overtopping flows. The assumed risk of debris blockage should reflect both the degree of upstream vegetation and the frequency of maintenance inspections.

The culvert should be 450mm or larger, and the culvert should not discharge onto, or over, fill material. Ideally, culverts should have a flow capacity at least equal to the normal capacity of the watercourse when the water level is just below the crest of the road crossing.



Photo 21 – Temporary bridge crossing



Photo 22 – Temporary culvert crossing



Photo 23 – Temporary ford crossing



Photo 24 – Temporary causeway

Embankments on a major crossing should be protected with suitable abutments, e.g. concrete, timber abutments, logs or rocks.

Appropriate consideration should be given to the following guidelines when designing temporary culvert crossings:

- culvert cells aligned with the downstream channel;
- culvert cells should extend well beyond the fill embankment;
- riprap should be placed on the upstream embankment face to prevent fill material being swept into the culvert during high flows;
- armour rock should be placed on the downstream embankment face to control erosion caused by overtopping flows;
- culvert cells recessed 20% of their height/diameter into the bed (if fish passage is an issue – refer to Witheridge, 2002);
- where circumstances allow (e.g. wide channels), an overtopping spillway may be formed adjacent the culvert to improve scour protection of the embankment (Figure 9).

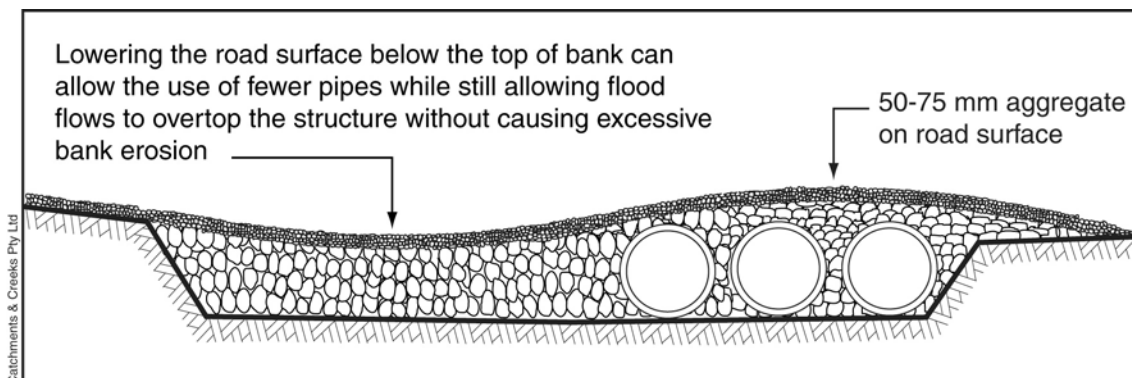


Figure 9 – Temporary culvert crossing in a wide channel



Photo 25 – Using only fine aggregate to form the fill embankment can result in severe wash-outs if overtopped



Photo 26 – If the culvert has insufficient hydraulic capacity, then overtopping flows are likely to cause severe bank erosion

When fish passage is critical, the low-flow conditions through culverts should be designed to simulate the existing low-flow geometry and flow velocities. Typical conditions include:

- maximum low-flow velocity over short reaches (e.g. at riffles) of 1m/s;
- maximum low-flow velocity over long reaches of 0.3m/s;
- minimum flow depth during periods of fish passage of 0.2 to 0.5m.

Ford crossings should not be used where the stream has a deep channel cross-section that would require considerable bank excavation to form the approach roads, or when medium to high traffic volumes are expected. Ford crossings are generally only suitable on alluvial streams (i.e. sand-based or gravel-based streams). If the ford crossing is stabilised with a concrete pad, then fish passage problems can occur over time if the downstream bed lowers in elevation relative to the concrete pad.

Appropriate consideration should be given to the following guidelines when designing ford crossings:

- crossings at right angles to the stream;
- ideally, no more than 10m road width;
- use of straight approaches that make the crossing's location obvious even when in flood;
- use of non-erodible road surfacing material on the surface of the crossing, and for at least 15m each side of the crossing;
- bed stabilisation, if used, must be recessed to align with normal bed level;
- preferred use of flexible surfacing materials on the surface of the ford (such as rock or granular material contained within a *cellular confinement system*) rather than concrete.

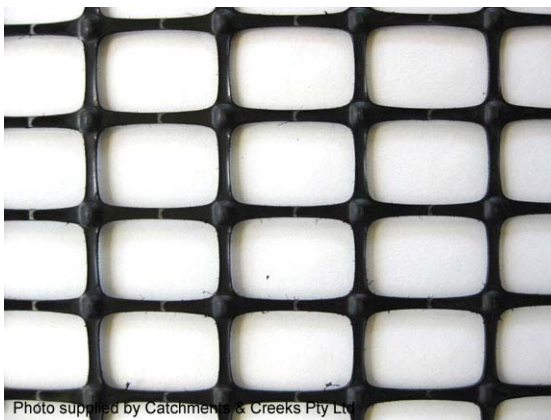


Photo 27 – Geogrid



Photo 28 – Cellular confinement system

Construction activities should be timed to coincide with dry weather, and wherever practical, removed before the commencement of the wet season. Upon removal of the crossing, the stream's bed and banks should be restored as near as possible to their original condition.

6. Road Construction

Road construction should incorporate the following practices wherever practicable.

- Access roads should be constructed with the general aim of minimising the overall disturbance to both soil and vegetation.
- Construct ground level roads by slashing or blading the surface vegetation. Avoid blading the soil except where it is necessary to build a track bench on side-slopes, to form drainage line approaches, or to make rough surfaces trafficable.
- Tree clearing should be limited to 0.5m each side of the track. Where extra clearing widths are needed to allow for sun drying of the track or adequate safe-sight distance, then clear by felling rather than dozing to limit the amount of soil disturbance.
- Road clearing should be reduced to the minimum practical within 30m of a watercourse.
- Where drainage conditions and soil properties allow, batters less than 1.5m in height should be cut vertically, or to the maximum sustainable gradient for the given soil conditions.
- If the soil exposed in batter construction is dispersive, then the batter should be cut back at a sufficient gradient to allow the placement of a minimum 200mm layer of non-dispersive soil over the batter.
- Cut batters that are higher than 1.5m may require special stabilisation measures including laying back, revegetation, and the installation of suitable batter drainage.
- Excessive or concentrated stormwater runoff up-slope of a batter should be suitably controlled with the use of catch drains (top of batter), or drainage chutes (down batter).
- Fill batters should be no steeper than 2:1(H:V) and flatter where possible to encourage natural revegetation. Vegetation debris should not be allowed to contaminate fill because this will result in poor soil compaction and long-term slumping.
- When work is necessary next to a watercourse, precautions must be taken to contain sediment and stabilise the work area during the construction process. Exposed surfaces should be stabilised as soon as practicable, or as appropriate for the expected stream flow conditions.
- Where necessary, swampy or unstable ground should be reinforced with synthetic earth reinforcement mesh (Photo 27) to allow construction of the track to progress and to reduce the risk of bogging heavy equipment.
- Grubbing in fine-grained soil should be avoided during wet weather.
- Appropriately bench the virgin soil before placement of fill to prevent slippage along the interface.
- If the road is temporary, then culverts and fill deposited within floodplain areas should be removed when no longer required.



Photo supplied by Catchments & Creeks Pty Ltd

Photo 29 – Rehabilitation of access track



Photo supplied by Catchments & Creeks Pty Ltd

Photo 30 – Fibre rolls used to control drainage during track rehabilitation

7. Road Maintenance

Frequent maintenance is essential to ensure effective erosion control and road stability, especially in the first few years after construction. Poorly maintained road drainage systems, however, can be more detrimental to roads and adjoining properties than no drainage at all.

During maintenance, soil exposure should be minimised. For example, use slashers or controlled herbicides rather than graders to maintain roadside vegetation. Where practical, slashed vegetation should be removed from drains to avoid blockages downstream.

Grader operators should be trained in appropriate maintenance techniques, including:

- Grading diversion channels from the outlet end towards the road. This will aid in topdressing the drain and rebuilding the table drain.
- Maintaining or converting table and diversion drains to a flat-bottom, instead of V-drain.
- Grading operations should not leave a windrow along the side of the road. These windrows can cause concentration of surface runoff and possible erosion.
- During road maintenance, grading should start from both edges, with material being moved towards the centre of the road (Photo 31). Then, to achieve crossfall and height, the material should be spread away from the centre line to the edge. If this operation is not carried out, the continual grading of a road can result in the carriageway becoming a sub-surface road with subsequent drainage and erosion problems.
- Adequate crowning needs to be provided for all roads. The crossfall on unsealed roads should be between 4% and 5% to prevent longitudinal scour along wheel path ruts.
- Where fines have been lost from unsealed road surfaces, investigate the possibility of importing and mixing clay or loam binder, or crushing oversize rock. This is considered preferable to wasting material on the side of the road reserve.



Photo 31 – Grading of fines in towards the centre of the road before re-profiling



Photo 32 – Damage to toe of cut batter caused during road maintenance

8. References

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