Erosion control on property roads and tracks – managing runoff

Roads and tracks on farms and grazing properties are often susceptible to erosion. This is because they collect runoff from overland flow, as well as from rain falling on the road surface. Roads and tracks produce runoff much faster than the surrounding landscape.

This science note describes techniques for managing runoff by using structures such as whoa-boys and spur drains. For introductory information to this topic, science note *L239 Erosion control on property roads and tracks—cross-sections and locations* is recommended.

Using whoa-boys for erosion control

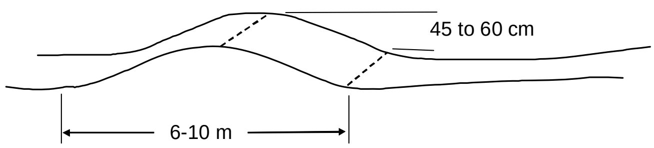

Figure 1 – Cross-sectional view of a whoa-boy.

Whoa-boys (Figure 1) are low profile, trafficable earth banks. They intercept runoff flowing down a road and allow it to continue its natural flow direction down the landscape. Whoa-boys are also referred to as water bars, cross banks, humps or diversion banks. They resemble speed bumps and visitors to a property may think that this is their purpose. Some property owners place a sign such as 'erosion control bank' on the first whoa-boy to make visitors aware of their function.

Locating whoa-boys

When locating whoa-boys, it is important to consider the direction of overland flow adjacent to the road. In flatter landscapes it may be necessary to take some levels to determine the best side of the road to divert runoff.

In Figure 2, the whoa-boys at A and B are directing runoff in a direction that will not interfere with lower sections of the road. Figure 3 shows poor design where runoff from the whoa-boy at point E will flow back towards the road and cause erosion.

Where roads are situated on ridges or directly up and down the slope (points C and D in Figure 2), runoff can be diverted to either side of the road.

It is preferable for roads to be aligned so whoa-boys are at right angles to the road direction. In Figure 2 the road has been re-aligned so the whoa-boy at point A crosses it at right angles. The whoa-boy at B, however, would be more difficult to cross. If it was at right angles to the road it may have an excessive gradient.

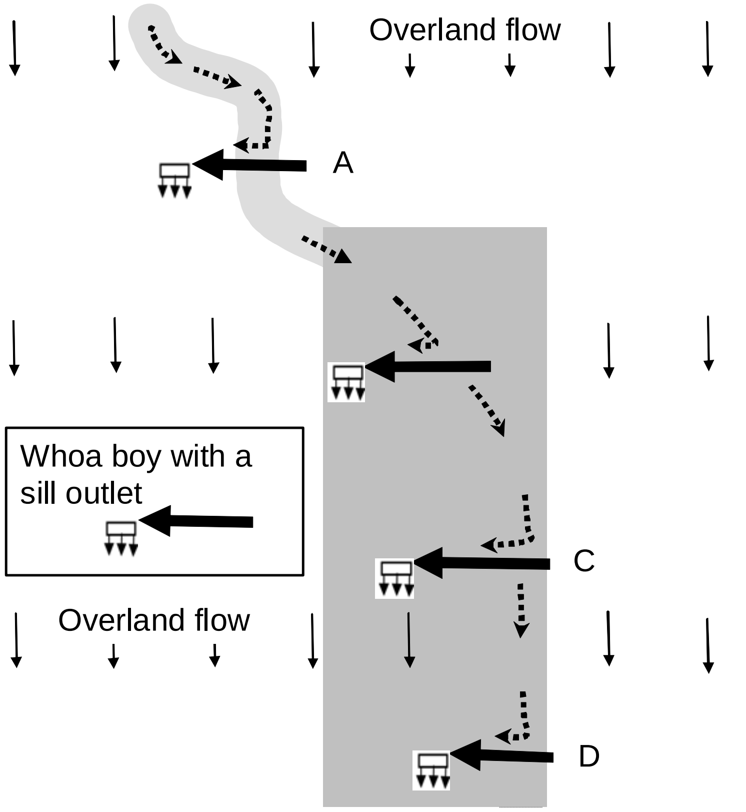

Figure 2 – Using whoa-boys to allow overland flows to cross a road.

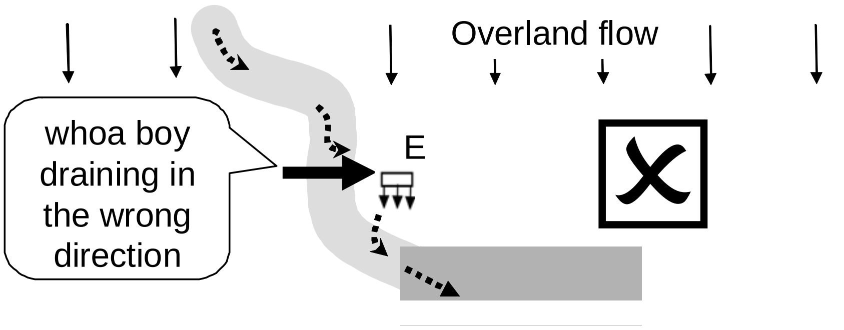

Figure 3 – Incorrect drainage in a whoa-boy.

Increasing the number of whoa-boys in use ensures the runoff problem is divided, however there are no strict rules to determine their spacing. Table 1 provides guidelines based on slope but other important considerations are listed below:

- take note of the soil types as some are more susceptible to erosion than others
- choose locations with a stable outlet such as a grassed or stony area
- locate whoa-boys where there is a significant change in slope (Figure 4) or on the approach to a drainage line or creek (Figure 5)
- align whoa-boys with contour banks in cultivated areas or where they can discharge into farm dams
- ensure that the top whoa-boy in an existing road is placed just above any rills occurring in the road. If the erosion appears to be active, it may be necessary to start even further up the slope.

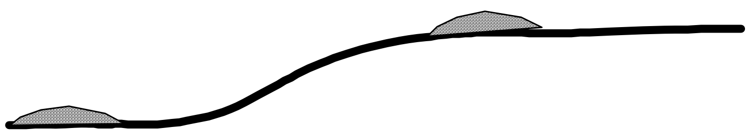

Figure 4 – Locating whoa-boys at changes in slope.

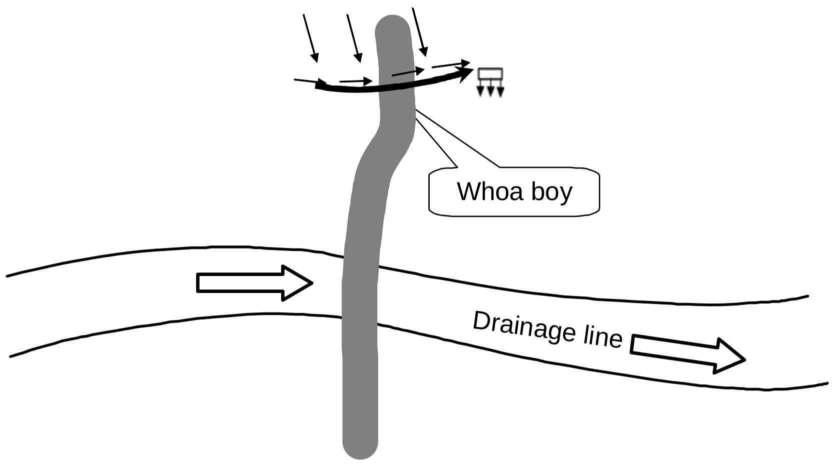

Figure 5 – A whoa-boy at the approach into a drainage line.

Table 1 – Guideline for whoa-boy spacing.

Land slope %	VI (m)	HI (m)	Land slope %	VI (m)	HI (m)
1	1.0	100	11	3.0	30
2	1.2	60	12	3.0	25
3	1.4	50	13	3.0	23
4	1.8	45	14	3.0	20
5	2.0	40	15	3.0	20
6	2.2	40	16	3.2	20
7	2.4	35	17	3.4	20
8	2.6	35	18	3.6	20
9	2.8	30	19	3.8	20
10	3.0	30	20	4.0	20

VI = Vertical interval
HI = Horizontal interval

Whoa-boys – specifications

The specifications and construction techniques for whoa-boys depends on the slope in the road and the amount of runoff they have to handle.

Slopes less than 10 per cent

Whoa-boys may be required on slopes as low as 1 per cent. A 1 per cent slope has a fall of 1m in 100m which can be sufficient to create an erosion problem. Table 2 shows the cross-sectional capacity for whoa-boys constructed to a height of 45cm and 60cm assuming that there is no cut and fill (refer to the section on whoa-boy construction).

Table 2 shows how the capacity of the channel behind a whoa-boy decreases dramatically as the slope increases. Whoa-boys with a height of 45cm may be acceptable on slopes of 1 to 2 per cent and in other situations where there is minimal overland flow to deal with. A 60cm height provides more safety on slopes above 2 per cent and these whoa-boys will have a longer maintenance interval. Some settlement will occur depending on the method of construction.

Table 2 – The cross-sectional capacity for whoa-boys constructed to a height of 45cm and 60cm

Land slope %	Height of whoa-boy above the channel	
	45cm	60cm
	Cross-sectional area (m^2) of the channel (assuming no cut and fill)	
1	10.7	18.8
2	5.6	9.8
5	2.6	4.4
10	1.6	2.6

Broad batters improve traffic ability and should be somewhere between 1:4 and 1:8 (Figure 6) depending on the type of vehicle using the track and the land slope.

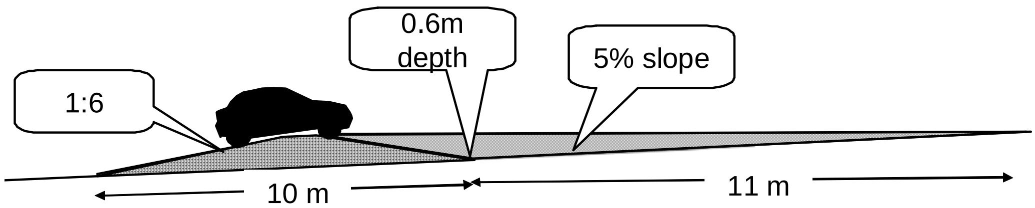

Figure 6 – A cross-section of a whoa-boy on a 5 per cent slope assuming that there has been no cut and fill.

Slopes greater than 10 per cent

As the road slope increases, it becomes more difficult to provide sufficient cross-sectional capacity and trafficable batters for whoa-boys. Even high clearance vehicles have difficulty negotiating whoa-boys on slopes steeper than 20 per cent. Whoa-boys on steep slopes can either be built using a cut and fill technique (Figure 7) or by importing soil (Figure 8). Table 3 compares the resulting cross-sectional areas.

Table 3 – A comparison of the cross-sectional areas for whoa-boys built with and without cut and fill

Land slope %	Cross-sectional area (m^2) of the channel			
	Without cut and fill		With cut and fill	
	45cm	60cm	45cm	60cm
10	1.6	2.6	3.9	5.5
15	1.2	2.0	3.7	5.1
20	1.1	1.7	3.6	4.9

Figure 7 shows that to build a 60cm high whoa-boy on a 20 per cent slope using cut and fill requires considerable earthmoving with up to 90cm of soil needing to be excavated to form the up slope batter leading into the channel. This batter would be very susceptible to erosion. The total distance required to build such a whoa-boy is around 20m.

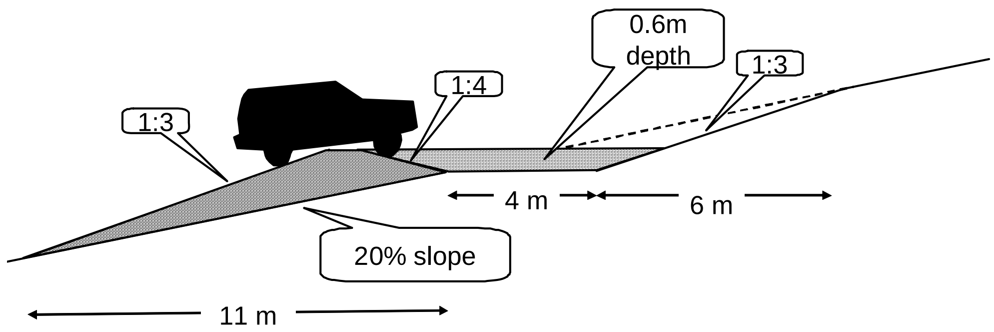

Figure 7 – A 60cm high whoa-boy constructed on a 20 per cent slope by using cut and fill.

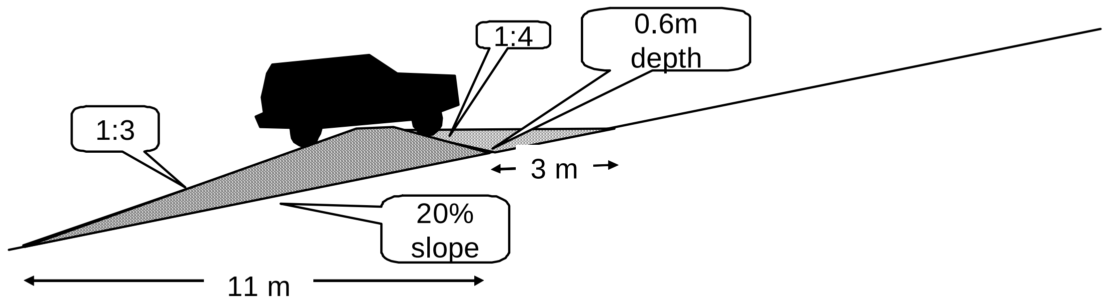

Figure 8 – A 60cm high whoa-boy constructed on a 20 per cent slope by importing road building material.

The required height for a whoa-boy on a steep slope could be decreased to 45cm if the road had an outfall type cross-section as shown in Figure 9. In this case, stormwater would run off the road rather than down it. The smaller whoa-boys could adequately deal with any runoff that flows down wheel ruts in the road. A 45cm high whoa-boy would be much easier to construct and would also be easier for vehicles to traverse.

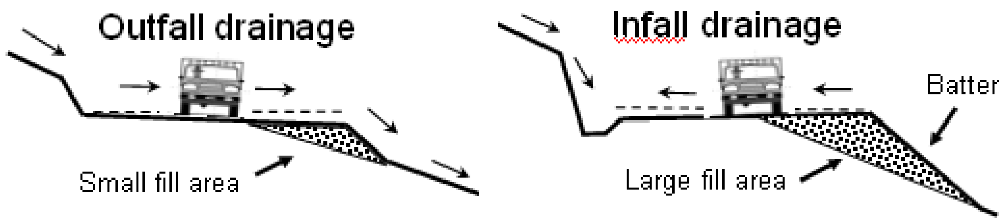

Figure 9 – A Outfall drainage removes runoff from the road and allows for the use of lower whoa-boys.

Gradients in whoa-boys

The fall in a whoa-boy from one side of the road to the other should be 10 to 25cm. Runoff from whoa-boys should flow into a grassed flat bottomed drain with a stable outlet such as a grassed or rock protected area. Flat bottomed drains are preferable to V-shaped drains, which are very susceptible to erosion. Flat drains are easier to install and maintain and there is less chance of exposing erodible subsoils. Flat bottomed, grass lined drains can have gradients from 0.2 per cent on lower slopes to 2 per cent on steeper slopes. If the channel is considered to be at risk of eroding, then 0.2 per cent gradients are recommended.

Whoa-boy construction

Whoa-boys can be constructed with a grader, dozer or scraper. For slopes up to 10 per cent, the soil for the whoa-boy can be moved from either the top side or the bottom side of the mound. For slopes above 10 per cent, the mound should be built from the top side using cut and fill or soil or gravel can be imported to the site. Care should be taken not to expose dispersible subsoils. This can be avoided by importing soil or gravel using a scraper.

The soil on which the mound is constructed should be ripped beforehand to ensure the soil in the mound binds well with the soil below it.

A useful source of soil to build the mound for a whoa-boy is a sill located at the whoa-boy outlet (Figure 10). A sill is an excavation at the end of a structure which has a level outlet that allows for the spread of runoff from the structure.

The average length of a sill is usually 10m and 6-9m in width. Their depth will usually be 20 to 30cm. The sill outlet should be surveyed to ensure it is level.

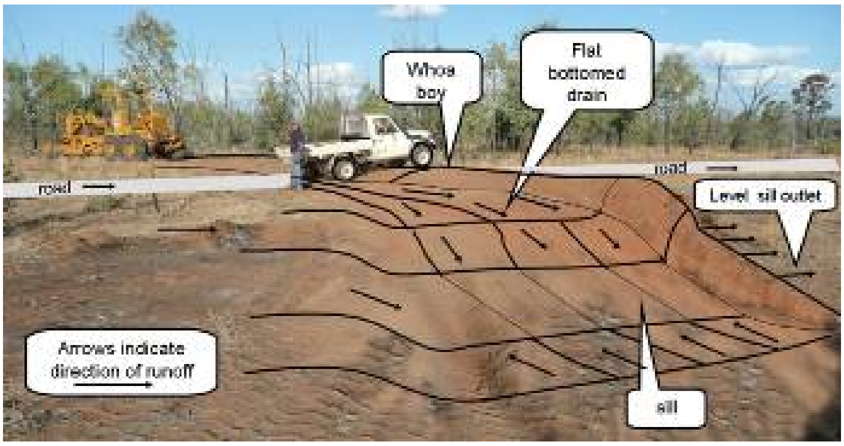

Figure 10 – A whoa-boy with a sill outlet to spread runoff.

An alternative to whoa-boys

Figure 11 shows an example of a track layout which avoids the necessity to cross whoa-boys. It has been used by graziers who need to travel through the middle of paddocks on a regular basis to deliver animal feed supplements. Rather than travelling diagonally across a slope, the track follows sections that are either on the contour or directly up and down the slope. The up and down slope sections can be protected by short diversion banks.

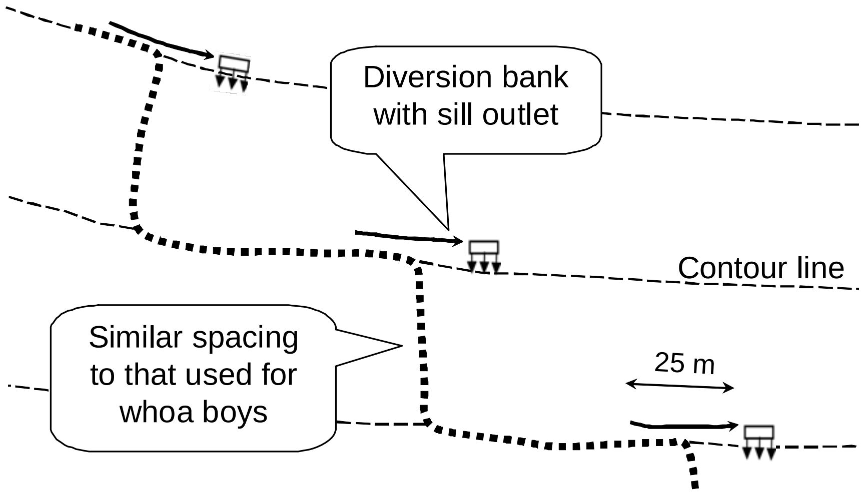

Figure 11 – A road traversing a slope by alternating contour sections with sections directly up and down slope.

Putting zigzags in a track can make it easier to drain a road on steeper slopes. The zigzagging reduces the length of each section of track as well as its slope. Runoff can be drained from the road at each change in direction. A downside is that the road will be difficult for long vehicles to negotiate.

Spur drains on formed or crown roads

On frequently used roads that are formed, it may not be appropriate to use whoa-boys. An alternative is to use culverts (pipes) to move water from one side of the road to the other. Spur drains (Figure 12) are used to direct runoff from table drains and culverts to the adjacent land. Spur drains are also referred to as turnouts, mitre drains, spoon drains or off-shoots.

Spur drains would have similar spacing's to that shown for whoa-boys in Table 1. Variations on these spacing's can be made to allow spur drains to connect up to contour banks in cultivated areas.

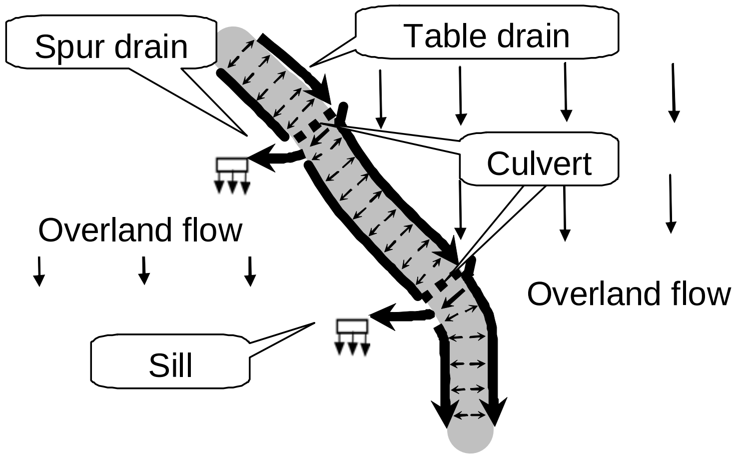

Figure 12 – Spur drains collect runoff from table drains and culverts on a formed road.

Figure 13 shows how inappropriately located spur drains can direct runoff to the side of the road where it immediately flows back towards the road. Eroding table drains are a likely result as the amount of runoff they have to accommodate increases going down the slope.

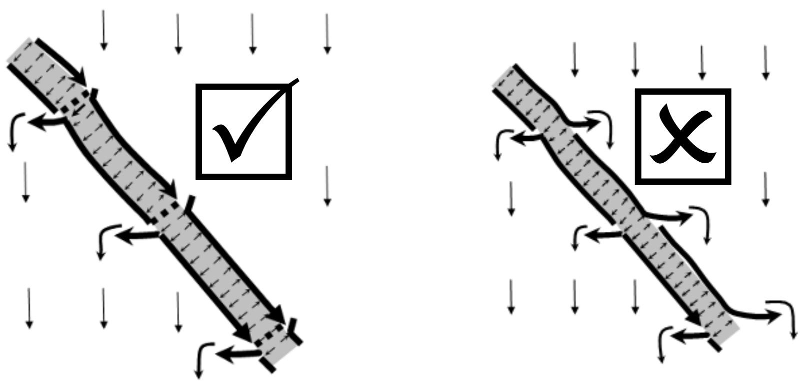

Figure 13 – Correct and incorrect use of spur drains to remove runoff from a formed road.

Both table drains and spur drains should have flat bottomed channels rather than V-shaped channels. A few additional metres of land is required for a flat bottomed channel but the benefits are worthwhile. A sill at the outlet of the spur drain can provide soil to construct and maintain the drain. Gradients for spur drains would be similar to that for whoa-boys.

Road and track maintenance

If possible, grading of table drains should be avoided as it will remove any grass in the drain and cause erosion. This can result in the drain becoming too low to discharge into the spur drain. Runoff then bypasses the spur drain causing additional erosion as it continues down the table drain.

Traditionally, spur drains are maintained by grading from the table drain to the spur drain outlet. This continually moves soil downhill. however, it is better to maintain spur drains in the opposite direction, from the outlet towards the table drain. If there is a sill at the outlet, it will have collected sediment, which can be used to maintain the bank and ensure that the spur drain connects up with the table drain.

When roads are graded to remove wheel ruts, soil from the road is often moved into windrows on each side of the road. This results in the road surface becoming lower than the surrounding land (Figure 14). A road in this condition becomes an eroding waterway from which runoff can't escape.

Figure 13 – Incorrect road maintenance can lead to subsurface roads from which runoff can't escape.

Windrows on either side of the road should be brought back onto the road during maintenance. Unavoidable windrows should be on the lower side of a track and gaps should be created at intervals of 20 to 30m to allow dispersal of accumulated runoff.

Further information

This and other science notes are available from the Queensland Government website www.qld.gov.au – search 'science notes' or for further information about this science notes series phone **13 QGOV** (13 74 68) – Ask for science notes – Land series 240. Other science notes related to this topic include:

- L239 Erosion control on property roads and tracks—cross sections and locations.
- L241 Erosion control on fences and firebreaks.

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