MANAGING OUTBACK ROADS

LET IT GO, LET IT FLOW.

WATER YOUR LANDSCAPES, NOT YOUR ROADS!

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FRONT COVER

This photograph was taken along the Oodnadatta Track east of Marla in South Australia. In the foreground is an area that now only gets rainfall and not the gentle sheet flow from above, which now goes down the road as a river after strong rains. There is no fence line – this has nothing to do with different grazing management. This is a road cutting off and draining away critical sheet flow thereby drying out the land below.

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INTRODUCTION

Prevention is better than cure.

Outback roads are a necessary disturbance of the managed landscape, indeed a requirement for managing productivity and profitability. What is not necessary is the wide range of problems associated with outback roads and the widespread adverse effects they have on the productivity of the land through soil erosion and disruption of natural water flow patterns. These problems are “normal”, but completely avoidable. They are also realistically fixable, but of course prevention is better than a costly cure. This is what we address in this manual based on decades of experience with land managers across the Australian Outback.

One of the most influential factors for landholders is how “experts” construct public outback roads. Many landholders view these as best practices and copy them. Too few see the damage done over tens of thousands of kilometres of public roads that “fight” rather than “fit” local landscapes. The potential exists to turn the public road network into best practice demonstrations for formed roads. It can be demonstrated that maintaining trafficability and landscape functioning are readily reconciled and don’t require a choice between one or the other.

We address the benefits of good outback roads, including economic benefits (it pays!), the problems, how to plan future roads, how to fix problem roads and how to close down roads that simply cannot be repaired practically.

Despite totally consistent objectives, there are different approaches used by experienced experts and these are accommodated by describing their strengths and weaknesses, rather than choosing a single “best” technique. The differences in approaches are mostly in the detail; principally as to whether the accurate surveying of banks is necessary and whether or not to include a spreader sill. As a rule of thumb; if in any doubt, get the survey gear out and include a spreader sill. This principle applies particularly in strongly sloping or fragile landscapes and when soil must be excavated to build any water spreading sill. It is recommended that landholders serious about addressing road and other erosion/dehydration issues acquire survey equipment. We also recommend accessing experienced practitioners for landholders starting out at road management.

By “outback roads” we mean all gravel and dirt roads, be they privately or publicly managed. The focus here is on private roads, regardless of whether they are on stations, Aboriginal lands, Government reserves or any other tenure.

TERMINOLOGY

Bund

Refers to a low earthen bank used for diverting water. In this manual it generally refers to a bank of relatively short length.

Gabion

A structure built with one or more wire baskets filled with small rocks/stones that allows water to flow over its centre. Very difficult to get right and a common cause of increased challenges when not done exactly right.

Spreader Sill

Refers to an excavation where the downslope edge is dead level (exactly on the contour). When the excavation fills with runoff, water flows out across the length of the sill edge as a broad sheet, rather than being released in a concentrated flow next to the whoaboy.

Weir

Solid barriers to flow, usually using concrete that allows overflow onto a calming apron to avoid exacerbating problems downslope. Very easy to make mistakes and things worse if not done exactly to fit the landscape. Porous weirs such as large rocks are safer than walls but still require exact implementation to avoid concentrating flows and more problems.

Whoaboy

This refers to a low bank constructed across a track or road to divert runoff back onto the surrounding terrain. Whoaboys are constructed in a manner to be easily traversed by vehicles.

Windrows

Refers to the low bank of soil that flows from the end of a grader blade during grading operations. Windrows are commonly present on the edge of outback roads constructed using traditional practices. They act as a dam wall until they are breached and then the banked up water is released in a high energy flow.

THE VALUE OF GOOD ROADS

The key values include:

1. Little maintenance required and less cost as a result.
2. Minimal disruption of natural surface flows.
3. Easy and safe to use in managing the land.
4. Quick drying and ready for use soon after rain.
5. Reduced Work Health and Safety risks.
6. Gentle on vehicles and machines ($$$$s).
7. More effective fire breaks.
8. Less siltation of earth tanks/dams from incoming roads.
9. Appreciation of visitors/tourists.

A good road network is obviously an asset, but many roads lead to problems that just increase and get costlier to repair again and again. Maintenance costs can be reduced by 50 per cent when you build good roads.

When building new roads a good starting point to avoid problems is to better 'fit' roads into the landscape

TYPICAL PROBLEMS WITH "BAD" OUTBACK ROADS

1. Eroded roads are difficult to use and sometimes unsafe. As well as the rough, washed out sections, there are the resultant areas of down-slope sandy deposits that also impede travel.
2. Unsafe roads are a legal liability.
3. They are bad for your vehicles, machines and maintenance budget.
4. They suck water out of the land above them and starve land below them.
5. They release high energy flows in valley floors, exacerbating erosion, flooding, sedimentation and weed spread.
6. They can even move water flows from one catchment to another if a natural drainage boundary (watershed or "rooftop") is cut through by a "road river".
7. They can initiate erosion upslope wherever oncoming flows drop into the road base over a mini waterfall (see Photo 1).
8. They present unnecessary challenges in emergencies; e.g. wildfires.

Quite clearly these are challenges that landholders can do without. The key is to plan to minimise these challenges and to maximise benefits of a well- planned and maintained road network.

Photo 1. A lateral gully cutting back upslope from a deep old road. (Hugh Pringle EMU™)

Taking a little extra time to develop good roads makes good economic sense!

AN OVERALL STRATEGY FOR OUTBACK ROADS

"Let it go, let it flow"

This is a favourite saying of co-author Col Stanton who has been a soil conservation officer in central Australia for four decades. It is a key thought process in planning the management of outback roads. When planning, constructing and maintaining roads, a good principle is to minimise alteration of natural water flows.

Whatever you do, allow natural processes to remain as unaltered as you can, because when we alter them, we do not know all the consequences. None of us can truly anticipate all undesirable consequences when we alter the workings of landscapes substantially. In practice, these suggestions might help:

1. Avoid creating new problems by developing "good" roads needing little future maintenance.
2. Develop a clear repair plan for problem roads based on your priorities on the basis of;
    a. Safety/liability;
    b. Importance to the business/community; and
    c. Importance to the ecosystem.
    These criteria are not mutually exclusive... Manage what matters to you.
3. Shut down problem roads and restore natural flows.
4. Provide adequate training and supervision to all operators of machinery capable of modifying natural flows.

PREVENTION: SOME KEY PRINCIPLES FOR PLANNING NEW OUTBACK ROADS

Perfect roads may not be achievable, but you can minimise the risk of disturbing natural processes and so also minimise your maintenance costs. Some key principles are listed and explained briefly below, but they need to be regarded as guides, not rules, for practicality and cost reasons:

1. Straight lines come at a cost

Landscapes don't work on straight lines. In the long-term, the fastest route from A to B may deviate from straight to accommodate terrain and contours.

2. Higher is better

The higher in the landscape a road is placed, the less water flows to it. This has to be within reason, avoiding steep slopes wherever possible. Along the crest of a broad rise, or close to the base of rocky outcrops are examples of high placement.

3. Contouring is better but can pond water if "dug in"

The closer a road is to nature's contours, the more likely it will allow natural cross flow and the less likely it will capture and divert natural flows along it. Additionally, if a road is below landscape level and on contour, it will pond water. Wind erosion can cut the road down despite best management, so it is suggested that "whoaboy" trafficable bunds are part of even the most carefully planned new road and existing roads not to be closed down.

4. Go away from contours in "quiet" flow areas to regularly spill any harvested sheet flow

Typical areas are "spurs" where the drainage is naturally away on each side and so easiest to avoid capturing by the road. Spurs are higher "fingers" with spreading flow between adjacent ravines or valleys where the flow is strongest.

5. Cross narrow (less than 50m wide) strong flows at right angles

Roads that are not at right angles to strong flows will tend to capture and divert flow along the road in the direction of its grade (slope).

6. Cross broad watercourses or floodplains close to the contour

Crossing broad flows at right angles (see point above) will tend to draw water to the lowest point and create problems, so try to keep to contour in such cases. Also, in building a road across such systems never cut through "bumps" as these keep floodplain flows separate and counteract any drawing of flows to the lower areas (see Photo 2).

7. Avoid placing roads along watercourses and active floodplains

Where this is impractical, place the road as high in the landscape as possible to minimise disruption to natural flows and make remedial actions cheaper and more effective. Whoaboys are essential in these cases, even with new roads (that for some very strong practical reason cannot be placed further upslope out of the flow zone).

Photo 2. Flow along a floodplain (blue line from top left to bottom right) is intercepted by a road taking all the flow to the floodplain lowest section (red line) dehydrating the higher, wide sections. (Hugh Pringle EMU™)

Roads along the base of valley floors cannot really be “fixed” because the land slopes upwards from them on both sides so drains or banks will not work. In such cases, the road should be shut down and relocated carefully out of this problematic landscape.

8. Avoid fragile areas

Roads built through powdery soil will inevitably develop expensive problems – as is the case with sand dunes for example. Consider the direction of potentially damaging water or wind.

9. Avoid areas likely to spread weeds

Weeds will spread if roads are constructed through areas already infested with them.

10. Consider fire risk and response needs

In some areas that are prone to wildfire, compromises may need to be made, particularly in steep terrain.

BUILDING AND REPAIRING ROADS

There are many similarities when building a new road and fixing/maintaining an old existing road, so they are covered together in this section.

1. Do not cut the land when clearing the vegetation

When creating a new road or widening an existing road, you can use the vegetation cleared to “sweep” the road in front of a big machine or drag something (e.g. angle iron implements, bound tyres) that should not dig in behind your vehicle. Be careful not to cut the land if you use the dragging method. The key is to ensure that water will flow across the road and not be captured and flow down it. Wherever practical, retain the protective gibber/stone mantle. Gibbers often protect highly erodible soils. The use of a roller to improve the road surface may be practical in some circumstances.

2. Make the road wide enough

“Spread the load” on the road. Ensure that vehicles can choose different paths each time and not create two-wheel ruts, which will become channels. You may need to widen existing roads if this has become a problem and install whoaboys.

3. No windrows along new and existing roads

If the periodic “sweeping” causes windrows, return and spread them back across the road to allow totally natural cross-flow. The respreading of windrows is highly desirable. Even if a road is lower than ground level, flows will cross it if there is not a sharp ledge on the top side causing waterfall erosion and then again on the lower side acting as a block (in particular). The momentum of flow will push the water across the road if it does not encounter such barriers. The diversion of flow will then reflect that landscape slope, not the banking effect of windrows and steep road edges. If the road is so low after respreading the windrow and there are still issues it may be necessary to build whoaboys to calm the flow and create a more natural flow (Appendix 2).

WINDROWS ARE ALWAYS BAD

They steal flows from sheet flow areas that most need them and “shoot” them into drainage lines which least need them (see Figure 1 and Photos 3a, b and c).

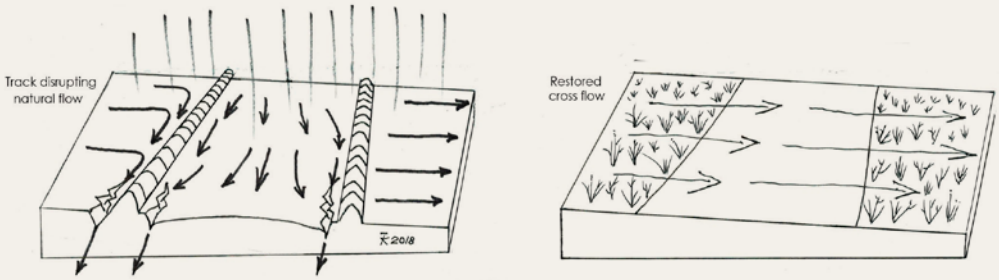


Figure 1. Windrow impacts and after being flattened out to restore natural cross-flows. (EMU™)

Photo 3a. A newly made road without cutting the land or creating whoaboys. A short, flat and very gently sloping drain is on the left. (Paul Theakston NSW LLS)

Photo 3b. A “track creek” with major sand deposition in the foreground and scouring in the background. Note the road is cut down and has windrows on both sides. Natural cross flow was from left to right before it was captured by the “road creek”. (Hugh Pringle EMU™)

Photo 3c. The same section of “road creek” now flattened out and with whoaboys along it in strategic places below stronger cross-flows (see Figures 6a, b). As the “creek” was a major station trucking road, good material was brought in to build the whoaboy. The windrows were sandy and whoaboys constructed with them would have been cut through by vehicle tyres and washed away. This well-repaired road will need minimal future maintenance. (Hugh Pringle EMU™)

BUILDING AND REPAIRING ROADS (CONT.)

4. Open up high energy flow sections upslope and below strong drainage crossing a road but keep the landscape level

This allows turbulent flow to slow and calm down before it meets the road and then allows easy cross flow. Ideally, keep the natural ground level so that you don't "dam" water, or conversely start gullies by cutting into the natural ground level. If it is feasible to bring in good road material (preferably limestone based), this may reduce long-term repair costs as it is less likely to wash away.

5. Locate whoaboys/ trafficable bunds in awkward sections to release captured water calmly

Sometimes (e.g. along steep hills) where you cannot follow the contour to get from A to B, identify stable areas where the water will flow calmly and safely back into the landscape and not aggressively. Aggressive outlets that "shoot" water flow cause gullies to cut back up the road. Common stable areas are spurs between lower ravines that naturally spread, rather than concentrate flows.

The placement of whoaboys needs to reflect many landscape and management factors. There are excellent, well-tested recommendations for spacing whoaboys, but that underpinning needs to fit around the local detail including patterns of inflow, breaks in slope and so forth is critical. See Appendix 2 for detailed information. As a rule, in all but the most gently sloping landscapes, build the trafficable bund with a surveyed sill to calm and spread outflows.

6. Protect entry and exit points to creek crossings

Steep slopes down banks into creek-bed crossings frequently wash out with flows caught and directed along the track. Protect the banks by ensuring that they are isolated from these flows by installing trafficable bunds upslope of the bank.

7. If drains are absolutely necessary for existing roads or a new road that needs to be in that particular location, make them short, flat and wide.

As a general rule, diversion banks are preferable to drains. As soon as a road is cut down below landscape level, "draining" it becomes difficult, particularly in landscapes with low slopes. In many cases it may be simpler and more cost-effective in the long term to build whoaboys instead. Long, V-drains usually cause problems with their "shooting" outflow and erosion heads that will cut back into the road.

Consider the following in building drains:

a. Make them flat, wide and short

   i. Flat –not angled, as concentrated bottom flow increases water speed and initiates erosion

   ii. Wide –the wider the flow, the lower its energy and speed as it leaves the works

iii. Short –reduced distance for released flow to gather speed. No more than a few metres maximum! Get the survey gear out to get it right rather than build a long monster drain that you know will drain the road and hurt the landscape (see Figures 2 and 3 and Photos 4 and 5 below)

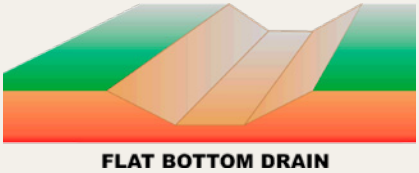


Figure 2 and Photo 4. Flat bottomed drains recommended. (courtesy of the Northern Territory Government)

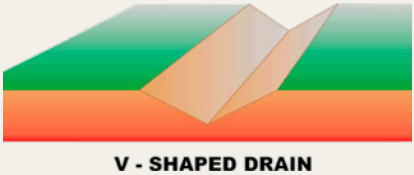


Figure 3 and Photo 5. V-shaped drains discouraged. (courtesy of the Northern Territory Government)

Aim them GENTLY down slope releasing it calmly at the end of the drain.

b. Put them in the best place for that section of road and NOT straight into watercourses, creeks. Rehydrate rather than dehydrate the landscape;

c. Avoid sending flow to problem areas downslope or dumping flows in borrow pits thereby depriving the broader landscape of that sheet flow; and

d. Spread and calm flows in difficult, steep situations by keeping the “drain” on the contour and blocking its end to then spill over the length of the drain, rather than out of the end.

In most cases, a well-planned and maintained road will not capture cross flowing water and drains will not be needed. The more drains you need, the less your road “fits” the landscape.

8. For existing roads, consider re-aligning some sections and close down abandoned sections to restore natural flows.

These roads provide a great learning opportunity when creating new ones. (see page 19 “Some specific situations”).

MAINTAINING YOUR OUTBACK ROADS

A well planned and built road can be destroyed by poor maintenance.

Some hints to road maintenance:

1. Do what you have to do to enable natural cross flows; remove windrows. Let it go and let it flow!
2. Watch the TV when the roads are wet – don't go out and cut your roads into future creeks.
3. If you cut the land because you had to – repair your damage before small problems get bigger. This includes restoring deep ruts where vehicles have become bogged.
4. Supervise any road works by contractors or you may have more repairs to do than before!
5. Fix problems as soon as you can. Early fixes are easier, quicker and CHEAPER.
6. Enforce your "road rules" for staff and visitors.
7. This applies particularly to "spreading the load" to avoid forming wheel ruts and do not allow driving around whoaboys. Outback roads should not be seen as an opportunity for a 4WD adventure and speed limits are critical to reduce the frequency of required maintenance and hence cost. Fast vehicles cut into the road surface far more than calmly driven vehicles do.

CLOSING DOWN PROBLEM ROADS

In some cases, you will have roads that simply don't fit the landscape and will require ongoing high maintenance and costs. That is the landscape telling you that the road does not "fit". This is particularly the case where the section of road is surrounded by higher ground so that the water cannot be spilled away or in very fragile landscapes inappropriate for roads. In such cases, the best option is to close the road down and restore natural flows. The key objectives are to:

1. Restore natural flows.
2. Avoid creating any new problems.
3. Repair any problems the road has caused nearby (e.g. sheet or gully erosion cutting back from the road).

Closing down problem roads with machines

If one accepts these three key objectives, there is still a budget decision to be made. How much harm to the land is the road doing and how much can you spend? If you do the job well with machines, you will save money by spending money:

1. The Gold Standard (recommended)
    a. Bring the windrow banks back into the road, clearing vegetation beforehand if necessary (see Photo 6);

Photo 6. Shut down road using the Gold Standard (recommended). (Hugh Pringle EMU™)

b. Put in earth check banks where needed to spill water gently away to its natural path, with spilling ponds unless clearly not required;

c. "S-rip" areas between bunds to increase infiltration and break up any flows along individual rip lines. "S-ripping" simply involves at least two winding passes with rippers or scarifiers down the road, crossing over as much as possible to break up any flow within a single ripper line. Ideally 3 or 4 passes on different, crossing paths are used (see Figure 4);

d. Bring in desired seeds/seedlings and reticulation for re-establishment of vegetation if desired; and

e. Stabilise any lateral erosion cutting back from the road.

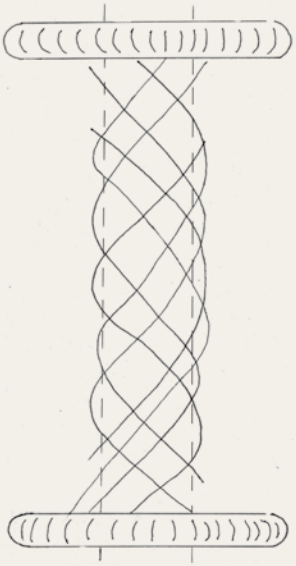


Figure 4. "S ripping" between two whoaboys on a shut down section of road (Ken Tinley and Hugh Pringle EMU™). The roadway (indicated by the dashed lines) should be flattened out as necessary and then ripping should extend beyond the width of the former roadway to ensure flows do not cut gutters alongside the rip-lines.

CLOSING DOWN PROBLEM ROADS (CONT.)

2. Medium Standard
   a. Bring in the windrows and batter ("shave down") any sharp edges;
   b. Build strategic check banks to restore natural flows with wide, gentle spill areas (this will require bringing in windrows for at least 20m above the check bank and battering any ledges); and
   c. Stabilise any lateral erosion cutting back from the road.
3. Low cost option
   a. Build check banks with windrow materials in place except to open up and allow gentle spill ways (this minimises but doesn't really fix the negative impacts of water capture); and
   b. Stabilise any lateral erosion cutting back from the road.
4. Using machinery and encroaching vegetation without earthworks
   a. In cases where a "road river" is in heavily scrub encroached country, a relatively simply way of restoring natural flows is to just push the adjacent vegetation (tall shrubs and low trees) into the road at intervals (see Photo 7). This approach can be particularly effective at the lower point of wetlands or watercourses and then spaced regularly along the section, particularly just below where there are lateral cutting heads indicating a section of stronger inflows. In other words, place vegetation filters where one might place whoaboys if not closing the road down (see Appendix 2.1).

Photo 7. This road through heavily wooded country could easily be filtered using adjacent encroacher trees. Rare or endangered species should not be used.

Closing down problem roads without machines

When machinery is not available, repairing the ecosystem requires skills that encourages land managers to become more in tune with their land and increases their understanding of how it "works". The objectives and desired outcomes above remain the same, but different techniques are needed. Even when machinery is available, some of these ideas might be very useful if the labour is available and affordable. The idea is to use what is in the surrounding landscape as the basis for restoration.

1. Where captured flows are not strong, build ground-anchored bush or mesh filters across the road and then at least half as wide each side, anchored with trees/posts and wire if needed (see Photo 8).

Photo 8. An old "road creek" closed down with a series of bush filters. Only the middle filter adequately protects the sides of the old road, preventing flows easily cutting around the filter.

2. Build suspension filters of bush tied to wires across the road to slow and spread the flow if it is too strong for a ground-anchored filter to "hold" (see Photo 9).

Photo 9. A sieve filter across an old road that extends well beyond its sides.

CLOSING DOWN PROBLEM ROADS (CONT.)

3. Build gabions or weirs with whatever solid materials are available to focus flows in the centre of the road and not the sides. Rocks, crushed limestone, carefully placed sets of logs or even bowed tree trunks have been used successfully elsewhere. Bear in mind, this needs skilful implementation or things can go horribly wrong. Ideally placed solid obstacles are “leaky” so that they allow water to pass through for a prolonged period (see Photo 10).

“Softer” approaches are recommended when learning to rehydrate landscapes by this method. You should always be prepared to monitor the structures and treat mistakes as learning opportunities, but always fix them.

Always extend any works at least half as wide each side as the old road channel being addressed and ”marry” the structure into the base and sides if using solid materials to ensure oncoming flows cannot gouge a path around or under the obstacle to flow. This is usually done by deep ripping the platform upon which the structure is to be built.

Photo 10. A suspension filter across an old road has changed it from an eroding channel to depositional “sweet spot”. It could be two metres wider on the left side.

SOME SPECIFIC SITUATIONS

Simply applying the “let it go, let it flow” approach will not always work. Sometimes, special techniques are needed and this is definitely not a “manual” for them. Rather, we alert land managers to some issues that require different thinking and approaches.

1. Wetlands

Areas prone to flooding and/or seasonal inundation from vast floodplains to local ephemerally inundated depressions. Avoid them at all costs when planning roads. If possible, avoid building roads:

a. Above areas that capture natural inflows above the wetland and divert water away from them;

b. Across areas that bring in invasive weeds and change flow patterns that affect the critical variations in wetting and drying by draining water towards low points; and

c. Down-slope of main overflow areas where any cutting of the land surface can initiate gully heads that could lead to drainage of the wetland (“unplugging”) (see Figure 5 over page).

2. Weedy Areas

Areas infested by problem weeds can be easily managed if protocols are put in place and observed by road users. Until the population has been eradicated, vehicle hygiene protocols are warranted. Where weeds have prickly seeds, signpost quarantine lines on all roads through them so any car travelling through checks the tyres before continuing on. This is very efficient at keeping roads clean of most problem weeds with prickly seeds.

These measures must also partner with directly addressing the cause of how the weeds got there in the first place.

3. Major drainage features

Inevitably, roads need to cross major creeks and rivers. From a practical perspective (as discussed previously) the challenge is to slow and spread oncoming flow and then allow it to pass by easily. Crossings should avoid channel bends which are inherently unstable with an erosional scour side and a depositional side opposite (see Figure 6). Both are unstable. Straight sections should be sought where practical. Channel crossings are also best made in sections where the channel base is close to the natural ground level.

Open, stable channel crossings can be used in a step-wise fashion to gradually restore the natural channel’s level (which is usually nearer to surrounding ground level). This can be achieved in steps as sediment accumulates on the upslope side. To simply restore the natural (base) ground level of an unnaturally incised channel invites an undesirable confrontation with a big flow event that might end up worse than in the original situation and quite costly to bring back to at least that state.

These activities still need repair.

SOME SPECIFIC SITUATIONS (CONT.)

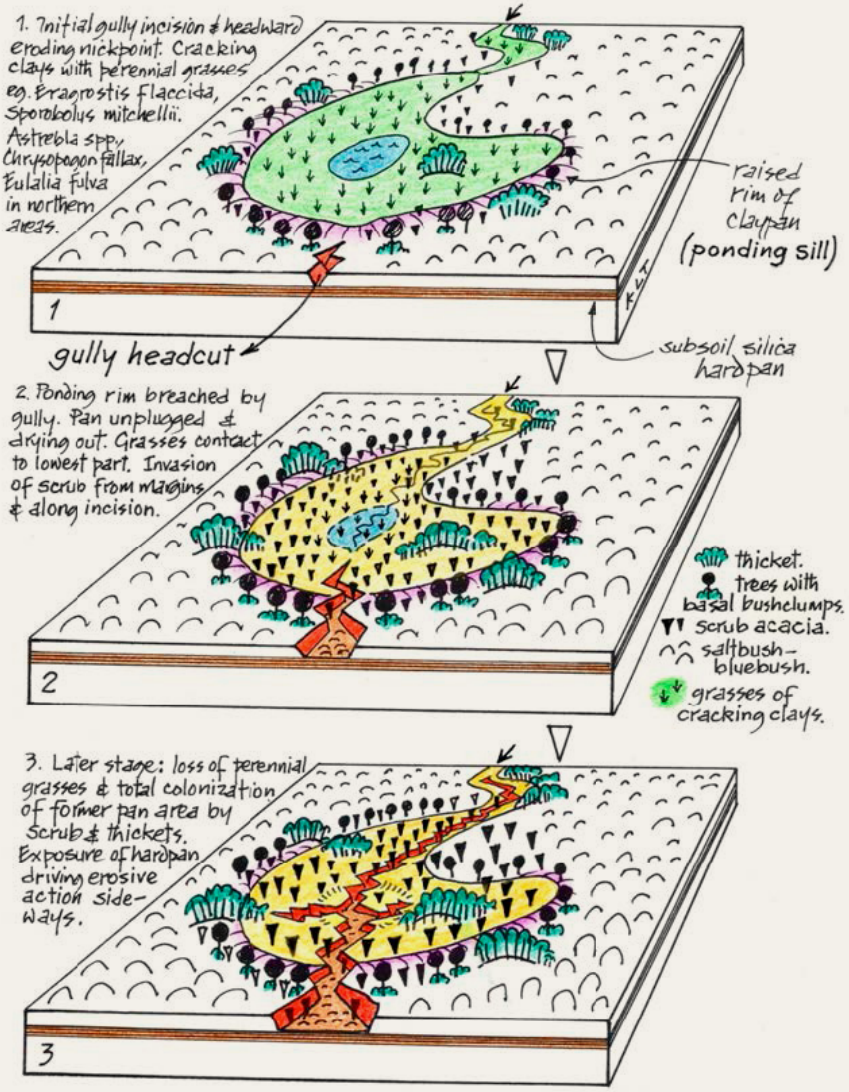


Figure 5. A healthy functioning wetland with a headcut from a “road creek downslope (not shown) approaching the natural “bank” holding up the wetland (1), cutting into and draining the wetland (2) and then destroying all ponding before cutting back upslope (3). (Ken Tinley EMU™)

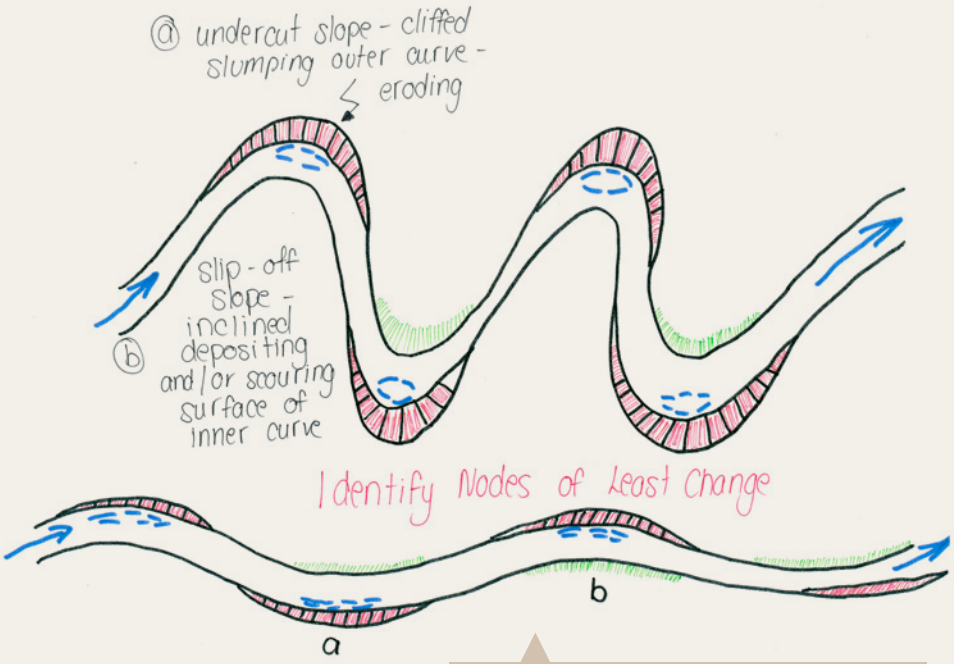


Figure 6. Bends in creeks should be avoided in choosing places for crossings. Rather, straighter, lower sections between bends are far likelier to require little ongoing maintenance.

4. "Flat", low lying areas are not immune from road problems

Land managers can easily be seduced into thinking that erosion does not occur in gently sloping areas and that may be the case in some circumstances. However, where these seemingly "gentle" landscapes are in a catchment of strong headwater run-off upslope, they can erode far deeper and more aggressively than the sloping land above them (see Photo 11 over page). Cutting the land below landscape level in such "gentle" areas, can initiate horrific (metres deep) erosion unlike that in source landscapes over page. The key principles apply just as much to these "gentle" landscapes as any other. Often, they are of disproportionately high ecological and pasture value because they receive run-on (see Photo 12 over page).

SOME SPECIFIC SITUATIONS (CONT.)

Photo 11. Low-lying areas often have deep soils and once the land is cut and gullying starts, it can be worse than higher flow zones upslope. (Photo courtesy of Northern Territory Government)

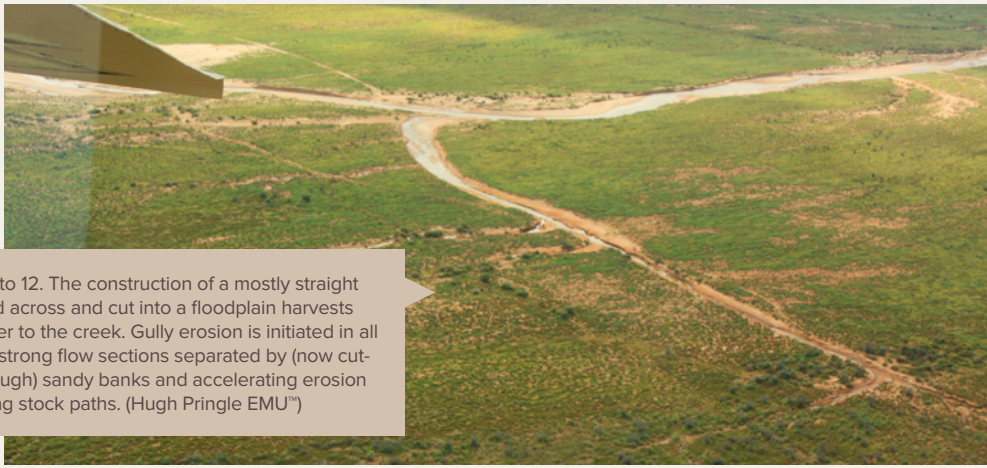


Photo 12. The construction of a mostly straight road across and cut into a floodplain harvests water to the creek. Gully erosion is initiated in all the strong flow sections separated by (now cut-through) sandy banks and accelerating erosion along stock paths. (Hugh Pringle EMU™)

5. Fire

If you need to make an emergency road, repair it soon after you needed to use it.

Sometimes in a fire, you need to make a road in hurry and you won't get it to fit the landscape because that is the last thing on your mind. BUT, please go back and rehabilitate it when the pressure is off, preferably before the next major rain event as the repairs will be comparably quick and cheap before major damage can occur. The costs of delayed repair will increase rapidly. This is also an issue for fire control authorities. In the heat of the moment they need to put human safety and fire containment above ecosystem health.

CONCLUDING COMMENTS

Let it go, let it flow!
Making the effort is worth it!

Be gentle on the land when it comes to the indispensable roads you need to manage. “Fit” the land and it will repay you many times over.

Plan new roads carefully to need minimal maintenance by fitting in with how the country works.

Manage the “problem roads” legacy by setting priorities and chipping away accordingly over a target time. “Park” the rest or it will drive you crazy.

Be cautious if you are just starting out with sustainable road management. Survey works carefully before you put them in.

Never release concentrated flows.

Let it go, let it flow! Naturally!

FURTHER INFORMATION

1. Soil Save: Erosion Control Workshop (by Darryl Hill)
A 16-page handout of simple and clear information with much attention paid to roads. A key resource of this manual with excellent, simple diagrams. Available online.

2. Introduction to Soil Erosion (by Col Stanton and David Waterson)
A manual targeting a landholder audience on erosion issues generally, but also with much attention paid to road and fenceline issues. Another foundational article of this manual.

Stanton C, Waterson D, 2007 (unpublished document). Introduction to Soil Erosion. Edition 1. Vegetation and Land Management, Northern Territory Government, Alice Springs. Available on request to the authors or regional group funding partners.

3. Rangeland Rehydration, 1. Field Guide (by Ken Tinley and Hugh Pringle)
A manual addressing broader rangeland management and repair aimed at landholders, but including road/road issues specifically. Developed for Western Australia, it has wide relevance for rangelands with flowing water.

Tinley, K.L., Pringle, H.J.R., 2014. Rangeland Rehydration: 1. Field Guide. Rangelands NRM, Western Australia.

Available at www.emulandrecovery.org.au

4. Soil Conservation Manual: A management guide 2011
A manual developed with and for land managers with a strong section on road management and similar issues. Very good examples with photographs and figures.

Jolley, K., 2011. Soil Conservation Manual: A management guide 2011.

Revised edition, Victoria River District Conservation Association. vrdca@bigpond.com

5. Back from the Brink: How Australia's Landscapes Can Be Saved. (Peter Andrews)
An innovative book written by a man of the land with limited formal education but an exceptional eye for landscape patterns and processes. Some ideas are very confronting and/or debatable, but that should not detract from the brilliance of the work. See also the follow up work "Beyond the Brink".

Andrews, P., 2006. Back from the Brink: How Australia's Landscapes Can Be Saved. ABC Books, Melbourne.

6. Water Harvesting from Low-Standard Rural Roads: A Good Road Lies Easy on the Land. (Bill Zeedyk)
An excellent but very detailed manual produced in the USA by a well respected soil conservation expert. Very useful for those land managers keen to dig deeper and soil conservation students.

Zeedyk, B., 2006, Water Harvesting from Low-Standard Rural Roads: A Good Road Lies Easy on the Land. The Quivira Coalition and others. 46 pages. Best contacts admin@quiviracoalition.org or www.quiviracoalition.org

7. "Water your landscape, not your roads" (Colin Stanton)
An excellent "hands on" video produced by the South Australian Arid Lands NRM Board.

video https://www.youtube. com/watch?v=WWd_cQ510aU

APPENDICES

Appendix 1. Some suggestions for a "Road Rules" pamphlet

- Owners/mangers' legal liability regarding work health and safety for everybody else on the land
  - Employees
  - Guests
  - Visitors/friends
  - Other?
- Owners' expectations of others in terms of compliance
  - Consolidated account of land manager exposure regarding legal liability and potential consequences of non-compliance
- Specific details
  - Notifications and communications etc. (non-road specific issues related mostly to safety)
  - Off-road driving
  - Road speed limits
  - Whoaboy protocols (no driving around them)
  - Spreading the load, not creating wheel ruts
  - Wet weather protocols
  - Reporting any issues

Appendix 2. Constructing trafficable road diversion banks ("whoaboys") to fit the landscape

Whoaboys are trafficable bunds put across roads to ensure they cannot capture and divert sheet flows along them and then "shoot" them into lowest lying cross flowing drainage features. It is recommended that they are installed in any existing roads that show signs of carrying strong flow as well as being included in constructing any new roads or fencelines. As stated previously, they should be surveyed carefully with spilling sills unless there is a good reason not to do so. As a rule, if the bank is to be any longer than 5 metres long, you should consider building a spreading sill. If in doubt, get the survey equipment out! The key point about spreader sills is that they calm outflows and release them over their length and on the contour instead of just as a concentrated outflow next to the whoaboy.

Appendix 2.1. Locating the key places for intercepting and diverting road flows

The key concept is to divert strongest inflows before they can gather momentum once captured by the "road river" and return them to their natural course calmly.

Most soil conservation manuals recommend that one starts at the highest point of a track to be treated and work your way down spacing (rather than strategically locating) whoaboys at defined intervals down-slope depending on slope and soil erodibility (see the Further Reading section). This makes sense until you step into a real landscape with different amounts of water entering the road at different points because of the shape of the land (Figure 7 a and b).

Figure 7 a and b. Locating key places along a roadway to place whoaboys to have greatest cost-effectiveness

In these two diagrams, the natural flows are shown with broad blue arrows, dashed for gentle sheetflows and solid for watercourse flows. Much depleted flows due to upslope road capture are shown in lighter, thinner arrows. Red arrows indicate unnatural, captured flows.

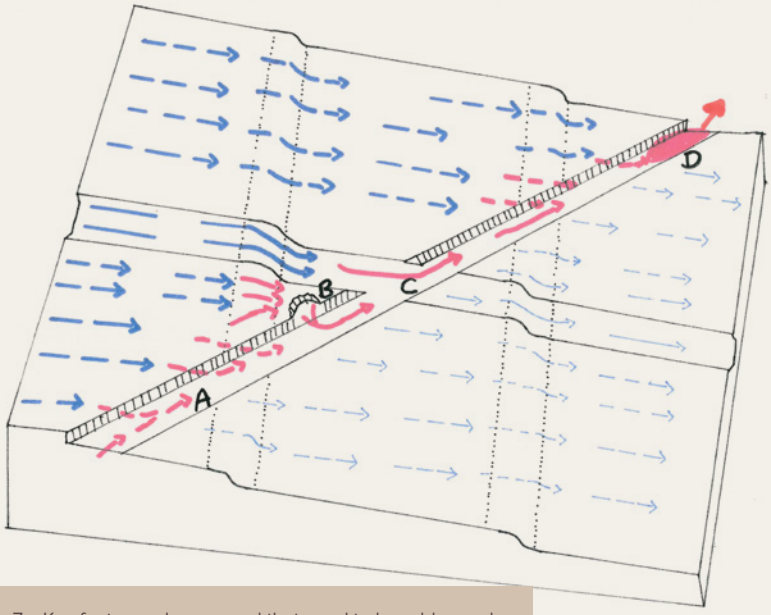


Figure 7a. Key features along a road that need to be addressed when locating whoaboys. (Ken Tinley and Hugh Pringle EMU™)

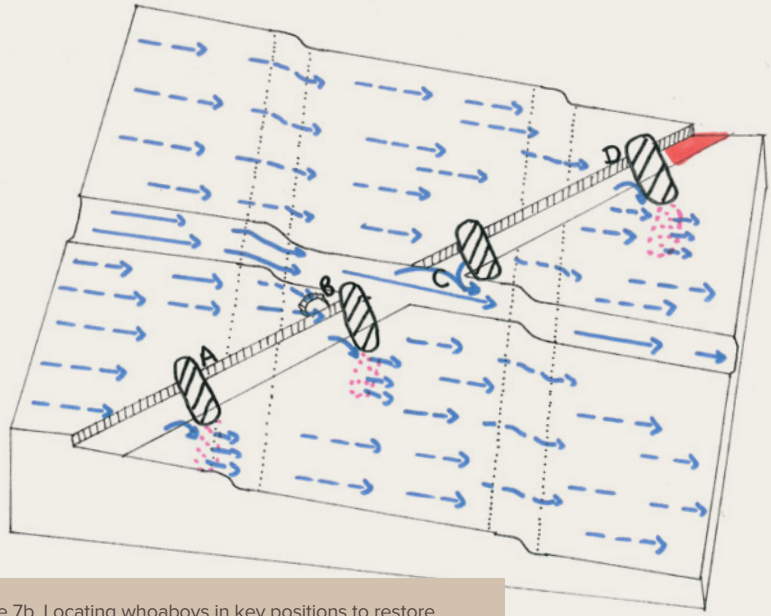


Figure 7b. Locating whoaboys in key positions to restore cross flows. (Ken Tinley and Hugh Pringle EMU™)

Key features (see Figure 7a) along a road that need to be addressed when locating whoaboys:

A: "Step downs"; where the landscape slope steepens and then flattens out again. Flows in the road will accelerate quickly when the slope increases.

B: Lateral erosion cut-backs indicating areas of stronger inflow from upslope. These cut-backs draw sheetflows to them as an easy exit (path of least resistance).

C: A watercourse with much stronger flow speed and volume. Once captured by a road, these strong flows can exacerbate problems lower down the road.

D: An active gully head (washaway) within the road. Gully heads within roads accelerate captured flows and reduce their chance of crossing the road. They also severely impact on the road's trafficability. Gully heads lower the local level of the land and thereby often initiate erosion upslope, away from the track.

Ideally, the road would be flattened out if it has ledges along its edges before whoaboys are built. Whoaboys are indicated by dashed brown bars across the road and spreading sills are indicated by dark blue dots (see Figure 7b).

A: Place the whoaboy above the step down and spread the flow calmly onto it. Step downs are often a lighter colour indicating the increased scouring by captured water as it accelerates down the step. If step downs are not obvious then they probably aren't so important along that section of road.

B: Ideally, the active cut-backs should be battered back and stabilised by whatever means available. For instance, machines can be used to knock the steep edges down and then make a sponge by ripping the area and upslope of it. The whoaboy should be just below the strong inflows to avoid it being scoured away by the inflows.

C: A carefully constructed, sturdy whoaboy can block road capture of the watercourse flow and take the pressure off problems further down the road. The whoaboy should be set back far enough (perhaps a few metres) from the watercourse to not be scoured away by watercourse flows, but close enough to restore natural flows and not create a new watercourse. A spreader sill is not used in this case as the objective is to block flow capture and return watercourse functioning.

D: Ideally, the gully head would be battered back before the whoaboy is built just above it. This will repair the road and minimise the threat of the gully head redeveloping.

If you do not feel comfortable "reading" the landscape as illustrated above, please use the survey method. If you can recognise these signs you can cut down on your total work and focus time on key places. If the whoaboys are still too far apart according to the published guidelines, then it is suggested you put some more whoaboys in-between to protect the key ones you have located by reading the landscape.

2.2. Spacing banks to fit slope and soil erodibility

With the key places to locate whoaboys, or just starting without that step, it is important to appreciate some "rules of thumb" developed by many scientists globally regarding the spacing of water diverting structures. As a general rule we suggest the following:

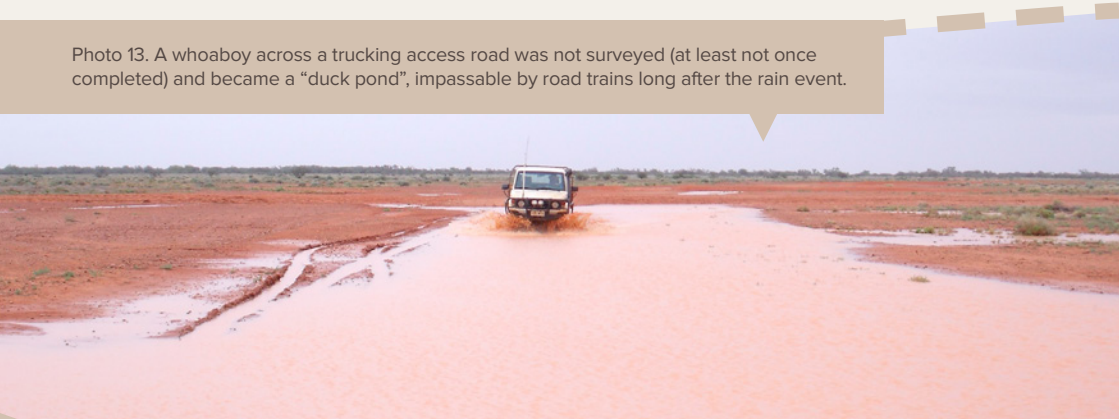
Slope		Whoa-Boy/Mitre Drain Spacing (meters)
%	Gradient	
0.5	1 : 200	170-180
1	1 : 100	120-130
2	1 : 50	90-100
3	1 : 33	70-80
4	1 : 25	60-70
5	1 : 20	55-60
6	1 : 17	50-55
10	1 : 10	40-45
18	1 : 5.5	25-30

Table 1. Spacing whoaboys according to and slope. Note if soils are fragile spacing should be much closer (NT closer). (Land Note: ASLN-13)

2.3. Building a "whoaboy" trafficable bund

The key objective of building whoaboys is to check captured flows within roads and spread them away calmly. Where flows in the road are calm and the surrounding slope is gentle and stable, a bund can should be built directly across the road as long as water can spill away calmly (see Figure 8). IN ALL OTHER CASES, a bund should be surveyed on a slight grade (usually 0.2% or 2cm per 10m, NOT more than 0.3%) and accompanied by a contour spilling sill to spread diverted "river road" flows. If diverted water causes new erosion, it is expensive and difficult to fix because the diverted flow may be concentrated (see Photo 13).

Photo 13. A whoaboy across a trucking access road was not surveyed (at least not once completed) and became a "duck pond", impassable by road trains long after the rain event.



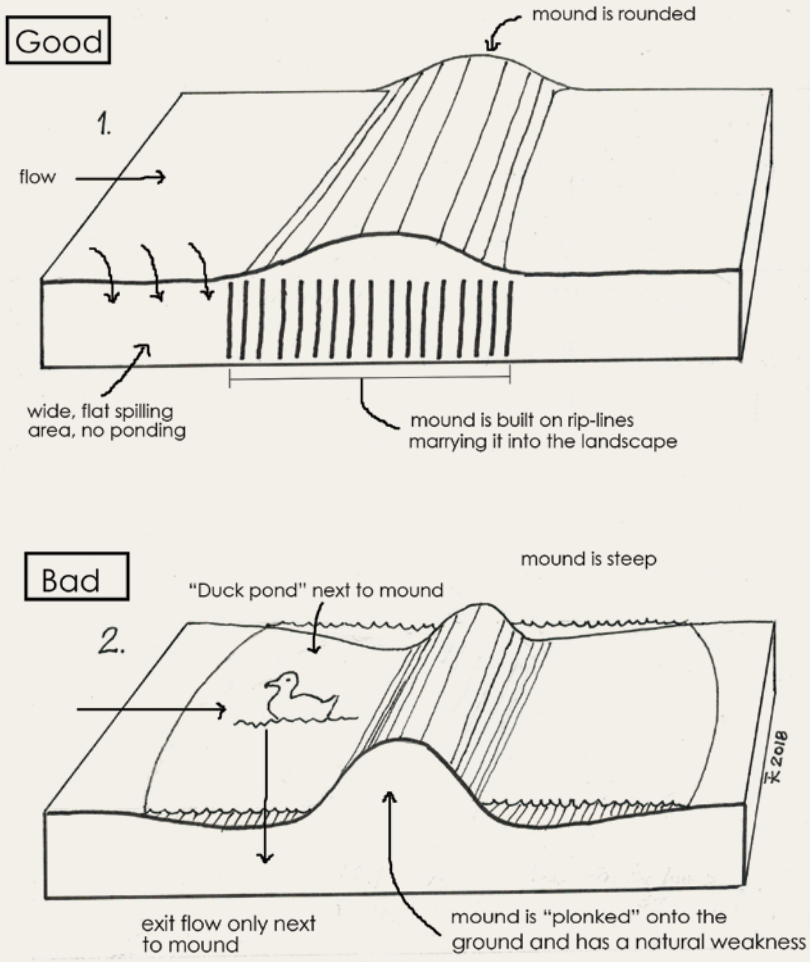


Figure 8. Key features of “good” and “bad” whoaboys. They may also require spreader sills in which case the borrow pit will produce most of the soil for the bank, which minimises the risk of creating “duck ponds”. (Ken Tinley EMU™)

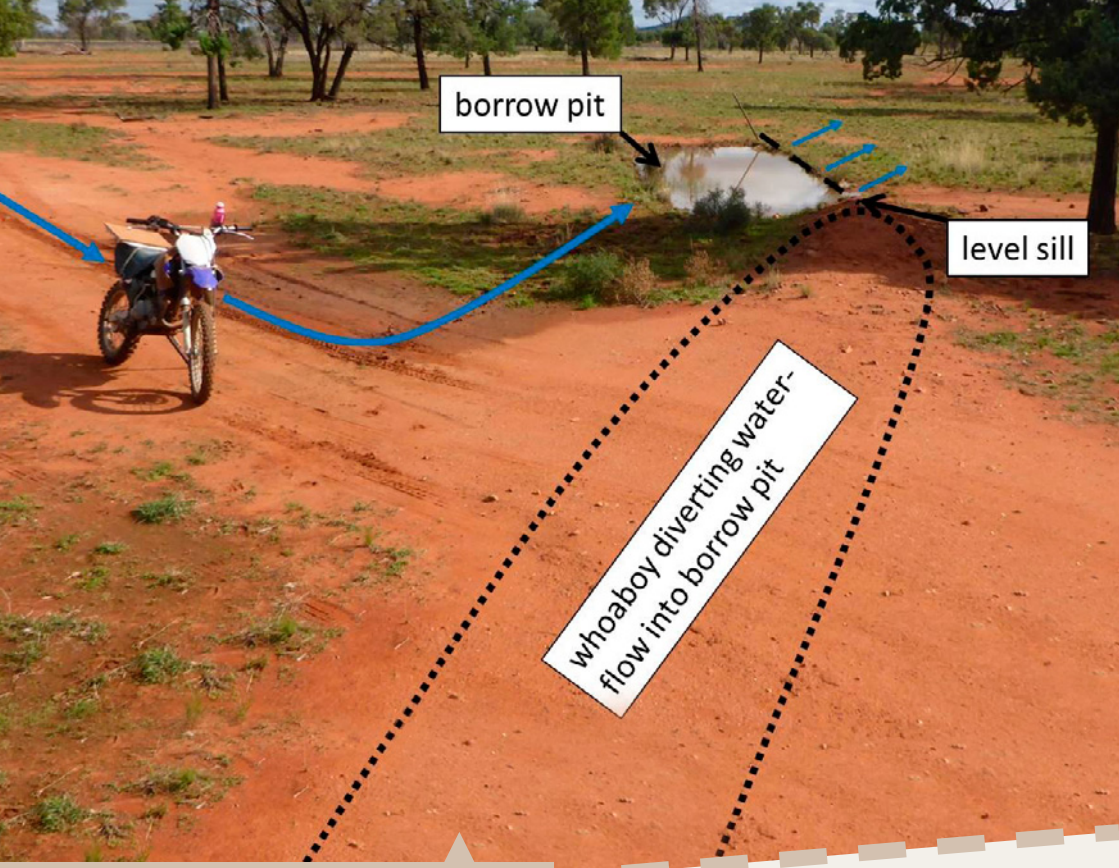


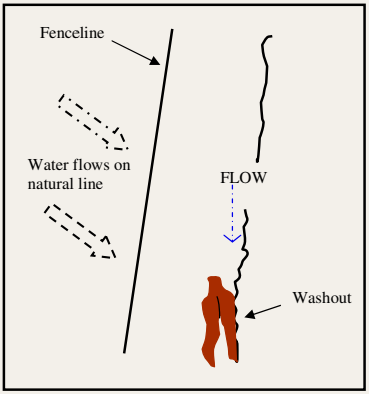
Photo 14. A “Gold Standard” whoaboy with carefully surveyed spreading sill. (Paul Theakston NSW LLS)

2.4 Constructing a spreading sill to prevent new erosion problems down-slope

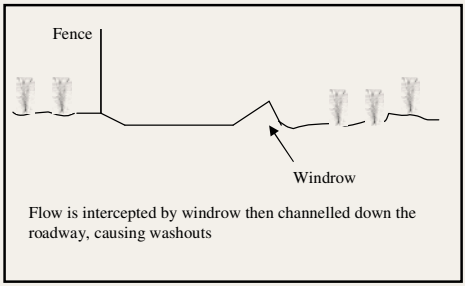
Some experts recommend surveying and constructing sills at every whoaboy and others suggest they are only built in extraordinary cases. The risk of not building sills varies not only with slope and landscape fragility, but also the amount of annual rainfall and the intensity of recurrent storms (even be they every few years). Given climate change prognoses for many regions of Australia, we suggest sills are put in place unless you are sure the diverted flow will spread calmly (see Photo 14 and Figures 9 and 10).

If in doubt, get the survey gear out!

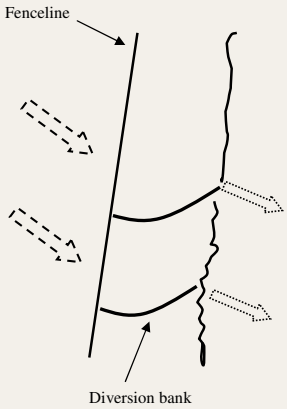
COMMON COMPLAINT



The washout is the result, not the problem



TREATED FENCE LINES



- Graded both sides of the fence line with speed bumps (diversion banks) installed.

- Single track with speed bump (diversion bank) installed.

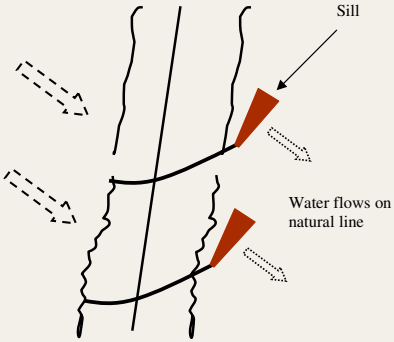
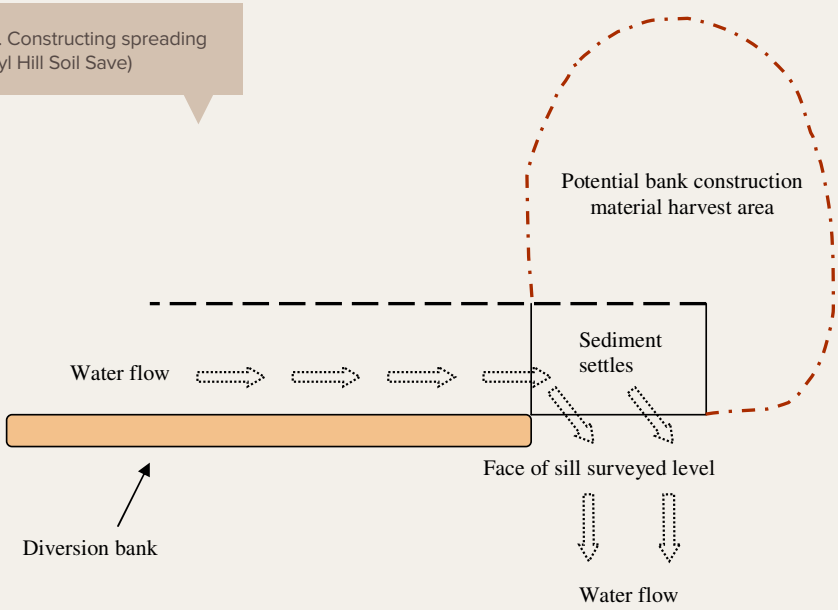


Figure 9. Addressing problem erosion using surveyed banks and sills. (Darryl Hill Soil Save)

Figure 10. Constructing spreading sills (Darryl Hill Soil Save)



- 'A common problem with ban construction is insufficient soils near roadways to construct bank. The average length of a sill is usually 10m and approximately 6-9m in width. Depth will vary with the amount of soil required. Extra length and width can be added if further soil from the upslope area if the sill is needed.
- Sills act as a sediment trap, by allowing soils/sands and debris carried in the water flows to settle thereby rehabilitating the borrow pit. Also, this action takes the force out of the water flow, enabling the flow to follow the natural drainage slowly.
- Surveyed level sill edge should never be disturbed by wheel tracks etc, as these disturbances may allow water to concentrate and flow, nullifying the effect of the sill.'

Appendix 3. Use of the grader blade including mouldboard

Graders are very versatile and can serve many purposes over long distances. The blade can shift in three dimensions for different, concurrent purposes. To keep things simple, we present only three scenarios of cutting, scraping/planing and dragging/rolling (see Figure 11). Land managers are encouraged to undertake formal hands-on training in the use of machinery that fits the landscape as has been provided by some Landcare groups, Government departments, local NRM Boards and private consultants. It is recommended that machinery courses include the use of survey equipment as occurs in some cases.

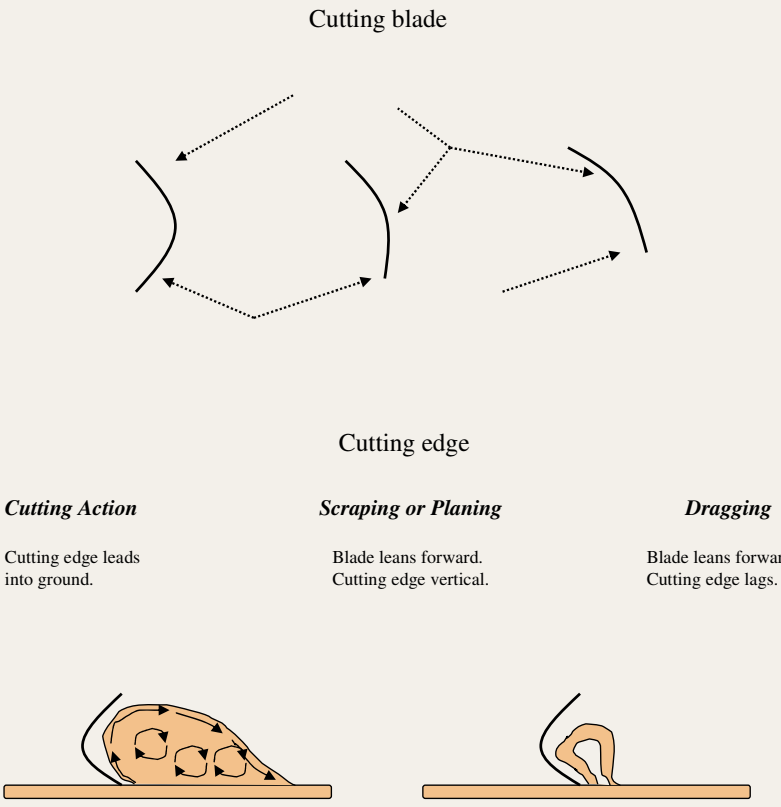


Figure 11. Use of grader blade including mouldboard. (Australian Road Research Board Limited)

Appendix 4. Using survey equipment

The most frequently used piece of survey equipment is a staff with measurements along it. Usually the staff has a zero value at its base (ground level) that then increases in centimetre increments up it. Thus, if the recorded number goes up when the staff is moved to another point, the landscape has gone down. This is because the dumpy level or laser beam are fixed at a set level and if the “hit” is higher on the staff, the land has to be lower. Conversely, if the recorded number on the staff goes down, the ground has risen from the last point (see Figure 12).

When the numbers go up, the land has gone down
When the numbers go down, the land has gone up

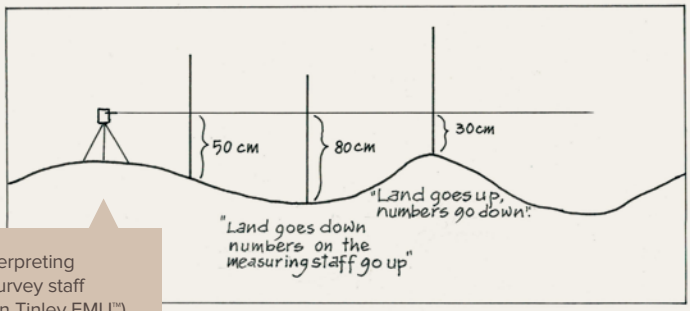


Figure 12. Interpreting changes in survey staff readings. (Ken Tinley EMU™)

Dumpy levels require somebody to move the survey staff around while measurements are recorded by somebody using the levelled eye-piece. Laser levels are set up and then the single operator uses a receiver attached to the survey staff to take readings. Dumpy levels can give accuracy in millimetres (which is usually unnecessary) but are notorious for creating tensions between the operating pair! They can also be used to assess distance between the level observation point and the staff, but for outback roads, this is usually unnecessary and requires some calculations. “Dumpies” do not require a power source so they never run out of battery power as laser levels sometimes do.

Laser levels are very easy to use, require just one operator and usually have quite adequate precision given that local surface roughness around the survey staff is often greater than the precision of the readings. Many laser levels can use both rechargeable and disposable batteries so that a backup set of disposable batteries can be carried. Recharging disposable batteries can wreck the laser level if it is plugged in to recharge as is normal for rechargeable batteries. Laser levels are becoming better and cheaper but will never be as (perhaps unnecessarily) accurate as a dumpy level. To some extent it is a personal preference. Whatever equipment is used, functioning needs to be understood and if the staff is not on the ground and upright, the reading you get is NOT for that spot.

Station track on Crocodile Station, Cape York
(Michael Goddard, Cape York NRM)

MANAGING OUTBACK ROADS

LET IT GO, LET IT FLOW.

WATER YOUR LANDSCAPES, NOT YOUR ROADS!

Rangelands NRM
Western Australia

NSW GOVERNMENT Local Land Services

Territory Natural Resource Management

Government of South Australia

Natural Resources SA Arid Lands

Cape York
Natural Resource Management

Australian Government | National Landcare Program