Track construction and management to withstand erosion

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Why worry about track erosion?

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minimise very real risk to water quality and stream condition

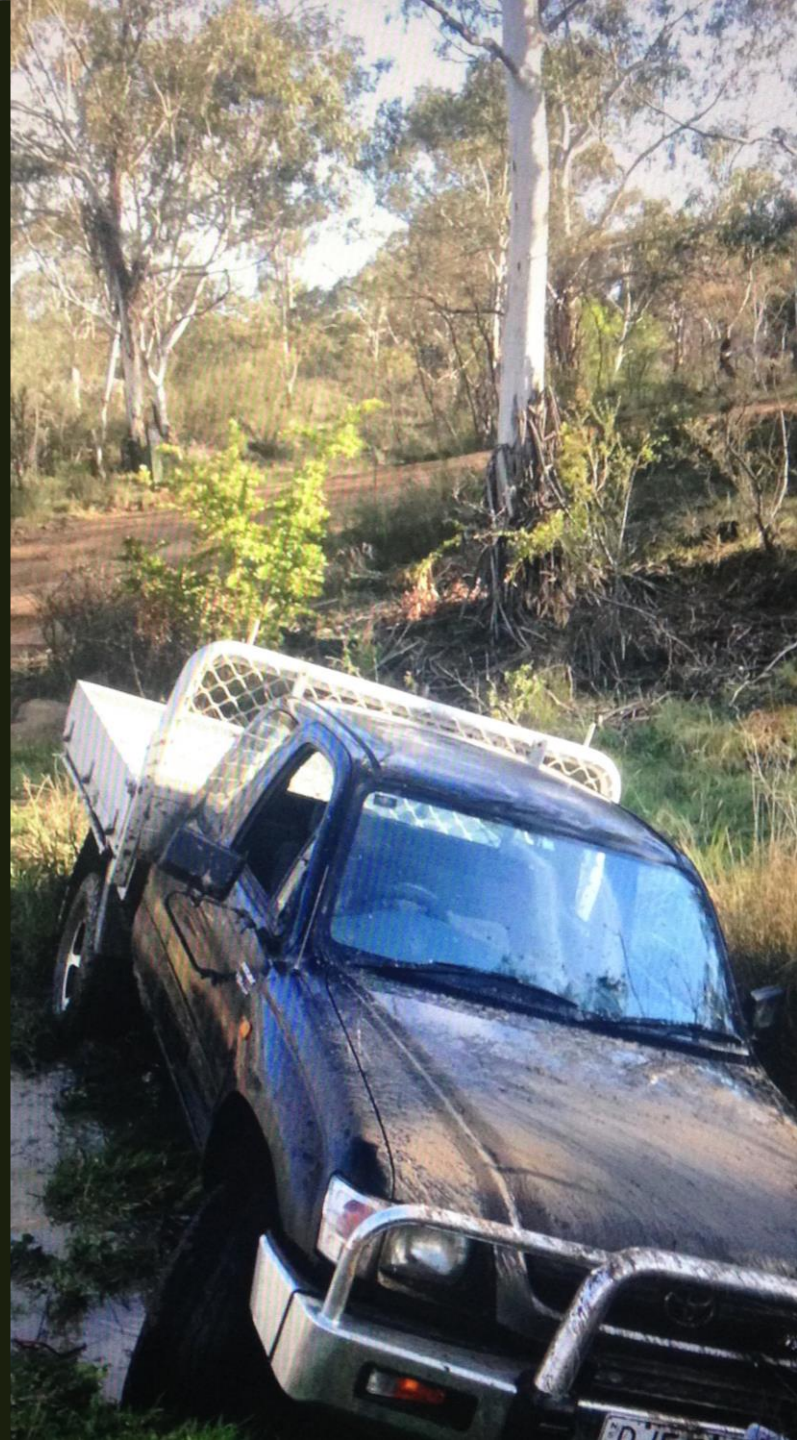
protect your investment, cost of construction typically $5,000 to $25,000 per kilometre

costs much more to repair than to construct properly; get it right the first time

obligations under Code of Practice and legislation

To help you avoid situations such as these …

And these….



… and have something like this

Photos: Forest Corp

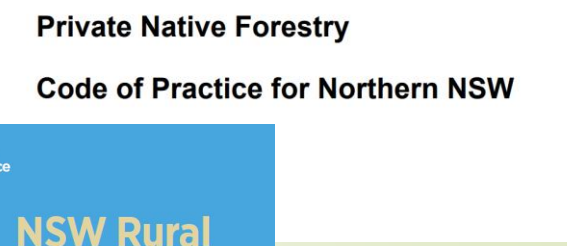
Resources

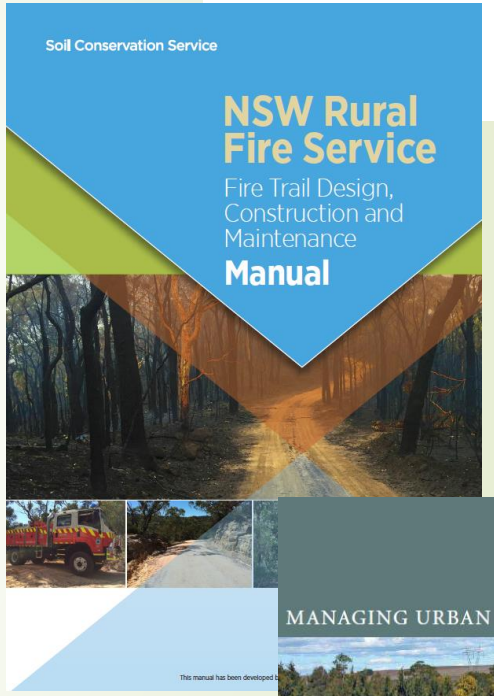
Key document

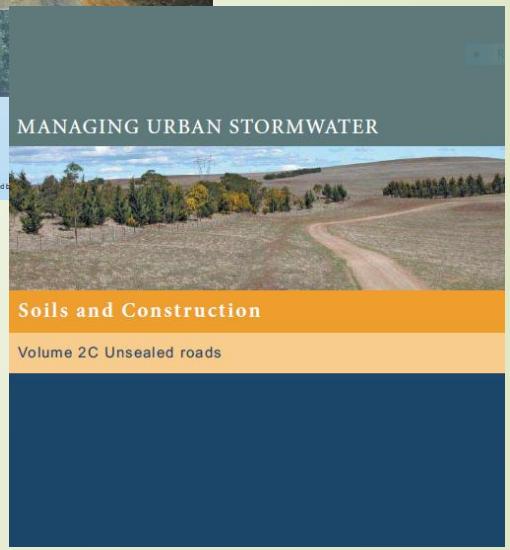
- Private Native Forestry Code of Practice

Supporting Publications and guides

- NSW RFS (2017) Fire Trail Design, Construction and Maintenance Manual
- NSW Government (2008) Soils and Construction Volume 2C: Unsealed roads
- Forests Corp (1999) Forest Practices Code, Part Four, Forest Roads And Fire Trails







Resources

Research

- Focus of major research project by CRC for Catchment Hydrology 1995-98
- Measure erosion from forest tracks and trails and sediment delivery to drainage system
- Special focus on effectiveness of management prescriptions
- Established sound research basis for management prescriptions and advice
- See *CRC for Catchment Hydrology (1999) Managing Sediment Sources and Movement in Forests*

What causes tracks to erode

- Protective vegetation and topsoil removed
- Compaction, wheel ruts
- Increased runoff amount
- Soil erosion of track surface and drains
- Sediment washes off track to watercourses

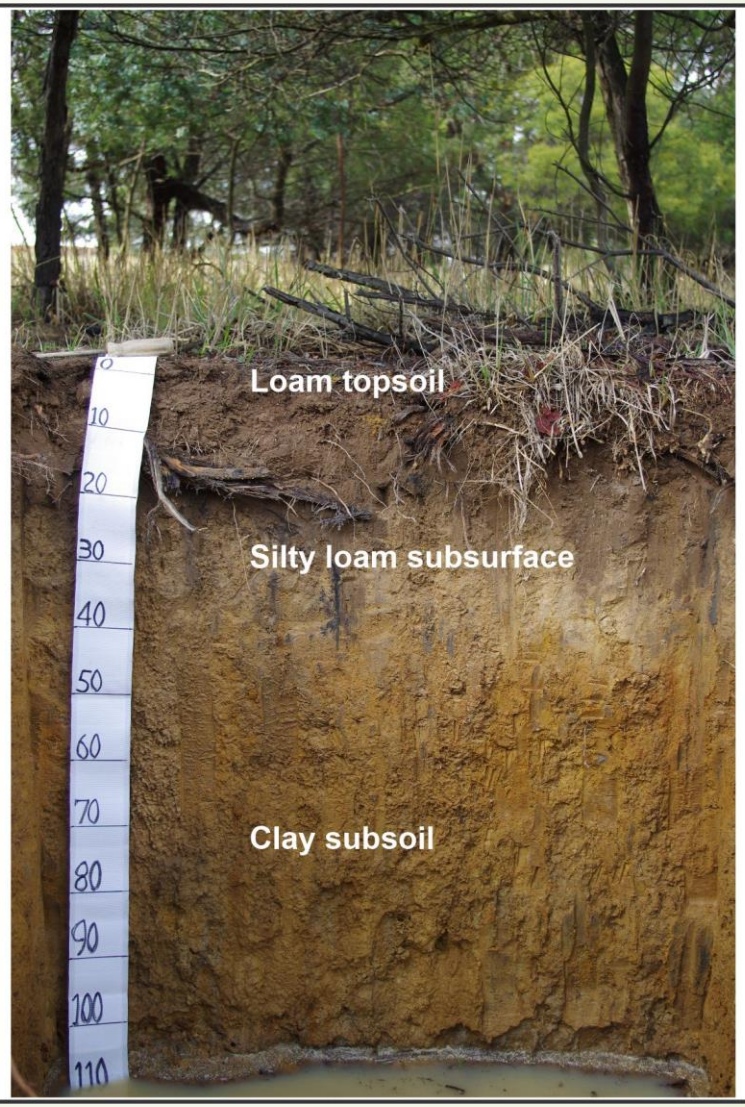
Photo: Ashley Bolton, NSW Soil Conservation Service

Why topsoil is important

infiltration >100mm/hr
saturation water storage: 60%

permeability: 10mm/hr
saturation water storage: 35%

permeability: 10mm/day
saturation water storage: 40%

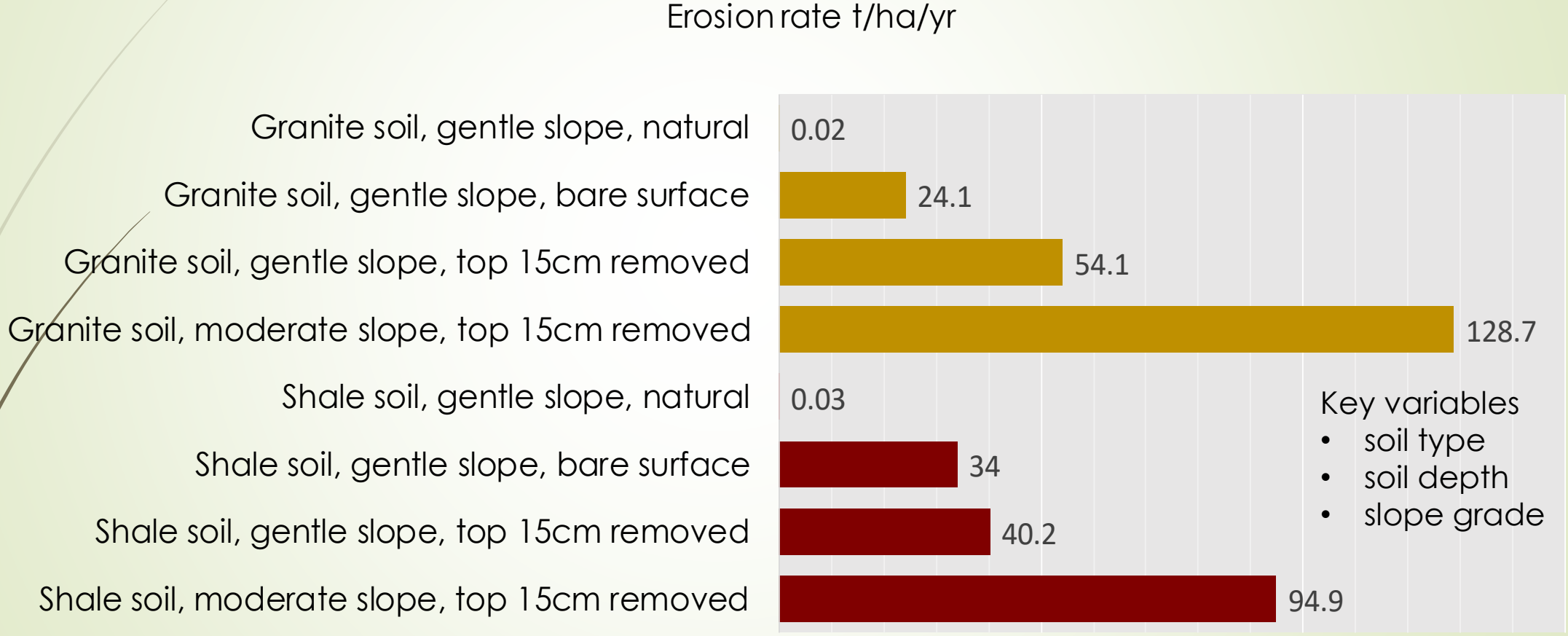


runoff rare, only after intense storms

runoff often, after all but very gentle rain

runoff almost always, after most types of rainfall events

Soil erosion rates on common forest soils



Based on RUSLE erosion model

Stable soil, coherent when wet

e.g. red shale soils

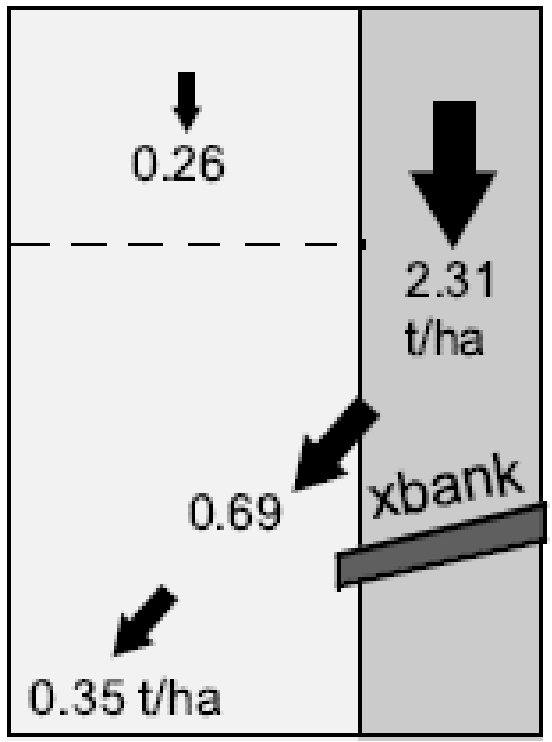
Unstable soil, low coherence when wet

e.g. yellow granite soils

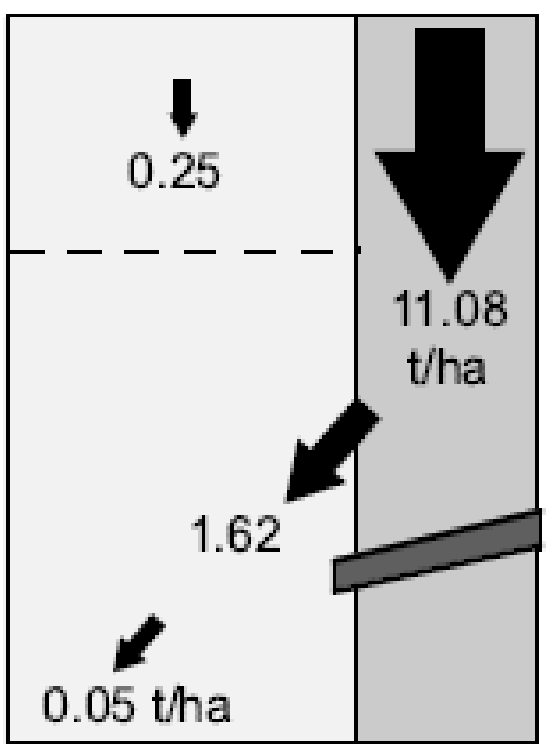
Photos: Ashley Bolton, NSW Soil Conservation Service

Sediment export from tracks from a major storm

shale soil



sandy granite soil



Noting:

Higher soil erosion rate on sandy granite soil than on shale soil

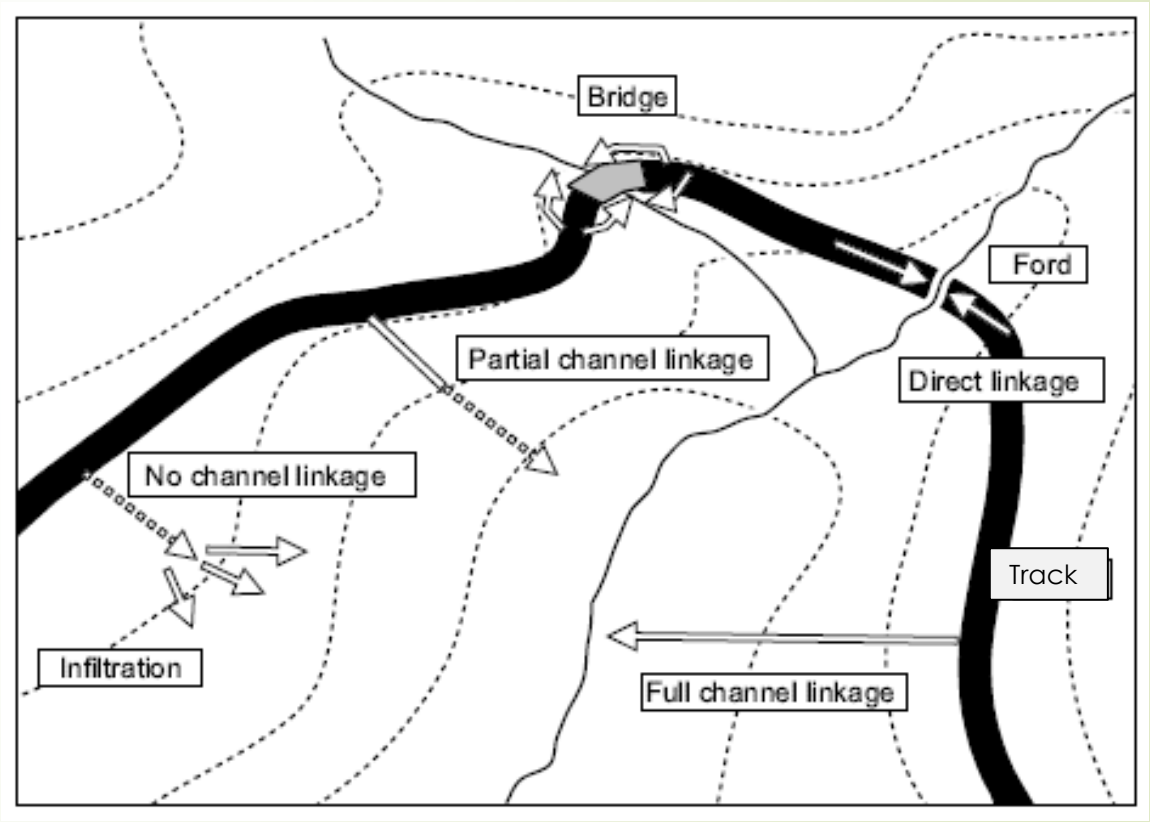
Much of eroded soil from sandy granite deposited as runoff hits vegetated verge

Eroded soil from shale is mostly clay so carried well beyond track

From: CRC CH, 1999

Sediment delivery from tracks to streams

- Concept of **connectivity**
- Aim of track management to minimise connectivity between tracks and streams
- Concentrated flow paths do not permit deposition and infiltration
- Dispersed flow paths allow infiltration and sediment deposition
- Track runoff tends to disperse and infiltrate within 20-50m on well vegetated hillslope
- Watercourse crossings most susceptible to sediment delivery to streams



From: CRC CH, 1999

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Key points on track erosion

Track surface generates runoff and sediment even after few mm of rain

Bare track surface has high erosion potential

Traffic breaks up surface into easily eroded particles

Sediment laden runoff leaves road, either across hillslope or directly to watercourses

Key principles

Keep disturbance to minimum possible

Maximise potential for absorption of runoff

Planning

Planning While you can't avoid track erosion, familiarization and planning can minimise these impacts!

Purpose of track

- Permanent or temporary
- Volume of traffic
- Type of traffic

Site assessment

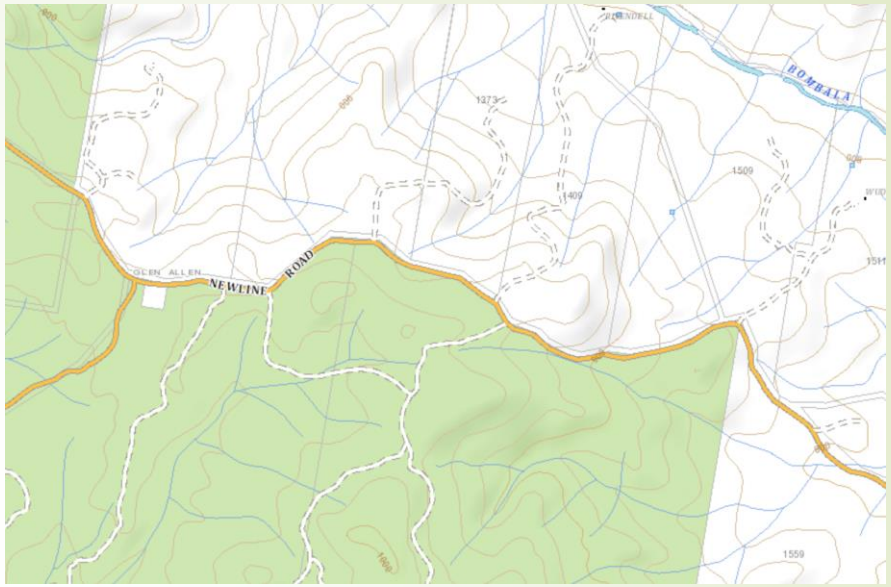
- Soil erosion hazards
- Drainage line crossings: depressions versus deep channels; catchment size
- Landform issues; very rocky ground, poorly drained areas
- Steep slopes; affects amount of cut and fill
- Potential land slip areas

Route identification

- Show on Forest Operation Plan

Site assessment tools

- 1:25000 scale topo maps: show contours for grade, drainage features
- Six Maps (http://maps.six.nsw.gov.au/); imagery with overlay of lot boundary
- Google imagery
- Soil landscape maps for NSW www.environment.nsw.gov.au/eSpade2Webapp



Key principle

Plan before you push

Managing track erosion

Erosion and sediment control practices

Track surface drainage

- Crowning
- Infall
- Outfall
- Table drains

Relief drainage

- Cross (diversion) banks
- Mitre drains
- Culverts

Drainage line crossings

- Major drainage features
- Depressions

Batter stabilization

- Cut
- Fill

Topsoil management

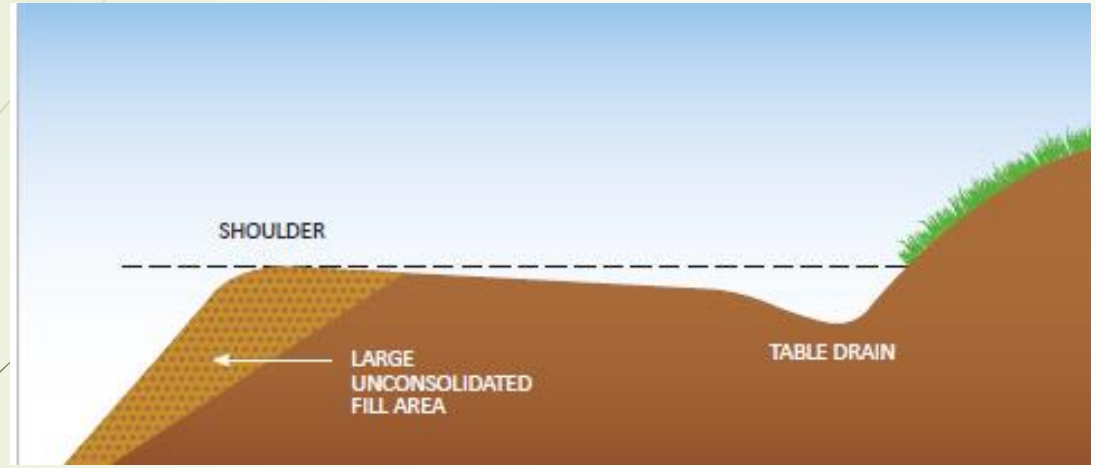
Key principle

Get the water off the road, safely

Surface drainage: crowning

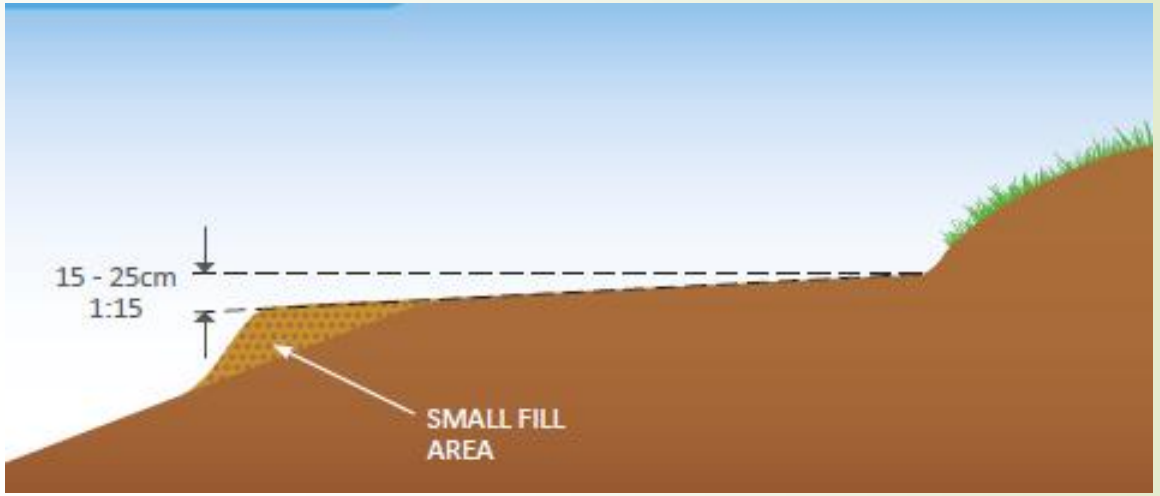
From: RFS (2017)

Surface drainage: infall



From: RFS (2017)

Surface drainage: outfall



From: RFS (2017)

Surface drainage: table drains

- Run beside track surface
- Collect runoff from track and direct to disposal point

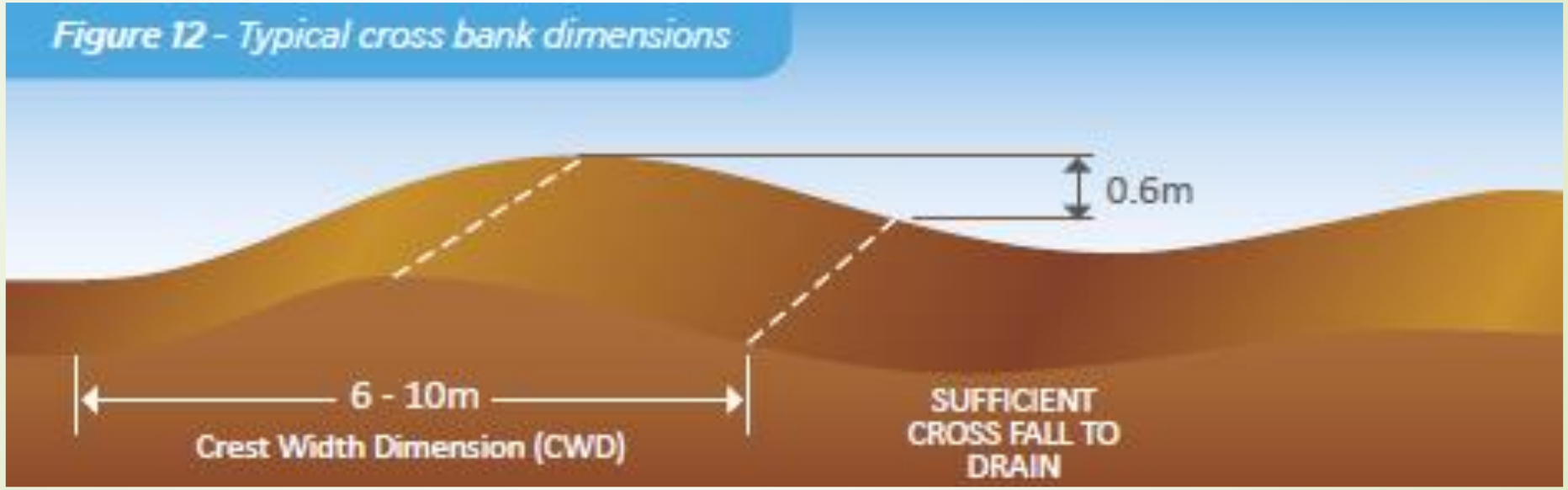
From: RFS (2017)

Table drains: cont'd

- Prone to washing out if:
  - soil is erodible
  - inadequate relief i.e. water runs in drain too far
- Erodible soils likely to need protection (rock, jute mesh)

Relief drainage: diversion banks

- Simple and effective for unformed roads
- Pick up track runoff and direct onto undisturbed ground
- Easy to drive over if well constructed
- Maximum suitable grade 20%



From: RFS (2017)

Cross banks cont'd

From: RFS (2017)

Well constructed cross bank

Poor construction, failed due to lack of volume and storage capacity

Cross banks: recommended spacing

Low erodibility ——— High erodibility

Road grade %	Road grade °	Soil class A	Soil class B	Soil class C	Soil class D
<14	<8	70-90 m	60-70 m	20-30 m	*
14-21	8-12	60-70 m	50-60 m	*	*
21-28	12-16	40-60 m	*	*	*
28-36	16-20	30-40 m	*	*	*
36-40	20-22	20m	*	*	*

From: RFS (2017)

Cross banks: how to build them

Watch the video: https://www.youtube.com/watch?v=0FYxJ0nIFso

Relief drainage: mitre drains

- Sometimes called 'push outs'
- Aim to take water from table drain out onto hillslope where it disperses
- Should slow water down before exit
- Should direct water onto undisturbed ground
- Not suited where runoff drains back to track

From: RFS (2017)

Relief drainage: culverts

- Culverts convey water under a road or track, in the following situations
  - Relieve flows in a table drain on the inside of the track, and
  - Convey small watercourses under the track
- Comprise pipes and headwalls
- Without a headwall, fill around pipe will be prone to washing out
- Outwash protection with rock often required to protect channel

Photo: Antia Brademann, NSW Waterwatch

Relief drainage: culverts cont'd

- Pipe size is crucial, too small and they will block up with debris, (photo 1)
- Blow out due to the large volume of runoff (photo 2)

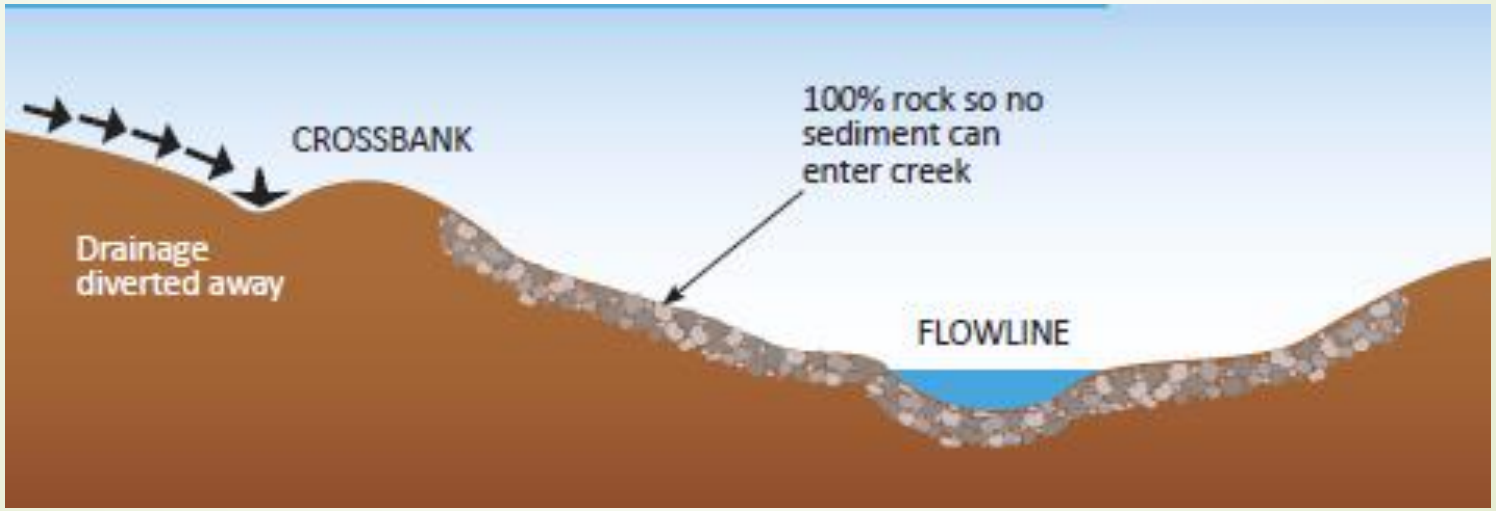
From: RFS (2017)

Photo: Ashley Bolton, NSW Soil Conservation Service

Try to avoid culverts for watercourse crossings, often better suited to a 'bed level' crossing

Drainage line crossings

- **Warning**: Controlled Activity approval required for any disturbance to bed and banks of a watercourse on 3rd order streams and higher
- Likely to need engineering design on all but smallest drainage features
- Aim to cause as little disturbance as possible to bed and banks
- Do not obstruct or divert flow



Minor drainage features

- Typically depressions rather than streams, no defined channel
- Bed level crossing or ford
- Bed of watercourse and approaches protected with rock or concrete

Photo: NSW Government

Major drainage features

- Discrete channel and banks, carry large flows during and after rain events
- Banks may be vertical or sloping
- Bed floor reinforced with rock if not natural
- Gullies and steep banks best avoided, likely to require box culvert or bridge

From: RFS (2017)

Photos: Ashley Bolton, NSW Soil Conservation Service

Road drainage at crossings

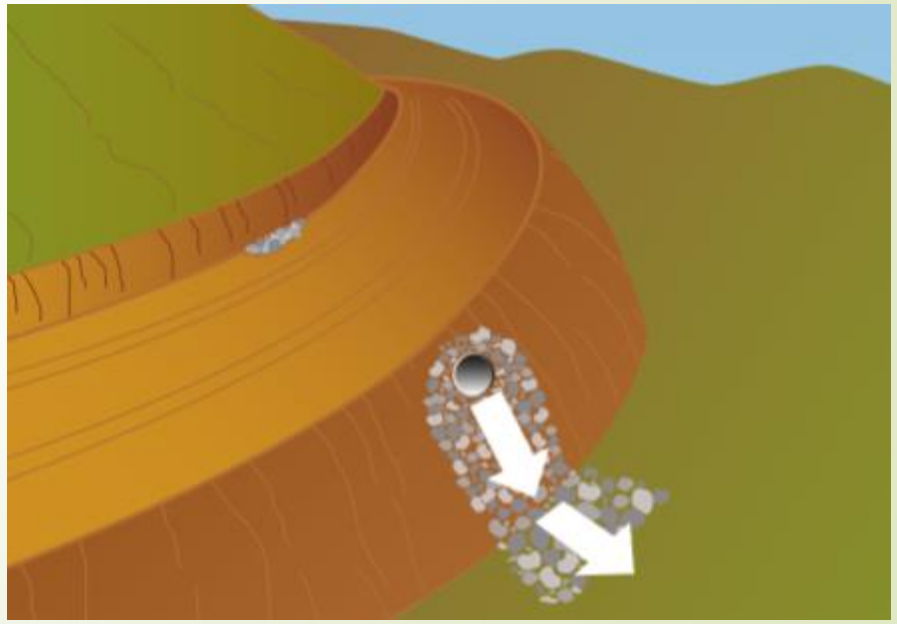
- Road drainage must be directed off road between 5 and 30m back from crossing
- Safe disposal across hillslope

Photo: NSW Government

Batter stabilisation

- Track construction across the slope creates a cut and a fill batter
- Aim to have batter grades gentler than 2:1, to hold topsoil and permit good grass cover
- As a guide aim to keep batter height to less than 1m
- Tracks across steep slopes (>25 degrees) will need geotechnical design as batters have high risk of erosion and slumping
- Drain outlets should be onto natural ground

Photo: Ashley Bolton, NSW Soil Conservation Service



From: RFS (2017)

Batter stabilisation cont'd

From: Forests NSW (1999)

From: Forests NSW (1999)

Topsoil management

- Keep topsoil disturbance to minimum required for track
- Topsoil crucial for rehabilitation of cut and fill batters after construction of permanent roads
- Ensure it is retained separately in stockpiles
- Respread on batters after construction finished
- Respread with max. depth 15cm

Track maintenance

- Absolutely will be required, no track is maintenance free
- Assess after storms, plus at least every two years
- Clean out blocked culverts and drains
- Cross banks fill with sediment and overtop

From: RFS (2017)

Four key principles

- Keep disturbance to the minimum possible
- Plan before you push
- Get the water off the road, safely
- Maximise potential for absorption of runoff

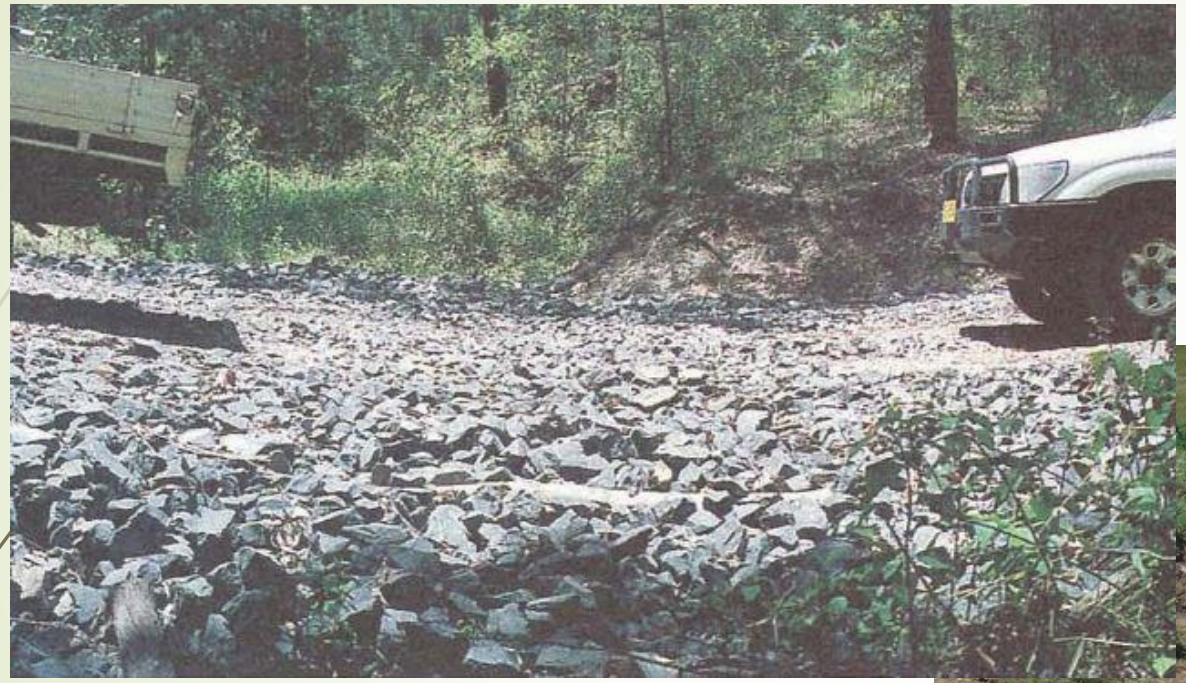
Practical examples

Example 1: good practice

- Snig track on steep site
- Disturbance limited
- Minimal box cut
- Good crossfall
- Effective banks

Photo: NSW Government

Example 2: good practice



- Bed level crossings
- Permit all weather access
- Protect bed and banks
- Do not obstruct flows

Example 3: good practice

- Drainage crossings
- Drained within 5 and 30m
- Good disposal points
- Bed level crossing with graded rock

Photos: NSW Government

Example 4: good practice

Photos: NSW Government

- Walk over harvesting
- Minimal disturbance
- Groundcover still intact
- No concentration of runoff
- Crossfall drainage

Example 5: excessive disturbance

Photos: NSW Government

- Very common problem and easily avoided
- Usually results from poor planning and siting
- Walk the route and mark up before you start driving

Example 6: unacceptable drainage crossings

- Potential for excessive sediment into drainage line
- Bed level rock crossing best solution
- Culverts must have headwalls

Photos: NSW Government

Example 6: windrows

Photo: Ashley Bolton, NSW Soil Conservation Service)

- Inadequate drainage of surface due to windrow along right side of trail
- Results in runoff remaining on track
- Need to be spread onto fill batter or breached in accordance with drain spacing spec

Example 7: steep slopes

- Tracks on steep slopes present high risk of erosion and landslip, should be avoided
- Tracks across >25 degrees need engineering design to ensure stability

Photos: NSW Government

Q&A session