2 Knowing your network
Scope and Introduction

Part A - General
- Road list - links, locations, and road class
- Maintenance & intervention standards
- Climate, Traffic, Wear & Tear

Part B – Technical components
- Pavement and subgrade type
- Drainage
- Geometry
1 Knowing your network (Part A - General)
Part A: Network definition: general

- Location & Functional Class
  - Start & end, length, C/L chainage & GPS
  - The (current) road class for each link

- Theoretical & Actual Standards by class/link:
  - geometry, pavement
  - condition / maintenance

- Climate, Traffic, Wear & Tear
Network definition: which roads?
Network definition: link location referencing

- **Desk study:** Identify road and its links on map (or Google Earth).
- **Field Survey:** Verify site, locate each end, fix length & define centre line.
Network definition: *current* road class per link

A road classification system should be associated with the what the road is used for (function), but not necessarily with what it looks like, although these two will invariably be related.

<table>
<thead>
<tr>
<th>Road class</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5A</td>
<td>Primary (a local ‘arterial’ type function)</td>
</tr>
<tr>
<td>5B</td>
<td>Secondary (a local ‘distributor’ type function)</td>
</tr>
<tr>
<td>5C</td>
<td>Minor (a local ‘collector’ type function)</td>
</tr>
<tr>
<td>5D</td>
<td>Access road</td>
</tr>
<tr>
<td>5E</td>
<td>Track</td>
</tr>
</tbody>
</table>

What do they look like!
Network definition: *Typical unsealed examples*

Class 5A: Primary Road (formed gravel)

Class 5B: Secondary Road (formed gravel)

Class 5C: Minor Road (formed, lightly gravelled)

Class 5D: Access Road (formed earth road)

Class 5E: Track (unformed earth)
Network definition: Standards per class

For each road class, there should be a set of associated Standards, which cover:

- **Geometric** design standards; width, lanes, design speed & alignment
- **Pavement** ‘design’, type standards; formed? gravel? quality & thickness?
- **Maintenance** standards / interventions, grading & resheet frequency
- **Drainage** standards; side drain, culvert, crossing type, capacity & level
- **Environmental** standards; erosion, siltation and runoff disposal.
- **Safety** standards; location & frequency of signage, guide posts, guardrail

Useful yardstick to compare with actual
Network definition: Maintenance classification

• Short-term, duty of care focus
  • Victorian Road Management Act (2004), Division 3 - Specific powers and statutory duties of road authorities
    – Road Register
    – Inspect, maintain and repair a public road
    – Defined hazards
    – Inspection frequency & response times by road maintenance category
  • Predominantly reactive
  • Drives Road Management Plans

• Asset preservation and LOS focus
  • Optimises performance under available budget
  • Drives Asset Management Plans
  • Preventative
    – Programmed/scheduled, e.g. Patrol grading, Vegetation, Drainage
    – Potential to reduce reactive works
  • Reactive
    – Intervention level driven
    – Significant defects (type and extent)
    – Major treatments / works
<table>
<thead>
<tr>
<th>Item</th>
<th>Activity description</th>
<th>Severity intervention level</th>
<th>Extent intervention level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Removal of isolated hazards and erection of warning signs. Attend to within 24 hours.</td>
<td>Likely damage to vehicles or injury to occupants.</td>
<td>Any</td>
</tr>
<tr>
<td>2.</td>
<td>Digouts and patching.</td>
<td>Failed areas.</td>
<td>&gt; 50 m²</td>
</tr>
<tr>
<td>3.</td>
<td>Culvert cleaning and clearing of table drains.</td>
<td>Waterway blockage &gt; 50%, ponding &lt; 450 mm below shoulder point.</td>
<td>Any</td>
</tr>
<tr>
<td>4.</td>
<td>Emergency callout. Mobilise within 15 minutes.</td>
<td>Accident, natural disaster.</td>
<td>Any</td>
</tr>
<tr>
<td>5.</td>
<td>Remove obstacles, fallen limbs, etc., from road formation.</td>
<td>Clear trees within 3 m of edge of pavement. Trim if sight distance obscured or vehicle clearance impeded.</td>
<td>Any</td>
</tr>
<tr>
<td>6.</td>
<td>Replace, install or clean signs.</td>
<td>Reflectivity &lt; 50% on signposts and guide posts. Not legible at 150 m on low beam. Missing guideposts.</td>
<td>Any</td>
</tr>
<tr>
<td>7.</td>
<td>Clean up fallen timber, prunings and unwanted seedlings from road reserve.</td>
<td>Fire hazard or unsightly.</td>
<td>Any</td>
</tr>
<tr>
<td>8.</td>
<td>Repair guardrail.</td>
<td>Damaged by vehicle.</td>
<td>Any</td>
</tr>
<tr>
<td>9.</td>
<td>Collect litter from wayside stops and areas of grass prior to mowing.</td>
<td>Quarterly and when bins overflow.</td>
<td>Any</td>
</tr>
<tr>
<td>10.</td>
<td>Remove weeds from road reserve or spray herbicide.</td>
<td>Noxious, declared plants.</td>
<td>Any</td>
</tr>
<tr>
<td>11.</td>
<td>Mowing and slashing.</td>
<td>Fire hazard or sight distance obscured.</td>
<td>Any</td>
</tr>
<tr>
<td>12.</td>
<td>Investigate complaints and report. Take justifiable action where required.</td>
<td>Other than frivolous.</td>
<td>Any</td>
</tr>
</tbody>
</table>

Source: Table B.1.1, ARRB Unsealed Roads Manual (2009)
## Description Of Hazard

<table>
<thead>
<tr>
<th>Pavements</th>
<th>RMC</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obstructions and Substances in Traffic Lanes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials fallen from vehicles, dead animals, wet clay and other slippery substances, hazardous materials, accumulation of dirt or granular materials on the traffic lane of sealed roads</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Ponding of water &gt;300mm deep, fallen trees, oil spills, stray livestock</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td><strong>Pavement or Surface Defects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Potholes in traffic lane of a sealed pavement greater than 300mm in diameter and greater than 100mm deep or in the traffic lane of an unsealed pavement greater than 500mm diameter and 150mm deep</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Where assessment in accordance with the skid resistance policy indicates remediation is required.</td>
<td>C</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Deformations &gt;100mm under a 3m straight edge</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Edge drops onto unsealed shoulder &gt;100mm</td>
<td>n/a</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td><strong>Drainage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damaged or missing drainage pit lids, surrounds or grates in pedestrian areas or traffic lanes</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>D</td>
<td>D</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Description Of Hazard</td>
<td>RMC</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td><strong>Roadside</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Vegetation</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tree limbs or trees that are in immediate likelihood of falling on the roadway</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Trees shrubs and grasses that have grown to restrict design sight distance to</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>intersections or restrict viewing of safety signs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetation clearance less than 4.5m in height, unless signed otherwise, over traffic</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>lanes and the trafficable portion of shoulders, or protruding over the edge of seal.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Vegetation clearance less than 2.5m in height, unless signed otherwise, over a</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>pedestrian/bicycle path, or protruding over the path edge.</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Roadside Furniture</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Signs** - Missing, illegible, damaged, and misleading making them</td>
<td>C</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>substantially ineffective.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guideposts - Missing or damaged at a critical location***</td>
<td>C</td>
<td>D</td>
<td>D</td>
<td>E</td>
<td>E</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>making them substantially ineffective</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Barriers and Fencing - Missing or damaged at a critical location***</td>
<td>C</td>
<td>D</td>
<td>D</td>
<td>E</td>
<td>E</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>making them substantially ineffective</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Islands, Footpaths and Bicycle/Shared Paths - Defective pedestrian areas with a</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>E</td>
<td>E</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>step &gt; 50mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pavement Markings - Missing, illegible or misleading at a critical location***</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>
Network definition: Take home messages

• Get to know your network

• Aim to define target conditions/standards and assess actual

• Distinguish between
  – mandatory interventions (‘Must Do’)  
  – asset preservation/LOS needs (‘Should Do’)  
  – asset improvements (‘Could Do’)
2 Knowing your network (Part A (contd.) – Climate, Traffic & Wear)
The information items discussed here are sometimes included as part of the Inventory, but here we have separated them out as they are the link between:

- what your network looked like when brand new
- how it is now (its condition)

These linking issues that have been hammering your network include:

- Climate
- Traffic
- Maintenance (or at least the effect of it)

The resulting condition is discussed in a later section.
Climate

The 3 most important things in building & maintaining an unsealed road:

Water...

Water...

and water!
Traffic
Traffic: *flow volumes*

Information is required for each link on the network:

Typical traffic flow volumes by Road Class

<table>
<thead>
<tr>
<th>Road class</th>
<th>5A Primary</th>
<th>5B Secondary</th>
<th>5C Minor</th>
<th>5D Access</th>
<th>5E Tracks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Annual Daily Traffic, AADT (No's)</td>
<td>&gt; 100</td>
<td>30 - 100</td>
<td>20 - 50</td>
<td>&lt; 20</td>
<td>&lt; 10</td>
</tr>
</tbody>
</table>

However, it’s not just the numbers, but the traffic mix which is important. There are two general traffic effects on the road:

- The **volume** of traffic, almost regardless of vehicle type, **has the effect of wearing out**, causing **damage to the road surface**.
- The **loading** caused by the heavier vehicles (trucks), causes **cumulative** and lasting **damage to the pavement structure**.
Traffic: vehicle type
Traffic

Information is required for each link on the network:

- Traffic flow volumes as two way AADT
- Traffic mix, especially the % heavy vehicles
- Traffic vehicle types, *and loadings per vehicle*
- Traffic growth, seasonal and tidal flows
- Link purpose (tourist, industrial, agricultural, school etc)

Q What are the points on your network where there is a mismatch?
Maintenance; or at least, the effect of it

- What if you do?
- What if you don’t?
- To what level?

Maintenance

Climate

Traffic
Maintenance; the effect of it

Collecting Data

Fitting a model

Looking at trends
Maintenance; general model of pavement behaviour

Uncontrolled deterioration or road asset (little or no maintenance)

Controlled deterioration or road asset (by wise investment of funds)

Date of construction

Level of maintenance required to control deterioration and extend life

Standard of maintenance for resurfacing

Major maintenance e.g. resurfacing

Minimum tolerable condition

Condition at which pavements are actually replaced

Remaining service life

Remaining actual life
Maintenance; or the effect of it – Unsealed roads

Photographs: © Intech Associates
Study commenced in 2002 and was completed in 2011

Special maintenance studies continued until 2014’.

The study aimed to:

• Develop road deterioration (RD) models for local roads (low volume) in Australia, for both sealed and unsealed roads

• Then make these models available for use by managers PMS systems
Unsealed roads

- Gravel loss
- Loss of shape
- Roughness (or Ride Quality)

Model parameters include:
- Traffic
- Rainfall
- Material properties

Works effects models produced for:
- Roughness improvements by type of grading/blading
Unsealed roads – treatments matter

Light grading/cushioning
no water or compaction

Heavy grading/reprocessing
with water and compaction

Source: Morosiuk & Toole 1997
Unsealed roads: Importance of water

Impact of watering and compaction and water on roughness progression
Unsealed roads - Someone’s getting it right!

- Better post-grading condition from good technique, materials and favourable timing
- … and a better, more long-lasting performance trend
- Need to quantify typical, good and poor performance
Traffic, Climate, Wear: Take home messages

• We need to understand and account for:
  – Traffic (numbers and composition)
  – Climate
  – Materials (more on this later)

• Account for maintenance and construction practices
  – Type and effectiveness of grading/blading
  – Watering and compaction
SHAPING OUR TRANSPORT FUTURE
Knowing your network (Part B - Technical components)
Scope & Purpose

• Scope
Gaining and understanding of:
  – The Natural and Operating Environment
  – Pavement and subgrade type
  – Drainage
  – Geometry (Cross-section & Alignment)

• Purpose
As a basis for informing current operation and future use
The Natural & Operating Environment: They vary

How do conditions change?
- Climate and Terrain
- Drainage
- Soil types
- Road materials
- Road use
Pavement and subgrade type
Pavement and subgrade type: Key elements

*Subgrade:*

- Soil types - clayey, loam, sandy or gravel, rock
- Interaction with the natural environment: terrain, geology and climate, and its performance in carrying traffic

*Pavement types:*

- Construction
  - Unformed earth road (just a track)
  - Formed earth road
  - Formed ‘graveled’ earth road (with thin gravel surface armouring)
  - Formed gravel road (single layer)
  - Formed gravel road (two layers)

- Implications for current and future use
Pavement and subgrade type

- UN-SEALED ROAD
- Formed earth road
- Natural Material
- Subgrade
- Side Drain
- 5% Cross-
Pavement and subgrade type

- UN-SEALED ROAD
  - Gravel road
  - Side Drain
  - Graded Gravel
  - Base Course
  - Natural Material
  - Subgrade
Main information (by desk study and field survey):

- Subgrade type (refer to soil distribution maps).
- Pavement type, by start and end chainage per Link, including year of original construction or recent major works that may now re-define it.
Pavement and subgrade type: Take home messages

- Important to document construction information
- Understanding to soil types and wearing course/pavement materials
- Knowledge of the natural environment also provides insights to likely construction and performance issues
Drainage: *general*;

Water is a major element in how our unsealed roads behave:

- As rainfall / floods it causes erosion, washouts and destruction.
- *Yet we need it for construction and maintenance*

A location without ready access to low cost water has big problems when it comes to managing a gravel roads network.

The key is managing the water effectively, with good drainage as:

- Surface drainage
- Subsoil drainage
- Water crossings

These are considered in turn below:
Drainage: *surface*

Surface drainage can be considered as having three aims:

- Get the water *off* the road by having a crossfall of about 5% and the road built to a crown.
- Take the water *away* from the road vicinity as quickly and as frequently as possible by having good side (table) drains, mitre drains and cross culverts.
- Keep the water *from* the road by having catch drains or banks.
Inter-relationship with Geometry: cross-section

The key elements for the cross-section are:
Drainage: *surface; cross-fall*

crown

cross-fall 5%
Drainage: *surface; side or table drains*

Take the water *away* from the road vicinity as quickly as possible by having good table drains, mitre and cross drains . . .
Drainage: *surface; side or table drains*

For unsealed roads these drains will likely not be lined, but other forms of erosion protection are possible such as *scour checks*.

However, take care to construct well, and have at sufficient frequency.

Reduced velocity and silt build up helps to restore scoured channel.

Hard rocks, 200 to 300 mm) placed under the structure and against the upstream face.

Fine/medium gravel filter (2–20 mm)
Drainage: *surface; side drains*

- Across the ditch can be used to make a small dam.
- This distance such that gradient (A) is about 1 in 70 to 1 in 100.
- Height 1/2 to 2/3 depth of drain.
Drainage: *surface; side or table drains*

Erosion can also be controlled by *mitre drains* (or *turnouts*)
Drainage: *surface; side or table drains*

The frequency can be designed:

<table>
<thead>
<tr>
<th>Gradient</th>
<th>Spacing (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in 100 or less</td>
<td>50</td>
</tr>
<tr>
<td>1 in 100 to 1 in 50</td>
<td>40</td>
</tr>
<tr>
<td>1 in 50 to 1 in 20</td>
<td>25</td>
</tr>
<tr>
<td>1 in 20 to 1 in 10</td>
<td>15</td>
</tr>
<tr>
<td>more than 1 in 10</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: Overseas Road Note 2 (2nd Edition) TRL (1985)
Example of extensive use of mitre drains or turnouts on a gravel road in the Northern Territory

Umbrawar Road, near Pine Creek, NT
Drainage: *surface; side or table drains*

The table drain water will need to be discharged at an outfall or via a cross-culvert.

The outlet treatment can be more sophisticated:

- **Culvert outlet**
- **Reduced velocity**
- **Rock or gabions**
- **Silt build up restores scour**
- **Gabion mattress on geotextile mat**
- **Construct the crest of the drain block lower than the road shoulder**
- **Ensure that the culvert is long enough, with a slope at least 2% to be self cleaning, but steeper than the incoming drain**
- **Erosion protection using rip-rap or vegetation**
- **Silt build up restores scour**

*Image credit: ARRB (Your National Transport Research Organisation)*
Drainage: *surface; catch drains (above cuttings)*

In this example, a cutting has been constructed without catch drains.

Cutting constructed without catch drains.  

After a few rainy seasons . . .  

Costly repair work.
Drainage: water crossings
Drainage: water crossings

Water crossings are for where the road passes over a natural creek or river (as opposed to the case of a cross-culvert). In ascending order of size:

- Ford
- Floodway
- Causeway
- Submersible low bridge
- High level culverts (including major)
- High level bridge (timber)
- High level bridge (concrete)
Drainage: *water crossings; floodway*

A floodway is often found in areas with seasonal flooding, with the water going straight over the top:
Drainage: *water crossings; location on road*

The location of a crossing structure must be selected to be safe with respect to the road alignment:

- Well located on the alignment
- Poor location just after bend
Drainage: *water crossings; causeway*

A causeway is like a floodway, except it has culverts to take ‘dry’ flows:

![Diagram of a causeway with labeled parts such as Culverts, Maximum expected high water level, Reinforced road surface, etc.](image)
Drainage: *water crossings; submersible bridge*

Low submersible bridges are used where the dry flows are already large, yet even at bigger water flows the traffic does not justify a high bridge.
Drainage: Take home messages

• Understand the challenges of drainage on your network and the type of location different drainage assets:
  – Surface (including table and catch) drains
  – Culverts and water crossings
  – Subsoil drains

• The key is managing water effectively, considering:
  – Typical conditions
  – Extreme events and their frequency
Geometry
Geometry: introduction

• Purpose
  Understand the characteristics of the road network and implications for
  – Maintenance (and performance)
  – Safe and efficient travel

• Key elements
  – Cross-section
  – Alignment (horizontal and vertical)

• Requirements
  – Location and length along each road link of sections of road with a particular set of geometric features.
Geometry: cross-section

The key elements for the cross-section are:

- carriageway
- right-of-way boundary
- verge
- shoulder
- traffic lanes
- shoulder
- crown
- cross-fall 5%
- hinge point
- natural surface
- battery
- pavement
- table drain
- battery
### Geometry: cross-section

Examples of the key cross-section elements:

#### Nominal X-sections (flat terrain)

<table>
<thead>
<tr>
<th>Road class</th>
<th>5A Primary</th>
<th>5B Secondary</th>
<th>5C Minor</th>
<th>5D Access</th>
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</thead>
<tbody>
<tr>
<td>Number of Lanes</td>
<td>2</td>
<td>1 or 2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Carriageway (pavt + shldrs) (m)</td>
<td>9</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Formation width (m)</td>
<td>11</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Minimum X-fall (%)</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
</tbody>
</table>

#### Nominal X-sections Class 5C (by terrain)

<table>
<thead>
<tr>
<th>Class 5C</th>
<th>Flat</th>
<th>Rolling</th>
<th>Mountainous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Lanes</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Carriageway (pavt + shldrs) (m)</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Formation width (m)</td>
<td>8</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Minimum X-fall (%)</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
</tbody>
</table>
Cross-section: Considerations and issues

Cross-section should match the road class and support:

- **Intended function and traffic use,** considering:
  - traffic volume
  - vehicle size(s)
  - terrain

- **Engineering performance,** and not impose an unnecessary maintenance burden, e.g.
  - avoid concentrated wear where possible
  - limit erosion
  - overall maintainability
Geometry: *cross-section (1)*

- Is the example too narrow?
- Does it match the use or purpose of the road?
- Maybe not, but it might be fit for purpose as a Class 5E Track.

- Too wide, too much gravel to maintain, or
- Fit for purpose for large trucks
Avoid the “3 wheel effect”.
Dependent on traffic & road class, re-configure road (if possible) as either:
• 2 lanes
• 1 lane (with passing places?)

• Maybe this road could be a 2 lane road.
• But it must be maintained as such (with good vegetation control at least).
Cross-section: What is required, and workable?

- Consider the intended function and traffic use, including:
  - traffic volume
  - vehicle size(s)
  - terrain

- Address engineering and safety performance, and avoid imposing an unnecessary burden
  - include essential features
  - consider overall maintainability
  - minimise concentrated wear and excessive erosion
Geometry: *Unsealed roads*

Roadway cross-fall should be at approximately 5%, and the road built (*and maintained*) to a crown.

A (relatively) flat crown can reduce effective treatment life by a factor of 5 (i.e. $1/5^{th}$ the life of a well-crowned road).

A flat crown, due to the
- “3 wheel effect”
- or
- bad maintenance practices?
Geometry: alignment
Geometry: Take home messages

• Ensure the full characteristics of the road network are known and implications for:
  – Safe and efficient travel
  – Maintenance (and performance)

• Assess and record the key geometric elements for each road link and its individual sections of road
  – Cross-section
  – Alignment (horizontal and vertical)
QUESTIONS?
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OUR
TRANSPORT
FUTURE