Integrated Curriculum Example

SCIENCE & MATHS

SSEP EXAMPLE // ROAD CONSTRUCTION
DEVELOPED BY // NGARUAWAHIA HIGH SCHOOL AND DOWNER

ACTIVITY EXAMPLE

KEY WORDS

Physics | geology | materials | metals | design | machines | numbers | calculations | measurement | area | perimeter | volume | mass

ALSO USEFUL FOR

Social sciences | Economics | Business Studies

PROGRAMME OUTLINE

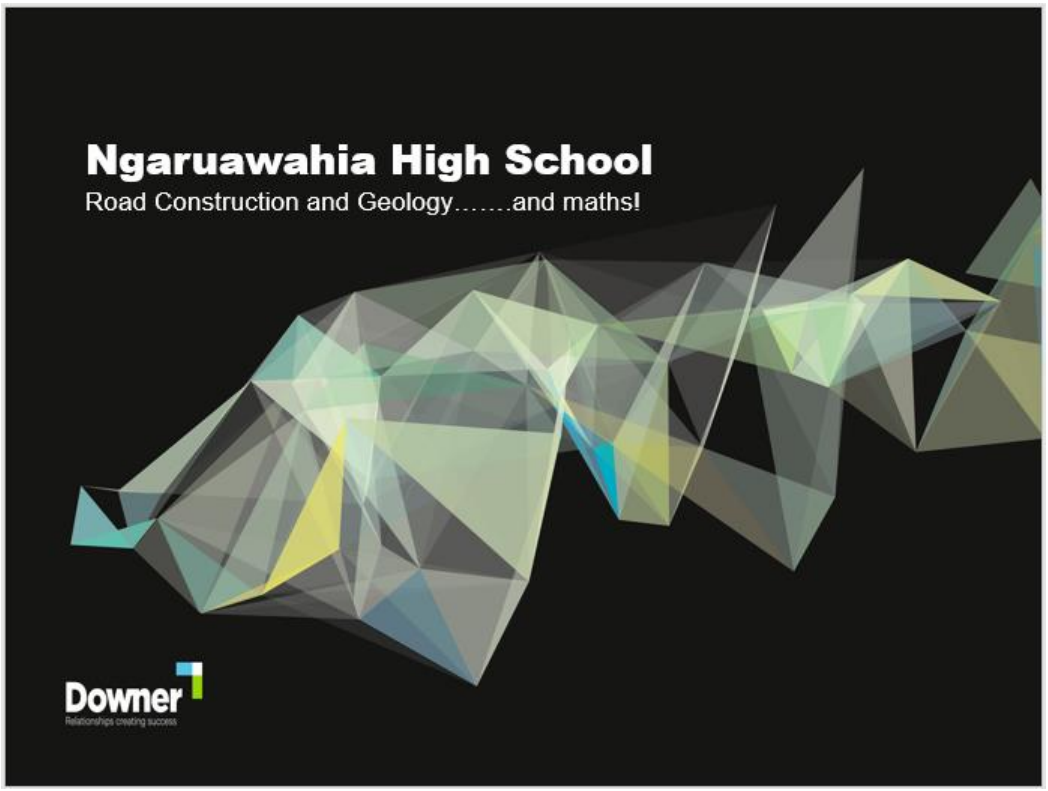
3 POINTS OF CONTACT

- Downer staff come into classroom (x2)
- Workplace visit (x1)

EXAMPLE

1. Downer staff come into the **science** class, introduce themselves, background to civil construction, their careers and how science is used in the industry.
2. **Workplace visit:** local road construction site. Students meet different workers on-site and hear about all the different roles behind road construction. Follow up on classroom session with real life example discussion about the local geography, different considerations that had to be factored into the construction plan, why certain construction materials have been chosen for the site.
3. Return to the classroom – this time **maths**. **Student Activity:** Road construction and maths.

For more on SSEP see:
www.smartnz.nz



Agenda

1. Choosing a Road Alignments
2. Key Geological Features
3. Dealing with Geology
4. Using natural materials to build roads
5. Pavement Construction
6. Questions

Downer
Relationships creating success

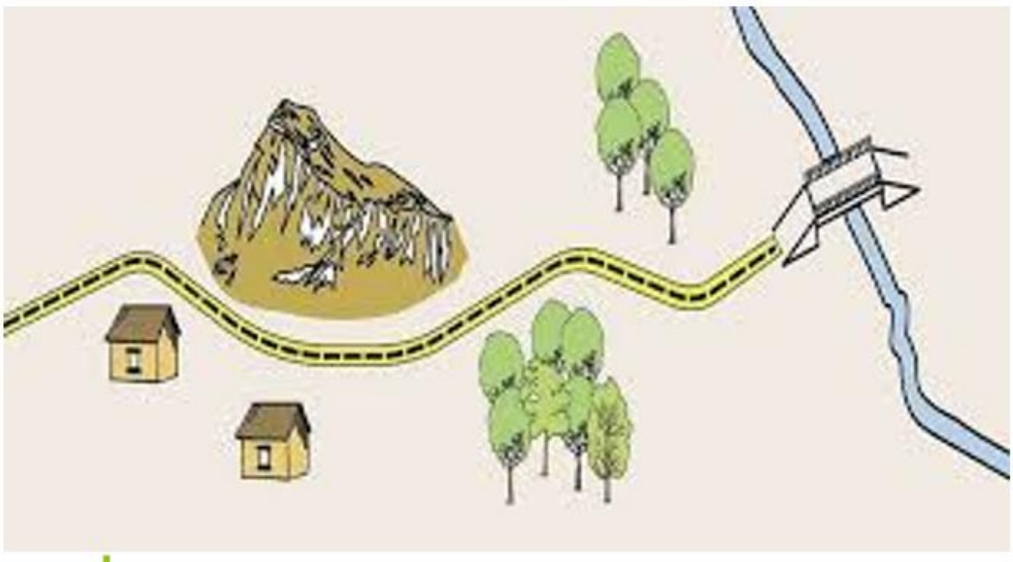
Choosing Road Alignments

Thinks to consider:

- Start and finish points
- Key surface features and obstructions
- Archaeological, cultural or nature
- Geology
- Gradients and bends
- Materials and availability

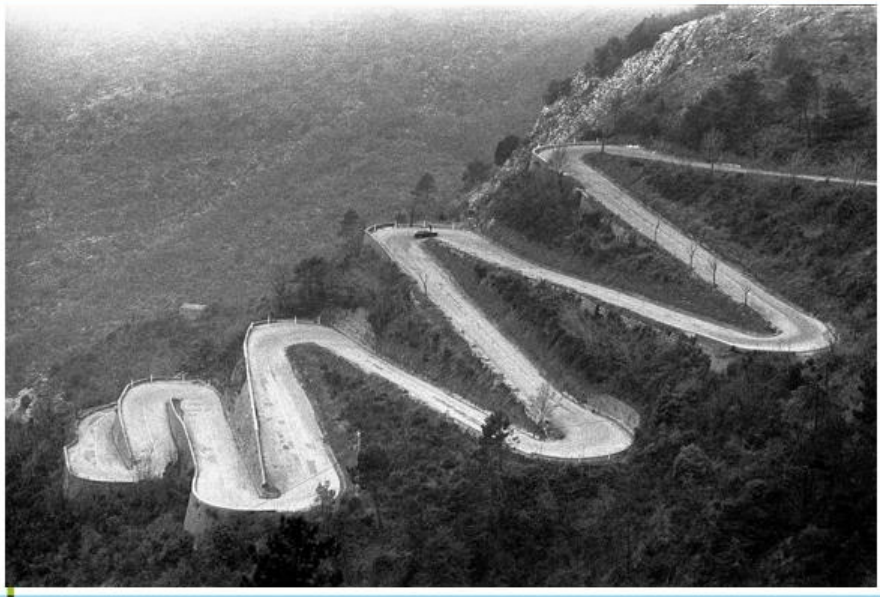
Downer
Relationships creating success

Road Alignment - Avoiding Surface Features



Downer

Sometimes you have to go up it!



Downer

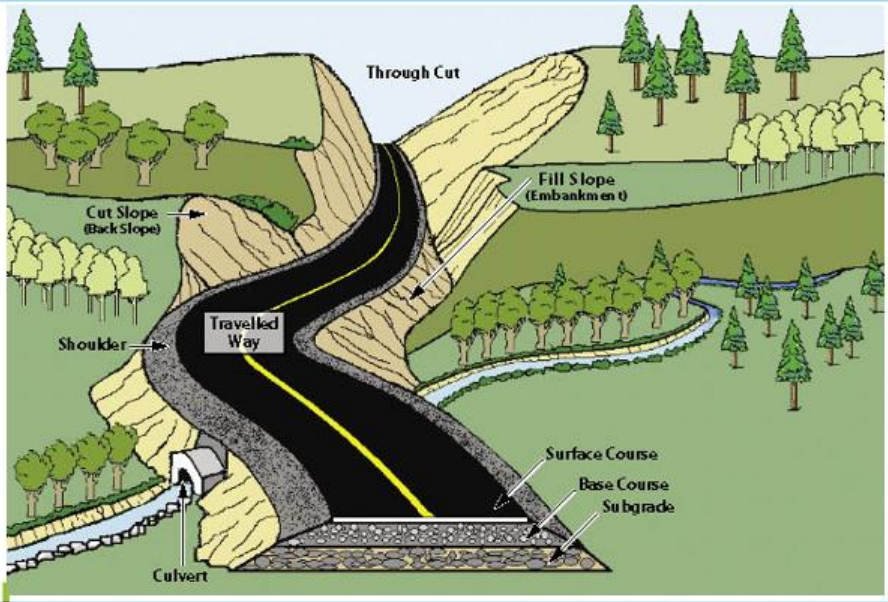
.....or through it!

Downer

.....or over it?

Downer

..or a combination of all.



Downer

Managing Cut and Fill

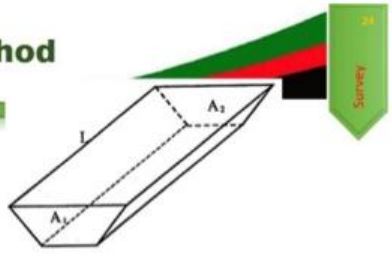
By re-using as much material from the excavation in the fill, if it is suitable, we minimise the amount of imported material we need to buy and transport and also the amount of material we need to dispose of in landfill.

Cut/Fill Balance

Downer

Calculating Volumes

Average-End-Area Method



$$V = \left(\frac{A_1 + A_2}{2}\right) \cdot L$$

where V = volume
A_1 and A_2 are the areas of the end sections
L = distance between sections

For *n* sections, distance L apart,

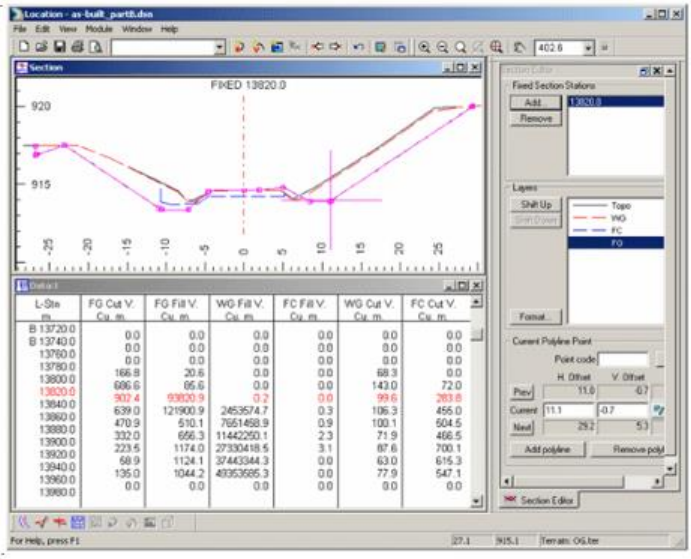
$$V = \frac{L}{2}\left(A_1 + A_n + 2\left(A_2 + A_3 + \ldots + A_{n-1}\right)\right)$$

12/27/2014 Survey Engineering

Downer

Calculating Volumes

Click



Downer

Excavating and moving material

Downer

ACTIVITY EXAMPLE

Cut to Fill – maths example!

Our excavator can dig at a rate of 240m3 per hour.

Fill site is 15 minutes round trip for dump truck. Dump truck can carry 15m3 in each load.

How many dump trucks do we need to keep our excavator going flat out?

Downer

Cut to Fill – maths example!

Excavator can dig at a rate of 240m3 per hour.

Dump site is 15 mins round trip for dump truck. Dump truck can carry 15m3 in each load.

Each dump truck can carry 4 loads per hour

4 loads x 15m3 = 60m3

240m3/60m3 = 4

How many dump trucks do we need to keep our excavator going flat out?

4 dump trucks required to keep excavator flat out busy.

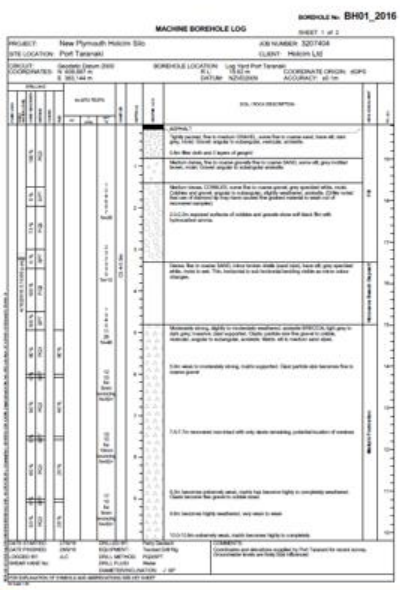
Downer

Key Geological Features

- Boreholes and Site Investigation
- Rock
- Soft material – alluvium or peat
- Sink Holes or Tomo
- Aquifers
- Slope stability for cut slopes and for filled embankments

Downer

Boreholes and Site Investigation



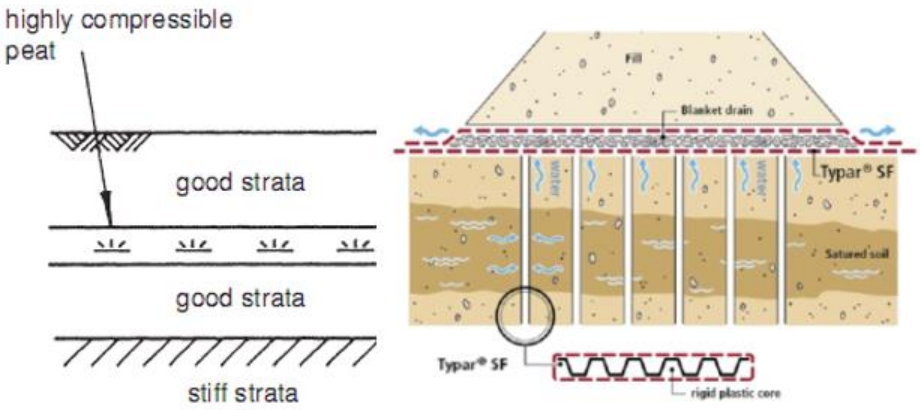
Downer

Rock

Rock can be excavated by blasting or by using hydraulic breakers

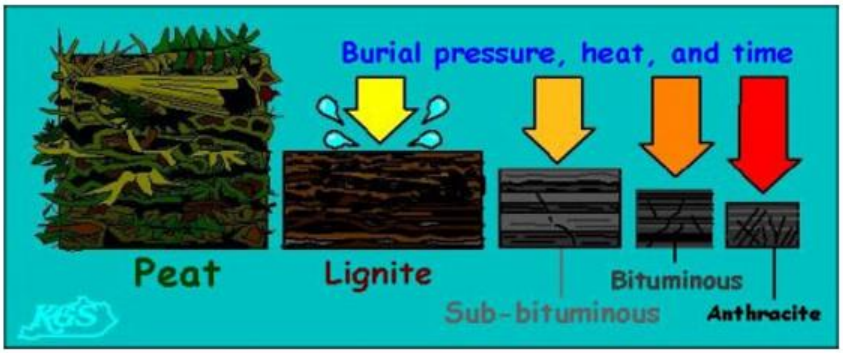
Downer

Peat or Alluvium



Downer

Life of Peat



Downer

Sink Holes or Tomo

Downer

Sink Holes or Tomo

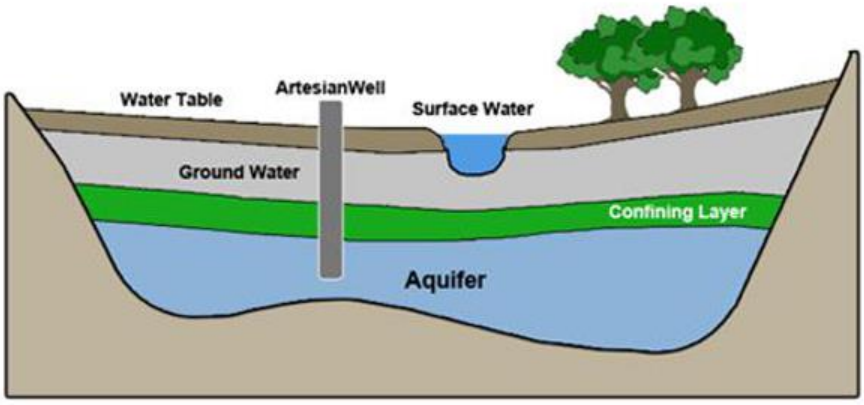
Downer

Sink Holes or Tomo

Downer

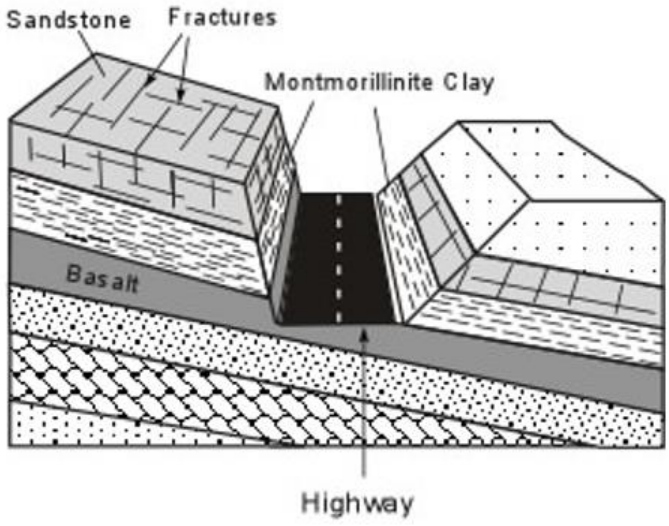
© Downer Group Limited All rights reserved

Aquifers



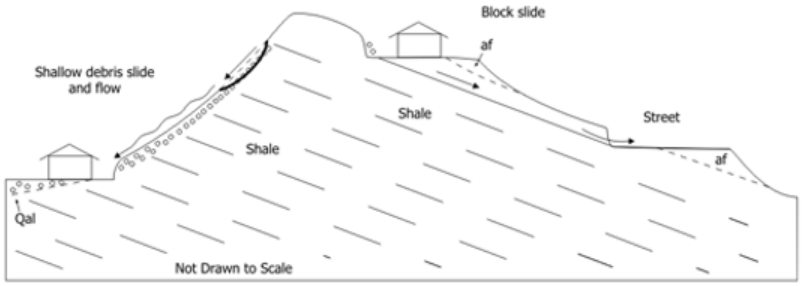
Downer

Slope Stability for cut slopes or embankments



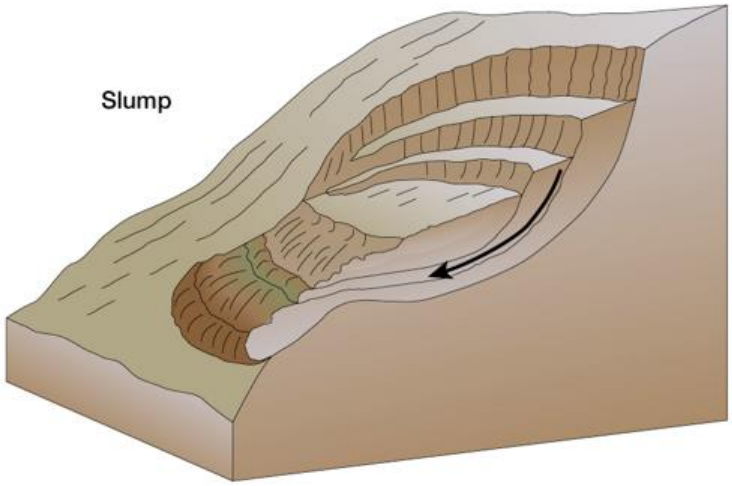
Downer

Slope Stability for cut slopes or embankments



Downer

Slope Stability for cut slopes or embankments



Downer

© Downer Group Limited All rights reserved

Slope Stability for cut slopes or embankments

Downer

Slope Stability for cut slopes or embankments

Downer

© Downer Group Limited All rights reserved

Slope Stability for cut slopes or embankments

Downer

Fill Materials

Good Fill Materials

- Rock/Stone
- Clay
- Sand

Downer

ACTIVITY EXAMPLE

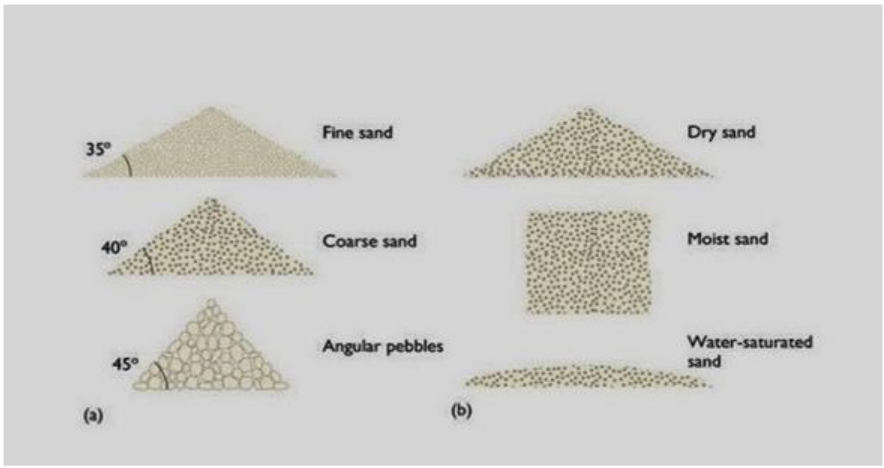
Fill Materials

Bad Fill Materials

- Alluvium
- Silts
- Peat or Organic Material

Downer

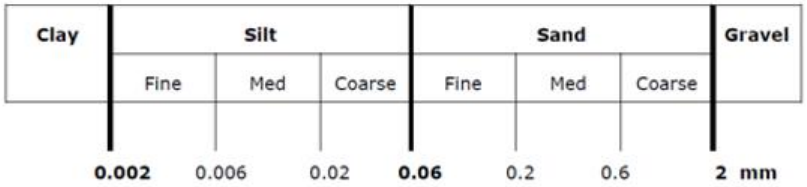
Self Supporting Slope Angles

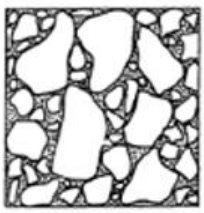


Downer

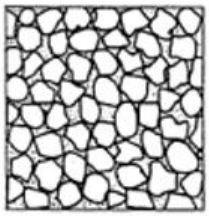
Material Grading

Particle Size Classification

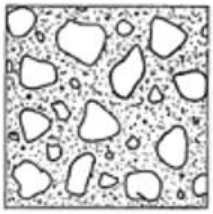




Continuously graded
(*Well* graded)



Uniformly graded



Gap graded

Downer

Density of Materials

Downer

Density of Materials

Material A – costs $10 per tonne and has a density of 2t/m3

Material B – costs $11 per tonne and has a density of 1.7t/m3

If we require 10m3 to fill our hole which material is cheaper to use.

Downer

Density of Materials

Material A – costs $10 per tonne and has a density of 2t/m3

10m3 x 2t/m3 = 20t **20t x $10/t = $200**

Material B – costs $11 per tonne and has a density of 1.7t/m3

10m3 x 1.7t/m3 = 18t **17t x $11/t = $187**

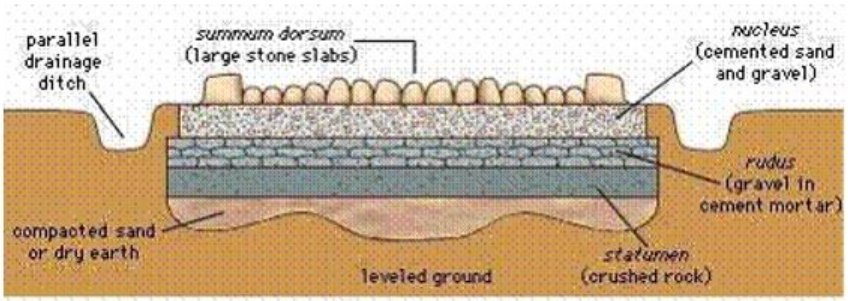
If we require 10m3 to fill our hole which material is cheaper to use.

Material B

Downer

Pavement Construction

- Romans first made 'real' roads around 300BC – (2300 years ago!)



Ancient Roman road shown in cross section.

Downer

Pavement Construction

- Not really changed in over 2000 years

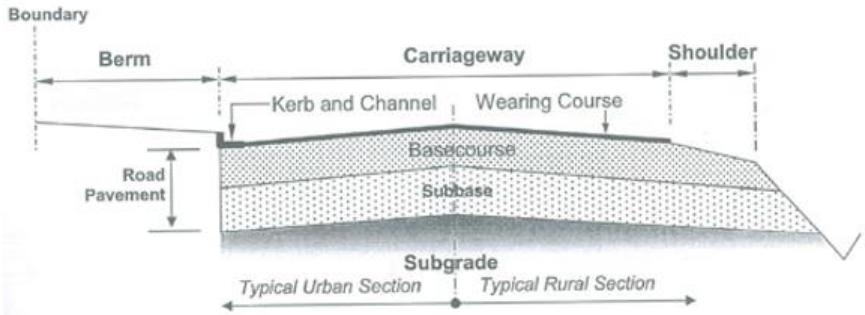


Fig 1.1 - Typical Road Pavement

Downer

Test Pits

Test Pit Photos

Downer

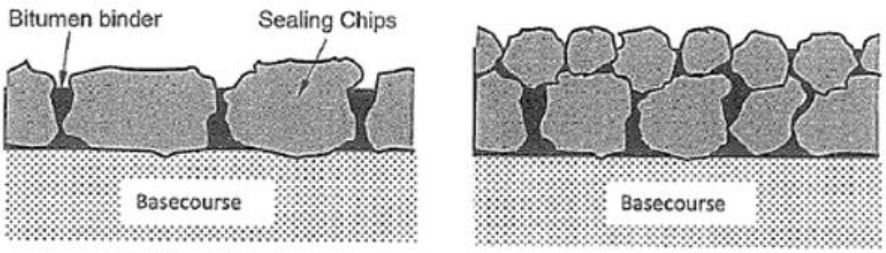
Pavement Construction

Downer

Bitumen Pavements

Downer

Road Surfaces



(a) Single Seal (b) Two Coat Seal

Fig. 3.1 - Sprayed Seal Surfaces

Downer

Bitumen Pavements

Downer

Road Construction and Geology...and maths!

1. **There are thousands of different jobs in construction**
   - Designing roads, bridges, drainage etc.
   - Surveying
   - Material specialists
   - Estimating and planning construction
   - Building roads – machine drivers, drain layers, concrete workers etc. etc.
   - Managing projects

2. **Whatever you do you need your sciences and maths to keep you options open.**

3. **You have plenty of time to decide what you want to do if you keep your options open.**

Downer

Integrated Curriculum Example

SCIENCE & MATHS

SSEP EXAMPLE // ROAD CONSTRUCTION
DEVELOPED BY // NGARUAWAHIA HIGH SCHOOL AND DOWNER

ACTIVITY EXAMPLE

ACTIVITY EXAMPLE

For more on SSEP see:
www.smartnz.nz