



**Gravel Road Design for the
Valencia Mine**
Revision 1
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1. GENERAL

This report covers the pavement design of the the upgrading of the gravel road for the Valencia Mine. The design is based on Draft TRH 20, "Structural Design, Construction and Maintenance of Unpaved Roads", published by the Department of Transport. This report consists of the following:

- Design traffic
- Centre line material investigation
- Borrow pit material investigation
- Structural design

2. DESIGN TRAFFIC

The client has provided an estimation of what the daily traffic criteria would be on the gravel road. It consists of:

- 2 diesel tankers (25t)
- 10 sulphur trucks (30t)
- 8 manganese trucks (25t)
- 5 delivery trucks (10t)
- 10 busses (50 seater)
- 60 light vehicles

An average annual daily traffic (AADT) volume of 95 vehicles has been calculated from the above information of which 37% are heavy vehicles.

3. MATERIAL INVESTIGATION

3.1 CENTRE LINE INVESTIGATION

A total of 23 centre line test pits were conducted on the existing gravel road to the Valencia Mine. The interval for the centre line test pits was 1km.

The test pits were profiled, the in-situ material described and the layer thicknesses measured. Samples of the typical materials were taken for laboratory testing. These tests include indicator tests (grading and Atterberg limits) as well as California Bearing Ratio (CBR) tests. Dynamic Cone Penetration (DCP) tests were also conducted at a 1 kilometre interval. Test results showed the following (see Appendix A for Summary of centre line test results):

- In general the material is transported quartzite gravel or rivers sand.
- Laboratory and DCP tests showed that the CBR of the insitu material is above 5%. According to TRH20 no subgrade protection is needed in this case.
- DCP tests from km 0 to km 5 was impenetrable at a depth of between 60mm and 340mm, from km 5 to km 19 the CBR range was mostly between 5% and 20% and from km 19 to km 23 the CBR was from 30% to 140%.
- Grading moduli varied between 1,61 and 2,73
- Plasticity index varied between non-plastic and 15, but the material is predominantly non plastic.

The shrinkage product and the grading coefficient were also calculated according to TRH20 to determine whether the in-situ material could be used for wearing course. Only the existing in-situ material in the region of km 23 can be used for the gravel wearing course. The relationship between the shrinkage product, grading coefficient and the performance of unpaved gravels of the centre line test pit material is shown in Appendix B.

3.2 BORROWPIT INVESTIGATION

Ten (10) borrow pits were identified in the region. Materials were sampled for laboratory tests, which included indicator tests (grading and Atterberg limits) and California Bearing Ratio (CBR) tests. The laboratory test results were used to calculate the shrinkage product and the grading coefficient according to TRH20. The relationship between the shrinkage product, grading coefficient and the performance of unpaved wearing course gravels for the borrow pit material is shown in Appendix B

Materials from Borrow pit 2 fell into zone A (prone to ravelling and erosion), according to TRH20. Materials in this area generally perform satisfactory, but are finely graded and particular prone to erosion by water. These materials should be avoided if possible, especially on steep grades and sections with steep cross-falls and super-elevations. Most roads constructed from these materials perform satisfactory, but require periodic labour-intensive maintenance over short lengths and have high gravel losses due to water erosion.

Materials from Borrow pit 1, 5, 6, 7, 8 and 10 fell into zone B. These materials generally lack cohesion and are highly susceptible to the formation of loose material (ravelling) and corrugations. Regular maintenance is necessary if these materials are used and the roughness is to be restricted to reasonable levels.

No Borrowpits fall into zone C or D.

Materials from Borrow pit 3 and 4 fell into zone E. Materials in this zone perform well in general, provided the oversize material is restricted to the recommended limits.

4. STRUCTURAL DESIGN

The best suited borrow pits for use of the wearing coarse layer are borrow pit 3 and 4 because of the zone E classification in accordance with TRH20, which requires no blending or special treatment. The in-situ material in the region of km 23 may also be used for the wearing coarse layer.

As shown in Table 4.1, the required wearing course thickness varies between 100mm to 260mm depending on the chosen design life or regraveling frequency. The proposed pavement design for the road is as follows:

Gravel wearing coarse:	260 mm to 100mm thick natural gravel (Table 4.1) compacted to 95% of Modified AASHTO density with minimum CBR of 15% at 95% of Modified AASHTO density (COLTO Table 3402/4 Type 1)
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Formation Layer:	150 mm thick natural gravel compacted to 90% of modified AASHTO density with minimum CBR of 5% at 93% of Modified AASHTO density
Fill:	Natural gravel compacted to 90% of Modified AASHTO density with minimum CBR of 3% at 93% of Modified AASHTO density

The proposed gravel road needs to be shaped to the correct line and level, and if required, the in situ material ripped and re-compacted to a depth of at least 150mm. The thickness of the wearing course is however dependant on the material properties of the anticipated borrow pits or in-situ material that may be utilized and design life of the road. Table 4.1 indicate the thickness of the gravel wearing course for the different material sources. The wearing course thickness design is shown in Appendix C.

Table 4.1: Required wearing course for different design life and borrow pits

Design life	Wearing coarse thickness (mm)		
	Borrow pit 3	Borrow pit 4	Km 23.00
7	125	115	100
10	175	165	140
13	225	210	180
15	260	245	210