



# ROAD MATERIALS SUPPLY STRATEGY

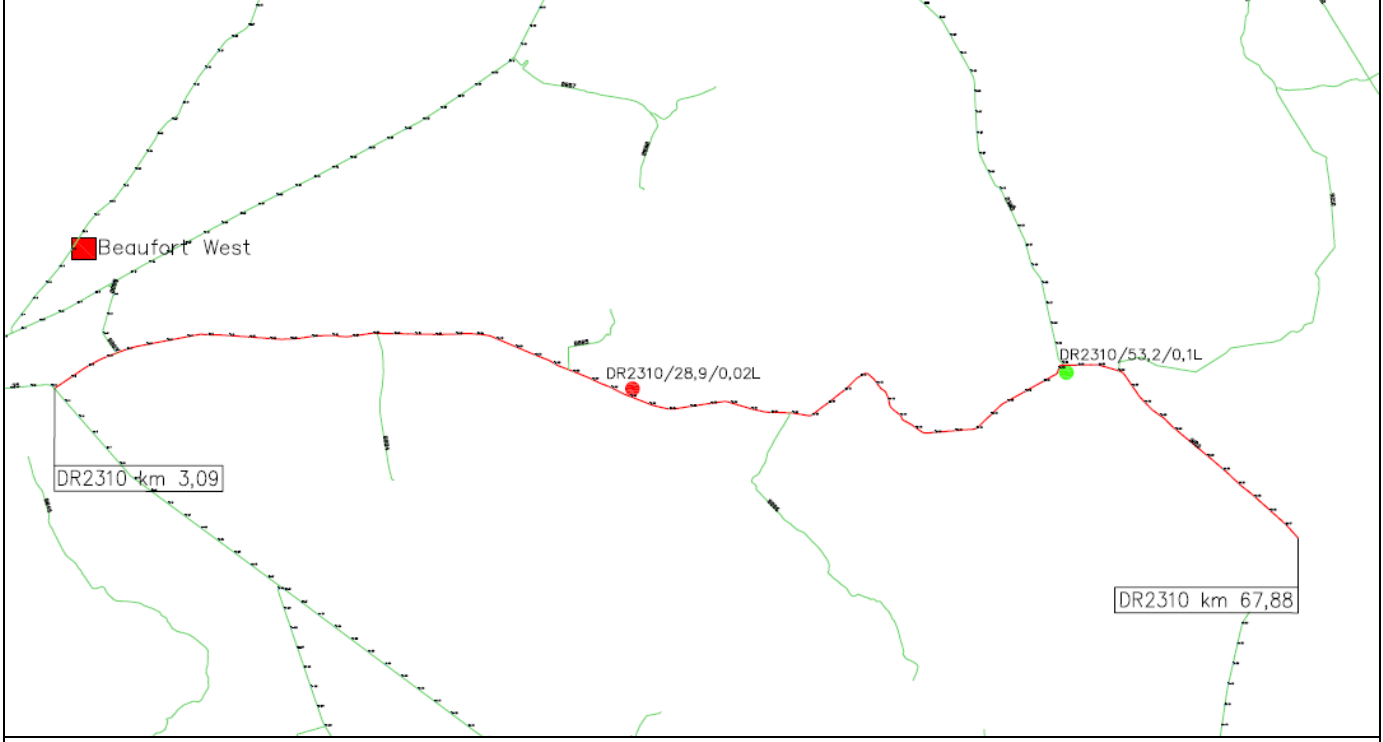
## BORROW PIT INVESTIGATION REPORT

**DR2310/28,9/0,02L**

**aurecon**

**NADESON**  
CONSULTING SERVICES

Project 402828  
NOV 2014

<b>Borrow Pit : DR02310/28,9/0,02L</b>		
<b>District:</b> Beaufort West		<b>Farm:</b> Helvetia
<b>Owner:</b> Mr A E G van Velden <b>Contact Person:</b> Mr A E G van Velden		<b>Contact Details:</b> P O Box 25, Beaufort West, 6970 <b>Phone &amp; Fax:</b> 023 414 2161, 023 414 3714 <b>Cell</b> 082 778 7834; vanvelden@crawfordsattorneys.co.za
<b>Intended Lifespan of Borrow Pit:</b> >50 years		<b>Representative Co-ordinates:</b> 32°21'5.15"S, 22°54'41.04"E
<b>Approximate Area of Proposed Pit:</b> 12 500m <sup>2</sup>		<b>Approximate Extent of Proposed Expropriation Area:</b> 15 000m <sup>2</sup>
<b>Date of Site Investigation:</b> 13 August 2014	<b>Date Sample Testing by Outeniqua Laboratory Completed:</b> 6 October 2014	<b>Date This Report Completed:</b> 26 November 2014
<b>Location:</b> <p>This proposed enlargement of a roughly oblong existing borrow pit is located on a flat pediment with a slight slope to the southeast and which DR2310 traverses in a roughly east west direction. The site lies on private land to the north (left hand) side of DR2310.</p> <p>An electricity power line crosses the field. It has an east-west alignment and its servitude defines the northern limit of potential gravel extraction.</p> <p>An ephemeral natural water courses marks the eastern possible limit of borrow pit enlargement. The existing pit holds runoff from the roadside drain.</p>		
		
<b>Potential Material Site: : BP DR02310/28,9/0,02L</b>		
<b>Vegetation:</b> Gamka Karoo		
<b>Land Usage:</b> Grazing and water for domestic and livestock.		

**Material Types:**

**Colluvium:** Dry, light greyish brown, medium dense, fine gravelly silty sand. In places, pedogenically calcretised and strongly streaked and spotted white, dense, and well cemented.

**Residual (disintegrated) mudstone:** Dry, black streaked reddish brown, loose to medium dense, silty sandy fine to medium GRAVEL of angular shards of mudstone. In places, pedogenically calcretised and grey discoloured light grey and streaked reddish brown and white, loose to medium dense, and with a film of hard calcite on shard surfaces.

**Mudstone:** Grey discoloured light blue-ish grey, fine to very fine grained, medium bedded horizontally. Slightly weathered, hard, closely to medium fractured with thick becoming thin to very thin downwards greyish brown silty sand fill. In places, pedogenically calcretised and discoloured light grey, highly weathered, and with a film of hard calcite on fracture surfaces. Teekloof Formation, Adelaide Sub-group, Beaufort Group.



DR02310/28,9/0,02L TP 1 Profile



DR02310/28,9/0,02L TP 2 Profile



DR02310/28,9/0,02L TP 1 Stockpile



DR02310/28,9/0,02L TP 2 Stockpile



**DR02310/28,9/0,02L R TP 3 Profile**



**DR02310/28,9/0,02L TP 4 Profile**



**DR02310/28,9/0,02L TP 3 Stockpile**



**DR02310/28,9/0,02L TP 4 Stockpile**



**DR02310/28,9/0,02L 1R TP 5 Profile**



**DR02310/28,9/0,02L TP 6 Profile**



**DR02310/28,9/0,02L TP 5 Stockpile**



**DR02310/28,9/0,02L TP 6 Stockpile**







**DR02310/28,9/0,02L TP 7 Profile**

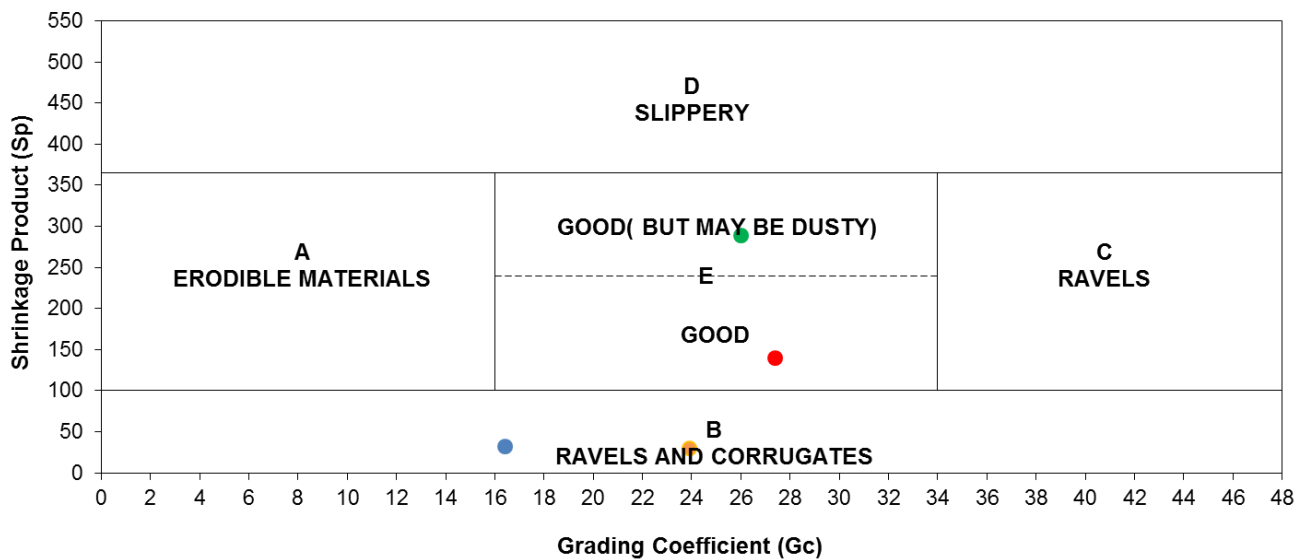


**DR02310/28,9/0,02L TP 7 Stockpile**



**270° Panorama of this site (south through northwest to east) from near TP 4**

<b>Material Suitability:</b> The laboratory test results are summarised alongside.  The test results indicate that the material from this site is <b>suitable</b> for use as <b>gravel wearing course</b> (Sp>100%; CBR>15%, Gc between 16 and 34%, Venter and Treton acceptable), provided the resource is mined full-face.  Note 1: The arithmetically-derived test results of the <b>Combined Uncrushed</b> material assumed that an average thickness of 0,75m of the <b>Colluvium and Residual Mudstone</b> material blanketed an average thickness of 1,25m of the <b>Weathered Mudstone</b> material.  Note 2: Field observations confirm that the higher Oversize Index percentages of the uncrushed material more accurately reflect the situation to be found, particularly if ripping excavations with, e.g. a D9 were to extend below the proven depths (2,5m) that were obtained with a 20tonne excavator in the Mudstone.  Note 3: The small proportion of oversize that does not break up with general handling in the borrow pit should be screened out prior to be despatched to the road prism,		<b>Combined uncrushed</b>	<b>Coll. and Res. M'st.</b>	<b>Weath'd Mudst. uncrushed</b>	<b>Weath'd Mudst. Crushed</b>
					
	<b>Oversize Index (I<sub>o</sub>)</b>	13,5%	1%	21,4%	0%
	<b>Grading Coef. (G<sub>c</sub>)</b>	27,4%	26,0%	16,4%	23,9%
	<b>Shrinkage Product (S<sub>p</sub>)</b>	139,2%	289%	32,5%	30%
	<b>CBR @ 95% Mod AASHTO</b>	23,1% (6 to 40%)	24% (8 to 40%)	22,5% (6 to 39%)	46%
	<b>Treton Value</b>	Not Tested		16,3%	
	<b>Venter Test</b>			1,1,1,1,1	



Relationship between shrinkage product, grading coefficient and performance of unpaved wearing course gravels

● Combined uncrushed    ● Colluvium and Residual Mudstone    ● Weathered Mudstone (Uncrushed)    ● Weathered Mudstone (Crushed)

Typical Profile	
Layer	General Description
1	Dry, light greyish brown, medium dense to loose, fine gravelly silty sand with roots. Colluvial topsoil.
2	Dry, light brown, firm, blocky, sandy silt with desiccation cracks. Washed in fill
3	Dry, light greyish brown, medium dense, fine gravelly silty sand. Colluvium.
4	As Layer 3 but strongly streaked and spotted white, dense, and well cemented. Pedogenically calcretised colluvium.
5	As Layer 4 but with thin layer of coarse gravel along the lower contact. Pedogenically calcretised colluvium with pebble marker.
6	Dry, black streaked reddish brown, loose to medium dense, silty sandy fine to medium GRAVEL of angular shards of mudstone. Residual completely weathered (disintegrated) mudstone
7	Dry, grey discoloured light grey and streaked reddish brown and white, loose to medium dense, silty sandy fine to medium GRAVEL of angular shards of mudstone with a film of hard calcite on shard surfaces. Pedogenically calcretised residual completely weathered (disintegrated) mudstone.
8	As Layer 7 but with minor calcrete film in places
9	MUDSTONE Grey discoloured light grey, fine to very fine grained, medium bedded horizontally. Highly weathered, hard, very closely to closely fractured with thick fill of greyish brown silty sand. Teekloof Formation, Adelaide Sub-group, Beaufort Group.
10	MUDSTONE As Layer 9 but strongly discoloured light grey, highly weathered, and with a film of hard calcite on fracture surfaces. Pedologically calcretised.
11	MUDSTONE As Layer 9 above but includes minor discontinuous thin layers of C, i.e. Residual completely weathered disintegrated mudstone.
12	MUDSTONE As Layer 9 above but closely to medium fractured with fill becoming very thin downwards.
13	MUDSTONE As Layer 12 but with a discontinuous film of hard calcite on fracture surfaces in places. Pedologically slightly calcretised.
14	MUDSTONE Grey discoloured light blue-ish grey, fine to very fine grained, medium bedded horizontally. Slightly weathered, hard, closely to medium fractured with minor thin fill of greyish brown silty sand. Teekloof Formation, Adelaide Sub-group, Beaufort Group.

TP1		
Depth (m)	Layer	Samples taken
0.0		
0.1	2	N/A
0.2		
0.3	4	RI
0.4		
0.5		

**Notes:**

Refusal at 0.5m on hard, medium to widely fractured with no fill, tight mudstone. D9 will excavated about 1m deeper but produce a high proportion of oversize clasts and minimal fines. Oversize will not break under heavy grid rolling - needs to be passed through a crusher plant.

TP2		
Depth (m)	Layer	Samples taken
0.0		
0.1	1	N/A
0.2		
0.3	3	RI
0.4		
0.5	7	
0.6		
0.7		
0.8	10	RI, CBR, Tretton, Venter
0.9		
1.0		
1.1		
1.2		
1.3	12	
1.4		

**Notes:**

Refusal at 1.4m on hard, medium to widely fractured with no fill, tight mudstone. D9 will excavated about 1m deeper but produce a high proportion of oversize clasts and minimal fines. Oversize will not break under heavy grid rolling - needs to be passed through a crusher plant.

TP3		
Depth (m)	Layer	Samples taken
0.0		
0.1	1	N/A
0.2		
0.3	3	
0.4		
0.5		
0.6		RI, CBR
0.7	7	
0.8		
0.9		
1.0		
1.1		
1.2		
1.3	9	
1.4		
1.5	6	
1.6		
1.7	9	
1.8		
1.9	6	
2.0		
2.1		
2.2		
2.3		
2.4	12	
2.5		
2.6		

**Notes:**

Refusal at 2.6m on hard, medium to widely fractured with no fill, tight mudstone. D9 will excavated about 1m deeper but produce a high proportion of oversize clasts and minimal fines. Oversize will not break under heavy grid rolling - needs to be passed through a crusher plant.

TP4		
Depth (m)	Layer	Samples taken
0.0		
0.1	1	N/A
0.2		
0.3	3	RI
0.4		
0.5		
0.6	6	RI
0.7		
0.8		
0.9		
1.0		
1.1		
1.2		
1.3	10	
1.4		
1.5		
1.6		
1.7		
1.8		

**Notes:**

Refusal at 1.8m on hard, medium to widely fractured with no fill, tight mudstone. D9 will excavated about 1m deeper but produce a high proportion of oversize clasts and minimal fines. Oversize will not break under heavy grid rolling - needs to be passed through a crusher plant.

Typical Profile	
Layer	General Description
1	Dry, light greyish brown, medium dense to loose, fine gravelly silty sand with roots. Colluvial topsoil.
2	Dry, light brown, firm, blocky, sandy silt with desiccation cracks. Washed in fill
3	Dry, light greyish brown, medium dense, fine gravelly silty sand. Colluvium.
4	As Layer 3 but strongly streaked and spotted white, dense, and well cemented. Pedogenically calcretised colluvium.
5	As Layer 4 but with thin layer of coarse gravel along the lower contact. Pedogenically calcretised colluvium with pebble marker.
6	Dry, black streaked reddish brown, loose to medium dense, silty sandy fine to medium GRAVEL of angular shards of mudstone. Residual completely weathered (disintegrated) mudstone
7	Dry, grey discoloured light grey and streaked reddish brown and white, loose to medium dense, silty sandy fine to medium GRAVEL of angular shards of mudstone with a film of hard calcite on shard surfaces. Pedogenically calcretised residual completely weathered (disintegrated) mudstone.
8	As Layer 7 but with minor calcrete film in places
9	MUDSTONE Grey discoloured light grey, fine to very fine grained, medium bedded horizontally. Highly weathered, hard, very closely to closely fractured with thick fill of greyish brown silty sand. Teekloof Formation, Adelaide Sub-group, Beaufort Group.
10	MUDSTONE as Layer 9 but strongly discoloured light grey, highly weathered, and with a film of hard calcite on fracture surfaces. Pedologically calcretised.
11	MUDSTONE As Layer 9 above but includes minor discontinuous thin layers of C, i.e. Residual completely weathered disintegrated mudstone.
12	MUDSTONE As Layer 9 above but closely to medium fractured with fill becoming very thin downwards.
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14	MUDSTONE Grey discoloured light blue-ish grey, fine to very fine grained, medium bedded horizontally. Slightly weathered, hard, closely to medium fractured with minor thin fill of greyish brown silty sand. Teekloof Formation, Adelaide Sub-group, Beaufort Group.

TP5		
Depth (m)	Layer	Samples taken
0.0		
0.1	1	N/A
0.2		
0.3	3	
0.4		RI, CBR
0.5		
0.6	7	
0.7		RI
0.8		
0.9	8	
1.0		RI, CBR
1.1		
1.2		
1.3		RI, CBR
1.4		
1.5		
1.6		RI, CBR
1.7		
1.8		
1.9		RI, CBR
2.0		
2.1		
2.2		RI, CBR
2.3		
2.4		
2.5		

**Notes:**

Refusal at 1.8m on hard, medium to widely fractured with no fill, light mudstone.  
D9 will excavated about 1m deeper but produce a high proportion of oversize clasts and minimal fines.  
Oversize will not break under heavy grid rolling - needs to be passed through a crusher plant.

TP6		
Depth (m)	Layer	Samples taken
0.0		
0.1	1	N/A
0.2		
0.3	3	
0.4		RI
0.5		
0.6		
0.7		RI
0.8		
0.9	4	
1.0		N/A
1.1		
1.2		
1.3	7	N/A
1.4		
1.5	6	
1.6		N/A
1.7		
1.8		
1.9		N/A
2.0		
2.1		
2.2		N/A
2.3		

**Notes:**

Refusal at 2.3m on hard, medium to widely fractured with no fill, light mudstone.  
D9 will excavated about 1m deeper but produce a high proportion of oversize clasts and minimal fines.  
Oversize will not break under heavy grid rolling - needs to be passed through a crusher plant.

TP7		
Depth (m)	Layer	Samples taken
0.0		
0.1	1	N/A
0.2		
0.3		
0.4		N/A
0.5		
0.6	3	
0.7		N/A
0.8		
0.9		
1.0		N/A
1.1		
1.2		
1.3		N/A
1.4		
1.5		
1.6		N/A
1.7		
1.8		
1.9		N/A
2.0		
2.1		
2.2		N/A
2.3		

**Notes:**

Refusal at 2.3m on hard, medium to widely fractured with no fill, light mudstone.  
D9 will excavated about 1m deeper but produce a high proportion of oversize clasts and minimal fines.  
Oversize will not break under heavy grid rolling - needs to be passed through a crusher plant.

TRIAL PIT PROFILES : BP DR02310/28,9/0,02L (Test Pits 5 to 7)

**Material Processing Requirements:**

Approximately half of the oversize mudstone clasts are expected to break up under general handling in the borrow pit. The remainder should be screened out in the borrow pit.

Care must be exercised in not excavating below the proven depth of about 2,5m into the Weathered Mudstone because the proportion of oversize clasts, that won't break up with general handling, is expected to significantly increase.

**Security:**

The existing pit and proposed extension are separated from DR2310 to the south by the road side fence with a locked gate, and are not separated from adjacent fields by any bounding fences.

**Existing Borrow Pit**

**Pit Development:**

An oblong-shaped depression in the pediment.

**Working Faces:**

Appear to be about 1v:3h and smooth.

**Drainage:**

Not free draining and fed by a man-made channel from the roadside drain.

**Potential Hazards:**

- Construction vehicles conflicting with traffic along road DR2310 during material extraction and placement
- Dust affecting road users, livestock, and the surrounding veld.
- Fines entering water courses.
- Electricity power line to the north of the site – the servitude thereof marks the limit of mining in that direction.

**Proving of Reserves:**

Seven (7 No.) trial pits were excavated at the proposed borrow pit extension area (using a 20 tonne, tracked JCB200sc excavator with a 4 tine rock bucket), at locations shown on the accompanying GPS Sketch Plan. All the trial pits encountered material **suitable as gravel wearing course**.

Estimated Proven Reserves: ~20 000m<sup>3</sup> over a trapezoidal shaped area with a maximum length and width of about 90m x 140m to a maximum depth of 2,5m (average about 1,6m deep and utilising 3v:1h cut face slopes).

**Future Pit Development:**

Vegetation and about 200mm of topsoil should be cleared from unworked ground and then stockpiled for later rehabilitation before excavation of the potential wearing course gravel material.

The extended pit should be designed to enlarge the existing off-stream borrow pit that temporarily retains runoff.

Extraction should be phased so that it commences from the existing pit and furthest from DR2310. Access to the various subsequent phases of excavation of the proposed pit should be via the existing pit, to avoid traversing previously mined and rehabilitated areas of the extension.

**Rehabilitation:**

- All possible worked surfaces above final water level should be covered as soon as possible with any available and stockpiled topsoil.
- Previously mined and rehabilitated areas should not be traversed as far as possible by access tracks to, nor covered by temporary stockpiles of gravel from, the subsequent mining phases.
- The proposed pit should be designed to be worked such that any portion/phase is free-draining at all times.
- A stockpile of loosened gravel should be left after each mining phase as close as possible to the access from DR2310.

**Requests/Concerns of Farm Owner:**

- None received in writing.

**Environmental Concerns:**

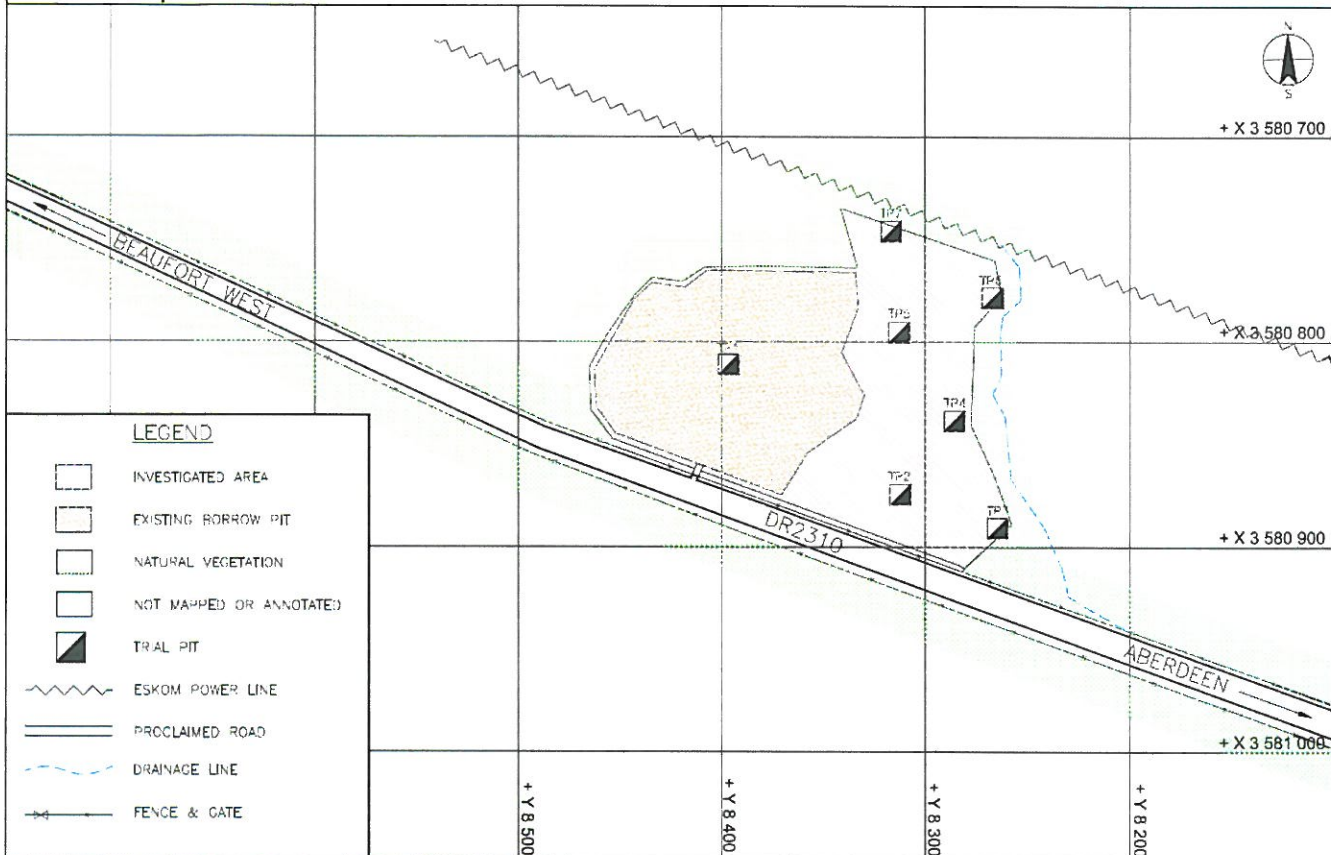
- The Teekloof Formation mudstone may contain fossils. However, no fossils were observed during the site investigation,
- Traffic control during exploitation of the resource.
- Dust affecting road users and the surrounding natural unimproved pasture lands..
- Fines entering and silting-up the local water courses
- Presence of electricity power line

- Possibility of livestock or personnel drowning in non-free draining excavation that temporarily holds runoff.

**DEA Approval Status:** Preparation of NEMA checklist will be undertaken following acceptance of this pit as an acceptable source of wearing course gravel, mainly for maintenance of DR2310.

**Expropriation Status:** No formal agreement with the landowner has been made to date. This will be done by the Western Cape Provincial Government officials.

**GPS Sketch plan:**



<b>Field Work &amp; Report by:</b> <b>Richard Galliers</b>	<b>Report Finalised By:</b> <b>Henning Jv Rensburg</b>	<b>Project Director:</b> <b>David A. Rose</b>
<b>Date:</b> 24 November 2014	<b>Date:</b> 24 November 2014	<b>Date:</b> 24 November 2014

Test Data - Gravel Wearing Course															T-DAT-GWC-E																				
Samples From Borrowpit / Road * (+37,5 mm Aggregate Included / Excluded *)															August 2000																				
Borrowpit at km: BP DR02310/km28,9					Distance from Road (km): 0,02L					Property: Helvetia																									
Particulars of Test Points, Samples ect.																																			
Road Section			From : to:																																
Test Point (Number / at km *)			<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> </table>															1	2	3	4	5	6	7	8	9	10								
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Sample Number		Field	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>1</td><td>415</td><td>5</td><td>425</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>															1	415	5	425														
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Laboratory	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>57778A</td><td>57787A</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>															57778A	57787A																		
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Depth below Surface m			<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>0,2-0,5</td><td>1,2-2,5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>															0,2-0,5	1,2-2,5																
0,2-0,5	1,2-2,5																																		
Description of Material			Weathered Mudstone, CRUSHED																																
Treatment of Oversize		In Borrowpit	screen out or crush oversize; too hard for heavy grid rolling																																
Material (+37,5mm)		On Road	remove by hand																																
Sample Identification N			<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> </table>															1	2	3	4	5	6	7	8	9	10								
1	2	3	4	5	6	7	8	9	10																										
Test Results																																			
N	Gradation - % Passing sieves (mm)												Atterberg Constants																						
	75	63	53	37,5	26,5	19,0	13,2	4,75	2,00	0,425	0,075	-0,425			-0,075 <sup>(3)</sup>																				
	LL	PI	LS	LL	PI	LS																													
1	100	100	100	100	97	87	73	20	6	3	1	23	11	5.0																					
2	100	100	100	100	100	97	89	34	14	7	5	30	14	7.0																					
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Mean (Total sample) <sup>(1)</sup> M	100	100	100	100	99	92	81	27	10	5	3	26.5	12.5	6.0																					
Gradation -37,5 mm <sup>(2)</sup> P				100	99	92	81	27	10	5	3																								
<b>Oversize Index; Shrinkage Product; Gradation Coefficient; Plasticity Factor</b> <b>CBR and Performance Classification Zone</b>																																			
$I_p = \text{Oversize Index} \quad (\% \text{ retained on } 37,5 \text{ mm of Lot from Mean Value}) = 0.0 \quad \% (\ln / \text{Out}^*)$ <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: Rural Roads <math>\leq 5\%</math> / Urban Roads <math>0\%</math> / Haul Roads <math>\leq 10\%</math> *</div>																																			
$S_p^{(5)} = \text{Shrinkage Product determined on } -37,5 \text{ mm gradation}^{(2)} = LS_{0,425}(P_{0,425}) = 30.0 \quad \% (\ln / \text{Out}^*)$ <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: Rural/Haul * Roads <math>100 \leq S_p \leq 365</math> / Urban Roads * <math>100 \leq S_p \leq 240</math></div>																																			
$G_c = (P_{26,5} - P_{2,00}) / (P_{4,75} - P_{2,00}) = 23.9 \quad \% (\ln / \text{Out}^*)$ Gradation Coefficient determined on -37,5 mm gradation <sup>(2)</sup> <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: <math>16 \leq G_c \leq 34</math></div>																																			
$PF^{(4)} = (LL_{0,425} - PI_{0,425}) / (P_{0,075} - P_{0,425}) = 40.6 \quad \% (\ln / \text{Out}^*)$ Plasticity Factor determined on -37,5 mm gradation <sup>(2)</sup> <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: <math>PF \geq 500</math></div>																																			
<b>CBR at Spec. Dens.: Spec.<sup>(6)</sup> = 15 @ 95 % MDD (4 days soaking)</b>																																			
N	MDD	OMC	CBR at % Compaction				Swell	Durability Test (Venter) - Mudrock																											
	kg/m <sup>3</sup>	%	98	95	93	90	100 % Comp.	N	5 Cycles Weathering					DMI																					
2	2170	6,8	59	46	37	23	0,13																												
<b>Performance Classification Zone: A; B; C; D; E or E'</b> where: A:- $100 \leq S_p \leq 365$ and $G_c < 16$ (Erodible material) B:- $S_p < 100$ and $G_c > 0$ (Ravels and corrugates) C:- $100 \leq S_p \leq 365$ and $G_c > 34$ (Ravels) D:- $S_p > 365$ and $G_c > 0$ (Slippery) E:- $100 \leq S_p \leq 240$ and $16 \leq G_c \leq 34$ (Good) <sup>(5)</sup> E': $240 < S_p \leq 365$ and $16 \leq G_c \leq 34$ (Good, but may be dusty)																																			
<b>Notes:</b> (1) Pertaining to the Mean Value. (2) Theoretical gradation of -37,5 mm material determined as follows: $P_{3,75} = 100\%$ ; $P_{26,5} = \%M_{26,5}(100)/\%M_{37,5}$ ; $P_{19,0} = \%M_{19,0}(100)/\%M_{37,5}$ etc. (3) PI of -0,075 may have bearing on slipperiness (criteria to be researched) (4) Reduction in gravel loss can be obtained with $PF \geq 500$ (5) With $S_p \leq 240$ preferable, this may be specified in project document. (6) CBR $\geq 15$ at 95% Mod. AASHTO compaction and 4 days soaking or otherwise specified in the project specification M Percentage passing by mass of total sample e.g. $M_{26,5} = \% \text{ passing } 26,5 \text{ mm}$ P Percentage passing by mass eg. $P_2 = \% \text{ passing } 2,0 \text{ mm}$ * Cross out whichever option is not applicable or delete if not applicable																																			
Remarks: Strategic Plan, Extension borrow pits - Sampled by: R.M.G; Date of Sampling: 26/11/2013															Sheet 1 of 1																				
Treton Value: <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>N</td><td></td><td></td><td>N</td><td></td><td></td><td>N</td><td></td><td></td><td>N</td><td></td><td></td><td>N</td><td></td><td></td><td>N</td><td></td><td></td> </tr> </table>																		N			N			N			N			N			N		
N			N			N			N			N			N																				

Test Data - Gravel Wearing Course															T-DAT-GWC-E									
Samples From Borrowpit / Road * (+37,5 mm Aggregate Included / Excluded *)															August 2000									
Borrowpit at km: BP DR02310/km28,9					Distance from Road (km): 0,02L					Property: Helvetia														
Particulars of Test Points, Samples ect.																								
Road Section			From : to:																					
Test Point (Number / at km *)																								
Sample Number			Field		1	415	2	417	3	420	4	423	5	425	6		7		8		9		10	
			Laboratory		57778B	57780B	57782	57785B	57787B															
Depth below Surface			m		0,2-0,5	0,45-1,4	1,0-2,6	0,85-1,8	1,2-2,5															
Description of Material			Weathered Mudstone																					
Treatment of Oversize			In Borrowpit		screen out or crush oversize; too hard for heavy grid rolling																			
Material (+37,5mm)			On Road		remove by hand																			
Sample Identification			N		1	2	3	4	5	6	7	8	9	10										
Test Results																								
N	Gradation - % Passing sieves (mm)												Atterberg Constants											
	75	63	53	37,5	26,5	19,0	13,2	4,75	2,00	0,425	0,075	-0,425			-0,075 <sup>(3)</sup>									
	LL	PI	LS	LL	PI	LS																		
1	100	100	100	87	79	71	56	16	4	2	1	25	12	6,0										
2	100	100	84	78	75	71	59	18	10	6	3	31	10	5,0										
3	92	91	82	65	44	28	25	10	5	3	1,4	24	9	4,0										
4	81	74	68	63	56	47	40	20	12	8	4	28	12	6,0										
5	100	100	100	100	97	90	70	17	7	3	2	30	16	8,0										
6																								
7																								
8																								
9																								
10																								
Mean (Total sample) <sup>(1)</sup> M	95	93	87	79	70	61	50	16	8	4	2	27,6	11,8	5,8										
Gradation -37,5 mm <sup>(2)</sup> P				100	89	78	64	21	10	6	3													
<b>Oversize Index; Shrinkage Product; Gradation Coefficient; Plasticity Factor</b> <b>CBR and Performance Classification Zone</b>																								
$I_p = \text{Oversize Index} \quad (\% \text{ retained on } 37,5 \text{ mm of Lot from Mean Value}) = 21,4 \quad \% (\ln / \text{Out}^*)$ <div style="border: 1px solid black; padding: 2px; display: inline-block;">Specification: Rural Roads <math>\leq 5\%</math> / Urban Roads <math>0\%</math> / Haul Roads <math>\leq 10\%</math> *</div>																								
$S_p^{(5)} = \text{Shrinkage Product determined on } -37,5 \text{ mm gradation}^{(2)} = LS_{0,425}(P_{0,425}) = 32,5 \quad \% (\ln / \text{Out}^*)$ <div style="border: 1px solid black; padding: 2px; display: inline-block;">Specification: Rural/Haul * Roads <math>100 \leq S_p \leq 365</math> / Urban Roads * <math>100 \leq S_p \leq 240</math></div>																								
$G_c = (P_{26,5} - P_{2,00}) / (P_{4,75} - P_{2,00}) = 16,4 \quad \% (\ln / \text{Out}^*)$ Gradation Coefficient determined on -37,5 mm gradation <sup>(2)</sup> <div style="border: 1px solid black; padding: 2px; display: inline-block;">Specification: <math>16 \leq G_c \leq 34</math></div>																								
$PF^{(4)} = (LL_{0,425} - PI_{0,425}) / (P_{0,075} - P_{0,425}) = 42,6 \quad \% (\ln / \text{Out}^*)$ Plasticity Factor determined on -37,5 mm gradation <sup>(2)</sup> <div style="border: 1px solid black; padding: 2px; display: inline-block;">Specification: <math>PF \geq 500</math></div>																								
<b>CBR at Spec. Dens.: Spec.<sup>(6)</sup> = 15 @ 95 % MDD (4 days soaking)</b>																								
N	MDD	OMC	CBR at % Compaction				Swell	N	5 Cycles Weathering		DMI													
	kg/m <sup>3</sup>	%	98	95	93	90	100 % Comp.																	
2	2201	6,7	9	6	4	1	1,73	2	1,1,1,1,1															
3	2228	6,3	56	39	28	11	0,07																	
<b>Performance Classification Zone: A; B; C; D; E or E'</b> where: A:- $100 \leq S_p \leq 365$ and $G_c < 16$ (Erodible material) B:- $S_p < 100$ and $G_c > 0$ (Ravels and corrugates) C:- $100 \leq S_p \leq 365$ and $G_c > 34$ (Ravels) D:- $S_p > 365$ and $G_c > 0$ (Slippery) E:- $100 \leq S_p \leq 240$ and $16 \leq G_c \leq 34$ (Good) <sup>(5)</sup> E': $240 < S_p \leq 365$ and $16 \leq G_c \leq 34$ (Good, but may be dusty)																								
<b>Notes:</b> (1) Pertaining to the Mean Value. (2) Theoretical gradation of -37,5 mm material determined as follows: $P_{3,75} = 100\%$ ; $P_{26,5} = \%M_{26,5}(100)/\%M_{37,5}$ ; $P_{19,0} = \%M_{19,0}(100)/\%M_{37,5}$ etc. (3) PI of -0,075 may have bearing on slipperiness (criteria to be researched) (4) Reduction in gravel loss can be obtained with $PF \geq 500$ (5) With $S_p \leq 240$ preferable, this may be specified in project document. (6) CBR $\geq 15$ at 95% Mod. AASHTO compaction and 4 days soaking or otherwise specified in the project specification M Percentage passing by mass of total sample e.g. $M_{26,5} = \% \text{ passing } 26,5 \text{ mm}$ P Percentage passing by mass eg. $P_2 = \% \text{ passing } 2,0 \text{ mm}$ * Cross out whichever option is not applicable or delete if not applicable																								
Remarks: Strategic Plan, Extension borrow pits - Sampled by: R.M.G; Date of Sampling: 26/11/2013																								
Treton Value: <span style="border: 1px solid black; padding: 2px;">N 2 16,3</span> <span style="border: 1px solid black; padding: 2px;">N</span> <span style="border: 1px solid black; padding: 2px;">N</span> <span style="border: 1px solid black; padding: 2px;">N</span> <span style="border: 1px solid black; padding: 2px;">N</span> <span style="border: 1px solid black; padding: 2px;">N</span> <span style="border: 1px solid black; padding: 2px;">N</span> <span style="border: 1px solid black; padding: 2px;">N</span> <span style="border: 1px solid black; padding: 2px;">N</span>																								
Sheet 1 of 1																								

Test Data - Gravel Wearing Course												T-DAT-GWC-E							
Samples From Borrowpit / Road * (+37,5 mm Aggregate Included / Excluded *)												August 2000							
Borrowpit at km: BP DR02310/km28,9				Distance from Road (km): 0,02L				Property: Helvetia											
Particulars of Test Points, Samples ect.																			
Road Section		From : 1 2 3 4 5 6 7 8 9 10 to:																	
Test Point (Number / at km *)																			
Sample Number	Field	2	416	3	419	4	421	4	422	5	424	6	426						
	Laboratory	57779B		57781		57783B		57784B		57786B		57788B							
Depth below Surface		m		0,2-0,45		0,2-1,0		0,15-0,5		0,5-0,85		0,2-1,2		0,55-1,3					
Description of Material		Colluvium + disintegrated Mudstone																	
Treatment of Oversize		In Borrowpit		screen out or crush oversize; too hard for heavy grid rolling															
Material (+37,5mm)		On Road		remove by hand															
Sample Identification		N		1	2	3	4	5	6	7	8	9	10						
Test Results																			
N	Gradation - % Passing sieves (mm)											Atterberg Constants							
	75	63	53	37,5	26,5	19,0	13,2	4,75	2,00	0,425	0,075	-0,425			-0,075 <sup>(1)</sup>				
												LL	PI	LS	LL	PI	LS		
1	100	100	100	100	100	100	100	96	87	58	26	29	13	6.0					
2	100	100	100	100	100	100	100	82	69	55	30	28	11	5.0					
3	100	100	100	100	93	87	87	85	74	53	20.6	25	9	5.0					
4	100	100	100	96	95	94	90	57	41	29	11	29	10	5.0					
5	100	100	100	100	100	100	98	66	34	19	12	33	15	7.0					
6	100	100	100	100	100	100	100	98	92	73	35	33	16	8.0					
7																			
8																			
9																			
10																			
Mean (Total sample) <sup>(1)</sup> M		100	100	100	99	98	97	96	81	66	48	22	29.5	12.33	6.0				
Gradation -37,5 mm <sup>(2)</sup> P					100	99	97	96	81	67	48	23							
<b>Oversize Index; Shrinkage Product; Gradation Coefficient; Plasticity Factor</b> <b>CBR and Performance Classification Zone</b> $I_p = \text{Oversize Index} \quad (\% \text{ retained on } 37,5 \text{ mm of Lot from Mean Value}) = 0.7 \quad \% (\text{In} / \text{Out}^*)$ <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: Rural Roads <math>\leq 5\%</math> / Urban Roads <math>0\%</math> / Haul Roads <math>\leq 10\%</math> *</div> $S_p^{(5)} = \text{Shrinkage Product determined on } -37,5 \text{ mm gradation}^{(2)} = LS_{0,425}(P_{0,425}) = 288.9 \quad \% (\text{In} / \text{Out}^*)$ <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: Rural/Haul * Roads <math>100 \leq S_p \leq 365</math> /—Urban Roads * <math>100 \leq S_p \leq 240</math>—</div> $G_c = (P_{26,5} - P_{2,00})(P_{4,75}) / 100 = 26.0 \quad \% (\text{In} / \text{Out}^*)$ <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: <math>16 \leq G_c \leq 34</math></div> $PF^{(3)} = (LL_{0,425} - PI_{0,425}) / (P_{0,075}) = 388.6 \quad \% (\text{In} / \text{Out}^*)$ <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: <math>PF \geq 500</math></div>																			
CBR at Spec. Dens.: Spec. <sup>(6)</sup> = 15 @ 95 % MDD (4 days soaking)										Durability Test (Venter) - Mudrock									
N	MDD kg/m <sup>3</sup>	OMC %	CBR at % Compaction				Swell 100 % Comp.	N	5 Cycles Weathering				DMI						
			98	95	93	90													
2	2077	7,7	54	40	30	16	0,06												
5	2108	8,4	12	8	6	2	1,72												
<b>Performance Classification Zone: A; B; C; D; E or E'</b> where: A:- $100 \leq S_p \leq 365$ and $G_c < 16$ (Erodible material) B:- $S_p < 100$ and $G_c > 0$ (Ravels and corrugates) C:- $100 \leq S_p \leq 365$ and $G_c > 34$ (Ravels) D:- $S_p > 365$ and $G_c > 0$ (Slippery) E:- $100 \leq S_p \leq 240$ and $16 \leq G_c \leq 34$ (Good) <sup>(5)</sup> E': $240 < S_p \leq 365$ and $16 \leq G_c \leq 34$ (Good, but may be dusty)										<b>Notes:</b> (1) Pertaining to the Mean Value. (2) Theoretical gradation of -37,5 mm material determined as follows: $P_{3,75} = 100\%$ ; $P_{26,5} = \%M_{26,5}(100)/\%M_{37,5}$ ; $P_{19,0} = \%M_{19,0}(100)/\%M_{37,5}$ etc. (3) PI of -0,075 may have bearing on slipperiness (criteria to be researched) (4) Reduction in gravel loss can be obtained with $PF \geq 500$ (5) With $S_p \leq 240$ preferable, this may be specified in project document. (6) $CBR \geq 15$ at 95% Mod. AASHTO compaction and 4 days soaking or otherwise specified in the project specification M Percentage passing by mass of total sample e.g. $M_{26,5} = \% \text{ passing } 26,5 \text{ mm}$ P Percentage passing by mass eg. $P_2 = \% \text{ passing } 2,0 \text{ mm}$ * Cross out whichever option is not applicable or delete if not applicable									
Remarks: Strategic Plan, Extention borrow pits - Sampled by: R.M.G; Date of Sampling: 26/11/2013										Sheet 1 of 1									
Treton Value: N N N N N N N N N N																			

Test Data - Gravel Wearing Course												T-DAT-GWC-E																							
Samples From Borrowpit / Road * (+37,5 mm Aggregate Included / Excluded *)												August 2000																							
Borrowpit at km: BP DR02310/km28,9				Distance from Road (km): 0,02L				Property: Helvetia																											
Particulars of Test Points, Samples ect.																																			
Road Section		From : to:																																	
Test Point (Number / at km *)		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> </table>													1	2	3	4	5	6	7	8	9	10											
1	2	3	4	5	6	7	8	9	10																										
Sample Number	Field	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>																																	
Laboratory	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>																																		
Depth below Surface m		Col+RMst	Col+RMst	Col+RMst		W Mst	W Mst	W Mst	W Mst	W Mst																									
Description of Material																																			
Treatment of Oversize		In Borrowpit	screen out or crush oversize; too hard for heavy grid rolling																																
Material (+37,5mm)		On Road	remove by hand																																
Sample Identification		N	1	2	3	4	5	6	7	8	9	10																							
Test Results																																			
N	Gradation - % Passing sieves (mm)											Atterberg Constants																							
	75	63	53	37,5	26,5	19,0	13,2	4,75	2,00	0,425	0,075	-0,425	-0,075 <sup>(3)</sup>																						
												LL	PI	LS																					
1	100	100	100	99	98	97	96	81	66	48	22	29,5	12,3	6,0																					
2	100	100	100	99	98	97	96	81	66	48	22	29,5	12,3	6,0																					
3	100	100	100	99	98	97	96	81	66	48	22	29,5	12,3	6,0																					
4																																			
5	95	93	87	79	70	61	50	16	8	4	2	27,6	11,8	5,8																					
6	95	93	87	79	70	61	50	16	8	4	2	27,6	11,8	5,8																					
7	95	93	87	79	70	61	50	16	8	4	2	27,6	11,8	5,8																					
8	95	93	87	79	70	61	50	16	8	4	2	27,6	11,8	5,8																					
9	95	93	87	79	70	61	50	16	8	4	2	27,6	11,8	5,8																					
10																																			
Mean (Total sample) <sup>(1)</sup> M	97	96	92	87	81	75	67	40	30	21	10	28,31	11,99	5,9																					
Gradation -37,5 mm <sup>(2)</sup> P				100	93	86	78	47	34	24	11																								
<b>Oversize Index; Shrinkage Product; Gradation Coefficient; Plasticity Factor</b> <b>CBR and Performance Classification Zone</b>																																			
$I_o = \text{Oversize Index} \quad (\% \text{ retained on } 37,5 \text{ mm of Lot from Mean Value}) = 13,5 \quad \% (\ln / \text{Out}^*)$ <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: Rural Roads <math>\leq 5</math> / Urban Roads <math>0\%</math> / Haul Roads <math>\leq 10\%</math> *</div>																																			
$S_p^{(5)} = \text{Shrinkage Product determined on } -37,5 \text{ mm gradation}^{(2)} = LS_{0,425}(P_{0,425}) = 139,2 \quad \% (\ln / \text{Out}^*)$ <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: Rural/Haul * Roads <math>100 \leq S_p \leq 365</math> / Urban Roads * <math>100 \leq S_p \leq 240</math></div>																																			
$G_c = (P_{26,5} - P_{2,00}) / (P_{4,75} - P_{2,00}) \times 100 = 27,4 \quad \% (\ln / \text{Out}^*)$ Gradation Coefficient determined on -37,5 mm gradation <sup>(2)</sup> <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: <math>16 \leq G_c \leq 34</math></div>																																			
$PF^{(4)} = (LL_{0,425} - PI_{0,425}) / (P_{0,075} - P_{0,425}) = 179,3 \quad \% (\ln / \text{Out}^*)$ Plasticity Factor determined on -37,5 mm gradation <sup>(2)</sup> <div style="border: 1px solid black; padding: 2px; text-align: center;">Specification: <math>PF \geq 500</math></div>																																			
<b>CBR at Spec. Dens.: Spec.<sup>(6)</sup> = 15 @ 95 % MDD (4 days soaking)</b>																																			
N	MDD kg/m <sup>3</sup>	OMC %	CBR at % Compaction				Swell	Durability Test (Venter) - Mudrock																											
			98	95	93	90	100 % Comp.	N	5 Cycles Weathering		DMI																								
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N			N			N			N			N			N			N																	
Sheet 1 of 1																																			

