# VERIFICATION PAGE

TITLE: GEOTECHNICAL INVESTIGATION OF THE CONSTRUCTION SITE FOR ATDC DAM, ROAD AND BORROW PIT, IN FREE STATE PROVINCE.

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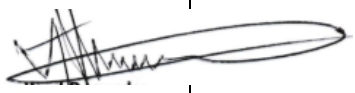
| Field Work and Author by | BSc Geology and Engineering Advanced Earth Science<br>(WITS UNIVERSITY.)<br>Honours Geology<br>(PRETORIA UNIVERSITY.)<br>Certificate Microsoft Projects (Instite)<br>Certificate of Project Management.<br>(Instite)<br>Certificate of Archview GIS. (Gims)<br>Havard University (Still on halt) | Lucas Radebe |  | 26th February 20201. |
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## EXECUTIVE SUMMARY

Mbani Projects Pty (Ltd) is appointed by Department of Agriculture in Free State Province to conduct geotechnical investigation to establish whether the ground conditions within the vicinity of ATDC Dam are suitable for development of a retain dam and the access road.

This report represents the results of the geotechnical investigation undertaken to establish whether the above-mentioned site is suitable for the proposed project from various dimensions. The geotechnical investigation including test pits, soil stability checks and DCP tests is conducted to ensure that the proposed developments and related infrastructure is catered for.

The ground surface or top soil of ATDC Road and Dam Site is dominated by homogeneous alluvial SILT soil layer throughout. The latter is underlain by the sedimentary rock mainly MUDSTONE, which occurs as a bed rock.

The ground surface of the Borrow pits 1, 2, 3 and 4 is mainly dominated by outcrop of MUDSTONE, subordinate SANDSTONE and DOLERITE dykes. No test pit successfully excavated within borrow pit sites due to rock outcrops throughout.

The MUDSTONE occurs in abundant for subbase and wearing course for the road. Like. The weathered MUDSTONE which occurs as a fine to very course debris material, occurs. This is the available material with adequate PI for the core of the Dam.

The modus operandi of the geotechnical investigation further follows the guide lines as laid down by COLTO in order to maintain good practice.

The methodology of this investigation includes desktop, site walkover, test pits, DCP tests, soil profiling, soil samples for laboratory analysis, fieldwork and observations.

The geotechnical investigation indicates that the ground conditions of ATDC Site are suitable for the above-mentioned project from various dimensions, provided the recommendations of this report are adhere to and implemented.

# 1. INTRODUCTION

## 1.1. Background and Terms of Reference

Mbani Projects Pty (Ltd) is appointed by Department of Agriculture in Free State Province to conduct geotechnical investigation to establish whether the ground conditions within ATDC Site are suitable for development of a retain dam and the access road from various dimensions, inter alia, soil stability checks, in an effort to ensure that the proposed developments and related infrastructure are catered for.

## 1.2. Objectives.

The objective of this investigation is to conduct the geotechnical investigation within the construction site and locate quarry/borrow pit site for fill material.

# 2. THE LOCALITY OF THE STUDY AREA.


Figure 1. The locality of the proposed construction site (road, dam) and configuration of borrow pits.

# 3. THE DESCRIPTION OF THE SITE.

The proposed construction site (road and dam) is pretty much located within low lying areas as opposed to the upper located lying areas of borrow pits. The upper lying areas of borrow pits are hills characterized of more resistance rocks DOLERITE dykes, subordinates SANDSTONES as well as MUDSTONE rock.

## 4. METHODOLOGY.

The methodology of this investigation includes desktop, site walkover, fieldwork, observations, test pits, DCP tests, soil profiling and soil samples for laboratory analysis.

## 5. GENERAL GEOLOGY AND SOILS.

The general geology of the study area is mainly dominated by alluvial SILT sediments, weathered MUDSTONE, layered MUDSTONE, intrusive igneous rock DOLERITE. The alluvial SILT sediments dominate low lying areas. The latter constitute the Balfour Formation of the Karoo Supergroup.

The **borrow pit sites** are dominated by the greenish to greyish blue MUDSTONE at some instances occur in alternating layers with further lithified reddish brown SHALE rock. They are intruded by DOLERITE sills and dykes. The latter forms hills due to their more resistance towards weathering.

The **dam and road access site** is mainly dominated by alluvial SILT with many fines occurs along the embankments of the stream throughout the proposed **dam** and **road** locality. The MUDSTONE forms the impervious bed rock of the stream and also within the proposed locality of the **dam.**

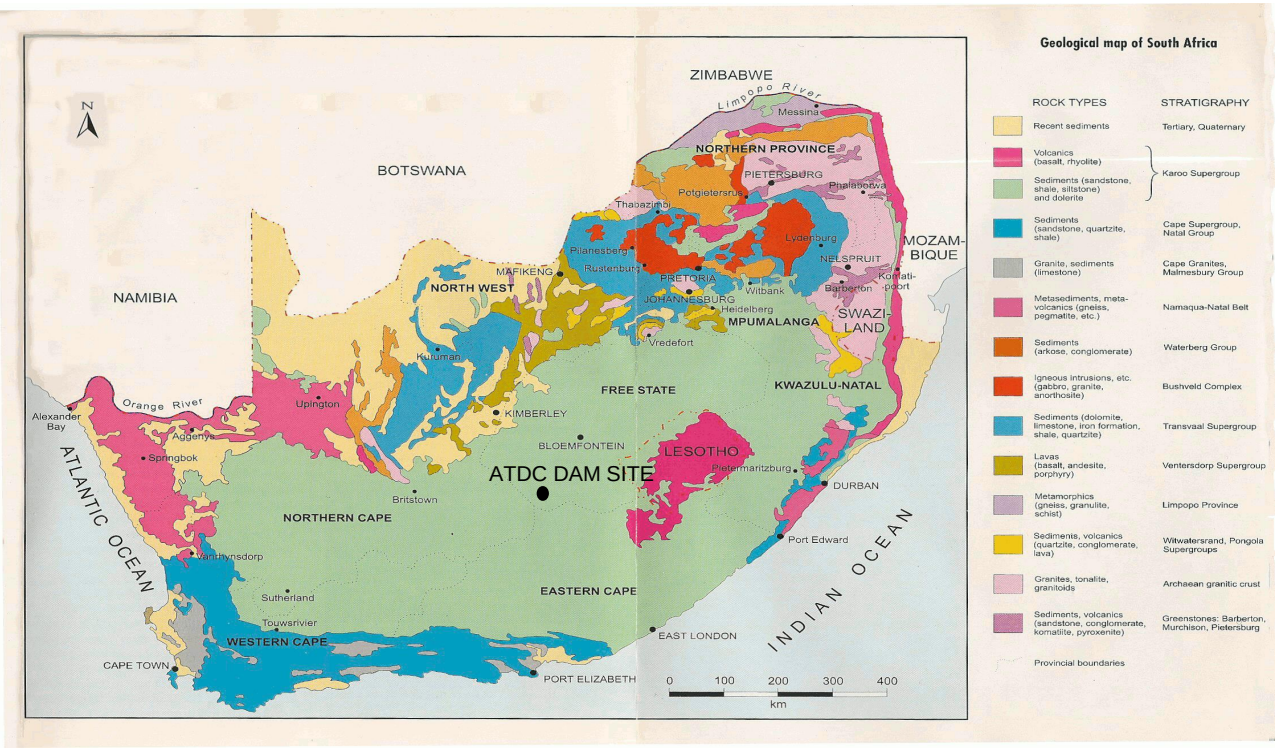


**Figure 2.** Indicates the locality of the study area within geology of South Africa.

## 6. GEOLOGY OF SOUTH AFRICA, COUNCIL OF GEOSCIENCE.

Figure 3.Indicates the locality of the study area within geology of South Africa, Council of GeoScience.

## 7. CLIMATE

The site falls within the region characterized by the summer rainfalls with thunderstorms. The annual rain fall figure is between 250 mm and 500 mm according to Vegetation of Southern Africa – by R.M. Cowling, D.M. Richardson and S.M. Pierce. Most rainfall occurs mainly during summer. Lowest rainfall (2mm) in June and highest (66 mm) in January.

The monthly distribution of average daily maximum temperature shows that the average midday temperatures ranges from 16°C in June to 29.2°C in January. The coldest in July, the mercury drops to 0°C on average during the night (SA Explorer 2013)

## 8. GENERAL GEOTECHNICAL CONDITIONS.

The geotechnical investigation has been conducted extensively including soil properties that could impose geotechnical constraints on the proposed development. The mitigations are provided per prevailing geotechnical constraints.

## 9. THE CONFIGURATION OF THE LAND PORTIONS GEOTECHNICALLY INVESTIGATED.

The entire terrain is dominated by MUDSTONE rock (referred herein as SHALE by laboratory results report), subordinate SANDSTONE ROCK, and sediments, which includes alluvial SILT material and weathered debris from weathered MUDSTONE (referred herein as weathered SHALE by laboratory results report).


| BORROW PIT NO. | | CO-ORDINATES | |
|---|---|---|---|
| 1. | BORROW 1. | 30°37'37.52"S | 25°28'27.48"E |



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| | | | |
|---|---|---|---|
| **2.** | **BORROW 2.** | 30°37'31.12"S | 25°28'50.94"E |
| **3.** | **BORROW 3.** | 30°36'38.78"S | 25°28'59.83"E |
| **4.** | **BORROW 4.** | 30°36'40.72"S | 25°28'29.93"E |
| **5.** | **ROAD.** | 30°37'35.39"S | 25°28'9.59"E |
| **6.** | **DAM.** | 30°37'36.98"S | 25°28'9.35"E |

Figure 4. The configuration of the various land portions and their localities, by GPS co-ordinate, within the prevailing topography around the proposed construction site.

## 10. GENERAL FINDINGS/RESULTS.

### 10.1. FIELDWORK.

The fieldwork indicated the insitu soils is not good for construction. The latter provided the guide lines about the design, construction and borrow pit material options for the above proposed project.

Observations during field work includes:

- The stream straddles the embankments of alluvium SILT soil.
- The geomorphology has defined the shape of the study area and rock outcrops.
- Rock outcrop along the river bed is an impervious MUDSTONE also referred to as SHALE in a laboratory result of which is more or less the same.
- The prevailing slopes of the study area.
- Geotechnical constraints within the study area.

Mitigations of the geotechnical constraints are further provided in this report.

#### 10.1.1. Sampling.

- The total number of ten (10) test pit are excavated. The total number of ten DCP test are also conducted adjacent to the excavated test pit. Test pit and DCP test locality/ies are marked by GPS coordinate.
- Three (3) test pit successfully excavated to 3000 mm depth without refusal within the site of the proposed dam and the access road.
- Seven (7) test pit excavated to shallower refusal within all borrow pits due to boulders and rock outcrops.
- All the total of ten test pits are profiled according to Jennings et al.
- The representative rock and soil sample are taken to the laboratory for engineering soil properties analysis.
- Top soil samples are discarded and regarded as a spoiled material.

### 10.2. THE SITE/S.

All sites dam, access road, borrow pits share common geology. The primary rocks and soils throughout all the above-mentioned sites include: MUDSTONE, subordinate SANDSTONE and alluvial SILT, the latter intruded by dolerite dykes at some instances. This is the Balfour Formation of the Karoo Supergroup.

### 10.2.1. The construction site.


| **PERIMETER.** | **CO-ORDINATES** | |
|---|---|---|
| CORNER 1. | 30°37'36.65"S | 25°28'10.28"E |
| CORNER 2. | 30°37'36.32"S | 25°28'9.76"E |
| CORNER 3. | 30°37'33.46"S | 25°28'9.80"E |
| CORNER 4. | 30°37'33.45"S | 25°28'9.45"E |
| CORNER 5. | 30°37'36.38"S | 25°28'9.25"E |
| CORNER 6. | 30°37'37.26"S | 25°28'8.78"E |
| CORNER 7. | 30°37'37.64"S | 25°28'8.94"E |
| CORNER 8. | 30°37'37.66"S | 25°28'10.29"E |
| **TEST PIT** | **CO-ORDINATES** | |
| TEST PIT 1. | 30°37'36.87"S | 25°28'9.58"E |
| TEST PIT 2. | 30°37'35.82"S | 25°28'9.56"E |
| TEST PIT 3. | 30°37'34.40"S | 25°28'9.59"E |
| **DCP TEST** | **CO-ORDINATES** | |
| DCP TEST 1. | 30°37'36.79"S | 25°28'9.58"E |
| DCP TEST 2. | 30°37'35.67"S | 25°28'9.50"E |
| DCP TEST 3. | 30°37'34.19"S | 25°28'9.57"E |

Figure 5. Indicates the localities of DCP and PIT TEST of the proposed road and dam construction.

The **construction site** comprises of the proposed **dam** and **access road**. The test pits are excavated within the embankments as well as longitudinally along the proposed access road. All excavated test

pits are profiled according to Jennings et al. Soil samples are taken to the laboratory for further engineering soil properties analysis.

#### 10.2.1.1. Road.

- The **wearing course** and or the **crown** requires material with some binding effect.
  - The gravel derived from MUDSTONE rock will serve the purpose.
  - Therefore, exploration for MUDSTONE rock commenced and located.
  - The borrow pit for MUDSTONE rock is sampled and taken to the laboratory analysis for the engineering soil properties including the required binding effect, PI content.
- The **subbase**, shale crushed to required engineering size can serve the purpose, provided the PI does not exceed the required engineering property standards.

##### 10.2.1.1.1. Geotechnical Constraints.

- Insitu soil material not good for construction.
- The alluvial SILT soil will slightly change its volume subject to the fluctuation of moisture content.

##### 10.2.1.1.2. Mitigations

- Therefore, cut and dispose the Insitu material, rip and compact at least 92% ASSHTO.
- Fill in with borrow pit material for subbase and crown with wearing course material containing low PI for binding effect.

#### 10.2.1.2. Dam.

- The construction of the dam requires the core of an impervious layer of which is CLAY as well as retain walls with conducive pH as well as constituent rock minerals for aquatic ecosystem including fish.
  - Therefore, exploration for CLAY soil and SANDSTONE rock commenced and located.
- The fieldwork indicated and confirmed the impervious MUDSTONE rock naturally occurring as the bed rock of the stream. The MUDSTONE occurring as a bed rock of the stream is geologically confirmed to be identical to the surrounding MUDSTONE, Balfour Formation of the Karroo Supergroup.
- The embankments comprise alluvial SILT material.
  - The embankments (alluvial SILT) are more permeable as opposed to the impermeable bed rock (MUDSTONE), as a results stream flow skim the surface of the bed rock, MUDSTONE.

#### 10.2.1.3. Geotechnical Constraints.

- Insitu soil material not good for construction.

#### 10.2.1.4. Mitigations

- Import fill in material from borrow pits.

- The CLAY core of the dam should be built directly on top/incotact with the naturally occurring bed rock of the stream which the MUDSTONE bed rock.

**NB** No rock blasting required and recommended during the construction of the road and the dam, the blasting will compromise the impervious layer of the stream bed rock.

### 10.2.2. The borrow pit sites.

The red coloured boundary demarcation of each borrow pit does not indicate the extent limit of the borrow pit material but locality. The borrow pit material extends beyond the red coloured boundary demarcations.

All **borrow pits** are dominated by rock out crops. Excavating 3 000 mm deep test pit has virtually been impossible except through blasting. The representative rocks samples are chipped and broken from the outcrop mother rock utilizing a TLB and taken to the laboratory analysis for further engineering soil properties.

#### 10.2.2.1. Borrow pit 1.


| PERIMETER. | CO-ORDINATES | |
|---|---|---|
| CORNER 1. | 30°37'36.54"S | 25°28'27.64"E |
| CORNER 2. | 30°37'37.58"S | 25°28'26.52"E |
| CORNER 3. | 30°37'38.74"S | 25°28'27.10"E |
| CORNER 4. | 30°37'39.06"S | 25°28'29.23"E |
| CORNER 5. | 30°37'37.51"S | 25°28'28.67"E |
| **PIT TEST** | **CO-ORDINATES** | |

| | | |
|---|---|---|
| PIT TEST 1. | 30°37'38.16"S | 25°28'27.26"E |
| **DCP TEST** | **CO-ORDINATES** | |
| DCP TEST 1. | 30°37'37.97"S | 25°28'27.24"E |

Figure 6. Indicating the locality by GPS co-ordinate of borrow pit 1 as well as points of the pit test and DCP test.

Picture 1. Illustrates SANDSTONE boulders within borrow 1.

The SANDSTONE for the retain walls of the dam has been allocated within borrow pit 1 by GPS coordinate 30°37'37.62"S 25°28'27.88"E.

#### 10.2.2.1.1. Geotechnical Constraints.

- None.
- No selective blasting and excavation required, i.e. it is homogeneously SANSTONE rock throughout the borrow pit.

#### 10.2.2.1.2. Mitigations.

- None.
- The pH content fall within the good range for the aquatic ecosystem including fish, see laboratory results.

### 10.3. Borrow pit 2.


| PERIMETER. | CO-ORDINATES | |
|---|---|---|
| CORNER 1. | 30°37'29.30"S | 25°28'53.30"E |
| CORNER 2. | 30°37'31.57"S | 25°28'47.68"E |
| CORNER 3. | 30°37'32.93"S | 25°28'47.83"E |
| CORNER 4. | 30°37'30.97"S | 25°28'54.51"E |
| **PIT TEST** | **CO-ORDINATES** | |
| PIT TEST 1. | 30°37'31.78"S | 25°28'49.19"E |
| PIT TEST 2. | 30°37'30.78"S | 25°28'52.04"E |
| **DCP TEST** | **CO-ORDINATES** | |
| DCP TEST 1. | 30°37'31.53"S | 25°28'48.91"E |
| DCP TEST 2. | 30°37'30.59"S | 25°28'52.54"E |

Figure 7. Indicating the locality by GPS co-ordinate of borrow pit 2 as well as points of the pit test and DCP test.

| | |
|---|---|
|  | This is pit test 1(GPS coordinate 30°37'31.78"S 25°28'49.19"E) within borrow pit 2.<br><br>It illustrates the MUDSTONE rock occurring in reddish brown to greyish blue.<br><br>It has been earmarked for the aggregate for the road subbase construction as well as the wearing course or crown of the road.. |

Picture 2. Pit test 1 (GPS coordinate 30°37'31.78"S 25°28'49.19"E) within the borrow 2.

| | |
|---|---|
|  | This is pit test 2 (GPS coordinate 30°37'30.78"S 25°28'52.04"E) within the borrow 2.<br><br>It illustrate the alternative material for CLAY required for the core of the dam construction.<br><br>It is the debris of the weathered MUDSTONE with many fines.<br><br>Alternatively the MUDSTONE from this borrow pit can be crushed for CLAY material. |

Picture 3. Pit test 2 (GPS coordinate 30°37'30.78"S 25°28'52.04"E) within the borrow 2.

## 10.4. Borrow pit 3.


| **PERIMETER.** | **CO-ORDINATES** | |
|---|---|---|
| CORNER 1. | 30°36'38.27"S | 25°29'1.35"E |
| CORNER 2. | 30°36'36.36"S | 25°28'55.94"E |
| CORNER 3. | 30°36'39.93"S | 25°28'55.19"E |
| CORNER 4. | 30°36'41.12"S | 25°29'1.74"E |
| **PIT TEST** | **CO-ORDINATES** | |
| PIT TEST 1. | 30°36'40.46"S | 25°28'59.43"E |
| PIT TEST 2. | 30°36'39.06"S | 25°29'0.22"E |
| **DCP TEST** | **CO-ORDINATES** | |
| DCP TEST 1. | 30°36'38.90"S | 25°29'0.11"E |
| DCP TEST 2. | 30°36'37.80"S | 25°28'56.41"E |

Figure 8. Indicating the locality by GPS co-ordinate of borrow pit 3 as well as points of the pit test and DCP test.


This is test pit 1 ( by GPS coordinate 30°36'40.46"S 25°28'59.43"E) within borrow pit 3.

This borrow pit has been selectively excavated, previously.

The readily excavatable material is mainly REGOLITH.

The REGOLITH is mainly the intensely weathered MUDSTONE, traces of SANDSTONE and DOLERITE embedded in the topsoil matrix.

The top soil matrix makes this material not good for construction.

Unweathered rock, MUDSTONE, need to be drilled and blastered.

Picture 4. Illustrates test pit 1 ( by GPS coordinate 30°36'40.46"S 25°28'59.43"E) within borrow pit 3.

This is test pit 2 (by GPS coordinate 30°36'39.06"S 25°29'0.22"E) within borrow pit 3.

This borrow pit has been selectively excavated, previously.

The readily excavatable material is mainly REGOLITH.

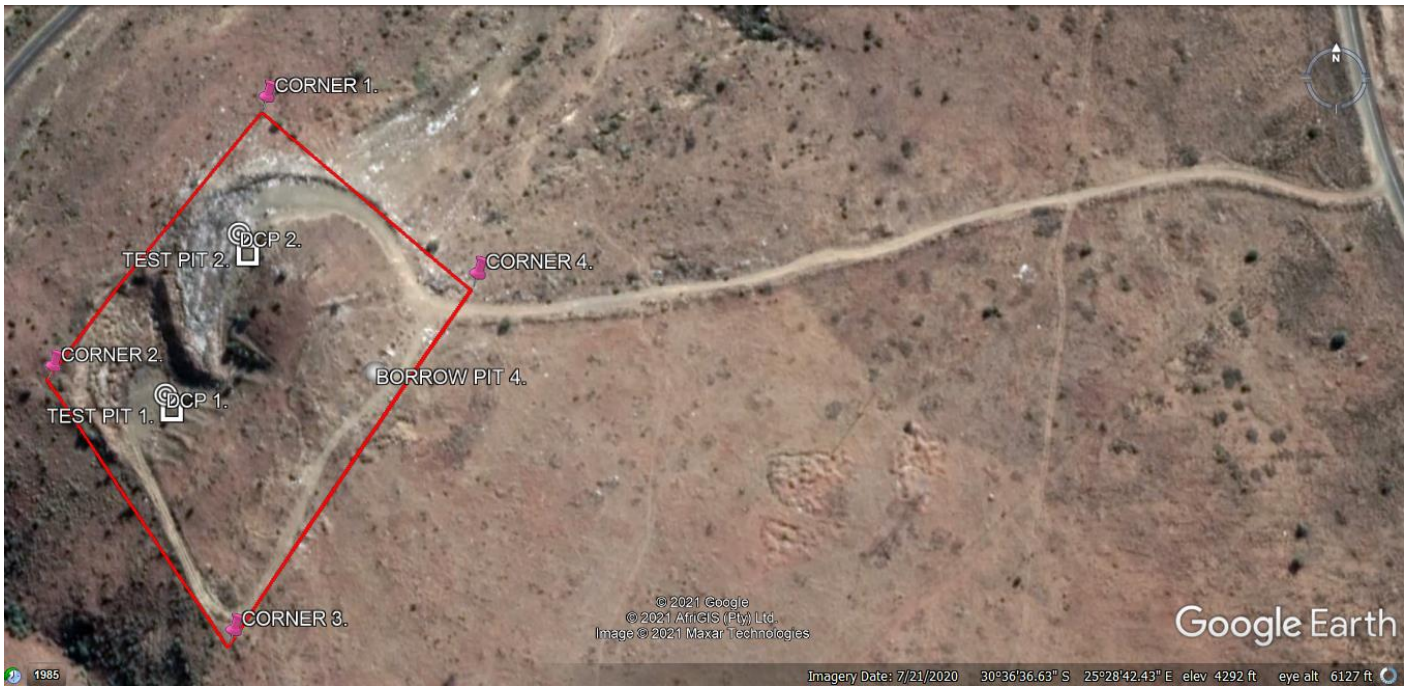
The REGOLITH is mainly the intensely weathered MUDSTONE, traces of SANDSTONE and DOLERITE embedded in the topsoil matrix.

The top soil matrix makes this material not good for construction.

Unweathered rock, MUDSTONE, need to be drilled and blastered.

Picture 5. test pit 2 (by GPS coordinate 30°36'39.06"S 25°29'0.22"E) within borrow pit 3.

## 10.5. Borrow pit 4.




| **PERIMETER.** | **CO-ORDINATES** | |
|---|---|---|
| CORNER 1. | 30°36'35.99"S | 25°28'33.10"E |
| CORNER 2. | 30°36'39.74"S | 25°28'28.92"E |
| CORNER 3. | 30°36'43.64"S | 25°28'32.45"E |
| CORNER 4. | 30°36'38.37"S | 25°28'36.70"E |
| **PIT TEST** | **CO-ORDINATES** | |
| PIT TEST 1. | 30°36'40.20"S | 25°28'31.32"E |
| PIT TEST 2. | 30°36'37.86"S | 25°28'32.68"E |
| **DCP TEST** | **CO-ORDINATES** | |
| DCP TEST 1. | 30°36'39.97"S | 25°28'31.20"E |
| DCP TEST 2. | 30°36'37.55"S | 25°28'32.50"E |

Figure 9. Indicating the dimensional boundary by GPS co-ordinate of borrow pit one as well as points of the pit test and DCP test.

This is test pit 1 (by GPS coordinate 30°36'40.20"S 25°28'31.32"E) within borrow pit 4.

This borrow pit has been selectively excavated, previously.

The readily excavatable material is mainly REGOLITH.

The REGOLITH is mainly the intensely weathered MUDSTONE, traces of SANDSTONE and DOLERITE embedded in the topsoil matrix.

The top soil matrix makes this material not good for construction.

No rock dust matrix observed, but mainly top soil present.

Unweathered rock, MUDSTONE, need to be drilled and blasted in order to be excavated.

*Picture 6.* llustrates test pit 1 (by GPS coordinate 30°36'40.20"S 25°28'31.32"E) within borrow pit 4.

This is test pit 2 (by GPS coordinate 30°36'37.86"S 25°28'32.68"E) within borrow pit 3.

This borrow pit has been selectively excavated, previously.

The readily excavatable material is mainly REGOLITH.

The REGOLITH is mainly the intensely weathered MUDSTONE, traces of SANDSTONE and DOLERITE embedded in the topsoil matrix.

The top soil matrix makes this material not good for construction.

No rock dust matrix observed, but mainly top soil present.

Unweathered rock, MUDSTONE, need to be drilled and blasted in order to be excavated.

Picture 7. test pit 2 (by GPS coordinate 30°36'37.86"S 25°28'32.68"E) within borrow pit 3.

## 10.6. TEST PIT/S.

### 10.6.1. TEST PIT WITHIN CONSTRUCTION SITE (DAM AND THE ACCESS ROAD)

**Table 1.** Summary of the test pit, soil profiling and interpretation of the site.

| TEST PIT | DEPTH (mm) | SOIL TYPE | GROUND WATER SEEPAGE | SIDE WALL STABILITY | SOIL PROPERTIES |
|---|---|---|---|---|---|
| 01 | 0 - 550 | Top soil. Alluvial SILT. | No water | Stable | Colloidal top soil. Alluvial SILT. |
| | 550 – 3000 No Refusal. | Alluvial SILT. | No water | Stable | Alluvial SILT |
| 02 | 0 - 650 | Top soil. Alluvial SILT. | No water | Stable | Colloidal top soil. Alluvial SILT. |
| | 650 – 3000 No Refusal. | Alluvial SILT. | No water | Stable | Alluvial SILT. |
| 03 | 0 - 620 | Top soil. Alluvial SILT. | No water | Stable | Colloidal top soil. Alluvial SILT. |
| | 620 – 3000 No Refusal. | Alluvial SILT. | No water | Stable | Alluvial SILT. |

The test pit profiles and photographs are attached as appendix C

- Test pit reveals that alluvial SILT within the embankments and along the longitudinal section of the proposed access road is a transported alluvial SILT material.
  - The alluvial SILT material contains many fine materials with very low presence of CLAY.
  - The side walls of all the excavated test pits exhibits stable side wall throughout, indicating the presence of some binding factor, PI, occurring as matrix around SILT particles.
  - The top soil is dry to slightly moist with depth.
  - No ground water seepage intersected with any of the excavated test pit.
  - All excavated test pits exhibits similar soil properties throughout the proposed dam and road construction site.
  - The representative soil samples of the above-mentioned soil layer are taken from the site for laboratory analysis.
  - Soil profiles are attached as appendix C.

## 10.7. GEOHYDROLOGY

The MUDSTONE along the river bed is the main aquiclude rock layer observed. Whilst the river banks are the main aquifers observed. Ground water may exist below the current aquiclude MUDSTONE occurring along the river bed.

The water that could be intersected with the test pits could be the high water table level and or water seepage from capillary water.

The test pit excavation intersected neigther water table nor capillary water.

**NB** No ground water seepage intersected with any of the test pit.

## 10.8. SEISMIC ACTIVITY.

There are no know seismic within the study area. The geomorphology and the geology depicts more stable grounds for the pond of 22 214 m³, unless during unforeseen circumstances or catastrophic event similar to earth quake or mining activities i.e. bastings.

## GENERAL ANALYSIS AND INTERPRETATION OF THE DCP TEST RESULTS.

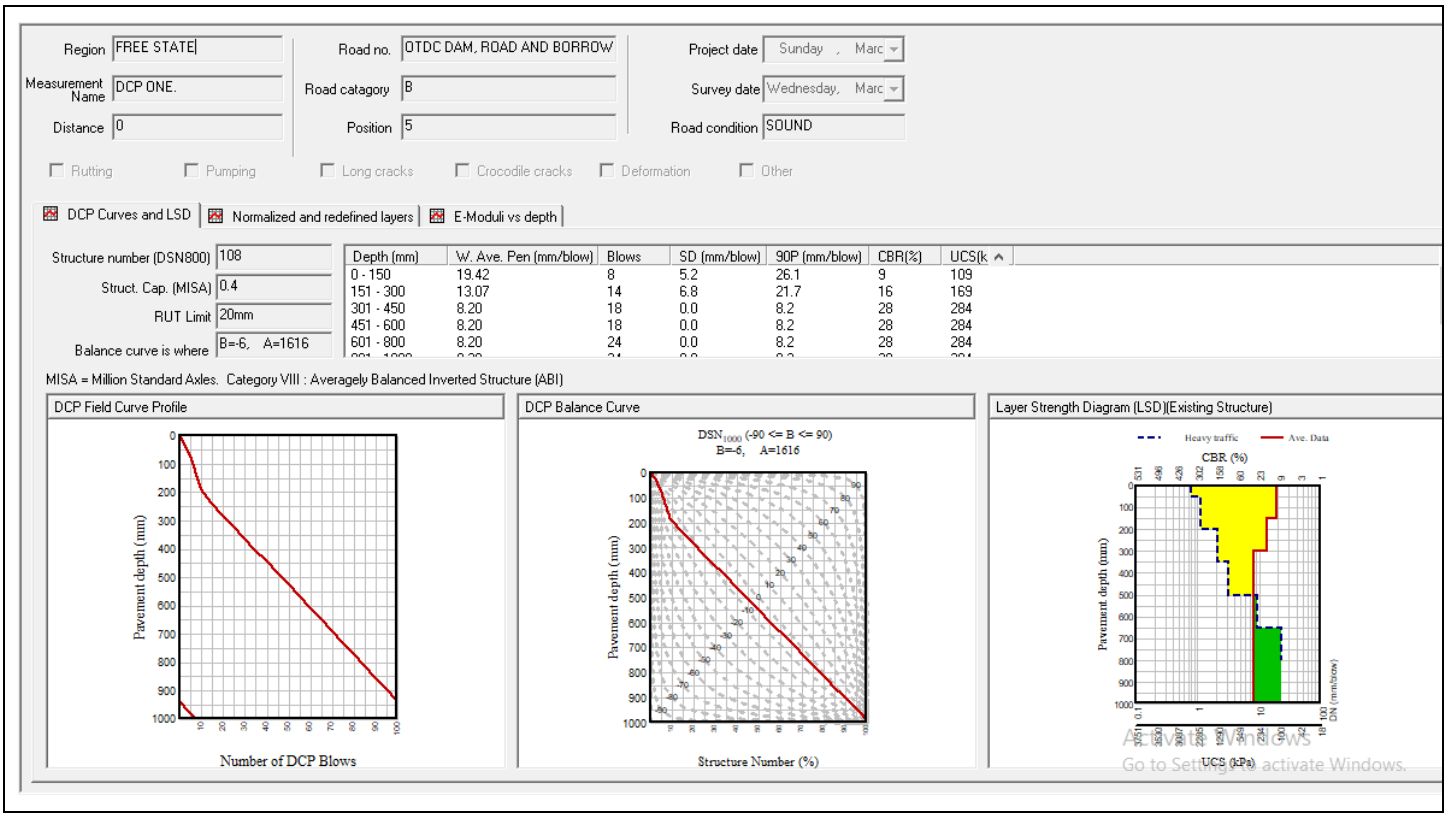



Figure 10 The summary of the representative DCP test results and interpretation within the construction site.

The DCP test further depicts homogeneous alluvial SILT, i.e. no boulders or rocks that disturbed the penetration within the construction site. See the above figure for further engineering properties.

DCP test results in appendix C.

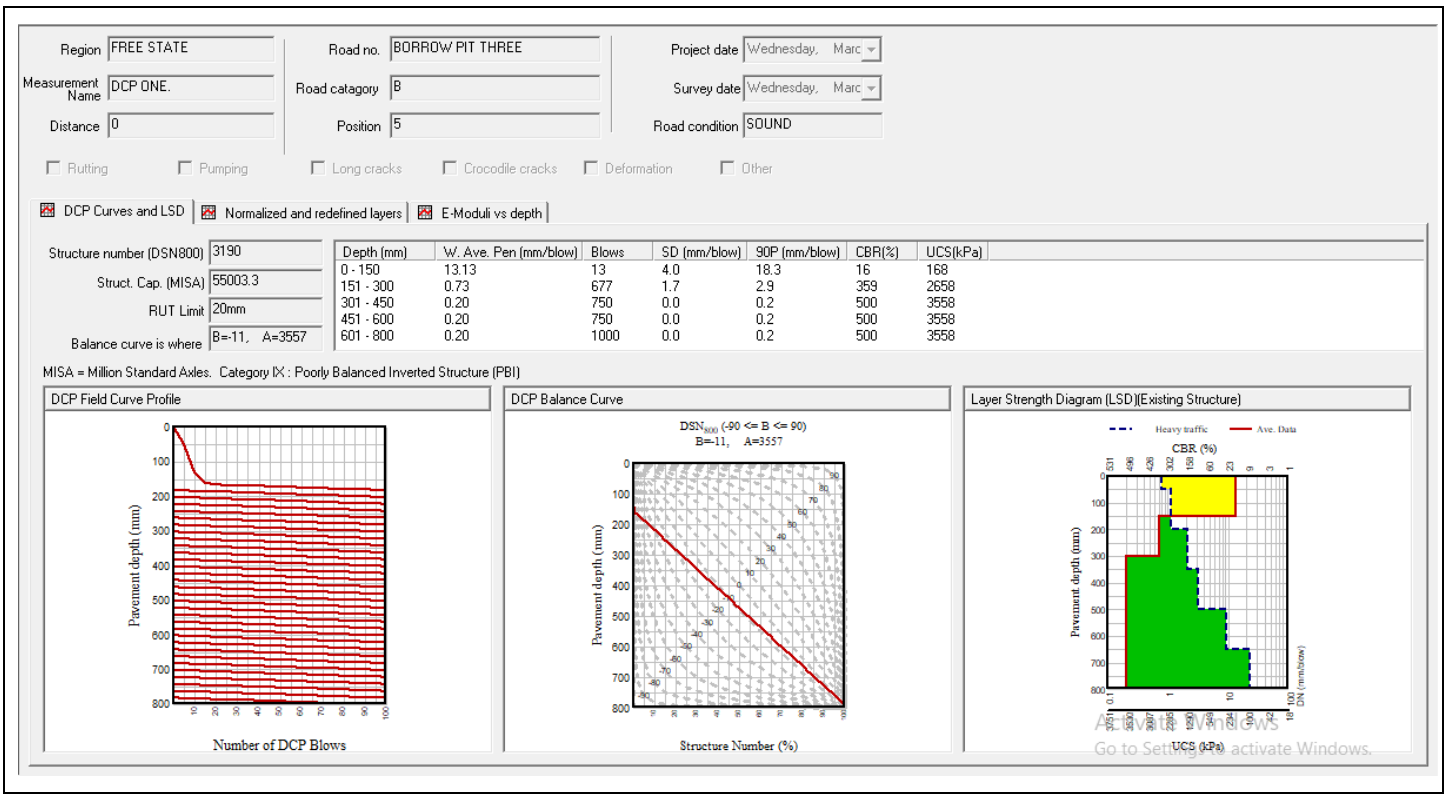



Figure 11. The summary of the representative DCP test results and interpretation within borrow pit.

The DCP test penetrated top soil and immediately intersect refusal at 189 mm due to the bed rock.

NB DCP TEST 2 WWITHIN BORROW PIT 2, 3 AND 4 IS DISCARDED, DUE TO ROCK OUTCROPS.

**10.9.** The proposed Dam Locality.

*Table 2. For Road and Dam Site. Engineering geological land use classification (Price and Bester. 1981).*

| TOTAL RATING | LAND-USE POTENTIAL | ENGINEERIN"G GEOLOGICAL QUALIFICATION |
|---|---|---|
| 91 -100 | Very good | Generally acceptable for development |
| 71 - 90 | Good | Acceptable for development |
| 41 · 70 | Fair | Terrain economically viable with further investigation |
| 21 ·40 | Poor | Development uneconomically viable analysis of the economic implications required before any further investigation. |
| < 21 | Very poor | Totaly unacceptable for development. If developed then at extremely high cost. |

The field observations analysis, tests and laboratory results indicate:

- The construction site is a good potential land use (Price and Bester. 1981).
- The construction site rates 71 - 90 total rating (Price and Bester. 1981).
- The engineering geological qualification confirms the site to be acceptable for development (Price and Bester. 1981).
-

Table 3. Typical strength values for rocks (after Goodman, 1980)

| ROCK | COHESSION (MPa) | FRICTIONAL ANGLE (°) | RANGE OF CONFINING PRESSURE (MPa) |
|---|---|---|---|
| **Muddy Shale** | 38.4 | 14.4 | 0-200 |
| **Sandstone** | 27.2 | 27.8 | 0-200 |

Table 4. *For Road and Dam Site*. Geotechnical classification for urban development.

| CONSTRAINT | | MOST FAVOURABLE | INTERMEDIATE | LEAST FAVOURABLE |
|---|---|---|---|---|
| A | Collapsible soil | Any collapsible horizon or consecutive horizons less than 750 mm in depth. | Any collapsible horizon or consecutive horizons more than 750 mm in depth. | A least favourable situation for this constraint does not occur. |
| B | Seepage | Permanent or perched water table more than 1,5 m below ground surface. | Permanent or perched water table less than 1,5 m below ground surface. | Swamps and marshes. |
| +C | Active soil | Low predicted soil-heave potential.* | Moderate predicted soil heave potential. | High predicted soil-heave potential. |
| D | Highly compressible soil | Low expected soil compressibility.* | Moderate expected soil compressibility. | High expected soil compressibility. |
| E | Erodability of soil | Low. | Intermediate. | High. |
| F | Difficulty of excavation to 1,5 m depth | Scattered or occasional gravel less than 10% of the total volume. | Rock between 10 and 40% of the total volume. | Rock more than 40% of the total volume. |
| G | Undermined ground | Undermining at a depth greater than 100 m below the surface (except where total extraction mining has not occurred). | Old undermined areas to a depth of 100 m below the surface where slope closure has ceased. | Mining within 100 m of surface or where total extraction mining has taken place. |
| H | Instability in areas of soluble rock | Possibly unstable. | Probably unstable. | Known sinkholes and dolines. |
| I | Steep slopes | Between 2 and 6 degrees (all regions). | Slopes between 6 and 18 degrees and less than 2 degrees (Natal and Western Cape). Slopes between 6 and 12 degrees and less than 2 degrees (all other regions). | More than 18 degrees (Natal and Western Cape). More than 12 degrees (all other regions). |
| J | Areas of unstable natural slope | Low risk. | Intermediate risk. | High risk (especially in areas subject to seismic activity). |
| K | Areas subject to seismic activity | 10% probability of an event less than 100 cm/s2 within 50 years. | Mining-induced seismic activity more 100 cm/s2. | Natural seismic activity more than 100 cm/s2. |
| L | Areas subject to flooding | A “most favourable” situation for this constraint does not occur. | Areas adjacent to a known drainage channel or floodplain with slope less than 1%. | Areas within a known drainage channel or floodplain. |

*Table 5. GRAVEL WEARING COURSE (after Goodman, 1980)*

| GRAVEL WEARING COURSE (after Goodman, 1980) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LAYER THICKNESS (mm) | DESCRIPTION | MAX-SIZE (mm) | OVERSIZE INDEX (10) (MAX), 10% | % COMP AASHTO | GRADING COEFFICIENT (Gc) | MAX. P.I. | SHRINKAGE PRODUCT (Sp) | MIN CBR AT % MOD ASSHTO |
| 200 | GRAVEL WEARING COURSE | 37.5 | C 10% | 92 | 16-34 | MIN P.I= 6 | 100-240 | >15 @ 92% |

**Table 6.** Summary of the laboratory results.

| **BORROW PIT 2.** | **SOIL/GRAVEL TYPE (WEARING COURSE AND SUBBASEE MATERIAL)** | **EXPANSIVE** | **LINEAR SHRINKAGE (%)** | **PLASTIC INDEX (PI)** |
|---|---|---|---|---|
| **TEST PIT 1.** | SHALE/MUDSTONE<br>(For subbase) | LOW | 4.7 | 9 |
| **TEST PIT 2.** | WEATHERED SHALE/MUDSTONE<br>(For wearing course) | LOW | 3.9 | 8 |

Test pit coordinates, see appendix C.
Detailed laboratory results, see appendix B.

*Table 7. Classification of the material for machine excavation (1200 D).*

| CLASSIFICATION | DESCRIPTION |
|---|---|
| NON-RESTRICTED EXCAVATION (within the Dam and Road proposed locality) | |
| Soft<br><br>Within a proposed construction site of the Dam and the access road. | Material can be efficiently removed or loaded, without prior ripping, by any of the following plant: |
| | (A) The bulldozer or a tract type front end loader having an approximate mass of 22 tonne and a fly wheel power of 145 kW. |
| | (B) A tracor scraper until having an approximate mass of 28 tonne and fly wheel power of 245 kW, pushed during loading by a bulldozer equivalent to that described above. |
| RESTRICTED EXCAVATION (within all borrow pit) | |
| Hard rock.<br><br>Within all Borrow pits, i.e. 1, 2, 3, and 4. | The material cannot be removed without blasting or wedging and splitting. |
| | The hard rock is intersected 150mm meters below ground level on site. |

Table 8. Geological classification of the site for urban development.

| GEOTECHNICAL CONSTRAINTS | ASSOCIATED PROBLEMS |
|---|---|
| BORROW PIT 2.<br>Weathered SHALE/MUDSTONE.<br>for "CLAY" material. | Heaving clay: The amount of expansion in millimeter (expressed as top soil heave) that can be expected when the moisture in the soil changes, causing vertical heave and differential movement that leads to structural damage. |

**Table 9.** ATDC dam and road access, Unified Soil Classification System (USCS).

| **Soil Description** | **Cohesion KPa** | **Frictional Angle** |
|---|---|---|
| SILT | 0 | 33 |
| SILTY SAND | 0 | 34 |
| SILTY SAND with many fines | 0 | 34 |

Figure 12. Borrow pit aggregate MUDSTONE rock, Unified Soil Classification System (USCS)

| **USCS Soil Class** | **Soil Description** | **Cohesion Kpa** | **Frictional Angle** |
|---|---|---|---|
| GC-CL | MUDSTONE gravel with many fines | 3 | 29 |
| GC | MUDSTONE gravel | 0 | 34 |

**Table 10. DAM AND ROAD** Site class designation, (Watermeyer and Tromp, 1992 and the joint structural engineering).

| **TYPICAL FOUNDING MATERIAL** | **CHARACTER OF FOUNDING MATERIAL** | **EXPECTED RANGE OF TOTAL SOIL MOVEMENT (mm)** | **ASSUMED DIFFERENTIAL MOVEMENT (% OF TOTAL)** | **CITE CLASS DESIGNATION** |
|---|---|---|---|---|
| Silty sands, sands, sandy and gravel soils. | compressible and potentially collapsible soils. | <5 | 75% | C |
| | | 5 to 10 | 75% | C1 |
| | | >10 | 75% | C2 |

Table 11. BORROW PIT 2, Core of the dam material weathered MUDSTONE, Site class designation, (Watermeyer and Tromp, 1992 and the joint structural engineering).

| **TYPICAL FOUNDING MATERIAL** | **CHARACTER OF FOUNDING MATERIAL** | **EXPECTED RANGE OF TOTAL SOIL MOVEMENT (mm)** | **ASSUMED DIFFERENTIAL MOVEMENT (% OF TOTAL)** | **CITE CLASS DESIGNATION** |
|---|---|---|---|---|
| Fine grained soils with moderate to very high plasticity (clays, silty clays, clayey silts and sandy clays) | EXPANSIVE | <7.5 | 50% | H |
| | | 7,5- 15 | 50% | H1 |
| | | 15-30 | 50% | H2 |
| | | >30 | 50% | H3 |

Table 12. Anticipated movement of material from Borrow pit 2 (30°37'32.04"S 25°28'50.54"E).

Table 13. TEST PIT 1 (30°37'31.78"S 25°28'49.19"E), Laboratory sample 2 SHALE, (for subbase and the wearing course).

| SOIL TYPE | DEPTH (mm) | DESCRIPTION AND CALCULATIONS | |
|---|---|---|---|
| Greyish and brown weathered MUDSTONE. ("CLAY MATERIAL") | 0 | Natural ground level (ngl) | |
| | 400 | Anticipated founding depth 400 mm below ngl | anticipated soil movement = 36.0 mm |
| | 700 | layer thickness with potential for expansiveness= 300 mm | Layer thickness movement = 27.0 mm |

Table 14.TEST PIT 2 (30°37'30.78"S 25°28'52.04"E), Laboratory sample 3 weathered SHALE, only possible "CLAY" material for the core of the dam.).

| SOIL TYPE | DEPTH (mm) | DESCRIPTION AND CALCULATIONS | |
|---|---|---|---|
| Greyish and brown weathered MUDSTONE. ("CLAY MATERIAL") | 0 | Natural ground level (ngl) | |
| | 400 | Anticipated founding depth 400 mm below ngl. | anticipated soil movement = 32.0 mm |
| | 700 | layer thickness with potential for expansiveness= 300 mm | Layer thickness movement = 24.0 mm |

**NB,** All the total of 10 (10) excavated test pit on sites exhibit the similar rocks and soil layer/s and properties.

## 11. LAND USAGE

The geotechnical investigation indicates that the construction site is suitable for the proposed development, provided the recommendations of this report are implemented to withstand the prevailing geotechnical constraints identified.

## 12. POTENTIAL RISKS

- The material with very high PI may cause rutting and prone settlement.
- The material with very high PI consists of poor compaction and workability.
- The non-plastic material lacks cohesive and may fail due to disintegration under load.

## 13. RECOMMENDATIONS AND MITIGATIONS.

- The fill material for the subbase and the crown is required to mitigate the geotechnical constraints imposed by alluvial SILT soil within the construction site.
- Therefore, the Insitu SILT will be cut and replaced by subbase and a crown with wearing course of MUDSTONE rock aggregate.
- The ground and soil of the above mentioned site is prone to flooding during heavy rainy seasons.

- The structural foundations can be located directly on CLAY.
- The excavatability of the soils on site can be considered to be soft in terms of earthworks excavations.
- Precautions should be taken in the design of the facility to accommodate the possibility of a perched groundwater table during the rainy season, and
- Site roads should be constructed with the wearing course consisting of imported gravel (minimum G7).

## 14. CONCLUSIONS

### Road construction site.

The detailed information has been provided to substantiate the findings of this report.
The alluvial SILT soil not suitable for construction. Its prone to settlement.
The alluvial SILT soil on site should be cut and removed. Rip and compact under the appropriate footprint.
The borrow pit material should be imported.

### Dam construction site

The dysfunctional spillways and the settlement of the dam should be avoided at all cost in order to avoid overtopping.
Overtopping and dysfunctional of the spillways may cause soil erosion.
Foundation defects should be avoided by taking into account the weight of the dam to avoid unequal settlements of the foundation and the ground.
High uplift pressures and uncontrolled foundation seepage should be avoided. This may compromise the foundation dam.
The too much water seeps and leaks may compromise the semi permeable embankments of the dam and cause dam failure.a
The weakening of the structure by internal erosion especially along the hydraulic structures, spillways, conduits, or cracks should be avoided, this may lead to the structural failure of the dam.
The dam should be properly maintained or built with adequate materials in order to avoid structural weaknesses that may lead to catastrophic dam failure.

### Borrow pit/s.

**Borrow pit 1** does not require selective excavation. It contains homogeneously SANDSTONE rocks.
Borrow pit 1 is suitable for the retain walls of the dam and it contains SANDSTONE rocks with adequate pH 7.49 and electric conductivity 0.022 for the river ecosystem including fish.
SANDSTONE rock is more resistance to weathering.
**Borrow pit 2.** Is homogeneously composed of MUDSTONE rock and weathered MUDSTONE debris earmarked for “CLAY” material.
This pit can provide both aggregate for the subbase and the wearing course of the crown with a required PI for the binding effect.

**Borrow pit 3 and 4** requires selective excavation. The readily excavatable material is mixed with topsoil. The topsoil makes the borrow pit 2 and 4 material to be less compactable. Competent rocks are intensely weathered. The unweathered rocks can be exposed through drill and blasting.
Therefore, borrow pit 1 has been the main source of the fill material both aggregate (for the road) and rock dust as CLAY material for the core of the dam.

NB DCP TEST 2 WITHIN BORROW PIT 2, 3 and 4 IS DISCARDED, DUE TO ROCK OUTCROPS.

## 15. REFERENCES.

Jennings Brink & Williams (1973). Revised Guide to Soil Profiling for Civil Engineering purposes in South Africa. The civil Engineer in S.A. Jan. 1973.

Watermeyer R.B. and Tromp B.E. A systematic approach to the design and construction of single storey residential and masonry structures on problem soils. The Civil Engineer in South Africa. (1992).

## 16. APPENDICES

# APPENDIX A

# PROVIDED INFORMATION.

| **Borrow pit.** | **coordinates.** | |
|---|---|---|
| Borrow pit 1. | 30°37'37.93"S | 25°28'27.88"E |
| Borrow pit 2. | 30°37'32.04"S | 25°28'50.54"E |
| Borrow pit 3. | 30°36'38.14"S | 25°28'59.54"E |
| Borrow pit 4. | 30°36'40.79"S | 25°28'30.94"E |

# APPENDIX B

# LABORATORY RESULTS.

W.I. 7.8.1 (a)

SNALAB CIVIL ENGINEERING LABORATORY

sanas T0345

SNA CIVIL AND STRUCTURAL ENGINEERS (PTY) LTD
191 VONKPROP ROAD SAMCORPARK PRETORIA
PO Box 72727 Lynnwood Ridge '0040
Tel :(012) 751-9388
E-MAIL : snalab@sna.co.za
REG. NO. 2005/006128/07

SANAS accredited facility since 2007

# TEST REPORT

REPORT NUMBER **25987**

| | |
|---|---|
| **Client :** | MBANI PROJECTS (PTY) LTD |
| **Address:** | 1352A WILLIAM ADOLPH<br>GLUKSDAL<br>BRAKPAN<br>1552 |
| **Cell :** | 076 257 8924 |
| **E-Mail:** | slraebe@gmail.com |
| **ATTENTION:** | LUCAS RADEBE |
| **Project/Order:** | ATDC RETAIN DAM |
| **Brief :** | MDD, CBR, GRAD, PI, HYDRO, COND, PH & G/ CLASS |

| | |
|---|---|
| Date requested | 01/03/2021 |
| Date sampled | SAMPLED BY CLIENT |
| Date received | 01/03/2021 |
| Date Tested | Start date : 02/03/2021 End date : 09/03/2021 |
| Location of sampling | ORANGE RIVER DAM (SUPPLIED BY CLIENT) |
| Sampling method/methods | SAMPLED BY CLIENT |
| Sampling plan | SAMPLED BY CLIENT |
| Sampled by | SAMPLED BY CLIENT |
| Sample number | REFER TO TEST REPORT |
| Sample Condition/Description | REFER TO TEST REPORT |
| Sample classification | COTO CHAPTER 4 TABLE A4.1.5 - 3704 |
| Sampling Environmental condition | SAMPLED BY CLIENT |
| Test Method/Methods used | REFER TO TEST REPORT |
| Test done at | SNALAB(PTA) |

**Deviation to test methods : Deviations, exclusions or additions will be noted on test result sheets**

**Test/Tests marked # Not SANAS Accredited in this report are not included in the SANAS Schedule of Accreditation for this laboratory.**

The results relate only to the items tested. Any opinions ,classifications , comments and interpretations do not fall within the scope of our SANAS accreditation.

This certificate is issued without any corrections what so ever.

Test report/reports shall not be reproduced except in full, without written approval of the Laboratory.

This test report relates only to samples received.

If the report is referred to as an INTERIM REPORT it is not fit for publication.

Information above noted as" **Supplied by Client/Sampled by Client**" may effect the validity of the test results.

Hendrik Diederiks. Pr Tech Eng
Laboratory Manager
Technical Signatory

4/03/2021
DATE ISSUED:

page 1 of 4

SNALAB CIVIL ENGINEERING LABORATORY

Project: ATDC RETAIN DAM
Rd/Sect/Bp:
Layer/ Test pit:

Lab No : 25987
Client No : 7200
Date : 01/3/2021

# INDICATORS

Methods: SANS 3001-GR 1 + GR2 + GR5 | SANS 3001 GR 10 | TMH 1: A20 | TMH 1: A21T | W.I.7.8.1(e)

| HOLE & / SAMPLE No. MATERIALS DESCRIPTION | DEPTH (m) | % PASSING 100.0 | 90.0 | 75.0 | 63.0 | 50.0 | 37.5 | 28.0 | 20.0 | 14.0 | 5.0 | 2.0 | 0.425 | 0.075 | SOIL MORTAR ANAL (% vs # mm) 2.0 - 0.425 | 0.425 -0.250 | 0.250 - 0.150 | 0.150 - 0.075 | <0.075 | GM | ATTERBERG LIMITS (%) LL | LS | PI | pH | ELEC-TRIC CONDUC. (S/m) | AASTHO Classification # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE 1A | | | | | | | | | | 100 | 100 | 99 | 99 | 32 | 1 | 4 | 26 | 36 | 33 | 0.70 | | | SP | | | A-2-6 ( 3 ) (1) |
| RED BROWN SILT SOIL | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SAMPLE 1B | | | | | | | | | | 100 | 100 | 100 | 99 | 42 | 0 | 3 | 22 | 32 | 42 | 0.58 | | | SP | | | A-6 ( 7 ) (2) |
| RED BROWN SILT SOIL | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SAMPLE 2 | | | | | 100 | 92 | 78 | 62 | 35 | 31 | 20 | 13 | 4 | 2 | 71 | 6 | 4 | 2 | 17 | 2.81 | 28 | 4.7 | 9 | | | A-2-4 ( 0 ) (3) |
| SHALE | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SAMPLE 3 | | | | | | | | | | 100 | 99 | 83 | 15 | 7 | 82 | 4 | 3 | 2 | 9 | 1.96 | 22 | 3.9 | 8 | | | A-2-4 ( 0 ) (4) |
| WEATHERED SHALE | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SAMPLE 4 | | | | | | | | | | | | | | | | | | | | | | | | 7.49 | 0.022 | A-1-a ( 0 ) (5) |
| SAND STONE | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | ( ) (6) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | ( ) (7) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | ( ) (8) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | ( ) (9) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | ( ) (10) |

REMARKS:

Tech:
Date: 19/03/2021

| SNALAB CIVIL ENGINEERING LABORATORY | Project | ATDC RETAIN DAM | Lab No : | 25987 |
|---|---|---|---|---|
| | Rd/Sect/Bp | | Client No : | 7200 |
| | Layer/ Test pit | | Date : | 01/3/2021 |

# HYDROMETER ANALYSIS #

## TMH 1: TM 6A (Modified) ($Na_4P_2O_7$)

| Sample No: | | | SAMPLE 1A | SAMPLE 1B | SAMPLE 2 | SAMPLE 3 | SAMPLE 4 |
|---|---|---|---|---|---|---|---|
| Description: | | | RED BROWN SILT SOIL | RED BROWN SILT SOIL | SHALE | WEATHERED SHALE | SAND STONE |
| Depth m : | | | | | | | |
| **SOIL MORTAR ANALYSIS** | | | | | | | |
| COARSE SAND | 2,0 TO 0,425 | % | | | | 82.4 | |
| FINE SAND | 0,425 TO 0,05 | % | | | | 15.1 | |
| SILT | 0,05 TO 0,005 | % | | | | 1.2 | |
| CLAY | 0,005 TO 0,002 | % | | | | 0.4 | |
| EXPANSIVE CLAY (C) | < 0,002 | % | | | | 0.9 | |
| MORTAR CHECK SUM | = 100 | % | | | | 100.0 | |
| SILT-CLAY FRACT. | < 0.05 | % | | | | 2.5 | |
| **ACTIVITY INDEX** | | | | | | | |
| EXPANSIVE CLAY FRACT % = 0,4x C | | % | | | | 0.4 | |
| EFFECTIVE PI = $\%_{<0,425}$ x PI (P) | | % | | | | 1.2 | |
| $K = 5((P-0,4C)(C-10))^{\wedge 0,6}$ | | K | | | | | |
| ACTIVITY CLASSIFICATION* | | | | | | LOW | |

* ACTIVITY CLASSIFICATION (<50), LOW ; (50-120), MED ; (120-200), HIGH ; (>200), VERY HIGH , & (where #NUM! = neg. val.), LOW .

| REMARKS: | file saved under W.I.7.8.1(e) | Tech: | |
|---|---|---|---|
| | | Date: | 19/03/2021 |

W.I.7.8.1(xxx)

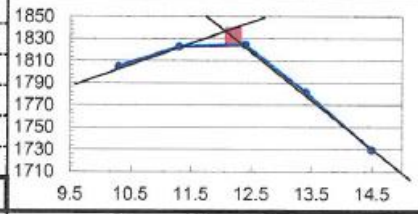
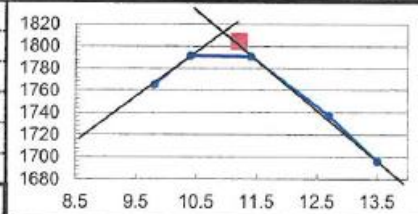
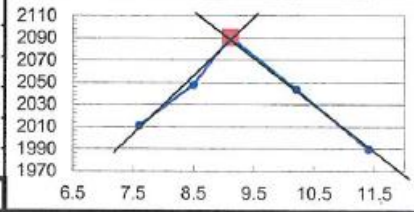
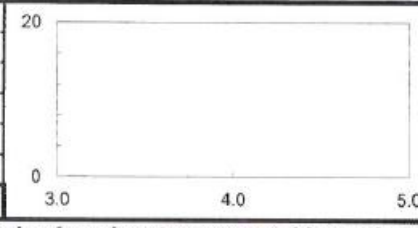
SNALAB CIVIL ENGINEERING LABORATORY

Project : ARDC RETAIN DAM
Rd name / No :
Section from :

Lab No: 25987
Client No 7200
Date : 01/03/2021

## MDD / OMC
SANS 3001-GR20/GR30

## CBR
SANS 3001-GR40

| Sample No. / Description / Stabilising agent % and type | MDD / OMC ( MOD.AASHTO. ) Mc % | Density Wet kg/m³ | Density Dry kg/m³ | MC% vs. Dry kg/m³ | Compaction Swell % | Comp MC % | Wet dens kg/m³ | Dry dens kg/m³ | Rel Comp % | CBR % (kPa) | Cor. Factor % / (kPa) | CBR % (kPa) | Summary Rel comp % | Summary CBR % | G- Classification GOTO CHAPTER 4 TABLE A4.1.5-3704 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE 1A | 10.3 | 1991 | 1805 |  | SAMPLE A | | | | | | | | 100 | 43.0 | |
| RED BROWN SILT SOIL | 11.3 | 2029 | 1823 | | 0.18 | 12.1 | 2052 | 1831 | 99.9 | 42.0 | -0.05 | 42.0 | 98 | 30.1 | |
| | 12.4 | 2051 | 1825 | | SAMPLE B | | | | | | | | 97 | 25.2 | NC |
| | 13.4 | 2021 | 1782 | | 0.29 | 12.2 | 1954 | 1742 | 95.0 | 18.0 | -0.27 | 17.7 | 95 | 17.7 | |
| | 14.5 | 1981 | 1730 | | SAMPLE C | | | | | | | | 93 | 12.4 | |
| | | | | | 0.31 | 12.5 | 1850 | 1644 | 89.7 | 7.0 | -0.10 | 6.9 | 90 | 7.3 | |
| OMC | 12.2 | MDD | 1833 | | | | | | | | | CBR(1) | 1 | Curing: | |
| SAMPLE 1B | 9.8 | 1938 | 1765 |  | SAMPLE A | | | | | | | | 100 | 26.9 | |
| RED BROWN SILT SOIL | 10.4 | 1978 | 1792 | | 0.03 | 11.1 | 2000 | 1800 | 99.7 | 26.0 | -0.46 | 25.5 | 98 | 18.0 | |
| | 11.4 | 1995 | 1791 | | SAMPLE B | | | | | | | | 97 | 14.7 | NC |
| | 12.7 | 1958 | 1737 | | 0.03 | 11.2 | 1907 | 1715 | 95.0 | 10.0 | -0.13 | 9.9 | 95 | 9.9 | |
| | 13.5 | 1925 | 1696 | | SAMPLE C | | | | | | | | 93 | 6.8 | |
| | | | | | 0.07 | 11.0 | 1805 | 1626 | 90.1 | 4.0 | -0.01 | 4.0 | 90 | 3.9 | |
| OMC | 11.2 | MDD | 1805 | | | | | | | | | CBR(1) | 1 | Curing: | |
| SAMPLE 3 | 7.6 | 2164 | 2011 |  | SAMPLE A | | | | | | | | 100 | 27 | |
| SHALE | 8.5 | 2222 | 2048 | | 0.00 | 9.1 | 2290 | 2099 | 100.4 | 28.5 | -0.51 | 28.0 | 98 | 22 | |
| | 9.1 | 2281 | 2091 | | SAMPLE B | | | | | | | | 97 | 20 | G8 |
| | 10.2 | 2252 | 2044 | | 0.03 | 9.0 | 2175 | 1995 | 95.4 | 17.7 | -0.26 | 17.4 | 95 | 17 | |
| | 11.4 | 2217 | 1990 | | SAMPLE C | | | | | | | | 93 | 14 | |
| | | | | | 0.69 | 9.0 | 2055 | 1885 | 90.2 | 11.0 | -0.14 | 10.9 | 90 | 11 | |
| OMC | 9.1 | MDD | 2091 | | | | | | | | | CBR(1) | 1 | Curing: | |
| | | | |  | SAMPLE A | | | | | | | | 100 | | |
| | | | | | | | | | | | | | 98 | | |
| | | | | | SAMPLE B | | | | | | | | 97 | | |
| | | | | | | | | | | | | | 95 | | |
| | | | | | SAMPLE C | | | | | | | | 93 | | |
| | | | | | | | | | | | | | 90 | | |
| OMC | | MDD | | | | | | | | | | CBR(1) | | Curing: | |

Remarks : Water added weighed and not measured by volume//Sample scalped through 37.5mm

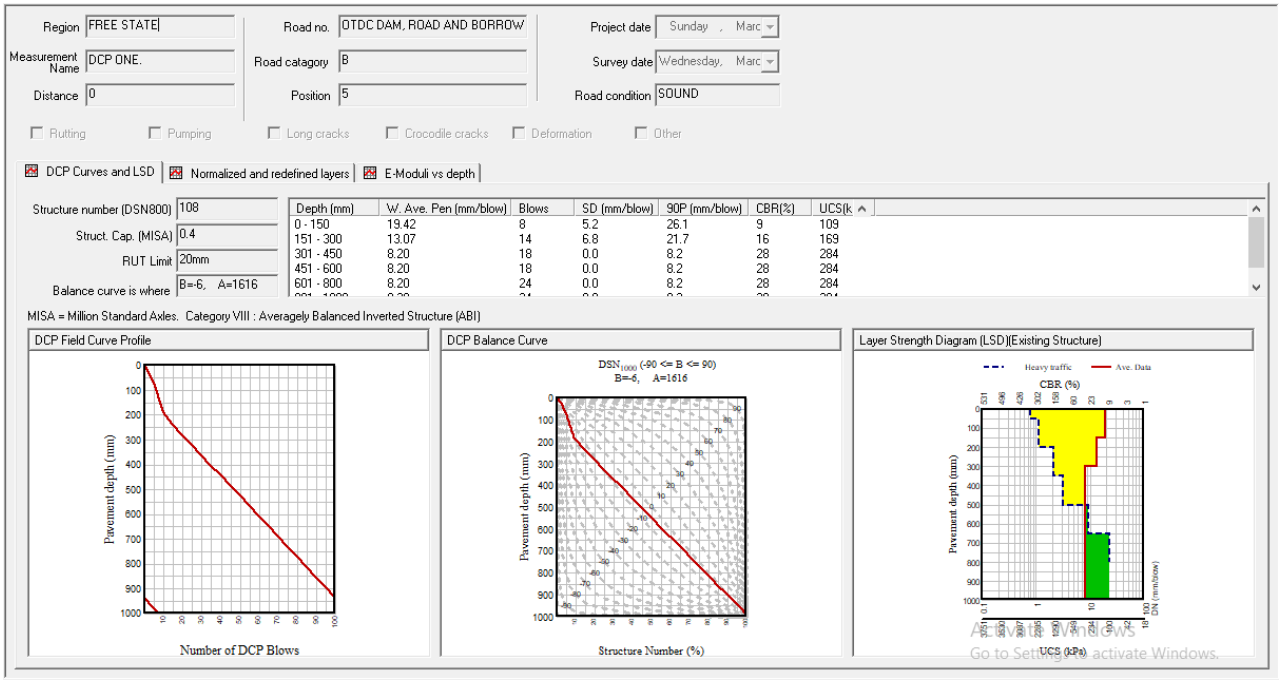
Tech:
Date : 19/03/2021

# APPENDIX C

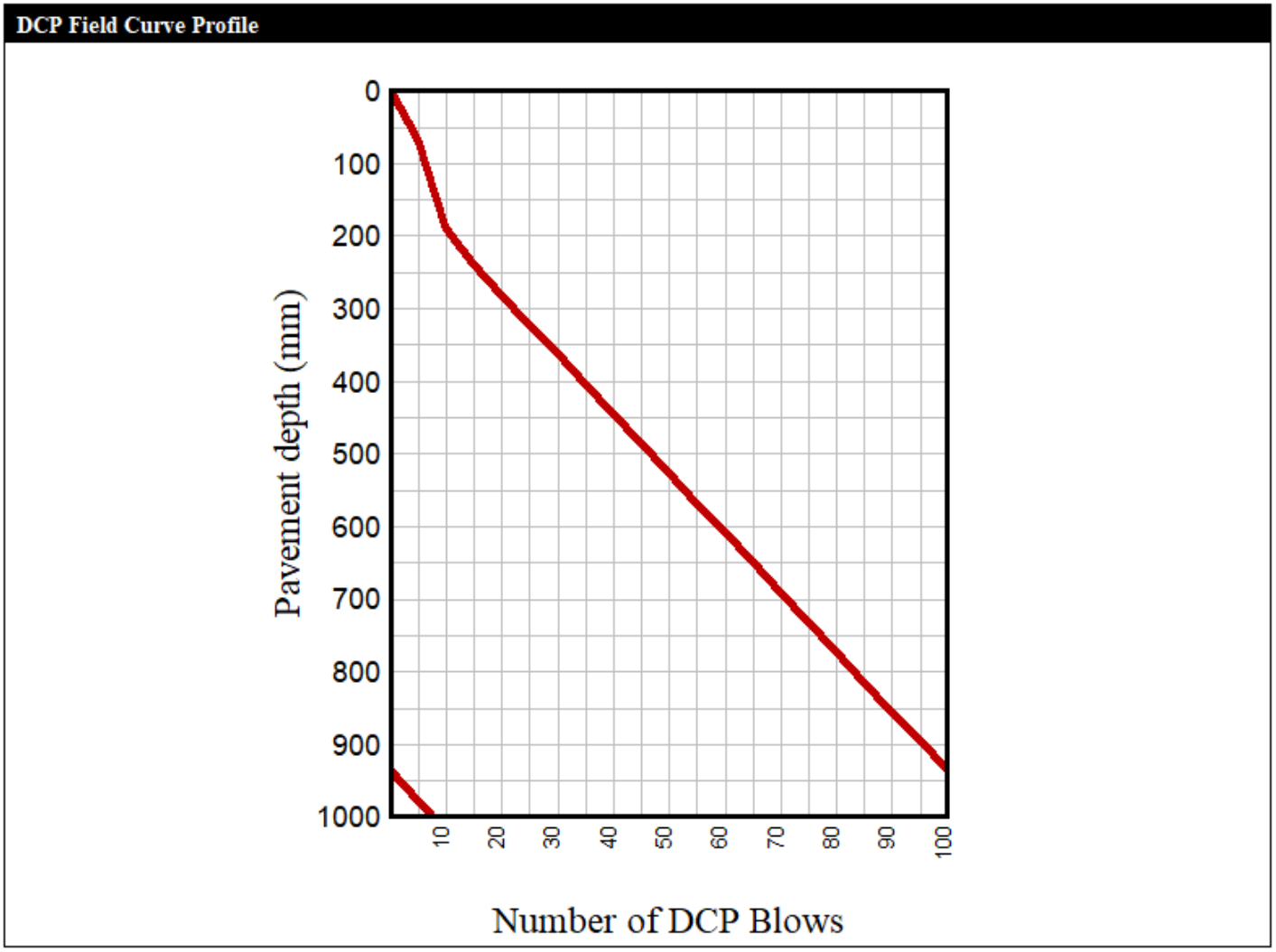
# TEST PIT PROFILES OF THE CONSTRUCTION SITE.

| | | | | |
|---|---|---|---|---|
| PROJECT: OTDC DAM SITE. | | | PROFILED BY: LUCAS RADEBE | |
| MECHINE:TLB | | | DATE: 26th February 2021 | |
| GPS CO-ORDINATE: 30°37'36.87"S 25°28'9.58"E | | | TEST PIT : 01. | |
| | | | | |
| DEPTH (mm) | | | LEGEND | DESCRIPTION | NOTES |
| 0 | 550 | | | Dry, light brownish to grey, fine gained, loose, colloidal, Transported, Alluvial SILT soil. | Side wall of the pit stable |
| | | | | Moist, light brownish to grey, fine gained,less loose, colloidal, Transported, Alluvial SILT soil. | |
| 3000 | 3000 | | NO Refusal | | |
| END OF HOLE: 300 mm | | | | | NO Ground water seepage |

## DCP 1, DAM.

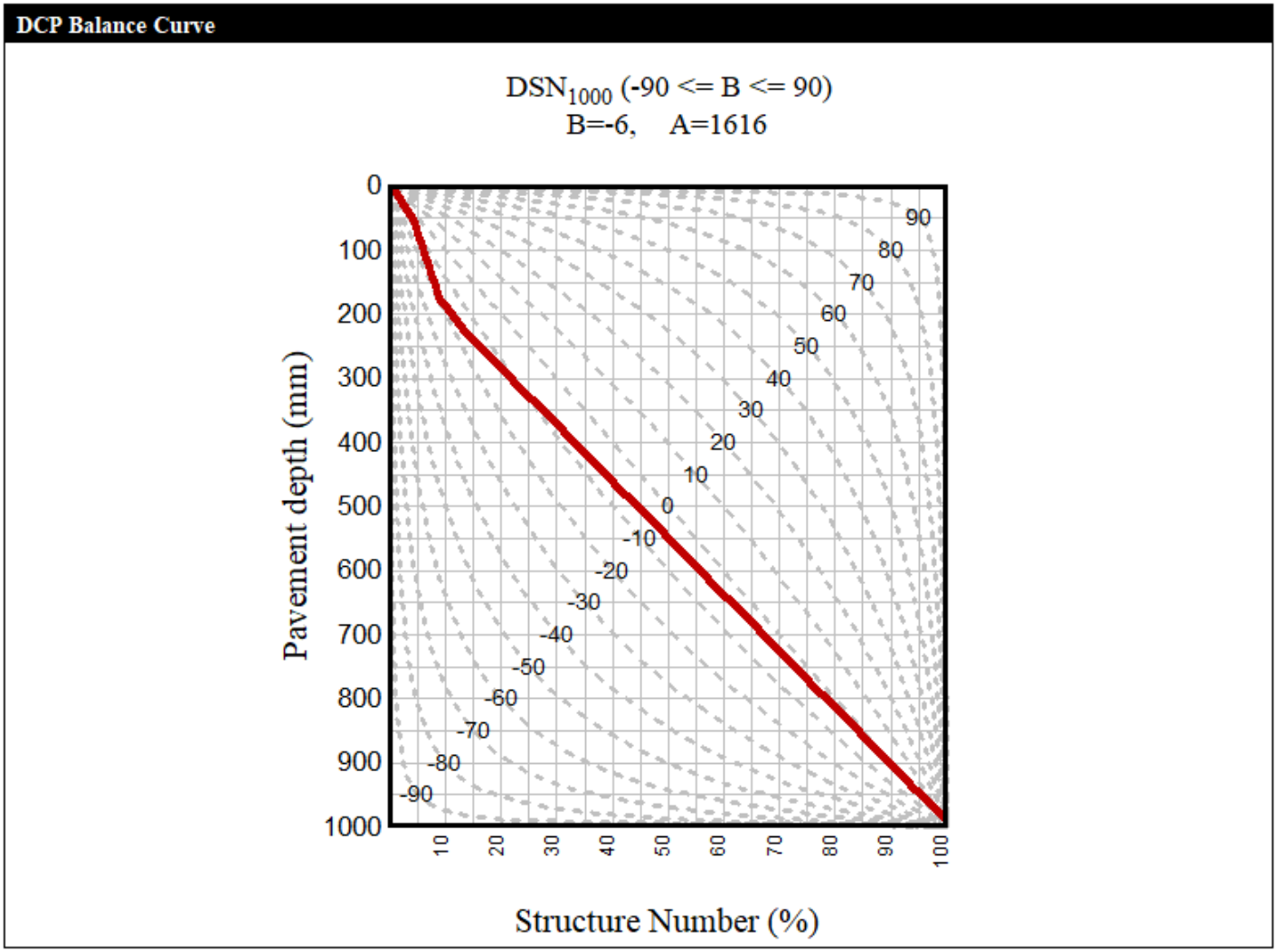


DCP 1, DAM.


DCP Field Curve Profile
Pavement depth (mm)
0
100
200
300
400
500
600
700
800
900
1000
10
20
30
40
50
60
70
80
90
100
Number of DCP Blows

**DCP 1, DAM.**

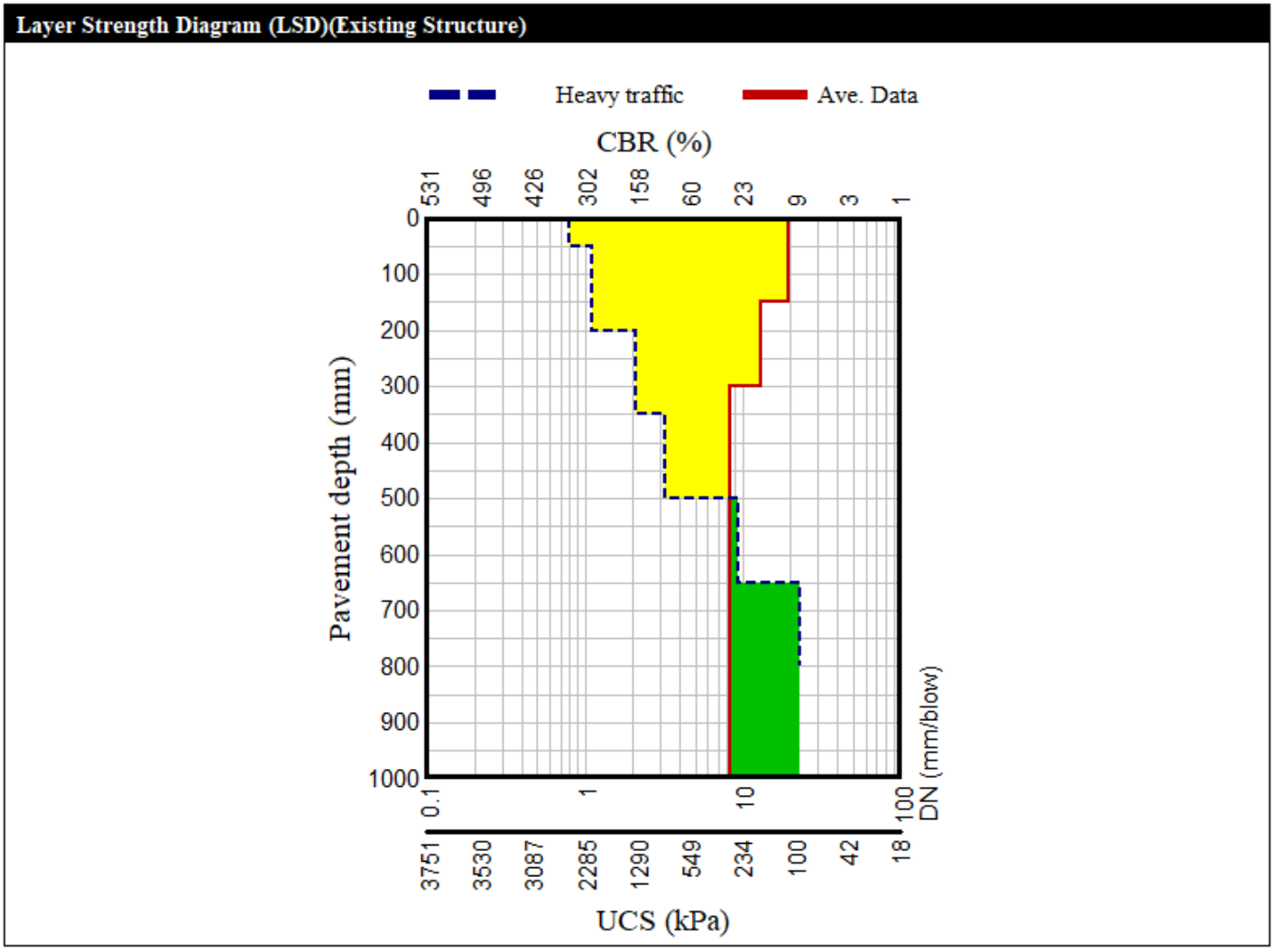
**DCP Balance Curve**






MBANI PROJECTS

**DCP 1, DAM.**

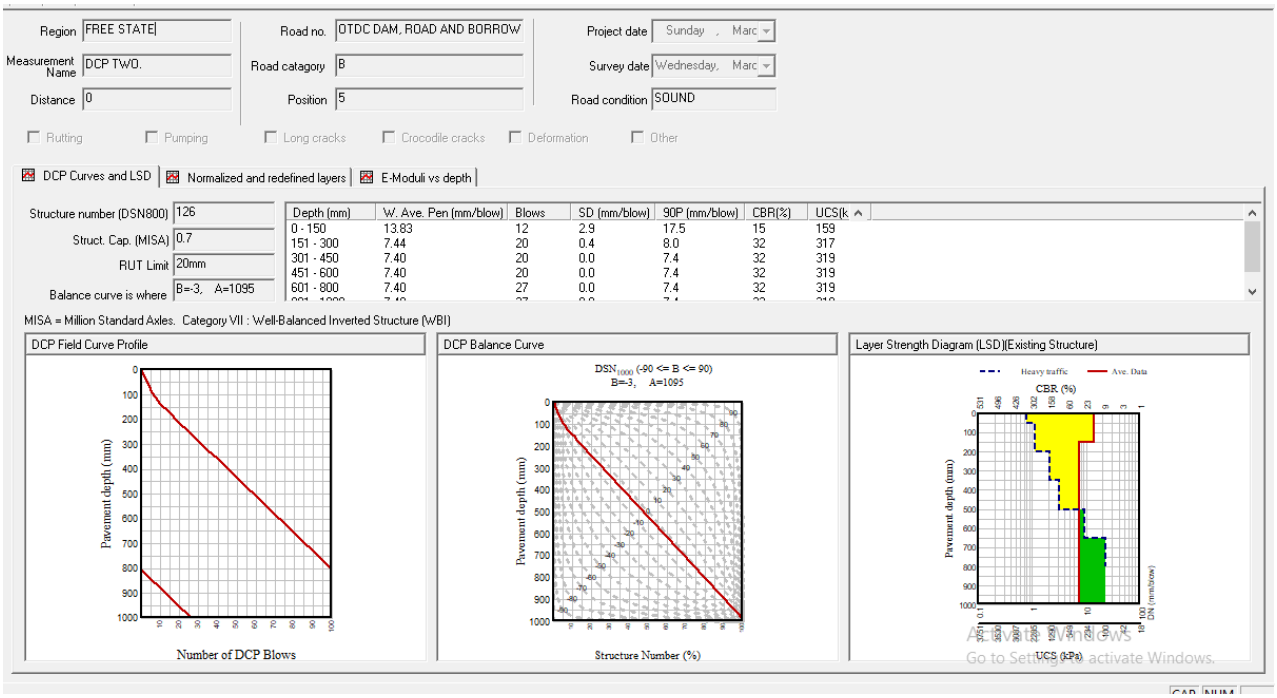





MBANI PROJECTS

| | | | | |
|---|---|---|---|---|
| PROJECT: OTDC ROAD.. | | | PROFILED BY: LUCAS RADEBE | |
| MECHINE:TLB | | | DATE: 26th February 2021 | |
| GPS CO-ORDINATE: 30°37'35.82"S 25°28'9.56"E | | | TEST PIT : 02. | |
| | | | | |
| DEPTH (mm) | | | LEGEND | DESCRIPTION | NOTES |
| 0 | 650 | | Dry, light brownish to grey, fine gained, loose, colloidal, Transported, Alluvial SILT soil. | | Side wall of the pit stable |
| 3000 | 3000 | | NO Refusal | Moist, light brownish to grey, fine grained, less loose, colloidal, Transported, Alluvial SILT soil. | |
| END OF HOLE: 3000 mm | | | | | NO Ground water seepage |

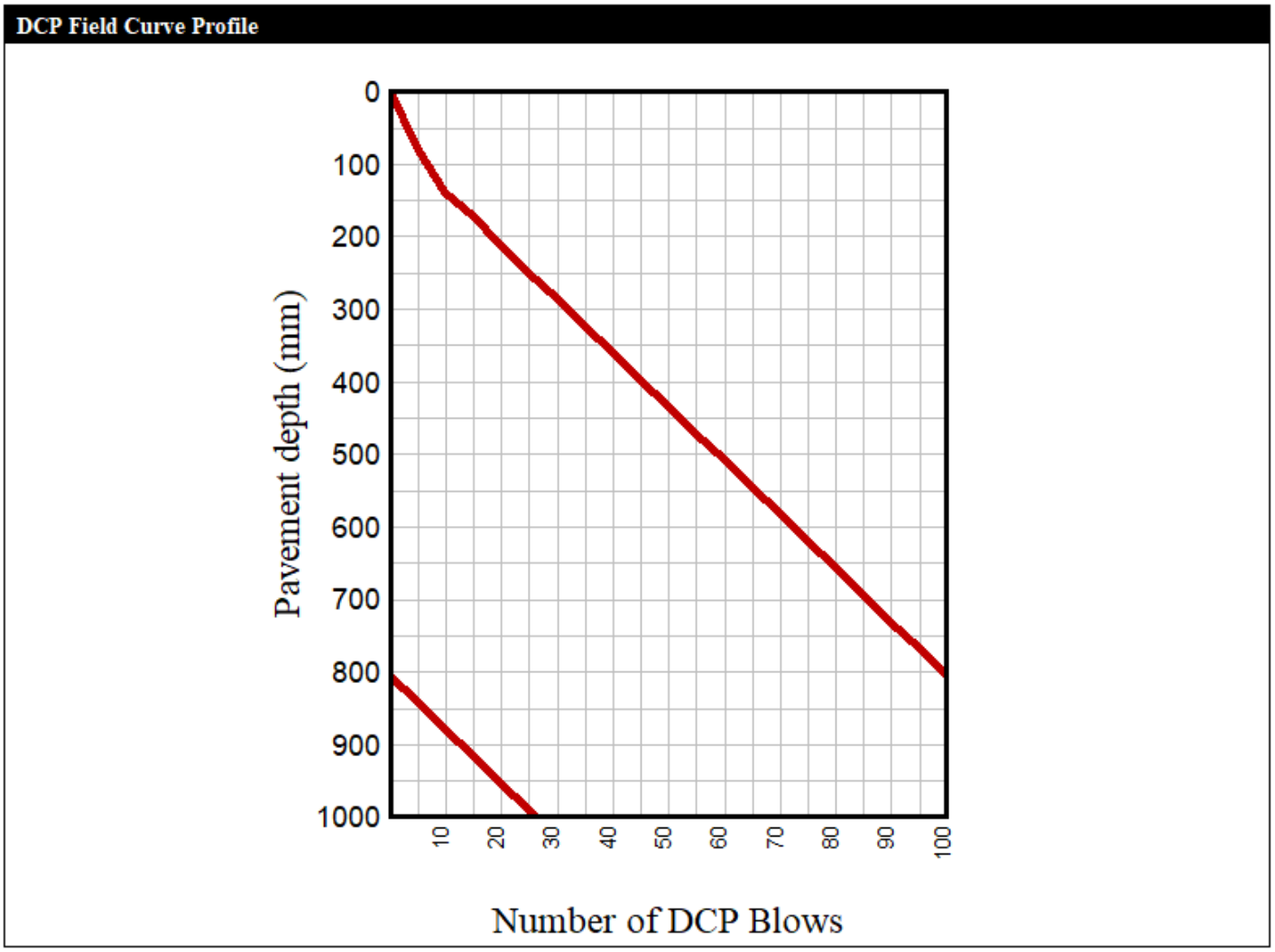
## DCP 2, ROAD.





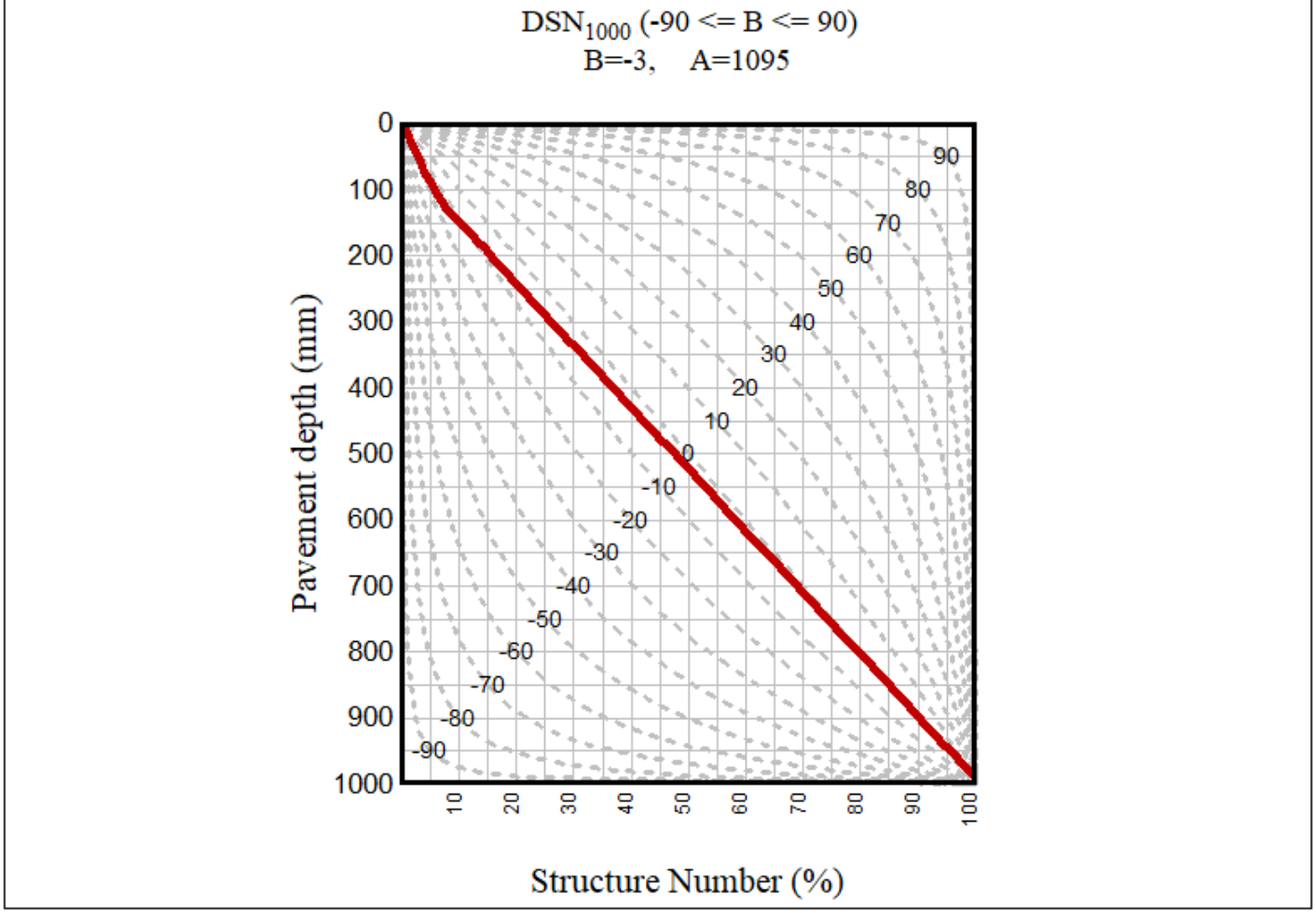

MBANI™ PROJECTS

DCP 2, ROAD.


DCP Field Curve Profile
Pavement depth (mm)
0
100
200
300
400
500
600
700
800
900
1000
10
20
30
40
50
60
70
80
90
100
Number of DCP Blows

DCP 2, ROAD.

**DCP Balance Curve**

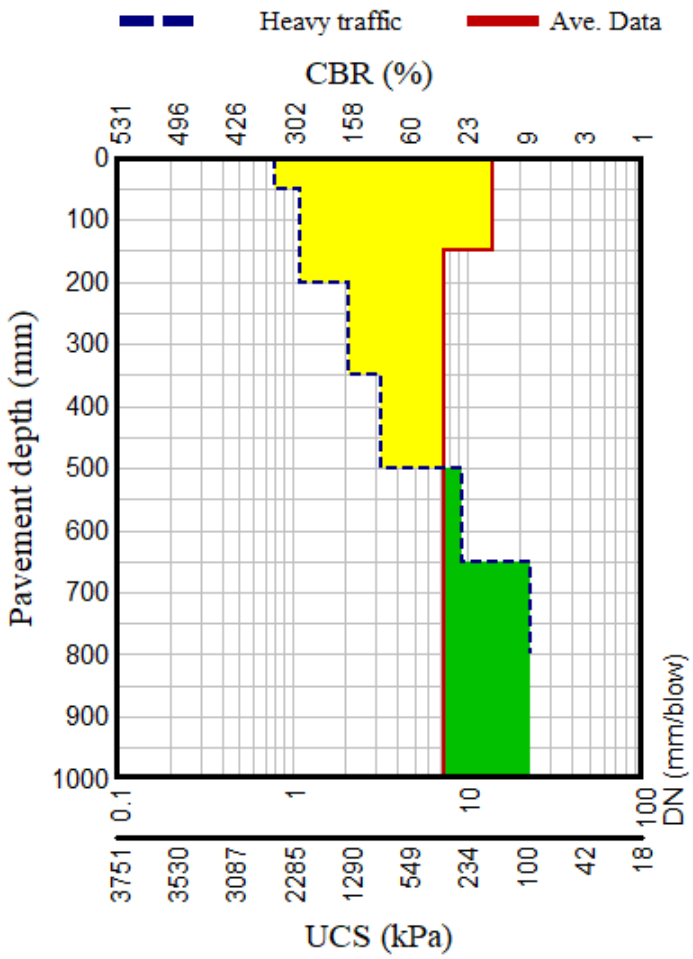





MBANI PROJECTS

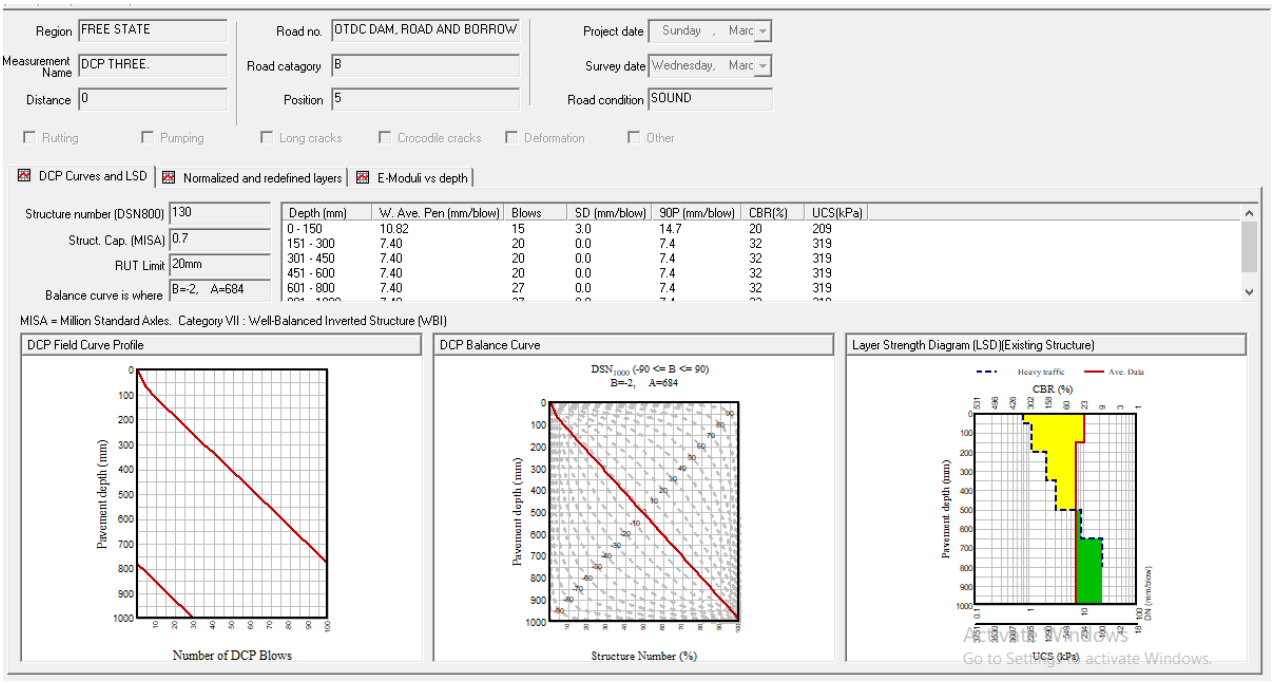
DCP 2, ROAD.

**Layer Strength Diagram (LSD)(Existing Structure)**

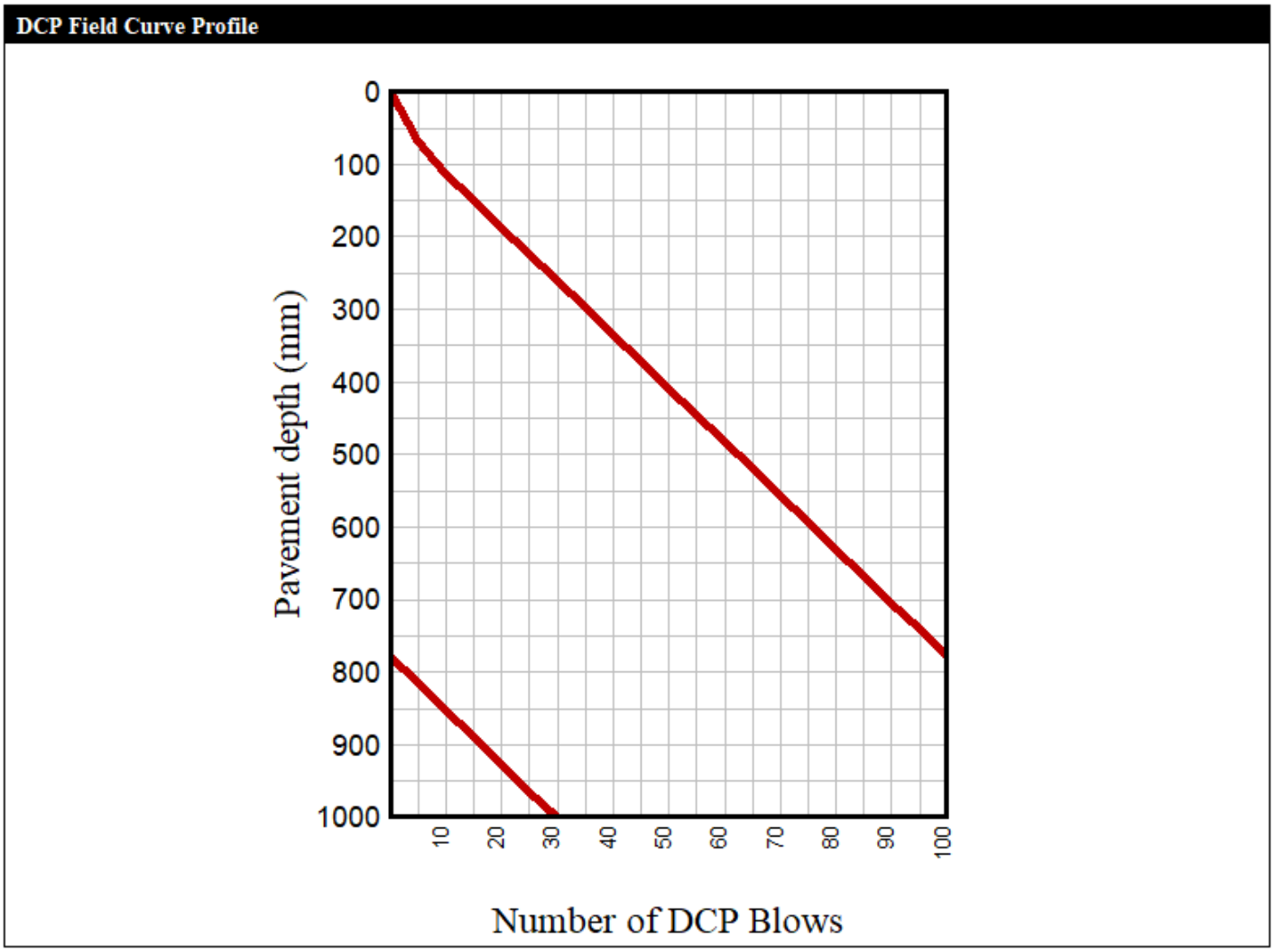


| | | | | |
|---|---|---|---|---|
| PROJECT: OTDC ROAD. | | | PROFILED BY: LUCAS RADEBE | |
| MECHINE:TLB | | | DATE: 26th February 2021 | |
| GPS CO-ORDINATE: 30°37'34.40"S 25°28'9.59" | | | TEST PIT: 03. | |
| | | | | |
| DEPTH (mm) | | | LEGEND | DESCRIPTION | NOTES |
| 0 | 620 | | | Dry, light brownish to grey, fine gained, loose, colloidal, Transported, Alluvial SILT soil. | Side wall of the pit stable |
| 3000 | 3000 | | NO Refusal | Moist, light brownish to grey, fine gained,less loose, colloidal, Transported, Alluvial SILT soil. | |
| END OF HOLE: 300 mm | | | | | NO Ground water seepage |

## DCP 3, ROAD.

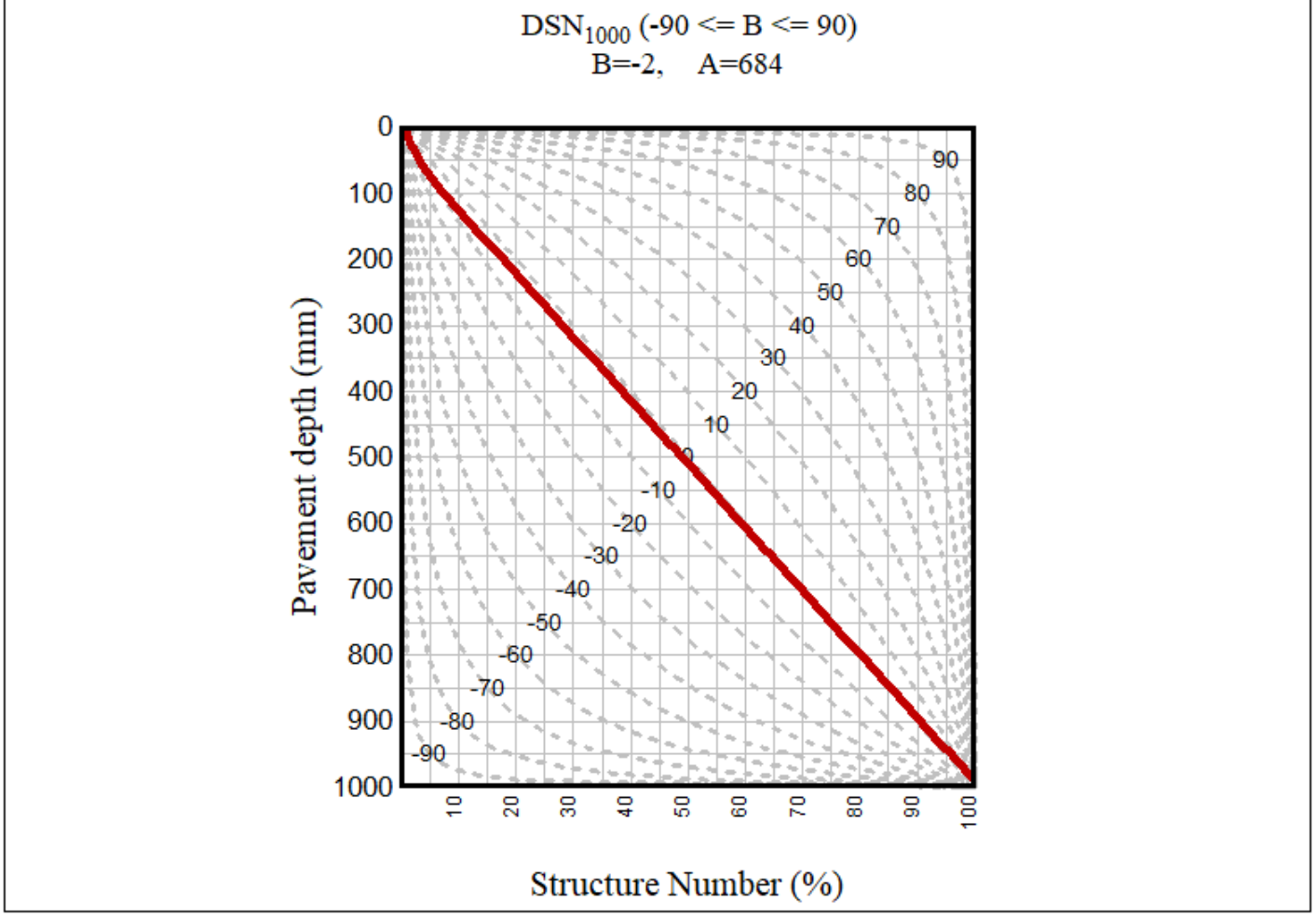

Region FREE STATE
Road no. OTDC DAM, ROAD AND BORROW
Project date Sunday
Measurement Name DCP THREE.
Road catagory B
Survey date Wednesday,
Distance 0
Position 5
Road condition SOUND
Rutting
Pumping
Long cracks
Crocodile cracks
Deformation
Other
DCP Curves and LSD
Normalized and redefined layers
E-Moduli vs depth
Structure number (DSN800) 130
Struct. Cap. (MISA) 0.7
RUT Limit 20mm
Balance curve is where B=-2, A=684
Depth (mm) | W. Ave. Pen (mm/blow) | Blows | SD (mm/blow) | 90P (mm/blow) | CBR(%) | UCS(kPa)
0 - 150 | 10.82 | 15 | 3.0 | 14.7 | 20 | 209
151 - 300 | 7.40 | 20 | 0.0 | 7.4 | 32 | 319
301 - 450 | 7.40 | 20 | 0.0 | 7.4 | 32 | 319
451 - 600 | 7.40 | 20 | 0.0 | 7.4 | 32 | 319
601 - 800 | 7.40 | 27 | 0.0 | 7.4 | 32 | 319
MISA = Million Standard Axles. Category VII : Well-Balanced Inverted Structure (WBI)
DCP Field Curve Profile
Pavement depth (mm)
Number of DCP Blows
DCP Balance Curve
DSN1000 (-90 <= B <= 90)
B=-2, A=684
Pavement depth (mm)
Structure Number (%)
Layer Strength Diagram (LSD)(Existing Structure)
Heavy traffic
Ave. Data
CBR (%)
Pavement depth (mm)
UCS (kPa)
Activate Windows
Go to Settings to activate Windows.

DCP 3, ROAD.


DCP Field Curve Profile
Pavement depth (mm)
0
100
200
300
400
500
600
700
800
900
1000
10
20
30
40
50
60
70
80
90
100
Number of DCP Blows

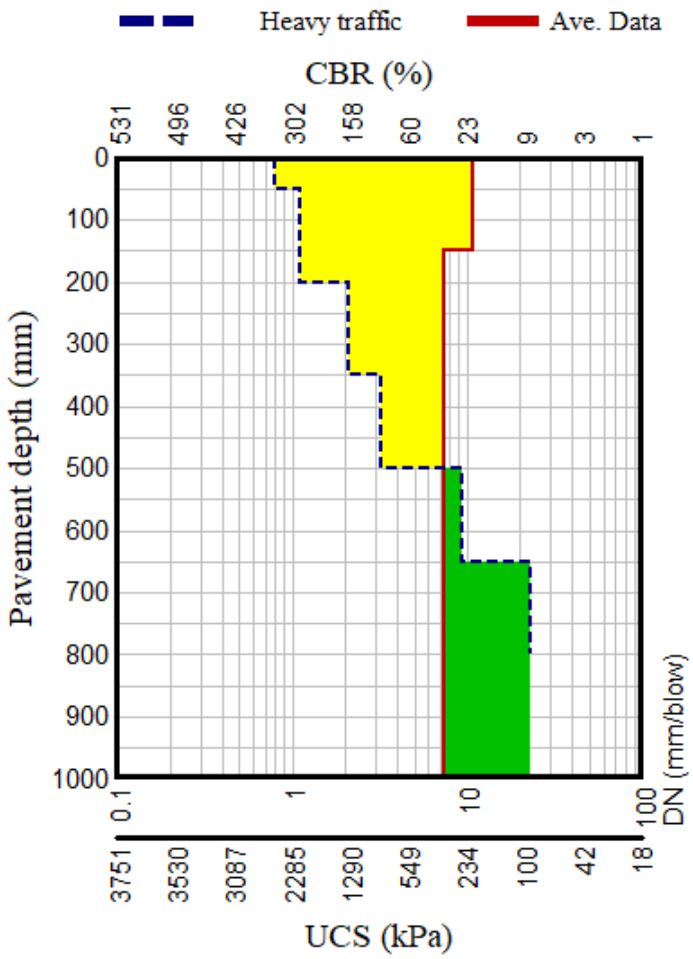
DCP 3, ROAD.

**DCP Balance Curve**



DCP 3, ROAD.

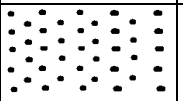
**Layer Strength Diagram (LSD)(Existing Structure)**



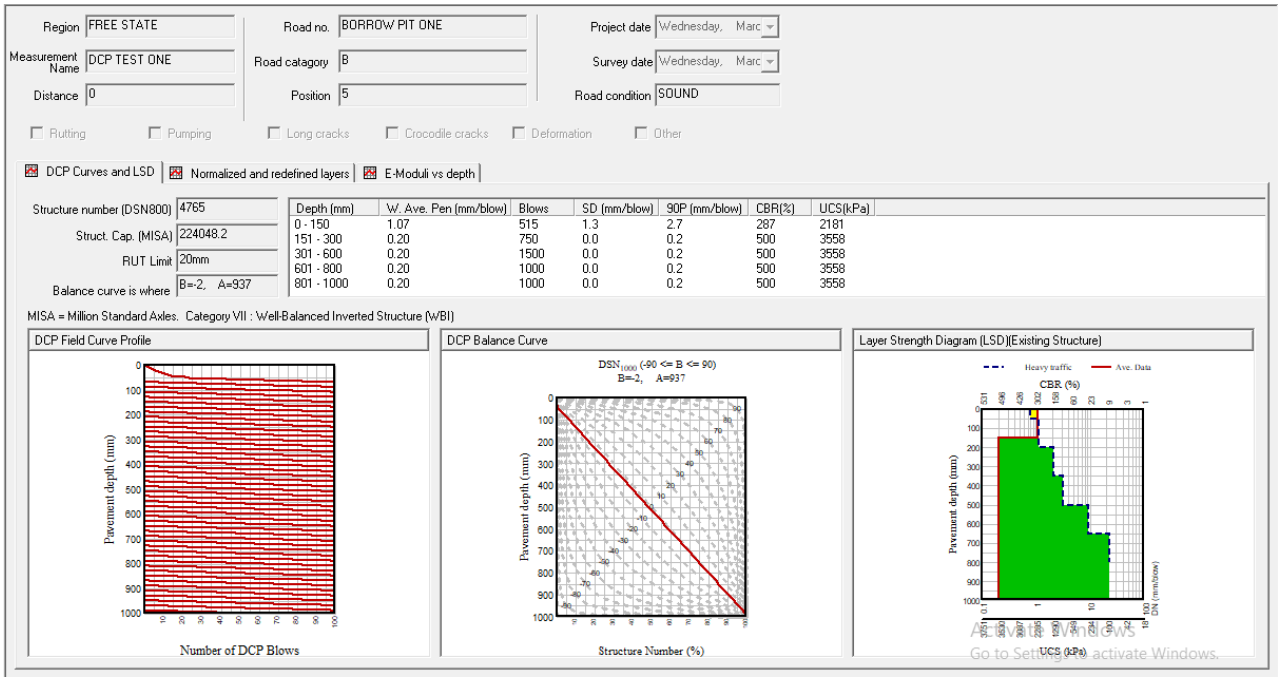
# APPENDIX D

# TEST PIT PROFILES OF THE BORROW PITS.

## BORROW PIT 1, TEST PIT PROFILE 1.

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: OTDC BORROW PIT 1. TEST PIT 1. PROFILED BY: LUCAS RADEBE<br>MECHINE:TLB DATE: 26th February 2021<br>GPS CO-ORDINATE: 30°37'38.16"S 25°28'27.26"E TEST PIT: 01. | | | | | |
| | | | | | |
| DEPTH (mm) | | | LEGEND | DESCRIPTION | NOTES |
| 0 | 980 | |  | Dry, cream white, coarse gained boulders, massive and dense, insitu, SANDSTONE rock boulders. | Side wall of the pit stable |
| 980 | 980 | | Refusal | | |
| END OF HOLE: 980 mm | | | | | NO Ground water seepage |

## DCP 1, BORROW PIT 1.



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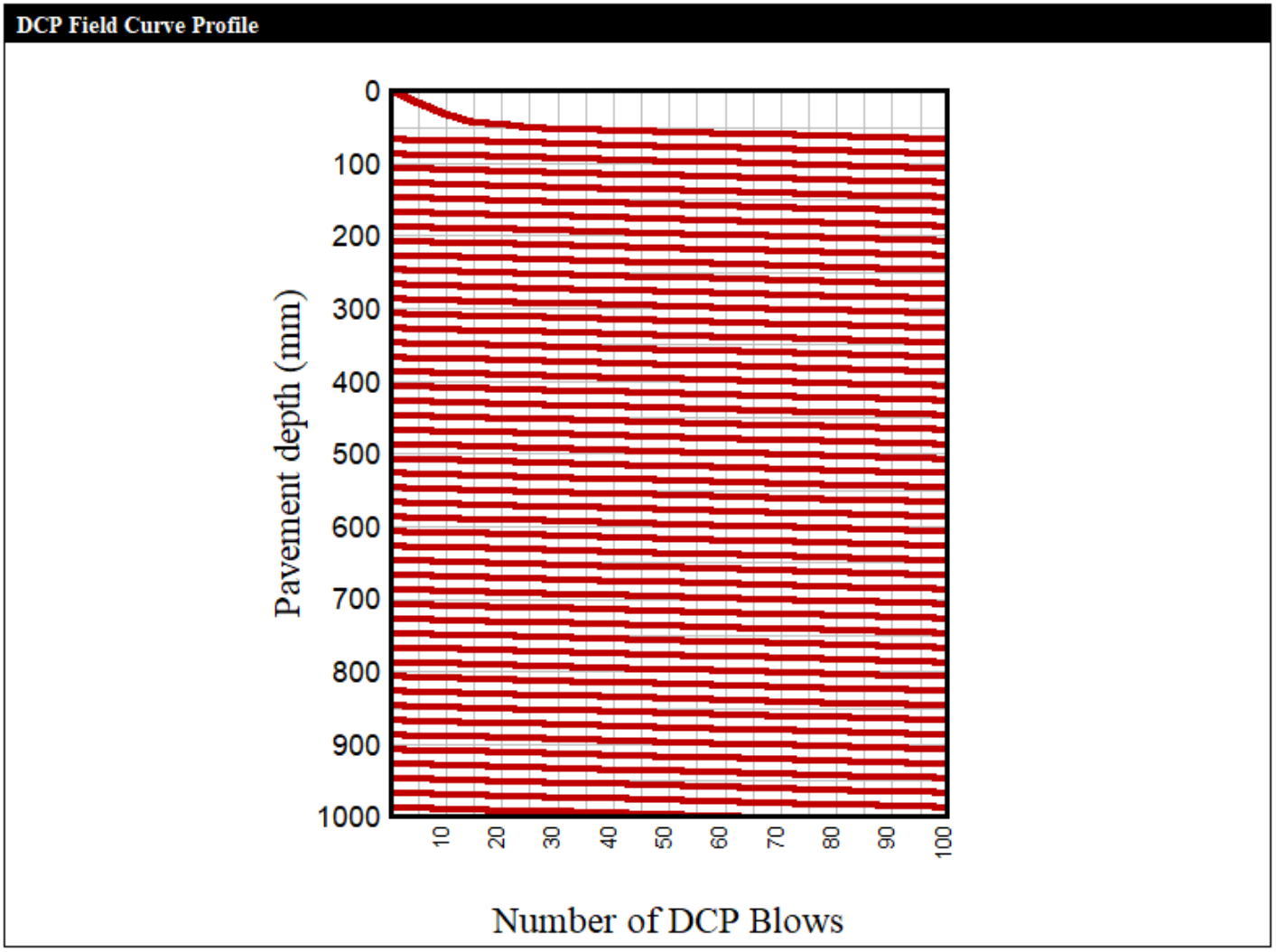
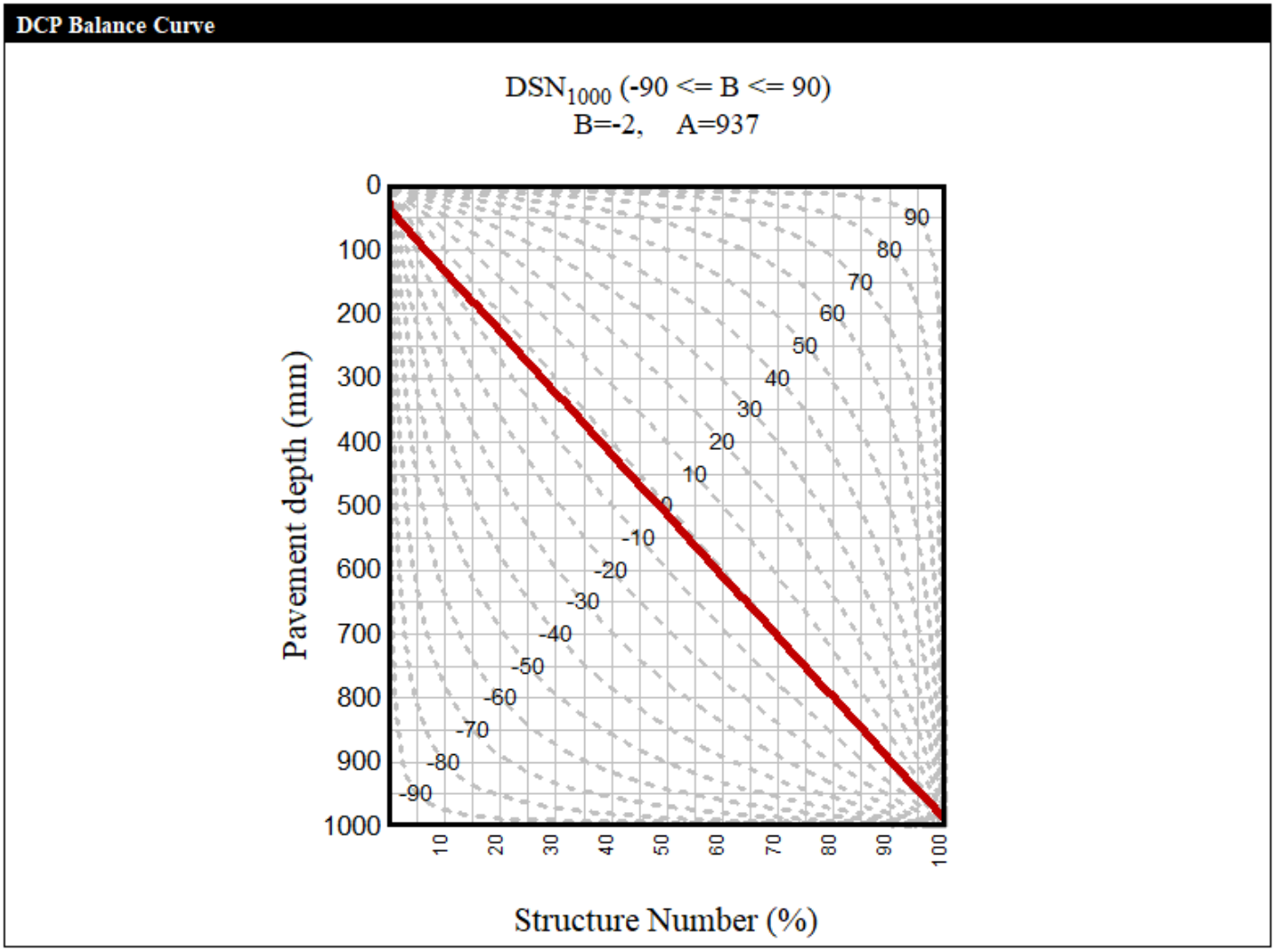
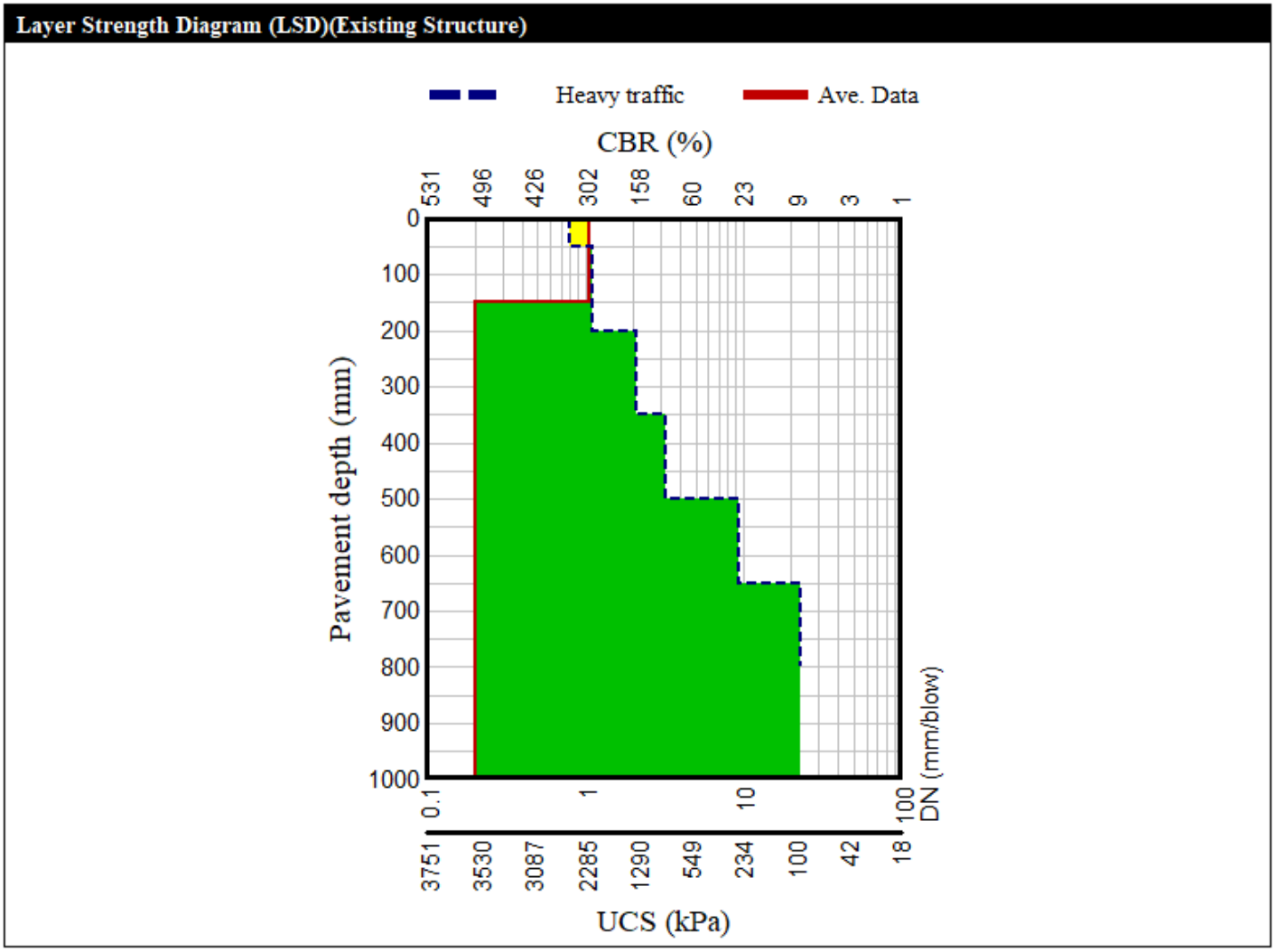
DCP 1, BORROW PIT 1.



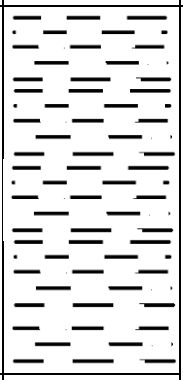
DCP 1, BORROW PIT 1.



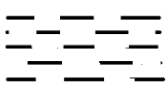
DCP 1, BORROW PIT 1.



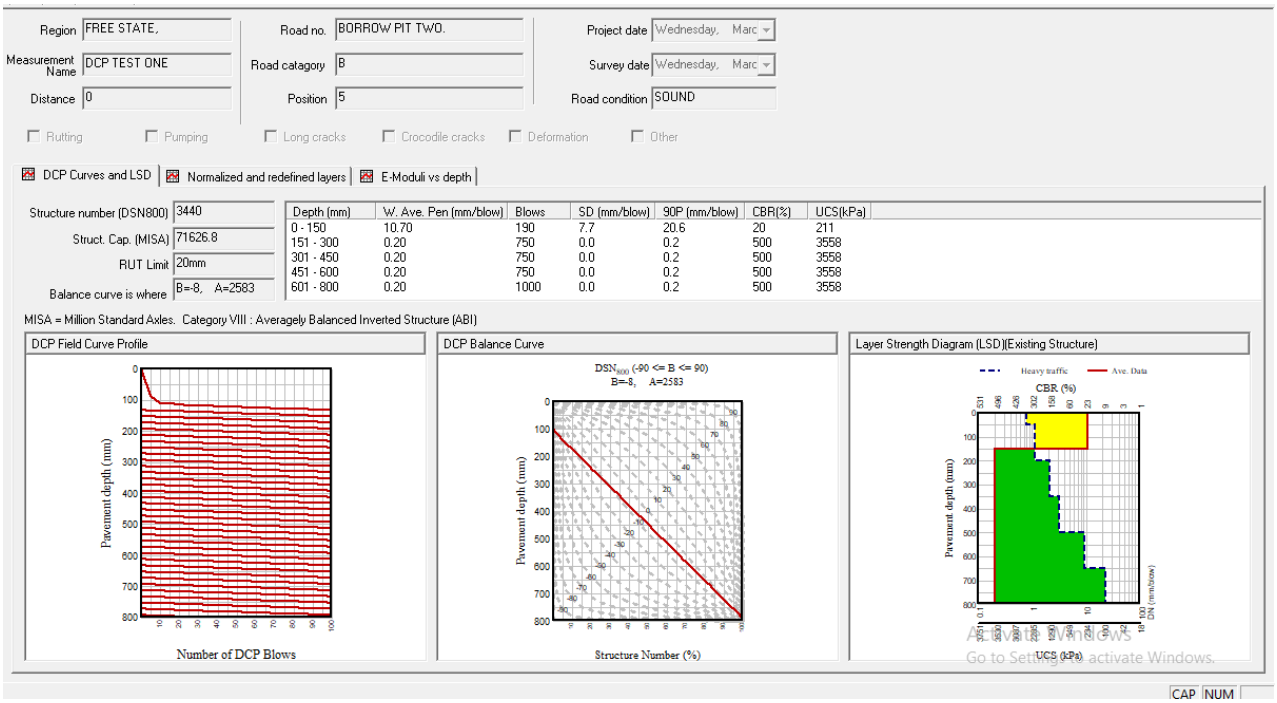
BORROW PIT 2, TEST PIT PROFILE 1.

| PROJECT: OTDC BORROW PIT 2. TEST PIT 1. PROFILED BY: LUCAS RADEBE<br>MECHINE: TLB DATE: 26th February 2021<br>GPS CO-ORDINATE: 30°37'31.78"S 25°28'49.19"E TEST PIT: 01. | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| DEPTH (mm) | | | LEGEND | DESCRIPTION | NOTES |
| 0 | | |  | Dry, reddish brown, fine to medium gained, laminated and dense, insitu, MUDSTONE rock. | Side wall of the pit stable |
| 1900 | 1900 | | Refusal | | |
| END OF HOLE:<br>1900 mm | | | | | NO Ground water seepage |

BORROW PIT 2, TEST PIT PROFILE 2.

| PROJECT: OTDC BORROW PIT 2. TEST PIT 2. PROFILED BY: LUCAS RADEBE<br>MECHINE: TLB DATE: 26th February 2021<br>GPS CO-ORDINATE: 30°37'30.78"S 25°28'52.04"E TEST PIT: 02. | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| DEPTH (mm) | | | LEGEND | DESCRIPTION | NOTES |
| 0 | 350 | |  | Dry, greyish blue, fine to medium gained, weathered, loose, residual, MUDSTONE rock. | Side wall of the pit stable |
| 350 | 350 | | Refusal | | |
| END OF HOLE:<br>350 mm | | | | | NO Ground water seepage |

## DCP 1, BORROW PIT 2.



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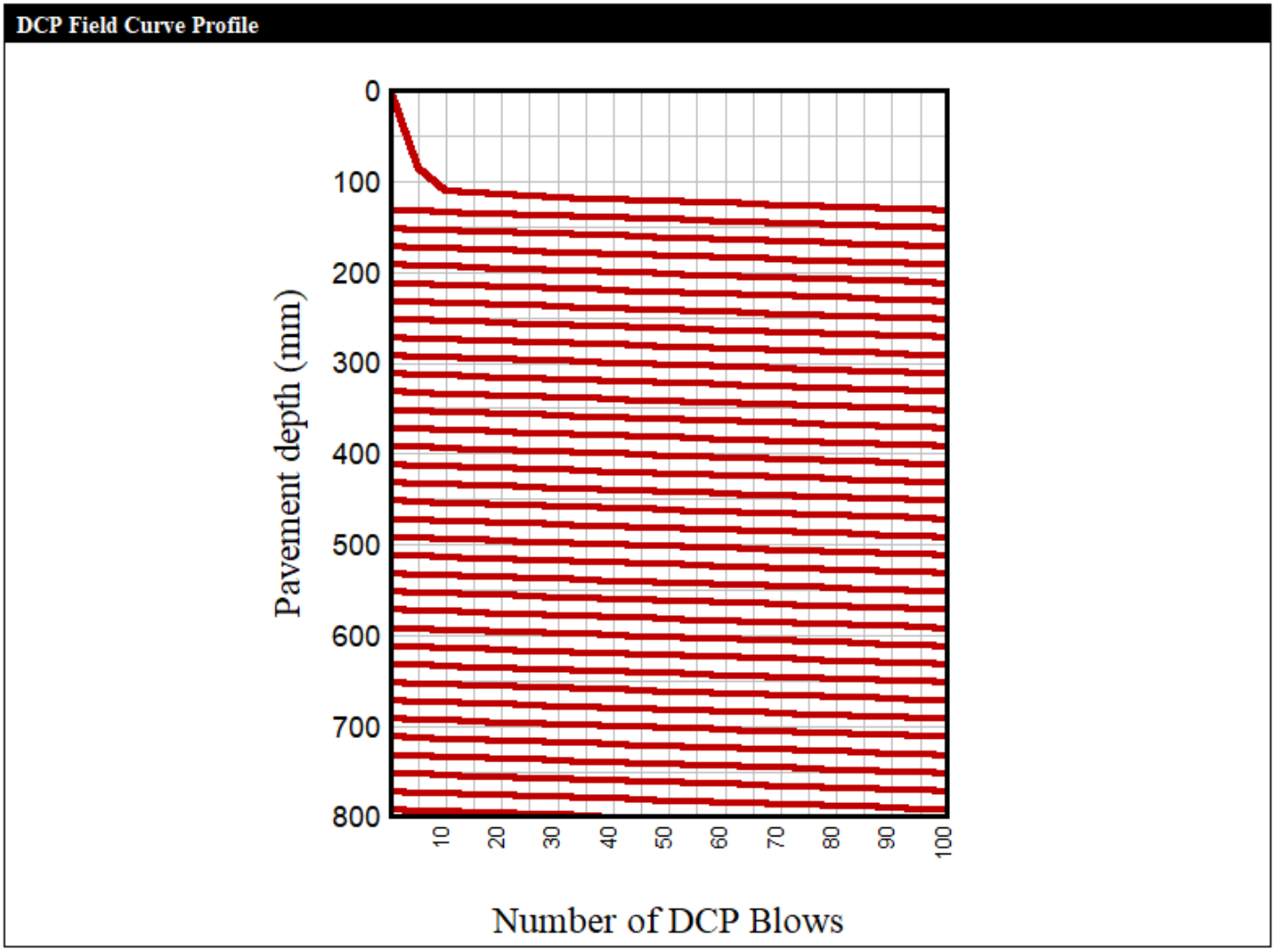
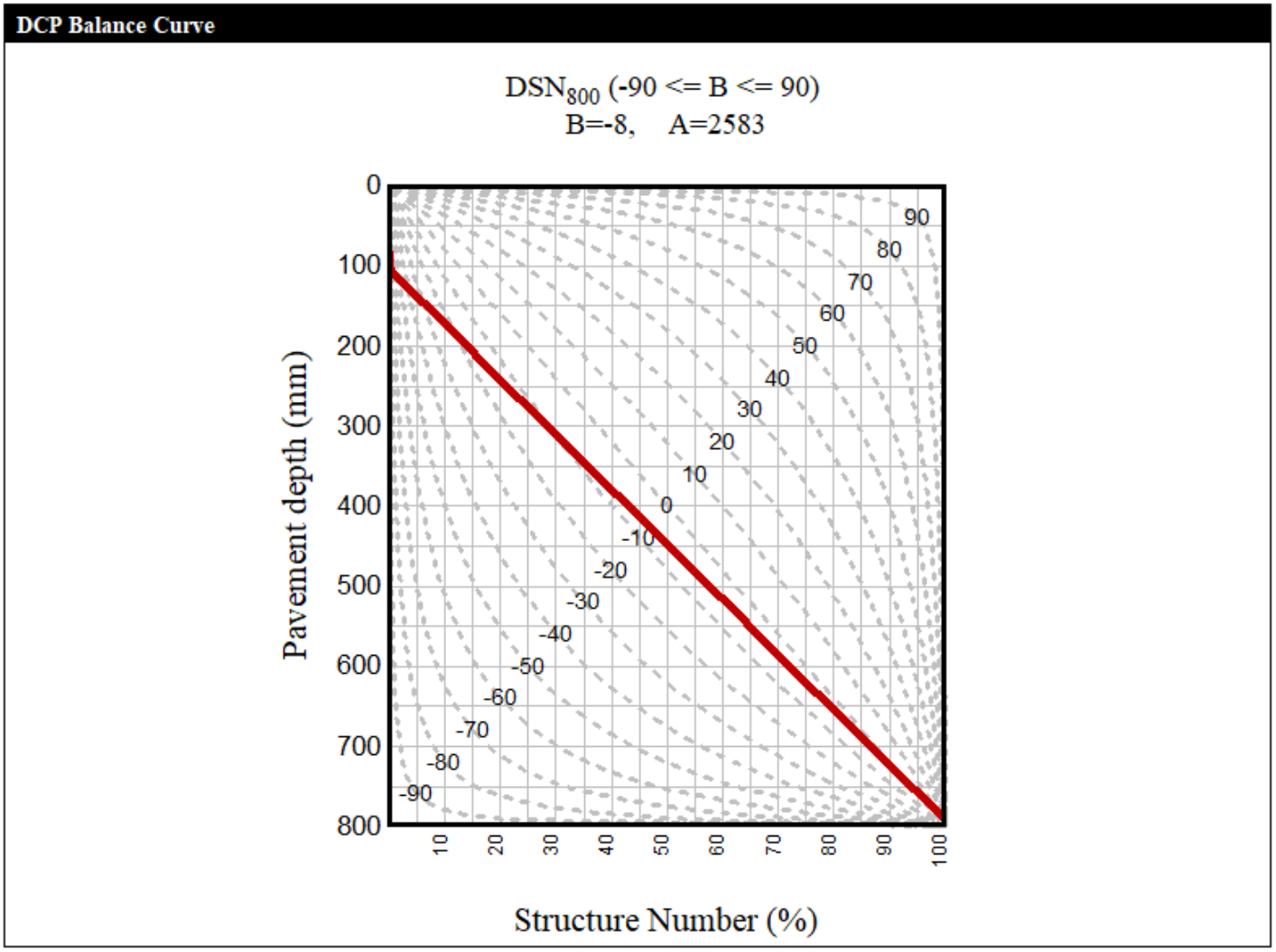
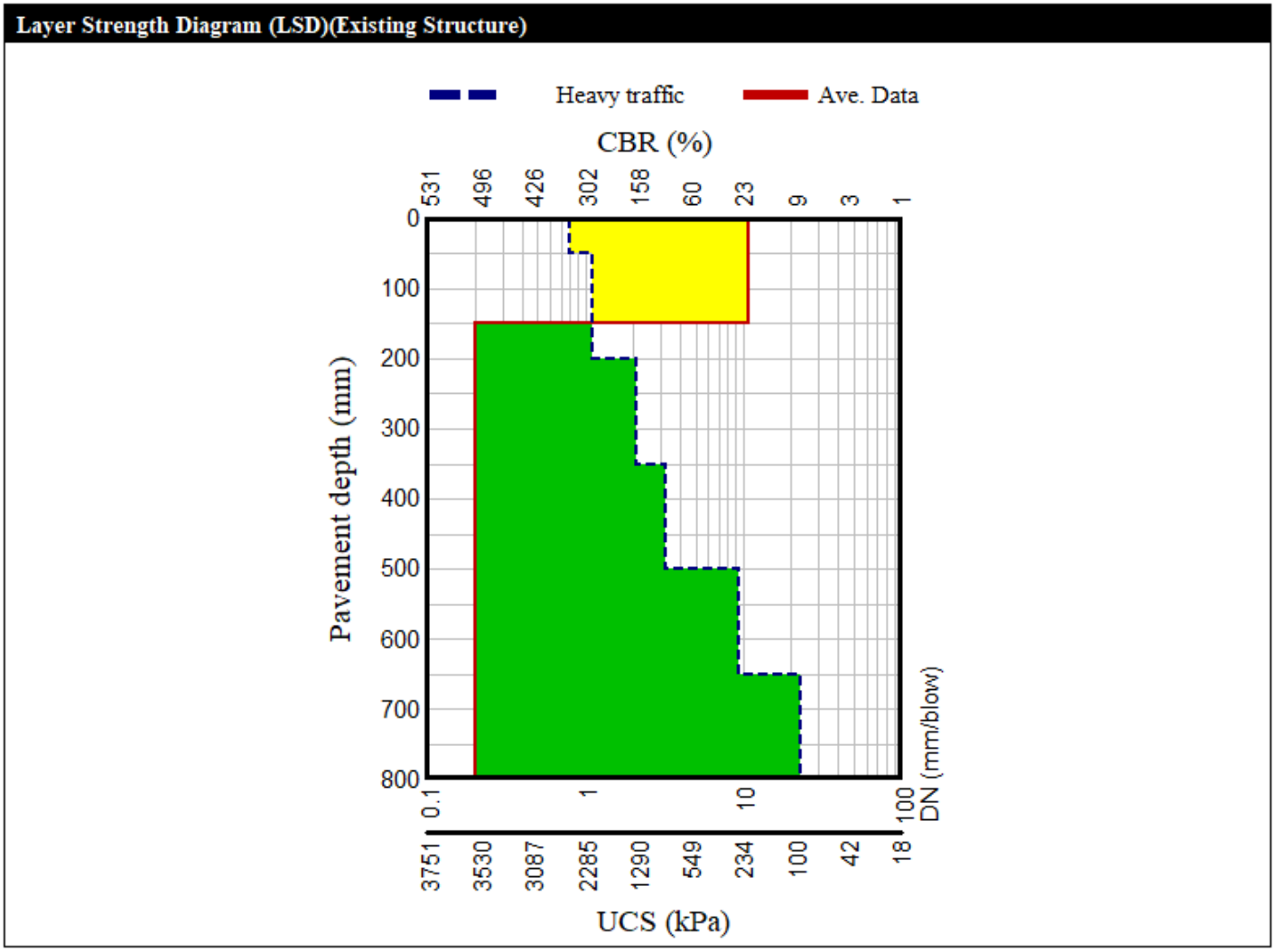
DCP 1, BORROW PIT 2.



DCP 1, BORROW PIT 2.



DCP 1, BORROW PIT 2.




NB DCP TEST 2 WWITHIN BORROW PIT 2 IS DISCARDED, DUE TO ROCK OUTCROPS.

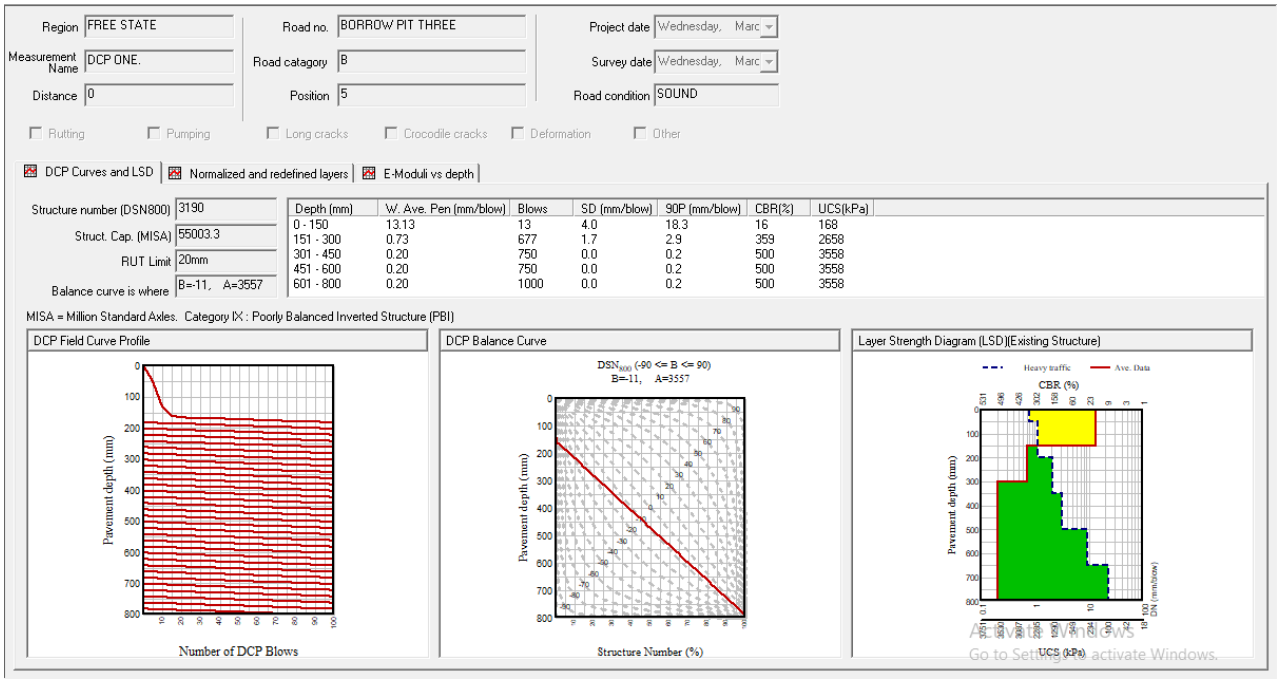
BORROW PIT 3, TEST PIT 1.

| PROJECT: OTDC BORROW PIT 3. TEST PIT 1. PROFILED BY: LUCAS RADEBE<br>MECHINE: TLB DATE: 26th February 2021<br>GPS CO-ORDINATE: 30°36'40.46"S 25°28'59.43"E TEST PIT: 03. | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| DEPTH (mm) | | | LEGEND | DESCRIPTION | NOTES |
| 0 | 320 | |  | Dry, yellowish to brown, fine to medium grained, weathered, loose, residual REGOLITH, MUDSTONE, DOLERITE DYKE and subordinate SANDSTONE rock. | Side wall of the pit stable |
| 320 | 320 | | Refusal | | |
| END OF HOLE:<br>320 mm | | | | | NO Ground water seepage |

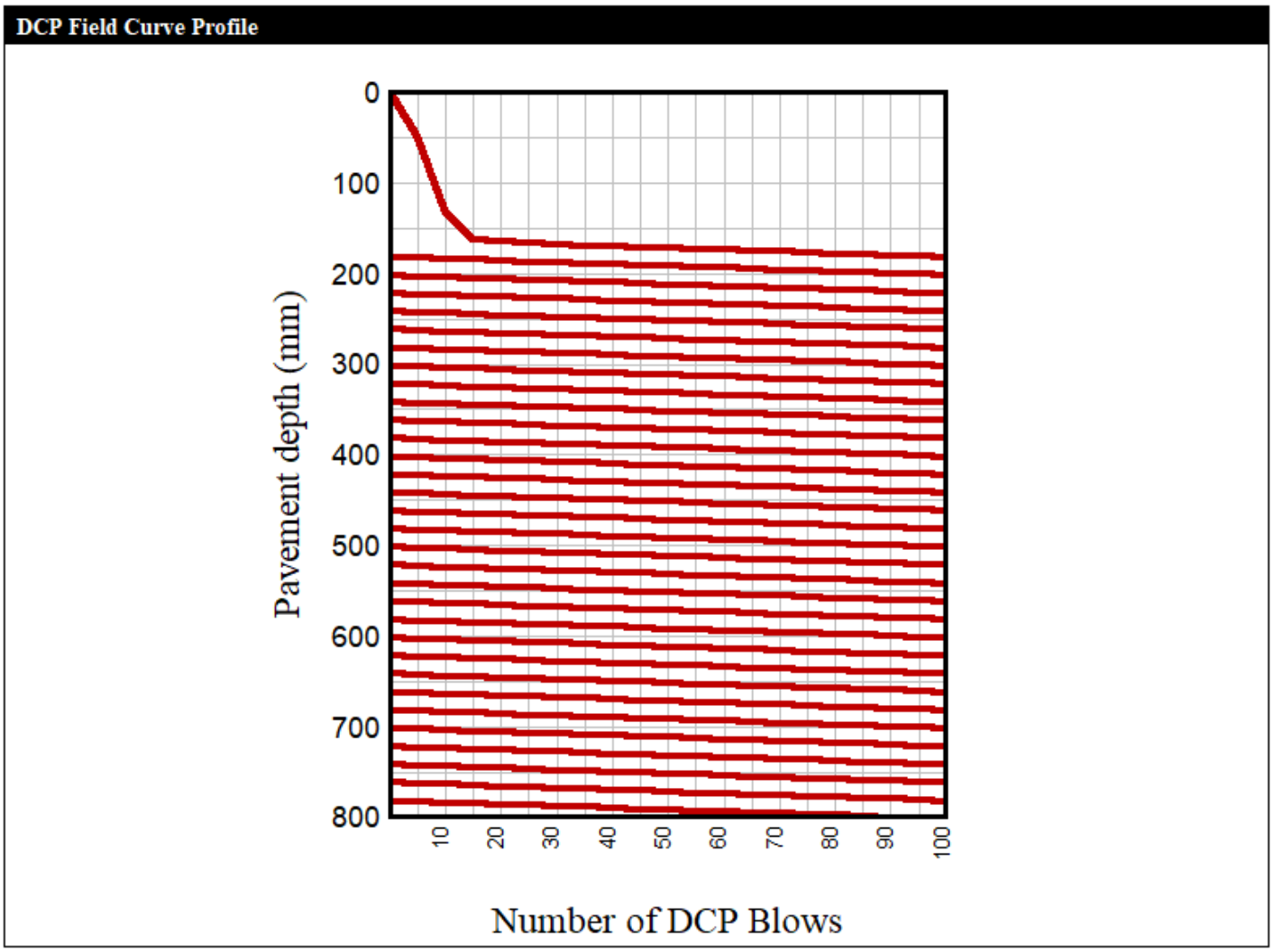
BORROW PIT 3, TEST PIT 2.

| PROJECT: OTDC BORROW PIT 3. TEST PIT 2. PROFILED BY: LUCAS RADEBE<br>MECHINE: TLB DATE: 26th February 2021<br>GPS CO-ORDINATE: 30°36'39.06"S 25°29'0.22"E TEST PIT: 03. | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| DEPTH (mm) | | | LEGEND | DESCRIPTION | NOTES |
| 0 | 315 | |  | Dry, yellowish to brown, fine to medium grained, weathered, loose, residual REGOLITH, MUDSTONE, DOLERITE DYKE and subordinate SANDSTONE rock. | Side wall of the pit stable |
| 315 | 315 | | Refusal | | |
| END OF HOLE:<br>315 mm | | | | | NO Ground water seepage |

DCP 1, BORROW PIT 3.

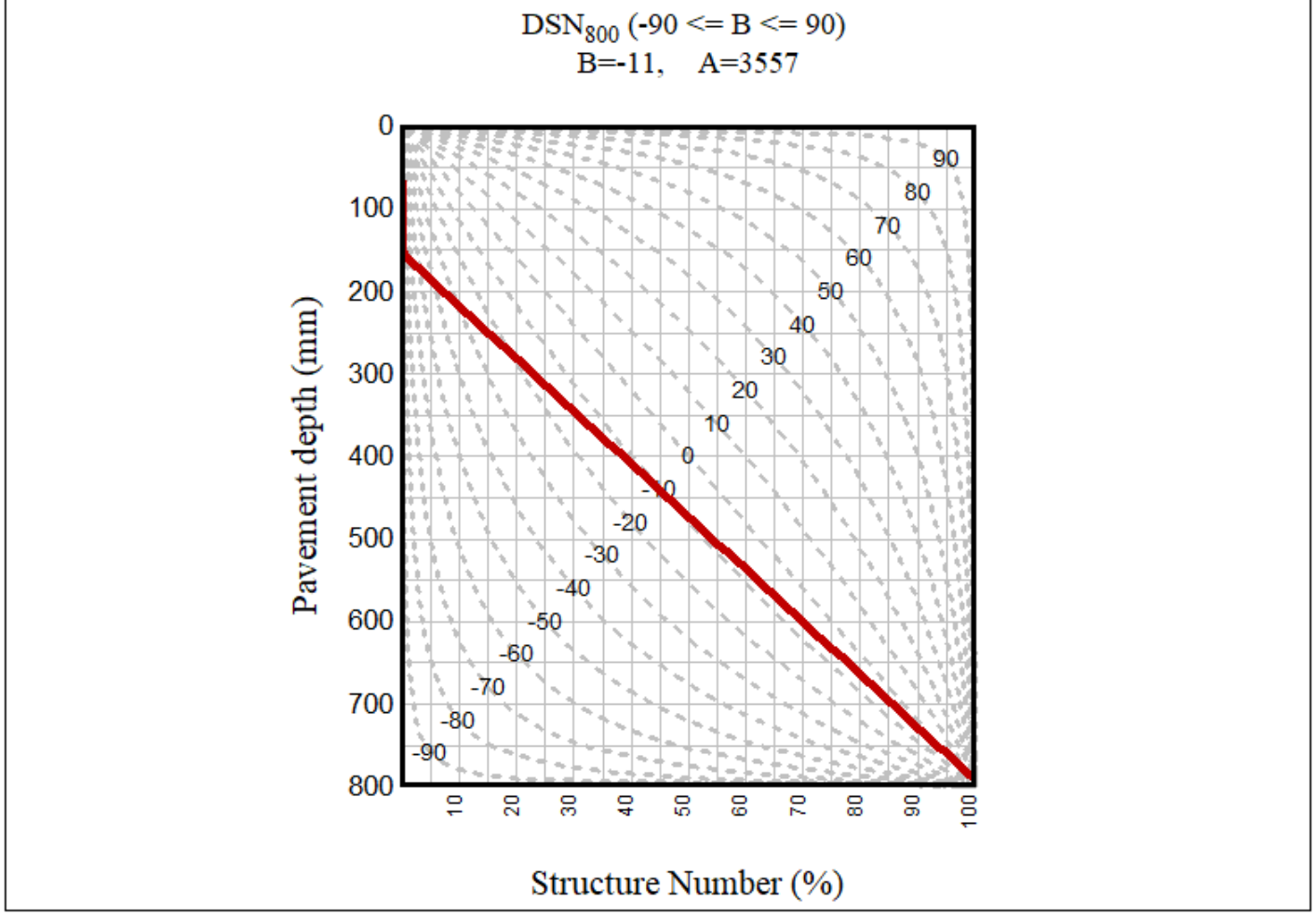


DCP 1, BORROW PIT 3.

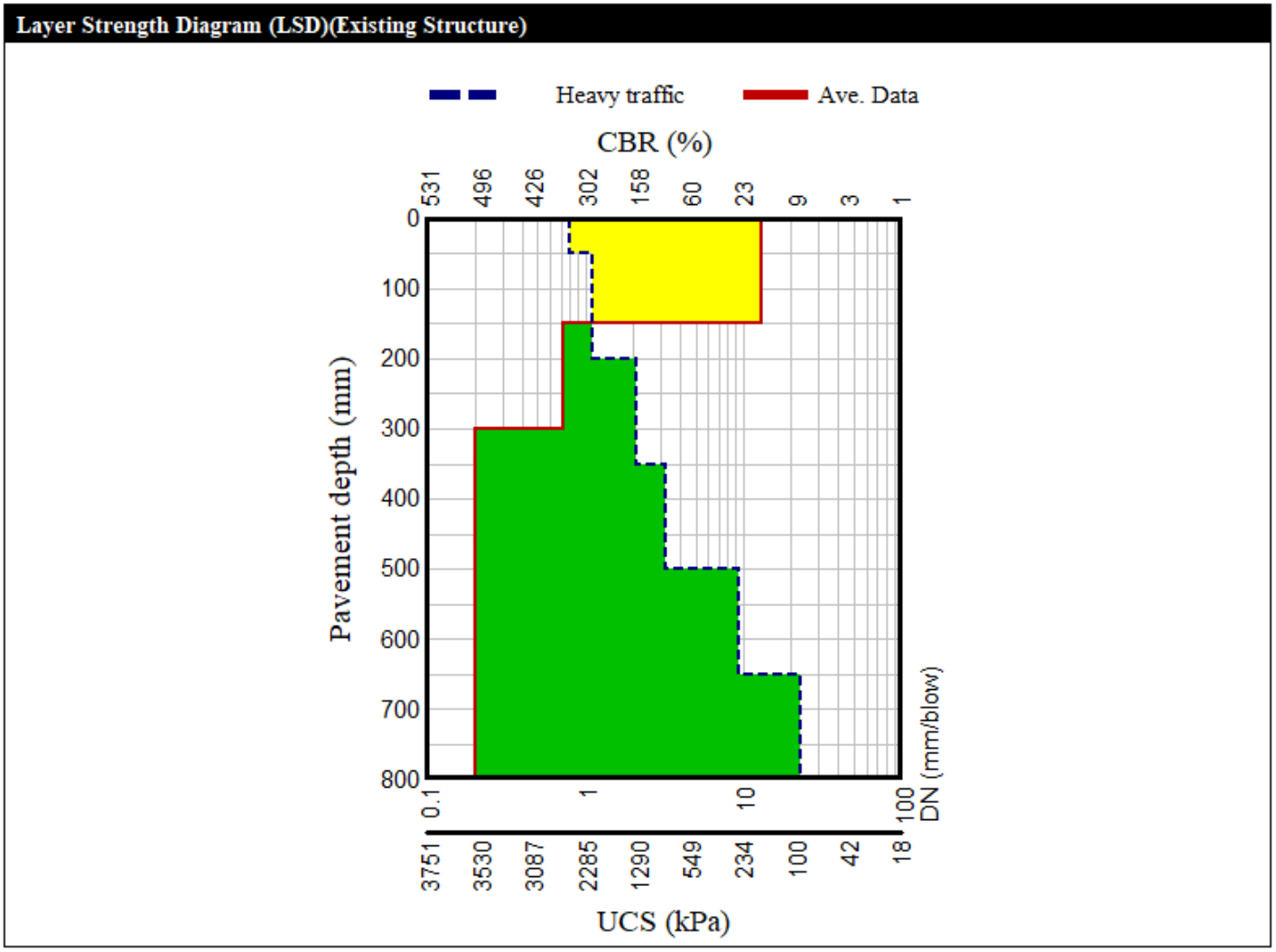


DCP 1, BORROW PIT 3.

**DCP Balance Curve**



DCP 1, BORROW PIT 3.




NB DCP TEST 2 WWITHIN BORROW PIT 3 IS DISCARDED, DUE TO ROCK OUTCROPS.

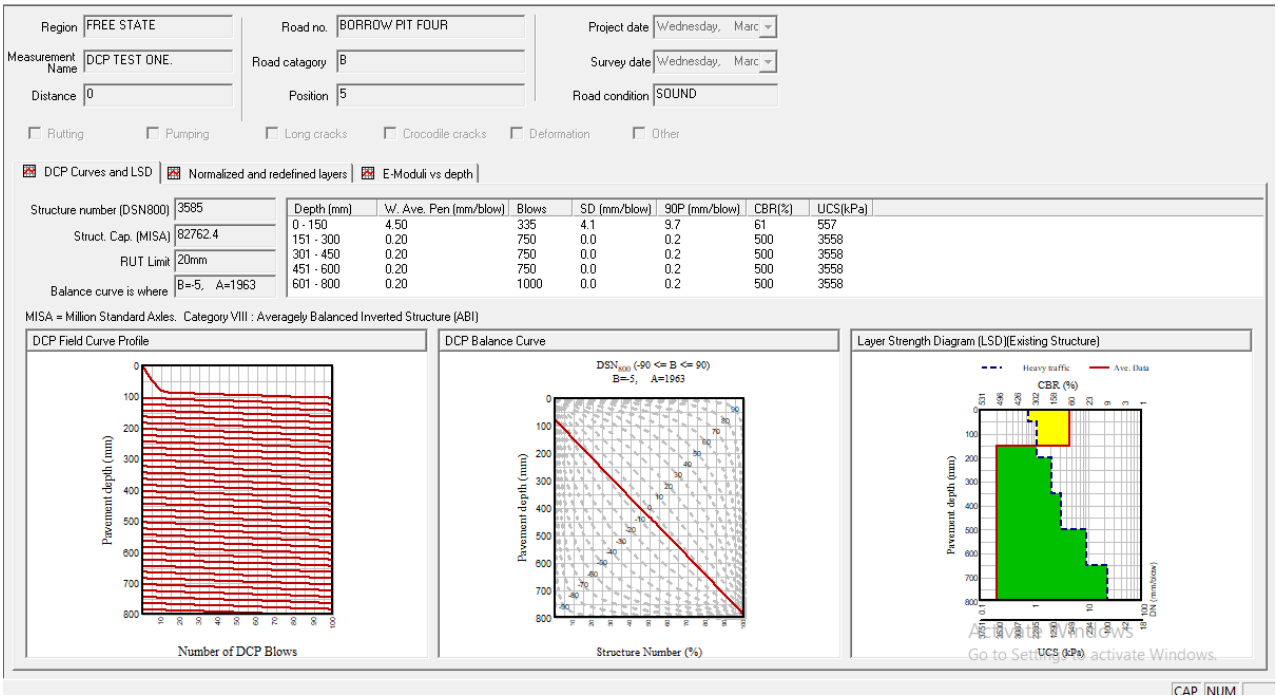
BORROW PIT 4, TEST PIT 1.

| PROJECT: OTDC BORROW PIT 4. TEST PIT 1. PROFILED BY: LUCAS RADEBE<br>MECHINE: TLB DATE: 26th February 2021<br>GPS CO-ORDINATE: 30°36'40.20"S 25°28'31.32"E TEST PIT: 01. | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| DEPTH (mm) | | | LEGEND | DESCRIPTION | NOTES |
| 0 | 320 | |  | Dry, yellowish to brown, fine to medium grained, weathered, loose, residual REGOLITH, MUDSTONE, DOLERITE DYKE and subordinate SANDSTONE rock. | Side wall of the pit stable |
| 320 | 320 | | Refusal | | |
| END OF HOLE:<br>320 mm | | | | | NO Ground water seepage |

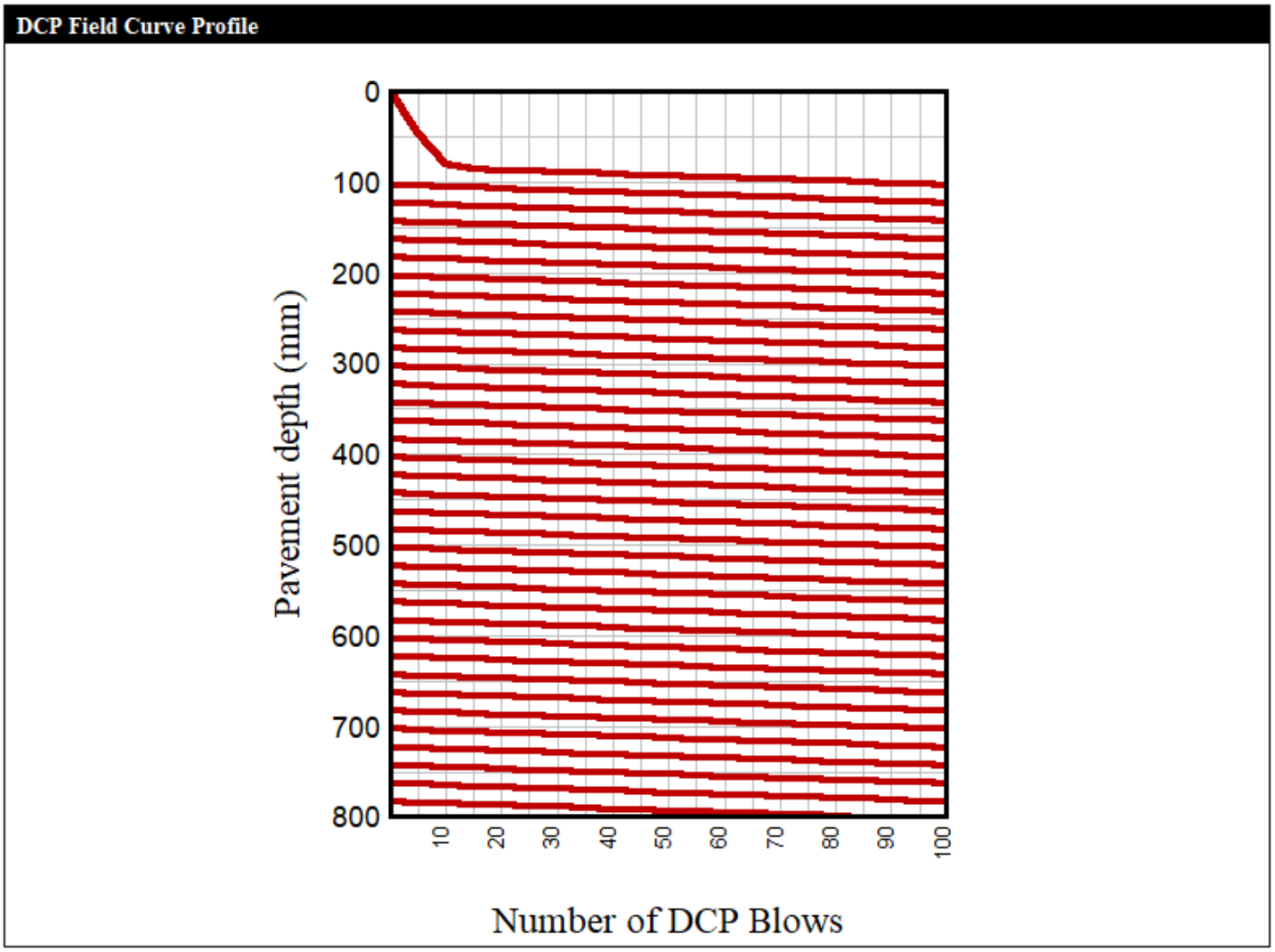
BORROW PIT 4, TEST PIT 2.

| PROJECT: OTDC BORROW PIT 4. TEST PIT 2. PROFILED BY: LUCAS RADEBE<br>MECHINE: TLB DATE: 26th February 2021<br>GPS CO-ORDINATE: 30°36'37.86"S 25°28'32.68"E TEST PIT: 02. | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| DEPTH (mm) | | | LEGEND | DESCRIPTION | NOTES |
| 0 | 315 | |  | Dry, yellowish to brown, fine to medium grained, weathered, loose, residual REGOLITH, MUDSTONE, DOLERITE DYKE and subordinate SANDSTONE rock. | Side wall of the pit stable |
| 315 | 315 | | Refusal | | |
| END OF HOLE:<br>315 mm | | | | | NO Ground water seepage |

## DCP 1, BORROW PIT 4.

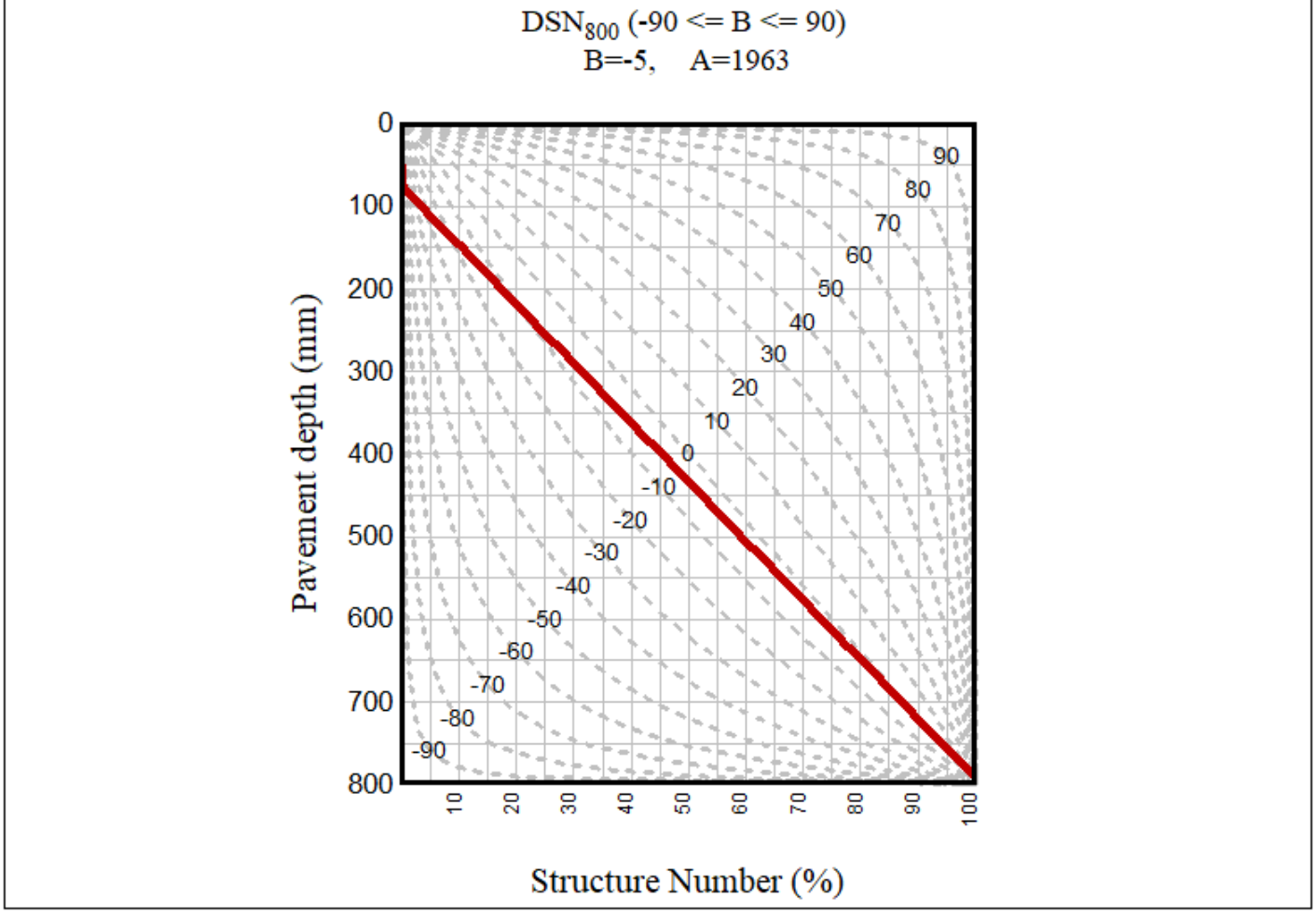


DCP 1, BORROW PIT 4.

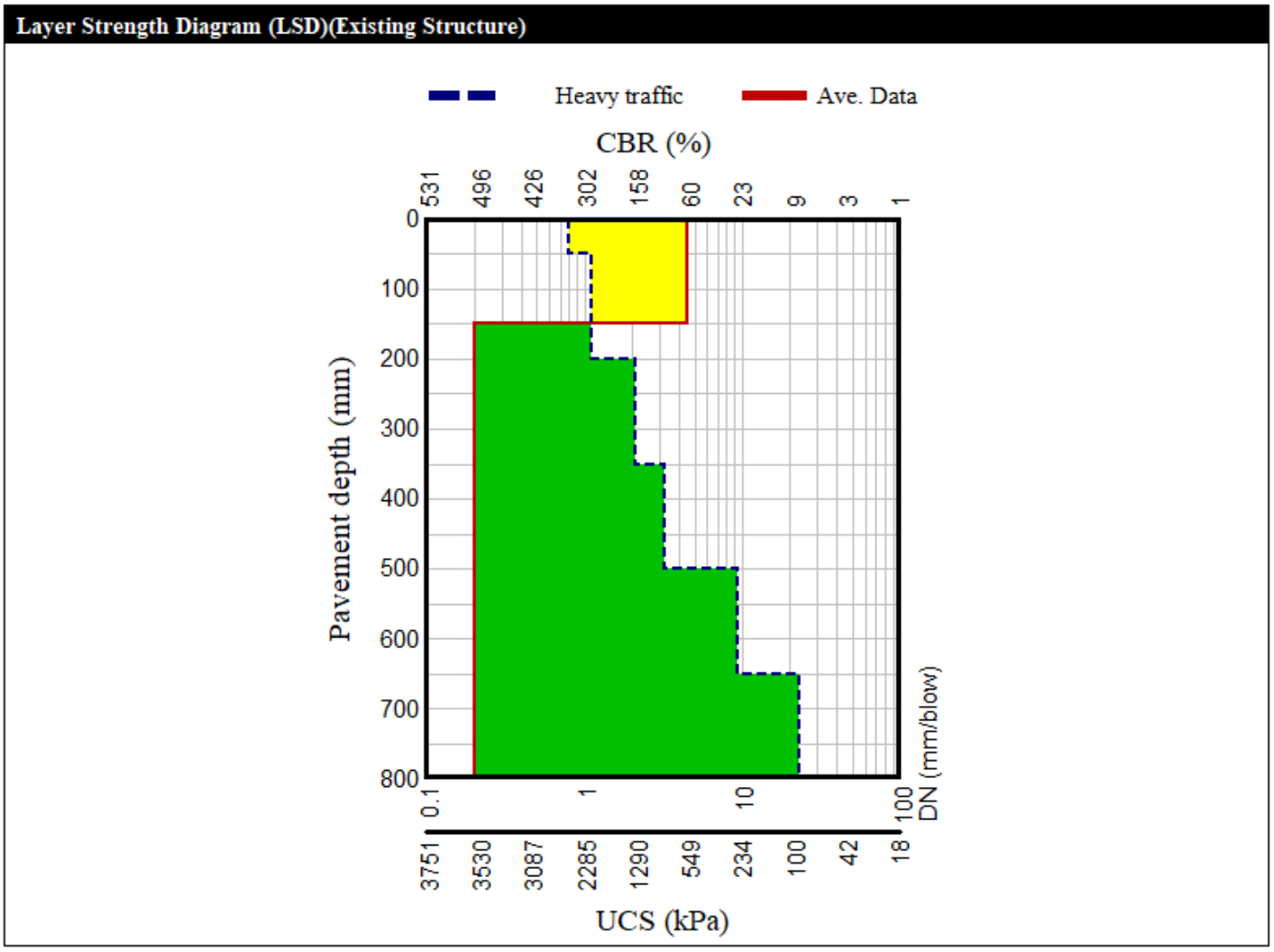


DCP 1, BORROW PIT 4.

**DCP Balance Curve**



DCP 1, BORROW PIT 4.




NB DCP TEST 2 WWITHIN BORROW PIT 4 IS DISCARDED, DUE TO ROCK OUTCROPS.