BRYPAAL SOLAR POWER (PV) PROJECT APRIL 2018

Geotechnical Investigation

Remainder of Portion 4 of the

farm Brypaal No. 134

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TITLE AND APPROVAL PAGE

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Declaration of Consultant's Independence

I Pieter Willem van Deventer, as the appointed independent specialist hereby declare that I:

- Acted as the independent specialist in this application;
- Regard the information contained in this report as it relates to my specialist input/study to be true and correct;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- Have disclosed any information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- Am fully aware of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- Have provided the competent authority with access to all information at my disposal regarding the application;
- Am aware that a false declaration is an offence in terms of regulation 71 of GN No. R. 543.

Pieter Willem van Deventer
P.W. van Deventer [Pr.Sci.Nat.2: 400075/08]

1 Introduction and Terms of Reference

1.1 Scope

This report presents the findings and results of a geotechnical investigation and surface soils resistivity survey undertaken approximately 60 km south west of Kakamas, Northern Cape. The proposed development will comprise a photovoltaic solar plant with associated infrastructure i.e. sub-station, maintenance facilities, office block, access tracks and roads. A lay out area for the construction phase is also included in the Development plan. The proposed solar plant together with office block, sub-station and maintenance facilities will cover an area of 320 ha. A reconnaissance survey and assessment was done on an initial area of 1032 Ha before the final 320 Ha was identified.

1.2 Terms of Reference

The work was carried out for Vintage Energy (Pty) Ltd, in accordance with our quote and negotiations and amendments and the instructions for the Kakamas Brypaal PV solar system. Mr Jan du Preez is the responsible person and representative from Vintage Energy and all negotiations were done with him.

Figure 1: Example of PV Solar Facility (Source: *www.pv-tech.org*).

1.3 Development Aspects

The proposed Solar Facility will have a peak power generating capacity of approximately 100 MW, and will consist of the following:

- Module Mounting structures 2 tier;
- String Inverters – 60 KVA;
- PV Modules – 250 WP;
- Meteor stations;
- Power reducer Boxes;
- Power Plant Controllers;
- Cluster Controllers;
- LV Substations;
- MV Substations;
- Access roads (temporary & permanent roads);
- Permanent office/workshop building.

A temporary laydown area was identified [workshops, mobile offices, mobile ablution facilities, material storage area, vehicle parking area, water tanks for drinking, construction and dust suppression) fencing, etc.]. The main activities during the construction phase area:

- Permanent living quarters for operational phase workers (only for residential staff). The rest of the staff will stay in Kakamas;
- Equipment (Trucks & front-end loaders, excavators, cranes, etc.);
- Topsoil/Overburden stockpiles/fill material. Topsoil stripping and stockpiling will be required only for the service roads and sub-station foundations. No concrete slabs or foundations are required for the screw-in pylons;
- Opencast quarries/excavations for cut and fill material. Very limited for roads and sub-station only, the rest of the construction site will follow a non-destructive-surface-topography approach because no foundations are required for the screw-in pylons;
- Water storage facilities (reservoir, tanks, etc.) mainly for construction phase;
- Water Desalination plant (pipelines towards water storage and power plant). Very small, just for standby water supply. The rest of the operational water will be transported from Kakamas or extracted from boreholes. Limited water is required for the washing of the PV-panels because nano-technology will be applied to the surface of the panels, which keeps it virtually clean for very long periods of time and washing of the panels will be required only once a year or even longer intervals;

- Waste handling facilities (for construction & operational phase). Solid, hydrocarbon and liquid waste to be sorted on site and keep in certified appropriate containers and to be removed to certified land fill sites.
- Surface run-off control systems. A non-destructive surface topography will be followed during the construction phase, drainage systems will be avoided, therefore surface runoff structures for instance trenches, canals, etc. will not be implemented and no large scale desalination plants and evaporation ponds will be constructed because of low water requirements for operational phase.
- A 400kV high voltage overhead grid connection of approximately 500 m between the substation at the solar facility and the Aries – Kokerboom 400 KV line.

Total footprint of the 100 MW PV solar farm will be approximately 320 ha. The terms of the land owner agreement for this project provides allowance for a 36 month construction period and foresees the use as a PV Solar facility for up to 25 years. During this period, it is anticipated that the PV modules may be replaced, however the primary plant and electrical infrastructure would be suitable for this intended project life.

1.4 Aims and Methodology

The objectives of the study are:

- To do a background desk top analysis on geological and other physiographic aspects which could have an influence on the construction of the proposed site or which could have an influence on design or decisions parameters for the development of the site.

- To do a geotechnical assessment of relevant conditions present, assess the general suitability of the site and to make recommendations for site works for the proposed development.

- To comment on geotechnical factors that would have an impact on the development of the site to enable economic and proper design and construction of the proposed development.

- To identify relevant surface related features and determine the variability of ground conditions and the effect of such variability on the proposed development.

- To assess the surface electrical resistivity of the area under discussion and the effect on the proposed development.

The following methodology was adopted to comply with the aims and objectives of the study:

- Review of available geological records and site plans and site conditions.

- Undertaking of a geotechnical site investigation comprising TLB excavated trial pits to profile soils up to bedrock, investigate soil consistency, strengths/capacities and identify potential problem soils on site.

- Undertake a penetration resistance investigation (HDPS) to determine the soil consistency conditions and related shear strength.
- Undertaking of laboratory testing to establish geotechnical indicator tests and design parameters of the soils.
- Identification of relevant ground-related features and their influence on the proposed development.

1.5 Codes of Practice and Standards

The investigation was carried out according to standard practice codes and guidelines. Reference has specifically been made to:

- Guide to practical Geotechnical Engineering in Southern Africa (2008).
- SAICE and IStructE Code of Practice for foundations of single storey masonry buildings.
- The 2010 SAICE Geotechnical Division Site Investigation Code of Practice.

1.6 Limitations of Assessment

The investigation comprised a total of 43 trial pits on the 1032 Ha and 18 on the final area to be developed. These trial pits are not likely to reveal all the detail of the conditions that will become evident during construction due to the highly variability of the lithology and rock outcrops. It is therefore imperative that a **Competent Person** inspects all analyses and attend the site investigations and excavations prior to the construction phase to ensure that conditions at variance with those predicted in this report do not occur. The **Competent Person** has to undertake a site-specific investigation and interpretation of the facts supplied in this report and other specialist studies to apply to on-site conditions as exposed during development of the site. It is possible that certain indications of ground contamination of groundwater levels were latent or otherwise not visible due to the time of assessment. Our opinions can only be based on what was visible at the time the geotechnical assessment was conducted in March to May 2017.

This report has been prepared for the exclusive use of the client, with specific application to the proposed project and the specific site under discussion.

2 Description of Site and Surrounding Area

2.1 Information Sources

The following information sources were consulted and made available:

- Geological maps from various authors;
- Google Maps;
- General layouts provided by the client;
- Published technical references;
- Other Specialist reports for the Kakamas Brypaal PV System.

2.2 Site Location

The proposed development is on remainder of Portion 4 of the farm Brypaal No.134, approximately 60 km south south-west of Kakamas in the Kai !Garib Local Municipality in the Northern Cape of South Africa. The locality plan is shown in Figure 2 and the final lay out plan for the proposed locality are shown in Figure 3.

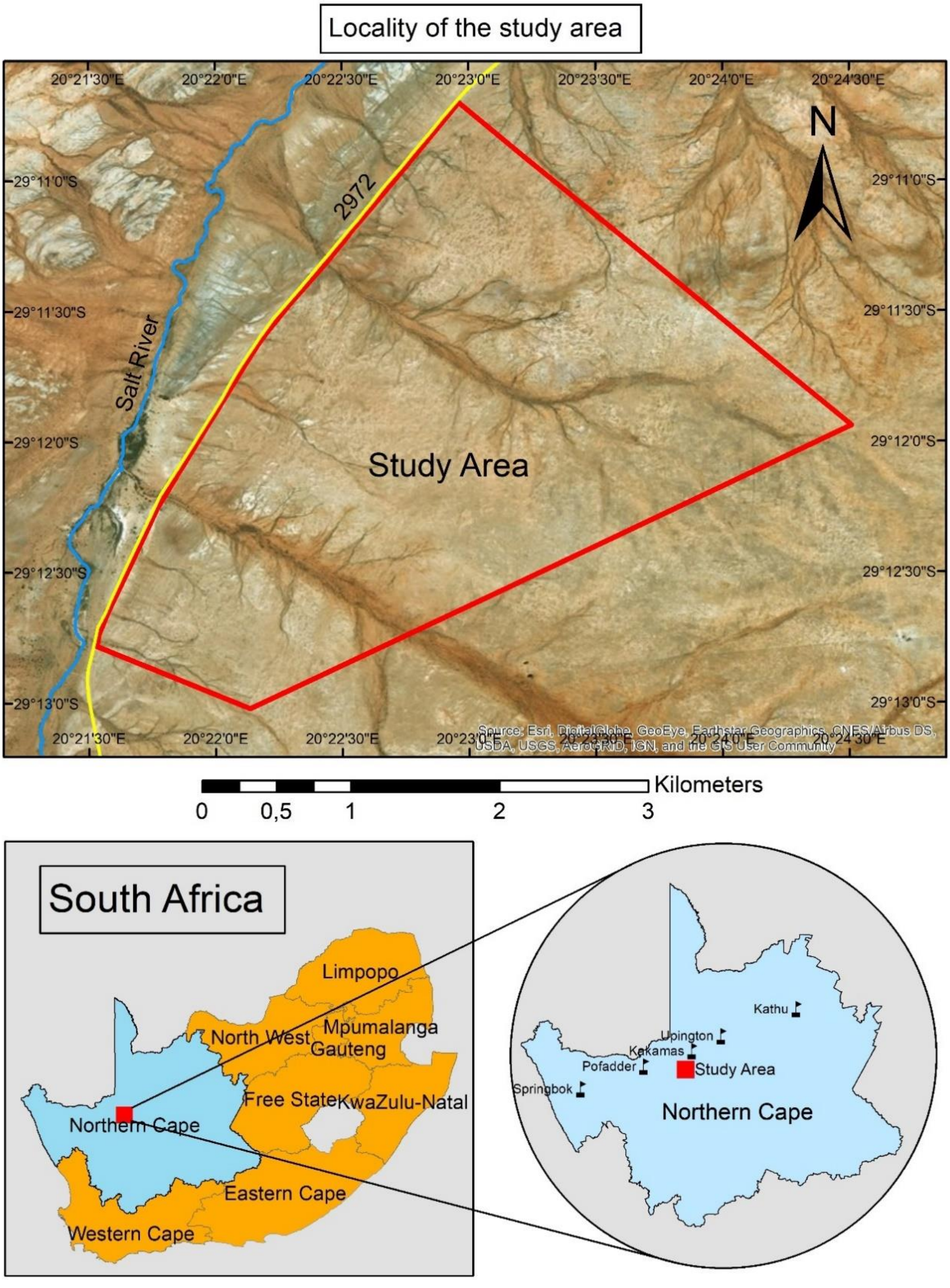

Figure 2: Locality map of the reconnaissance study area (Red line shows the boundaries of the area where the reconnaissance assessment was conducted) (Google Earth, 2016).

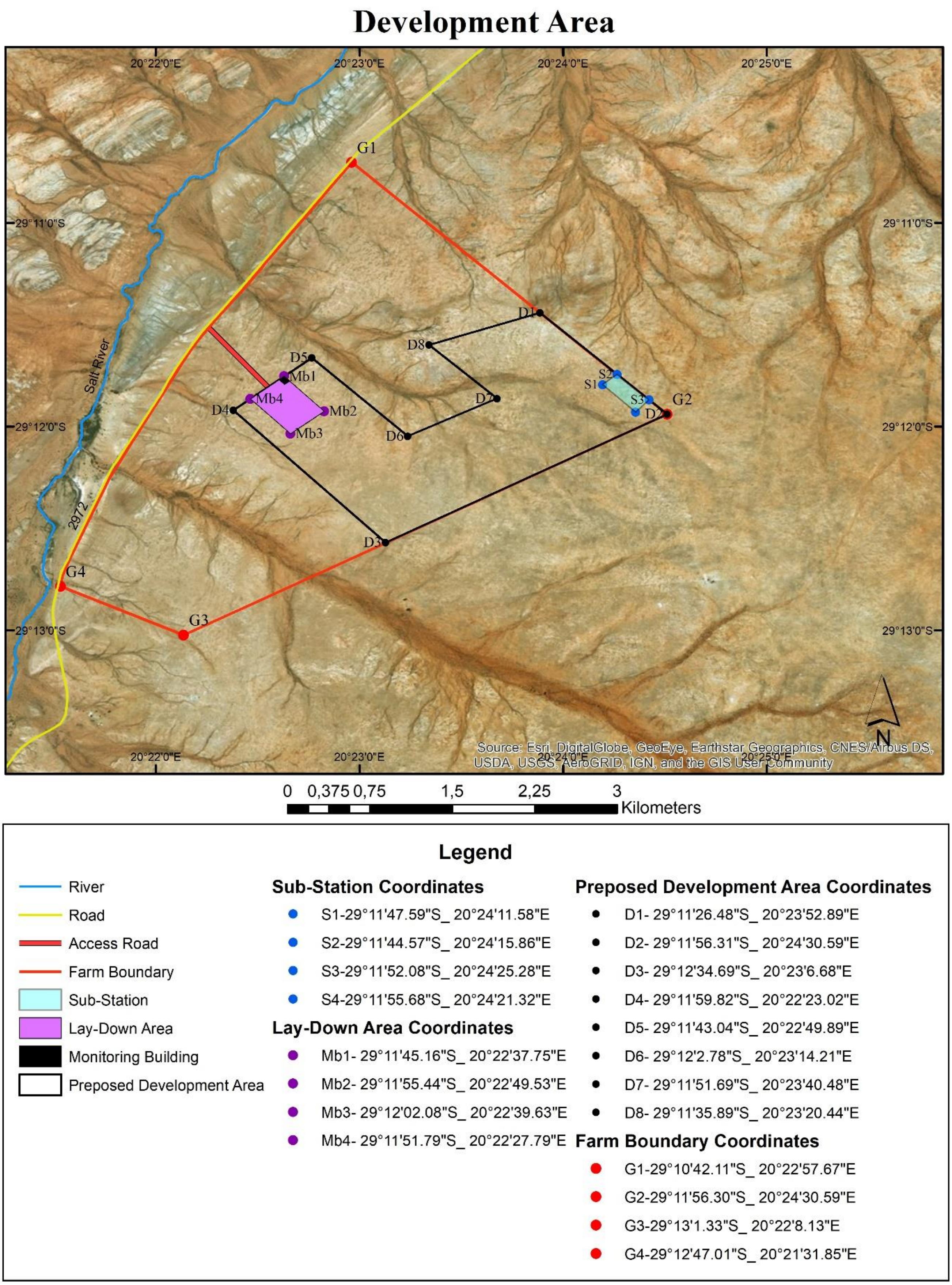

Figure 3: Map indicating the proposed development area (Google Earth, 2016).

2.3 Site Description and Physiographic Background

2.3.1 Climate and Rainfall

As illustrated in Figure 4, the study area forms part of the semi-arid Bushmanland region and falls within the very late summer rainfall region (Schulze, 1997). According to meteorological statistics from the South African Weather Services (Weather Bureau, 2016) (Figure 5 – Figure 8) the average annual rainfall for this area, from 1992 up to 2015, was between 140 mm and 250 mm per annum.

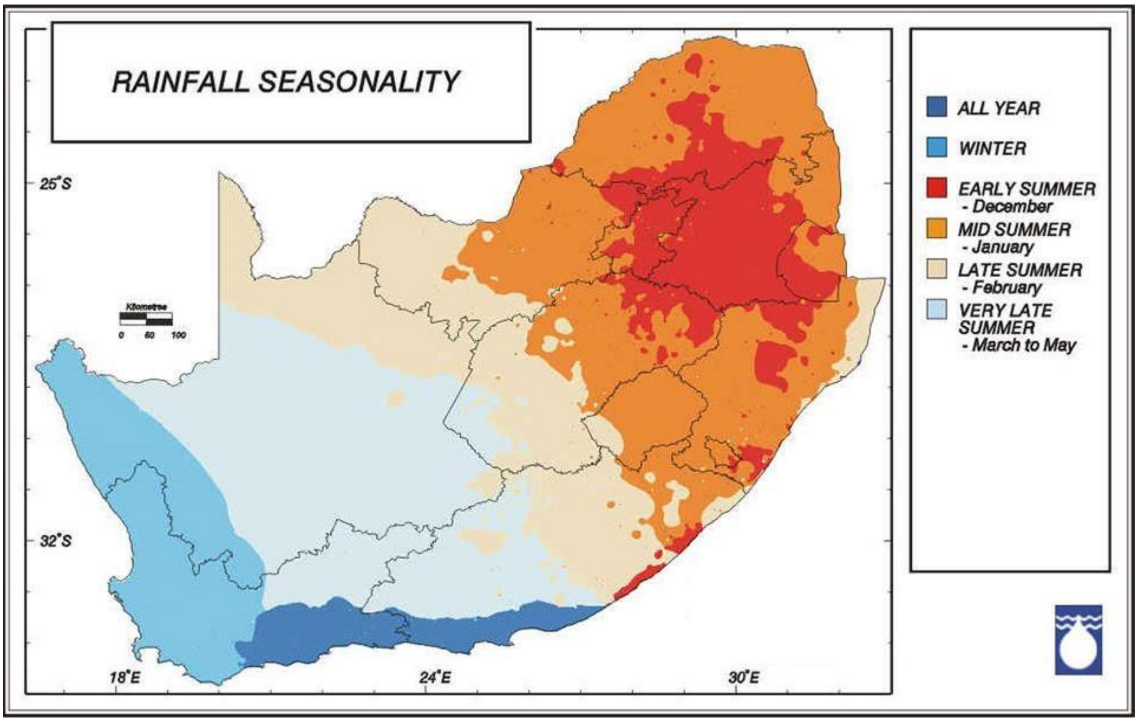

Figure 4: Map indicating the rainfall seasonality in South Africa (Schulze, 1997).

Figure 5 and Figure 6 revealed that severe drought conditions were experienced during 1992, 2003, 2004 and 2013. The variation in average temperatures within this area is extreme with maximum temperatures during the summer reaching up to 40.8 °C and minimum temperatures as low as -3 °C. Figure 7 illustrates the daily maximum temperatures (°C) for the Pofadder area while the daily minimum temperatures (°C) (measured at 8 am in the morning) for the same area are illustrated in Figure 8.

Daily maximum temperatures (Figure 7) range from an average of 35 °C (January) to 17 °C (June) with daily minimum temperatures (Figure 8) ranging from an average of 19 °C (February) to 4 °C (July). According to Mucina and Rutherford (2006) this site forms part of an area with a mean annual evaporation potential of 2771 mm per annum, experiencing between 21 and 30 mean frost days per annum.

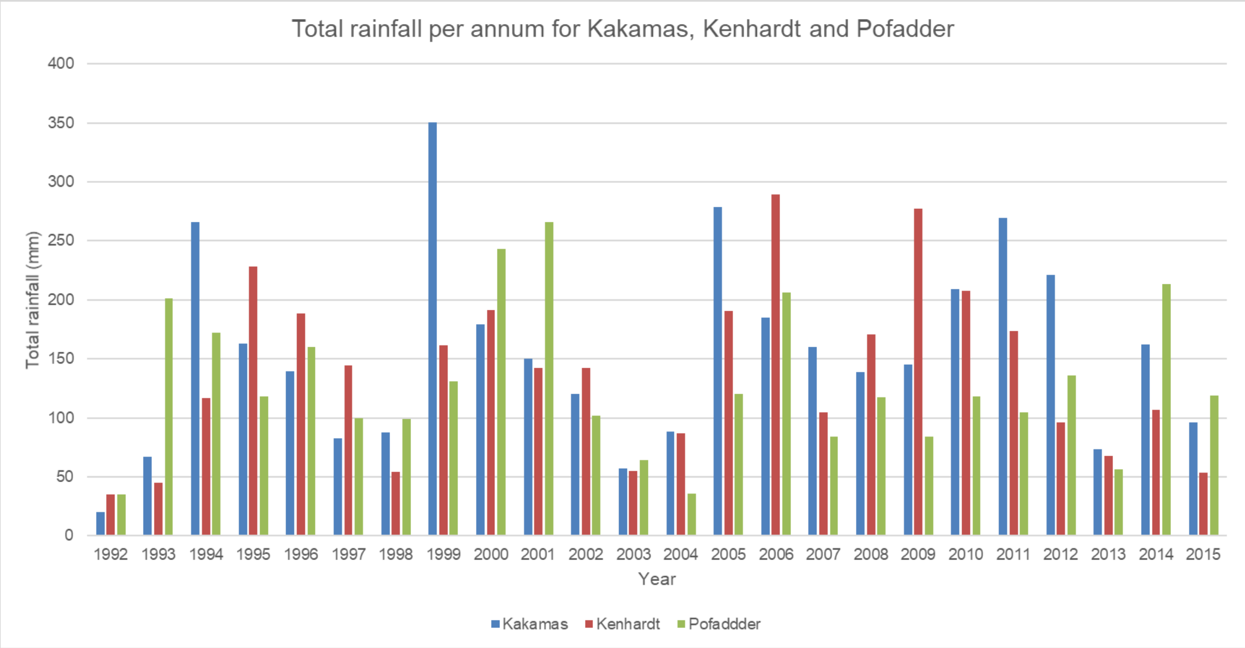

Figure 5: Total rainfall per annum for Kakamas, Kenhardt and Pofadder respectively (Weather Bureau, 2016).

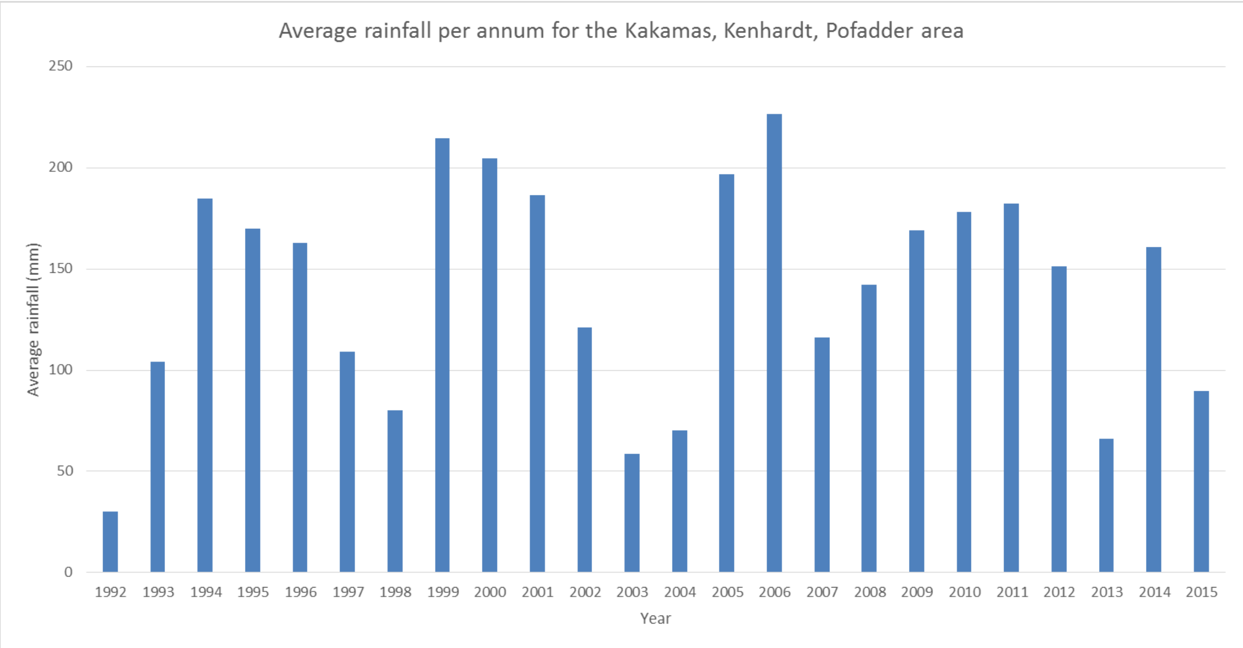

Figure 6: Average rainfall per annum for the Kakamas, Kenhardt and Pofadder area (Weather Bureau, 2016).

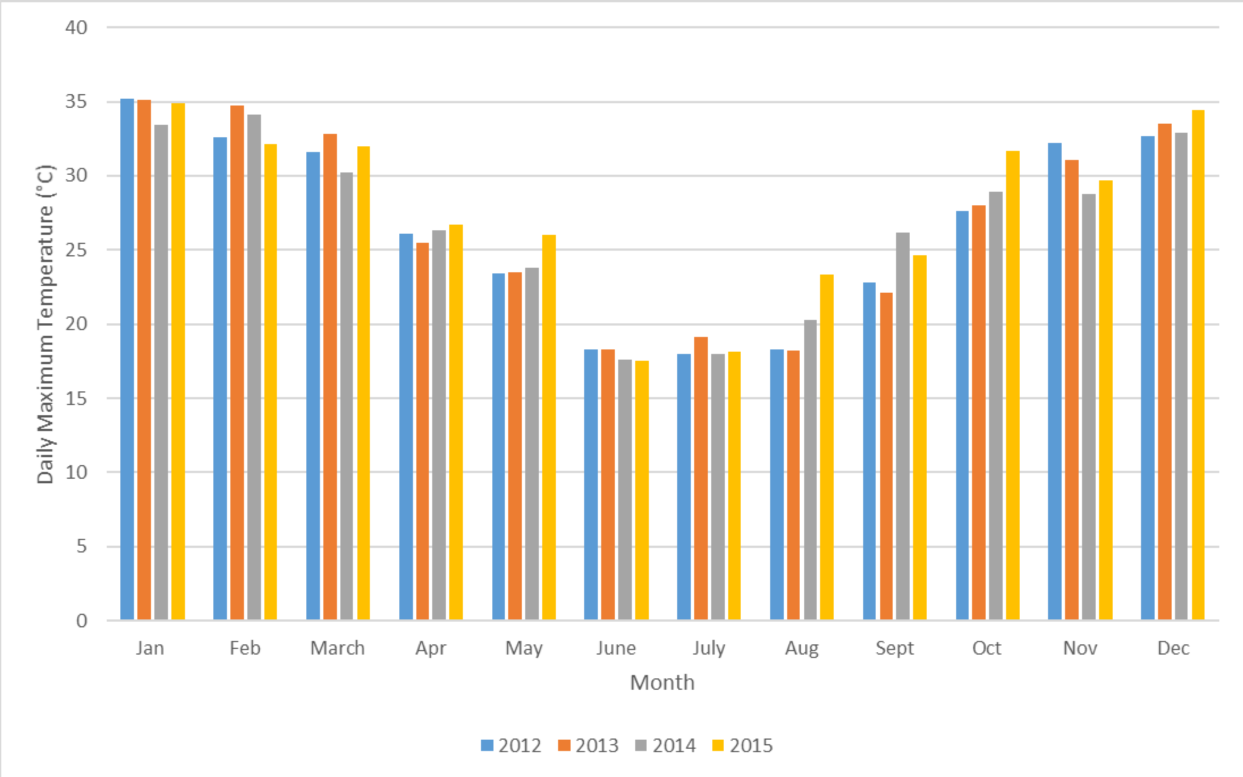

Figure 7: The daily maximum temperatures (°C) for the Pofadder area (Weather Bureau, 2016).

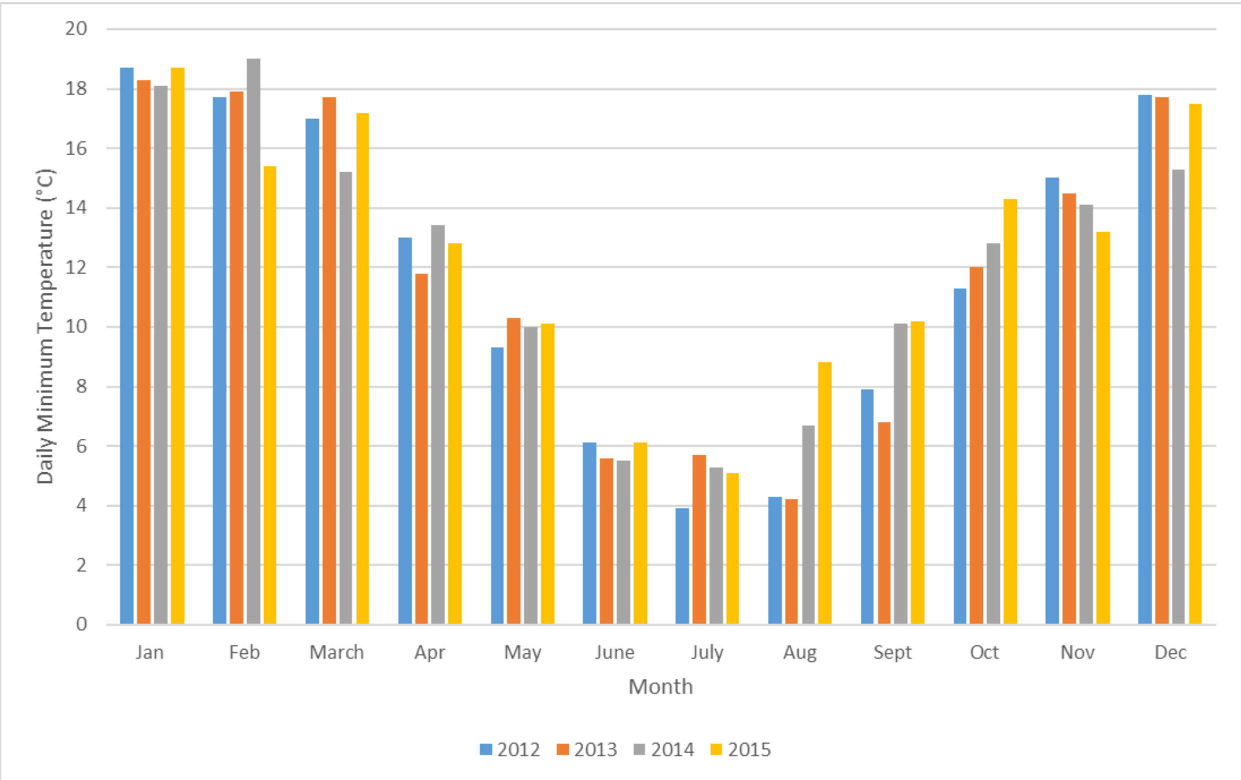

Figure 8: The daily minimum temperatures (°C) for the Pofadder area (Weather Bureau, 2016).

PALAEOCLIMATE

Climatic factors determine the mode of weathering and rate of weathering of rock. The effect of paleo-climate on the weathering process and soil formation is determined by the climatic N value defined by Weinert. The N-value for the area is approximately 35 which implies a deficiency of water i.e. total potential evapotranspiration exceeds the precipitation.

The implication of the N-value in general (for an N>5 area) is that the soil profile is likely to be shallow unless covered with aeolian sands, and comprise mainly physically disintegrated residual soils and pedogenic calcretes. This phenomenon of physical weathering is applicable on the geotechnical quality of the foundations and pilons.

2.3.2 Topography and Drainage

The overall topography of the site is relatively homogenous and ranges from 857 m to 880 m above mean sea level with the highest part of the landscape to the south-east and the lowest part to the north-west.

The area with the lowest elevation (north-west) lies south-east of the Salt River which is situated north-west of the study area. The Salt River flows to the north-east into the Hartbees River which eventually connects to the Gariep River.

2.3.3 Soil

Note that since the information obtained from the land type survey is of a reconnaissance nature, only the general dominance of the soils in the landscape can be provided and not the actual area of occurrence within a specific land type. Land type data was obtained from the Agricultural Research Council (Land Type Survey Staff, 2003) and entails the division of land into land types, typical terrain cross sections and dominant soil types for each terrain unit. A land type can be defined as an area with similar climate, topography and soil distribution patterns.

One land type (Ag3) dominates the entire study area. According to the Land Type Survey Staff (2003), 40% of land type Ag3 consists of freely drained, shallow (< 300 mm deep), red, eutrophic, apedal soils with yellow-brown soils comprising less than 10% of this land type. The average depth of all soils is 280.5 mm. Approximately 77% of land type Ag3 consist of soils with a depth of ≤ 300 mm (depth class D1), whereas 12.5% consist of soil with a depth of 901 mm to 1200 mm (depth class D4). The average topsoil clay percentage of land type Ag3 is 10.7%. Around 88.5% of land type Ag3 consist of loamy sand soils (clay class C2) with an average clay percentage of 6.1% to 15% in the topsoil, whilst 1% consist of sandy loam soils (clay class C3) with an average clay percentage of 15.1% to 25% in the topsoil (Land Type Survey Staff, 2003).

The soils of land type Ag3 can be divided into three soil classes. Table 1 illustrates the different soil classes, description of soil classes, soil forms and percentage occupancy of each soil class within land type Ag3.

Table 1: Description of classes within land type Ag3 (Land Type Survey Staff, 2003).

Soil Classes	Description	Soil Form	Percentage occupancy
S2	Freely drained, structureless soils.	*Hutton, Clovelly, Griffen, Shortlands, Oakleaf.*	58,3%
S13	Lithic soil (shallow soils on hard weathering rocks).	*Mispah, Glenrosa.*	31,2%
S16	Non-soil land classes	*Pans, rivers, stream beds, erosion structures, marshes, reclaimed land, dunes, gravel, etc.*	0,5%

Approximately 58.3% of land type Ag3 consists of freely drained, structureless soils, whereas 31.2% consist of characteristic lithic soils. A small part (0.5%) of land type Ag3 is occupied by structures like pans, rivers, stream beds, erosion structures, marshes, reclaimed land, dunes and gravel.

2.3.4 Land Capability and Land Use

Mainly extensive grazing due to climatic constraints. Irrigation land uses are limited due to lack of large volumes of water.

2.3.5 Agricultural Potential

Low potential due to shallow soils and low and erratic rainfall. Dryland crop production is not viable in areas with rainfall lower than 500 mm unless significant groundwater is available (not the case for this specific survey site).

2.3.6 Hydrology and Geohydrology

The study area is situated within the Lower Orange Management Area, Quaternary Drainage Area D53H. North-east of the site lies the non-perennial Salt River, with drainage lines running off in a north-eastern direction towards the Salt River. Due to the gradual decline in altitude this area contains seasonal and ephemeral drainage lines. Based on vegetation, no wetland conditions occur along the drainage lines on site. There are also no pans or drainage depressions on site. In the northern corner of the site there is a small earth dam with a free board of approximately 70 cm which cannot be considered as a pan system. Different factors including domestic stock farming with sheep, dirt track crossings and weirs all affect the watercourses of the Salt River in the surrounding area, but not on the specific site. However due to the low rainfall and seasonal nature of the river, there will be no significant impact on the river systems.

2.3.7 Storm Water Management

The Brypaal Solar Farm area is situated in the quaternary catchment D53H, approximately 60 km south west of Kakamas, in the Kai Garib Local Municipality of the Northern Cape. The perennial river in the project area, namely the Orange River, flows to the west. The non-perennial river in the project area, namely the Salt River, closest to the site, flows in a north-eastern direction before flowing into the Hartbees river, a tributary of the Orange River. The area is characterised with relatively flat areas with minor variation of approximately twenty metres across the site with a maximum elevation of 881 m above sea level.

A flood assessment was undertaken for the non-perennial rivers to determine the 1:100-year floodlines in the proximity of the Brypaal PV Solar Project. For detail of Storm Water Management see Specialist studies and Geotechnical Section 3 and 4 of this report.

2.3.8 Existing Land Use

This area is predominantly used for livestock farming. The infrastructure present within the boundaries of the study area is limited to a feeding and water trough and border fences. There is also a small earth dam (not considered as a pan system) with a free board of approximately 70 cm in the northern corner of the site. Parallel to the north-western border of the site (located outside the study area) is the Loeriesfontein-Kakamas road (Road No 2972).

2.3.9 Vegetation

The area under investigation (semi-arid Bushmanland region) forms part of the Nama Karoo Biome (Bezuidenhout, 2009). Based on the classification of Mucina and Rutherford (2006), it was concluded that the study area comprises mainly the Bushmanland Arid Grassland, the Bushmanland Sandy Grassland and the Bushmanland Basin Shrubland. The Bushmanland Arid Grassland is characterised by irregular plains dominated by *Stipagrostis* species. In some regions the vegetation structure is altered by low shrubs of *Salsola species.* The Bushmanland Sandy Grassland is characterised by sandy grassland plains dominated by *Stipagrostis* and *Schmidtia* species. There is also a common occurrence of drought-resistant shrubs, and after rainfall the display of ephemeral spring flora including *Grielum humifusum* and *Gazania lichtensteinii.* The Bushmanland Basin Shrubland is characterised by irregular plains dominated by shrubs including *Rhigozum, Salsola, Pentzia* and *Eriocephalus* as well as different *Stipagrostis* grass species. After rainfall *Gazania* and *Leysera* species may also be present (Mucina & Rutherford, 2006).

The vegetation differences on this site reflects the substrate conditions including soil depth, texture, and geology. The areas with coarse material (for instance the deep, sandy soils in the drainage systems) are dominated by shrubby vegetation, while the areas with fine material or abundant geological outcrops (for instance the calcic soils) are dominated by grasses.

The north-western part of the study area consists of abundant outcrops with the following order of abundancy: Gneiss > metaquartzite > pegmatite > surficial calcrete deposits. This area has a large proportion of grasses (to a lesser extent than the south-eastern parts), combined with shrubs and rocky outcrops with no vegetation. The south-eastern part of the study area consists of surficial calcrete deposits with occasional gneiss outcrops, and a dominating grassland. The drainage systems consist of alluvial and aeolian sandy material and are dominated by shrubs.

2.3.10 Critical Biodiversity Area

For this study area no Critical Biodiversity Areas have been defined and no fine-scale conservation planning has been done. This area does not fall within a National Protected Areas Expansion Strategy Focus Area (NPAES), and therefore is **not** characterised:

- With exceptional biodiversity;
- As significant for the maintenance of ecological processes; or
- As significant to climate change buffering.

According to Mucina and Rutherford (2006) the Bushmanland Arid Grassland, Bushmanland Sandy Grassland as well as the Bushmanland Basin Shrubland are considered as least threatened. According to the Department of Environmental Affairs, there are no proposed renewable energy facilities in the immediate surrounding area. The renewable energy project closest to the proposed Brypaal PV Project, is situated near Kenhardt.

2.3.11 General Geology

The study area falls within the geological province known as the Bushmanland Terrane which forms part of the Namaqua Sector within the Namaqua-Natal Metamorphic Province. The Namaqua-Natal Metamorphic Province is a large area of contiguous structural fabric which formed during a tectonic metamorphic event. The Bushmanland Terrane covers approximately 60 600 km^2 and is known as the largest crustal block in the Namaqua Sector. It is comprised of granitic gneisses (~2000 Ma), supracrustal rocks of amphibolite to granulite grade (1600 – 1200 Ma) and granitoids (1200 – 1000 Ma). The Groothoek Thrust and Wortel Belt form the northern boundary of the Bushmanland Terrane, and the Hartbees River Thrust the eastern boundary (Cornell *et al.*, 2006).

The Bushmanland Terrane is divided into three age groups known as the Kheisian strata (1700 – 2050 Ma), the young, deformed supracrustal and plutonic rocks (1200, 1600 and ~1900) and the syn-tectonic and late-tectonic Namaquan intrusive rocks (Cornell *et al.*, 2006; Moore *et al.*, 1990; SACS, 1980; Thomas *et al.*, 1994). Pegmatites of different ages intruded into these basement rocks.

Surficial deposits such as calcrete, gypcrete, dorbank, alluvial as well as aeolian deposits and soils (all from the Cenozoic Era) dominate the surface. The origin of the soils of the area are from “mixed origin" as described by Brink (1985). The soils of mixed origin are a mixture in a variation of ratios between aeolian sand, alluvial deposits, residual soils (in situ weathered base rock) and also pedogenic material (mainly calcrete, gypcrete and dorbank). Calcrete outcrops are of limited depth (1.0 m) and no excavations are present on the site.

This particular area of interest lays south-west of the Kaapvaal Craton and west of the Hartbees River Thrust. The rock types which dominates the area are gneiss, meta-quartzite (with minor calc-silicates), pegmatites with calcrete and soils covered the major part of it. The calcrete and soils are intermixed with the outcrops but are more dominant in the south-eastern portion of the study area. See Appendix E (Photo Section) for more detail.

More detail geological descriptions are present in the Specialist study report and geological information related to geotechnical aspects are present in Section 3 of this report.

Figure 9 is a simplified geological map of the area showing the main geological features.

Table 2 is a lithostratigraphic description of the study area.

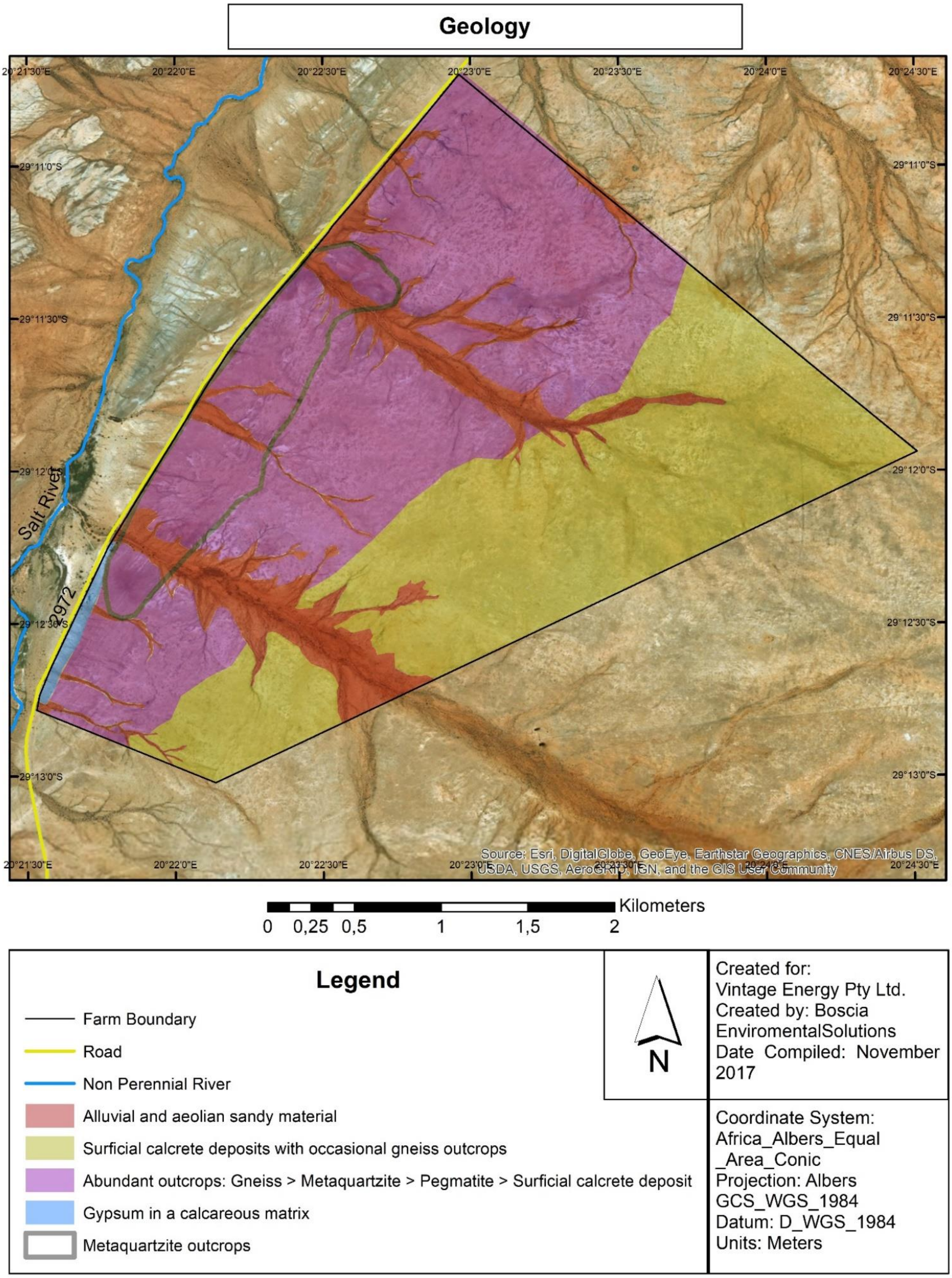

Figure 9: Geological map of the study area (Google Earth, 2016).

Table 2: Lithostratigraphic column of the study area (Bailie *et al*., 2007; Colliston *et al*., 2008; Cornell *et al*., 2009; Cornell *et al*., 2006; Eglington, 2006; Haddon, 2005; McClung, 2006; Reid *et al*., 1997; Von M Harmse & Hatting, 2012; Watts, 1980).

Ma	Group	Subgroup	Formation	Intrusive Rocks	Lithological Description	Epoch	Period	Era	Eon	Ma
0 - 0.01	Kalahari Group				Kalahari calcrete, sandy material of mixed origin, lag deposit and gypsic deposits	Holocene	Quaternary	Cenozoic	Phanerozoic	0 – 0.01
0.01 – 1.6					Kalahari calcrete, sandy material of mixed origin, and lag deposit	Pleistocene				0.01 – 1.6
1.6 – 5.0					Kalahari calcrete (soft, hard bank, nodular, tabular)	Pliocene	Tertiary			1.6 – 5.0
~ 1130	Bushmanland Group	Kouboom Subgroup	Vaalkop Formation		Biotite-gneisses.			Mokolian	Proterozoic	900 - 2050
			Driekop Formation		Metagreywacke comprised of grey quartzite.					
			Geelvloer Formation		Biotite-schist hosting calc-silicate and carbonate rich rocks. Emplacement of pegmatites.					
			Broken Hill Quartzite Formation		Typical purplish-red to dark grey glassy quartzite and metaquartzite.					
~1640		Wortel Subgroup	Namies Schist Formation		Calc-silicate gneiss, biotite-rich schist, quartzite and metaquartzite.					
~ 1650				Hoogoor Suite	Pink gneiss					
1700-2050				Achab Gneiss	Migmatitic leucogneiss					
Note: No Karoo Supergroup outcrops occur on the site										

3 Geotechnical Assessments

The geotechnical assessment includes the following:

1. TLB Soil profile pits (43 in total on total area and 18 on final site lay out area) (see Figure 10).
2. Profile descriptions according to the MCSSO system (43) (Appendix A and B).
3. Indicator test summary analyses (Table 4).
4. Penetration tests: 23 in total (Dynamic probe super heavy) (DPSH) (Table 6 and Appendix C).
5. Earth electrical resistivity (Figure 11 and 12; Appendix D1 and D2).
6. Atterberg limits (Table 4 and Appendix E).
7. Particle size distribution (PSD) analyses (Table 7 and Appendix F).
8. Chemical analysis (pH, electrical conductivity, redox potential, cation exchange capacity, exchangeable cations, anion salt concentrations) (Table 8 and 9 and Appendix E2).
9. Photos of typical profiles (Appendix G).

3.1 Profile Pits

The geotechnical investigation which started with trial pits comprised 43 trial pits which were carried out in March 2017 and they are shown in Figure 10. Trial pits were done with a TLB down to bedrock according to standard practice. Profiling was done according to standard practice and soil samples were recovered from representative materials on site and submitted for laboratory testing.

The soil and surface cover in the trial pits showed conditions across the site to be consistent, and comprised a thin cover of gravelly topsoil of mixed origin overlying cemented to strongly cemented calcrete or gneiss or metaquartzite or pegmatite at very shallow depth. The TLB refused on the cemented calcrete or other bedrock at depths of between 0.1m and 2.2 m. Soft powdery calcrete mixed with gypsum were encountered in one profile pit deeper than 2.2 m.

Typical soil profiles are shown in Appendix G (Photo Section). Trial pit profiles are included in Appendix A.

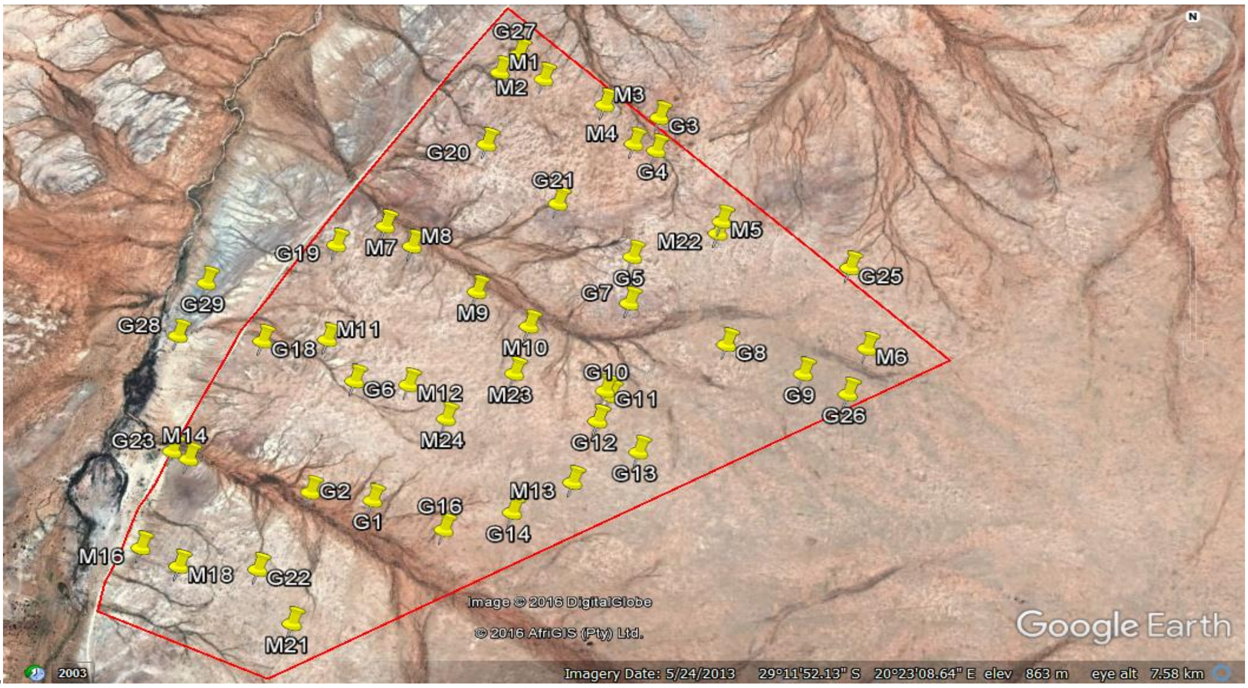

Figure 10: Locality plan of Profile Pits (Google Earth, 2016).

All geotechnical analyses were not done on all the samples from all the pits. Penetration resistance, Indicator tests and Electrical resistivity assessments were done as shown in Table 3 with the results in Table 4, 6 and 7 and Appendix C and D.

Indicator tests are a guideline to be more cautious and alert on that specific profile or layer and are shown in Table 4.

Profile G2 is in the drainage system and the clay beneath the alluvial sand was sampled separately and according to the indicator tests in Table 4 the linear shrinkage % is above 5% but the total expansiveness is low. The explanation for high shrinkage and low expansiveness is that the shrinkage was done on - 425-micron material and the expansiveness was calculated for the total sample (with only 9% clay fraction).

Profile G28 is situated in a low-lying area with a profile depth of 220 cm and with seepage water at 120 cm. The plasticity index (PI) is 23 and the linear shrinkage 9.8%. But with a low clay content.

All these profiles with anomalous geotechnical values are not on the proposed development site and are therefore not under discussion with respect to sensitive soil or rock profiles. All profile pits which are on the proposed development site are highlighted in Table 3. Profile pits on the proposed development site are:

G5; G8; 9; 10; 11; 12; 13, 14, 25; 26 as well as M5; 6; 10; 12; 13; 22; 23 and 24.

Penetration resistance is discussed in more detail in Section 3.2 and Electrical resistivity in Section 3.5.

The gneiss bedrock was often laminated, banded as usual and joints were frequently founded. Some of the joints and fractures are filled with secondary calcrete.

There was a sulphur odour present in Profiles 23 and 28 approximate 24 hours after the excavations and there was seepage water in Profile 28 (low lying area close to the Salt river).

Table 3: Brief description of surface geology and soils at soil profile pits (refer to Figure 10).

Site No	Final depth (cm)	Brief description (all depths are in cm)	Surface cover geology/soil
G1	195	0-80 soil, 80-140 calcrete with weathered gneiss	Gneiss
G2 *#@	150	0-110 alluvial sand, 110- 150 alluvial clay	Alluvial sand
G3 *#@	120	0-120 Duricrust (dorbank)	Duricrust with gneiss
G4	110	0-30 soil, 30-110 weathered gneiss	Lag deposit and soil of mixed origin
G5 *@	155	0-50 soil, 50-80 calcrete, 80-155 weathered gneiss	Quarts and lag deposit
G6 *	210	0-15 soil, 15-120 tabular nodular calcrete, 120-210 gneiss	Sand
G7 *@	150	0-20 soil, 20-150 quarts	Quarts/pegmatite
G8	200	0-15 soil, 15-70 calcrete, 70-200 weathered gneiss	Gneiss
G9 *@	170	0-15 soil, 15-50 calcrete, 50-170 weathered gneiss	Gneiss
G10	130	0-10 soil, 10-40 calcrete, 40-130 weathered gneiss	Lag deposit
G11	145	0-40 soil, 40-70 calcrete, 70-145 weathered gneiss	Gneiss, quarts and calcrete
G12 *#@	110	0-20 soil, 20-110 quarts	Quarts and sand
G13 *@	250	0-15 soil, 15-70 calcareous soil, 70-250 weathered gneiss	Gneiss
G14	210	0-40 soil, 40-150 calcrete, 120-250 calcareous gneiss	Calcrete and gneiss
G16	120	0-30 soil, 30-60 calcareous gneiss, 60-120 weathered gneiss	Gneiss
G18	200	0-15 soil, 15-40 calcrete, 40-200 weathered gneiss	Lag deposit
G19	80	0-20 soil. 20-80 weathered gneiss	Gneiss
G20 *@	180	0-15 soil, 15-65 calcareous soil, 65-180 needle gneiss	Lag deposit
G21 *@	40	0-30 soil, 30-40 quarts	Quarts/pegmatite
G22	180	0-15 soil, 15-30 calcareous soil, 30-50 calcareous gneiss, 50-180 weathered gneiss	Lag deposit
G23 *#@	210	0-120 gypsic calcareous soil, 120-210 weathered gneiss, with a slight sulphur odour and slightly moist at bottom of hole after 24 hours	Gypsic calcareous
G25 *@	150	0-15 soil, 15-30 calcrete, 30-150 weathered gneiss	Calcrete
G26 *#	200	0-40 Soil, 40-200 weathered gneiss	Sand
G27 *#@	120	0-20 soil, 20-120 weathered gneiss, prominent joints	Calcrete
G28*	180	0-20 calcareous soil, 20-100 gypsic soil, 100-180 weathered gneiss ?, Seepage water table 120 cm, sulphur odour after 24 hours	Gypsic calcrete in flood plain next to Salt river
G29#@	110	0-10 stony soil, 10-50 weathered meta-quartzite, 50-110 meta-quartzite with abundant joints	Meta-quartzite, jointed

Table 3 (continued): Brief description of surface geology and soils at soil profile pits (refer to Figure 10).

Site No	Final depth (cm)	Brief description	Surface cover geology
M1 *#@	220	0-30 soil, 30- 220 weathered gneiss	Calcrete and lag
M2 @	180	0-25 soil, 25-40 calcrete, 40-180 weathered gneiss	Gneiss
M3	200	0-20 soil, 20-200 weathered gneiss	Gneiss
M4#	60	0-30 soil, 30-60 quarts and calcrete	Quarts and calcrete
M5	100	0-20 soil, 20-50 calcrete, 50-100 quarts	Quartz/ pegmatite
M6 *	180	0-20 soil, 20-100 tabular calcrete, 100-180 calcareous weathered gneiss	Calcrete
M7	180	0-30 soil, 30-60 calcrete, 60-180 weathered gneiss	Gneiss
M8 *	210	0-15 soil, 15-80 calcrete, 80-120 weathered gneiss	Gneiss
M9 *#	130	0-10 soil, 10-80 calcareous soil, 80-130 weathered gneiss	Calcrete
M10	180	0-10 soil, 10-180 weathered gneiss	Gneiss
M11 *@	170	0-20 stony soil, 20-170 weathered gneiss with meta-quartzite	Gneiss and meta-quartzite,
M12 *@	120	0-30 calcareous soil, 30-120 calcsilicate and meta-quartzite?	Calcsilicate and meta-quartzite
M13	150	0-30 stony soil, 30-150 weathered gneiss	Sand
M14#@	180	0-30 soil, 30-180 weathered gneiss	Gneiss and sand
M16	140	0-45 soil, 45-140 weathered gneiss	Sand
M18	90	0-25 stony soil, 25-90 quarts, gneiss and meta-quartzite	Gneiss and meta-quartzite
M20@			
M21	140	0-25 stony soil, 25-140 weathered gneiss	Sand
M22 *@	120	0-28 soil, 28-70 calcrete, 70-120 weathered gneiss	Calcrete and gneiss
M23*#	120	0-30 stony soil, 30-40 calcareous soil, 40-120 meta-quartzite, an diopside	Meta-quartzite and calc-silicate and diopside
M24 *	180	0-40 calcareous soil, 40-180 weathered gneiss	Calcrete and lag

* DPSH penetration tests # Indicator, CBR and Atterberg limits @Electrical resistivity
Profile pits on proposed development site are highlighted

Table 4: Summary of Indicator tests on selected profile samples.

Profile No	Sample No		Material type	Max Dry Bulk Density Kg/m^3	Grading modules	Clay %	Silt %	Sand %	Gravel %	Larger 63 mm %	PI	LL	Expansiveness	Linear shrinkage %
						< 63 mm								
G2	G2		Below alluvial sand	1940	1.35	9	4	76	11	0	9	29	Low	12
G3	G3		Sand	2014	1.56	0	9	68	23	-	-	-	Low	3
G12	G12		Sand, quartzite, calcrete, gneiss	2002	2.28	2	5	35	58	5	4	26	Low	3
G20	G20		Sand, gneiss, calcrete	2061	2.26	1	5	31	51	5	5	25	Low	0
G23	G23		Sand, calcrete, gneiss	1920	1.67	5		59	36	11	-	-	Low	0.8
G26	G26		Sand, gneiss	2026	2.27	2	8	33	57	3	5	32	Low	0
G26	G26 A		Sand, gneiss	2120	1.30	2	8	80	10	-	-	-	Low	3.8
G27	G27-1		Sand, granite, gneiss	2054	2.37	1	11	28	60	5	4	-	Low	0.6
G28	G28		Sand, calcrete, gneiss	1925	1.33	3	0	73	24	-	23	-	Low to medium	9.8
G29	G29		Sand, granite, gneiss	2121	2.12	0	0	48	52	8	7	-	Low	2.3
M1	M1		Sand, calcrete	2152	2.14	2	12	41	43	12	5	-	Low	0.4
M9	M9		Sand, calcrete	2200	2.06	2	8	48	42	12	-	-	Low	0.8
M14	M14		Sand, gneiss	2070	2.15	1	5	46	48	12	10	-	Low	0.4
M23	M23		Sand, gneiss	2067	2.10	0	6	44	50	4	6	-	Low	0.5
* See also Table 5 for linear shrinkage on all profile samples														

Remark: All anomalous values are highlighted

Table 5: Linear shrinkage % of all samples from profile pits.

Sample No	**Replica**				**Average %**		**Sample No**	**Replica**				**Average %**
	1	**2**	**3**	**4**				**1**	**2**	**3**	**4**	
G1(1)	2,23	2,05	2,04	1,24	1,9		G12(1)	2,41	4,63	3,22	3,48	3,4
G1(2)	10,26	9,61	9,58	9,3	9,7		G13(1)	0,64	0,5	0,66	0,63	0,6
G2(1)	0	0	0	0	0,0		G13(2)	1,79	2,87	2,47	1,76	2,2
G2(2)	11,66	11,67	13,4	11,23	12,0		G13(3)	0	0	0	0	0,0
G3(1)	2,94	2,94	2,95	2,95	2,9		G14(1)	0,35	0,17	0,36	0,25	0,3
G4(1)	2,48	2,34	2,22	2,4	2,4		G14(2)	4,6	4,02	4,34	4,57	4,4
G4(2)	4,36	4,34	4,33	6,09	4,8		G16(1)	2,68	2,46	1,11	0,71	1,7
G5(1)	2,88	3,08	3,01	3,01	3,0		G18(1)	1,07	0,7	0,87	0,71	0,8
G5(2)	4,02	4,12	3,29	3,67	3,8		G18(2)	4,13	3,78	2,51	3,53	3,5
G6(1)	1,64	1,37	1,39	1,79	1,5		G19(1)	1,85	0,91	1,22	1,68	1,4
G6(3)	4,5	4,3	4,56	4,45	4,5		G20(1)	1,04	1,64	1,51	1,37	1,4
G7(1)	1,08	0,99	1,02	1,04	1,0		G20(2)	1,79	1,74	1,81	1,6	1,7
G7(4)	2,51	3,39	2,1	2	2,5		G20(3)	0	0	0	0	0,0
G8(1)	1,24	1,1	1,2	1,04	1,1		G21(1)	1,34	0,76	1,49	1,51	1,3
G8(2)	1,35	1,2	2,14	1,9	1,6		G22(1)	1,02	0,84	1,11	0,96	1,0
G9(1)	1,41	1,23	0,67	1,15	1,1		G22(2)	0,63	0,48	0,66	0,55	0,6
G9(2)	2,98	1,86	3,06	3,18	2,8		G23(1)	1	0,72	0,79	0,55	0,8
G10(1)	0,77	0,81	1,05	0,97	0,9		G23(2)	6,83	7,32	7,83	6,19	7,0
G11(1)	1,26	1	1,11	0,98	1,1		G25(1)	0,37	0,61	0,26	0,24	0,4
G11(2)	1,36	1,75	2,11	2,13	1,8		G25(2)	2,03	2,35	1,46	1,57	1,9

Remark: All anomalous values (> 5%) are highlighted

Table 5. (continued): Linear shrinkage % of all samples from profile pits

Sample No	Replica				Average %		Sample No	Replica				Average %
	1	**2**	**3**	**4**				**1**	**2**	**3**	**4**	
G26(1)	0	0	0	0	0,0		M6(1)	0,48	0,57	0,34	0,34	1,5
G26(2)	4,03	3,3	4,04	4,02	3,8		M7(1)	0,35	0,63	0,44	0,44	0,6
G26(3)	2,32	2,11	2,93	1,36	2,2		M9(1)	0,27	0,43	0,43	0,24	0,8
G27(1)	0,61	0,59	0,45	0,62	0,6		M10(1)	1,09	0,45	1,74	1,42	1,1
G27(2)	3,23	3,13	2,93	3,6	3,2		M11(3)	0	0	0	0	0,0
G27(3)	0,68	1,18	0,92	1,19	1,0		M12(1)	0,87	1,25	0,36	0,99	0,9
G28(1)	0	0	0	0	0,0		M13(1)	0,52	0,75	0,38	0,43	1,2
G28(2) 25-60	2,9	2,61	2,77	3,62	3,0		M14(1)	0,24	0	0,39	0,22	0,4
G28(4) 100+	9,28	10,25	9,01	10,75	9,8		M16(1)	0	0	0	0	0,0
G29(1)	2,48	2,16	2,21	2,45	2,3		M18(1)	1,5	1,27	0,78	0,62	1,4
							M18(2)	1,14	1,53	1,28	1,76	1,9
M1(1)	0,72	0,41	0,48	0,46	0,4		M21(1)	0,47	0,36	0	0,52	0,4
M2(1)	1,66	2,03	2,38	2,6	4,3		M22(1)	1,28	1,39	1,52	1,11	1,5
M2(3)	3,14	4,83	4,66	3,71	3,9		M23(1)	0,46	0,55	0,86	0,86	0,5
M3(1)	1,11	1,35	1,18	1,2	1,5		M24(1)	1,24	1,34	0,53	0,97	0,8
M3(2)	0,79	0,95	0,93	0,68	2,2							
M3(3)	0,21	0,38	0	0	0,9							
M4(1)	1,56	0,88	1,16	0,71	1,8							
M5(1)	1,19	0,7	0,34	0,6	1,0							

Remark: All anomalous values (> 5%) are highlighted

3.2 Penetration Tests

3.2.1 In-Situ Penetration Testing

Soil strength and stiffness are correlated with consistency of earthy soil material and penetrometer testing is used l to determine the consistency of both cohesive and non-cohesive materials below the surface. Standard penetration testing (SPT) has become accepted worldwide as a useful test in geotechnical investigation and foundation design.

In Southern Africa an alternative testing method were developed and the Dynamic Probe Super Heavy test (DPSH) are used frequently instead of the SPT. DPSH are approximately the same as SPT "N" values.

A 50 mm diameter cone with 60^{o} angle is fitted onto the bottom of a steel rod and driven into the ground by a 63.5 kg hammer with a falling head of 762 mm. The number of blows required to drive the cone through each successive 300 mm layer are continuously recorded.

3.2.2 Site specific ground conditions

The following conditions and precautionary measures on the specific site should be taken into consideration with the interpretation of the data:

- Refusal beyond 50 blows per 30 cm are not necessarily hard rock layers, but it could be due to layers of pedogenic materials such as calcrete. Profile test pit descriptions should be used in conjunction with the DPSH data as well as electrical resistivity for each pylon.
- Erratic profile test data are anticipated with alluvial, aeolian and pedogenic deposits. The metaquartzite and pegmatites have a shallower bedrock comparing to the gneiss. The majority of the profile descriptions reveal soil of "mixed origin" on surface as shown in Profile descriptions (aeolian, alluvial, pedogenic and residual). It is anticipated that a deeper penetration was achieved at some sites due to the highly jointed bedrock and deep weathering of gneiss.
- It is important to test the penetration of each site prior to the installation of the driven pylons.

Table 6: Dynamic Probe Super Heavy (DPSH) Blows/30 cm (the graphs and descriptions are shown in Appendix C).

	DIAGRAM 1 (Appendix C)					**DIAGRAM 2 (Appendix C)**			
Profile	***M 1***	***M 6***	***M 8***	***M 9***	***M 11***	***M 12***	***M22***	***M 23***	***M 24***
Depth cm 0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
30	4	38	6	12	14	11	12	13	6
60	20	50	18	17	33	22	29	31	13
90	41	Solid	34	17	55	42	40	50	21
120	50		30	32	Solid	50	50	Solid	27
150	Solid		21	50		Solid	Solid		39
180			43	Solid					50
210			50						Solid
			Solid						

Table 6. (continued): Dynamic Probe Super Heavy (DPSH) Blows/30 cm (the graphs and descriptions are shown in Appendix C).

	DIAGRAM 3 (Appendix C)					**DIAGRAM 4 (Appendix C)**					**DIAGRAM 5 (Appendix C)**			
Profile	***G 2***	***G 3***	***G 5***	***G 6***	***G 7***	***G 9***	***G 12***	***G 13***	***G 20***	***G 21***	***G 23***	**G25**	***G 26***	***G 27***
Depth cm 0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
30	10	10	9	8	14	21	21	12	8	31	11	4	3	29
60	10	21	22	13	39	21	50	20	11	50	50	5	11	38
90	15	34	44	23	50	50	Solid	31	7	Solid	Solid/stiff	10	16	50
120	37	45	50	31	Solid	Solid		44	16			19	27	Solid
150	45	50	Solid	42				50	39			28	41	
180	50	Solid		50				Solid	50			47	50	
210	Solid/stiff			Solid/stiff					Solid			50	Solid	
												Solid		

3.3 Ground Electrical Resistivity (University of Venda).

3.3.1 Introduction

This report describes a geophysical survey carried out on the 5th to 8th June 2017. The work was undertaken as part of investigation of the Kakamas site for construction of a solar plant. The report was prepared subsequent to the interpretations of the apparent resistivity curves. This shallow apparent resistivity is very useful when comparing to the **Penetration resistance** and these profiles are shown in Appendix D1. During geotechnical investigation of the site, the focus of the investigation, subsequently, turned to the deeper subsurface formations in order to delineate where the formations might inhibit structures, groundwater and also to determine the existence of a buried channel, potentially creating ground movement and subsequent collapse. These graphs are shown in Appendix D2.

The field measurements of apparent resistivity were made using an ARES electrical resistivity meter powered by a 12 V car battery and stainless-steel electrodes which were driven into the earth to make the contacts for the potential and current connections. To reduce the contact resistance at the electrodes, the earth was wetted and tamped tightly against the electrodes. The electrode intervals were expanded outward from the central station and apparent resistivity observations were made on each expanded interval.

3.3.2 Resistivity Survey Method

The electrical resistivity (Ωm) is defined by the Ohm's law, E = ρj, where E ($V\ m^{-1}$) is the electrical field and j ($A\ m^{-2}$) is the current density. Electrical resistivity can also be defined as the ratio of the potential difference ΔV (V) to the current I (A), across a material which has a cross-sectional area of 1 m^2 and is 1 m long (ρ = ΔV/I). The survey provides a means of shallow subsurface exploration by the utilization of electrical measurements taken at the surface of the earth. Resistivity of the different geological materials differs greatly from about 10^{-6} Ωm in minerals such as graphite to more than 10^{12} Ωm for dry quartzitic rocks (Reynolds 1997).

An electrical current is forced to flow through the earth between two electrodes pushed into the ground. The voltage-drop created by this current flow is measured across two other electrodes (current electrodes). The electrode array is expanded after each measurement in order to increase the depth of penetration of the current, and consequently, providing information from greater depths in the earth. This field method is known as Vertical Electrical Sounding (VES). The two measured quantities of current and voltage-drop are related to the resistivity through Ohm's Law. Since resistivity is a characteristic property of each earth material, different materials can be determined according to variations in resistivity. However, the electrical characteristics of the specific lithologic units that overlie this site are not completely known.

Electrical resistivity surveys generate a two-dimensional cross section of geology based on the electrical properties of the subsurface. These properties are controlled by the type of soil or rock at a location and the electrical conductivity of the fluids in that soil. Rock that has low porosity and is very competent will be more resistive than rock that is fracture or weathered. Soil that is composed of fine grained material, like clay, is more electrically conductive than soils that are sandy. Features with more water content or higher salinity cause more electrically conductive signals while those with less water or salinity generate resistive signature.

3.3.3 Resistivity Survey Fieldwork

The resistivity survey fieldwork at Kakamas utilized the Wenner electrode array to acquire data for the subsurface formations (Figure 11). In the Wenner array configuration, potential electrodes are nested within the current electrodes with a common lateral distance between adjacent electrodes called the electrode *a*-spacing. For sounding measurements, the electrodes in a Wenner array are expanded about a center point by equally incrementing the *a*-spacing. This method was chosen because of its high sensitivity to vertical changes in the subsurface and its strongest signal strength as this is an important factor if the survey is carried in areas with high background noise. The Wenner array is also the most efficient in terms of the ratio of received voltage per-unit of transmitted current and in homogeneous isotropic earth, the resistivity data will be constant. However, if the earth is non- homogeneous and the electrode spacing varied, a different value of resistivity (ρ_a) will be found for each measurement. This measured value of resistivity is known as the apparent resistivity. The apparent resistivity is a function of the array geometry, measured voltage (Δv), and injected current (I);

$$\rho_{aw} = 2\pi a \frac{\Delta v}{I} \qquad \text{(i)}$$

$$\rho_{aw} = 2\pi a R \qquad \text{(ii)}$$

Where ρ_{aw} is the apparent resistivity (Ω), a is probe spacing (m), Δv is the voltage measured (volts), I is the injected current (Amps) and R is the measured resistance (Ω).

A closely spaced grid of observation points was used to accurately characterize the subsurface formation. The survey design also took into account probable heterogeneity of the subsurface electrical conductivity properties and the areal extent of the site to be investigated.

Figure 11: Showing ARES electrical resistivity survey of the Kakamas Brypaal PV site.

3.3.4 Resistivity Data Processing

Resistivity data was downloaded on excel spread sheet and processed using IPI2WIN software to derive modelled electrical cross-sections of the subsurface. The obtained apparent resistivity values were then plotted against half-electrode spacing on a bi-logarithmic scale to produce a VES curve using the software. The plot of apparent resistivity against half current electrode spacing (AB/2) for the VES data is shown in on Appendix D2. From the VES curve, the number of soil layers, their depths, their apparent resistivity, and the thickness of each underlying layer at all the surveyed stations was obtained. For simplicity, it was assumed that the subsurface resistivity only changes with depth, and not in the lateral direction.

3.3.5 Results and Discussion

The results of the geophysical survey at Kakamas are shown in Figure 12 and Appendix D2. The anomalous stations M12 and M14 had very resistive second layer at depth >7.63 and conductive third layer at depth > 27.54 m respectively. In general, the area could be characterized with two to three major geo-electric resistivity zones within the shallow subsurface depth of up to 43 m. At least sixteen stations had two geo-electric zones whilst nine indicated three zones. The first zone has a depth ranging from 1.65 to 25.3 m surface layer with low to moderate resistivity values. The second zone has variable resistivity values ranging from 37.4 to 52668 Ωm and is fairly thick. The third zone for eight stations has high resistivity with resistive values ranging from 280 - 32054 Ωm whilst, one station, M14 had a conductive anomaly of 2.51 Ωm on the third zone to infinity depth >27.54 m. Electrical conductivity at this depth could be due to water saturation on a highly saline bedrock.

Six stations (G23, G26, G2, G6, G27 and M11) had resistivity <100 Ωm with depth ranging from 3.34 to 5.57 meters and could be due to water saturated sandy and gravels. Geotechnical logging of pits at these stations reported moist soils of up to 1.8 m depth. Twelve stations (G3, G5, G7, G8, G13, M2, M6, M8, M12, M22, M23 and M24) had moderate resistivity of 100-500 Ωm with depth ranging from 2.72 to 25.3 m and typifying the present of significantly weathered bedrock material with variable moisture content. Seven stations (G12, G20, G21, G25, G27, M9 and M14) had resistivity of 500-1000 Ωm with a maximum depth of 11 meters and this high resistivity could be due to un-weathered gneiss or quartzite bedrock. The layers which are to infinity depth had resistivity values which ranged from 1035 to 52668 Ω m. This may be due to fresh basement of resistive quartzite and gneiss lenses. Clasts of these lithologies were observed in most of the pits excavated at the site during geotechnical studies.

An initial shallow profile was done with a follow up deep profiling. The shallow one is graphically presented in Appendix D1 and Table 7 and the deeper one in Appendix D2.

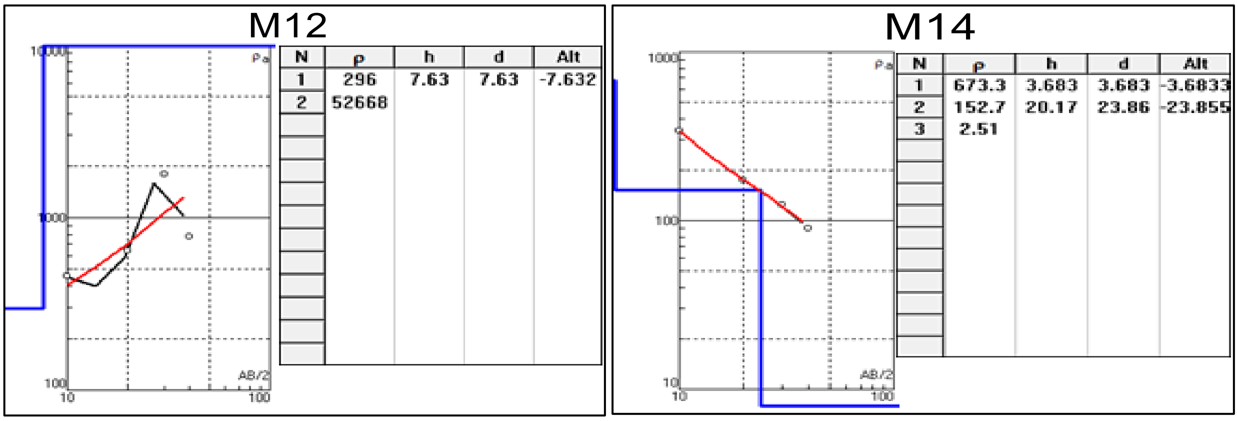

Figure 12: Examples of very resistive second layer at depth >7.63 m (M12) and conductive third layer at depth >27.54 m (M14).

Explanation of Graph: The red and blue line gives information about the relationship between AB/2 (electrode spacing) and (ρ_a) apparent resistivity. The black line indicates the electrical response of the subsurface formation. Depth, thickness and altitude are in meters.

Table 7: Electrical resistivity at shallow depth (Ωm).

	Depth m			
Profile Pit No	10	20	30	40
	Ωm resistivity			
G2	10,37	16,98	27,85	46,73
G3	280,07	397,29	472,92	588,57
G5	102,79	125,34	202,77	224,31
G6	94,83	189,7	318,84	258,82
G7	295,74	469,67	696,01	887,4
G9	534,54	635,62	677,83	777,84
G12	1370,51	1173,03	1348,6	1188,86
G13	251,2	219,17	238,35	238,94
G20	289,79	162,82	153,45	137,2
G21	668,87	514,6	485,37	427,45
G23	39,22	53,51	63,38	69,6
G25	607,88	622,6	687,6	754,36
G27	1261,8	2830,42	4354,61	6722,59
G29	49,26	81,01	133,12	165,07
M1	6714	1131,59	1419,94	1507,95
M2	133,68	198,54	289,13	373,17
M6	112,99	121,83	108,66	243,46
M8	362,81	349,57	307,02	380,05
M9	228,95	148,28	239,62	194,66
M11	61,59	51,09	41,68	36,25
M12	454,77	641,94	1793,01	772,85
M14	342,48	173,18	123,71	90,14
M22	526,6	611,62	728,6	758,21
M23	415,82	583,8	829,83	861,99
M24	137,78	121,6	135,23	188,17

Variation in the layer resistivity was attributed to grain size variations (medium to coarse), degree of weathering and water saturation. The two-layered profiles were classified into either unconsolidated overburden laying on a bedrock (i.e.$p2>p1$) or poor conducting alluvium laying over a better conducting sand or clay formation (i.e. $p2<p1$). The standard curves of the three-layered stations were a manifestation of H-type ($p1>p2<p3$) of curve with an exception of profile G9 that showed a typical A-type of curve ($p1<p2<p3$).

3.3.6 Conclusion

The Kakamas Brypaal site could be characterized as having two to three major geo-electric resistivity zones within a depth of 43 m below ground level. The upper subsurface geo-electric zone of 2.34 to

11m thickness had resistivity range of 6.72-2215Ωm. The middle geo-electric zone with resistivity range of 37.4-4586Ωm had a thickness of 2.83-37.06 m. The lower geo-electric zone with resistivity range of 2.51-34366Ωm was to infinity. The transition from the lower resistivity of the overlying soil layers to the higher resistivity of the underlying lithologies was apparent. It is concluded that electrical resistivity correlated well with changes in moisture content as well as changes in lithology as observed during soil geotechnical studies. In addition, the basement rocks at the Kakamas Brypaal site are highly resistivity metasedimentary with few locations saturated with saline fluids.

3.4 Soil Sensitivity

3.4.1 Introduction

As illustrated in Figure 13 from the Soil Specialist Report a total of ten soil forms and eleven soil families were identified accordingly. The identified soil forms include Dundee, Oakleaf, Augrabies, Knersvlakte, Oudtshoorn, Addo, Brandvlei, Coega, Etosha and Mispah.

These soil forms were grouped into four individual soil groups (which coincide with geotechnical classification systems) known as silicic soils, calcic soils, cumulic soils and lithic soils (Fey, 2010; Brummer, 2015; Fanourakis, 1991; IUSS Working Group WRB, 2006; Schmidhuber, 2015; Von M Harmse & Hatting, 1985). Each soil group is discussed in more detail in Table 3 – Table 6, based on description, properties, morphology, and genesis in the Soil Specialist report.

3.4.2 Sensitivity and Erodibility

It is important to determine the erosion sensitivity of the soils to ensure erosion prevention and storm water management measures are implemented and a large enough footprint area around the development area is left open.

Soil sensitivity can be established by determining the dispersivity and erosion potential of soil, by means of calculating the sodium exchangeable percentage:

$$\frac{Na}{CEC} x \ 100$$

Sodium exchangeable percentage values are divided into classes based on the amount of exchangeable potential, indicating the degree of soil dispersivity.

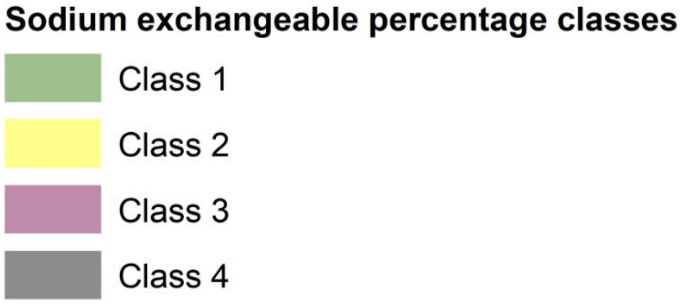

Figure 13 illustrates the soil sensitivity map based on soil dispersivity (sodium exchangeable percentage). The erosion potential is based on the presence of sodium in the upper horizons of the soil profiles comparing to the other basic cations.

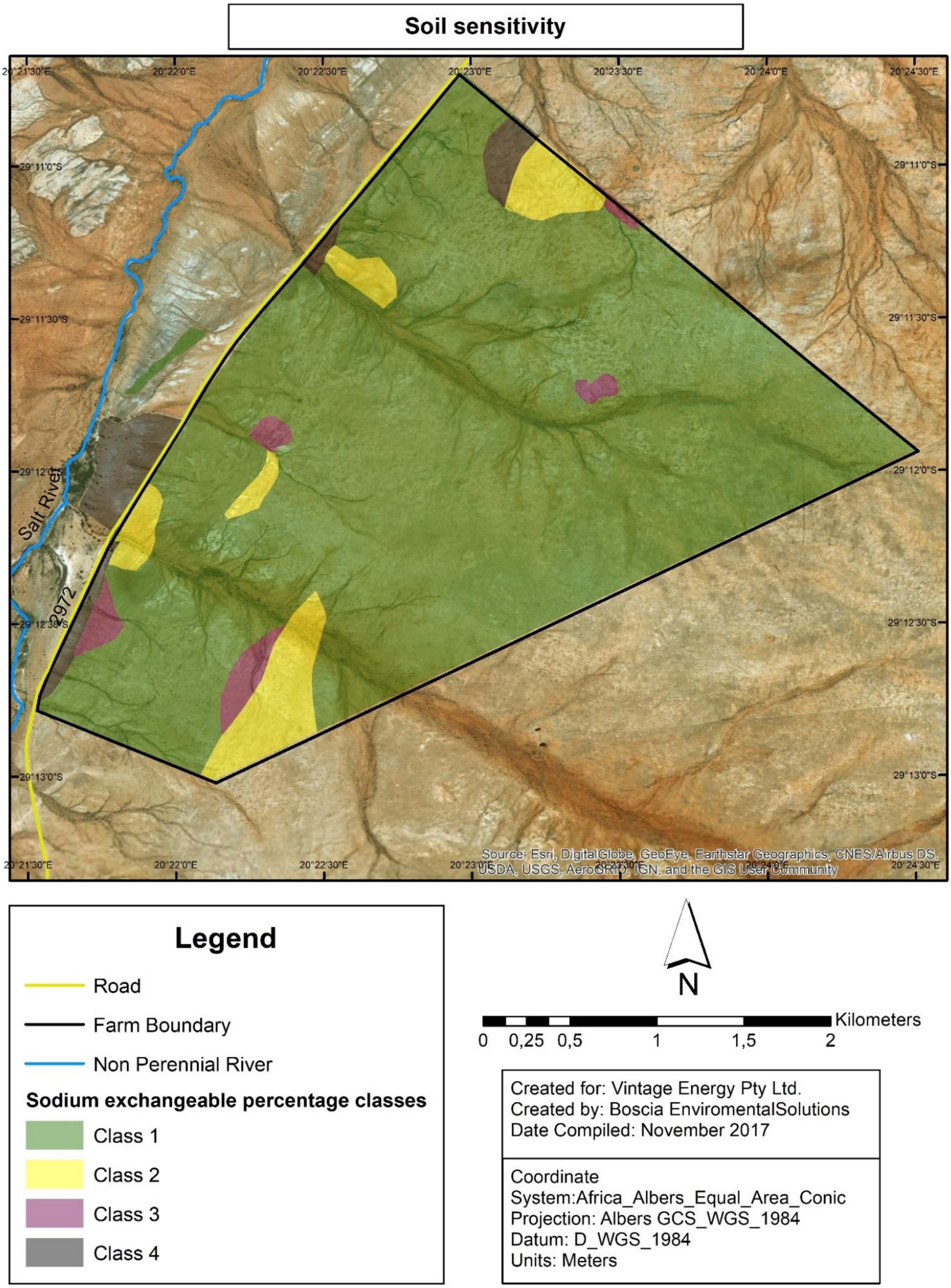

Figure 13: Soil sensitivity map of the study area (Google Earth, 2016).

3.4.3 Conclusion

It is recommended to avoid any development on Class 3 or 4 soils. Wherever road crossings do occur on these soils, it is necessary to pay special attention to the stabilization of the surface and sub-surface.

No expansive soils occur on the area. It is, however, possible to have collapsible soils on the area, especially where the horizon of “mixed origin” are > 50 cm thick. For the building foundations it might be a problem, but not for the screw pylons.

The quality of borrow material for roads and filling from the low-lying areas next to or close to the Salt river, might be suspicious. Profile G28 and G23 have seepage water with a sulphur odour.

3.5 Laboratory Testing and Analyses

Laboratory tests and analyses were done to verify on-site investigations and observations.

Geotechnical tests include the following:

- Particle size distribution (Appendix F)
- Atterberg limits (LL, PI) (Appendix E1)
- Expansiveness (Table 4)
- MOD AASHTO (Appendix E1)
- NRB (Appendix E1)
- Proctor (Appendix E1)
- CBR (Appendix E1)
- TRH14 COLTO Classification (Appendix E1)
- Grading modules (Table 4 and Appendix E1)

Tests were undertaken by SANAS accredited laboratory Simlab (Pty) Ltd in Kimberley. The anomalous values and test results and information are highlighted in Table 4 and Appendix E1.

3.5.1 Particle Size Distribution

Three class particle size distribution (PSD) analyses are shown in Table 8. The 7 Class particle size distribution are shown in Appendix F.

Table 8: Three class particle size distribution of Profile pit samples.

Sample	> 2mm	Sand	Silt	Clay
no.	(%)	(% < 2mm)		
G1-1	0,0	95,0	2,9	2,1
G2-1	2,0	97,4	0,7	1,9
G2-2	0,3	82,2	12,7	5,2
G3-1	0,4	92,6	5,2	2,2
G4-1	0,8	88,0	7,6	4,4
G5-1	0,9	90,2	7,6	2,2
G5-2	1,1	97,2	2,7	0,1
G6-1	0,7	90,2	7,6	2,2
G6-2	2,1	87,3	7,7	5,0
G7-1	0,6	92,8	5,1	2,1
G7-2	0,6	87,4	9,9	2,7
G7-4	3,1	92,5	5,3	2,2
G8-1	0,4	88,0	9,8	2,2
G9-1	1,5	92,5	5,3	2,2
G9-2	1,4	87,7	7,8	4,6
G10-1	0,4	90,7	7,2	2,1
G11-1	0,3	90,5	7,3	2,1
G12-1	1,5	89,3	7,9	2,8
G12-2	1,6	82,0	12,7	5,2
G13-1	0,7	90,7	7,2	2,1
G13-2	1,3	83,1	10,0	6,9
G13-3	1,3	95,1	2,9	2,1
G14-1	1,3	95,1	4,8	0,1
G14-2	0,5	84,3	10,4	5,2
G16-1	0,0	85,4	12,4	2,2
G18-1	0,6	90,3	7,6	2,2
G18-2	2,6	85,4	10,0	4,5
G19-1	1,3	88,0	9,8	2,2
G20-1	0,9	87,7	10,1	2,2
G20-2	2,4	95,0	2,9	2,1
G21-1	0,5	85,1	9,6	5,4
G21-2	1,9	85,3	9,4	5,3
G22-1	0,6	87,9	6,9	5,2
G23-1	0,4	71,0	23,3	5,7
G25-1	0,7	95,4	2,0	2,6
G25-2	2,7	79,2	15,4	5,3
G25-3	2,8	96,6	3,0	0,4

Sample	> 2mm	Sand	Silt	Clay
no.	(%)	(% < 2mm)		
G26-1	0,7	95,6	4,1	0,4
G26-2	2,2	76,6	15,2	8,2
G26-3	1,9	93,0	4,3	2,7
G27-1	0,5	90,7	6,6	2,7
G27-2	3,5	93,2	6,4	0,4
G28-1	0,3	90,9	6,4	2,6
G28-2	0,2	75,1	22,0	2,9
M1-1	0,2	93,4	4,6	2,1
M1-2	0,5	72,0	20,5	7,5
M1-3	1,4	86,0	9,5	4,5
M2-1	0,5	72,3	21,8	5,9
M3-1	1,1	86,4	10,6	3,0
M4-1	1,1	81,3	13,3	5,5
M5-1	0,9	86,0	10,9	3,1
M6-1	0,9	91,5	7,8	0,7
M6-2	2,2	83,5	11,0	5,5
M7-1	1,2	93,5	5,8	0,7
M9-1	1,5	93,7	5,7	0,7
M9-2	1,1	93,5	5,8	0,7
M9-3	2,1	86,1	10,8	3,1
M10-1	2,1	83,5	11,0	5,5
M11-1	0,9	95,9	3,4	0,6
M11-2	2,3	71,0	18,6	10,4
M11-3	1,2	85,5	12,2	2,3
M12-1	0,9	87,9	9,8	2,3
M12-2	3,6	90,5	7,2	2,2
M13-1	1,3	88,2	9,6	2,2
M14-1	0,7	93,1	4,8	2,2
M16-1	0,3	95,6	2,4	2,1
M18-1	1,1	85,7	12,0	2,3
M21-1	0,8	90,8	7,0	2,2
M22-1	0,5	83,4	12,0	4,6
M22-2	3,4	85,6	9,8	4,7
M23-1	1,2	88,1	9,7	2,3
M23-2	3,3	93,0	2,5	4,5
M24-1	2,0	86,9	10,3	2,8
M24-2	3,3	96,7	2,9	0,4
M24-3	3,4	74,5	20,2	5,3

CHEMICAL ANALYSES

Chemical analyses were done by accredited laboratory Eco Analitica at North West University on the following: (Table 9 and 10):

- pH (water and KCl)
- Electrical conductivity
- Exchangeable cations, CEC, and exchangeable sodium
- Redox potential

3.5.2 Conclusion

- pH> 9 is regarded as medium alkaline and could have corrosive properties
- Electrical conductivity (EC) >260 mS/m is regarded as saline and could have corrosive properties
- ESP>10 % is dispersive and could have erosive potential
- Redox potential < 80 mV could be in chemical disequilibrium

Table 9: Chemical analyses of Profile samples. All Ca, Mg, K, Na and CEC are in (cmol(+)/kg) (with anomalous values highlighted.

No	Ca	Mg	K	Na	CEC	S-value	Base Saturation%	pH(H_2O)	pH(KCl)	EC(mS/m)	ESP= Na/CEC*100
G1-1	2,50	0,62	0,42	0,76	8,29	4,30	51,91	9,22	7,94	44	9,2
G2-1	0,41	0,09	0,02	0,02	6,61	0,54	8,17	7,80	8,16	16	0,3
G2-2	8,26	1,67	0,41	12,52	20,00	22,86	114,28	8,70	8,10	2840	62,6
G3-1	14,55	3,50	0,27	3,01	20,98	21,34	101,70	7,77	7,63	492	14,4
G4-1	11,78	1,42	0,41	0,02	12,18	13,63	111,92	8,12	7,93	41	0,2
G5-1	9,13	0,91	0,45	0,00	10,40	10,49	100,90	8,11	7,87	26	0,0
G5-2	16,03	0,75	0,16	0,63	14,58	17,57	120,51	8,52	8,30	85	4,4
G6-1	9,93	0,60	0,43	0,09	10,60	11,06	104,29	8,34	8,04	40	0,9
G6-2	15,31	0,49	0,04	4,24	14,13	20,07	142,05	8,36	8,36	636	30,0
G7-1	13,33	0,68	0,49	0,17	11,99	14,67	122,31	8,64	8,37	35	1,4
G7-2	14,94	0,79	0,77	0,44	16,67	16,94	101,61	8,96	8,11	47	2,7
G7-4	16,93	1,23	0,27	0,19	16,40	18,62	113,55	8,54	8,16	46	1,1
G8-1	6,26	0,93	0,55	0,12	11,11	7,86	70,73	8,06	7,69	35	1,0
G9-1	6,88	0,72	0,57	0,01	10,55	8,19	77,61	8,27	7,94	32	0,1
G9-2	16,65	1,15	0,03	0,13	15,66	17,96	114,65	8,59	8,50	45	0,8
G10-1	8,26	0,53	0,53	0,00	9,93	9,32	93,85	8,39	7,16	30	0,0
G11-1	5,19	1,03	0,51	0,02	8,30	6,75	81,42	8,43	7,04	27	0,2
G12-1	7,45	1,29	0,55	0,05	9,23	9,34	101,10	8,30	7,68	54	0,5
G12-2	15,40	1,19	0,24	0,10	14,84	16,92	113,98	8,41	7,92	32	0,6

Table 9 (continued): Chemical analyses of Profile samples. All Ca, Mg, K, Na and CEC are in (cmol(+)/kg) (with anomalous values highlighted.

No	Ca	Mg	K	Na	CEC	S-value	Base Saturation%	pH(H_2O)	pH(KCl)	EC(mS/m)	ESP= Na/CEC*100
G13-1	8,52	0,60	0,39	0,01	11,31	9,52	84,12	8,70	7,68	30	0,1
G13-2	16,93	1,02	0,06	0,41	14,52	18,42	126,85	8,60	8,16	76	2,8
G13-3	16,65	0,47	0,09	1,56	14,43	18,77	130,05	8,92	8,36	277	10,8
G14-1	9,14	0,58	0,47	0,00	10,01	10,20	101,91	8,72	8,48	33	0,0
G14-2	15,37	0,85	0,39	0,23	14,56	16,84	115,71	8,62	8,25	55	1,6
G16-1	6,07	2,07	0,76	0,28	12,26	9,18	74,85	7,99	7,50	43	2,3
G18-1	11,89	0,55	0,34	0,00	11,30	12,78	113,08	8,17	8,00	40	0,0
G18-2	15,21	0,55	0,09	0,74	13,46	16,58	123,18	8,41	8,16	132	5,5
G19-1	14,74	0,96	0,28	0,05	13,68	16,03	117,22	8,28	7,92	38	0,4
G20-1	14,43	0,99	0,62	0,14	13,03	16,17	124,15	8,24	8,03	147	1,1
G20-2	12,93	0,55	0,63	2,16	12,75	16,26	127,59	9,59	8,43	239	16,9
G21-1	8,47	2,72	0,88	0,15	12,10	12,22	101,06	8,27	7,29	54	1,2
G21-2	15,21	3,62	0,69	0,26	19,30	19,78	102,53	8,36	7,76	52	1,4
G22-1	15,29	0,77	0,49	0,17	14,79	16,71	112,99	8,47	7,95	34	1,1
G23-1	15,83	1,77	0,83	14,84	8,37	33,27	397,77	8,07	8,10	2041	177,4
G25-1	7,01	0,63	0,35	0,14	12,58	8,13	64,62	8,78	8,03	27	1,1
G25-2	15,77	0,67	0,03	0,16	16,01	16,62	103,83	8,49	8,32	34	1,0
G25-3	15,69	0,70	0,41	3,17	18,39	19,97	108,61	8,30	7,96	388	17,3
G26-1	11,38	0,44	0,32	0,03	11,95	12,18	101,93	8,75	8,32	26	0,3
G26-2	15,09	1,24	0,34	0,10	13,50	16,77	124,27	8,84	8,52	36	0,8
G26-3	14,63	1,04	0,29	1,22	14,37	17,17	119,43	8,10	8,38	284	8,5
G27-1	8,86	0,72	0,60	0,20	10,22	10,39	101,65	8,41	8,02	41	2,0
G27-2	15,19	0,75	0,12	0,14	15,87	16,21	102,12	8,36	7,93	42	0,9
G28-1	15,44	1,23	0,27	16,25	12,43	33,19	267,07	8,77	8,52	1866	130,8
G28-2	13,49	1,13	0,17	15,64	21,71	30,43	140,14	8,63	8,28	4620	72,0

Table 9 (continued): Chemical analyses of Profile samples. All Ca, Mg, K, Na and CEC are in (cmol(+)/kg) (with anomalous values highlighted.

No	Ca	Mg	K	Na	CEC	S-value	Base Saturation%	pH(H_2O)	pH(KCl)	EC(mS/m)	ESP= Na/CEC*100
M1-1	13,45	0,57	0,28	0,01	10,40	14,31	137,58	7,77	7,36	26	0,1
M1-2	16,09	0,47	0,11	0,08	11,69	16,74	143,27	7,89	7,90	25	0,7
M1-3	15,66	0,98	0,30	0,45	12,50	17,39	139,04	8,36	8,10	71	3,6
M2-1	17,18	1,90	0,72	13,41	19,08	33,21	174,08	7,58	7,47	3640	70,3
M3-1	14,68	0,85	0,71	1,05	13,95	17,28	123,90	8,87	8,02	170	7,5
M4-1	7,38	1,63	0,59	0,23	9,70	9,83	101,35	8,34	7,54	41	2,4
M5-1	7,41	1,30	0,69	0,31	9,65	9,72	100,68	8,38	7,30	49	3,2
M6-1	5,73	0,72	0,50	0,02	6,63	6,97	105,04	8,07	7,61	29	0,2
M6-2	15,98	1,67	0,20	0,12	16,61	17,97	108,22	8,36	8,07	40	0,7
M7-1	5,08	0,68	0,28	0,04	5,89	6,09	103,38	8,35	7,70	19	0,6
M9-1	13,60	0,47	0,20	0,04	13,63	14,31	104,97	8,60	7,79	20	0,3
M9-2	13,56	0,47	0,19	0,04	14,14	14,25	100,80	8,63	7,85	21	0,3
M9-3	16,06	0,51	0,06	0,04	16,43	16,66	101,43	8,51	8,20	20	0,3
M10-1	6,96	1,72	0,61	0,09	9,20	9,38	101,97	8,24	7,71	34	1,0
M11-1	10,03	0,32	0,11	1,13	11,13	11,58	104,06	8,99	8,01	129	10,1
M11-2	16,11	0,58	0,00	0,64	12,39	17,33	139,85	8,40	8,27	163	5,2
M11-3	13,94	0,91	0,66	0,19	15,53	15,69	101,05	8,50	7,80	76	1,2
M12-1	6,11	1,42	0,62	0,02	7,95	8,17	102,79	8,07	7,59	65	0,3
M12-2	16,23	1,12	0,00	0,35	12,10	17,71	146,29	8,20	8,35	225	2,9

Table 9 (continued): Chemical analyses of Profile samples. All Ca, Mg, K, Na and CEC are in (cmol(+)/kg) (with anomalous values highlighted.

No	Ca	Mg	K	Na	CEC	S-value	Base Saturation%	pH(H_2O)	pH(KCl)	EC(mS/m)	ESP= Na/CEC*100
M13-1	6,03	1,19	0,67	0,09	7,86	7,97	101,42	8,25	7,49	46	1,1
M14-1	13,19	0,66	1,03	1,11	14,00	15,99	114,21	9,46	8,30	81	7,9
M16-1	12,92	0,43	0,19	0,04	11,77	13,59	115,39	8,60	8,48	23	0,4
M18-1	16,27	0,91	0,51	0,09	17,43	17,78	102,02	8,33	8,04	46	0,5
M21-1	11,28	0,71	0,52	0,79	13,07	13,30	101,75	8,34	8,10	150	6,1
M22-1	6,04	1,69	0,51	0,11	8,28	8,34	100,79	8,01	7,38	34	1,3
M22-2	16,31	1,66	0,15	0,27	18,11	18,39	101,51	8,19	8,09	81	1,5
M23-1	8,06	0,86	0,61	0,05	9,53	9,58	100,52	8,38	7,83	33	0,5
M23-2	16,14	0,58	0,02	0,33	13,15	17,07	129,84	8,43	8,34	57	2,5
M24-1	13,30	0,88	0,71	0,06	13,79	14,95	108,41	8,31	7,88	31	0,4
M24-2	14,99	0,70	0,21	1,41	13,02	17,31	132,95	8,24	8,20	246	10,9
M24-3	15,63	0,53	0,00	0,29	12,94	16,44	127,09	8,51	8,39	73	2,2

Table 10: Redox potential (mV) of Profile samples (redox < 80 mV is anomalous in disequilibrium).

Sample No	Redox mV		Sample No	Redox mV		Sample No	Redox mV		Sample No	Redox mV		Sample No	Redox mV
G1-1	-85		G10-1	-113		G21-1	108		M1-1	-120		M11-1	-85
G1-2	-56		G10-2	-114		G21-2	-109		M2-1	-35		M11-2	-82
G1-3	-74		G11-1	-98		G22-1	-113		M2-2	-116		M11-3	-131
G2-1	-94		G11-2	-106		G22-2	-124		M2-3	-60		M12-1	-68
G2-2	-100		G12-1	-110		G23-1	-77		M3-1	-124		M12-2	-80
G3-1	-78		G12-2	-106		G23-2	-67		M3-2	-94		M13-1	-79
G4-1	-105		G13-1	-89		G25-1	-116		M3-3	-80		M14-1	-162
G4-2	-107		G13-2	-111		G25-2	-116		M4-1	-68		M14-2	-107
G4-3	-97		G13-3	-123		G25-3	-87		M4-2	-115		M16-1	-116
G5-1	-93		G14-1	-119		G26-1	-119		M5-1	-116		M16-2	-106
G5-2	-105		G14-2	-115		G26-2	-127		M5-2	-103		M16-3	-115
G6-1	-112		G14-3	-110		G26-3	-128		M6-1	-106		M18-1	-95
G6-2	-74		G16-1	-107		G27-1	-123		M6-2	-113		M18-2	-108
G7-1	-123		G18-1	-107		G27-2	-119		M7-1	-98		M18-3	-112
G7-2	-126		G18-2	-108		G27-3	-110		M7-2	-108		M21-1	-96
G7-3	-111		G18-3	-102		G28-1	-93		M9-1	-112		M21-2	-107
G7-4	-95		G19-1	-113		G28-2	-56		M9-2	-105		M21-3	-87
G8-1	-100		G20-1	-104		G28-3	-44		M9-3	-112		M22-1	-86
G8-2	-123		G20-2	-165		G28-4	-71		M10-1	-94		M22-2	-87
G9-1	-107		G20-3	169		G29-1	-139		M10-2	-103		M23-1	-100
G9-2	-118											M23-2	-102
												M24-1	-96
												M24-2	-101
Redox <80 mV = not in chemical equilibrium												M24-3	-92

3.6 Additional Observations

- Indicator Tests: Results are shown in Table 4 and Appendix E1 and anomalous values are highlighted. Particle size analyses (full grading) and indicator tests were undertaken on representative samples of the materials on site. The tests showed the calcrete and related soils to be generally of low plasticity.

- *Mining activity and undermining.* No evidence of mining was observed on site and there are no known occurrences of economic mineral deposits on the site.

- *Slopes and cuttings*; the area to be developed is generally flat and no terracing is required.

- *Contaminated soils (including tailings).* No anthropogenic ground was evident during the fieldwork and the land is undeveloped. Therefore, the presence of contaminated soils is highly unlikely on this site.

- *Excavatability.* Trial pits were excavated using a CAT TLB down to bedrock or hard gneiss or to a maximum of 2.2 m depth. The final depth of each profile pit is shown in Table 3. Bedrock exceeded 2.2 was encountered at G2, G23 and G28.

- *Stability of Trenches:* The side-walls of the trial pits were stable during excavation. Only trial pit G28 with a water seepage line at 1.2 m collapse within 24 hours. It remains the responsibility of the contractor and engineer and Competent Person on site to ensure that excavations are safe.

  If any PV cells are erected with concrete foundations e.g. deep weathered sub-surface, the soils should be stable enough for the predrilled holes at the pile positions to remain open prior to filling with concrete.

- *Ground water seepage:* Perched ground water seepage occurred in trail pit G28 within 24 hours at an apparent depth of 1.2 m below surface. This profile pit is however close to the Salt river. Profile G23 was slightly moist at bottom after 24 hours. Both these two profiles had a slight Sulphur odour after 24 hours.

- *Ground water:* The average ground water table in boreholes varies between 45 and 150 m and the yield is 0.5 liters / second in the area. The Salt river is a seepage riverine and is seasonal to ephemeral in nature.

- *Drainage systems and flooding risk:* Storm water management recommendations are that the drainage systems should be avoided as far as possible. The final development plan as well as the lay out plan shown in Figure 2 and Specialist Report specifically show no development within the 100-m exclusion zone (100m from the drainage line center). This is wider than the 100 yr floodline crossing the project site. The Salt river is a seepage riverine and is seasonal to ephemeral in nature and flooding conditions do occur.

- *Joints and fractures:* Some outcrops and bedrock have pronounced joints and fractures. G29 and G27.

- *Roads and Materials:* Sufficient calcrete was able to be excavated for road building material, it is anticipated that high sodium concentrations are present in soils from neighbour borrow pits. The existing road building material are from a gypsic borrow pit on the farm next door and at some places it is classified as "sensitive" soils with medium to high erodibility factor. A mixture of weathered gneiss and calcrete are a good road building material.

- *Concrete aggregates:* Sand from the G2 site is suitable for concrete mixture, but be careful not to borrow deeper into the alluvial clay, that might have expansive properties. Aggregates on site would be a problem due to the deep weathering of the gneiss and jointed metaquartzite. The pegmatites might be a better option.

- *Redox potential:* The overall redox potential is below 85 mV and only a few are close to chemical disequilibrium with a potential of erosion upon exposure (see Table 9)

- *Made Ground / Fill:* Made ground/fill was not encountered on the site except for on the Road 2972. No borrow pits are located on the 320 ha proposed development area. Some borrow pits with a calcrete-gypsic material are south west of the proposed site.

- *Seismic evaluation:* The seismicity of Africa, especially Southern Africa is, by world standards, very moderate and of shallow character. Some seismic activities were encountered and recorded at Augrabies on a local scale the last two year. The earthquake swarm is concentrated over a very narrow band about 10 km wide on either side of the Gariep river. This area is highly deformed and there are numerous faults, shear zones, folds and other lineaments, which could provide weak areas in the crust. It also lies on strike of the Hebron fault in Namibia, which is known to have been active during recent times.

  The peak horizontal acceleration for the Kakamas Brypaal site is very low (<50 cm/s2) with a 10% probability of being exceeded at least once in a period of 50 years. Seismic intensities (Modified Mercalli Scale) with a 10% probability of being exceeded at least once in a period of 50 years Class VI (very low) is applicable for the Brypaal site. There are no major fault zones, structural deformation, shear zones or other pronounced geological lineaments.

4 Geotechnical Interpretation and Summary

An evaluation of the impact of the geotechnical characteristics on the development, is discussed below and summarised in Section 5.

4.1 Ground Conditions

The ground conditions encountered within the trial pits comprise a thin cover of gravelly sand (topsoil) from mixed origin, overlying a variety of calcrete e.g. soft powdery, nodular, hard pan and tabular. The calcrete is not very deep and are limited to a depth of approximately 1.2 meters and some places intergrowth with the weathered gneiss.

4.2 Laboratory Testing

Laboratory tests were done on selected samples from the profile pits. Tests were undertaken by Simlab (Pty) Ltd in Kimberley. The various tests and pertinent information from these tests are highlighted below and the detailed test results are included as Appendix E1. Tests undertaken include:

- Indicator tests (including full grading and moisture content)
- pH and conductivity tests
- Chemical tests

4.3 Further Investigation

Site specific investigations should be done at the sub-station for foundation purpose as well as at each pylon site with special attention to the required depth of the pylons and related to the bedrock strength and type and weathering potential.

5 Geotechnical Recommendations

Founding conditions are favourable for the proposed development and conventional construction methods can be implemented. Depending on the design and loads to be applied, the following recommendations are made;

It is assumed that the calcrete and gneiss encountered on the site are suitable for construction of access roads and tracks, based on the existing main road.

6 Final Recommendations

➢ It is imperative that a **Competent Person** inspects all anomalous sites and attend the site investigations and excavations prior to the construction phase to ensure that conditions are suitable for the specific foundation system to be implemented. The **Competent Person** has to undertake a site-specific investigation and interpretation for each pylon screw.

- ***Stormwater management*:** Stormwater management is critical to prevent erosion and to prevent any damage to the environment.
- ***Drainage systems*:** Avoid as far as possible any development on drainage systems and if deemed necessary, please adhere to precautionary measures.
- ***Seepage water*:** During the investigation, seepage water was present close to the Salt river.
- ***Stability of Trenches:*** Trench instability are present where seepage water is encountered.
- ***Sulphur odour*:** A Sulphur odour was present during the investigations and it could have negative effects on the development.
- ***Linear shrinkage*:** Medium linear shrinkage of the soils was only encountered at the low-lying areas close to the Salt river as well as in the alluvial clay below surface in the other main drainage system (Profile G2).
- ***Electrical resistivity*:** Three layers of resistivity exist on the majority of the surface: A shallow layer < 7 m; very resistive second layer at depth >7.63 and conductive third layer at depth > 27.54 m. Design principles should take this in consideration.
- ***Soil sensitivity and soil erosion:*** Potential soil erosion upon disturbance is possible at certain areas, precautionary measures and rehabilitation specifications should be noticed.
- ***Soil alkalinity:*** High pH conditions are present and could have corrosive properties.
- ***Salinity:*** Saline soils could have corrosive potential and should be avoided as far as possible
- ***Redox potential:*** Low redox potential was encountered at a few sites and are indicative of sensitive soils which are prone to soil erosion upon disturbance.

7 References

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8 Appendices

Appendix A: Geotechnical profiles descriptions and logs

Appendix B: Profiling and parameters: MCSSO system

Appendix C: Penetration diagrams (DPSH)

Appendix D1: Shallow electrical resistivity profiles

Appendix D2: Deep electrical resistivity profiles

Appendix E1: Geotechnical laboratory data

Appendix E2: Chemical laboratory data

Appendix F: Particle size distribution semi-log graphs

Appendix G: Photos

CURRICULUM VITEA OF PIETER WILLEM VAN DEVENTER

ABRIDGED CURRICULUM VITAE

PIETER WILLEM VAN DEVENTER

February 2018

PERSONAL

1.1. Name: Pieter Willem van Deventer
1.2. Date of birth: 25 August 1950
1.3. Age: 67 years
1.4.a Boscia Environmental Solutiuons
1.4.b Address: 1239 Barret street , Queenswood, 0186, Pretoria Cell: 082 855 4533 / email: pietwvd@gmail.com

1. **HIGHEST ACADEMIC QUALIFICATION**
   1.1 MSc in Soil Science at PU for CHE (North-West University) in 1996.
   1.2 Post graduate diploma in Terrain evaluation (North West Univ) (1995)

2. **OTHER EDUCATIONAL & TRAINING PROGRAMMES** (only five major ones)
   2.1 Cleaner Production: Best Practice for the Mining Industry (Witwatersrand University, 2007);
   2.2 Master Course in Mine Water Management (Witwatersrand University, CSMI, 2007);
   2.3 Mine Closure Design (University of Western Australia, Perth, 2006);
   2.4 Quarternary geology research (Peking University, China, 1991);
   2.5 Certificate in Integrated Environmental Management (UCT, 1987).

3. **BRIEF CAREER EXPERIENCE (last five)**
   3.1 Geotechnical Terrain evaluation for solar farm construction (2015 -): Consultant
   3.2 Project manager and study supervisor for 20 MSc and >30 Honours students (2011 –)
   3.3 Lecturer [Environmental Geology] & Researcher [Soil Classification, Cenozoic Geology, Engineering Geology, Soil Degradation & Rehabilitation] (North-West University, 2009–2015)
   3.4 Environmental Research & Development (Fraser Alexander, 2003-2009)
   3.5 Research & Development (Envirogreen, 1999-2003)

4. **CURRENT RESEARCH PROJECTS & FIELD OF STUDY (last five)**
   4.1 Rehabilitated gold tailings: multiple and re-acidification
   4.2 Agri-business systems: post closure land use on mine sites
   4.3 Decision support systems:
      4.3.1 Surface stability aspects of mine sites
      4.3.2 SA mining environment: heavy metal pollution
      4.3.3 Gypsum tailings dam rehabilitation specifications
      4.3.4 Geo-environmental footprints of gold mines
      4.3.5 Mine tailings dam rehabilitation design parameters
      4.3.6 Solar farm stability and long term sustainability

4.4 Soil degradation assessments: metal trace element pollution, acid mine drainage (AMD), salinity pollution
4.5 Vegetation: phyto-toxicity, phyto-rehabilitation, biomass production, grazing capacity

5. RESEARCH EXPERIENCE (only five major projects):

5.1 Stability of areas on and around solar farms (2015 -2018)
5.2 Bio-geochemical base metal exploration (2015 – 2017)
5.3 Water requirements for rehabilitation of gold tailings (WRC, 2000-2004)
5.4 Mine tailings rehabilitation design, specifications and alternative land use
5.5 Hydraulic properties of stony soils (WRC, 1995-1999)

6. FIELDS OF EXPERTISE (only five major fields)

6.1 Development of Decision support systems (DSS) for various purposes i.e. solar farms, mine rehabilitation, geo-exploration etc
6.2 Rehabilitation and mine closure design
6.3 Quality control of rehabilitation projects
6.4 Soil physics, pedology, pedochemsitry, clay mineralogy, water holding capacity
6.5 Terrain evaluation (multi-disciplinary)

7. PROFESSIONAL SOCIETIES, AFFILIATIONS & MEMBERSHIPS

7.1 Professional Natural Scientist [Earth Science] (Reg No 400075/08)
7.2 Professional Natural Scientist [Soil Science] (Reg No 400075/08)
7.3 Soil Science Society of SA
7.4 International Soil Science Union
7.5 SA Soil Classification Working Group
7.6 Honorary member of LaRSSA (Land Rehabilitation Society of South Africa)

8. PUBLICATIONS, TECHNICAL REPORTS & PRESENTATIONS

8.1 Contributions to Scientific publications & books : 9
8.2 Technical reports : 185
8.3 Scientific presentations (workshops & conferences) : >52
8.4 Last Six Publications:

1. Van Deventer, P.W. 2000. Influence of Exchangeable sodium and clay mineralogy on the infiltration capacity of soils. WRC Report No. 499/1/00. Water Research Commission, Pretoria, South Africa.

2. Van Deventer, P.W., Bennie, A.T.P. & Hattingh, J.M. 2002. Hydraulic properties of stony soils. WRC Report No. 725/1/02. Water Research Commission, Pretoria, South Africa.

3. Schoeman, J.L. & Van Deventer, P.W. 2004. Soils and the Environment: The past 25 years. SA Journal of Plant and soils. Vol. 21, No5. South Africa.

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REFERENCES (current employment & field of study only)

1. Mr K Davel (previous colleague) Chief Design Engineer: Business owner Cell: 082 067 2347

2. Mr SJ Steenekamp (consultant and previous colleague) Agreenco: Manager and owner Cell: 083 263 7509 / email: SJ@agreenco.co.za

3. Mr Ray van Rensburg: Geotron Owner. Tel 018 294 4004 , Cell 083 750 0944, email ray@geotron.co.za

APPENDIX A: GEOTECHNICAL PROFILE DATA

PROFILES: 43 IN TOTAL

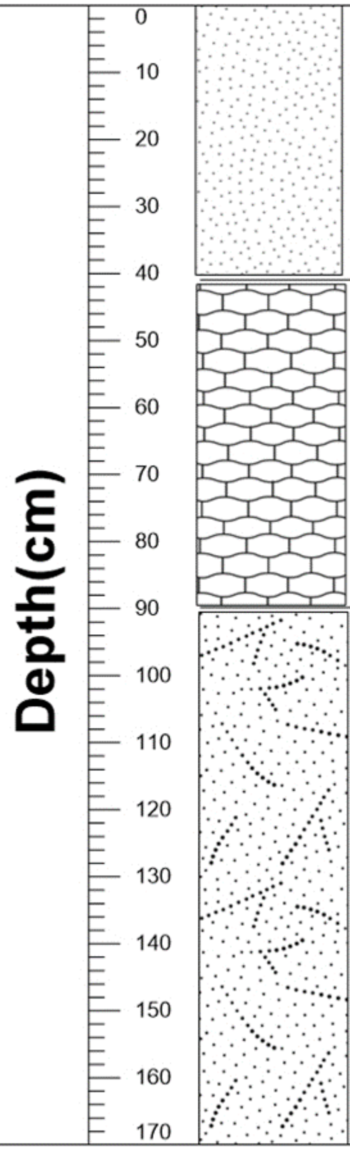
G1; G2; G3; G4; G5; G6; G7; G8; G9; G10; G11; G12; G13; G14

G16; G18; G20; G21; G23; G25; G26; G27; G28; G29

M1; M2; M3; M4; M5; M6; M8; M9; M10; M11; M12; M13; M14

M18; M21; M22; M23; M24

Profile No : G1
Project : THRIP
Area : Kakamas
Profiled by : Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 01 April 2017



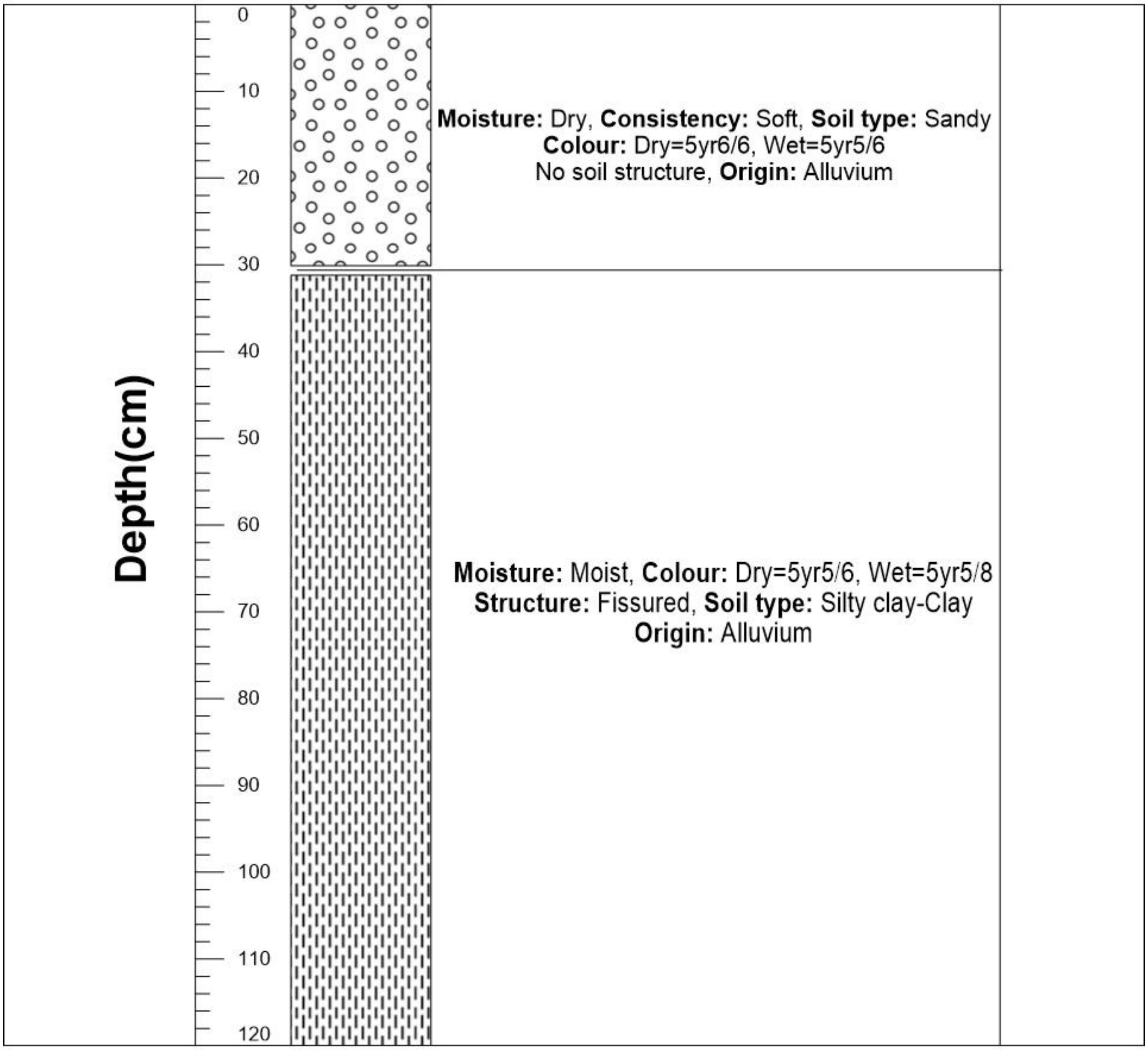
Moisture: Dry, Consistency: Soft-firm
Colour: Dry=7.5yr6/8, Wet=7.5yr4/4
Structure: Fissured, **Soil type:** Sandy silt
Origin: Transported-Alluvium/Minor Aeolian

Moisture: Dry, Consistency: Very stiff
Colour: Dry=10yr8/1, Wet=10yr7/3
Structure: Fissured/Shattered,
Origin: Pedogenic-Calcrete Hardpan

Colour: Streaked, **Weathering:** Slightly weathered
Fabric: Fine grained Quartz and coarse grained Gneiss
Hardness: Hard-Very Hard,
Roughness: Smooth-Slightly rough,
Discontinuities: Foliated thinly, **Separation:** Narrow
Fill: Filled with Calcrete lenses
Rock type: Gneiss and Quartz

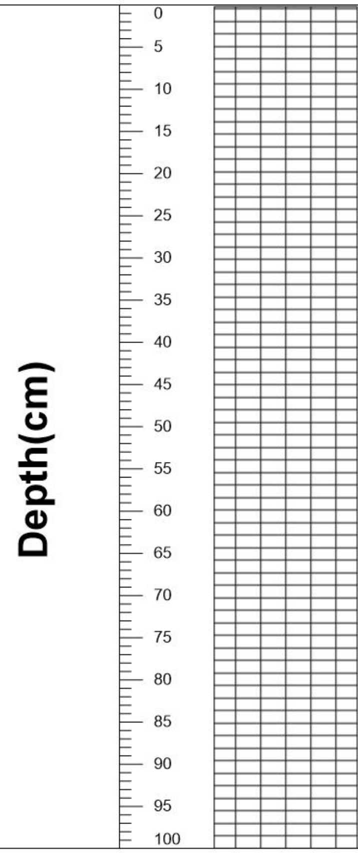
Quartz and feldspars around the soil profile

Profile No : G2
Project : THRIP
Area : Kakamas
Profiled by : Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 01 April 2017



Profile surrounded by a stream with lots and lots of well graded sand

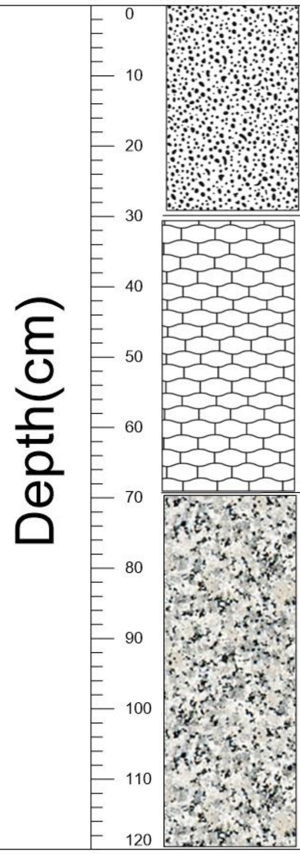
Profile No : G3
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L
Supervisor : Mr Van Deventer
Date of profile: 1 April 2017



Moisture: Dry
Colour: Dry-7.5yr4/6
Wet-5yr3/4
Consistency: Firm-Stiff
Structure: Honeycomb structure with 1joint
Soil type: Sandy silt
Soil Origin: Pedogenic(ferricrete)

Profile is surrounded by Dorbank with gneisses and sandy soil

Profile no : G4
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 30 March 2017



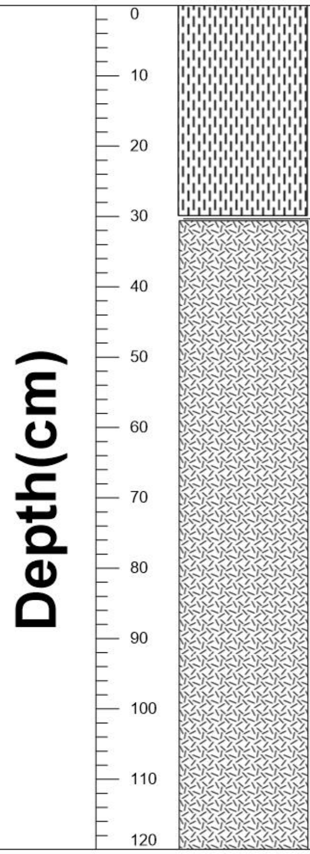
Moisture: Dry, **Consistency:** Soft-Firm
Colour: Dry-7.5yr5/6
Wet-7.5yr3/4
Structure: Fissured
Soil type: Silty clay with gravel adn cobbles
Soil origin: Transported(Alluvium)

Moisture: Dry, **Consistency:** Stiff
Structure: Shattered
Colour: Dry-5yr8/3
Wet-5yr8/1
Soil origin: Pedogenic(Calcrete Nodular)

Colour: Streaked, **Weathering:** Slightly weathered
Fabric: Medium grained
Discontinuities: foliated thinly
Fill: Filled with calcium carbonate
Separation: Wide
Hardness: Hard
Roughness: Slightly rough

The profile is surrounded by Quartz, Feldspars, Script granite and pegmitites

Profile No : G5
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 30 March 2017

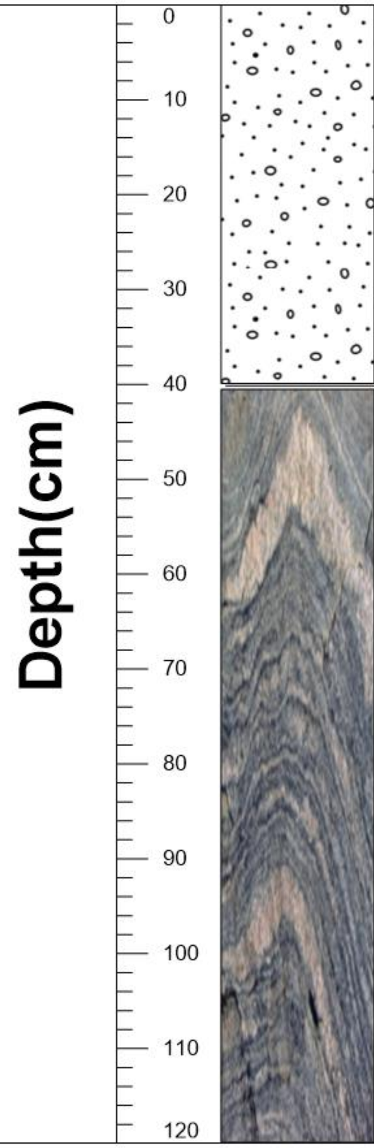


Moisture: Dry, **Consistency:** Soft-Firm
Colour: Dry-7.5yr4/6
Wet-7.5yr7/6
Structure: Fissured, **Soil type:** silty clay
Soil origin: Transported(Alluvium/Minor aeolian

Colour: Streaked, **Weathering:** Highly weathered
Fabric: Coarse grained, **Hardness:** Soft
Discontinuities: Foliated and jointed with 2 vertical joints/1m
Separation: Very narrow, **Fill:**clean
Roughness: Rough-Very rough
Rock type: Pegmatite

Profile surrounded by Quartz, gneisses and metaquartzite

Profile No : G6
Project : THRIP
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 01 April 2017

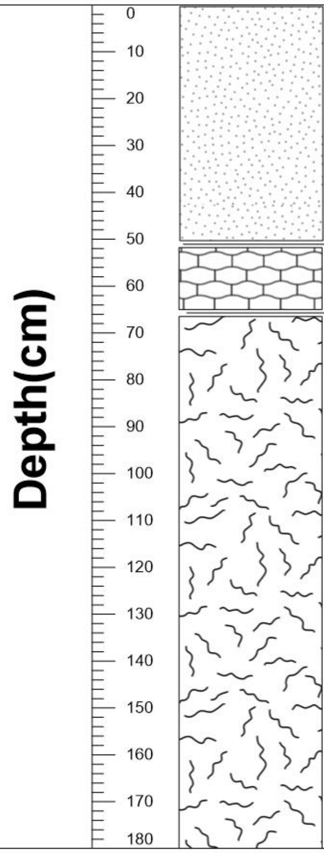


Moisture: Slightly moist, **Consistency:** Soft-Firm
Colour: Dry=7.5yr6/4, Wet=7.5yr4/4
Structure: Fissured, **Soil type:** Sandy silt with gravel
Origin: Transporetd-Alluvium/Minor Aeolian

Colour: Streaked, **Weathering:** Slightly-Moderately weathered
Fabric: Coarse grained, **Hardness:** Soft
Discontinuities: Foliated and Banded thickly
Separation: wide, **Fill:** Calcrete fill, **Roughness:** Rough
Rock type: Gneiss

Abundant quartz and calcrete around the profile

Profile No : G7
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 30 March 2017



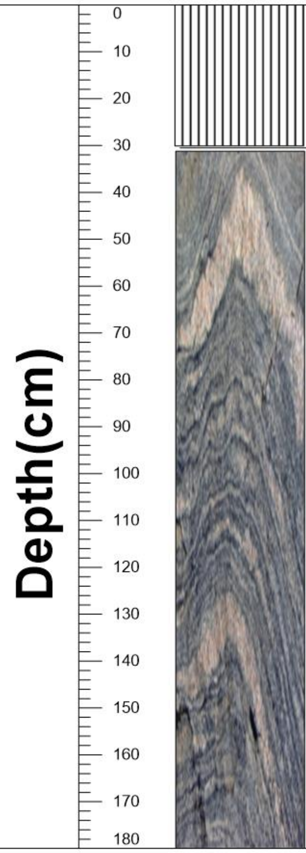
Moisture: Moist, **Consistency:**Soft
Colour: Dry-7.5yr5/6
Wet-7.5yr4/4
Structure: Fissured, **Soil type:** Sandy silt
Soil Origin: Transported(Alluvium/Minor Aeolian)

Moisture: Moist, **consistency:** Stiff, **Structure:** Shattered
Colour: Dry-7.5yr8/1
Wet-7.5yr8/2
Soil Origin: Pedogenic(Calcrete hardpan)

Colour: Streaked, **Weathering:** Slightly weathered
Fabric: Fine grained
Discontinuities: Foliated thinly
Hardness: Hard, **Separation:** Narrow
Fill: Filled with micas, **Roughness:**Smooth
Rock type: Quartz

The soil profile is surrounded by Quartz, Feldspars, Quartzite and calcrete

Profile No : G8
Project : Thrip
Area :Kakamas
Profiled by : Tshilate I and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 30 March 2017

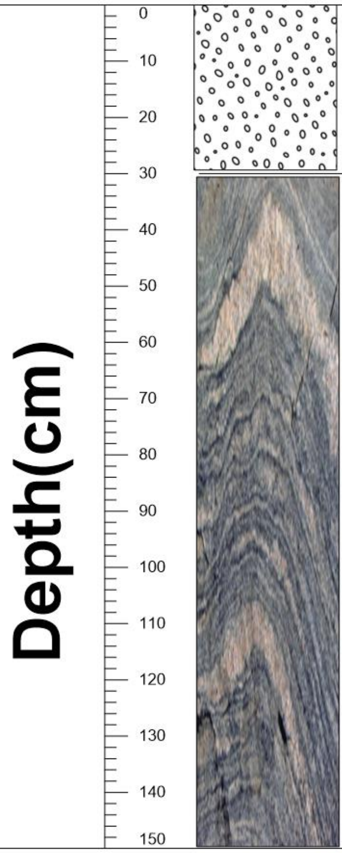


Moisture: Dry, **Consistency:** Soft-firm
Colour: Dry-7.5yr8/6
Wet-7.5yr3/3
Structure: Clast supported/Fissured
Soil type: Silty
Soil Origin: Transported(Alluvium/Aeolian)

Colour: Streaked, **Weathering:** Medium-Highly weathered
Fabric: Coarse grained, **Hardness:** Soft
Discontinuities: Banded and foliated thinly
Separation: Narrow, **Fill:** Clean
Roughness: Rough-very rough
Rock type: Gneiss

There is Quartz, Feldspars, Calcrete, Gneisses and micas surrounding the profile

Profile No : G9
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 29 March 2016

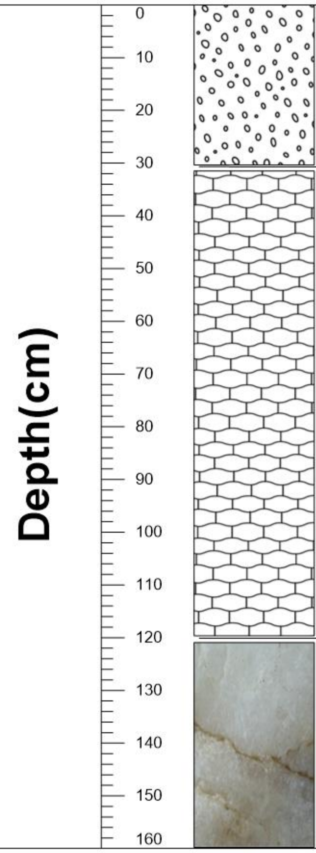


Moisture: Dry, **Consistency:** Firm
Colour: Dry-7.5yr4/6
Wet-7.5yr3/4
Structure: Fissured, **Soil type:** Sandy silt
Soil Origin: Transported(Alluvium/Minor Aeolian)

Colour: Streaked, **Weathering:** Highly weathered
Fabric: Coarse grained, **Hardness:** Very soft
Discontinuities: Foliated thinly
Separation: Narrow, **Fill:** Filled with Calcium Carbonate
Roughness: Rough
Rock type: Gneiss

Profile is surrounded by Quartz, Gneisses and Feldspars

Profile No : G10
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervieor : Mr Van Deventer
Date of Profile: 30 March 2017



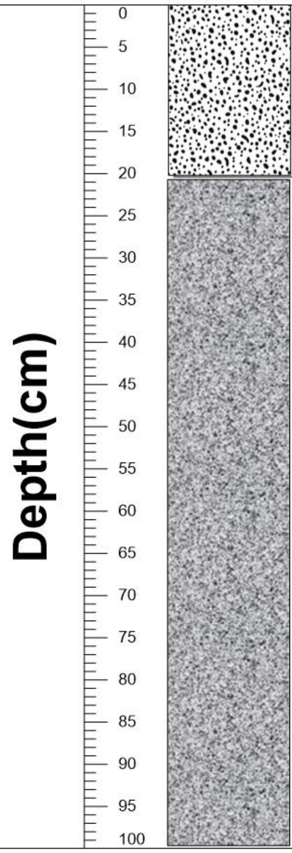
Moisture: Dry, **Consistency:** Soft
Colour: Dry-7.5yr5/6
Wet-7.5yr4/6
Structure: Fissured, **Soil type:** Sandy soil
Soil Origin: Transported(Alluvium)

Moisture: Dry, **Consistency:** stiff
Colour: Dry-7.5yr8/2
Wet-10yr8/2
Structure: Intact
Origin: Pedogenic(Calcrete soft)

Colour: Blotched, **Weathering:** Slightly weathered
Fabric: FIne-medium grained
Discontinuities: Foliated thinly, **Fill:** Clean
Separation: Closed, **Hardness:** Very hard
Roughness: Smooth
Rock type: Quartzite

Quartz, Calcrete and Quartzite around the profile

Profile No : G11
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 30 March 2017

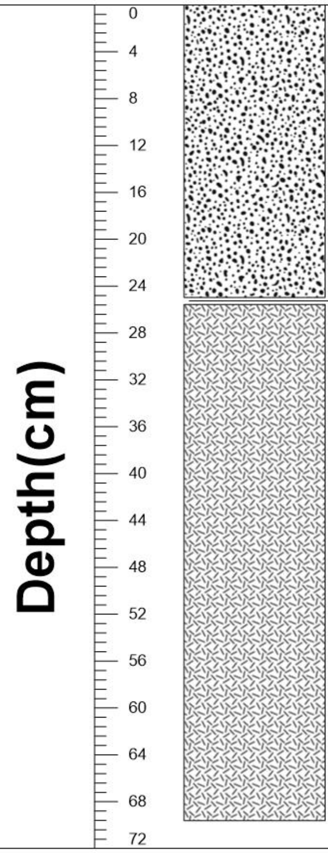


Moisture: Moist, **Consistency:**Soft
Colour: Dry-7.5yr5/6
Wet-7.5yr3/4
Structure: Fissured, **Soil type:** Sandy silt
Soil Origin: Transported(Alluvium/Minor Aeolian)

Colour: Streaked, **Weathering:**Moderately-highly weathered
Fabric: Medium-Coarse grained
Discontinuities: Foliated thinly
Separation: Very narrow, **Fill:** Filled with Calcium carbonate
Hardness: Moderately Hard
Roughness: Rough
Rock type: Script Granite

Profile is surrounded by Quartz, Feldspars , Calcrete, Gneisses and script granites

Profile No : G12
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 31 March 2017

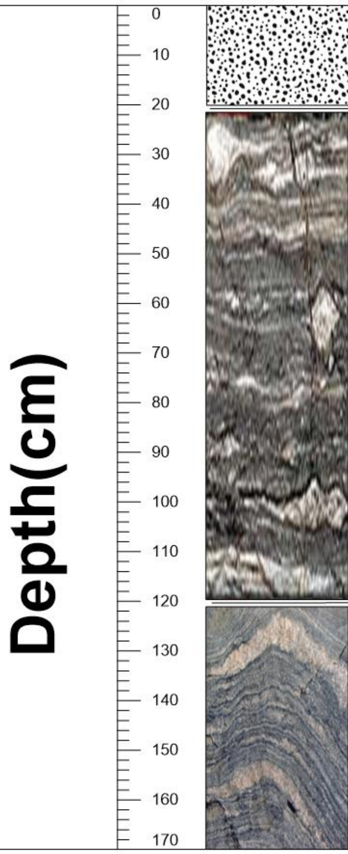


Moisture: Dry, **Consistency:** Soft-firm
Colour: Dry-7.5yr5/6
Wet-7.5yr3/4
Structure: Fissured, **Soil type:** Sandy silt
Soil Origin: Transported(Alluvium/Minor Aeolian)

Colour: Blotched, **Weathering**: Moderately weathered
Fabric: Coarse grained
Discontinuities: Foliated thickly
Hardness: Hard-very hard, **Fill:** Filled with Calcrete
Separation: Wide, **Roughness:** Rough-very rough
Rock type: Pegmatite

There is Quartz, Calcrete, Metaquartzite and gneisses aroung the profile(Potential pegmatite)

Profile No : G13
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 31 March 2017



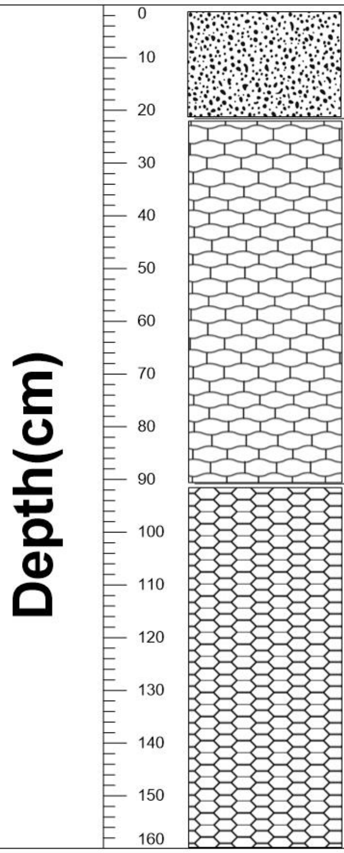
Moisture: Dry, **Consistency:** Firm, **Structure:** Fissured
Colour: Dry-7.5yr6/6, **Soil type:** Sandy silt
Wet-7.5yr4/6
Soil Origin: Transported(Alluvium/Minor Aeolian)

Colour: Streaked, **Weathering:**Moderately-highly weathered
Fabric: Coarse-very coarse grained
Discontinuities: Foliated thickly
Separation: Wide, **Fill:** Filled with calcrete lenses
Hardness: Soft, **Roughness:** Rough-very rough
Rock type: Calcrete and gneiss

Colour: Streaked, **Weathering:** Moderately weathered
Fabric: Medium-coarse grained
Discontinuities: Foliated and jointed with 13 vertical joints/1m
Separation: Very narrow-narrow
Fill: Filled with calcrete, **Hardness:** Soft
Roughness: Rough
Rock type: Gneiss

Profile surrounded by Calcrete, Quartz, Feldspars and weathered gneiss

Profile No : G14
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 31 March 2017



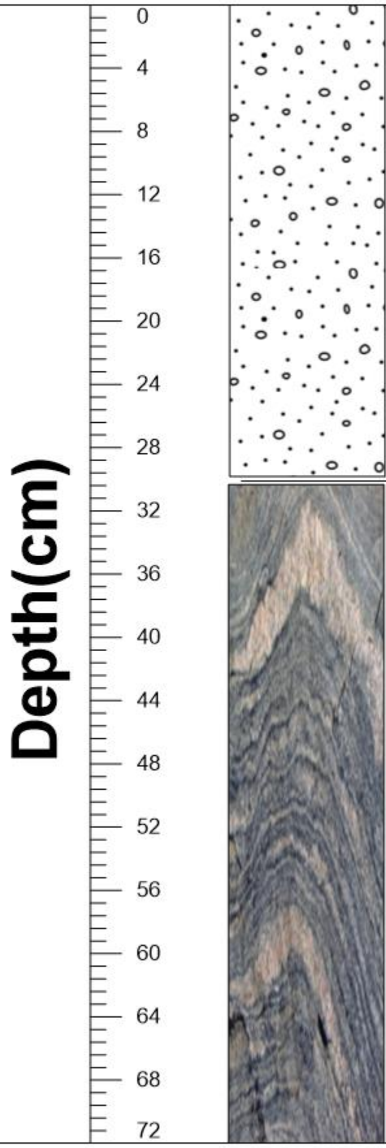
Moisture: Dry, **Consistency:** Soft
Colour: Dry-7.5yr4/6
Wet-7.5yr3/4
Structure: Fissured, **Soil type:** Sandy silt
Soil Origin: Transported(Alluvium/Minor Aeolian)

Moisture: Dry, **Consistency:** Stiff
Colour: Dry-10yr4/3
Wet-10yr7/6
Structure: Intact, **Soil Origin:** Pedogenic(Calcrete Hardpan)

Moisture: Moist, **Consistency:** Firm
Colour: Dry-10yr8/3
Wet-10yr7/6
Structure: Intact
Soil Origin: Pedogenic(Calcrete Soft/Powder)

The profile is surrounded by Quartz and Calcrete

Profile No : G16
Project : THRIP
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of Profile : 30 March 2017

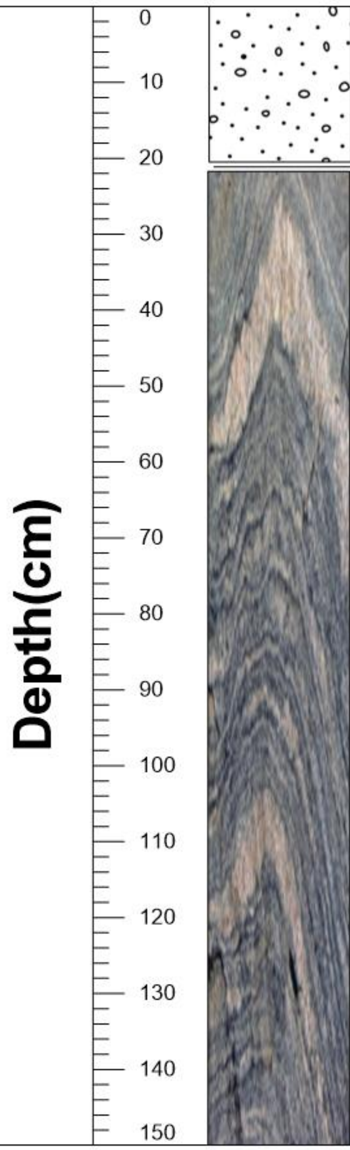


Moisture: Dry, **Consistency:** Soft
Colour: Dry=7.5yr5/6, Wet=7.5yr4/6
Structure: Fissured, **Soil type:** Sandy silt and gravel
Origin: Transported-Alluvium/Minor Aeolian

Colour: Streaked, **Weathering:** Slightly weathered
Fabric: Coarse grained, **Hardness:** Soft
Discontinuities: Thinly banded/Foliated
Separation: Narrow, **Fill:** Clean
Roughness: Slightly Rough
Rock type: Gneiss

Abundant quartz, gneiss and feldspars around the profile

Profile No : G18
Project : THRIP
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 10 April 2017



Moisture: Dry-Slightly moist, **Structure:** Fissured
Colour: Dry=10yr5/4, Wet=10yr4/4
Consistency: Soft-Firm, **Soil type:** Sandy silt with gravel
Origin: Transported-Alluvium/Minor Aeolian

Colour: Streaked, **Weathering:** Moderately weathered
Fabric: Medium-Coarse grained, **Hardness:** Soft
Discontinuities: Foliated and jointed with 8 joint/meter
Separation: Narrow, **Fill:** Carbonate fill
Roughness: Rough, **Rock type:** Gneiss

Abundant quartz, feldspars, gneiss and calcretes around the profile

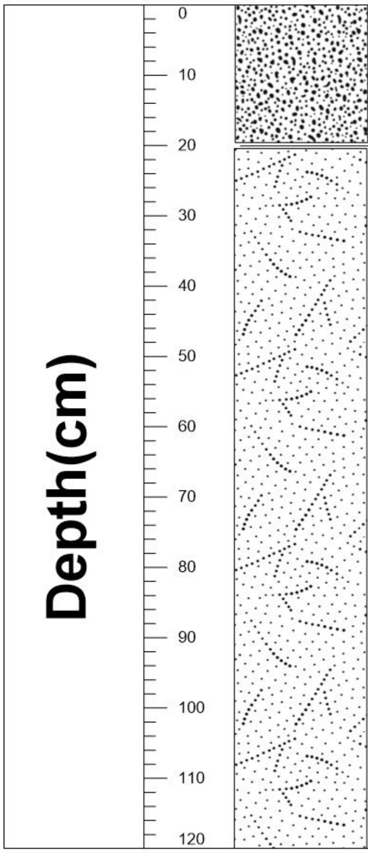
Profile No : G20
Project : Thrip
Area : Kakamas
Profiled by : TshilateL and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 29 March 2017

Moisture: Dry, **Consistency:** Soft
Colour: Dry-7.5yr5/8
Wte-7.5yr4/4
Structure: Clast supported, **Soil type:** Silty clay with boulders and cobbles
Soil Origin: Transported(Alluvium/Minor Aeolian)

Colour: streaked, **Weathering:** Highly weathered
Fabric: Medium-coarse grained
Discontinuities: foliated and jointed with 7 vertical joints/2m
Hardness: Soft, **Separation:** Closed
Fill: Clean, **Roughness:** Rough
Rock type: Gneiss

There are conglomerates, Calcrete,Feldspars, Quartz, Quartzite and Gneisses around the profile

Profile No : G21
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deveter
Date of profile: 30 March 2017

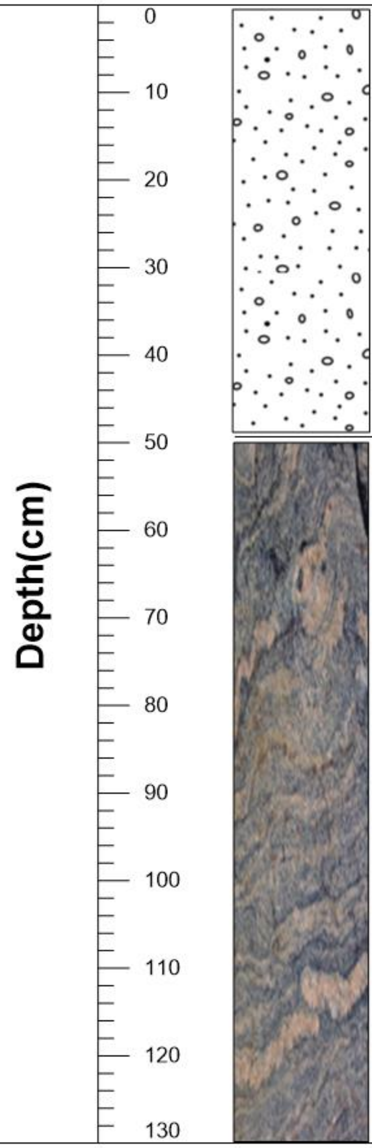


Moisture: Dry, **Consistency:** Soft-firm
Colour: Dry-7.5yr5/8
Wet-7.5yr3/4
Structure: Fissured, **Soil type:** Sandy silt
Soil Origin: Transported(Alluvium/Minor Aeolian)

Colour: Blotched, **Weathering:** Slightly weathered
Fabric: Fine-Medium grained
Discontinuities: Medium foliated
Hardness: Hard-very hard, **Separation:** Wide
Fill: Completely filled with calcium carbonate
Roughness: Medium rough-rough
Rock type: Pegmatite and quartzite

The profile is surrounded by Gneisses, Quartz and Pegmatites

Profile No : G22
Project :THRIP
Area :Kakamas
Profiled by :Tshilate L
Supervisor :Mr Van Deventer
Date of profile :01 April 2017

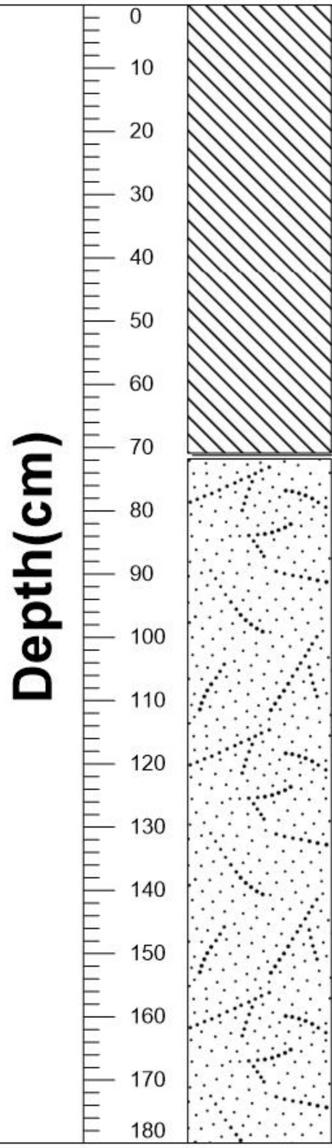


Moisture: Dry, **Consistency:** Soft-firm,
Structure: Shattered
Soil type: Sandy silt with gravel and cobbles
Colour: Dry=7.5yr7/8, Wet=7.5yr5/8
Origin: Transported- Alluvium/minor Aeolian
(There is calcerete soft with quartz pebbles on this layer)

Colour: Streaked, **Weathering:** Highly weathered
Fabric: Coarse grained, **Hardness:** Hard
Discontinities: Foliated and jointed with 1 vertical joint
Separation: Closed, **Fill:** Clean, **Roughness:** Rough
Rock type: Gneiss

Profile is surrounded by Quarts, calcrete, feldspars, granites and micas

Profile No : G23
Project : THRIP
Area : Kakamas
Profiled by : Tshilate I and Scholtz
Supervisor : Mr Van Deventer
Date of Profile : 01 April 2017

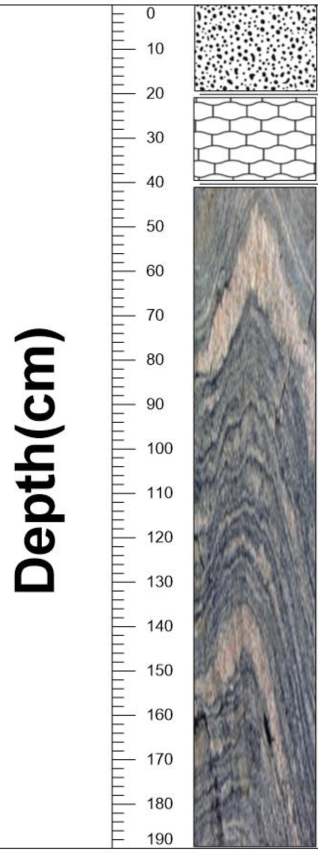


Moisture: Moist, **Consistency:** Firm
Colour: Dry=10yr8/4, Wet=10yr8/6
Structure: Fissured, **Soil type:** Clay
Origin: Pedogenic-Gypcrete

Colour: Mottled, **Weathering:** Highly wethered
Fabric: Fine grained, **Hardness:** Moderately hard
Discontinuities: Foliated thinly, **Separation:** Narrow
Fill: Filled with gypcrete, **Roughness:** Smooth
Rock type: Quartzite

Profile surrounded by Quartz, calcrete, feldspars and quartzite

Profile No : G25
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 30 March 2017



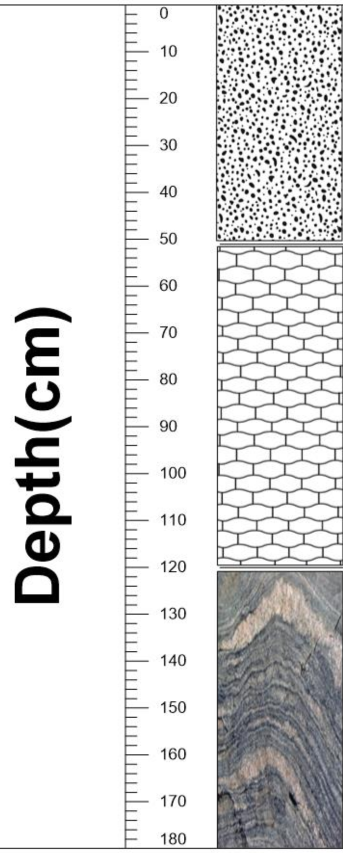
Moisture: Moist, **Consistency:** Soft
Colour: Dry-7.5yr5/6
Wet-7.5yr3/3
Structure: Fissured, **Soil Type:** Sandy silt
Soil Origin: Transported(Alluvium/Minor Aeolian)

Moisture: Moist, **Consistency:** Firm
Colour: Dry-7.5yr8/1
Wet-7.5yr8/3
Structure: Shattered, **Origin:** Pedogenic(Calcrete Powder)

Colour: Streaked, **Weathering:** Highly weathered
Fabric: Medium-coarse grained
Discontinuities: Foliated thinly, **Separation:** Narrow
Fill: Clean, **Hardness:** Very soft-soft
Roughness: Rough-very rough
Rock type: Gneiss

The profile is surrounded by Calcretes, Quartz, Feldspars, Pegmatites and gneisses

Profile No : G26
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 30 March 2017



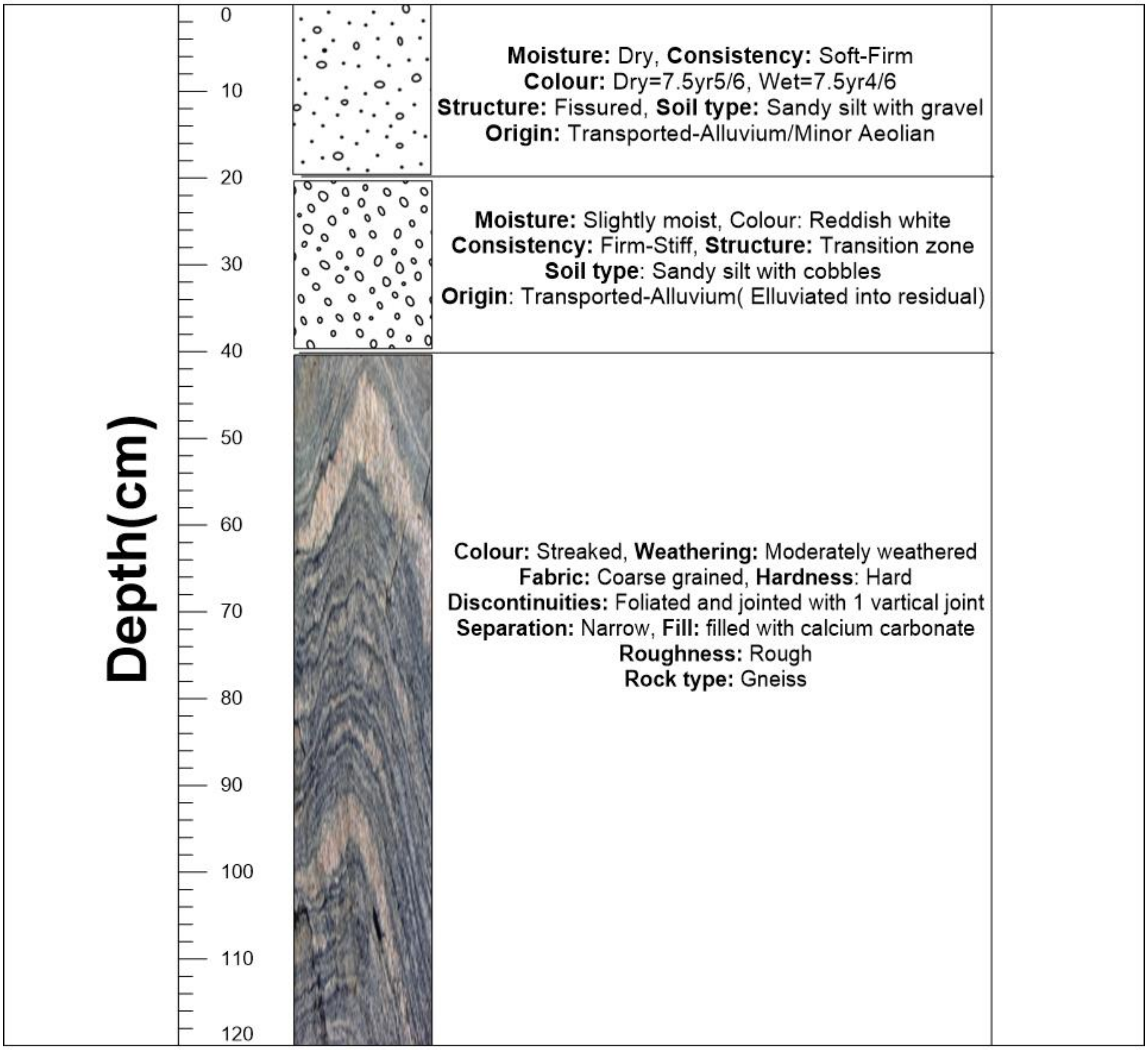
Moisture: Moist, **Consistency:** Soft
Colour: Dry-7.5yr5/6
Wet-7.5yr4/4
Structure: Fissured, **Soil type:** Sandy silt
Soil Origin: Transported(Alluvium/Minor Aeolian)

Moisture: Moist, **Consistency:** Firm
Colour: Dry-10yr8/3
Wet-10yr6/4
Structure: Intact
Soil Origin: Pedogenic(Calcrete powder)

Colour: Streaked, **Weathering:** Highly weathered
Fabric: Medium-coarse grained
Discontinuities: Foliated very thinly, **Hardness:** Soft
Separation: Closed, **Fill:** Clean, **Roughness:** Rough
Rock type: Gneiss

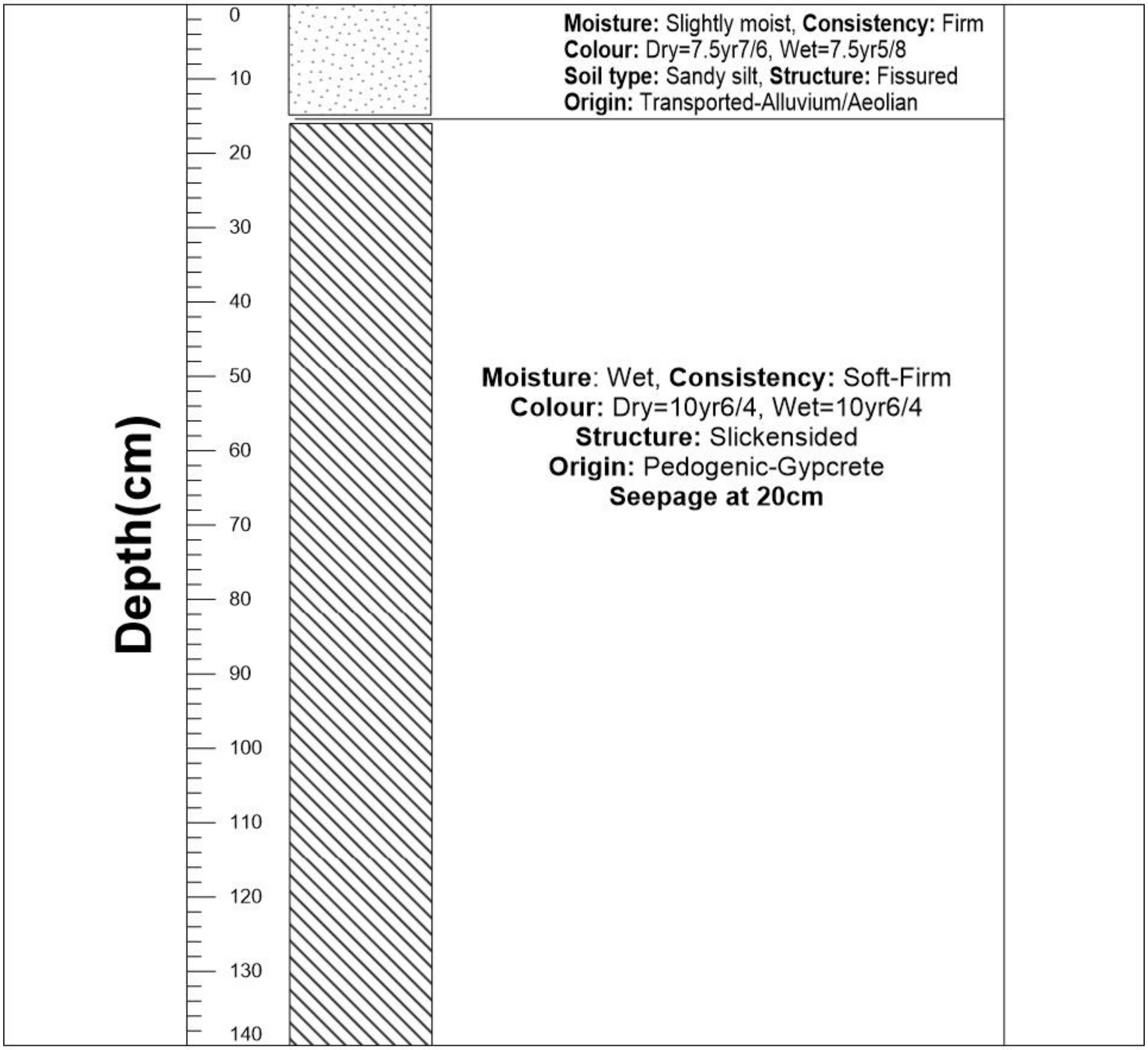
The profile is surrounded by Gneisses, Quartz and Calcretes

Profile No : G27
Project : THRIP
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile : 30 March 2017



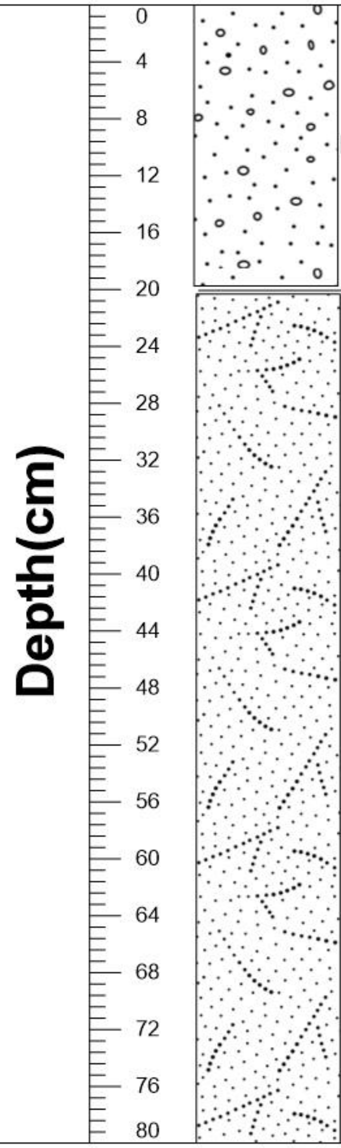
Abundant calcrete, gneiss and quartz around the profile

Profile No : G28
Project : THRIP
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 01 April 2017



Profile surrounded by Schist, quartz and feldspars

Profile No : G29
Project : THRIP
Area : Kakamas
Profiled by : Tshilate L
Supervisor : Mr Van Deventer
Date of profile: 01 April 2017

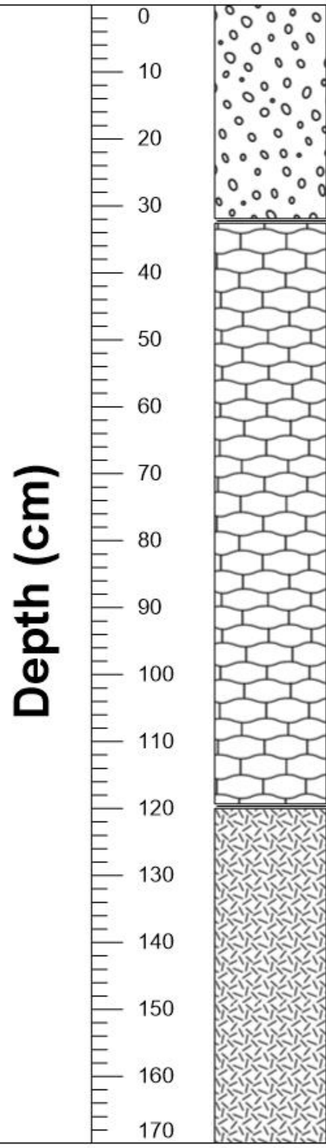


Moisture: Dry, **Consistency:** Soft, **Structure:** Fissured
Colour: Dry=10yr6/6, Wet=10yr6/8
Soil type: Sandy silt with gravel
Origin: Transported-Alluvium/Minor Aeolian

Colour: Streaked, **Weathering:** Moderately weathered
Fabric: Fine grained, **Hardness:** Hard-Very hard
Discontinuities: Foliated and jointed with 15 vertical joints/meter
Separation: Narrow, **Fill:** Clean, **Roughness:** Smooth
Rock type: Meta-Quartzite

Abundant quartzite and pegmatite outcroups around the profile

Profile No : M1
Project : THRIP
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr van Deventer
Date of profile : 01 April 2017



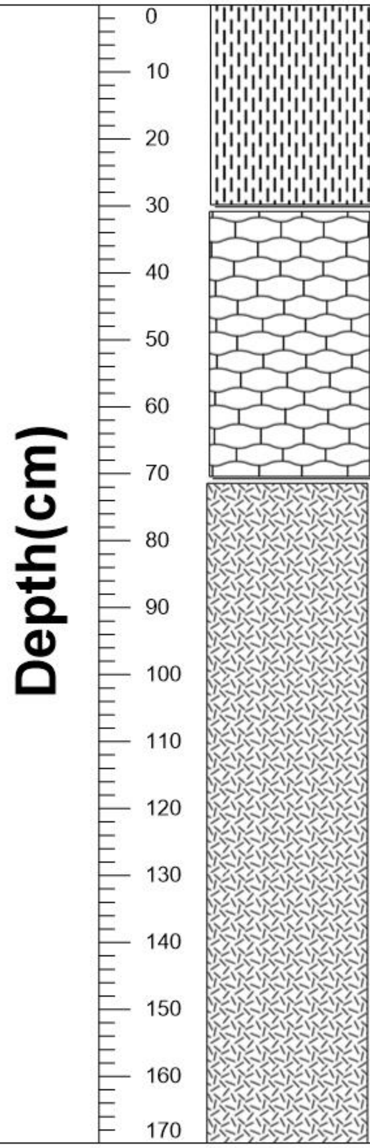
Moisture: Moist, **Soil type:** Sandy silt soil with gravel, **Consistency:**Very soft, **Structure:** Fissured, **Origin:** Transported-Alluvium/Aeolian, **Colour:** Dry=7.5yr6/6, Wet=7.5yr4/4

Moisture: Slightly moist, **Consistency:** Very stiff **Origin:** Pedogenoc- Calcrete Nodular, **Structure:** Clast and matrix supported, **Colour:** Dry=7.5yr8/4, Wet=7.5yr7/8

Colour: streaked, **Weathering:** Highly weathered, **Fabric:** Coarse grained, **Hardness:** Hard, **Discontinuity:** Foliated thickly, **Separation:** Narrow, **Fill:** partial fill of calcium carbonate **Roughness:** medium rough-rough **Rock type:** Pegmatite

Profile surrounding dominated by calcrete, quartz, feldsparsand pegmatie. There was also some nice present and a small stream with sandy material

Profile No : M2
Project : THRIP
Area : Kakamas
Profiled by : Tshilate I and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 01 April 2017



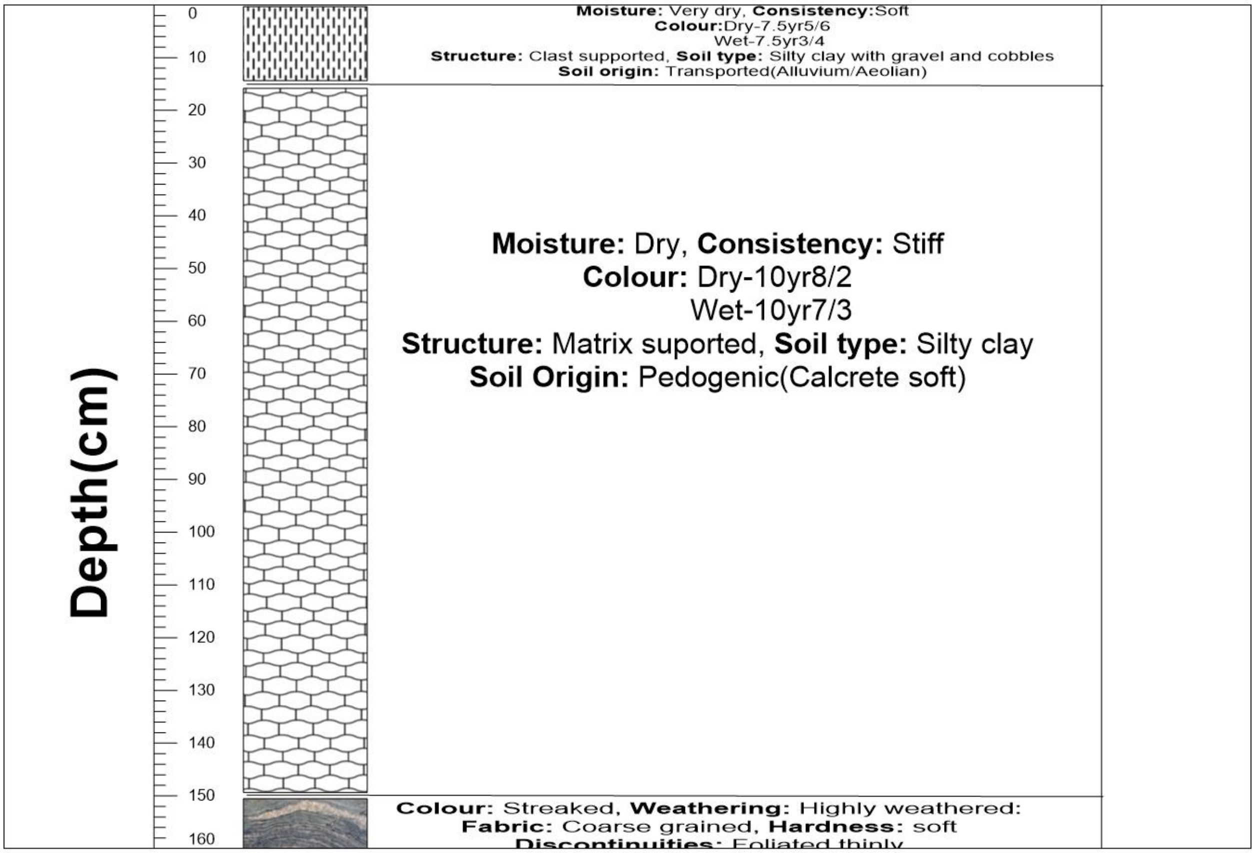
Moisture: Dry, **Consistency:** Firm-Stiff
Colour: Dry=7.5yr4/5, Wet=5yr4/8
Structure: Fissured, **Soil type:** Silty clay
Origin: Transported-Aeolian

Moisture: Dry, **Consistency:** stiff
Colour: Dry=10yr3/4, Wet=10yr4/4
Structure: Shattered
Origin: Pedogenic-Calcrete Hardpan

Colour: Blotched, **Weathering:** Moderately weathered
Fabric: Coarse grained, **Hardness:** Very Hard
Discontinuties: Thinly-Medium Foliated
Separation: Closed
Fill: Clean, **Roughness:** Rough
Rock type: Pegmatite

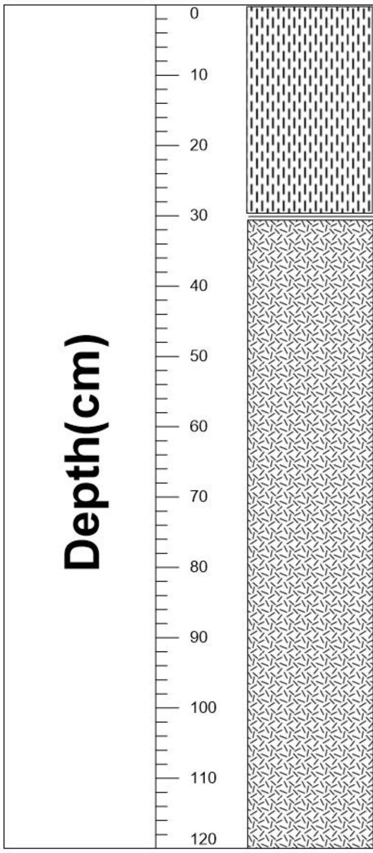
Profile surrounded by Feldspars, quartz and micas(potential pegmatite).
There was also some calcrete and gneiss present

Profile No : M3
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 29 March 2017



Profile surrounded by Quartz, Calcretes, Conglomerates, Gypsum and Gneisses

Profile No : M4
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 29 March 2017

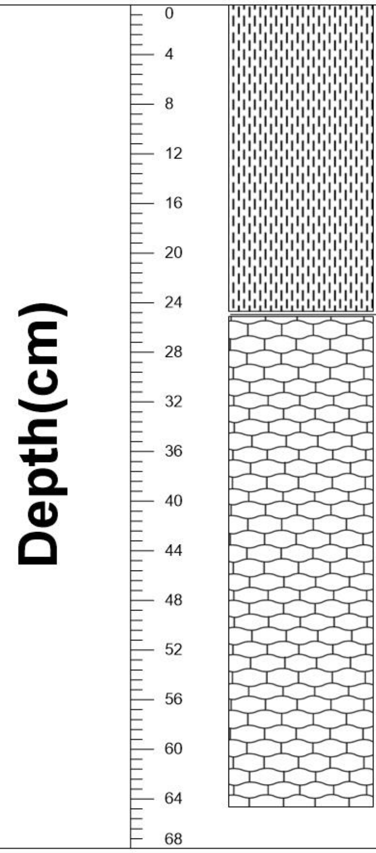


Moisture: Dry, **Consistency:** Soft
Colour: Dry-7.5yr5/6
Wet-7.5yr3/4
Structure: Fissured, **Soil type:** Silty clay with Gravel
Soil Origin: Transported(Alluvium/Aeolian)

Colour: Blotched, **Weathering:** Slightly weathered
Fabric: Medium- Coarse grained, **Hardness:** Hard
Discontinuities: Foliated thickly
Separation: Narrow, **Fill:** Clean, **Roughness:** Rough
Rock type: Pegmatite

The soil profile is surrounded by Quartz, Gneiss, Feldspars and pegmatites

Profile No : M5
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 30 March 2017

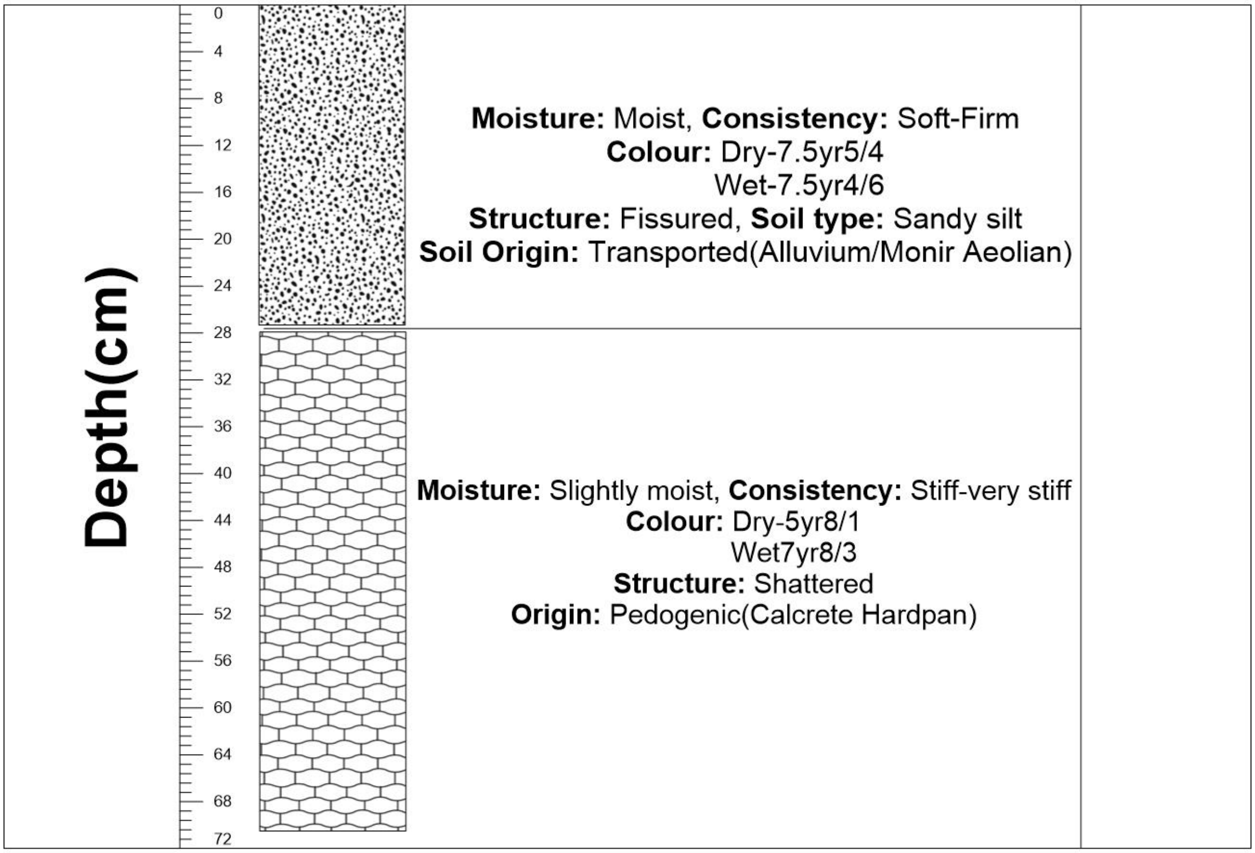


Moisture: Dry, **Consistency:** Soft-firm
Colour: Dry-7.5yr4/6
Wet-7.5yr4/4
Structure: Fissured,
Soil type: Silty clay with gravel and cobbles
Soil Origin: Transported(Alluvium/Aeolian)

Moisture: Dry, Consistency: Firm
Colour: Dry-5yr8/1
Wet-5yr8/3
Structure: Shattered, **Soil type:** Silty clay
Soil Origin: Pedogenic(Calcrete soft)

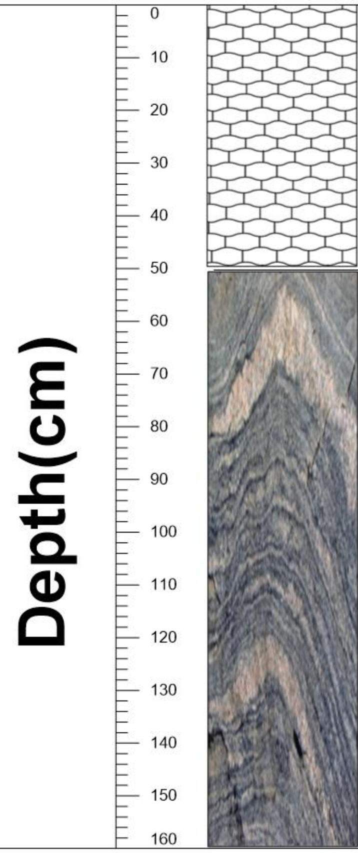
The profile is surrounde by Calcrete, Quartz, Quartzite and Pegmatite

Profile No : M6
Project : Thrip
Area :Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of Profile: 30 March 2017



The profile is surrounded by Calcrete, Quartz, Gneisses and Quartzite

Profile No : M8
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor :Mr Van Deventer
Date of profile: 31 March 2017

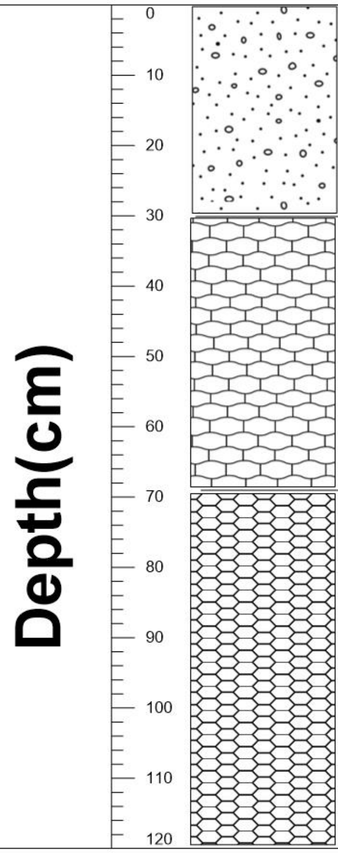


Moisture: Dry, **Consistency:** Stiff-very stiff
Colour: Dry-7.5yr8/1
Wet-7.5yr5/4
Structure: Shattered/Clast supported
Origin: Pedogenic(Calcrete hardpan)

Colour: Streaked, **Weathered:** Highly weathered
Fabric: Coarse grained, Hardness: Soft
Discontinuities: Foliated thinly
Separation: Narrow, **Fill:** Completely filled with calcrete
Roughness: Rough
Rock type: Gneiss

The profile is surrounded by Calcrete, Quartz, Gneisses and Feldspars

Profile No : M9
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Date of profile: 31 March 2017



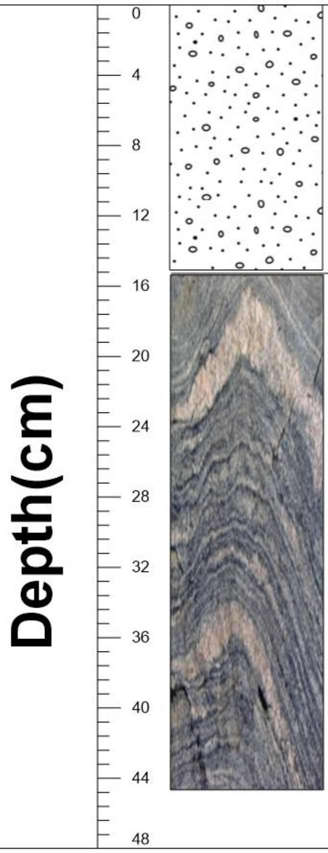
Moisture: Dry, **Consistency:** Soft-firm
Colour: Dry-7.5yr5/8
Wet-7.5yr3/4
Structure: Fissured, **Soil type:** Sandy silt
Soil Origin: Transported(Alluvium/Aeolian)

Moisture: Dry, **Consistency:** Very stiff
Colour: Dry-7.5yr8/5
Wet-7.5yr8
Structure: Shattered(Calcrete hardpan)

Moisture: Dry, **Consistency:** Firm
Colour: Dry-10yr7/3
Wet-10yr4/4
Structure: Fissured
Origin: Pedogenic(Calcrete soft)

Profile surrounded by Calcrete, Quartz and Feldspars

Profile No : M10
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of Profile: 31 March 2017

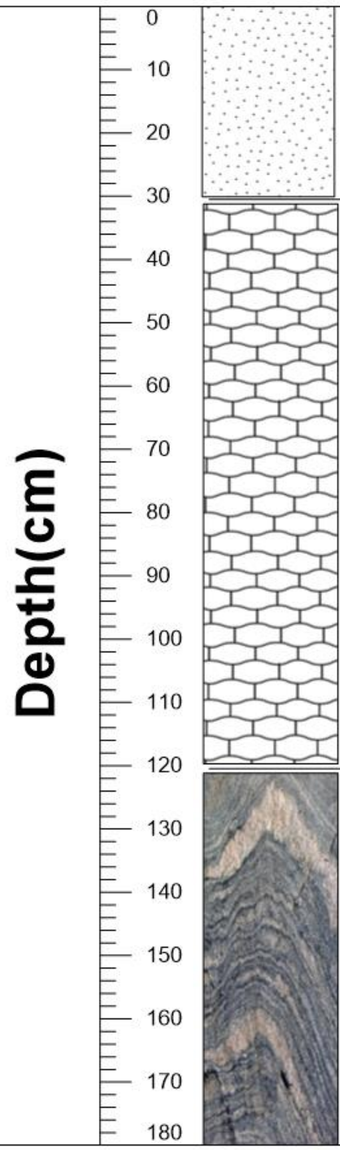


Moisture: Dry, **Consistency:** Soft-firm
Colour: Dry-7.5yr5/8
Wet-7.5yr3/4
Structure: Fissured, Soil type: Sandy silt
Soil Origin: Transported(Alluvium/Aeolian)

Colour: Streaked, **Weathering:** Slightly weathered
Fabric: Coarse grained, Hardness: Moderately Hard
Discontinuities: Foliated thinly
Separation: Closed, **Fill:** Clean
Roughness: Rough
Rock type: Gneiss

Profile surrounsed by Quartz, Gneisses and Feldspars

Profile No : M11
Project : THRIP
Area : Kakamas
Profiled by : Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 01 April 2017



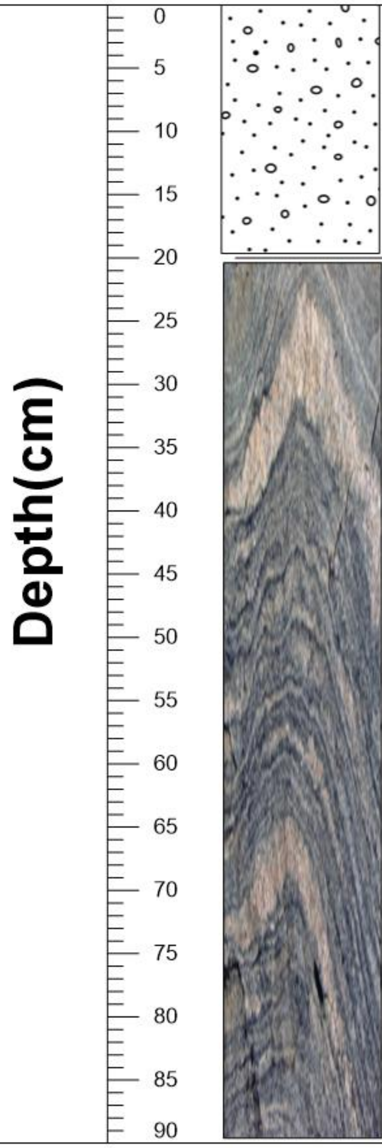
Moisture: Slightly moist, **Consistency**: Soft-Firm
Colour: Dry=10yr5/8, Wet=7.5yr4/6
Structure: Fissured, **Soil type:** Sandy silt with gravel
Origin: Transported -Alluvium/Minor Aeolian

Moisture: Dry, **Colour:** Dry=10yr8/2, Wet=10yr7/4
Consistency: Fim-Stiff, **Structure:** Fissured
Origin: Pedogenic-Calcrete Nodular

Colour: Streaked, **Weathering:** Moderately weathered,
Fabric: Coarse grained, **Hardness:** Medium hard-Hard
Discontinuities: Foliated and Banded thinly
Separation: Narrow, **Fill:** Clean, **Roughness:** Rough
Rock type: Gneiss

Calcrete, quartz and feldspars surrounding the profile

Profile No : M12
Project : THRIP
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 30 March 2017



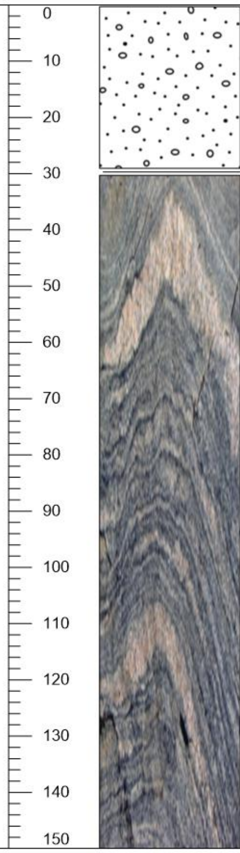
Moisture: Slightly moist, **Consistency:** Soft-Firm
Colour: Dry=7.5yr5/6, Wet=7.5yr5/8
Structure: Fissured, **Soil type:** Sandy silt with gravel
Origin: Transported-Alluvium/Minor Aeolian

Colour: Streaked, **Weathering:** Moderately weathered
Fabric: Medium grained, **Hardness:** Soft
Discontinuities: thinly foliated, Fill: Clean
Separation: Very narrow, **Roughness:** Medium rough
Rock type: Gneiss with calcrete lenses

Quartz, calcrete and feldspars around the profile

Profile No : M13
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 31 March 2017

Depth(cm)

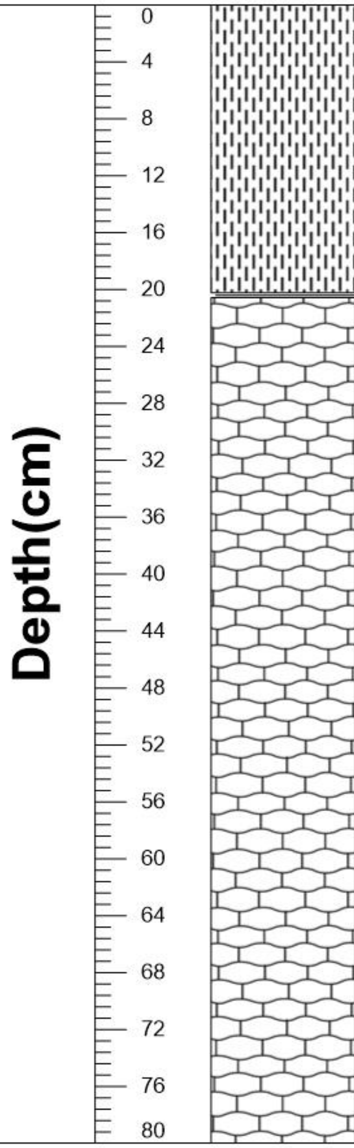


Moisture: Dry, **Consistency:** Firm
Colour: Dry-7.5yr5/6
Wet-7.5yr4/6
Structure: Fissured, **Soil type:** Sandy silt
Soil Origin: Transported(Alluvium/Aeolian)

Colour: Streaked, **Weathering:** Moderately weathered
Fabric: Coarse grained, **Hardness:** Moderately hard
Discontinuities: Foliated thinly
Separation: Closed, **Fill:** Clean
Roughness: Moderately rough-Rough
Rock type: Gneiss

Profile surrounded by Calcretes, Quartz and Gneisses

Profile No : M14
Project : THRIP
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
Date of profile: 01 April 2017

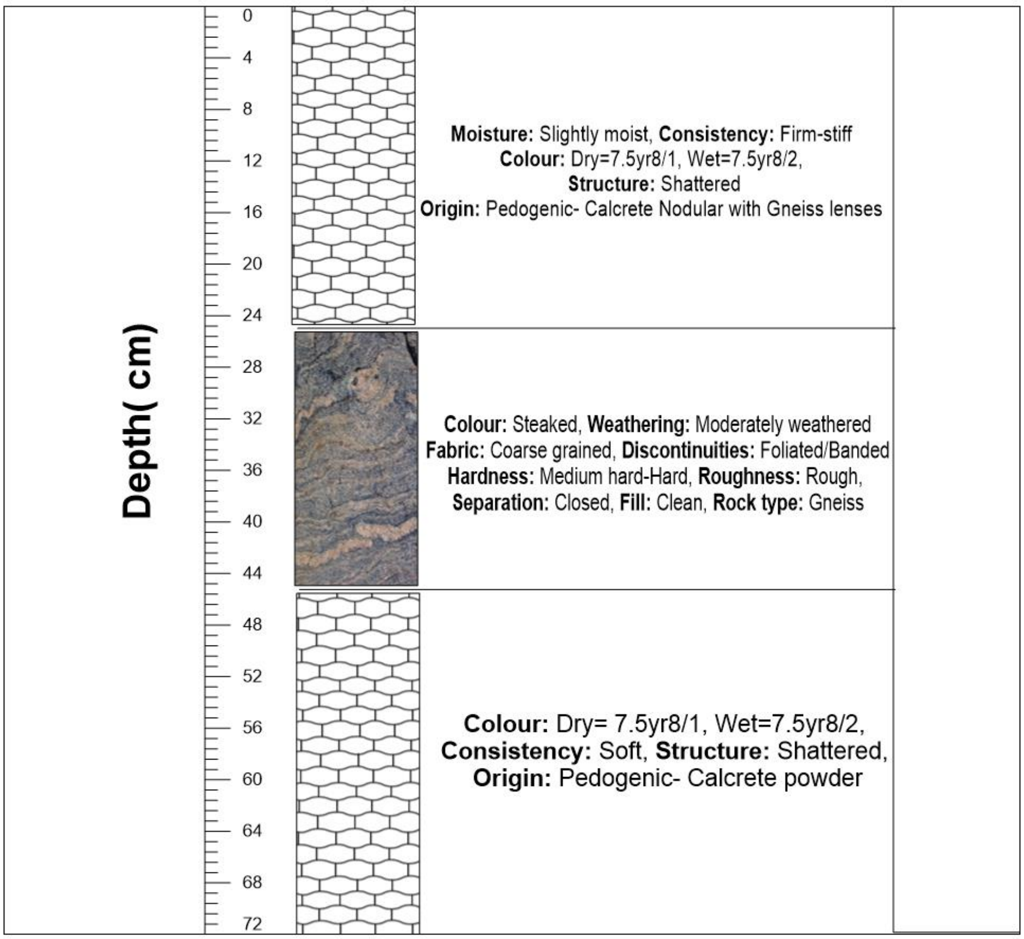


Moisture: dry, **Consistency**: Firm-Stiff
Colour: Dry=5yr7/8, Wet=5yr5/8
Structure: Clast supported/Slightly fissured
Soil type: Silty clay with quartz and calcrete pebbles
Origin: Transported-Aeolian

Colour: Dry=7.5yr8/2, Wet=7.5yr8/3
Consistency: stiff, **Moisture:** Dry
Structure: Shattered
Origin: Pedogenic-Calcrete Hardpan

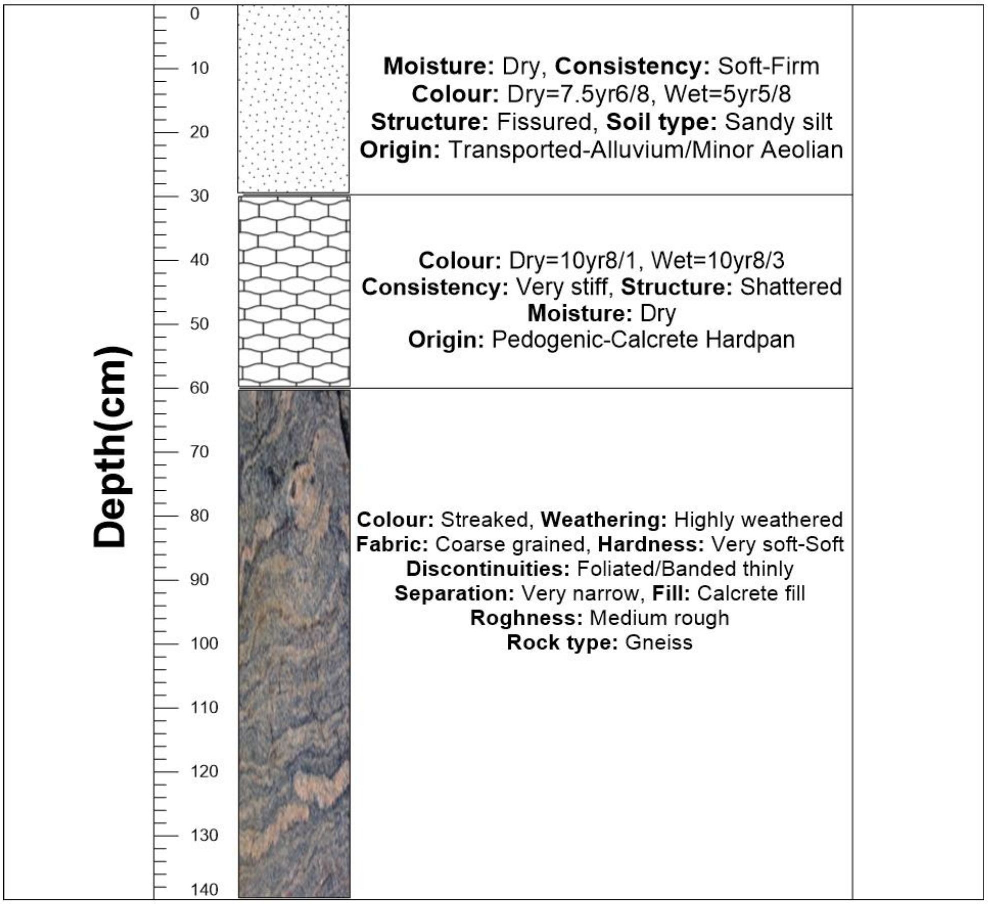
Quartz, feldspars, calcrete and gneiss around the profile

Profile No : M18
Project : THRIP
Area : Kakamas
Profiled by : Tshilate L and Faul C
Supervisor : Mr Van Deveter
Date of profile: 01 April 2017



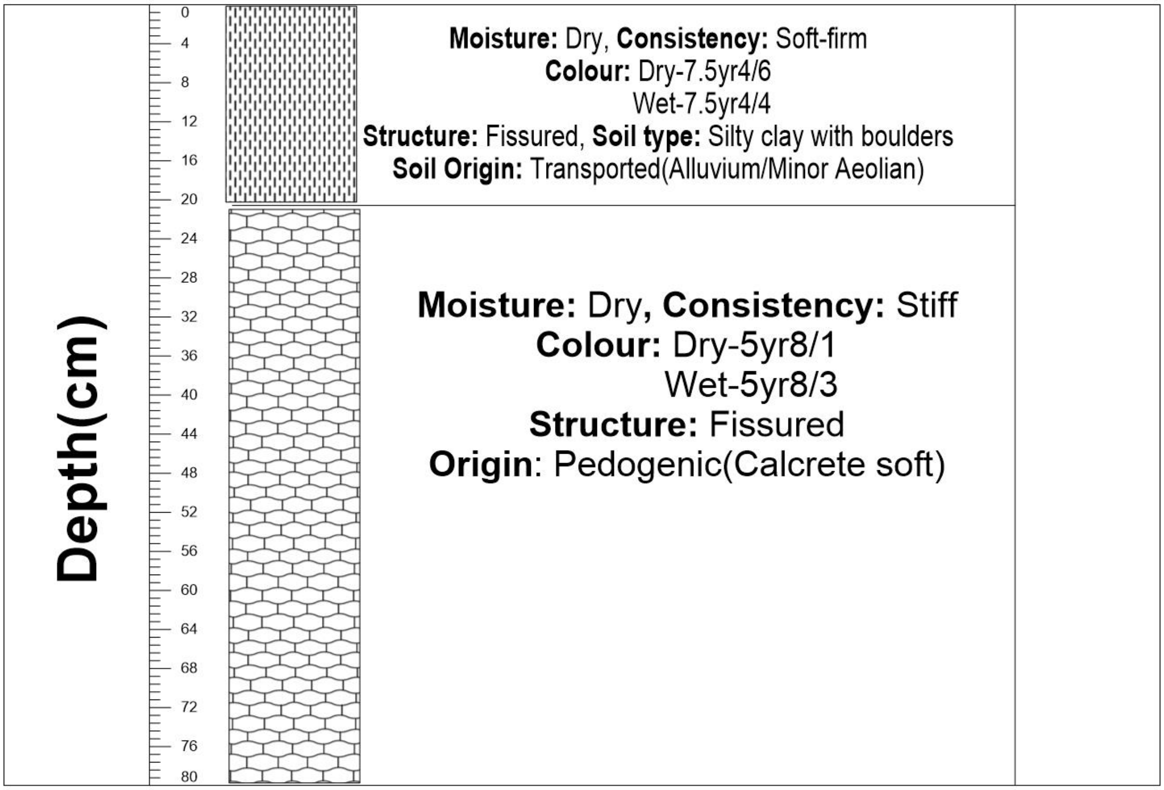
Quartz, calcrete,feldspars, gneiss and quartzite outcrops around the profile

Profile No : M21
Project : THRIP
Area : Kakamas
Profiled by : Tshilate Land Scholtz R
Supervisor : Mr Van Deventer
Date of profile : 01 April 2017



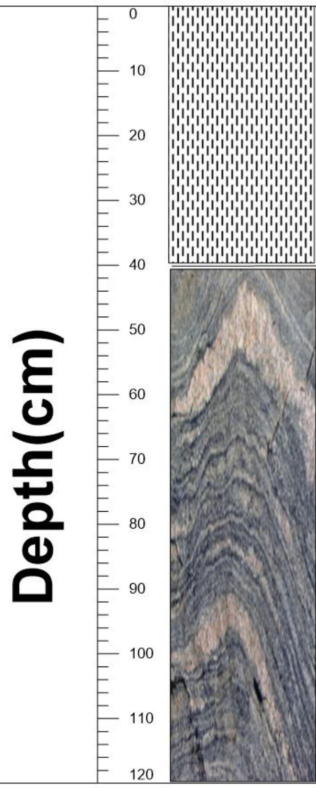
Profile surrounded by quartz, calcrete and feldspars

Profile No : M22
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
DAte of profile: 30 March 2017



Profile surrounded by Quartz, Calcrete, Script granites and feldspars

Profile No : M23
Project : Thrip
Area : Kakamas
Profiled by : Tshilate L and Scholtz R
Supervisor : Mr Van Deventer
DAte of profile: 31 March 2017

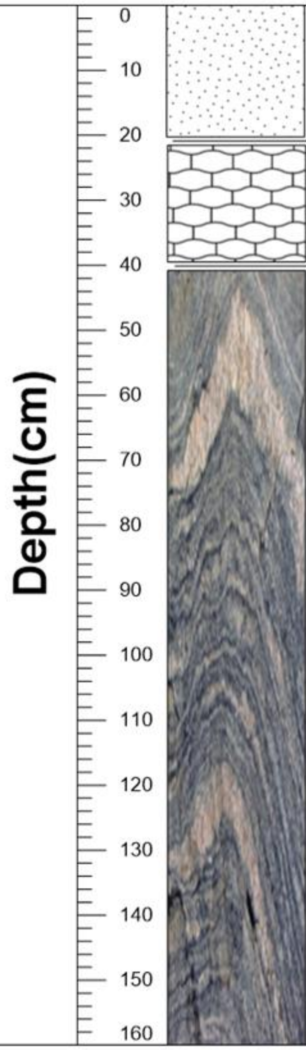


Moisture: Dry, **Consistency:** Soft-Firm
Colour: Dry-7.5yr5/6
Wet-7.5yr4/6
Structure: Fissured/Clast supported
Soil type: Silty clay
Soil Origin: Transported(Alluvium/Minor Aeolian)

Colour: Streaked, **Weathering:** Moderately weathered
Fabric: Coarse grained, **Hardness:** Moderately hard
Discontinuties: Thinly-Medium foliated
Separation: Narrow, **Fill:** Filled with Calcrete
Roughness: Rough
Rock type: Gneiss

Profile surrounded by Quartz, Green schist, Metaquartzites and gneisses

Profile No : M24
Project : THRIP
Area : Kakamas
Profiled by : Tshilate I and Scholtz R
Supervisor : Mr Van Deventer
Date of profile : 01 April 2017



Moisture: Slightly moist, **Consistency:** Soft-Firm
Colour: Dry=7.5yr6/8, Wet=7.5yr4/6
Structure: Fissured, **Soil type:** Sandy silt
Origin: Transported-Alluvium/Minor Aeolian

Moisture: Dry, **Colour:** Dry=10yr8/1, Wet=10yr7/3
Consistency: Firm, **Structure:** Fissured
Origin: Pedogenic-Calcrete Nodular

Colour: Streaked, **Weathering:** Moderately-Highly weathered
Fabric: Medium grained, **Hardness:** Soft
Discontinuities: Foliated and jointed with 2 vertical joints/1m
Separation: Narrow
Fill: Filled with calcium carbonate
Roughness: Slightly rough
Rock type: Gneiss

Profile surrounded by calcretes, quartz, feldspars and gneiss outcrops

APPENDIX B.

Example of MCSSO classification profile description sheet

ROFILE No	G11	**SUPERVISOR**	Mr PW Van Deventer	**PEDOGENIC CLASSIFICATION: FORM**
PROJECT:	Brypaal PV solar system	**CONTRACTOR:**	CA Bruwel	**Glenrosa**
AREA:	KAKAMAS	**DATE EXCAVATED:**	28/03/2017	**REMARKS:**
CLIENT:	VINTAGE ENERGY	**DATE PROFILED:**	30/03/2017	
PROFILED BY:	TSHILATE L AND SCHOLTZ R	**REVIEWED**	Mr PW Van Deventer	

	MOISTURE	CONSISTENCY		STRUCTURE	SOIL TYPE	SOIL ORIGIN			
		Cohesionless	Cohesive			Transported	Pedogenic	Residual	Other
SOIL	Dry	Very loose	Very soft	Intact	Boulders > 200	Hillwash	Gypcrete	Gneiss	Anthropogenic
	Slightly moist	Loose	Soft	Fissured	Cobbles 60-200	Colluvium	Ferricrete	Granite	Backfill
	Moist	Mod dense	Firm	Slickensided	Gravel 2-6-20-60	Alluvium	Silcrete	Pegmatite	
	Very moist	Dense	Stiff	Shattered	Sand	Littoral	Calcrete Soft	Quartz	
	Wet	Very dense	Very stiff	Micro-shattered	Sandy silt	Aeolian	Calcrete Powdered	Meta Quartzite	
				Stratified	Silty clay	Talus	Calcrete Nodular	Shale/schist	
				Inherent	Clay		Calcrete Honeycomb	Dyke	
							Calcrete Hardpan		
ROCK	**COLOUR**	**WEATHERING**	**FABRIC**	**DISCONTINUETIES Banded, foliated, jointed**	**HARDNESS**	**DISCONTINUITY DETAILS**			**ROCK TYPE**
						Separation	**Fill material**	**Roughness**	
	Banded	Fresh	Very fine grained	Very thinly	Very soft	Closed	Clean	Smooth	Granite/gneiss
	Streaked	Unweathered	Fine grained	Thinly	Soft	Very narrow	Stained	Slightly rough	Pegmatite
	Blotched	Slightly weathered	Medium grained	Medium	Moderately hard	Narrow	Partial	Medium rough	Quartz
	Mottled	Mod weathered	Coarse grained	Thickly	Hard	Wide	Filled	Rough	M Quartzite
	Speckled	Highly weathered	Very coarse	Very thickly	Very hard	Very wide		Very rough	Shale/schist
	Stained								Dyke

TEST PIT M or G		Excavation	Seepage		Sidewall Stability	Backfilling	Latitude	Longitude	DCP Test
		Refused	Slight	Strong	Good	Good			Surface
		Stopped	Moderate	Very strong	Moderate	Moderate	**Elevation**	**GPS waypoint**	Bottom of pit
		mln	Depth	mbgl	Poor	Poor			Mbgl

DEPTH (m)	DESCRIPTION	SAMPLE NR	SAMPLE TYPE	
0-20cm	Moisture: Moist Consistency: Firm Soil Origin: Transported-Alluvium/Minor Aeolian Colour: Dry-7.5yr$\frac{3}{6}$ Structure: Fissured Wet-7.5yr$\frac{3}{4}$ Soil type: Sandy silt	1	Soil	
20-100cm	Colour: Streaked Hardness: Hard Rock type: Gneiss Weathering: Moderately-Highly weathered Separation: Very Narrow Fabric: Coarse grained Fill: Partial fill of calcrete Discontinuities: Foliated thinly Roughness: Moderately rough-rough	2	Rock	

NOTES: Profile surrounded by Quartz, Script Granite, Feldspars, Calcretes and gneisses

APPENDIX C: DPSH Diagram 1-5

Table is applicable to all Diagrams for non-cohesive soils

Table 3.3.7 FRANKI	SPT"N "= DPSH		Consistency	
	< 5		Very Loose	
	5 to 10		Loose	
	10 to 30		Medium Dense	
	30 to 50		Dense	
	> 50		Very Dense	

DIAGRAM 1: Profiles M1, M6, M8, M9 and M11

cm Depth	M 1	M 6	M 8	M 9	M 11	Very Loose	Loose	Med Dense	Dense
	Blows / 30 cm								
0	0	0	0	0	0	5	10	30	50
-30	4	38	6	12	14	5	10	30	50
-60	20	50	18	17	33	5	10	30	50
-90	41		34	17	55	5	10	30	50
-120	50		30	32		5	10	30	50
-150			21	50		5	10	30	50
-180			43			5	10	30	50
-210			50			5	10	30	50

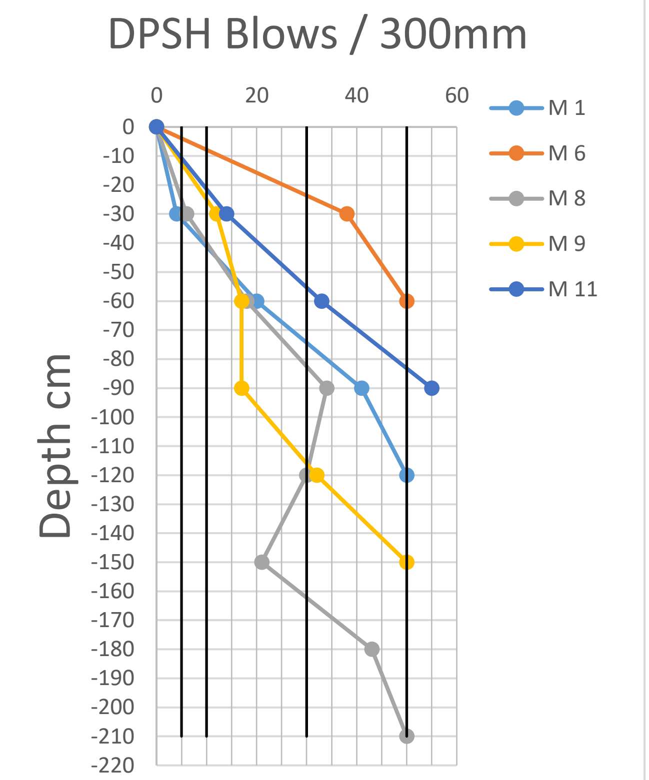


FIGURE 1. DPSH Test results: M1, M6, M8, M9 and M11

Profile M8: Loose to medium dense soil and powdery calcrete down to -90 cm, from -90 to -150 - medium dense hardpan or boulder calcrete, below -180 cm it is dense to very dense rock.

All other profiles have a consistent increase in Consistency from very loose to dense from surface to -150 cm

Brypaal DPSH Diagram Appendix C

DIAGRAM 2; PROFILE M12; M22; M23 and M24

cm Depth	M12	M22	M23	M24		Very Loose	Loose	Med Dense	Dense
	Blows / 30 cm								
0	0	0	0	0		5	10	30	50
-30	11	12	13	6		5	10	30	50
-60	22	29	31	13		5	10	30	50
-90	42	40	50	21		5	10	30	50
-120	50	50		27		5	10	30	50
-150				39		5	10	30	50
-180				50		5	10	30	50
-210						5	10	30	50

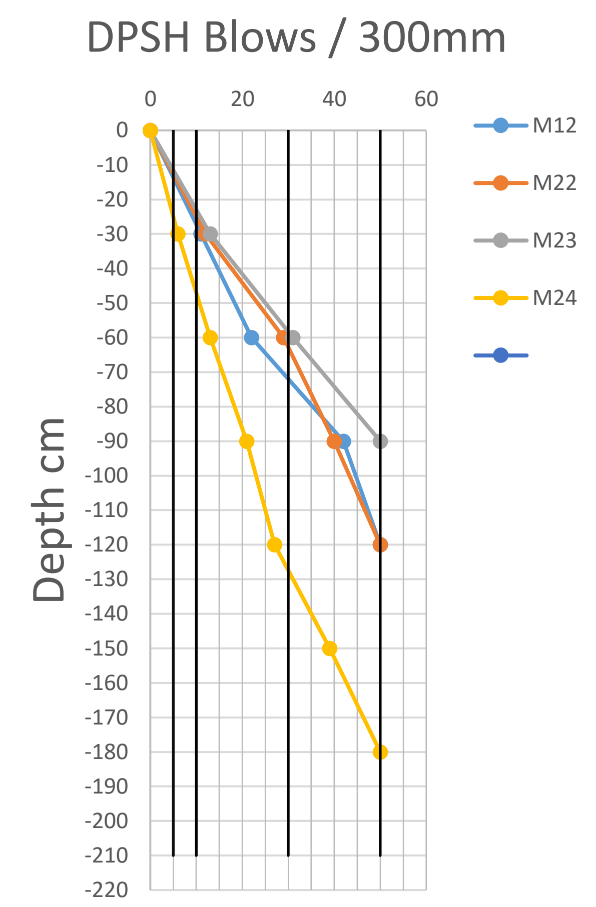


FIGURE 2. DPSH Test results:M12, M22, M23 and M24

All profiles have a consistent increase in Consistency from very loose to dense from surface to -180 cm

DIAGRAM 3: Profiles G2, G3, G5, G6 and G7

cm Depth	Blows / 30 cm G2	G3	G5	G6	G7	Very Loose	Loose	Med Dense	Dense	P
0	**0**	**0**	**0**	**0**	**0**	**5**	**10**	**30**	**50**	
-30	**10**	**10**	**9**	**8**	**14**	**5**	**10**	**30**	**50**	
-60	**10**	**21**	**22**	**13**	**39**	**5**	**10**	**30**	**50**	
-90	**15**	**34**	**44**	**23**	**50**	**5**	**10**	**30**	**50**	
-120	**37**	**45**	**50**	**31**		**5**	**10**	**30**	**50**	
-150	**50**	**50**		**42**		**5**	**10**	**30**	**50**	
-180				**50**		**5**	**10**	**30**	**50**	
-210						**5**	**10**	**30**	**50**	

All profiles have a steady increase in Consistency from surface to -180 cm depth

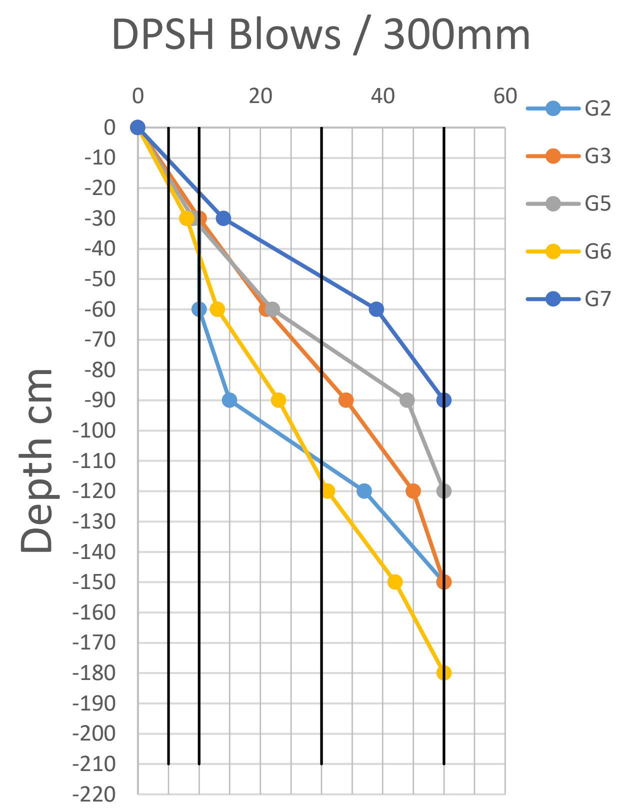


FIGURE 3. DPSH Test results: G2, G3, G5, G6 and G7

DIAGRAM 4: Profiles G9, G12, G13, G20 and G21

cm Depth	Blows / 30 cm									
	G9	G12	G13	G20	G21	Very Loose	Loose	Med Dense	Dense	Pr
0	0	0	0	0	0	5	10	30	50	
-30	21	21	12	8	31	5	10	30	50	
-60	21	50	20	11	50	5	10	30	50	
-90	50		31	7		5	10	30	50	
-120			44	16		5	10	30	50	
-150			50	39		5	10	30	50	
-180				50		5	10	30	50	
-210						5	10	30	50	

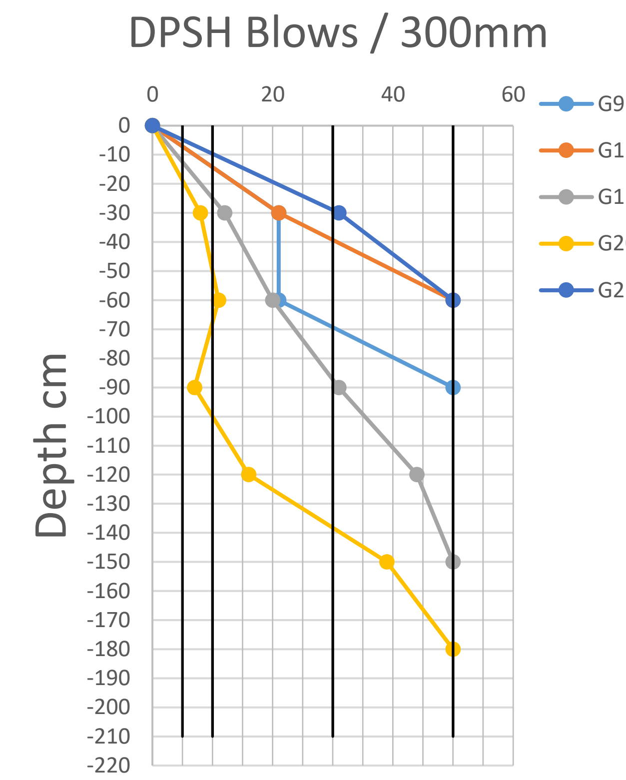


FIGURE 4. DPSH Test results: G9, G12, G13, G20 and G21

Profile G20: Loose to medium dense soil and powdery calcrete down to -90 cm, From -90 to -120 - medium dense hardpan or boulder calcrete, below -150 cm it is dense to very dense rock.

All other profiles have a consistent increase in Consistency from very loose to dense from surface to -150 cm

DIAGRAM 5 : Profiles G23, G25, G26 and G27

cm Depth	Blows / 30 cm G23	G25	G26	G27		Very Loose	Loose	Med Dense	Dense	F
0	**0**	**0**	**0**	**0**		**5**	**10**	**30**	**50**	
-30	**11**	**4**	**3**	**29**		**5**	**10**	**30**	**50**	
-60	**50**	**5**	**11**	**38**		**5**	**10**	**30**	**50**	
-90		**10**	**16**	**50**		**5**	**10**	**30**	**50**	
-120		**19**	**27**			**5**	**10**	**30**	**50**	
-150		**28**	**41**			**5**	**10**	**30**	**50**	
-180		**47**	**50**			**5**	**10**	**30**	**50**	
-210		**50**				**5**	**10**	**30**	**50**	

All profiles have a consistent increase in Consistency from very loose to dense from surface to -210 cm

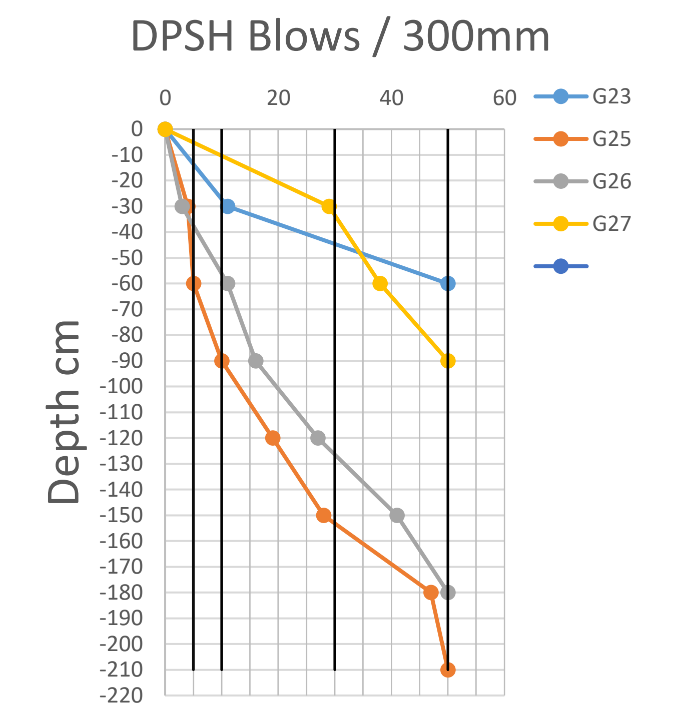
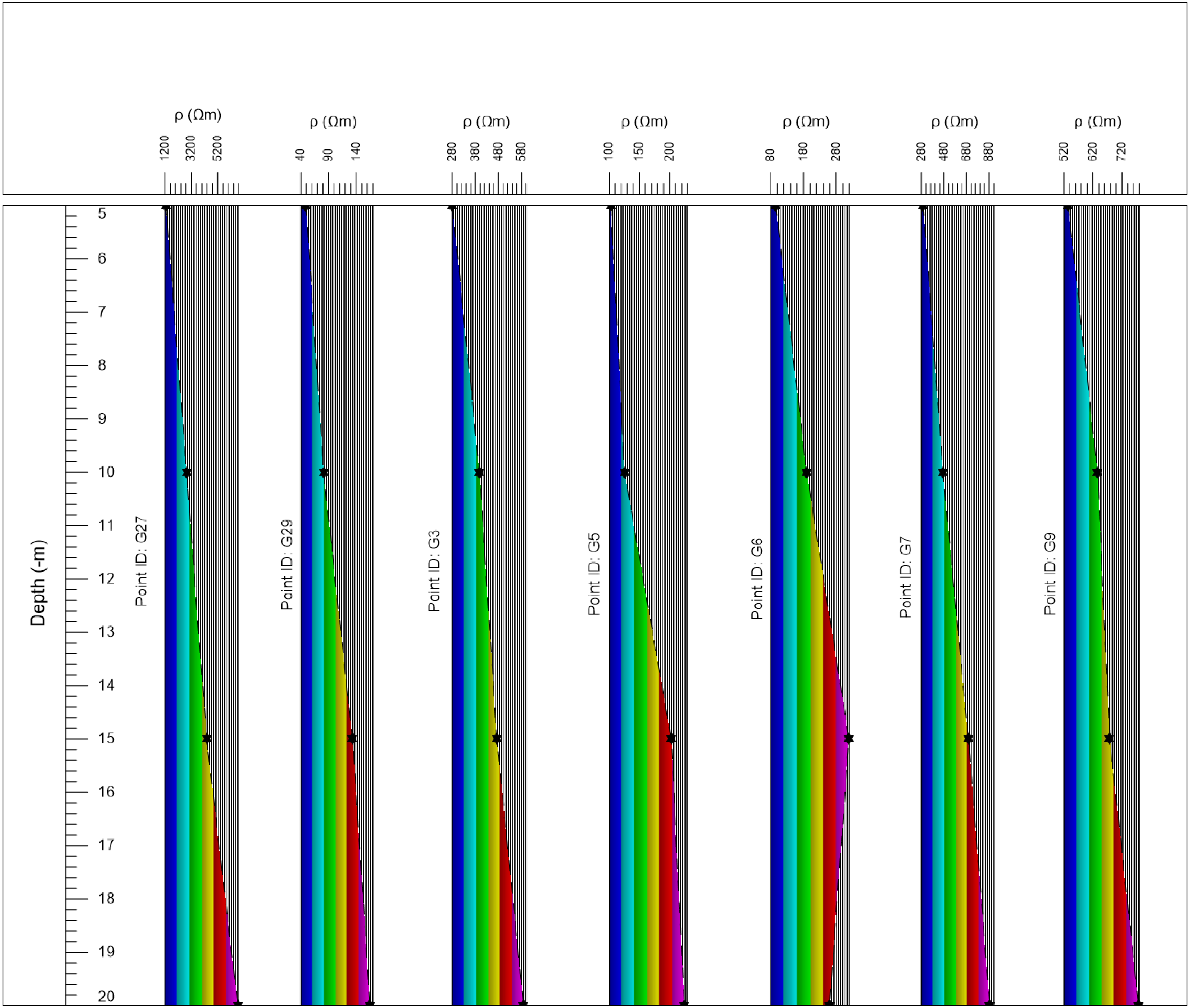
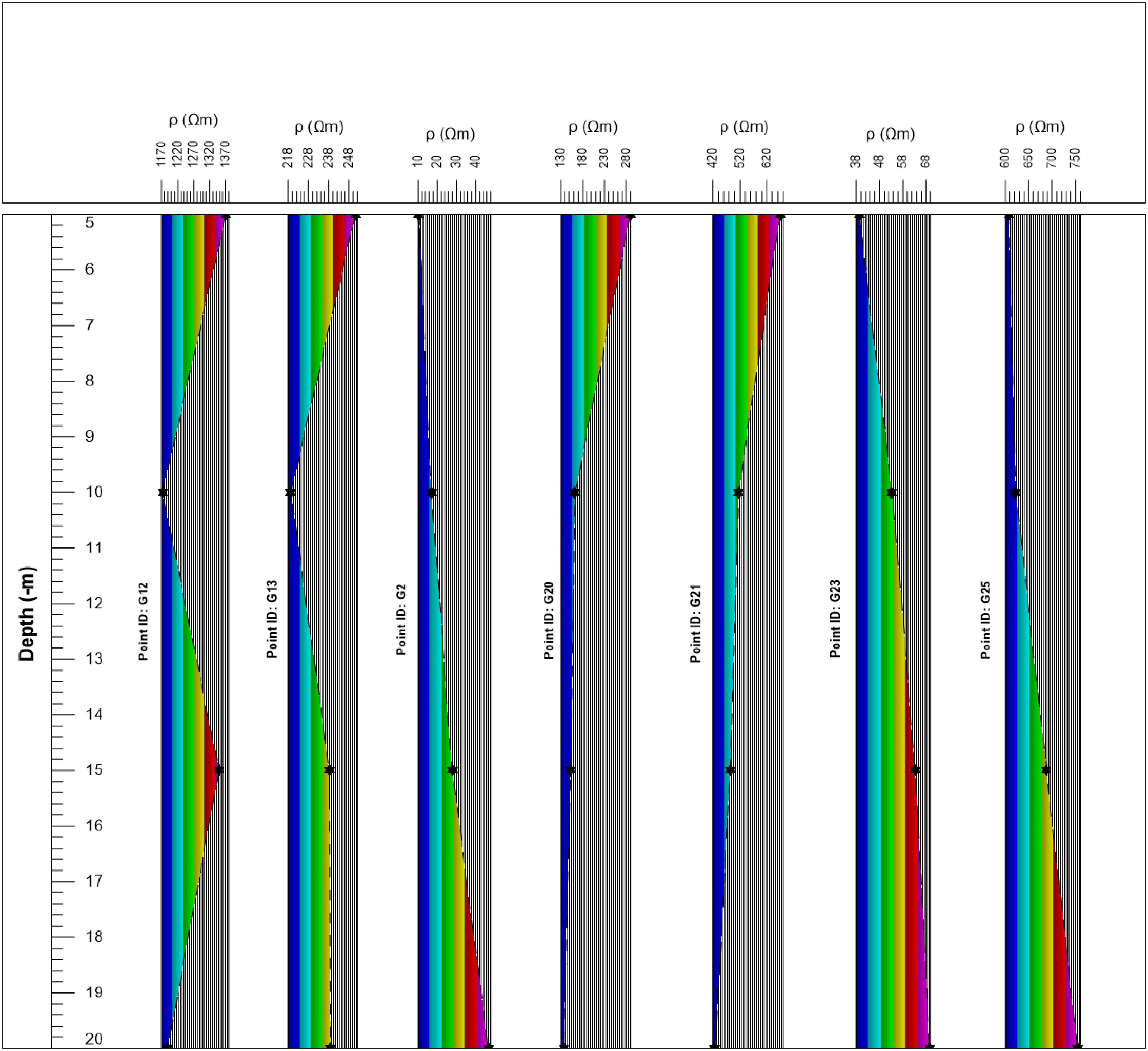


FIGURE 5. DPSH Test results: G23, G25, G25 and G27

Brypaal DPSH Diagram Appendix C


ρ (Ωm)
1200
3200
5200
40
90
140
280
380
480
580
100
150
200
80
180
280
280
480
680
880
520
620
720
Depth (-m)
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Point ID: G27
Point ID: G29
Point ID: G3
Point ID: G5
Point ID: G6
Point ID: G7
Point ID: G9



ρ (Ωm)
1170 1220 1270 1320 1370
ρ (Ωm)
218 228 238 248
ρ (Ωm)
10 20 30 40
ρ (Ωm)
130 180 230 280
ρ (Ωm)
420 520 620
ρ (Ωm)
38 48 58 68
ρ (Ωm)
600 650 700 750
Depth (-m)
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Point ID: G12
Point ID: G13
Point ID: G2
Point ID: G20
Point ID: G21
Point ID: G23
Point ID: G25

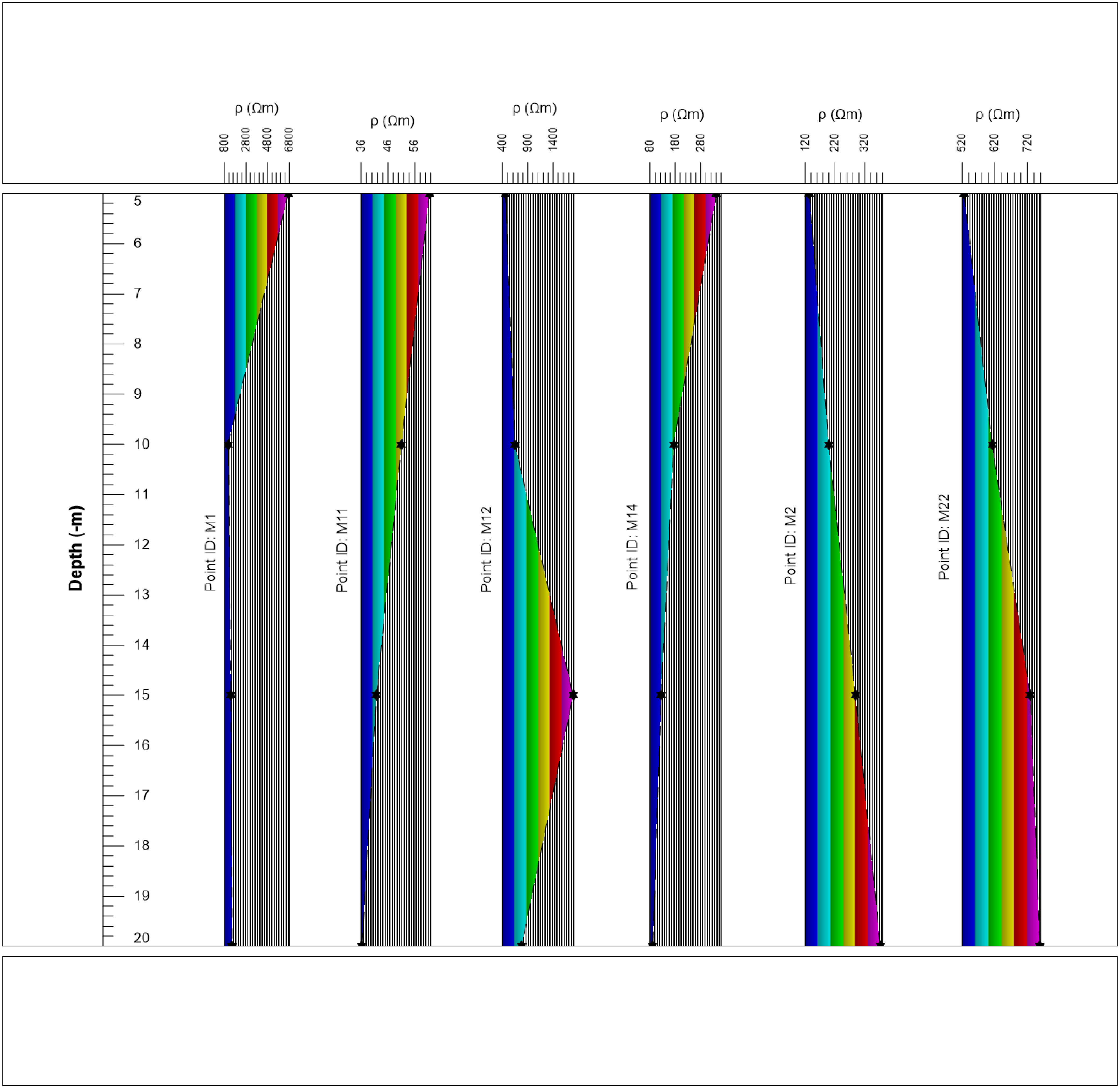
APPENDIX D1 : SHALLOW ELECTRICAL RESISTIVITY DATA

Shallow resistivity

Profile No	Electrical resistivity Ωm			
Depth m	10	20	30	40
G2	10,37	16,98	27,85	46,73
G3	280,07	397,29	472,92	588,57
G5	102,79	125,34	202,77	224,31
G6	94,83	189,7	318,84	258,82
G7	295,74	469,67	696,01	887,4
G9	534,54	635,62	677,83	777,84
G12	1370,51	1173,03	1348,6	1188,86
G13	251,2	219,17	238,35	238,94
G20	289,79	162,82	153,45	137,2
G21	668,87	514,6	485,37	427,45
G23	39,22	53,51	63,38	69,6
G25	607,88	622,6	687,6	754,36
G27	1261,8	2830,42	4354,61	6722,59
G29	49,26	81,01	133,12	165,07

M1	6714	1131,59	1419,94	1507,95
M2	133,68	198,54	289,13	373,17
M6	112,99	121,83	108,66	243,46
M8	362,81	349,57	307,02	380,05
M9	228,95	148,28	239,62	194,66
M11	61,59	51,09	41,68	36,25
M12	454,77	641,94	1793,01	772,85
M14	342,48	173,18	123,71	90,14
M22	526,6	611,62	728,6	758,21
M23	415,82	583,8	829,83	861,99
M24	137,78	121,6	135,23	188,17

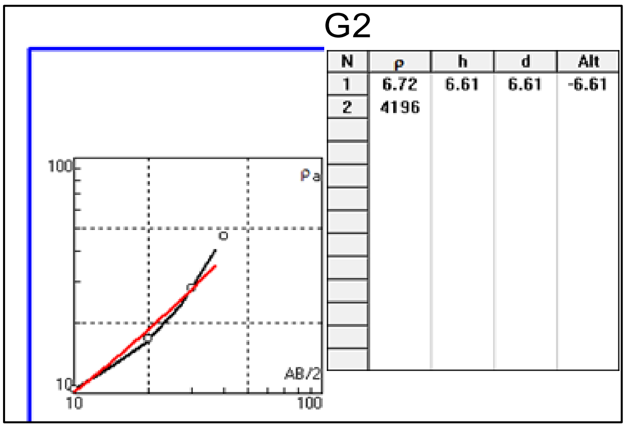
High resistivity highlighted



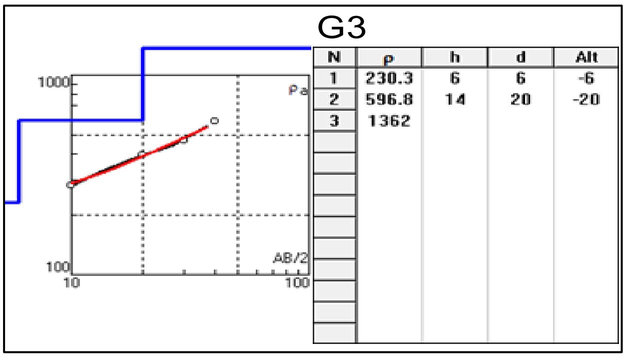
ρ (Ωm)
800
2800
4800
6800
ρ (Ωm)
36
46
56
ρ (Ωm)
400
900
1400
ρ (Ωm)
80
180
280
ρ (Ωm)
120
220
320
ρ (Ωm)
520
620
720
Depth (-m)
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Point ID: M1
Point ID: M11
Point ID: M12
Point ID: M14
Point ID: M2
Point ID: M22

APPENDIX D2: DEEP ELCTRICAL RESISTIVITY

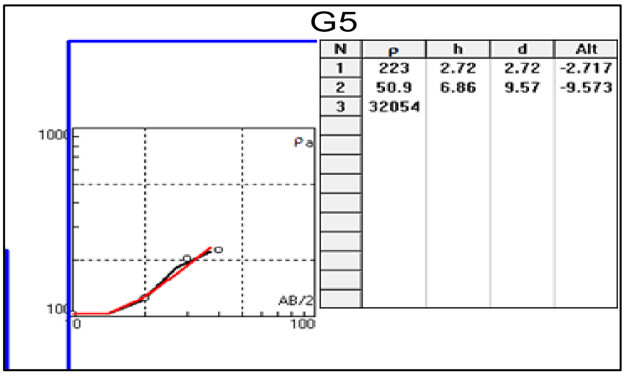
Appendix A: VES plots showing their number of layers(N), Apparent resistivity(p), thickness of the layers(h), depth(d) and altitude.



N	ρ	h	d	Alt
1	6.72	6.61	6.61	-6.61
2	4196			

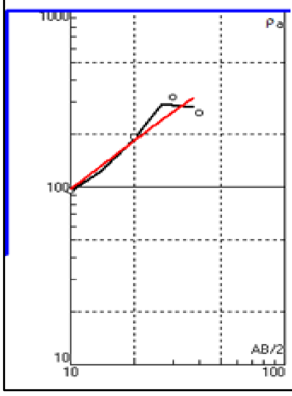


N	ρ	h	d	Alt
1	230.3	6	6	-6
2	596.8	14	20	-20
3	1362			



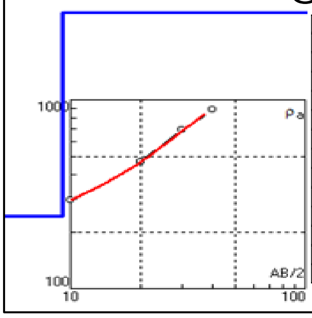
N	ρ	h	d	Alt
1	223	2.72	2.72	-2.717
2	50.9	6.86	9.57	-9.573
3	32054			

G6



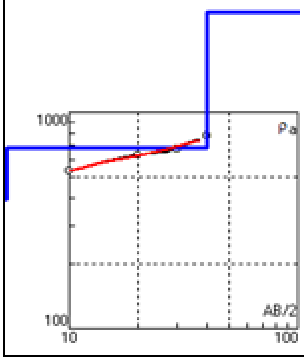
N	ρ	h	d	Alt
1	41.7	3.81	3.81	-3.812
2	1984			

G7



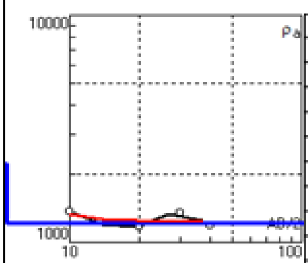
N	ρ	h	d	Alt
1	241.7	9.258	9.258	-9.2576
2	12196			

G9



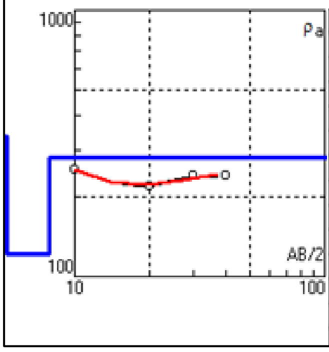
N	ρ	h	d	Alt
1	398.8	2.962	2.962	-2.9616
2	685.2	37.06	40.02	-40.019
3	8783			

G12



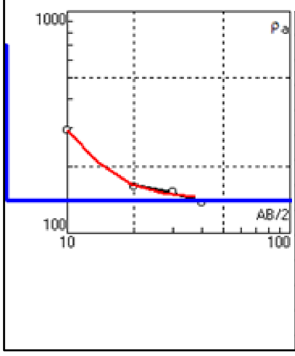
N	ρ	h	d	Alt
1	2215	1.65	1.65	-1.652
2	1218			

G13



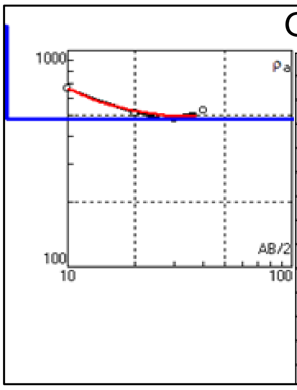
N	ρ	h	d	Alt
1	336.9	4.26	4.26	-4.2597
2	121.1	3.699	7.958	-7.9585
3	280.2			

G20



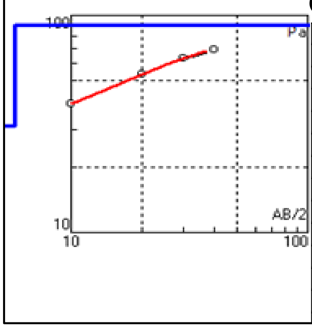
N	ρ	h	d	Alt
1	705.5	3.128	3.128	-3.1281
2	141			

G21

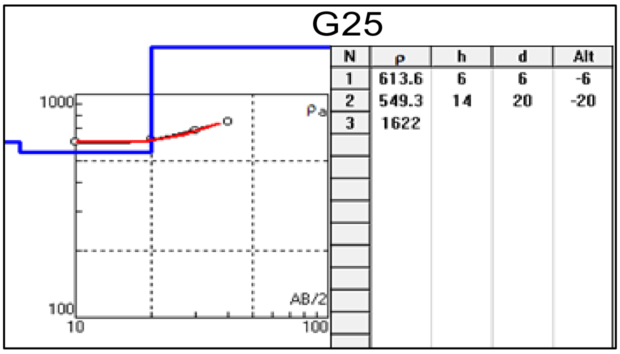


N	ρ	h	d	Alt
1	1295	2.66	2.66	-2.659
2	485			

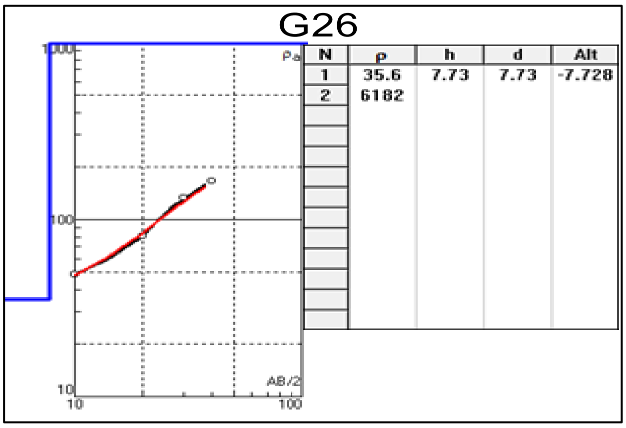
G23



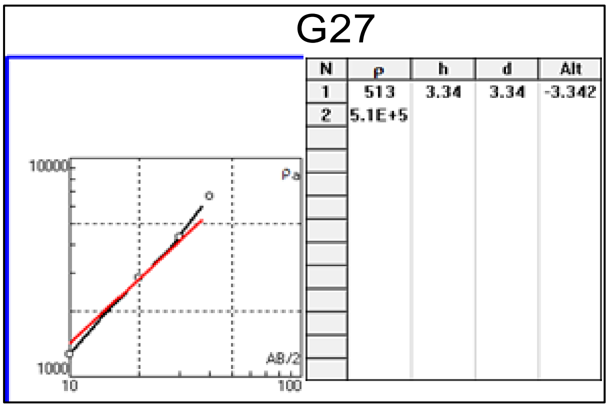
N	ρ	h	d	Alt
1	30.9	5.753	5.753	-5.7529
2	89.98			



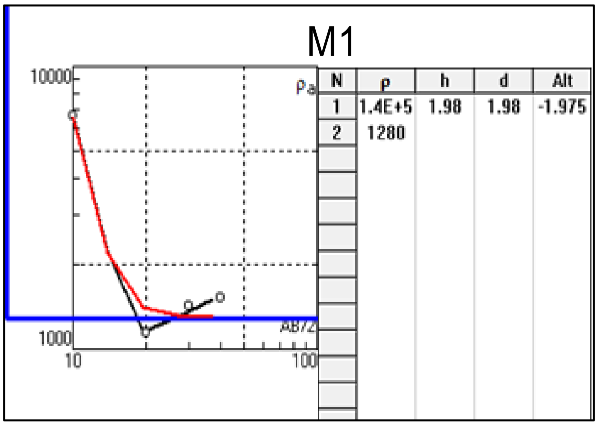
N	ρ	h	d	Alt
1	613.6	6	6	-6
2	549.3	14	20	-20
3	1622			



N	ρ	h	d	Alt
1	35.6	7.73	7.73	-7.728
2	6182			

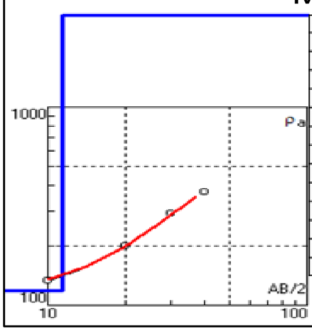


N	ρ	h	d	Alt
1	513	3.34	3.34	-3.342
2	5.1E+5			



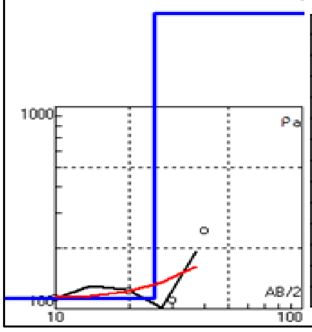
N	ρ	h	d	Alt
1	1.4E+5	1.98	1.98	-1.975
2	1280			

M2



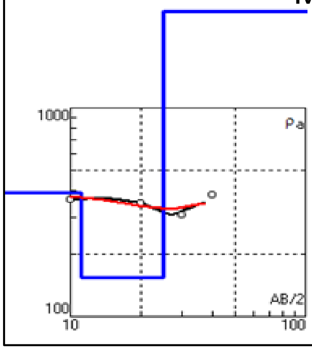
N	ρ	h	d	Alt
1	117.9	11.37	11.37	-11.373
2	34366			

M6



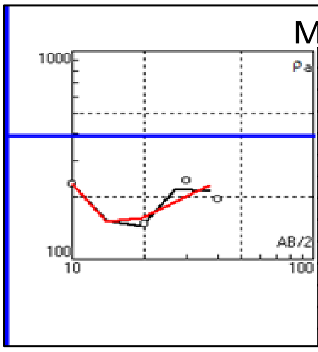
N	ρ	h	d	Alt
1	112	25.3	25.3	-25.33
2	4586	87.1	112	-112.4
3	10172			

M8



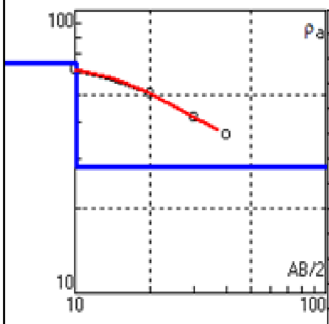
N	ρ	h	d	Alt
1	392	11	11	-11.04
2	154	13.7	24.8	-24.77
3	23411			

M9



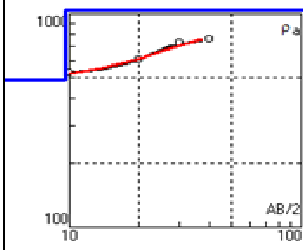
N	ρ	h	d	Alt
1	1766	2.34	2.34	-2.343
2	37.4	2.83	5.17	-5.174
3	394			

M11



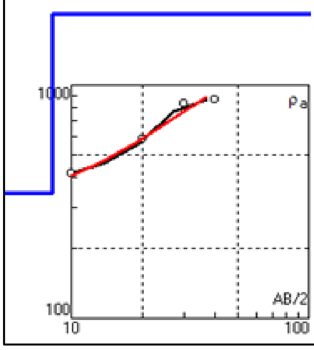
N	ρ	h	d	Alt
1	65.23	10.18	10.18	-10.18
2	27.89			

M22



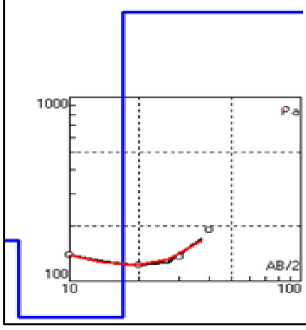
N	ρ	h	d	Alt
1	490.8	9.625	9.625	-9.6245
2	1035			

M23



N	ρ	h	d	Alt
1	343	8.36	8.36	-8.362
2	2010			

M24



N	ρ	h	d	Alt
1	165	6	6	-6
2	63.5	11	17	-16.95
3	10371			

Project:	BOSCIA ENVIRONMENTAL SOLUTIONS
Project No.:	S17-0520
Date:	2017-05-03

TESTS ON AGGREGATE	
Soillab Sample Number	S17-0520-01
Sample Number	RIVERSAND
Sample Position	
Source	SIMLAB
Description	

Sieve Analysis (% Passing)	
Sieve size (mm)- SANS 3001-AG1	
14	
10	
5	
2	
1	
0.600	
0.300	
0.150	
0.075	

Fineness modulus	

Soluble Deleterious Impurities – TMH 1 B12	
Sand Strength as % washed sand	
Water as % of mass cement	

Other tests		
Water demand	**SABS 835**	
* Bulk Relative Density	**SANS 3001-AG20**	
* Apparent Relative density	**SANS 3001-AG20**	
* Water absorption (%)	**SANS 3001-AG20**	
* Bulk Density loose (kg/m^3)	**SANS 5845**	
* Bulk Density compacted (kg/m^3)	**SANS 5845**	
Shape: Voids	**SANS 5845**	
Liquid Limit	**TMH 1 A2**	
Plasticity Index	**TMH 1 A3**	
Linear Shrinkage	**TMH 1 A4**	
* Sand equivalent	**SANS 3001-AG5**	
pH	**SANS 5854**	
EC (Sm^{-1})	**SANS 6240**	
* Sugar	**SANS 5833**	NOT PRESENT
* Soluble salts (%)	**SANS 5849**	
* Soluble Sulphates (%)	**SANS 5850**	
* Organic Impurities	**SANS 5832**	LIGHTER THAN INDICATOR
* Chloride content (%)	**SANS 5830**	0.0032
* Light material (%)		
* Methylene blue adsorption (Value)	**SANS 6243**	0.10
Clay content (%)	**TMH 1 A6**	0.2
* Weathering $MgSO_4/NaSO_4$ Representative loss (%)	**SANS 5839**	
* Shrinkage as percent of reference agg.	**SANS 5836**	
* Expansion as percent of reference agg.	**SANS 5836**	

Note * Not Accredited

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CLIENT :	**BOSCIA ENVIROMENTAL SOLUTIONS**	**DATE :**	18/04/2017
	10 Borrius Street	**REFERENCE :**	SLN976
	POTCHEFSTROOM	**DOCUMENT No.:**	017/0391(a)
	2531	**ORDER No.:**	-
		NUMBER OF PAGES :	1 of 5

ATTENTION : Mr Piet van Deventer
PROJECT : Geotechnical Analysis for THRIP Spatial DSS Project (NWU)

TEST REPORT

SAMPLE / LABORATORY No. :	Sample 1 (017/0391), Sample 2 (017/0392), Sample 3 (017/0393), Sample 4 (017/0394), Sample 5 (017/0395), Sample 6 (017/0396), Sample 7 (017/0397), Sample 8 (017/0398), Sample 9 (017/0399), Sample 10 (017/0400), Sample 11 (017/0401), Sample 12 (017/0402), Sample 13 (017/0403) ,Sample 14 (017/0404)
DATE SAMPLE RECEIVED :	05/04/2017
DATE SAMPLE TESTED :	06/04/2017 - 18/04/2017
TESTING LABORATORY :	Simlab (Pty) Limited (Kimberley)
SAMPLE REPORTED BY :	Schantell Malan (Technical Assistant)
DATE SAMPLED :	Sampled by Potchefstroom University
LOCATION SAMPLED :	Geotechnical Analysis for THRIP Spatial DSS Project (NWU)
SAMPLE METHOD :	Sampled by Potchefstroom University
ENVIRONMENTAL CONDITIONS DURING SAMPLING :	N/a
SAMPLE CONDITION :	Sample in good condition.
CLIENT REFERENCE / MARKINGS :	N/a

TEST METHODS :

1.) The wet preparation and sieve analysis of gravel, sand and soil samples, TMH1 : 1986, Method A1(a)
2.) The determination of the liquid limit of soils by means of the flow curve method, TMH1 : 1986, Method A2
3.) The determination of the plastic limit and plasticity index of soils, TMH1 : 1986, Method A3
4.) The determination of the linear shrinkage of soils, TMH1 : 1986, Method A4
5.) The determination of the percentage of material passing a 0.075mm sieve in a soil sample, TMH1 : 1986, Method A5
6.) The determination of the maximum dry density and optimum moisture content of gravel, soil and sand, TMH1 : 1986, Method A7
7.) The determination of the California Bearing Ratio of untreated soils and gravels, TMH1 : 1986, Method A8
8.) The determination of the moisture content of a field sample, TMH1 : 1986, Method A17

REMARKS :

NOTE : Report continues on next page, see attached sheet 2 of 2

S MALAN (Technical Assistant)

JP DU PLESSIS (Laboratory Manager)

for : SIMLAB (PTY) LIMITED - GEOTECHNICAL SERVICES

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DOCUMENT No.: 017/0391 (a)

CLIENT & PROJECT : BOSCIA ENVIROMENTAL SOLUTIONS - Geotechnical Analysis for THRIP Spatial DSS Project (NWU)					DATE : 18/04/2017
HOLE No. / KM (Chainage)		G2-2	G3	G12	G20
MATERIAL DEPTH (mm)					
SAMPLE / LABORATORY No.		017/0391	017/0392	017/0393	017/0394
MATERIAL DESCRIPTION		Slightly moist dark reddish brown sand	Dry dark red sand	Dry light reddish brown sand with quartzite and calcrete	Dry light grey sand with gneiss and calcrete
* IN SITU FIELD MOISTURE (%)		7.5	2.8	1.6	0.7
UNIFIED SOIL CLASSIFICATION					
TRH14 / * COLTO CLASSIFICATION		G8	G6	G8	G6
SIEVE ANALYSIS, PERCENTAGE OF MATERIAL PASSING 0.075 mm SIEVE (TMH 1 : 1986, METHOD A1 (a), A5) - % PASSING SIEVES					
SIEVE ANALYSIS	63.0 mm			95	95
	53.0 mm			89	95
	37.5 mm			84	93
	26.5 mm			78	93
	19.0 mm		100	73	90
	13.2 mm	100	96	62	88
	4.75 mm	97	90	46	68
	2.00 mm	89	77	37	44
	0.425 mm	53	49	25	22
	0.075 mm	23	19	10	9
	0.002 mm	9	0	2	1
SOIL MORTAR	COARSE SAND	40	36	33	49
	FINE SAND	7 / 14 / 13	7 / 17 / 15	7 / 17 / 15	6 / 13 / 12
	MATERIAL<0.075 mm	26	24	28	20
GRADING MODULUS (GM)		1.35	1.56	2.28	2.26
ATTERBERG LIMITS ANALYSIS (TMH 1 : 1986, METHOD A2, A3, & A4), PH VALUE & CONDUCTIVITY (TMH 1 : 1986, METHOD A20 & A21T)					
ATTERBERG LIMITS PASSING SIEVE 0.425mm	L.L (%)	29	-	26	25
	P.I. / L.S. (%)	9 / 4.5	S.P. / 1.8	4 / 2.0	5 / 2.5
POTENTIAL EXPANSIVENESS (mm)		-	-	-	-
pH VALUE / CONDUCTIVITY (Sm^{-1})		-	-	-	-
MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT, CALIFORNIA BEARING RATIO ANALYSIS (TMH 1 : 1986, METHOD A7 & A8) UNCONFINED COMPRESSIVE STRENGTH & INDIRECT TENSILE STRENGTH OF STABILISED MATERIAL (TMH 1 : 1986, METHOD A13T, A14 & A16T)					
CBR / UCS / ITS DETERMINATION — MOD AASHTO	MAX DRY DENSITY (kg/m^3)	1940	2014	2002	2061
	OPT MOISTURE (%)	11.9	9.6	8.2	8.8
	COMP MOISTURE (%)	11.7	9.5	7.9	8.7
	DRY DENSITY (kg/m^3)	1940	2014	1997	2061
	CBR (%)	45	41	66	55
	SWELL (%)	0.0	0.0	0.0	0.0
	UCS (KPa)	-	-	-	-
	ITS (KPa)	-	-	-	-
NRB	DRY DENSITY (kg/m^3)	1867	1940	1883	1984
	CBR (%)	15	25	20	36
PROCTOR	MAX DRY DENSITY (kg/m^3)	1740	1817	1813	1878
	OPT MOISTURE (%)	-	-	-	-
	CBR (%)	5	15	6	24
CBR	100%	45	41	66	55
	98%	29	33	41	47
	95%	15	25	20	36
	93%	10	20	12	31
	90%	5	15	6	24

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DOCUMENT No.: 017/0391 (a)

CLIENT & PROJECT : BOSCIA ENVIROMENTAL SOLUTIONS - Geotechnical Analysis for THRIP Spatial DSS Project (NWU)

DATE : 18/04/2017

			G23	G26	G26 - A	G27 - 1
HOLE No. / KM (Chainage)			G23	G26	G26 - A	G27 - 1
MATERIAL DEPTH (mm)						
SAMPLE / LABORATORY No.			017/0395	017/0396	017/0397	017/0398
MATERIAL DESCRIPTION			Slightly moist light olive sand with calcrete and gneiss	Dry light brown sand with gneiss	Dry light olive sand with gneiss	Dry light grey sand with granite gneiss
* IN SITU FIELD MOISTURE (%)			14.4	1.1	3.6	1.4
UNIFIED SOIL CLASSIFICATION						
TRH14 / * COLTO CLASSIFICATION			G6	G6	G7	G6
SIEVE ANALYSIS, PERCENTAGE OF MATERIAL PASSING 0.075 mm SIEVE (TMH 1 : 1986, METHOD A1 (a), A5) - % PASSING SIEVES						
SIEVE ANALYSIS	63.0 mm		89	97		95
SIEVE ANALYSIS	53.0 mm		89	96		92
SIEVE ANALYSIS	37.5 mm		84	91		90
SIEVE ANALYSIS	26.5 mm		81	86		87
SIEVE ANALYSIS	19.0 mm		76	81		81
SIEVE ANALYSIS	13.2 mm		69	73	100	74
SIEVE ANALYSIS	4.75 mm		59	57	96	49
SIEVE ANALYSIS	2.00 mm		53	40	90	35
SIEVE ANALYSIS	0.425 mm		44	23	57	20
SIEVE ANALYSIS	0.075 mm		36	10	23	8
SIEVE ANALYSIS	0.002 mm		5	2	2	1
SOIL MORTAR	COARSE SAND		17	42	36	43
SOIL MORTAR	FINE SAND		3 / 7 / 7	5 / 15 / 14	6 / 16 / 16	6 / 15 / 12
SOIL MORTAR	MATERIAL<0.075 mm		67	24	26	24
GRADING MODULUS (GM)			1.67	2.27	1.30	2.37
ATTERBERG LIMITS ANALYSIS (TMH 1 : 1986, METHOD A2, A3, & A4), PH VALUE & CONDUCTIVITY (TMH 1 : 1986, METHOD A20 & A21T)						
ATTERBERG LIMITS PASSING SIEVE 0.425mm	L.L (%)		-	32	-	27
ATTERBERG LIMITS PASSING SIEVE 0.425mm	P.I. / L.S. (%)		S.P. / 1.5	5 / 2.5	S.P. / 0.9	4 / 2.0
POTENTIAL EXPANSIVENESS (mm)			-	-	-	-
pH VALUE / CONDUCTIVITY (Sm^{-1})			-	-	-	-
MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT, CALIFORNIA BEARING RATIO ANALYSIS (TMH 1 : 1986, METHOD A7 & A8) UNCONFINED COMPRESSIVE STRENGTH & INDIRECT TENSILE STRENGTH OF STABILISED MATERIAL (TMH 1 : 1986, METHOD A13T, A14 & A16T)						
CBR / UCS / ITS DETERMINATION	MOD AASHTO	MAX DRY DENSITY (kg/m^3)	1920	2026	2120	2054
	MOD AASHTO	OPT MOISTURE (%)	7.6	10.1	7.0	7.0
	MOD AASHTO	COMP MOISTURE (%)	7.6	9.9	7.0	6.9
	MOD AASHTO	DRY DENSITY (kg/m^3)	1920	2026	2120	2054
	MOD AASHTO	CBR (%)	55	47	66	67
	MOD AASHTO	SWELL (%)	0.0	0.0	0.0	0.0
	MOD AASHTO	UCS (KPa)	-	-	-	-
	MOD AASHTO	ITS (KPa)	-	-	-	-
	NRB	DRY DENSITY (kg/m^3)	1823	1940	2022	1980
	NRB	CBR (%)	30	37	24	53
	PROCTOR	MAX DRY DENSITY (kg/m^3)	1720	1840	1900	1840
	PROCTOR	OPT MOISTURE (%)	-	-	-	-
	PROCTOR	CBR (%)	17	29	9	42
	CBR	100%	55	47	66	67
	CBR	98%	44	43	44	61
	CBR	95%	30	37	24	53
	CBR	93%	24	33	16	48
	CBR	90%	17	29	9	42

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HOLE No. / KM (Chainage)		G28	G29	M1	M14
MATERIAL DEPTH (mm)					
SAMPLE / LABORATORY No.		017/0399	017/0400	017/0401	017/0402
MATERIAL DESCRIPTION		Slightly moist light olive sand with calcrete and gneiss	Dry light brown sand with granite gneiss	Dry light olive sand with calcrete	Dry light olive sand with gneiss
* IN SITU FIELD MOISTURE (%)		11.4	1.9	1.6	2.8
UNIFIED SOIL CLASSIFICATION					
TRH14 / * COLTO CLASSIFICATION		No Classification	G6	G6	G6
SIEVE ANALYSIS, PERCENTAGE OF MATERIAL PASSING 0.075 mm SIEVE (TMH 1 : 1986, METHOD A1 (a), A5) - % PASSING SIEVES					
SIEVE ANALYSIS	63.0 mm		100	88	88
	53.0 mm	100	98	86	87
	37.5 mm	97	94	83	87
	26.5 mm	97	89	81	84
	19.0 mm	95	84	80	80
	13.2 mm	91	70	77	70
	4.75 mm	83	49	62	49
	2.00 mm	76	40	45	40
	0.425 mm	56	33	29	29
	0.075 mm	36	15	12	17
	0.002 mm	3	0	2	1
SOIL MORTAR	COARSE SAND	27	19	37	28
	FINE SAND	5 / 12 / 9	9 / 19 / 16	7 / 15 / 14	5 / 13 / 12
	MATERIAL<0.075 mm	48	37	27	42
GRADING MODULUS (GM)		1.33	2.12	2.14	2.15
ATTERBERG LIMITS ANALYSIS (TMH 1 : 1986, METHOD A2, A3, & A4), PH VALUE & CONDUCTIVITY (TMH 1 : 1986, METHOD A20 & A21T)					
ATTERBERG LIMITS PASSING SIEVE 0.425mm	L.L (%)	50	26	29	30
	P.I. / L.S. (%)	23 / 11.5	7 / 3.5	5 / 2.5	10 / 5.0
POTENTIAL EXPANSIVENESS (mm)		-	-	-	-
pH VALUE / CONDUCTIVITY (Sm^{-1})		-	-	-	-
MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT, CALIFORNIA BEARING RATIO ANALYSIS (TMH 1 : 1986, METHOD A7 & A8) UNCONFINED COMPRESSIVE STRENGTH & INDIRECT TENSILE STRENGTH OF STABILISED MATERIAL (TMH 1 : 1986, METHOD A13T, A14 & A16T)					
CBR / UCS / ITS DETERMINATION — MOD AASHTO	MAX DRY DENSITY (kg/m^3)	1925	2121	2152	2070
	OPT MOISTURE (%)	12.6	6.8	8.1	7.0
	COMP MOISTURE (%)	12.4	6.6	7.8	6.8
	DRY DENSITY (kg/m^3)	1925	2103	2152	2070
	CBR (%)	31	84	59	49
	SWELL (%)	0.0	0.0	0.0	0.0
	UCS (KPa)	-	-	-	-
	ITS (KPa)	-	-	-	-
NRB	DRY DENSITY (kg/m^3)	1850	2030	2070	1954
	CBR (%)	19	41	32	40
PROCTOR	MAX DRY DENSITY (kg/m^3)	1740	1900	1960	1870
	OPT MOISTURE (%)	-	-	-	-
	CBR (%)	12	20	17	32
CBR	100%	31	84	59	49
	98%	25	63	46	45
	95%	19	41	32	40
	93%	16	31	25	37
	90%	12	20	17	32

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*** PAGE CONTINUES FROM PAGE 1 DOCUMENT No.: 017/0391 (a)

CLIENT & PROJECT : BOSCIA ENVIROMENTAL SOLUTIONS - Geotechnical Analysis for THRIP Spatial DSS Project (NWU)						DATE : 18/04/2017
HOLE No. / KM (Chainage)			M23	M9		
MATERIAL DEPTH (mm)						
SAMPLE / LABORATORY No.			017/0403	017/0404		
MATERIAL DESCRIPTION			Dry light olive sand with gneiss	Dry light brown sand with calcrete		
* IN SITU FIELD MOISTURE (%)			1.2	2.3		
UNIFIED SOIL CLASSIFICATION						
TRH14 / * COLTO CLASSIFICATION			G6	G6		
SIEVE ANALYSIS, PERCENTAGE OF MATERIAL PASSING 0.075 mm SIEVE (TMH 1 : 1986, METHOD A1 (a), A5) - % PASSING SIEVES						
SIEVE ANALYSIS		63.0 mm	96	88		
		53.0 mm	94	86		
		37.5 mm	89	80		
		26.5 mm	86	76		
		19.0 mm	82	74		
		13.2 mm	75	67		
		4.75 mm	59	54		
		2.00 mm	46	46		
		0.425 mm	30	33		
		0.075 mm	14	15		
		0.002 mm	0	2		
SOIL MORTAR		COARSE SAND	34	28		
		FINE SAND	6 / 15 / 14	7 / 17 / 16		
		MATERIAL<0.075 mm	30	31		
GRADING MODULUS (GM)			2.10	2.06		
ATTERBERG LIMITS ANALYSIS (TMH 1 : 1986, METHOD A2, A3, & A4), PH VALUE & CONDUCTIVITY (TMH 1 : 1986, METHOD A20 & A21T)						
ATTERBERG LIMITS PASSING SIEVE 0.425mm		L.L (%)	25	-		
		P.I. / L.S. (%)	6 / 3.0	S.P. / 1.5		
POTENTIAL EXPANSIVENESS (mm)			-	-		
pH VALUE / CONDUCTIVITY (Sm^{-1})			-	-		
MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT, CALIFORNIA BEARING RATIO ANALYSIS (TMH 1 : 1986, METHOD A7 & A8) UNCONFINED COMPRESSIVE STRENGTH & INDIRECT TENSILE STRENGTH OF STABILISED MATERIAL (TMH 1 : 1986, METHOD A13T, A14 & A16T)						
CBR / UCS / ITS DETERMINATION	MOD AASHTO	MAX DRY DENSITY (kg/m^3)	2067	2200		
		OPT MOISTURE (%)	8.5	7.4		
		COMP MOISTURE (%)	8.4	7.3		
		DRY DENSITY (kg/m^3)	2067	2200		
		CBR (%)	68	53		
		SWELL (%)	0.0	0.0		
		UCS (KPa)	-	-		
		ITS (KPa)	-	-		
	NRB	DRY DENSITY (kg/m^3)	1988	2105		
		CBR (%)	41	44		
	PROCTOR	MAX DRY DENSITY (kg/m^3)	1890	2002		
		OPT MOISTURE (%)	-	-		
		CBR (%)	25	36		
	CBR	100%	68	53		
		98%	56	49		
		95%	41	44		
		93%	34	40		
		90%	25	36		

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APPENDIX F: PSD semi-log

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	86,7
5	62,8
3,5	57,8
2	45,0
1,25	39,2
1	36,3
0,5	26,1
0,25	15,9
0,106	6,2
0,053	1,0
0	0,0

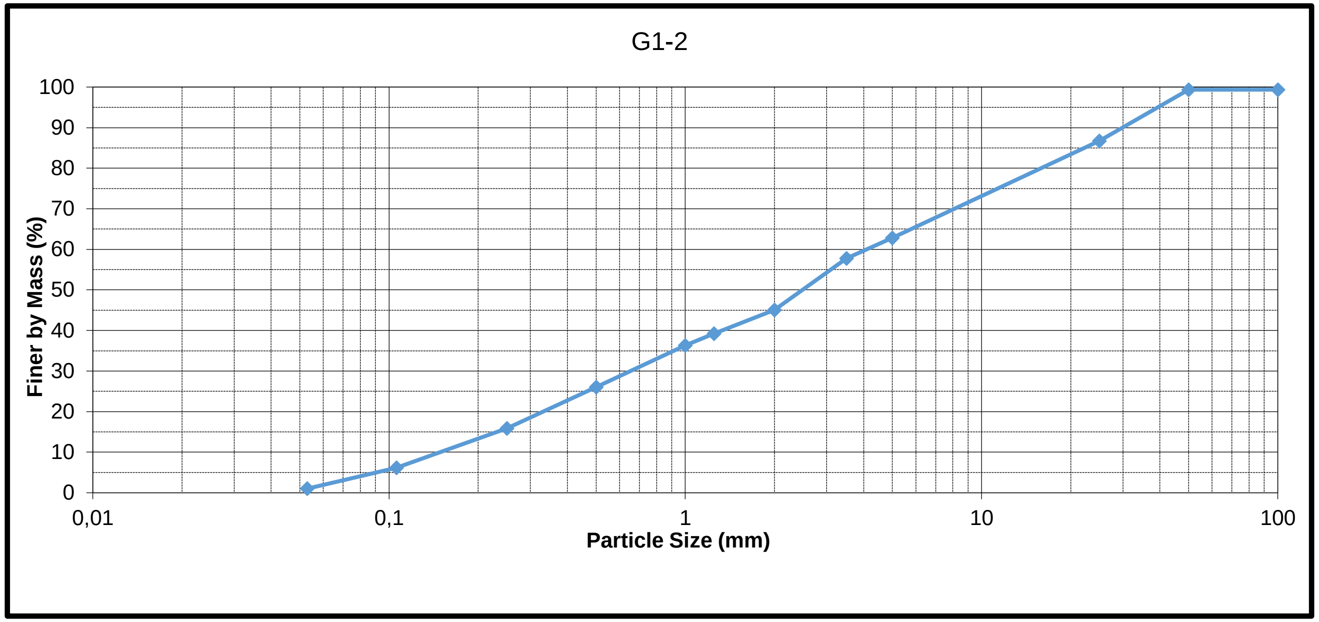


Figure F1-1. Semi-log PSD of Profile G1, layer 2.

Sieve Size/mm	% Passing
100	99,5
50	87,4
25	78,0
5	44,4
3,5	37,7
2	25,8
1,25	21,2
1	19,0
0,5	11,8
0,25	5,9
0,106	1,9
0,053	0,4
0	0,0

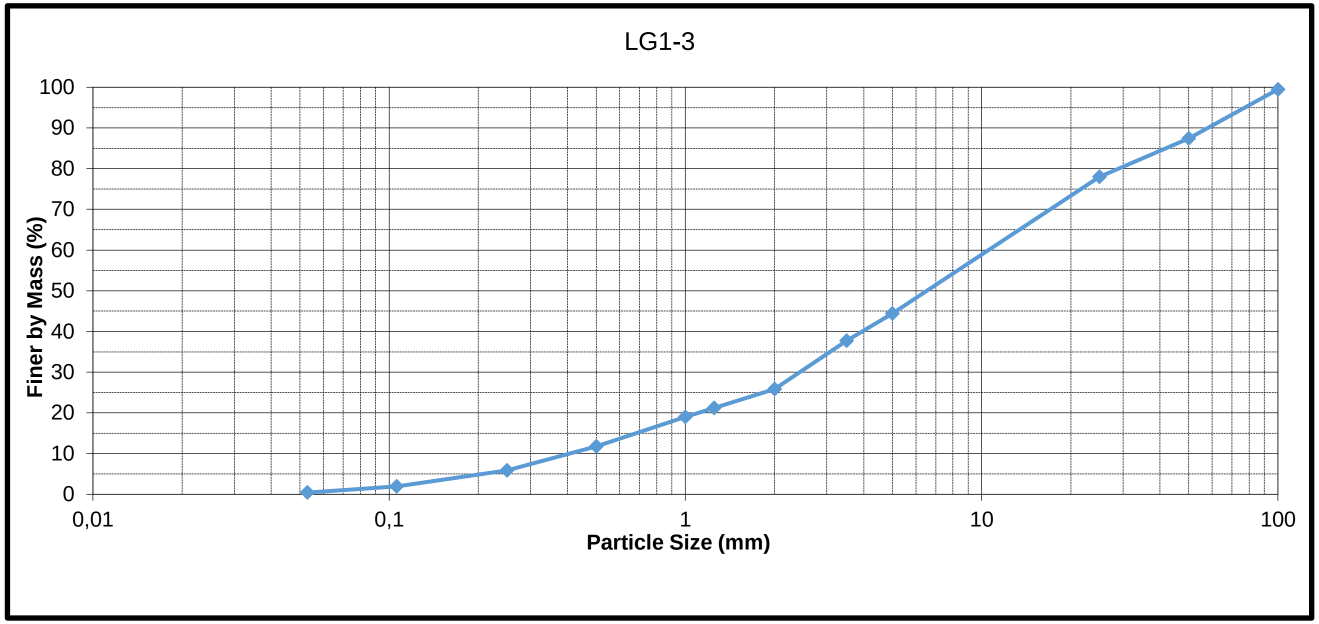


Figure F1-2. Semi-log PSD of Profile G1, layer 3

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	99,3
5	98,8
3,5	98,2
2	89,9
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

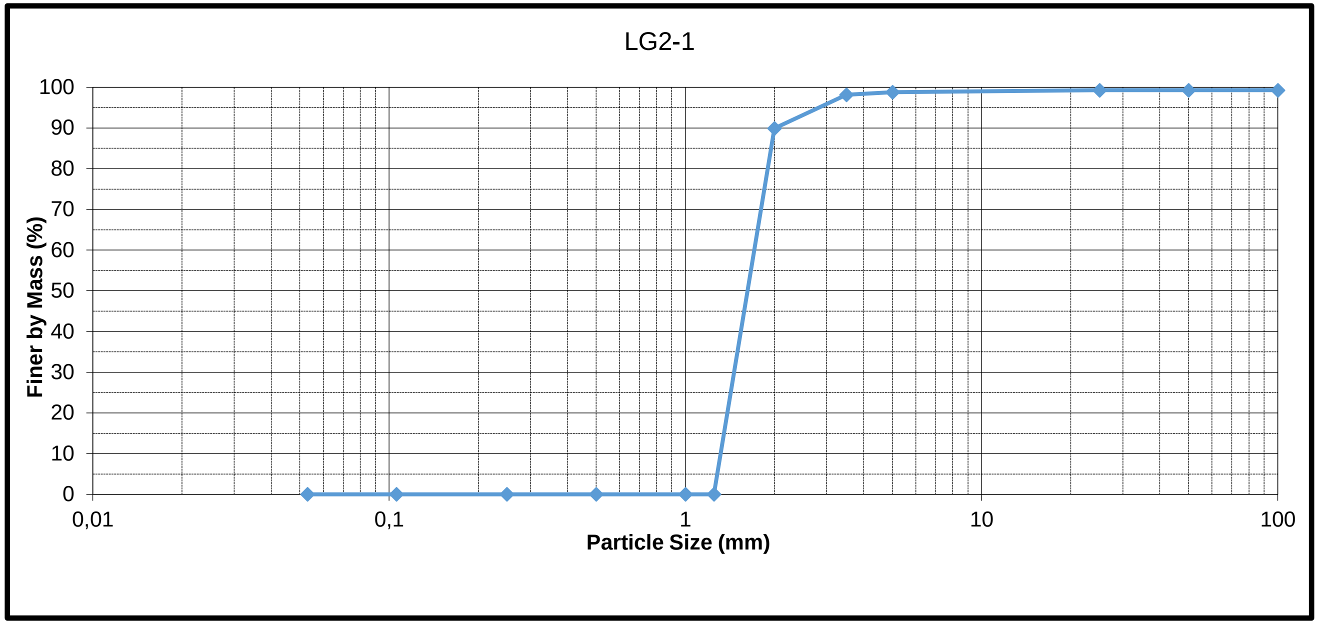
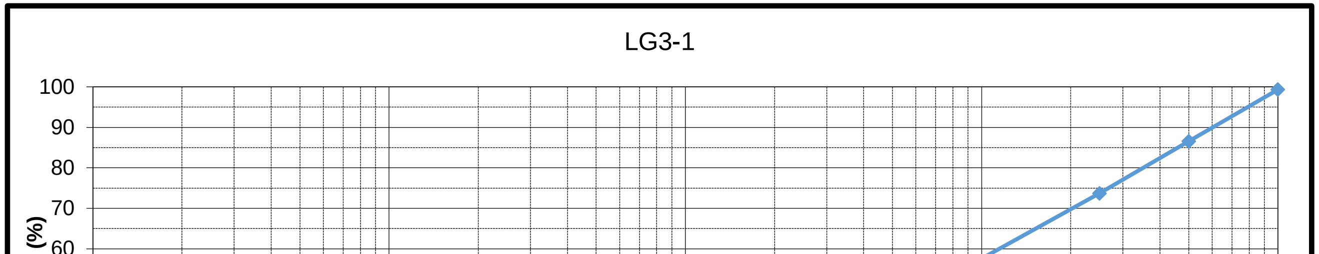


Figure F1-3. Semi-log PSD of Profile G2, layer 1 (alluvial sand in drainage system)



Sieve Size/mm	% Passing
100	99,3
50	86,6
25	73,7
5	45,4
3,5	42,7
2	32,6
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

Figure F1-4. Semi-log PSD of Profile G3, layer 3.

LG4-1

Sieve Size/mm	% Passing
100	99,7
50	99,7
25	99,7
5	82,0
3,5	48,1
2	42,8
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

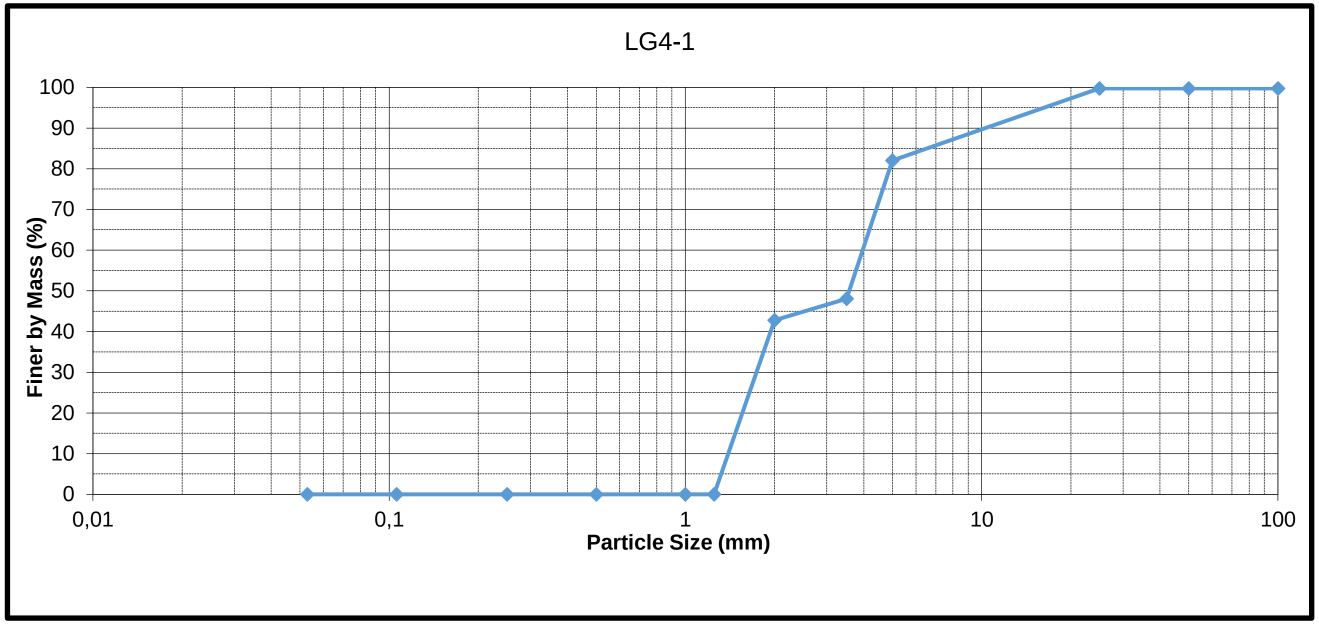


Figure F1-5. Semi-log PSD of Profile G4, layer 1.

LG4-2

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	87,5
5	60,7
3,5	54,6
2	42,1
1,25	36,4
1	34,0
0,5	25,2
0,25	15,4
0,106	5,9
0,053	1,2
0	0

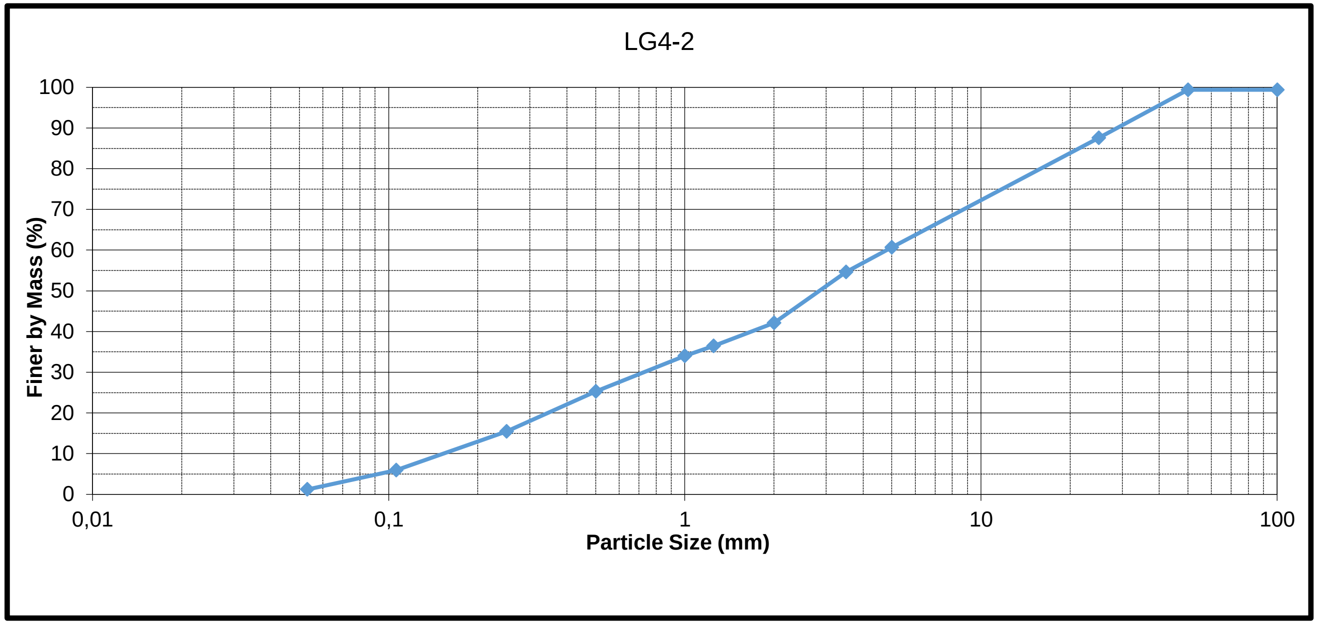


Figure F1-6. Semi-log PSD of Profile G4, layer 2.

LG4-3

Sieve Size/mm	% Passing
100	98,8
50	71,7
25	26,1
5	11,7
3,5	9,8
2	7,7
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

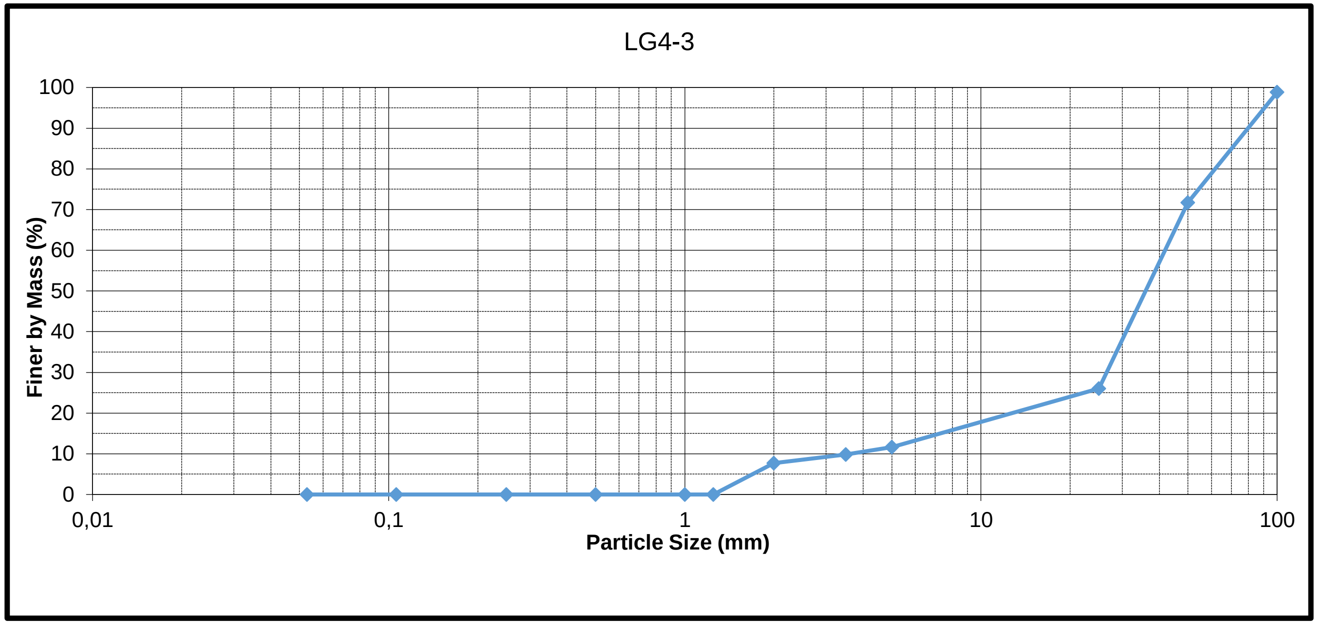


Figure F1-7. Semi-log PSD of Profile G4, layer 3.

LG5-1

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	91,7
5	67,3
3,5	64,2
2	57,0
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0

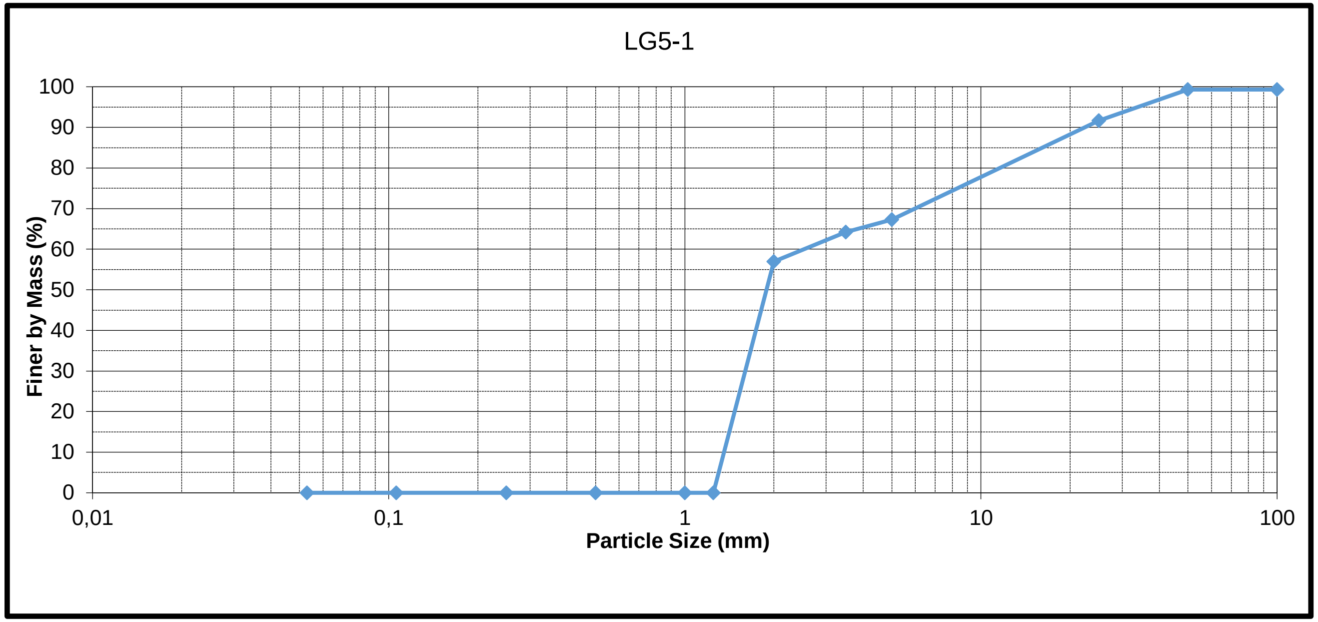


Figure F1-8. Semi-log PSD of Profile G5, layer 1.

LG5-2

Sieve Size/mm	% Passing
100	96,3
50	96,3
25	88,2
5	38,2
3,5	31,2
2	20,9
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

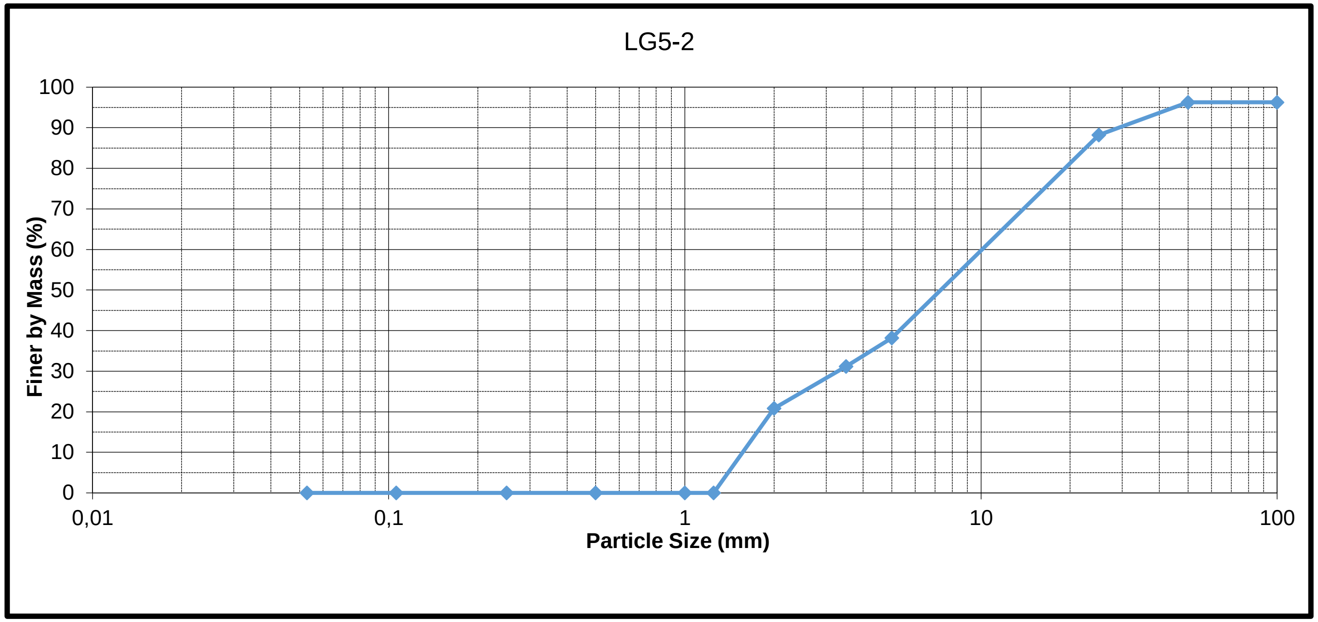


Figure F1-9. Semi-log PSD of Profile G5, layer 2.

LG6-1

Sieve Size/mm	% Passing
100	97,9
50	97,9
25	97,9
5	88,9
3,5	84,8
2	74,9
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

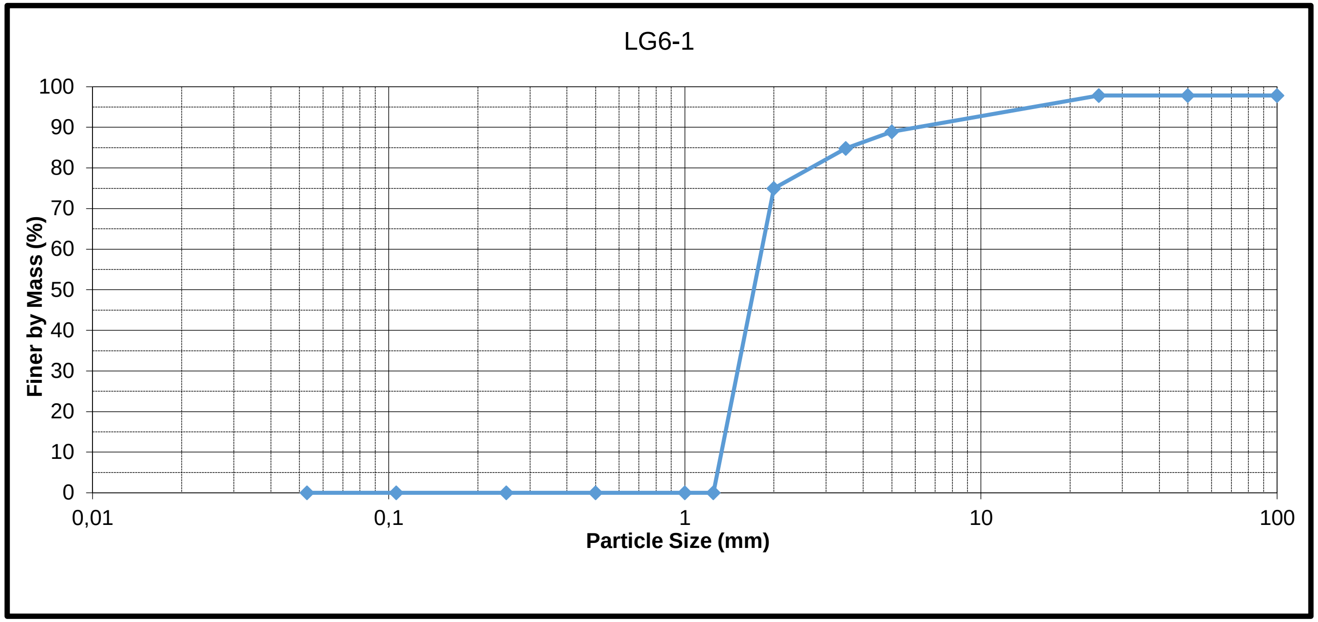


Figure F1-10. Semi-log PSD of Profile G6, layer 1.

LG6-2

Sieve Size/mm	% Passing
100	99,2
50	93,0
25	87,9
5	52,8
3,5	44,8
2	32,5
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

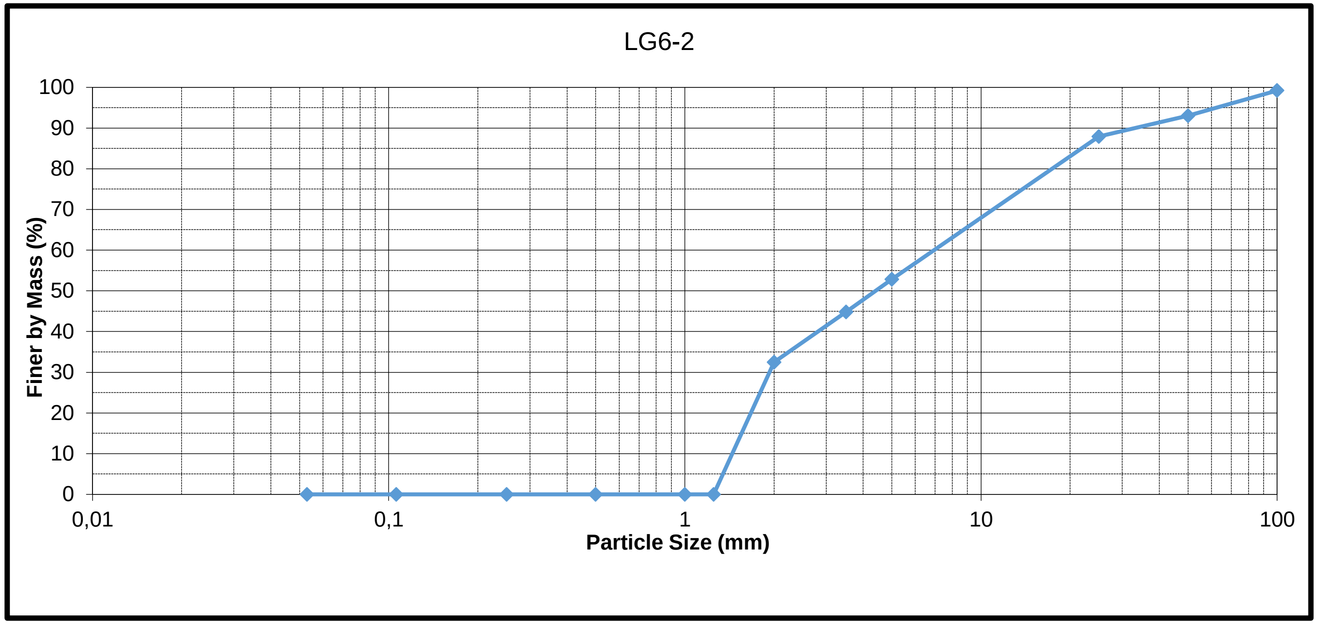


Figure F1-11. Semi-log PSD of Profile G6, layer 2.

LG7-1

Sieve Size/mm	% Passing
100	99,5
50	99,5
25	99,5
5	96,1
3,5	95,0
2	89,8
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

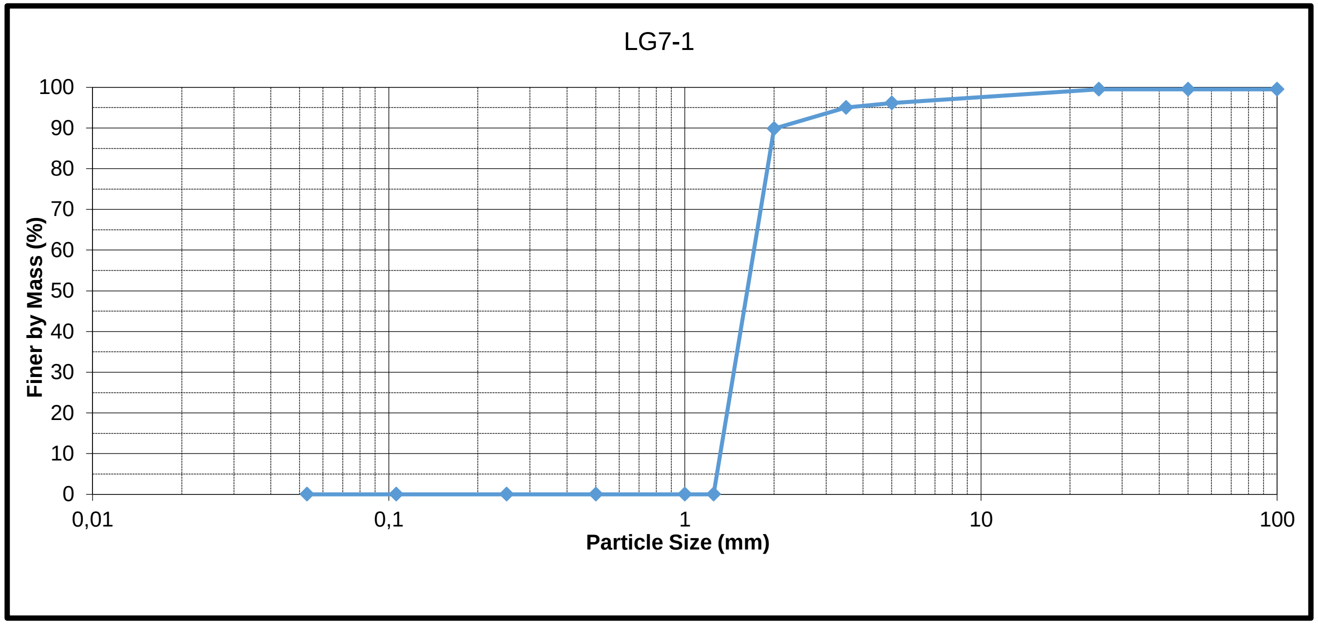


Figure F1-12. Semi-log PSD of Profile G7, layer 1.

LG7-3

Sieve Size/mm	% Passing
100	100
50	7
25	0
5	0
3,5	0
2	0
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

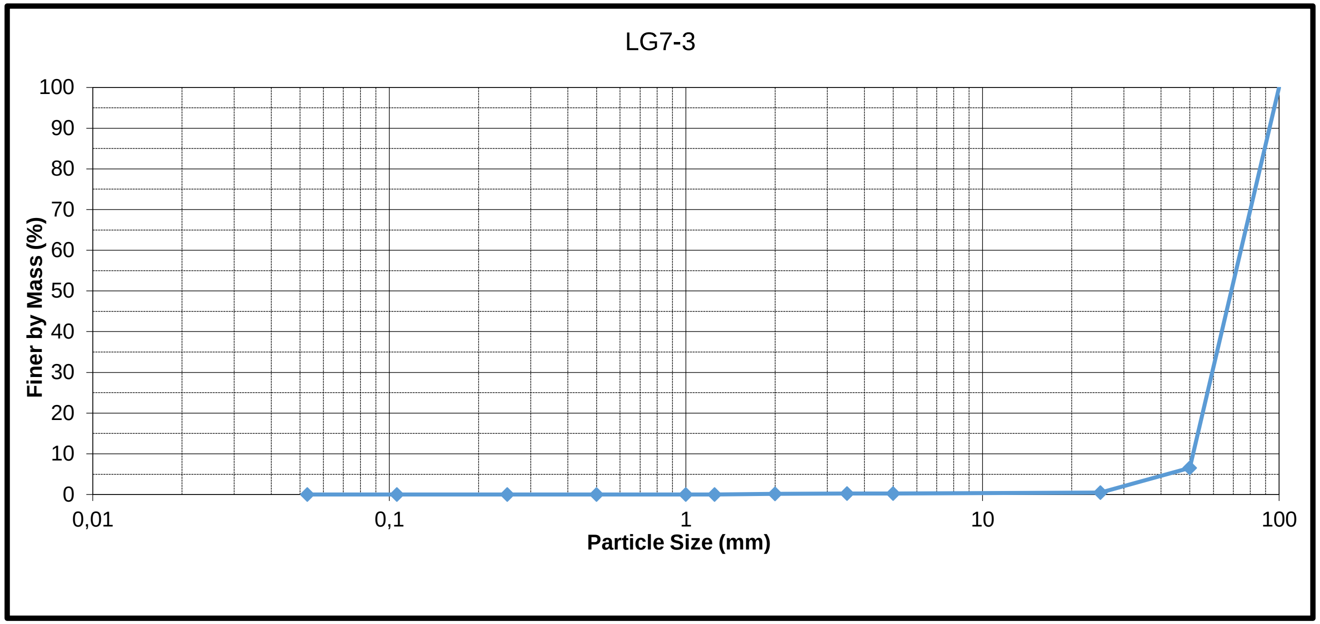


Figure F1-13. Semi-log PSD of Profile G7, layer 3.

LG7-4

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	94,0
5	51,1
3,5	44,6
2	28,4
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

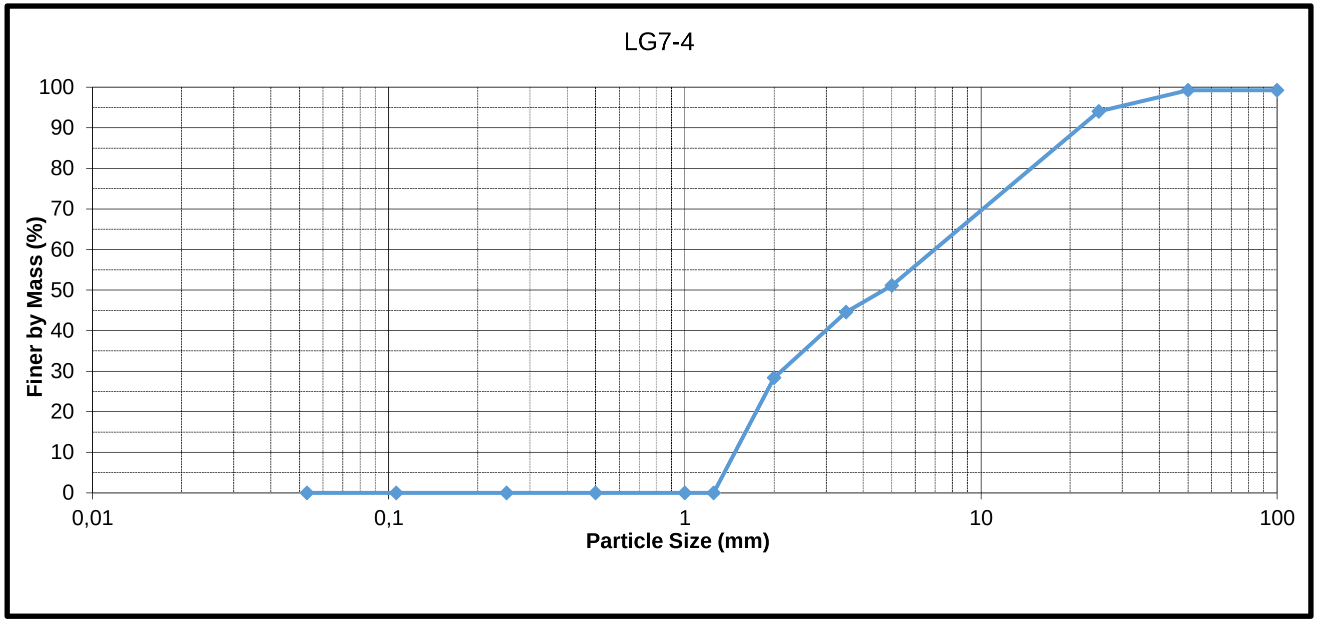


Figure F1-14. Semi-log PSD of Profile G7, layer 4.

LG8-1

Sieve Size/mm	% Passing
100	99,1
50	99,1
25	98,3
5	91,0
3,5	87,9
2	78,7
1,25	71,1
1	67,8
0,5	56,8
0,25	39,9
0,106	12,9
0,053	2,0
0	0,0

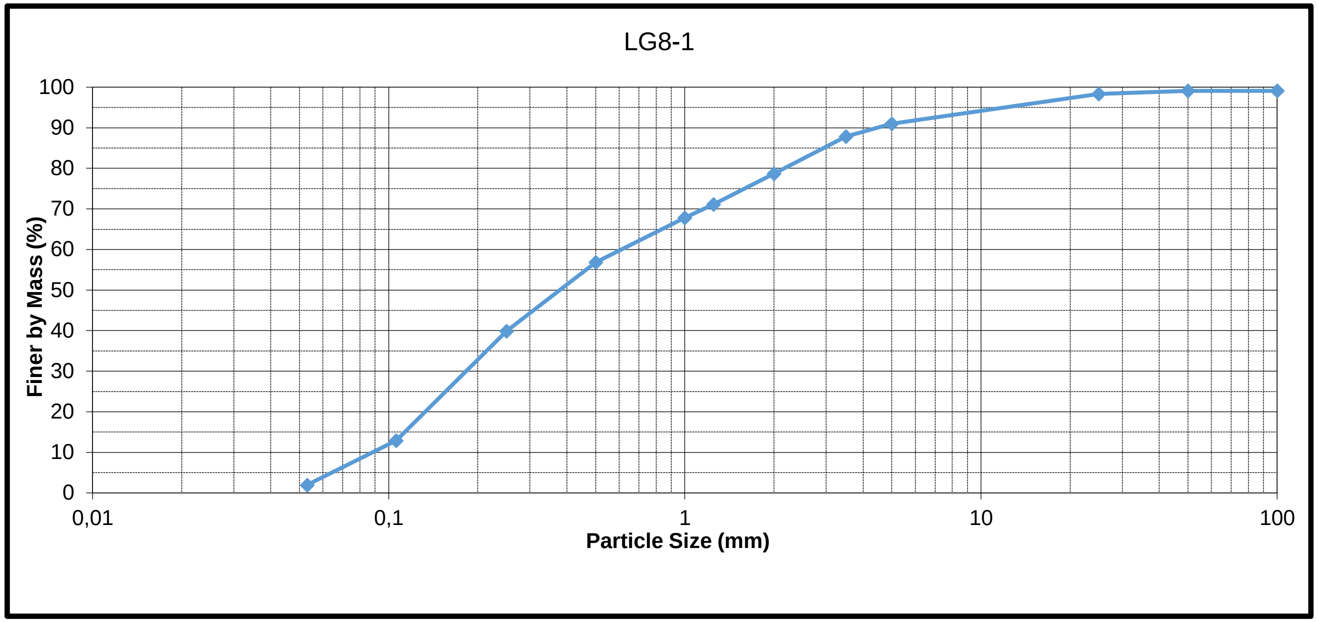


Figure F1-15. Semi-log PSD of Profile G8, layer 1.

LG8-2

Sieve Size/mm	% Passing
100	99,3
50	91,4
25	83,7
5	49,3
3,5	43,8
2	32,2
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

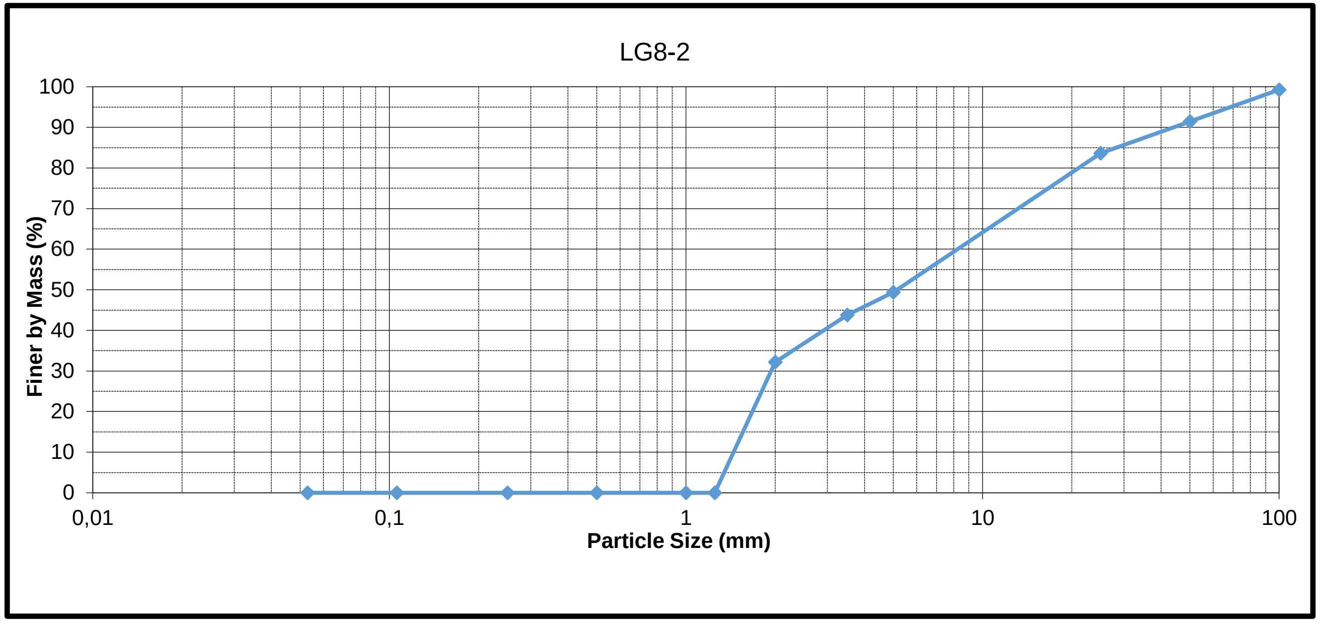


Figure F1-16. Semi-log PSD of Profile G8, layer 2.

LG9-1

Sieve Size/mm	% Passing
100	98,9
50	98,9
25	98,9
5	90,3
3,5	88,3
2	79,3
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

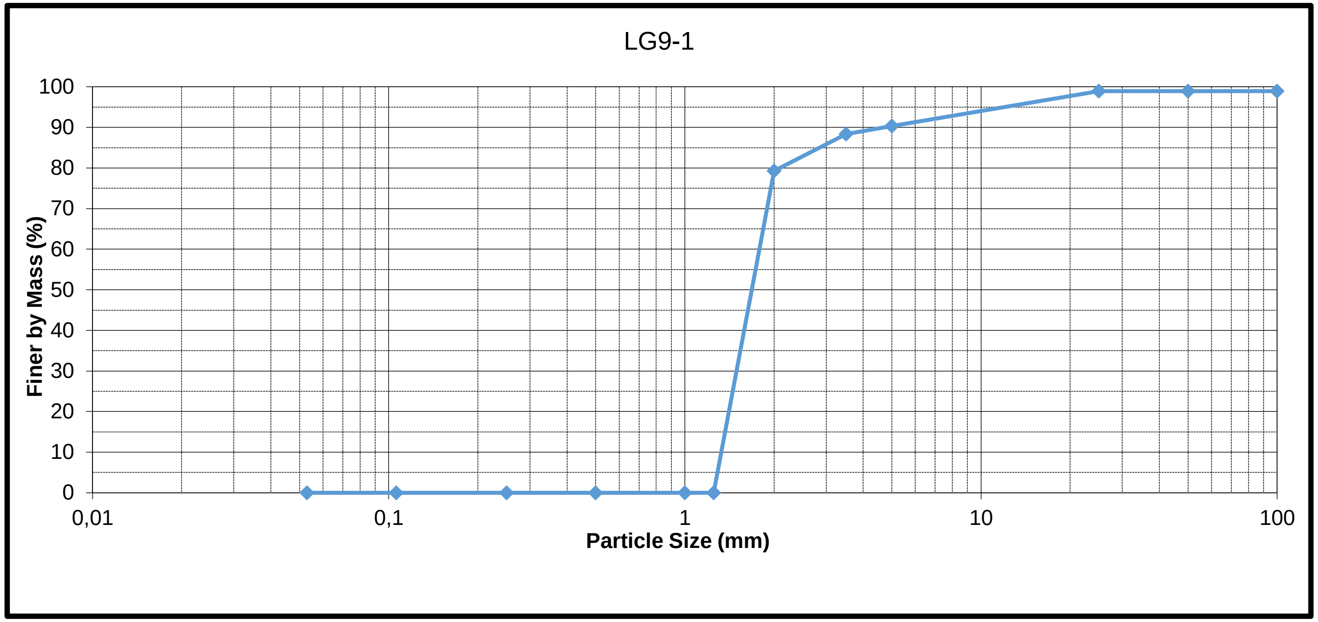


Figure F1-17. Semi-log PSD of Profile G9, layer 1.

LG9-2

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	99,3
5	90,7
3,5	44,0
2	33,3
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

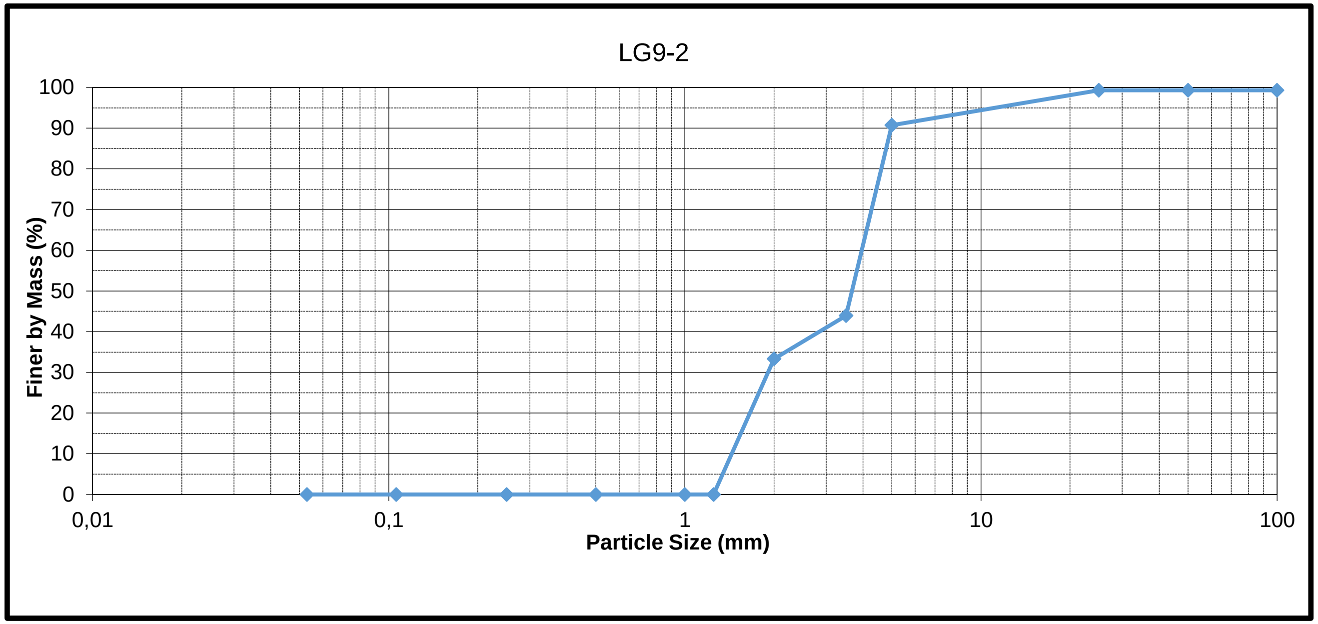


Figure F1-18. Semi-log PSD of Profile G9, layer 2.

LG10-1

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	92,2
5	68,4
3,5	67,0
2	63,8
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

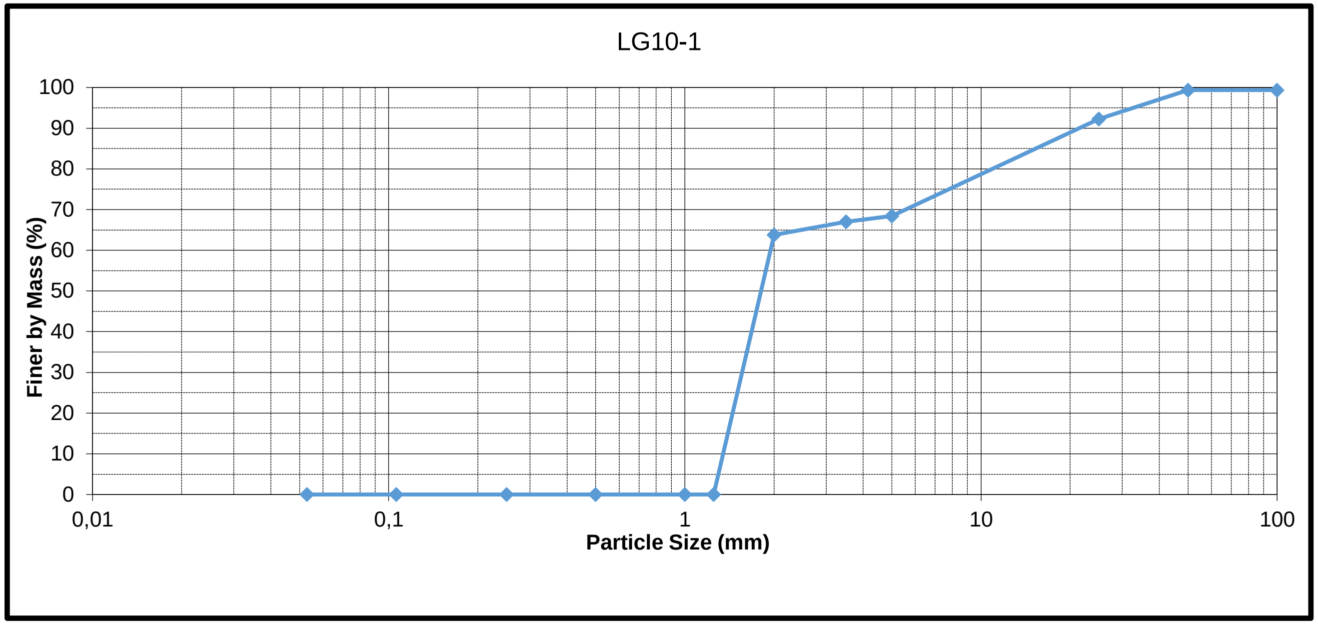


Figure F1-19. Semi-log PSD of Profile G10, layer 1.

LG10-2

Sieve Size/mm	% Passing
100	99,1
50	99,1
25	73,9
5	32,2
3,5	28,5
2	21,0
1,25	18,0
1	16,9
0,5	13,5
0,25	9,4
0,106	3,7
0,053	0,7
0	0,0

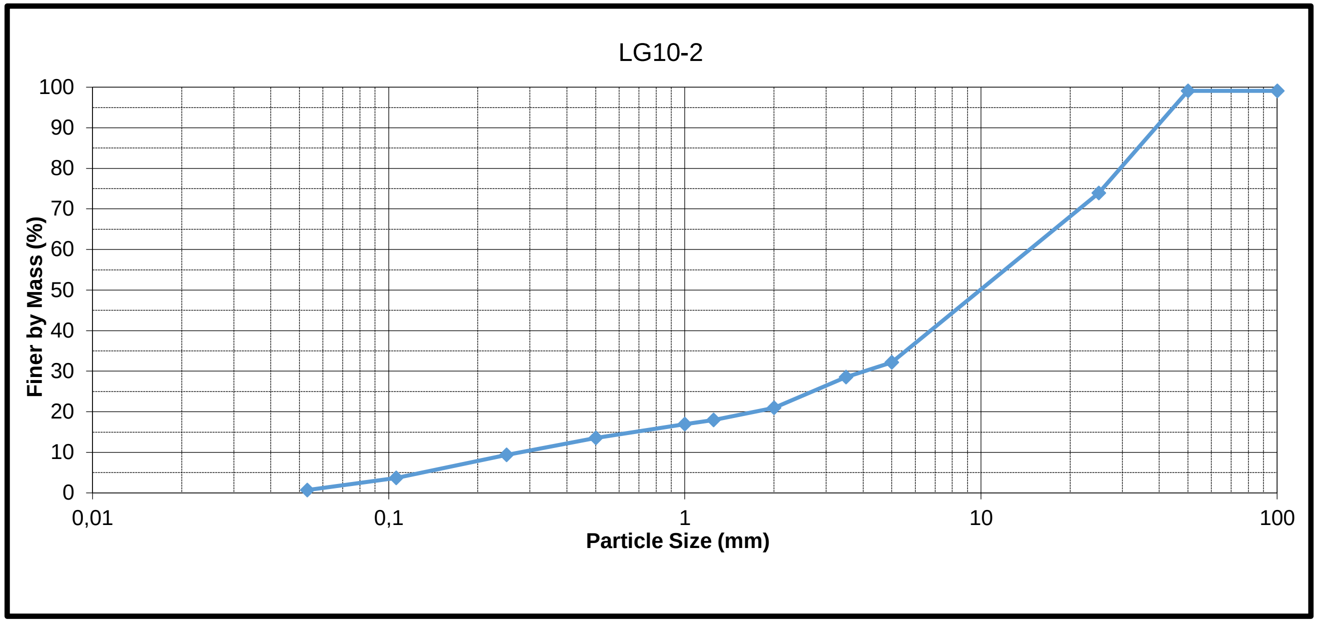


Figure F1-20. Semi-log PSD of Profile G10, layer 2.

LG11-1

Sieve Size/mm	% Passing
100	98,9
50	98,9
25	98,9
5	90,7
3,5	88,3
2	82,0
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

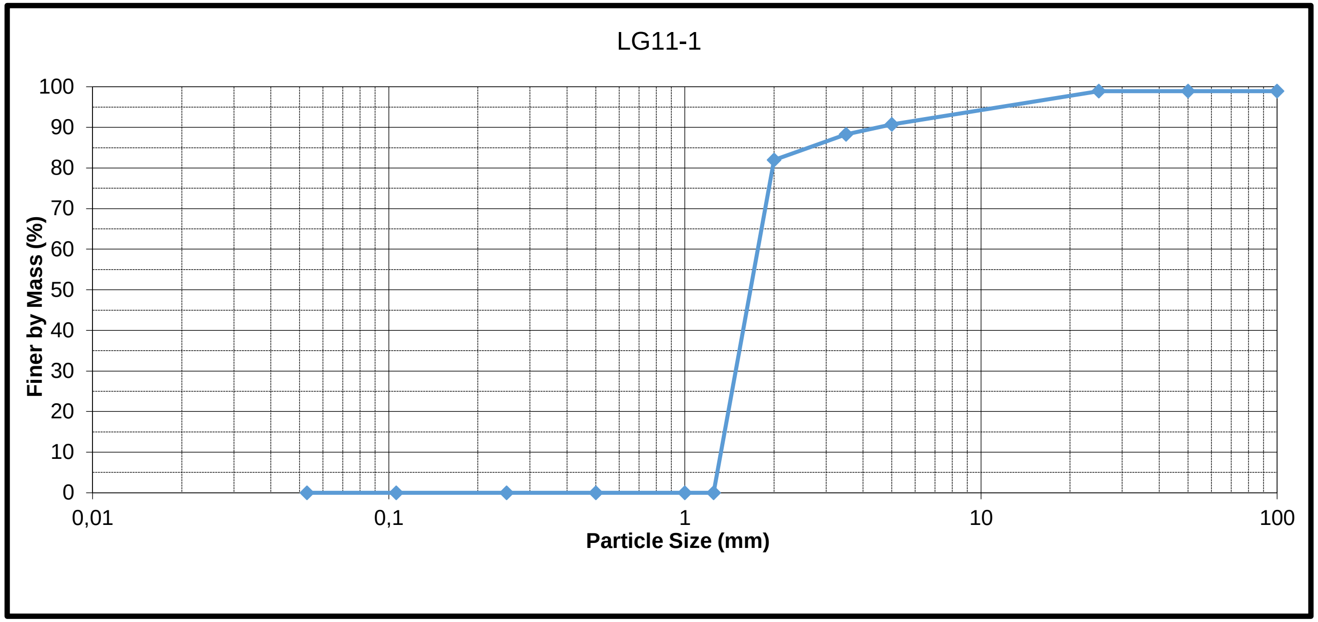


Figure F1-21. Semi-log PSD of Profile G11, layer 1.

LG11-2

Sieve Size/mm	% Passing
100	99,5
50	69,8
25	55,7
5	24,1
3,5	21,0
2	14,9
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

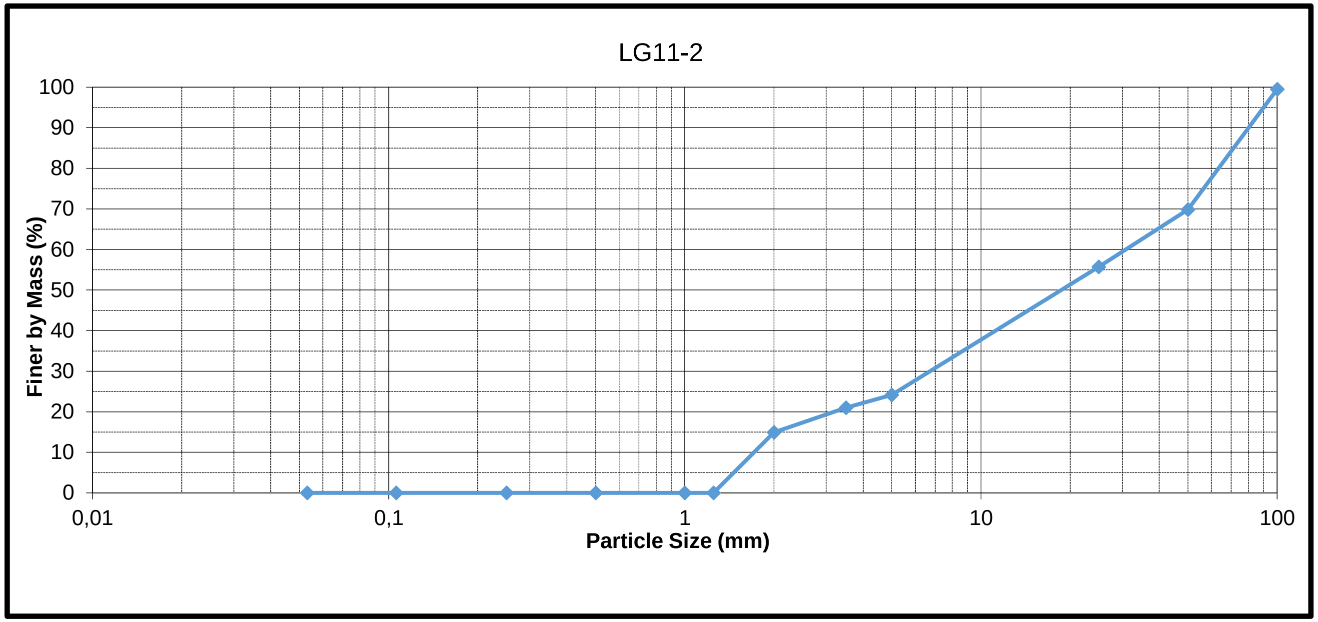


Figure F1-22. Semi-log PSD of Profile G11, layer 2.

LG12-1

Sieve Size/mm	% Passing
100	98,8
50	94,5
25	78,1
5	43,3
3,5	42,5
2	38,4
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

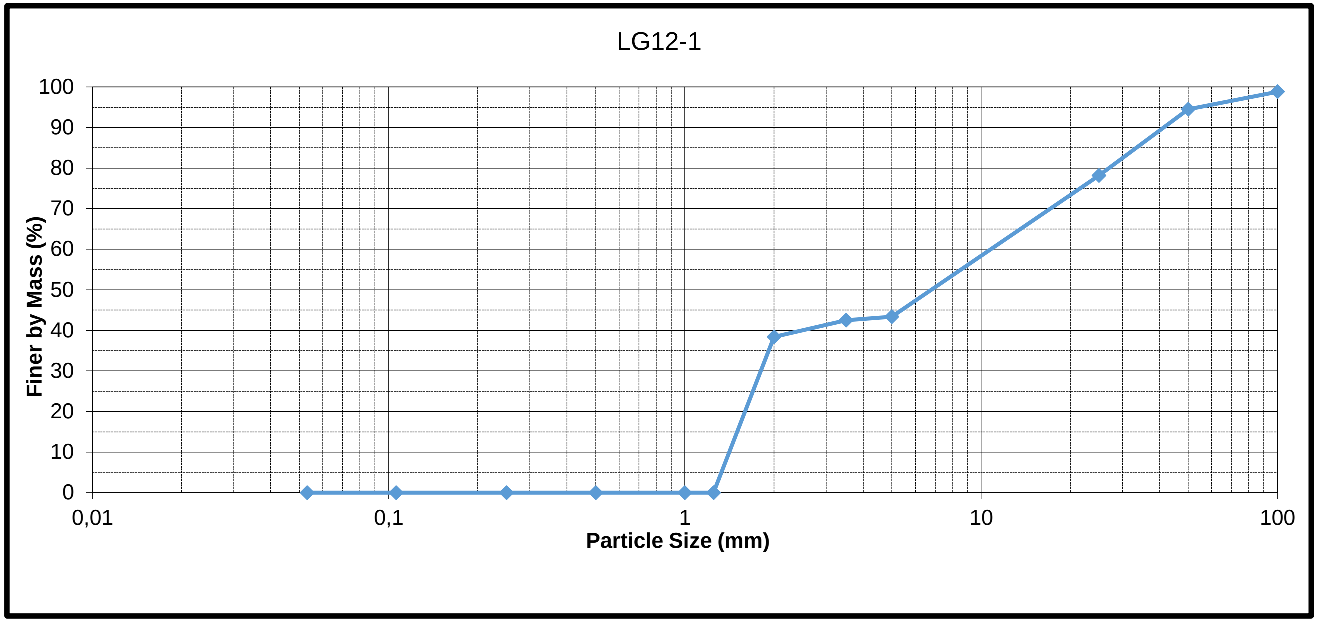


Figure F1-23. Semi-log PSD of Profile G12, layer 1.

LG12-2

Sieve Size/mm	% Passing
100	99,4
50	69,5
25	57,2
5	27,0
3,5	24,5
2	20,2
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

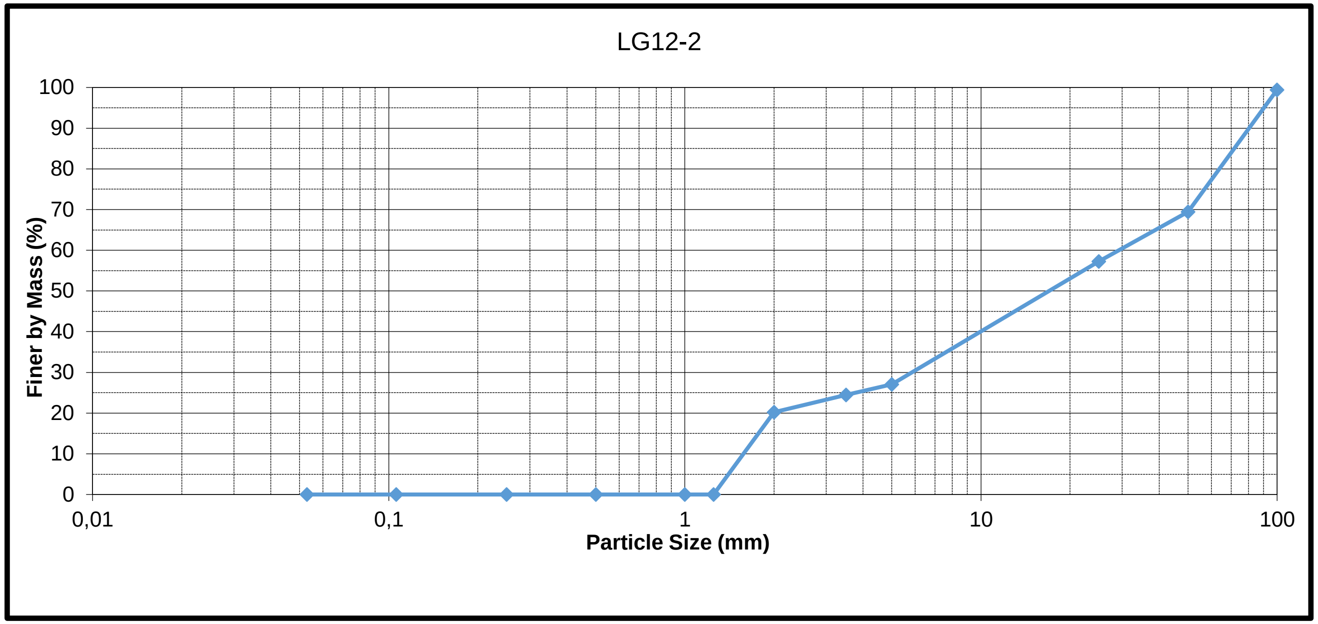


Figure F1-24. Semi-log PSD of Profile G12, layer 2.

LG13-1

Sieve Size/mm	% Passing
100	100
50	100
25	100
5	92
3,5	90
2	82
1,25	0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

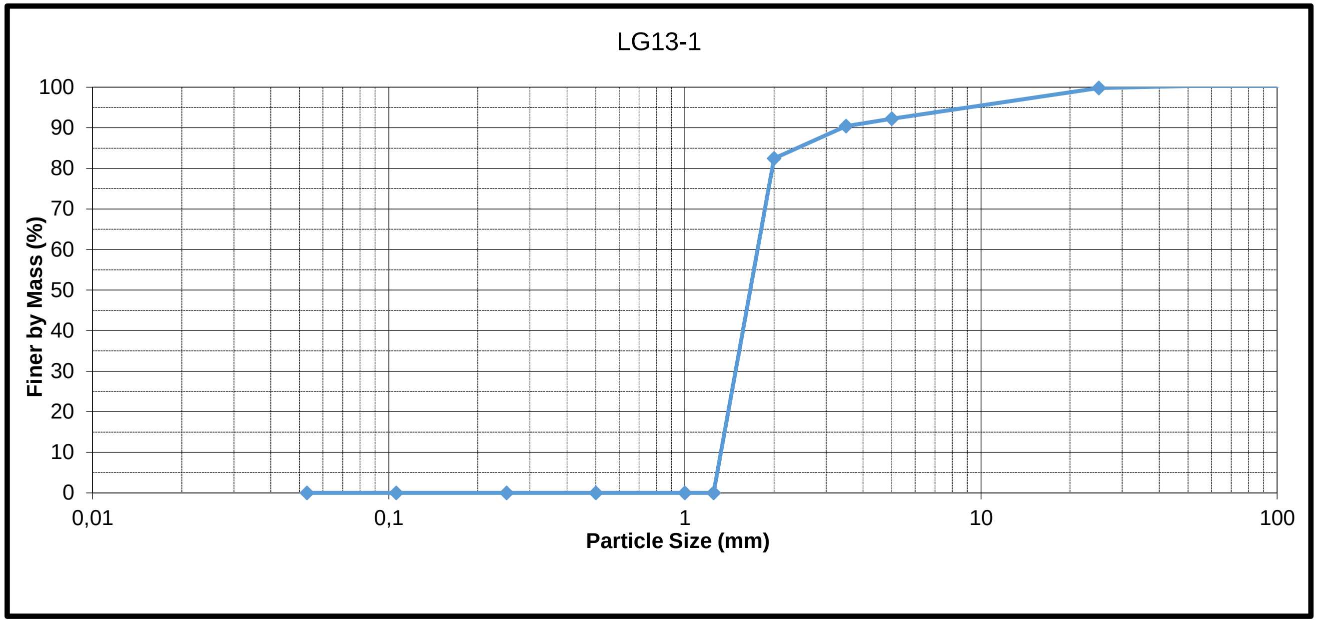


Figure F1-25. Semi-log PSD of Profile G13, layer 1.

LG13-2

Sieve Size/mm	% Passing
100	99,5
50	99,5
25	89,2
5	55,4
3,5	49,4
2	36,4
1,25	0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

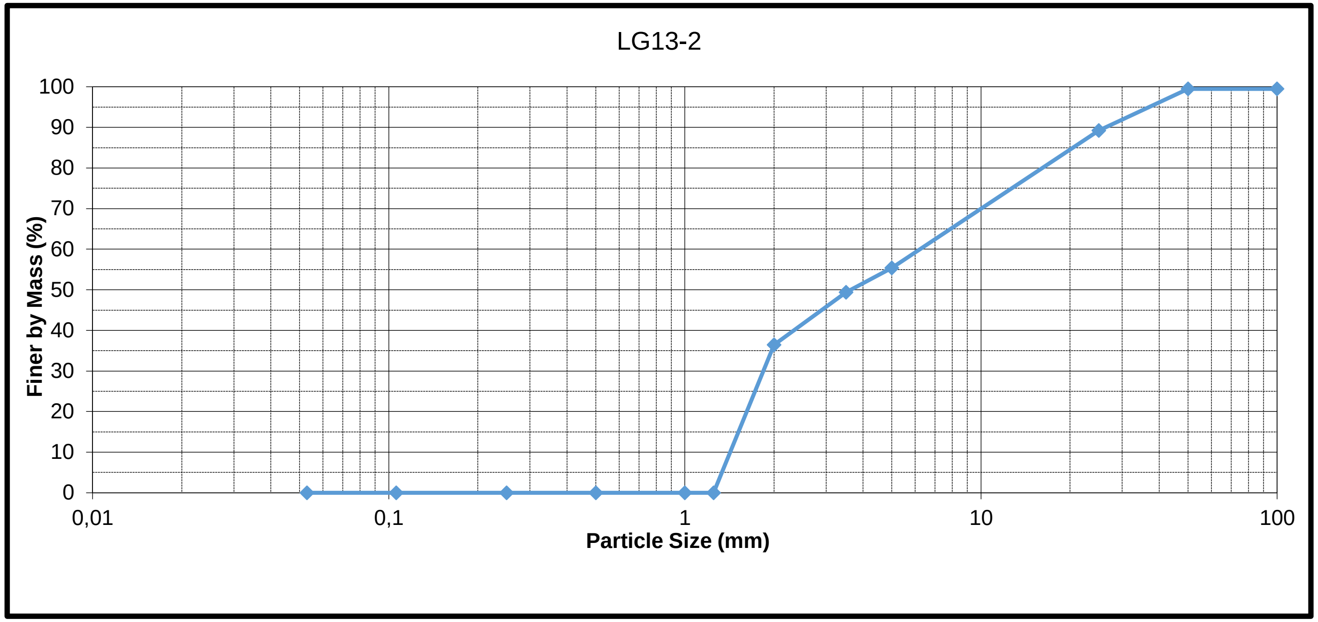


Figure F1-26. Semi-log PSD of Profile G13, layer 2.

LG13-3

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	83,6
5	37,6
3,5	30,8
2	20,3
1,25	0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

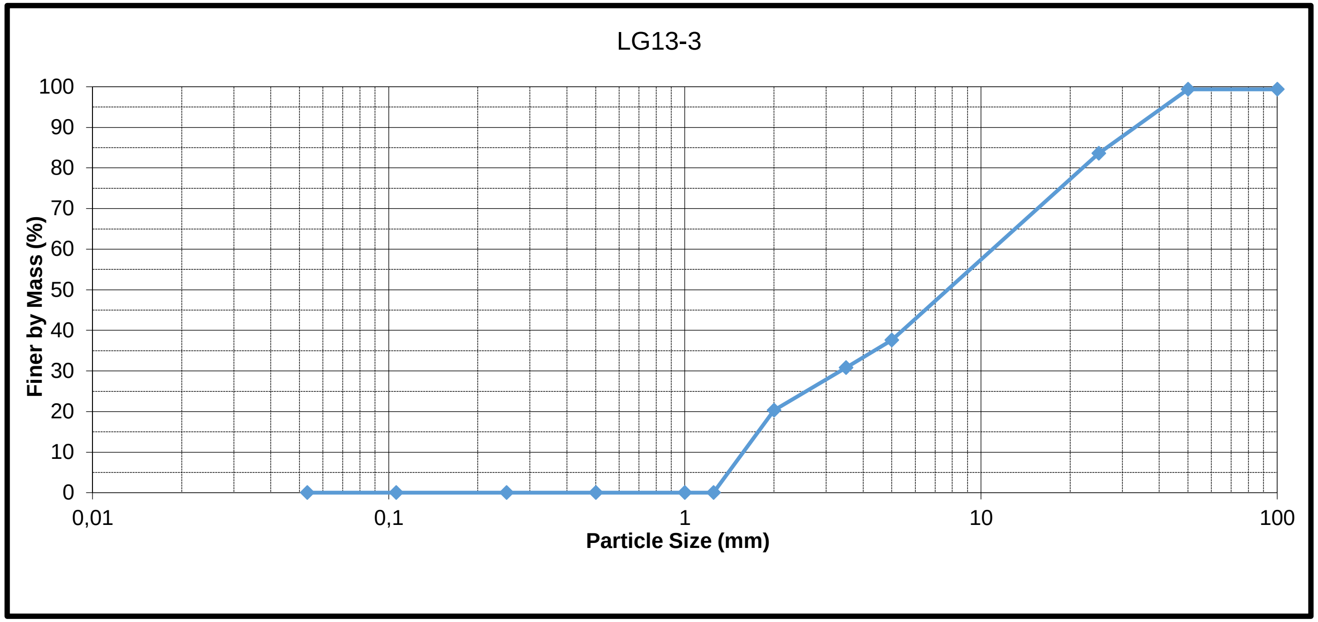


Figure F1-27. Semi-log PSD of Profile G13, layer 3.

LG14-1

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	99,4
5	98,1
3,5	97,1
2	89,9
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

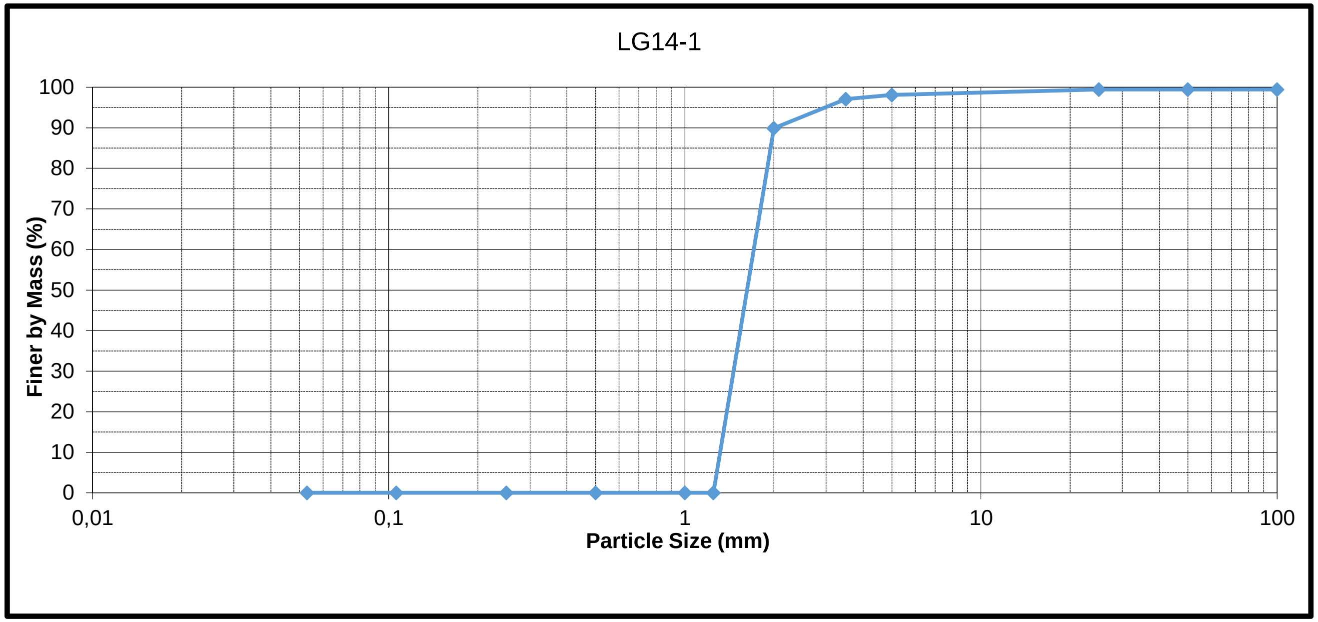


Figure F1-28. Semi-log PSD of Profile G14, layer 1.

LG14-2

Sieve Size/mm	% Passing
100	100,0
50	100,0
25	100,0
5	100,0
3,5	100,0
2	100,0
1,25	88,6
1	83,7
0,5	65,8
0,25	42,1
0,106	16,3
0,053	4,4
0	0,0

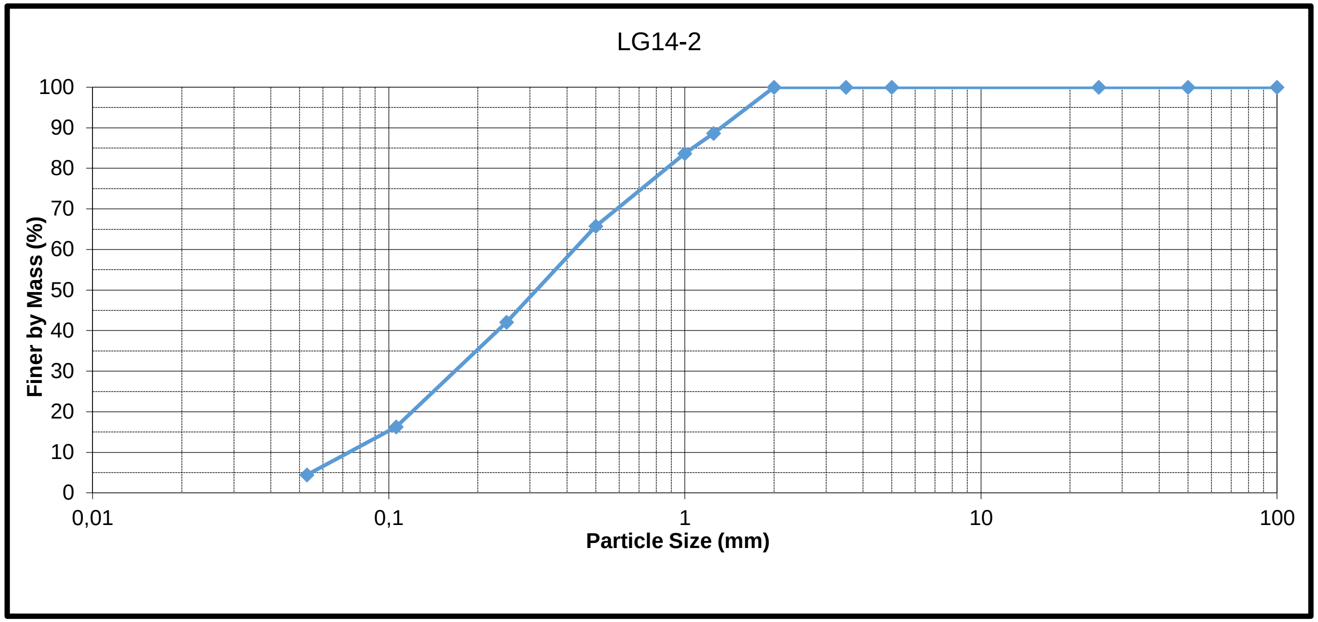


Figure F1-29. Semi-log PSD of Profile G14, layer 2.

LG14-3

Sieve Size/mm	% Passing
100	98,0
50	98,0
25	76,7
5	51,3
3,5	48,6
2	41,7
1,25	36,3
1	34,2
0,5	27,1
0,25	18,2
0,106	7,8
0,053	1,6
0	0

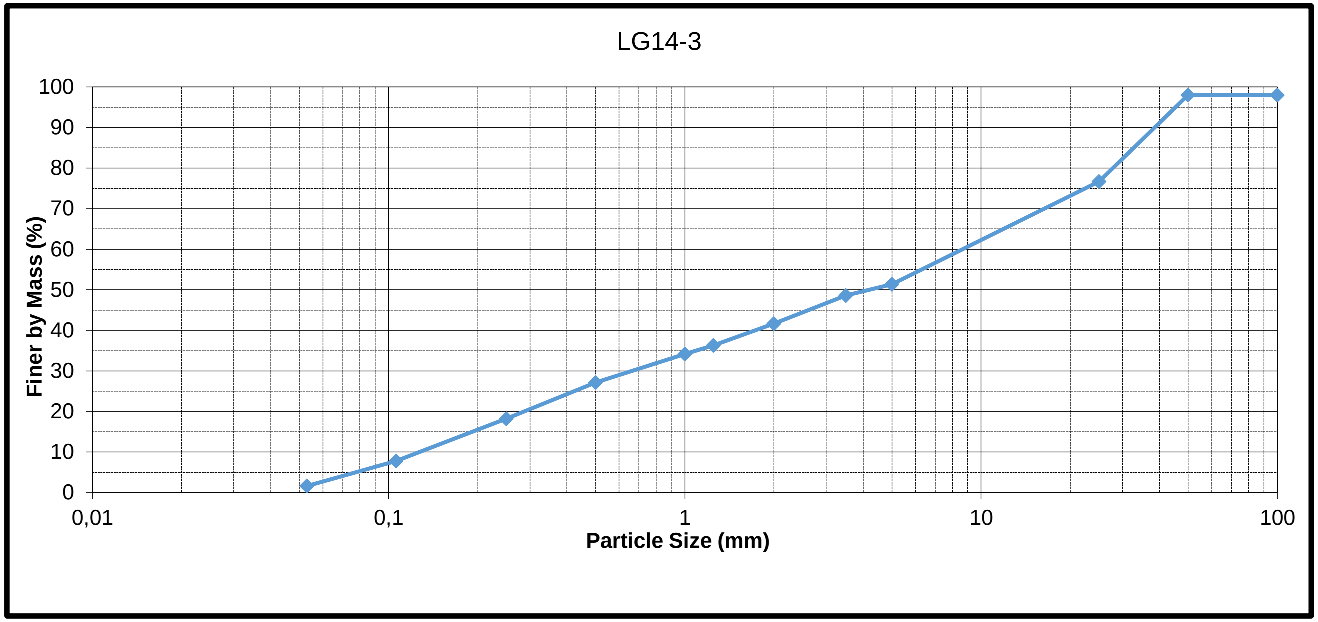


Figure F1-30. Semi-log PSD of Profile G14, layer 3.

LG16-1

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	93,7
5	74,4
3,5	72,6
2	66,0
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

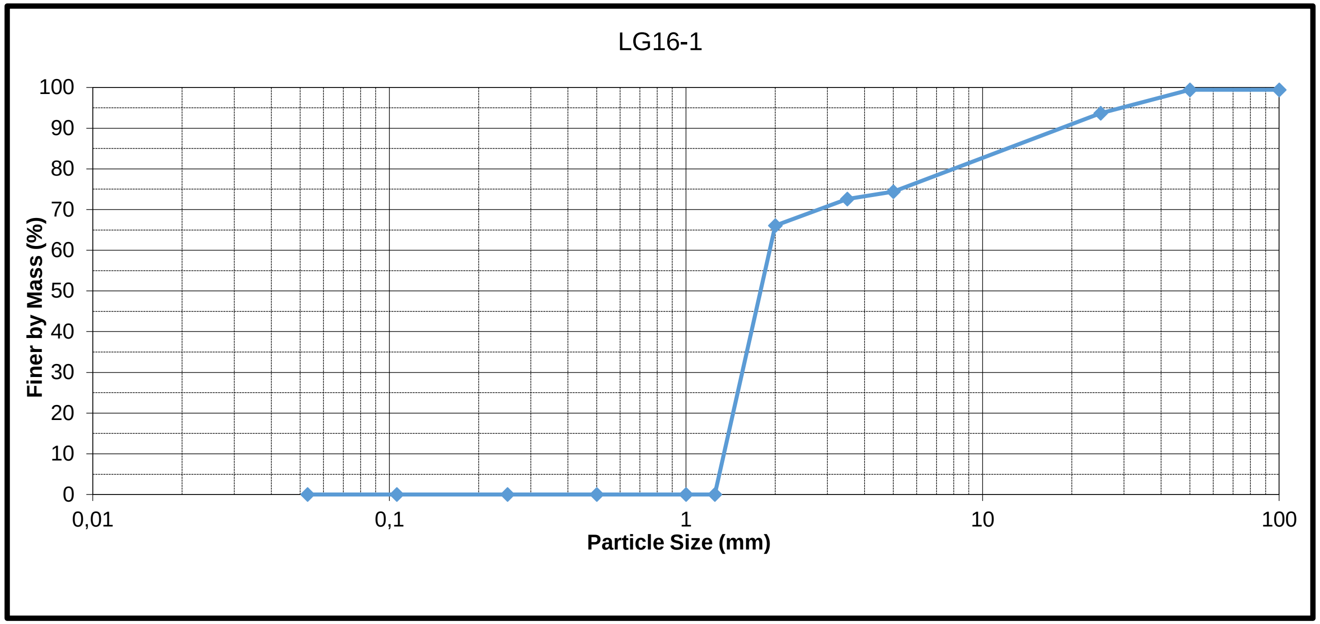


Figure F1-31. Semi-log PSD of Profile G16, layer 1.

LG18-1

Sieve Size/mm	% Passing
100	97,5
50	97,5
25	93,9
5	76,7
3,5	74,4
2	67,4
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

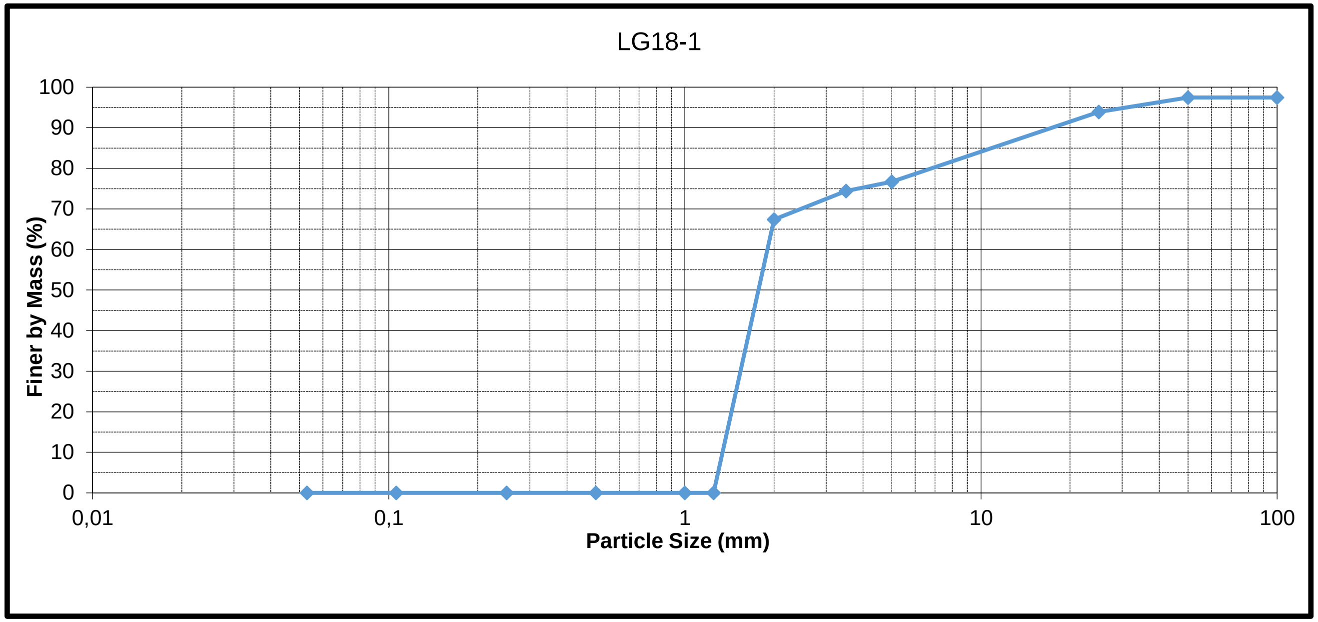


Figure F1-32. Semi-log PSD of Profile G18, layer 1.

LG19-1

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	88,6
5	61,8
3,5	58,6
2	51,4
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

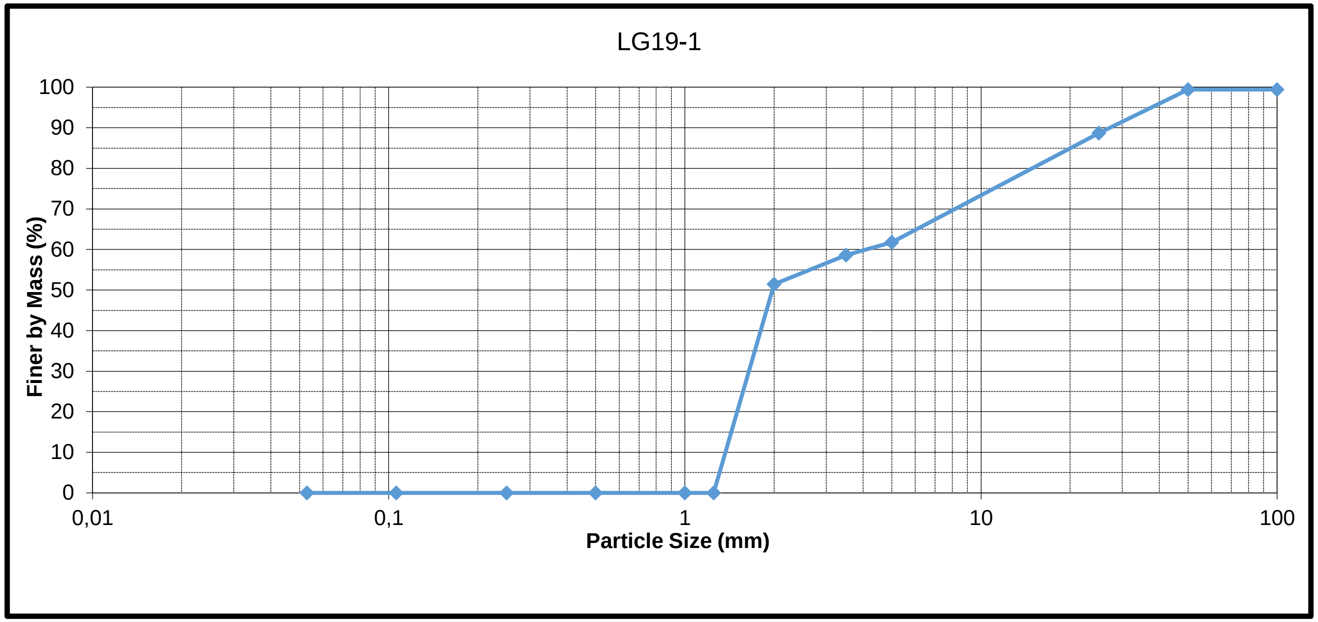


Figure F1-33. Semi-log PSD of Profile G19, layer 1.

LG20-1

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	68,9
5	36,5
3,5	34,0
2	29,5
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

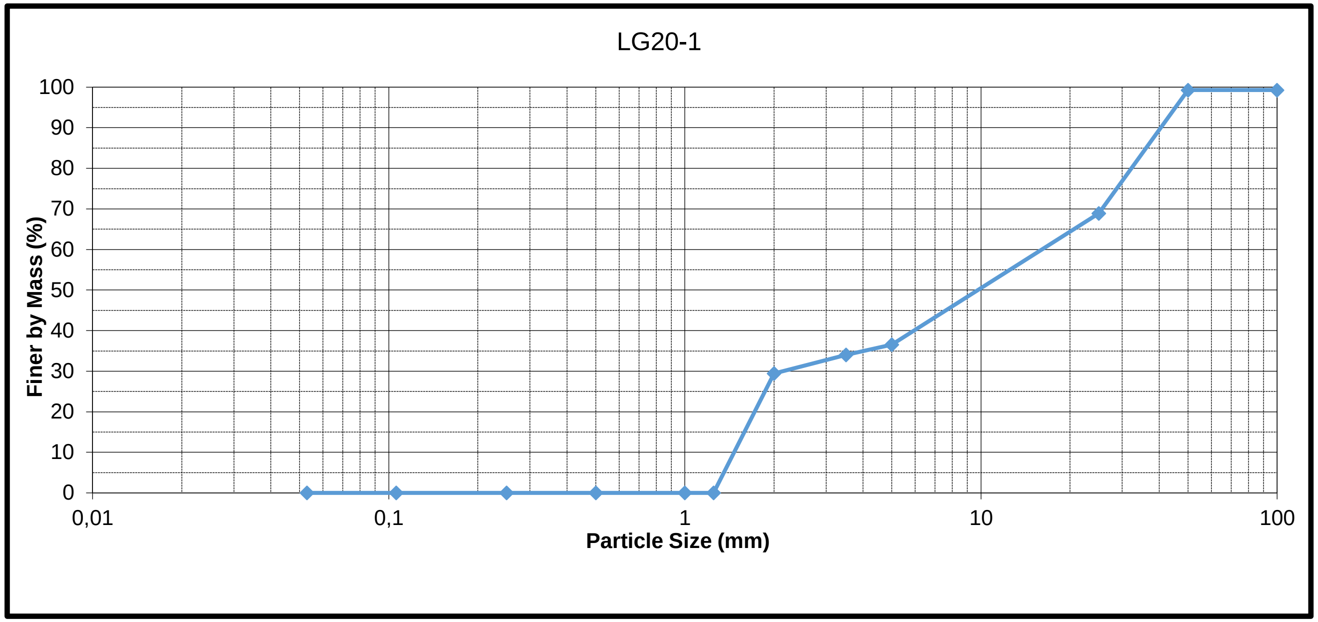


Figure F1-34. Semi-log PSD of Profile G20, layer 1.

LG20-2

Sieve Size/mm	% Passing
100	99,2
50	99,2
25	99,2
5	59,9
3,5	49,3
2	32,4
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

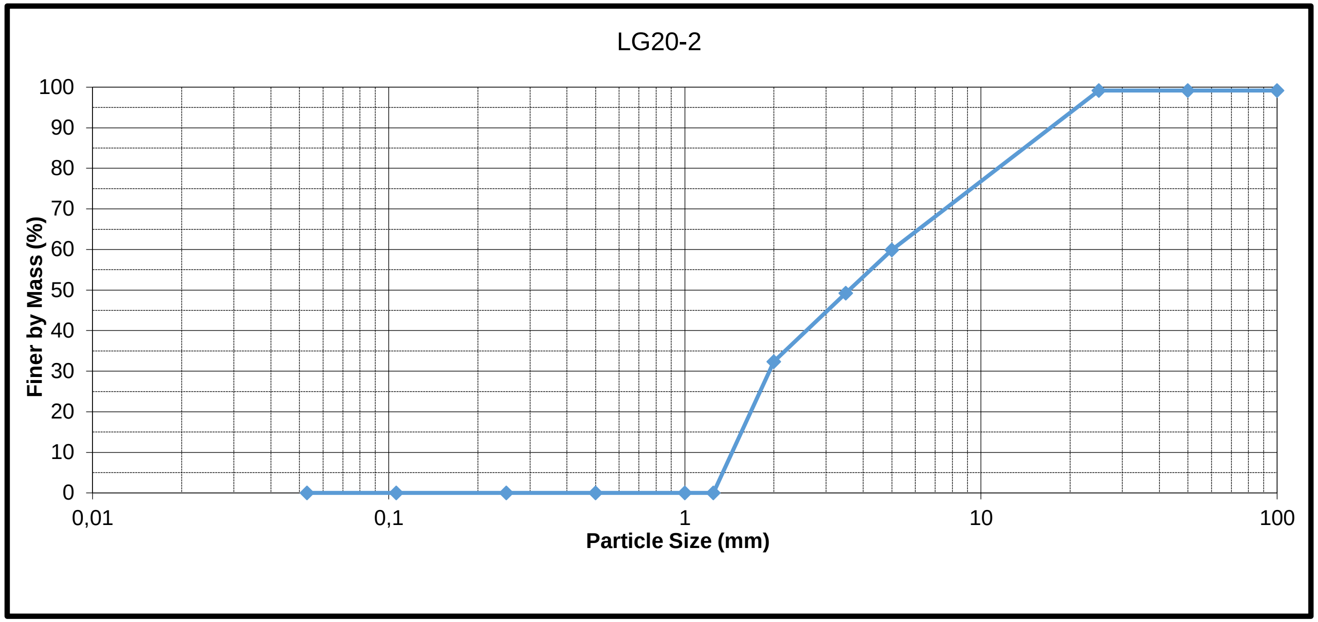


Figure F1-35. Semi-log PSD of Profile G20, layer 2.

LG21-1

Sieve Size/mm	% Passing
100	99,6
50	93,9
25	65,2
5	32,6
3,5	30,0
2	27,1
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

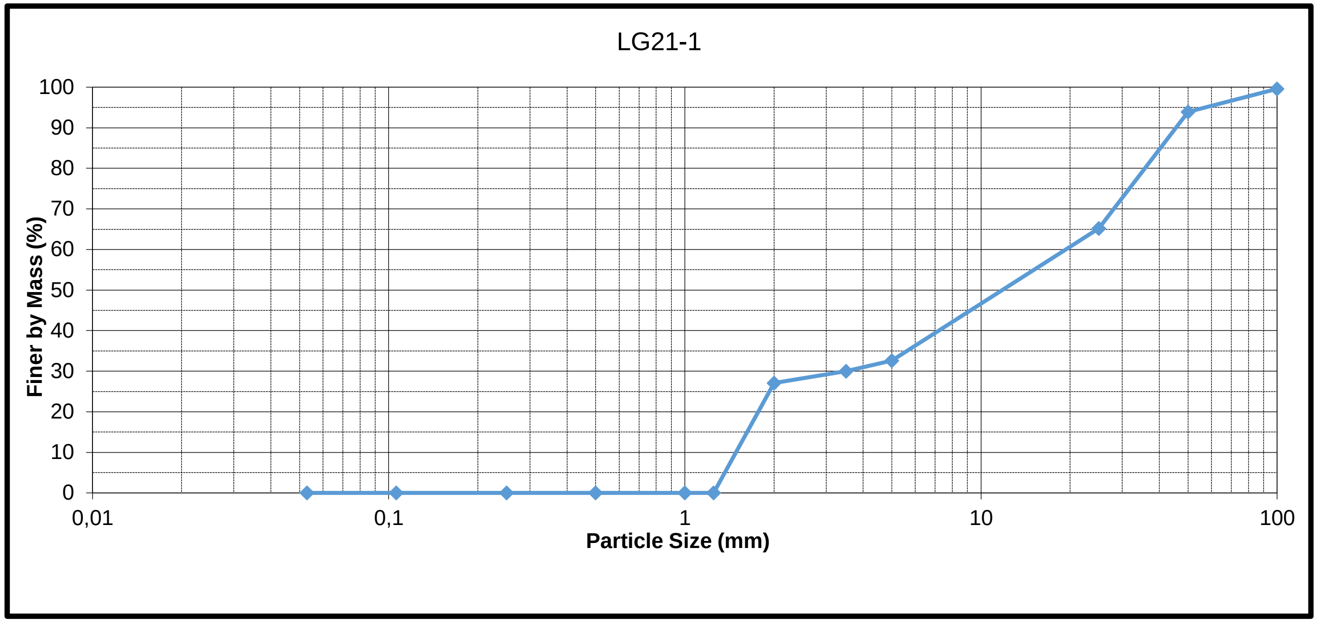


Figure F1-36. Semi-log PSD of Profile G21, layer 1.

LG21-2

Sieve Size/mm	% Passing
100	99,4
50	67,8
25	47,6
5	17,7
3,5	15,6
2	13,0
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

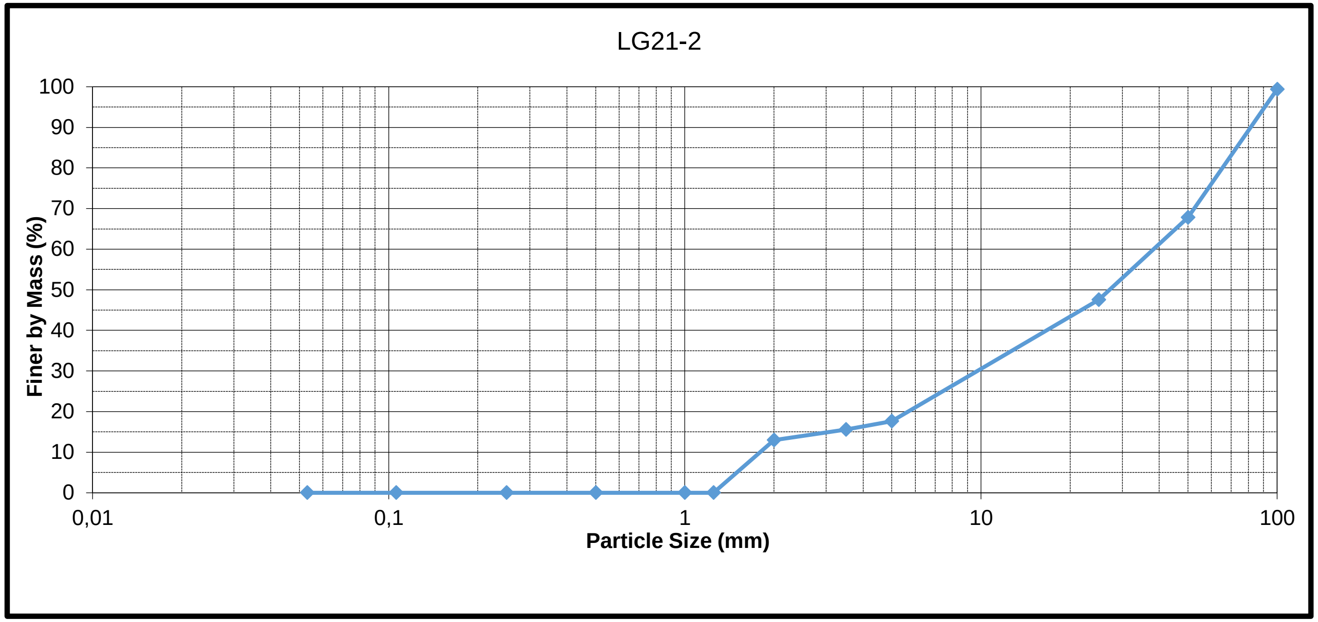


Figure F1-37. Semi-log PSD of Profile G21, layer 2.

LG22-1

Sieve Size/mm	% Passing
100	98,6
50	98,6
25	89,7
5	54,1
3,5	50,6
2	43,2
1,25	0,0
1	0,0
0,5	0,0
0,25	0,0
0,106	0,0
0,053	0,0
0	0,0

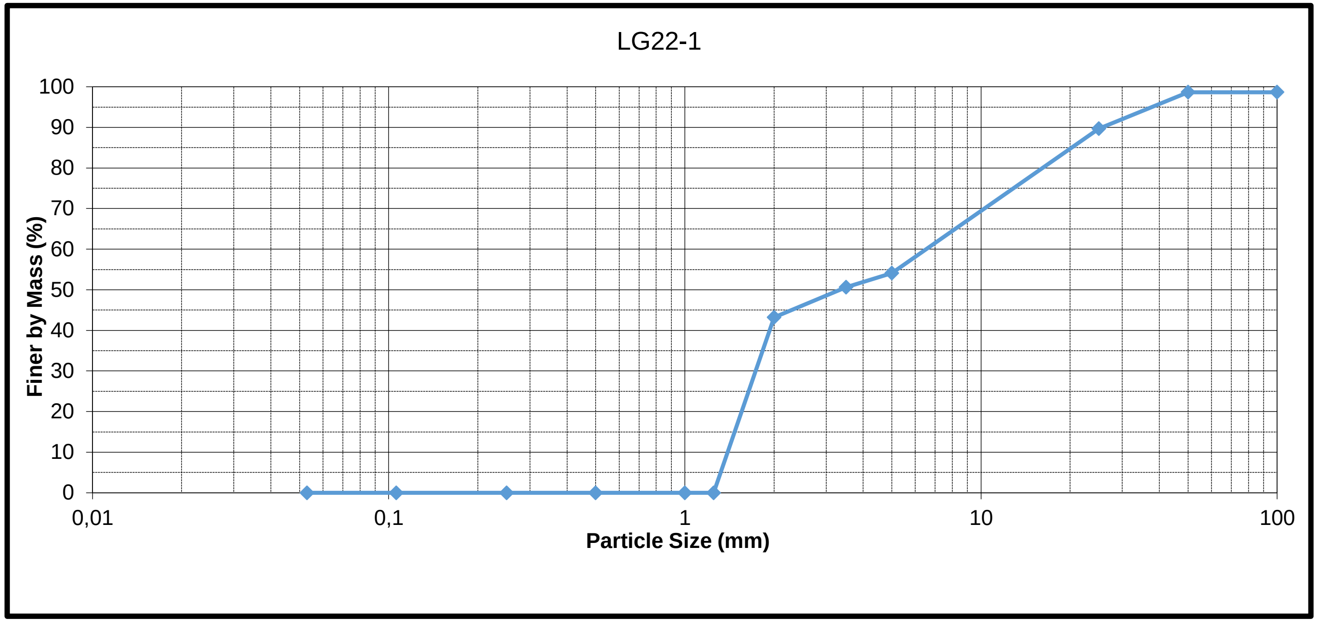


Figure F1-38. Semi-log PSD of Profile G22, layer 1.

LG22-2

Sieve Size/mm	% Passing
100	84,6
50	84,6
25	81,3
5	45,5
3,5	37,2
2	34,5
1,25	22,9
1	18,8
0,5	9,4
0,25	4,5
0,106	1,6
0,053	0,5
0	0

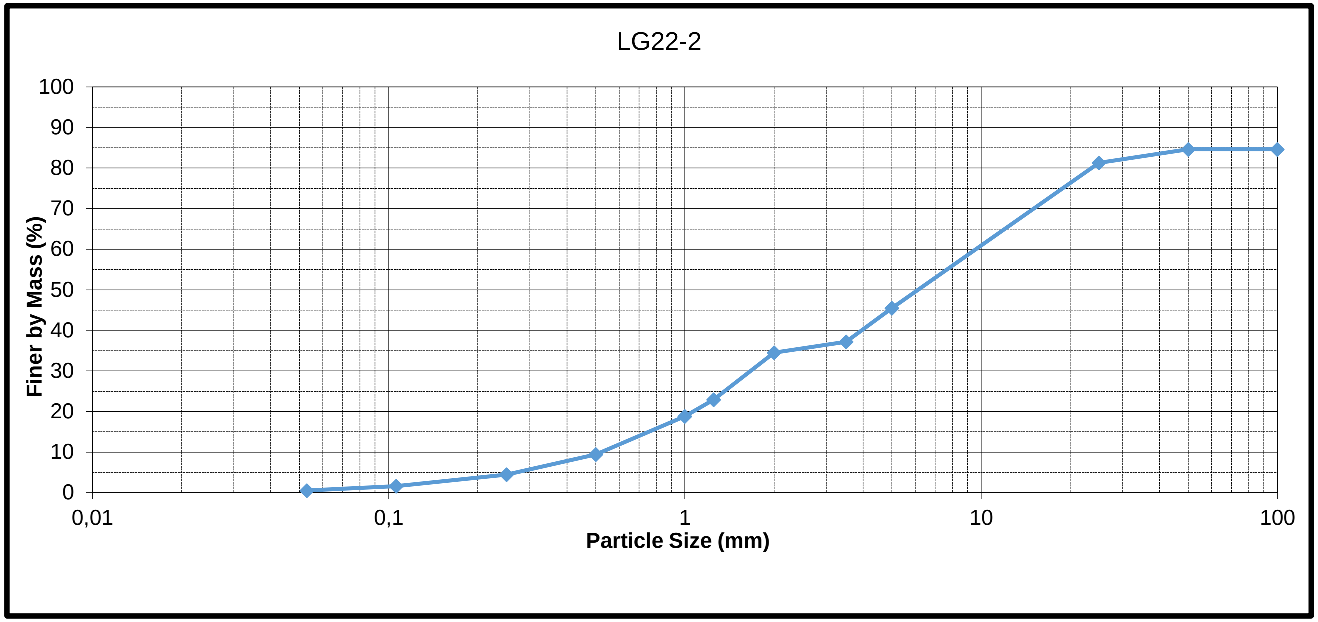


Figure F1-39. Semi-log PSD of Profile G22, layer 2.

LG23-1

Sieve Size/mm	% Passing
100	98,9
50	87,1
25	71,9
5	47,0
3,5	44,2
2	37,7
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

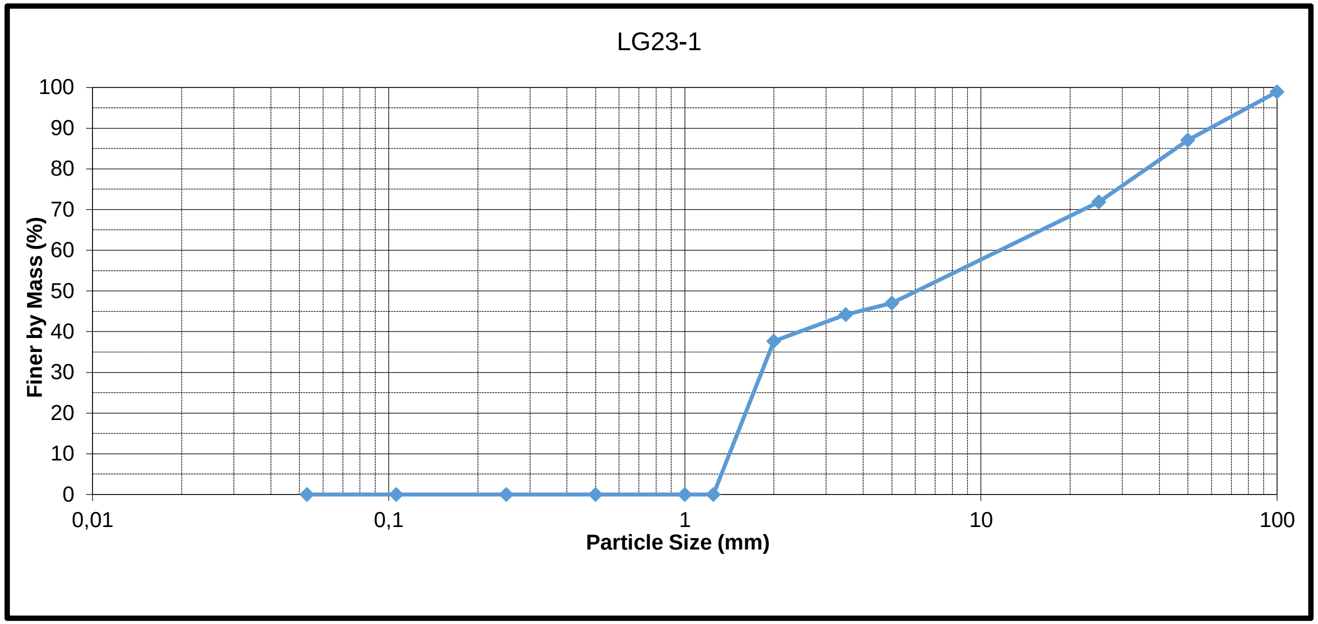


Figure F1-40. Semi-log PSD of Profile G23, layer 1.

LG23-2

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	94,9
5	43,7
3,5	39,1
2	30,7
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

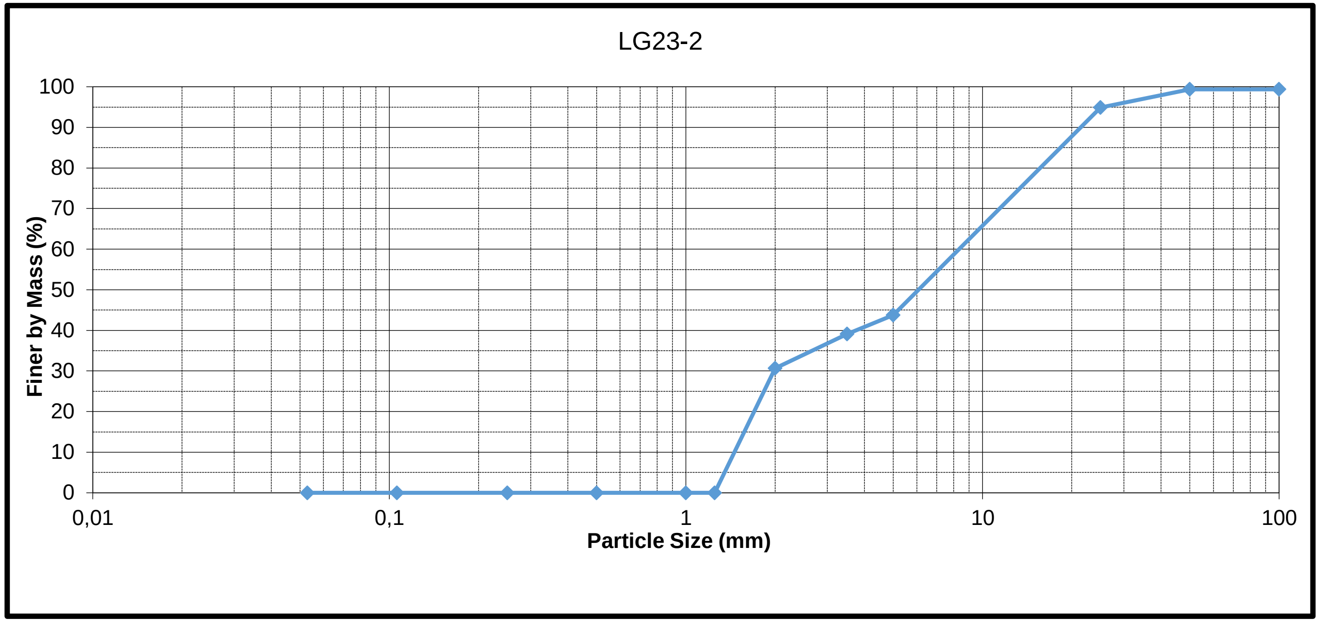


Figure F1-41. Semi-log PSD of Profile G23, layer 2.

LG25-1

Sieve Size/mm	% Passing
100	100,0
50	100,0
25	98,0
5	93,3
3,5	91,4
2	84,8
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

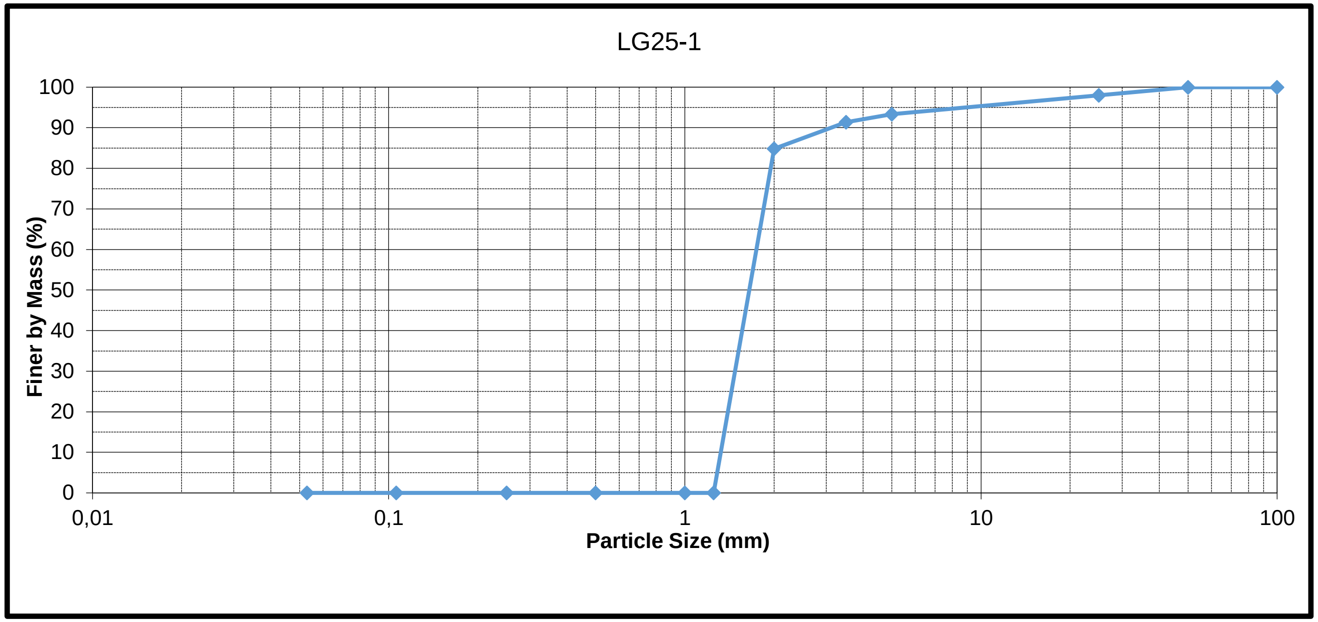


Figure F1-42. Semi-log PSD of Profile G25, layer 1.

LG25-2

Sieve Size/mm	% Passing
100	98,7
50	98,7
25	95,9
5	74,0
3,5	65,6
2	48,4
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

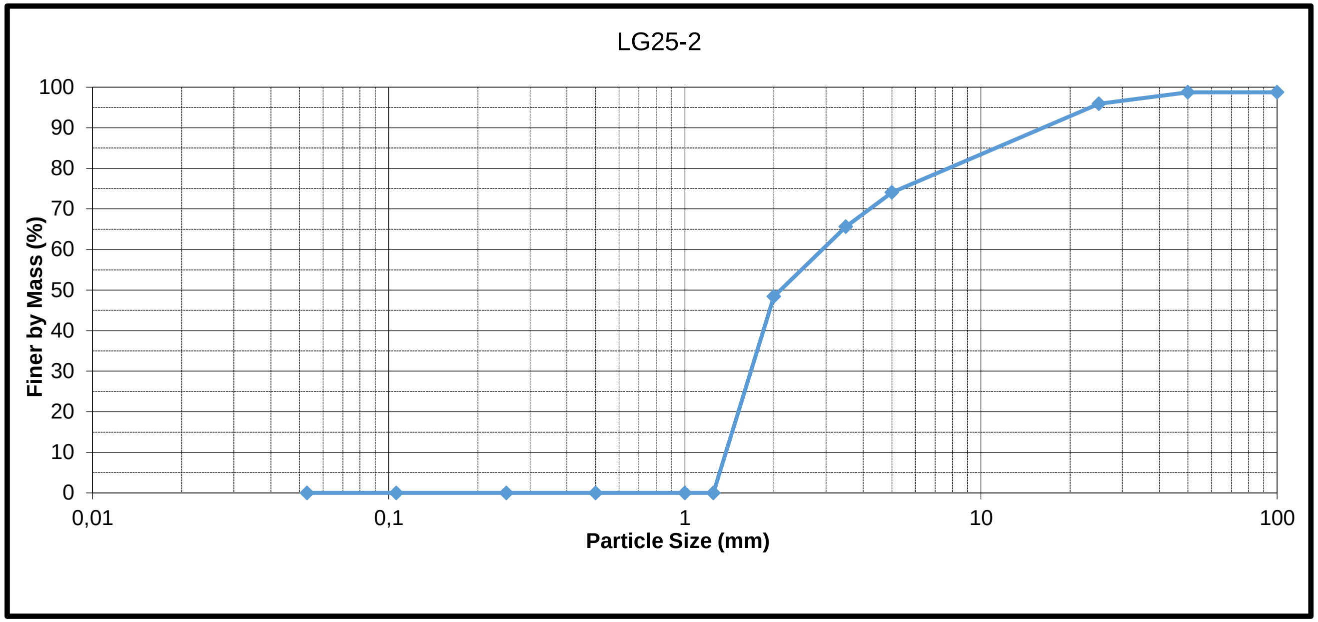


Figure F1-43. Semi-log PSD of Profile G25, layer 2.

LG25-3

Sieve Size/mm	% Passing
100	98,0
50	98,0
25	94,0
5	62,5
3,5	55,3
2	38,3
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

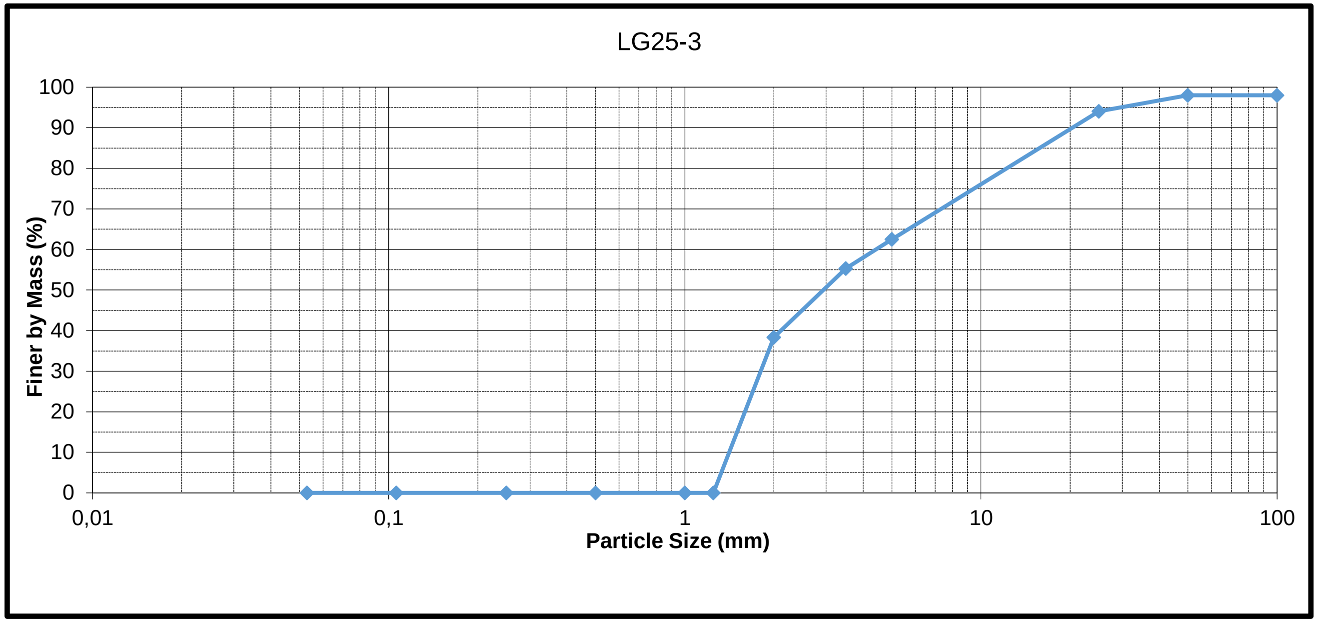


Figure F1-44. Semi-log PSD of Profile G25, layer 3.

LG26-1

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	99,4
5	94,1
3,5	92,7
2	87,9
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

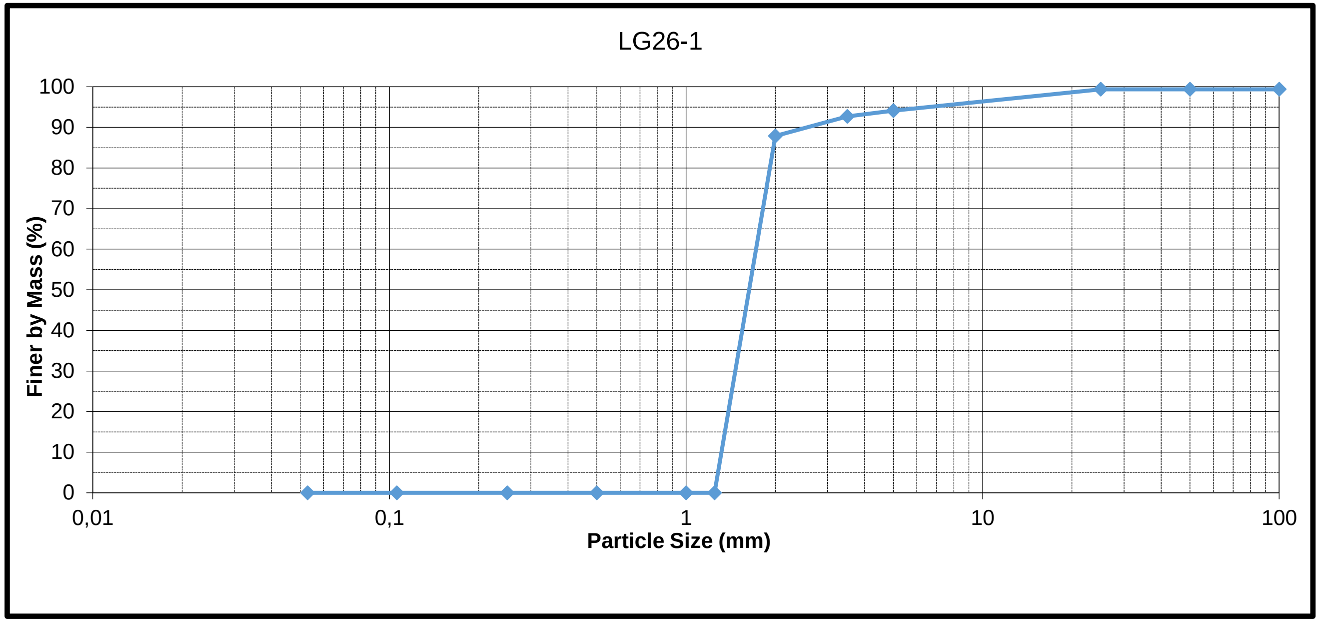


Figure F1-45. Semi-log PSD of Profile G26, layer 1.

LG26-2

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	88,5
5	57,1
3,5	52,2
2	41,3
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

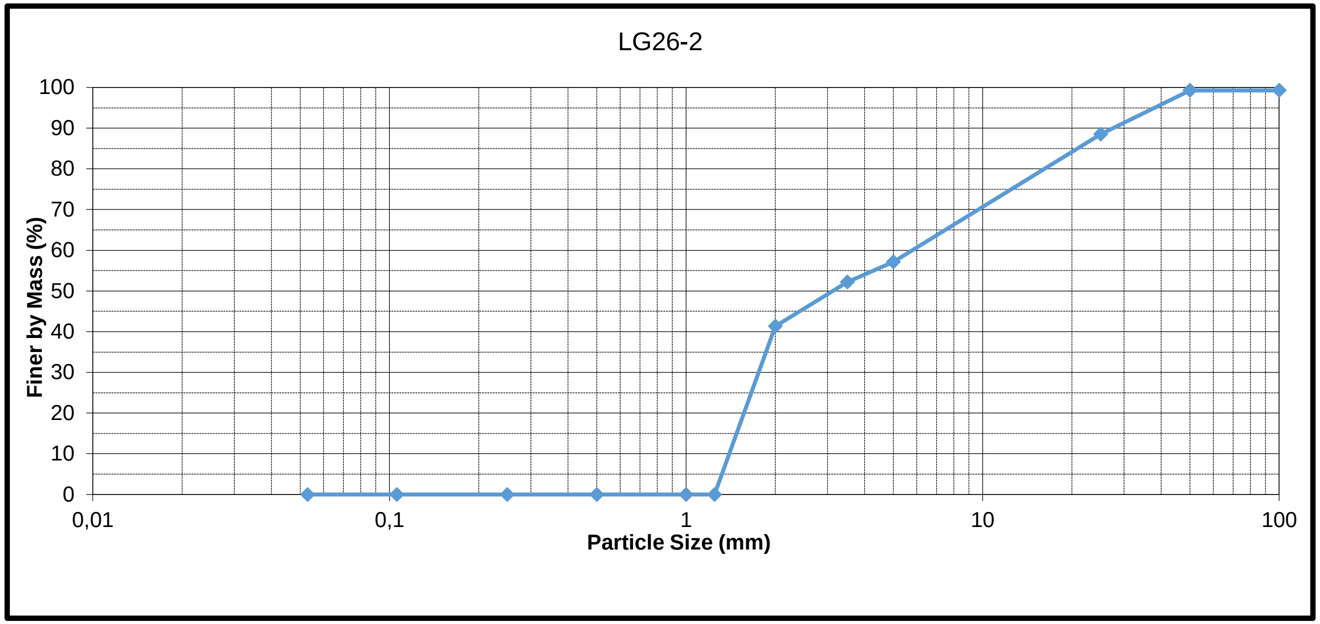


Figure F1-46. Semi-log PSD of Profile G26, layer 2.

LG26-3

Sieve Size/mm	% Passing
100	99,7
50	99,7
25	78,2
5	38,5
3,5	34,7
2	23,1
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

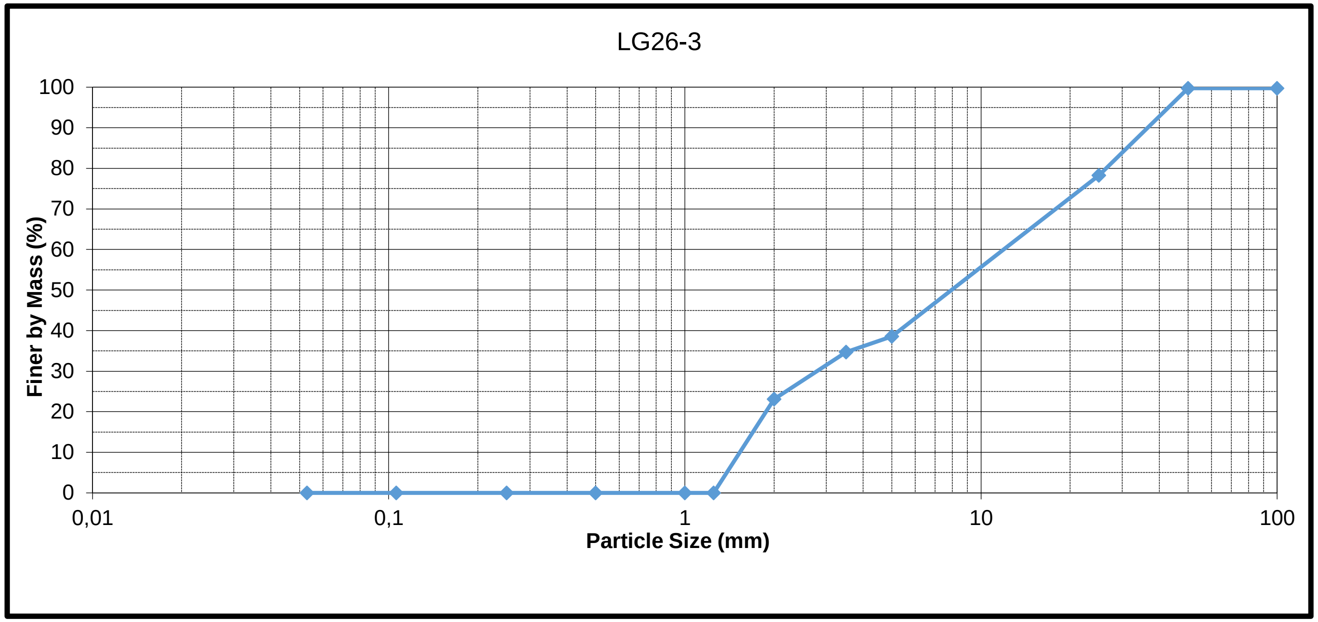


Figure F1-47. Semi-log PSD of Profile G26, layer 3.

LG27-1

Sieve Size/mm	% Passing
100	99,5
50	99,5
25	94,2
5	69,5
3,5	67,1
2	61,1
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

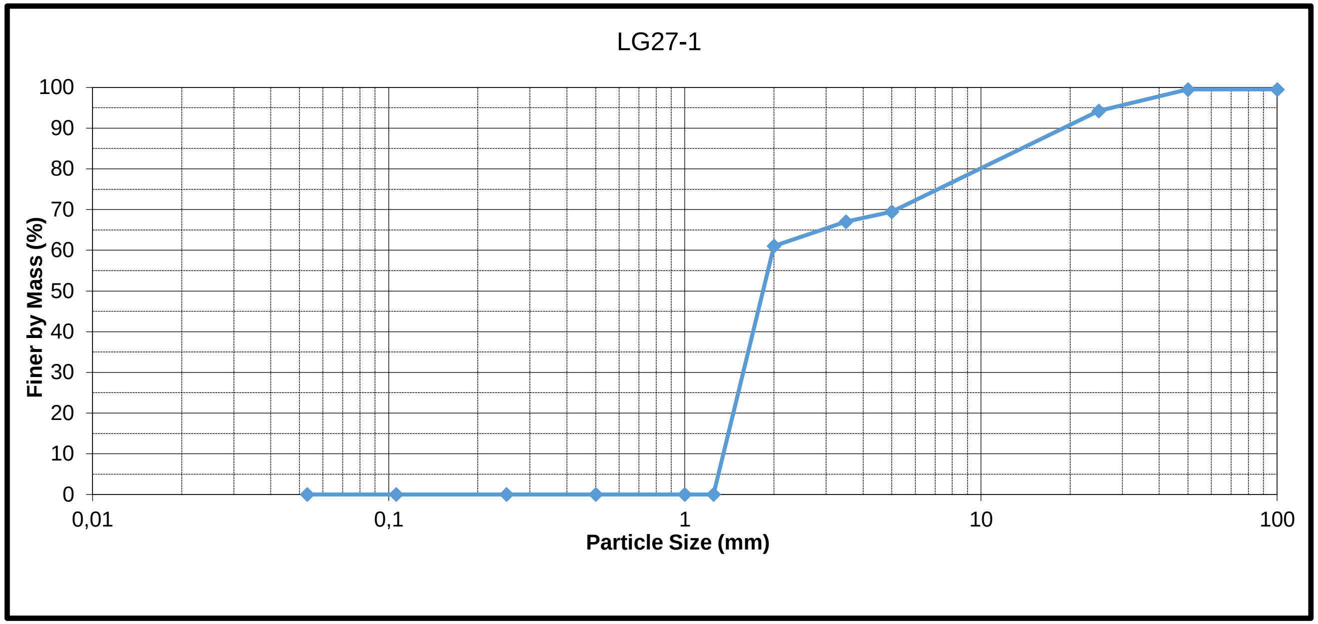


Figure F1-48. Semi-log PSD of Profile G27, layer 1.

LG27-2

Sieve Size/mm	% Passing
100	99,0
50	99,0
25	92,5
5	45,2
3,5	38,1
2	25,7
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

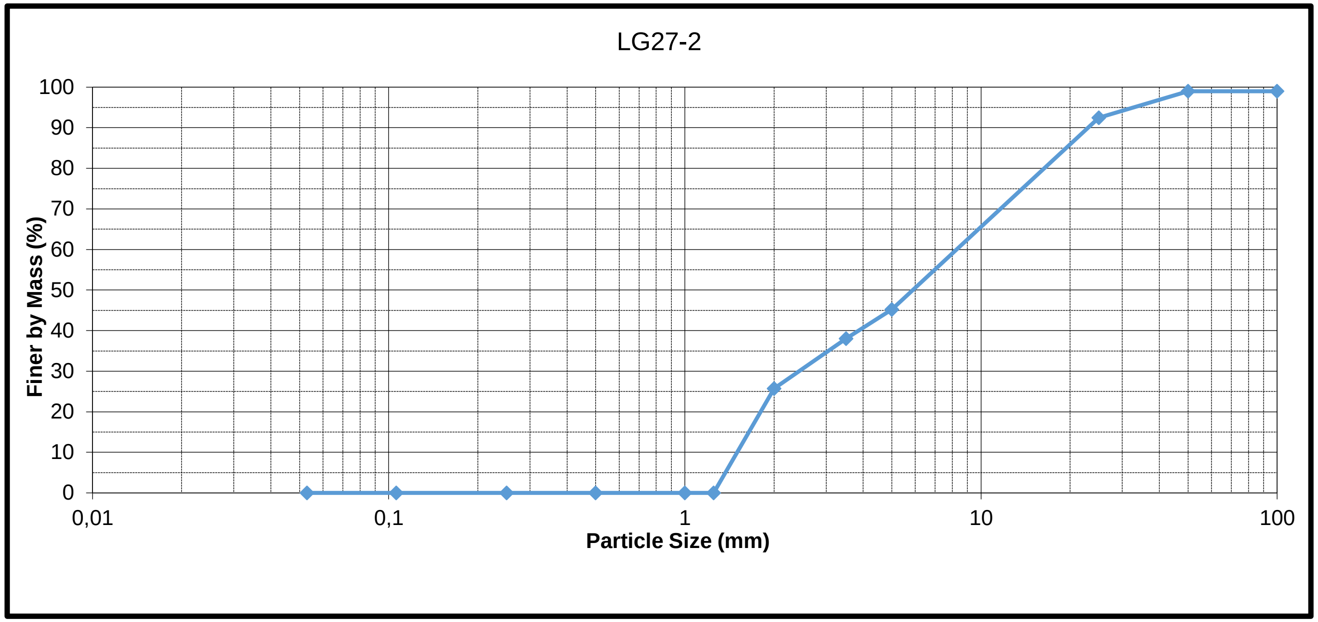


Figure F1-49. Semi-log PSD of Profile G27, layer 2.

LG28-1

Sieve Size/mm	% Passing
100	99,8
50	99,8
25	99,8
5	94,7
3,5	93,1
2	87,5
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

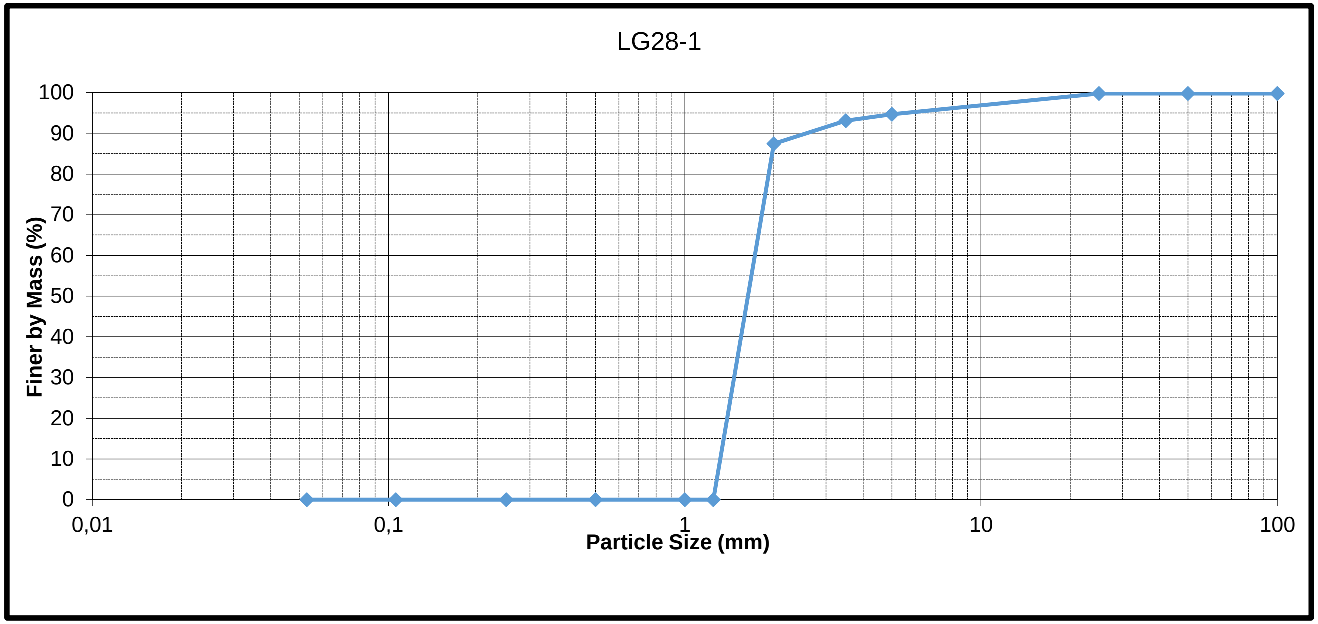


Figure F1-50. Semi-log PSD of Profile G28, layer 1.

LG28-2

Sieve Size/mm	% Passing
100	98,0
50	98,0
25	98,0
5	52,6
3,5	45,8
2	31,7
1,25	27,4
1	25,3
0,5	17,6
0,25	10,9
0,106	5,5
0,053	1,5
0	0

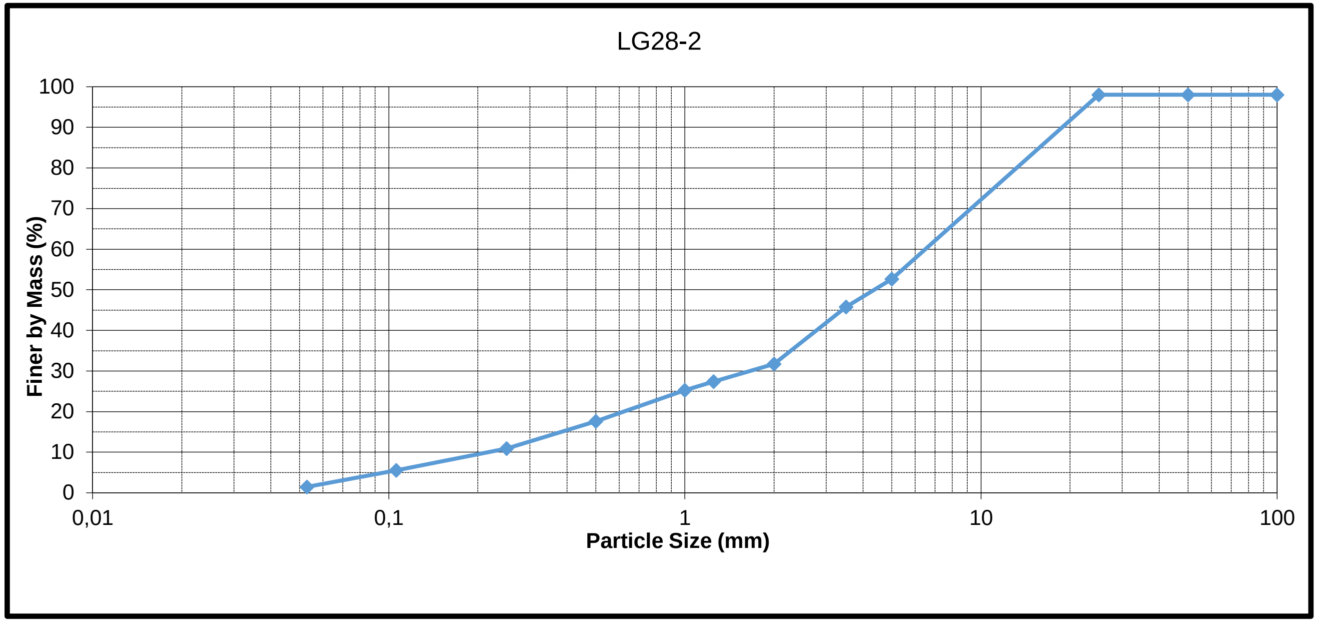


Figure F1-51. Semi-log PSD of Profile G28, layer 2.

LG28-3

Sieve Size/mm	% Passing
100	98,9
50	98,9
25	98,9
5	55,2
3,5	47,4
2	29,1
1,25	26,2
1	24,9
0,5	19,4
0,25	13,6
0,106	8,2
0,053	1,8
0	0,0

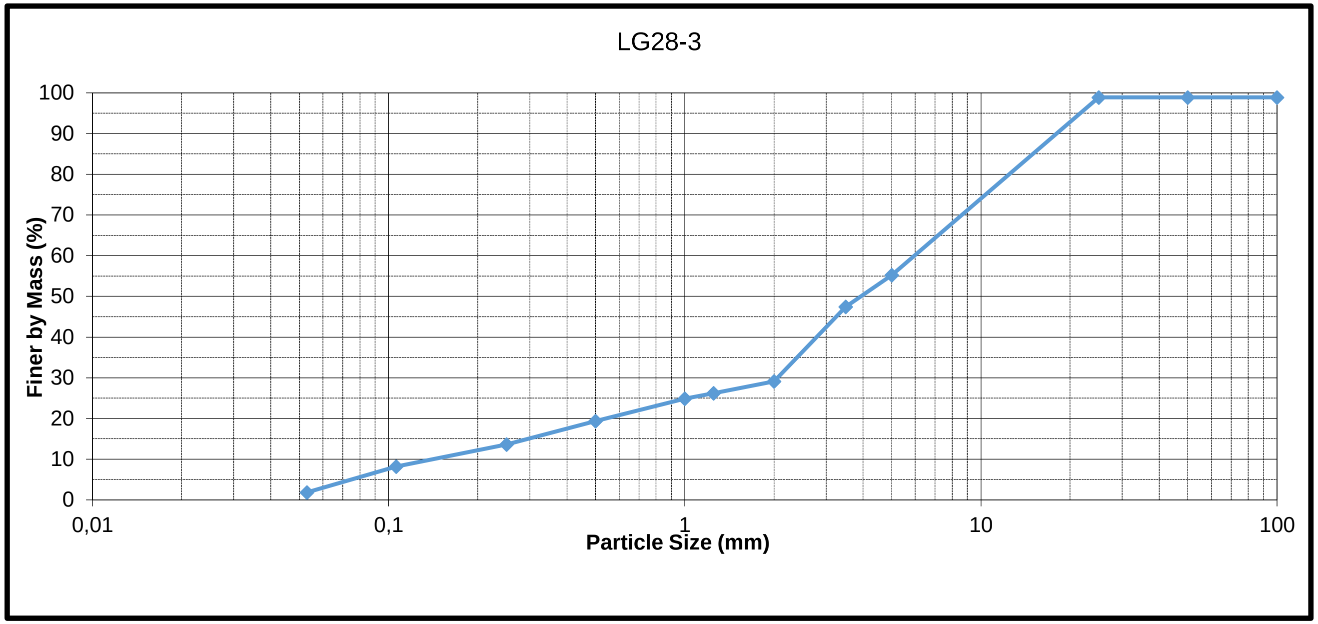


Figure F1-52. Semi-log PSD of Profile G28, layer 3.

LG28-4

Sieve Size/mm	% Passing
100	100,0
50	100,0
25	100,0
5	100,0
3,5	100,0
2	100,0
1,25	90,6
1	86,0
0,5	67,9
0,25	40,0
0,106	12,4
0,053	1,7
0	0

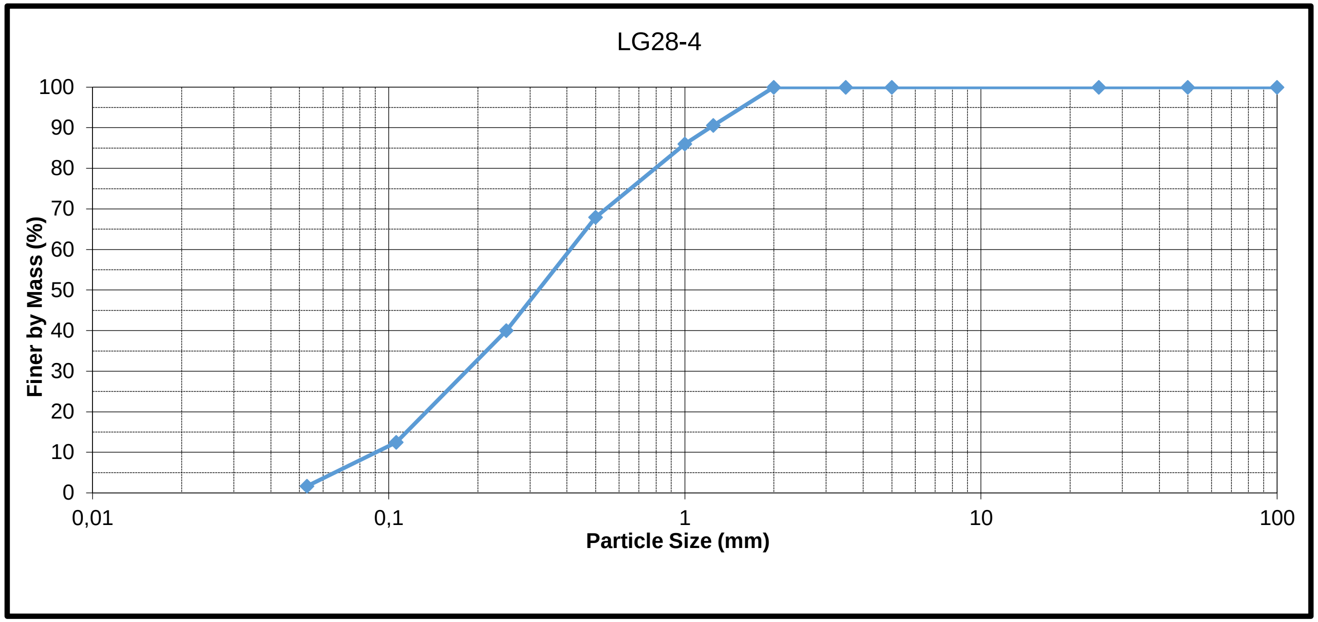


Figure F1-53. Semi-log PSD of Profile G28, layer 4.

LG29-1

Sieve Size/mm	% Passing
100	99,1
50	83,8
25	59,6
5	24,1
3,5	22,2
2	19,9
1,25	17,9
1	17,0
0,5	14,1
0,25	8,6
0,106	2,8
0,053	0,8
0	0,0

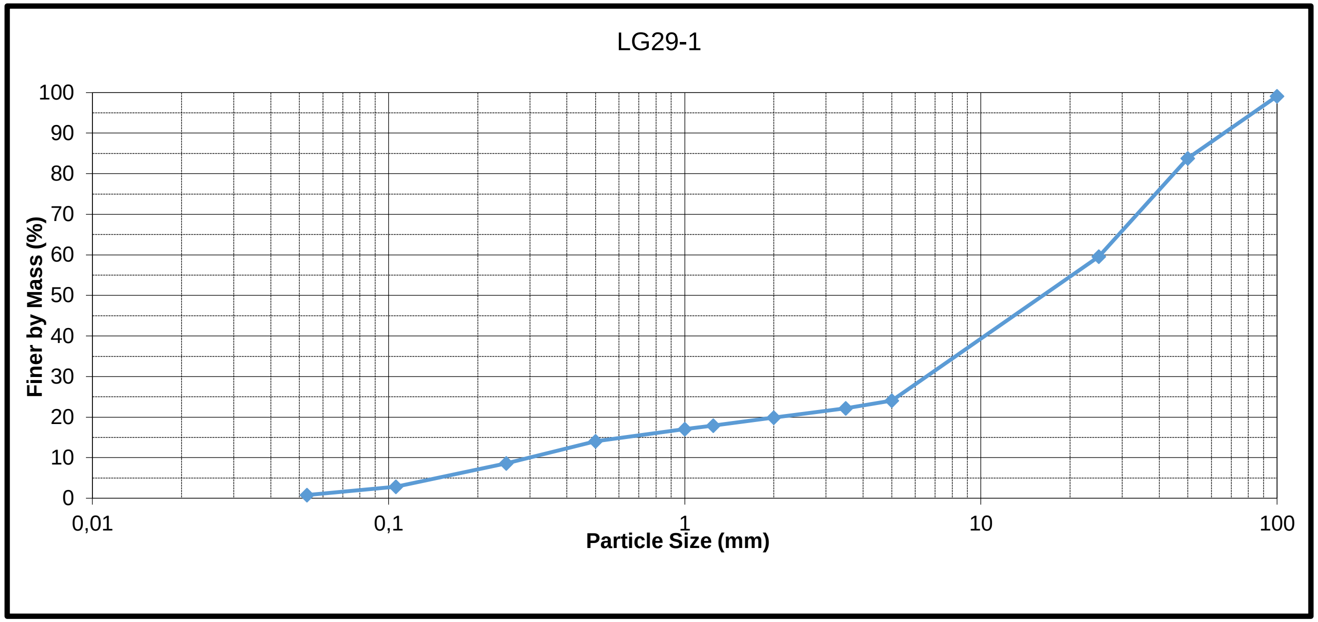


Figure F1-54. Semi-log PSD of Profile G29, layer 1.

LM1-1

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	99,4
5	89,1
3,5	87,4
2	79,7
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

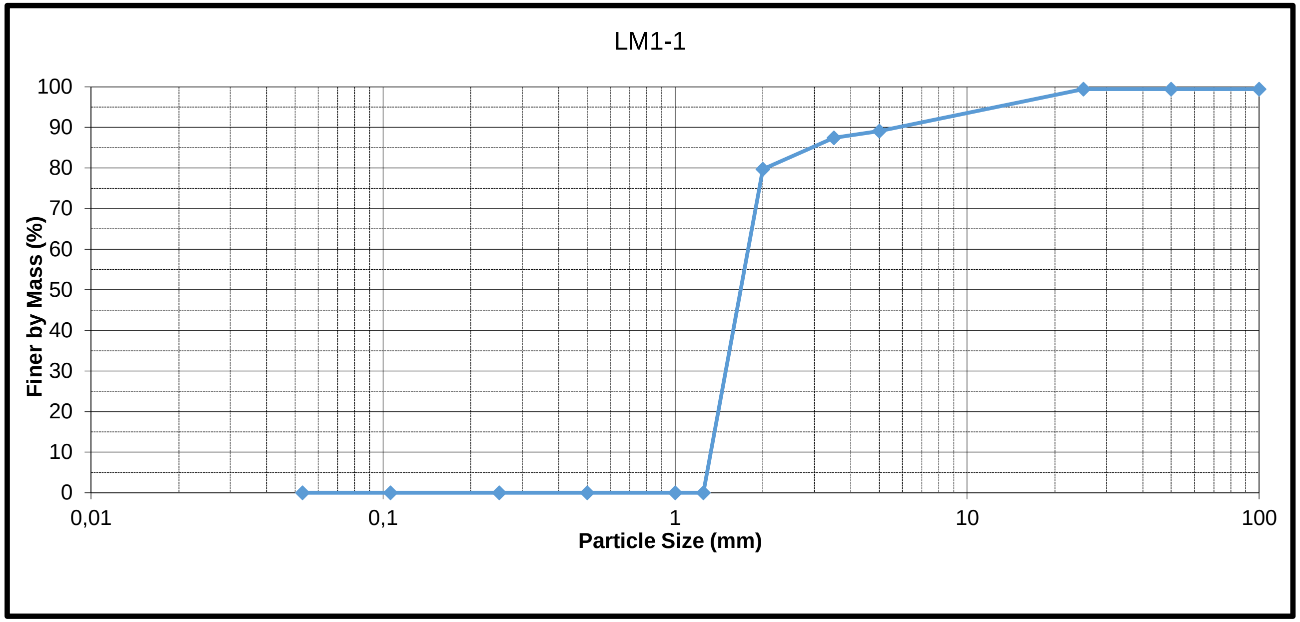


Figure F1-55. Semi-log PSD of Profile M1, layer 1.

LM1-2

Sieve Size/mm	% Passing
100	99,2
50	99,2
25	99,2
5	53,8
3,5	45,7
2	36,1
1,25	0,0
1	0,0
0,5	0,0
0,25	0
0,106	0
0,053	0
0	0

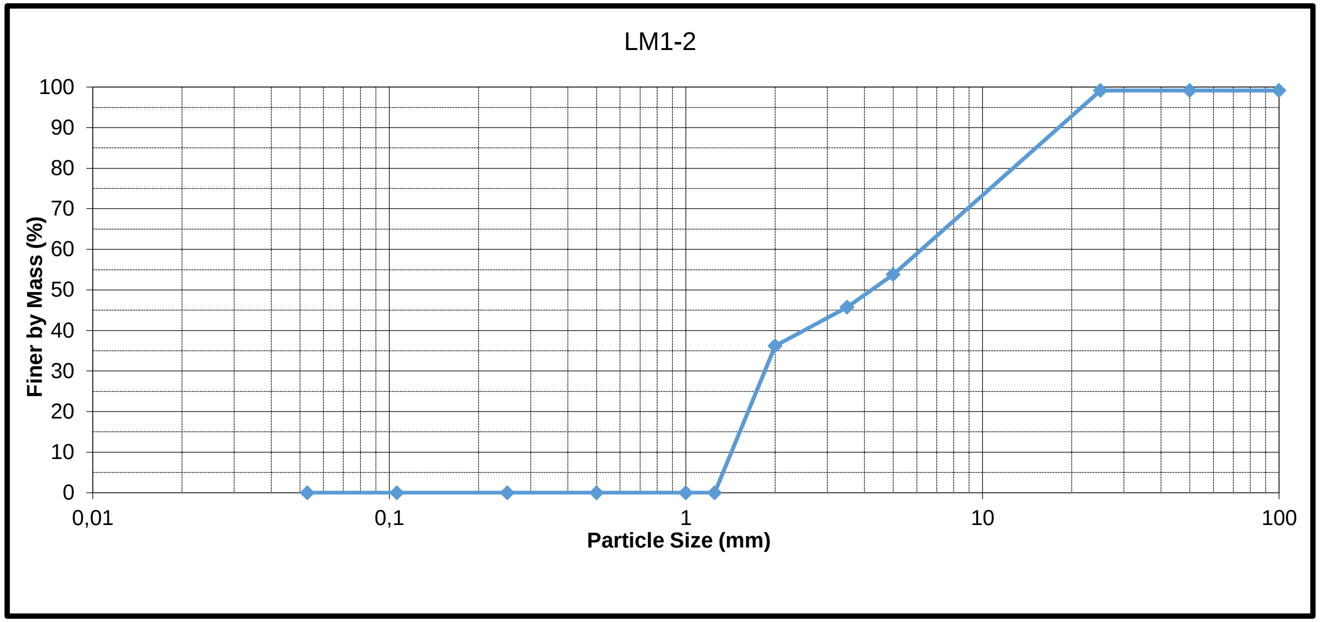


Figure F1-56. Semi-log PSD of Profile M1, layer 2.

LM1-3

Sieve Size/mm	% Passing
100	99,2
50	82,6
25	66,2
5	38,9
3,5	32,9
2	23,3
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

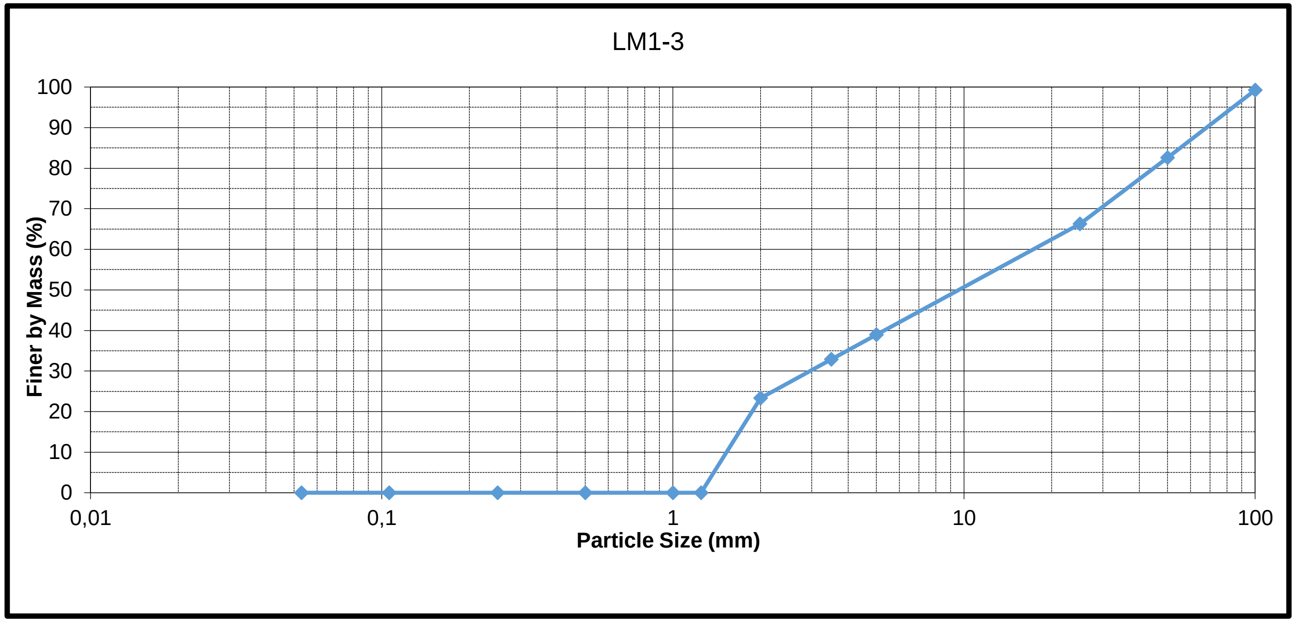


Figure F1-57. Semi-log PSD of Profile M1, layer 3.

LM2-1

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	99,3
5	74,8
3,5	68,2
2	57,0
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

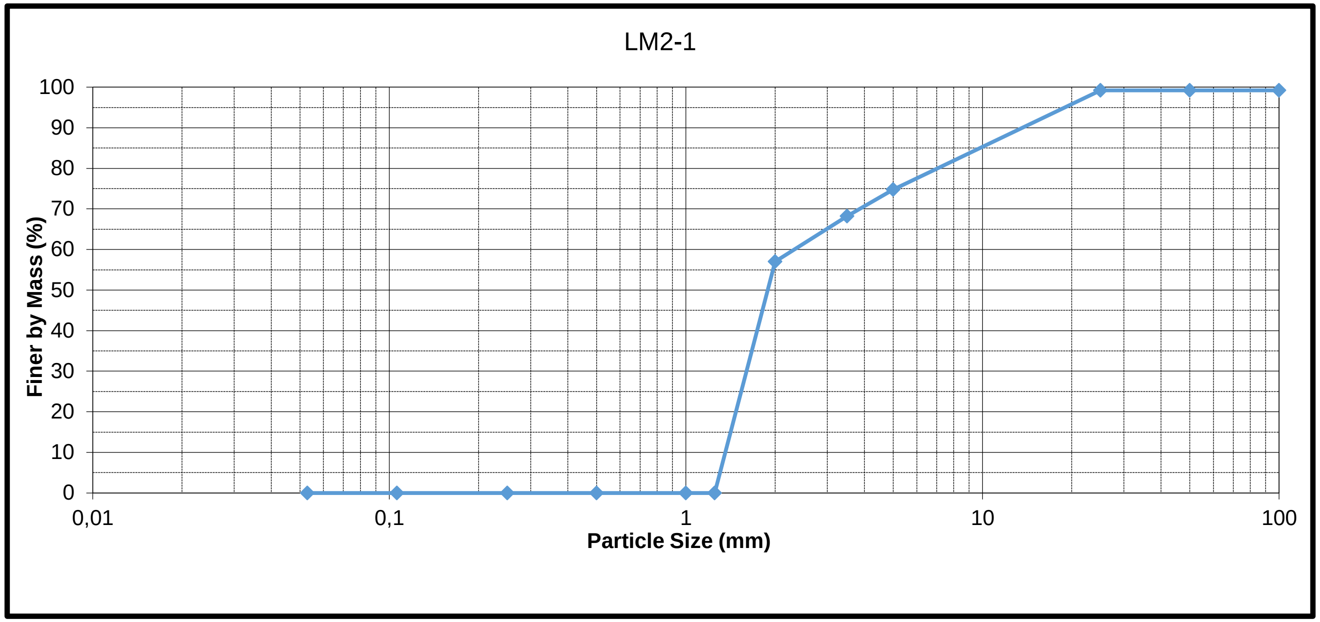


Figure F1-58. Semi-log PSD of Profile M2, layer 1.

LM2-2

Sieve Size/mm	% Passing
100	98,8
50	98,8
25	98,8
5	61,9
3,5	54,2
2	37,2
1,25	31,3
1	28,9
0,5	20,9
0,25	12,4
0,106	4,8
0,053	1,2
0	0

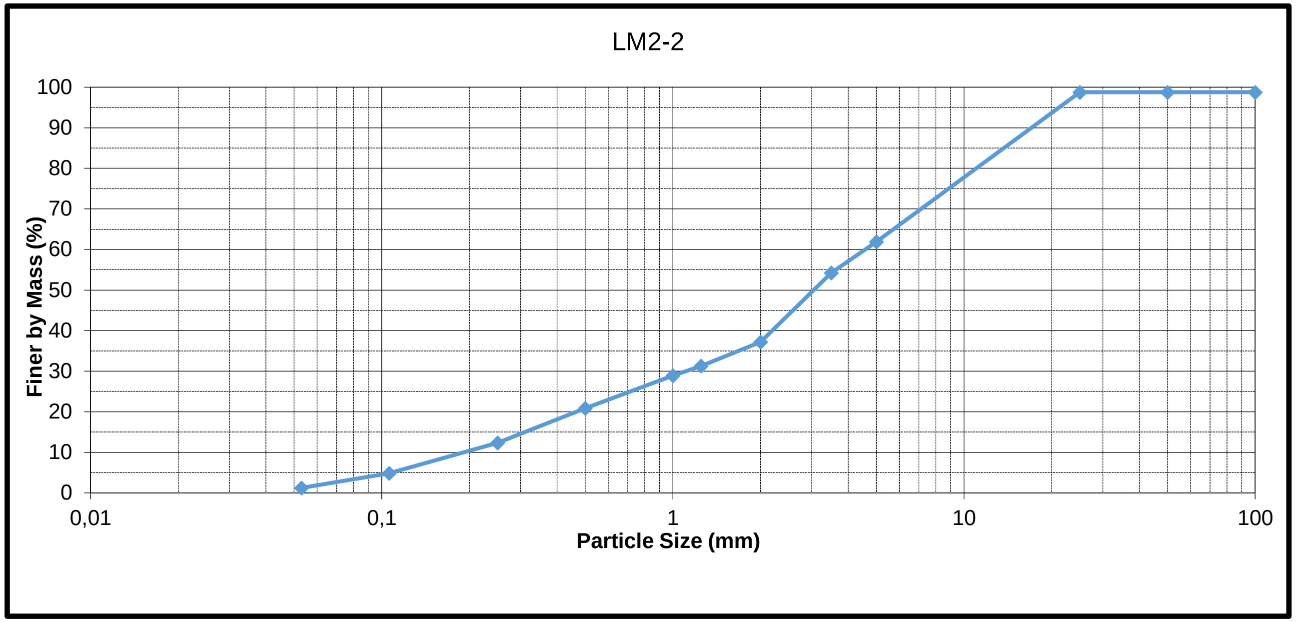


Figure F1-59. Semi-log PSD of Profile M2, layer 2.

LM2-3

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	68,9
5	31,6
3,5	26,9
2	20,5
1,25	18,0
1	17,0
0,5	13,1
0,25	7,9
0,106	3,0
0,053	1,1
0	0,0

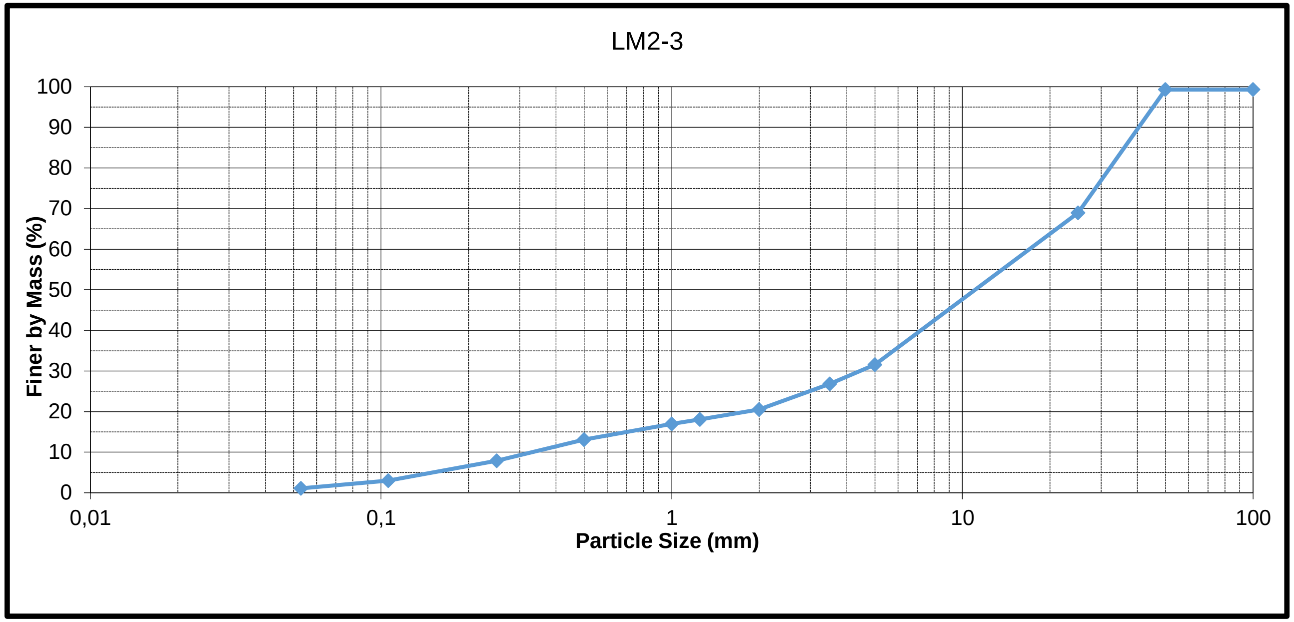


Figure F1-60. Semi-log PSD of Profile M2, layer 3.

LM3-1

Sieve Size/mm	% Passing
100	99,7
50	61,6
25	46,9
5	19,8
3,5	18,7
2	17,0
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

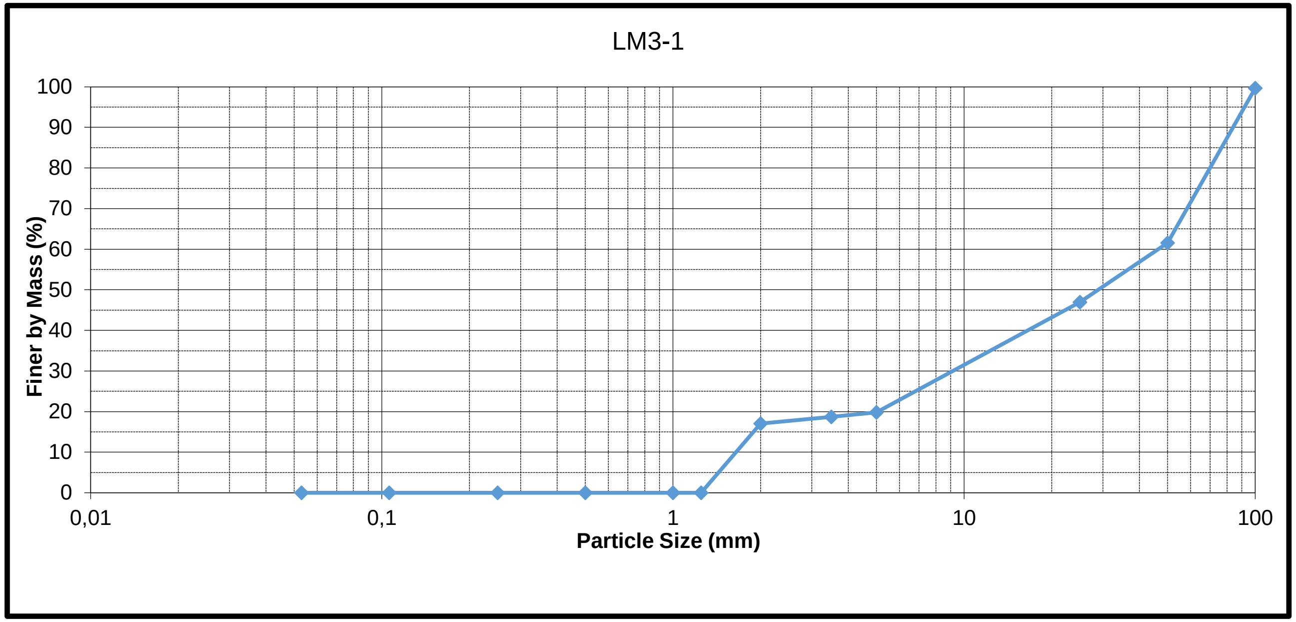


Figure F1-61. Semi-log PSD of Profile M3, layer 1.

LM3-2

Sieve Size/mm	% Passing
100	99,6
50	60,6
25	47,2
5	24,5
3,5	22,5
2	18,6
1,25	16,9
1	16,2
0,5	13,7
0,25	9,2
0,106	3,5
0,053	1,0
0	0,0

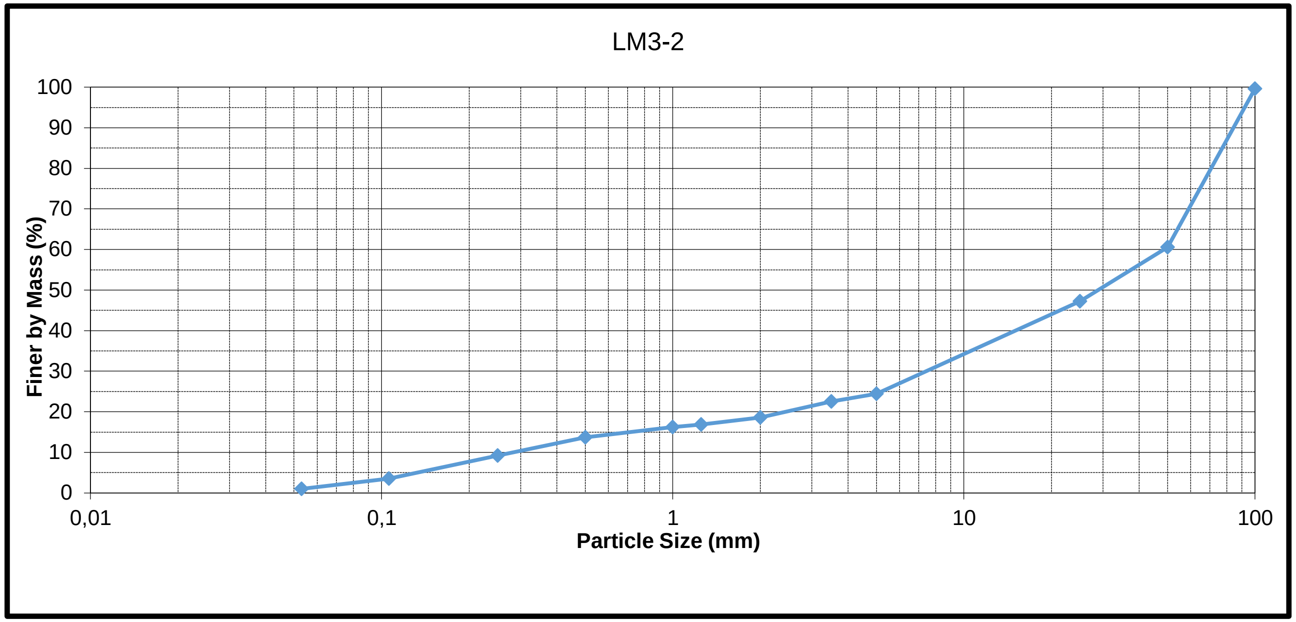


Figure F1-62. Semi-log PSD of Profile M3, layer 2.

LM3-3

Sieve Size/mm	% Passing
100	99,0
50	99,0
25	87,4
5	58,3
3,5	54,6
2	44,9
1,25	40,4
1	38,0
0,5	29,5
0,25	19,5
0,106	8,8
0,053	3,4
0	0

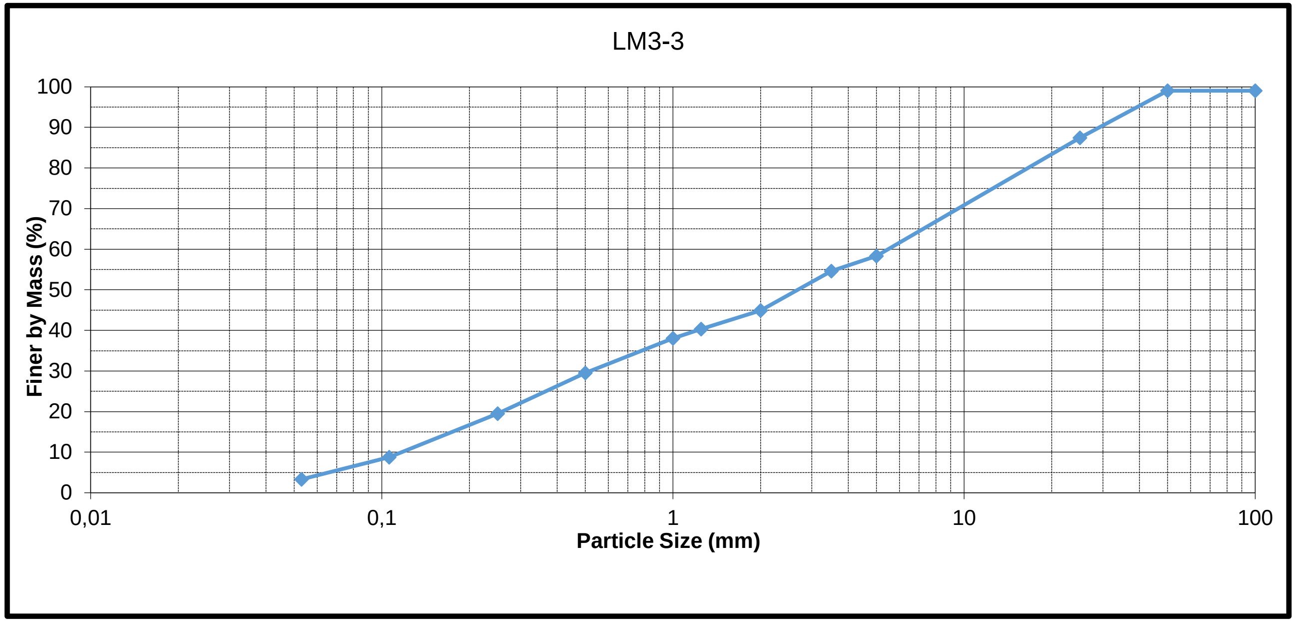


Figure F1-63. Semi-log PSD of Profile M3, layer 3.

LM4-1

Sieve Size/mm	% Passing
100	99,5
50	99,5
25	88,9
5	57,3
3,5	55,2
2	50,5
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

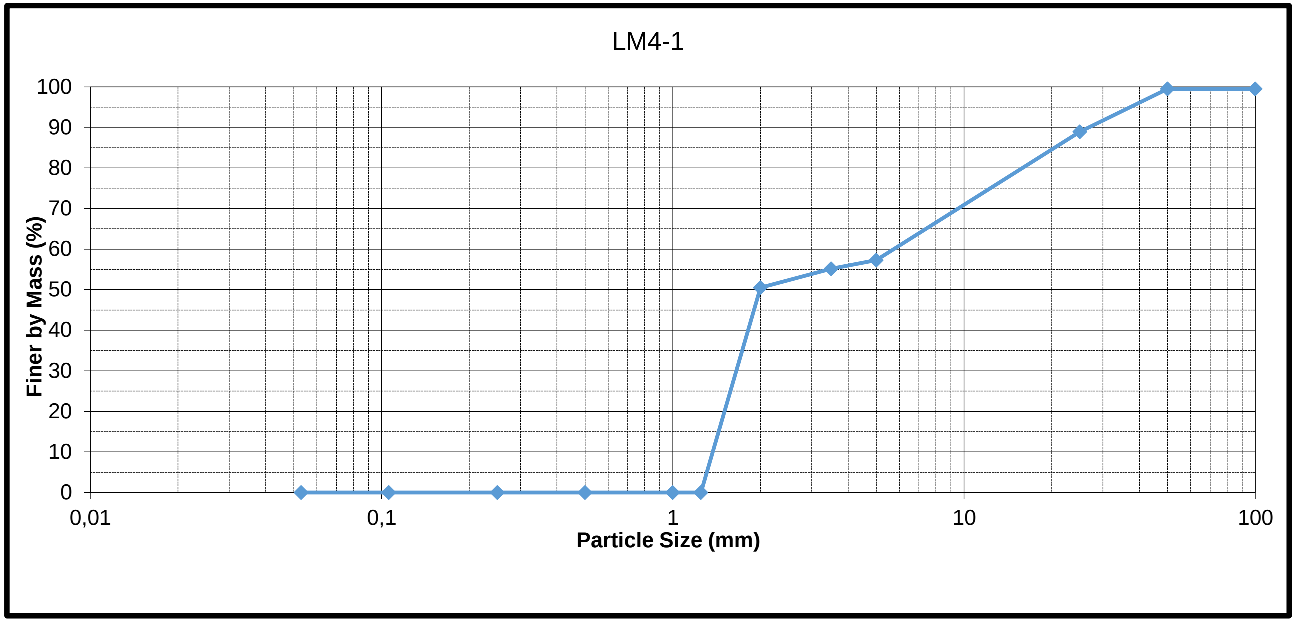


Figure F1-64. Semi-log PSD of Profile M4, layer 1.

LM4-2

Sieve Size/mm	% Passing
100	101,9
50	92,4
25	75,7
5	36,7
3,5	32,4
2	22,5
1,25	18,3
1	16,7
0,5	12,0
0,25	7,5
0,106	2,9
0,053	1,0
0	0,0

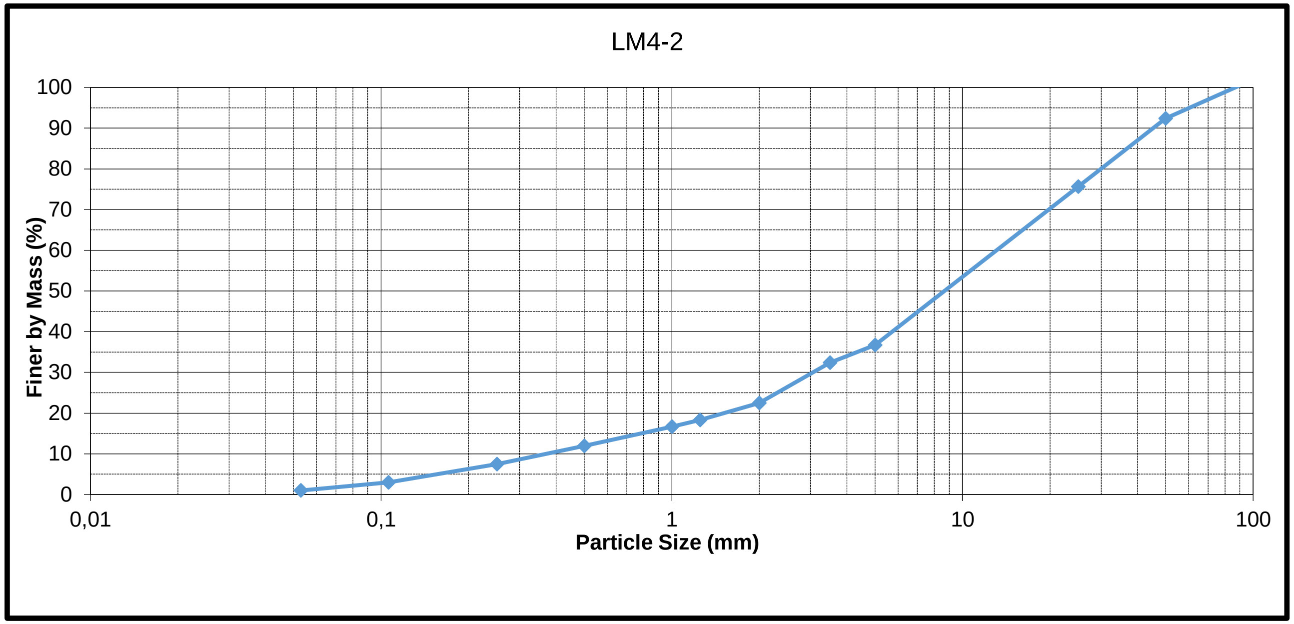


Figure F1-65. Semi-log PSD of Profile M4, layer 2.

LM5-1

Sieve Size/mm	% Passing
100	99,2
50	99,2
25	84,2
5	66,5
3,5	63,9
2	56,1
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

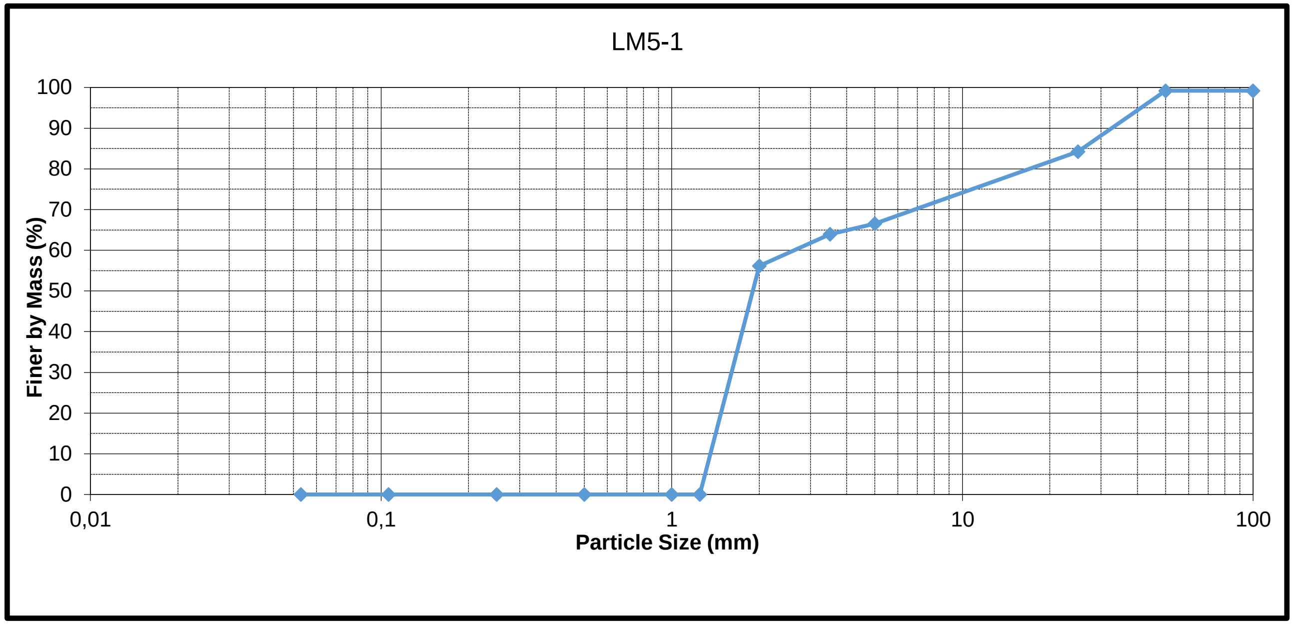


Figure F1-66. Semi-log PSD of Profile M5, layer 1.

LM5-2

Sieve Size/mm	% Passing
100	99,1
50	99,1
25	76,6
5	39,4
3,5	34,8
2	25,5
1,25	21,1
1	19,4
0,5	14,1
0,25	12,2
0,106	6,9
0,053	4,8
0	3,5

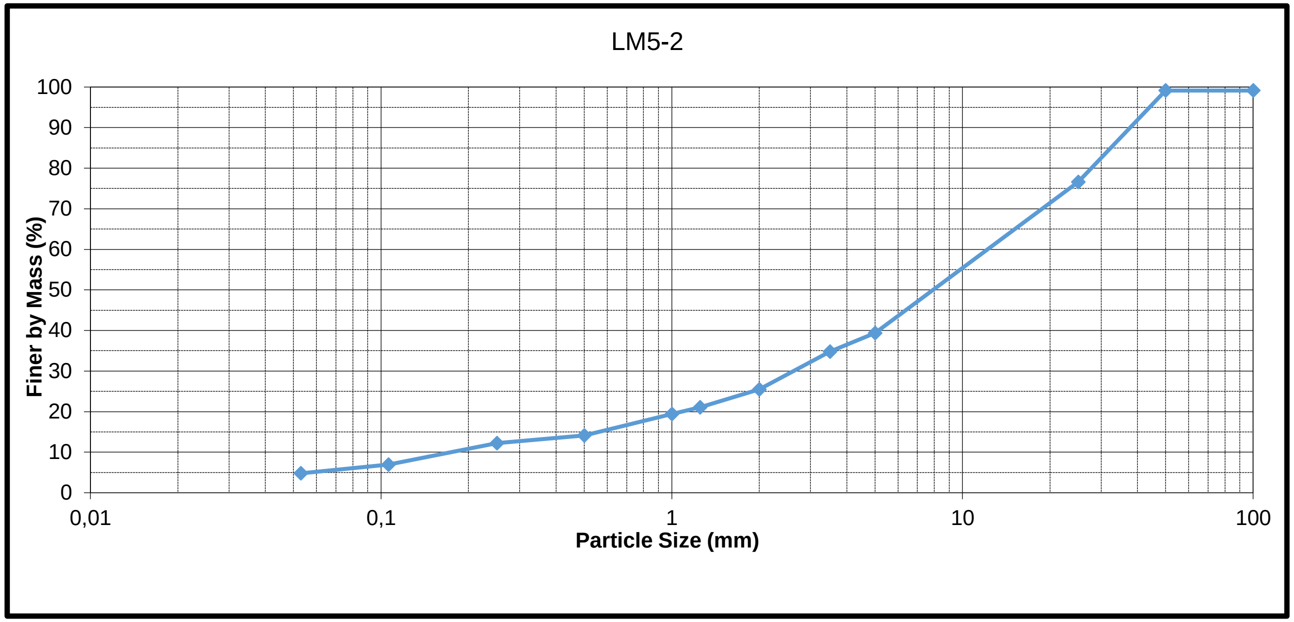


Figure F1-67. Semi-log PSD of Profile M5, layer 2.

LM6-1

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	99,4
5	95,3
3,5	94,1
2	85,4
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

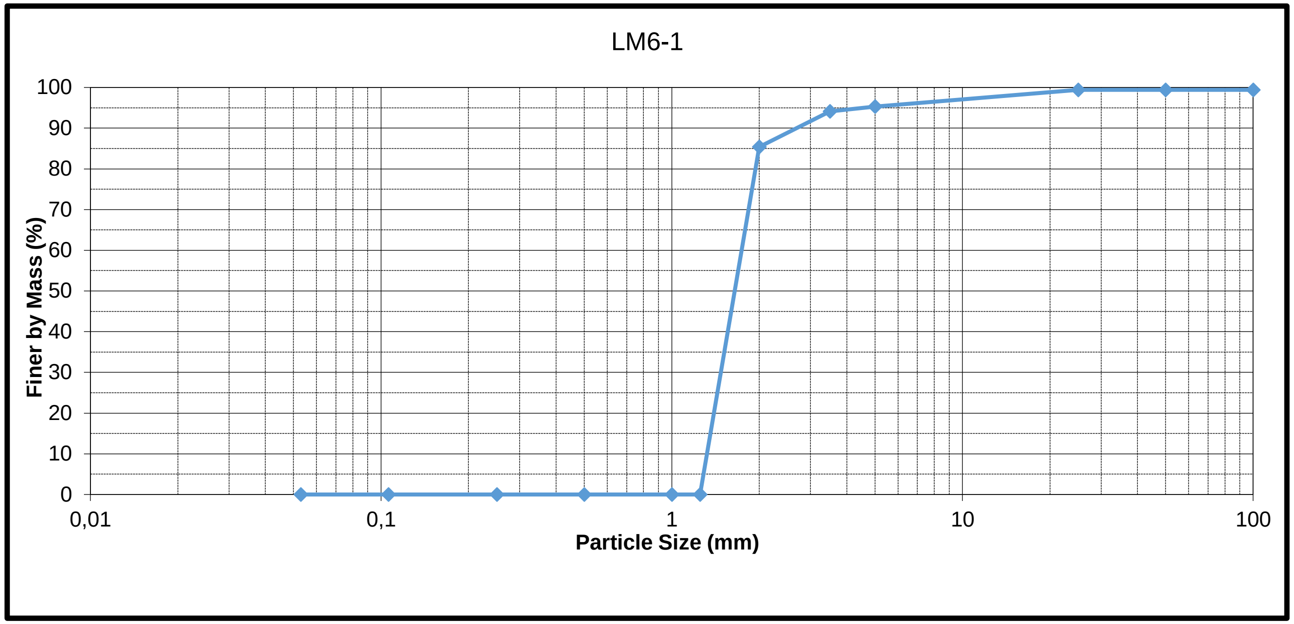


Figure F1-68. Semi-log PSD of Profile M6, layer 1.

LM6-2

Sieve Size/mm	% Passing
100	98,7
50	98,7
25	79,7
5	41,0
3,5	35,9
2	26,7
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

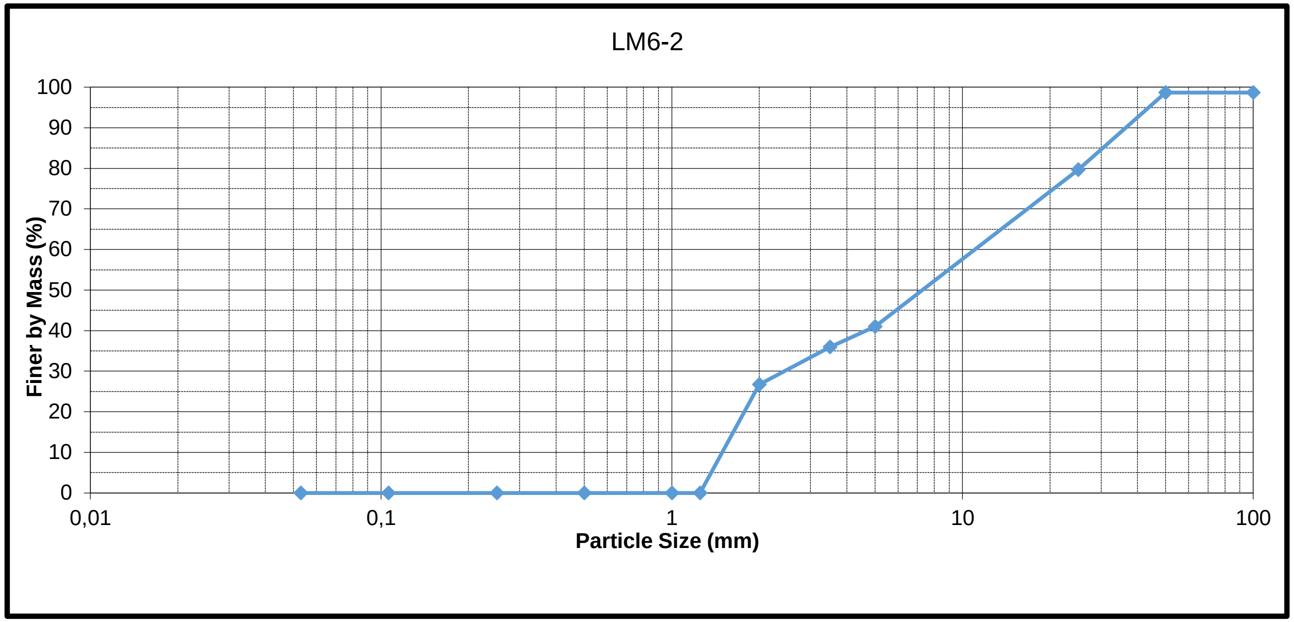


Figure F1-69. Semi-log PSD of Profile M6, layer 2.

LM7-1

Sieve Size/mm	% Passing
100	99,5
50	99,5
25	99,5
5	79,3
3,5	75,8
2	69,4
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

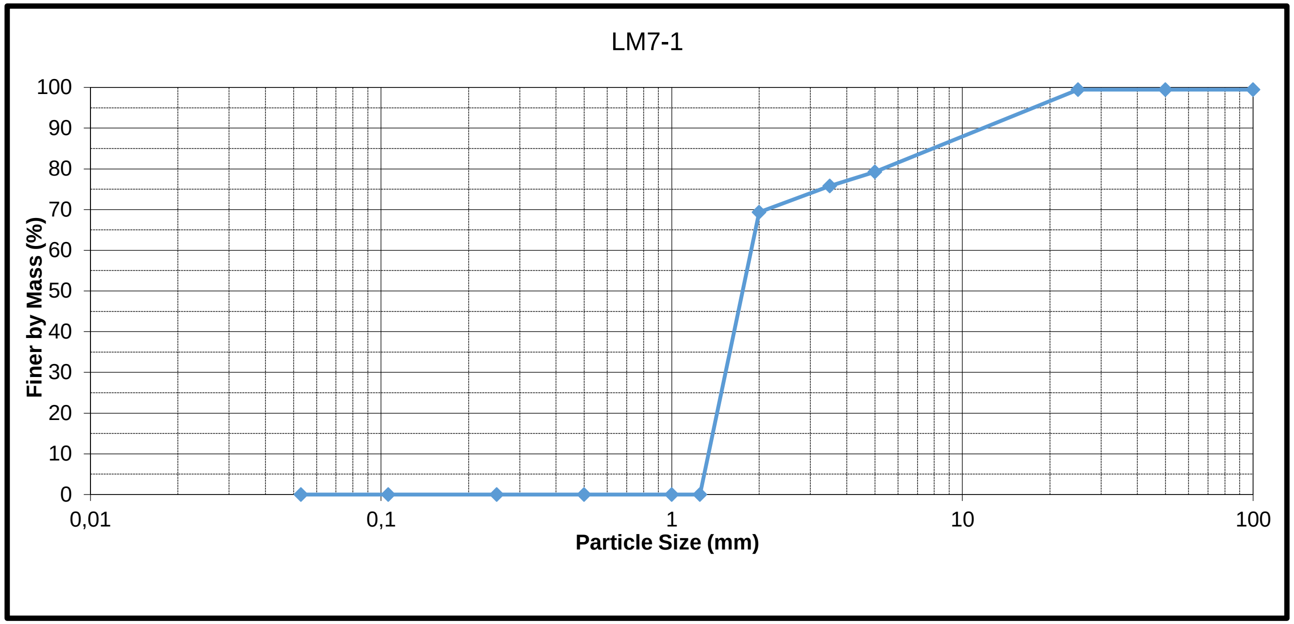


Figure F1-70. Semi-log PSD of Profile M7, layer 1.

LM7-2

Sieve Size/mm	% Passing
100	98,1
50	98,1
25	96,8
5	67,8
3,5	59,0
2	39,6
1,25	28,9
1	24,9
0,5	14,8
0,25	7,5
0,106	2,6
0,053	0,8
0	0

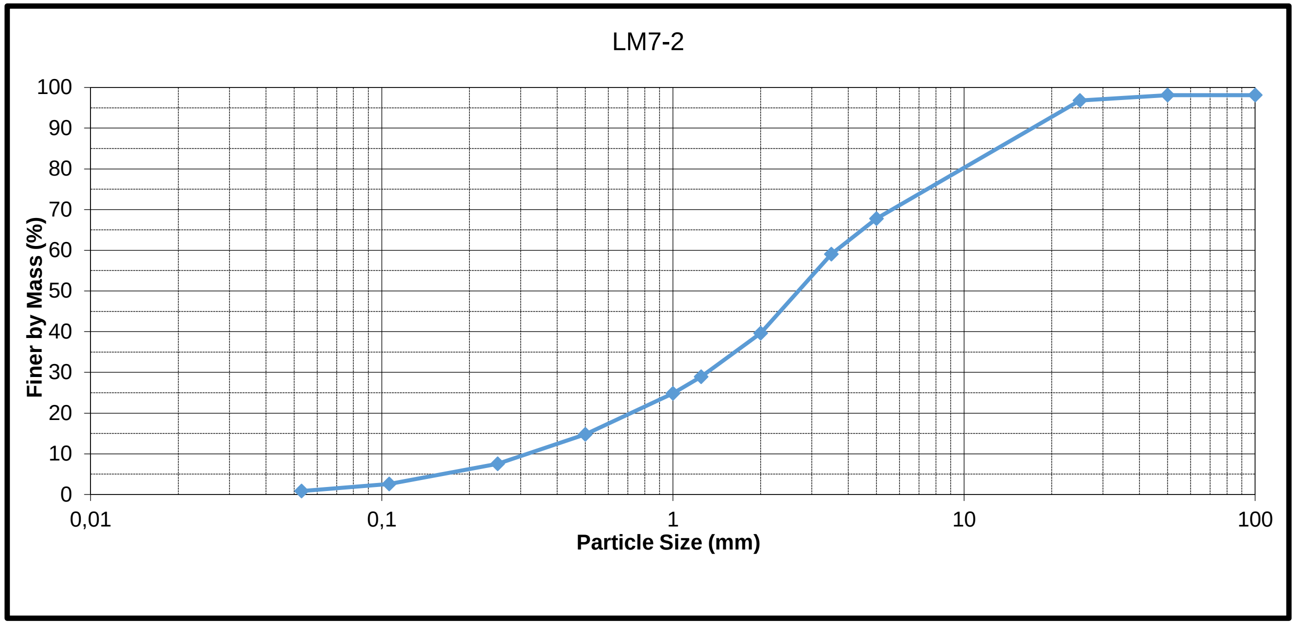


Figure F1-71. Semi-log PSD of Profile M7, layer 2.

LM9-1

Sieve Size/mm	% Passing
100	99,5
50	99,5
25	98,4
5	92,7
3,5	90,7
2	83,1
1,25	0,0
1	0,0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

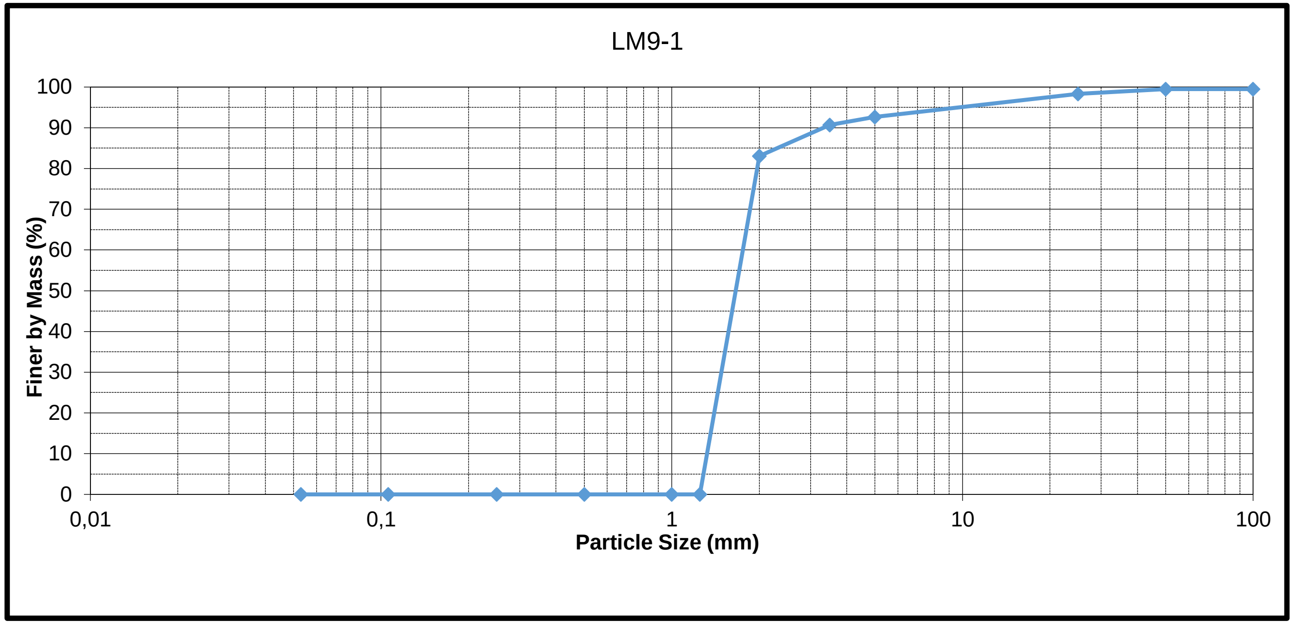


Figure F1-72. Semi-log PSD of Profile M9, layer 1.

LM9-3

Sieve Size/mm	% Passing
100	99,0
50	99,0
25	97,7
5	63,2
3,5	56,4
2	45,3
1,25	0,0
1	0,0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

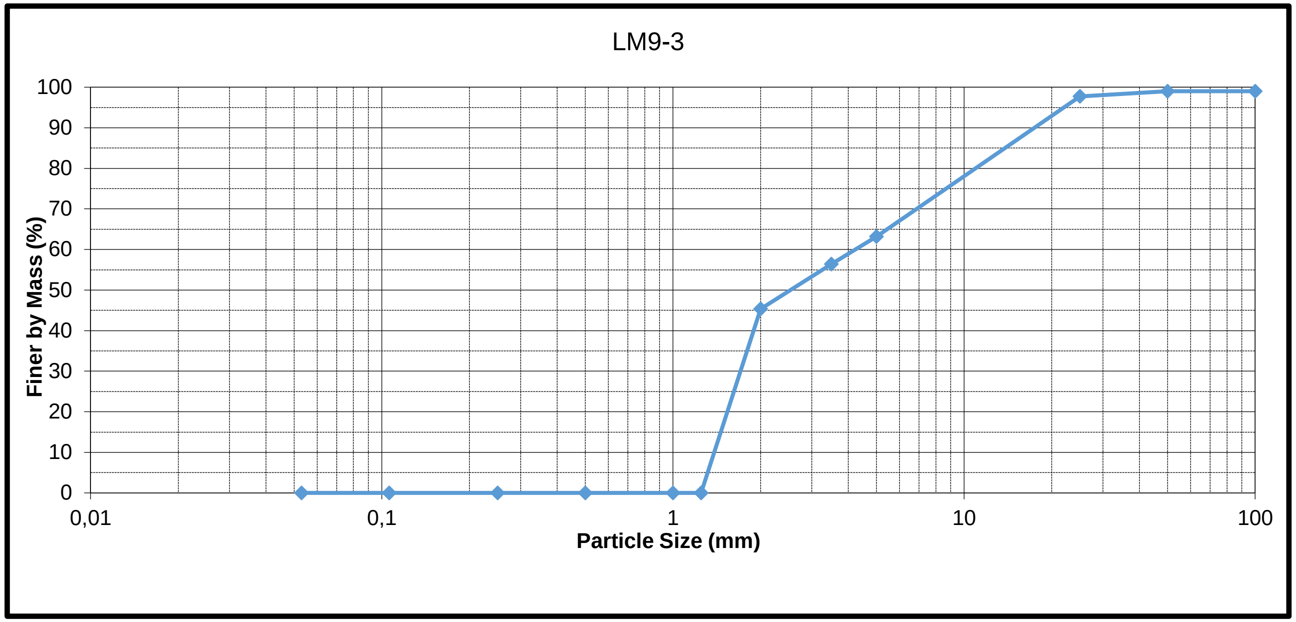


Figure F1-73. Semi-log PSD of Profile M9, layer 3.

LM10-1

Sieve Size/mm	% Passing
100	95,9
50	95,9
25	90,0
5	62,9
3,5	60,3
2	50,8
1,25	0,0
1	0,0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

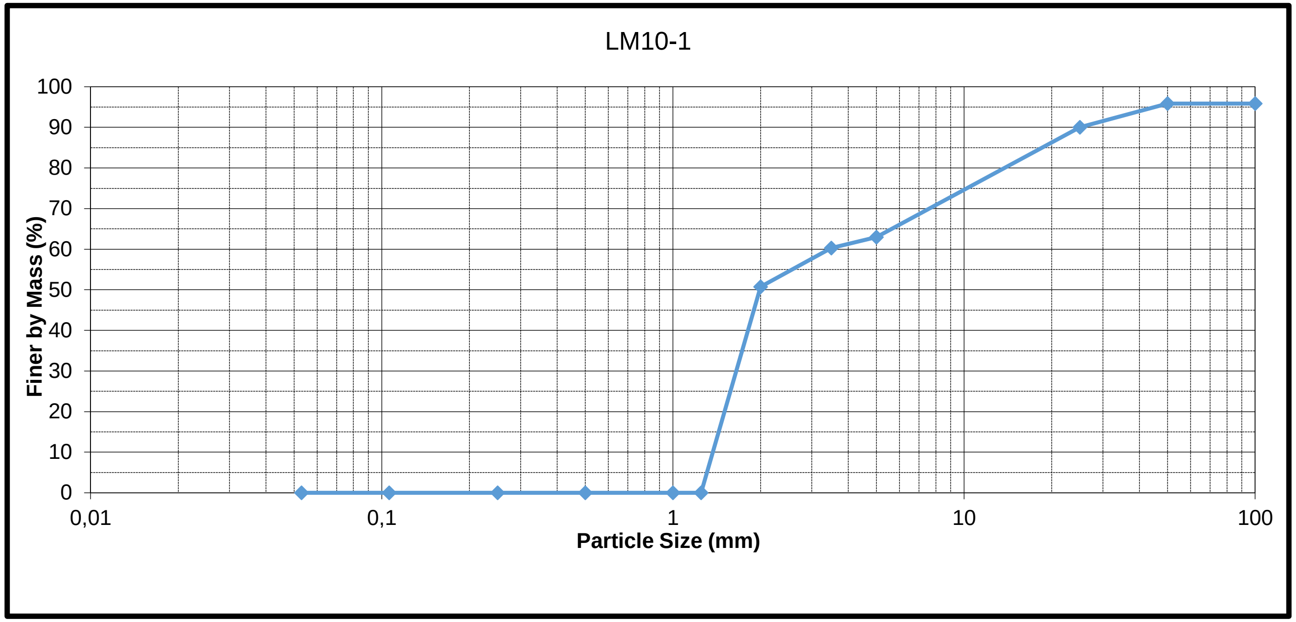


Figure F1-74. Semi-log PSD of Profile M10, layer 1.

LM10-2

Sieve Size/mm	% Passing
100	99,2
50	99,2
25	81,4
5	30,5
3,5	26,9
2	19,0
1,25	14,4
1	12,6
0,5	7,8
0,25	5,3
0,106	2,1
0,053	0,8
0	0

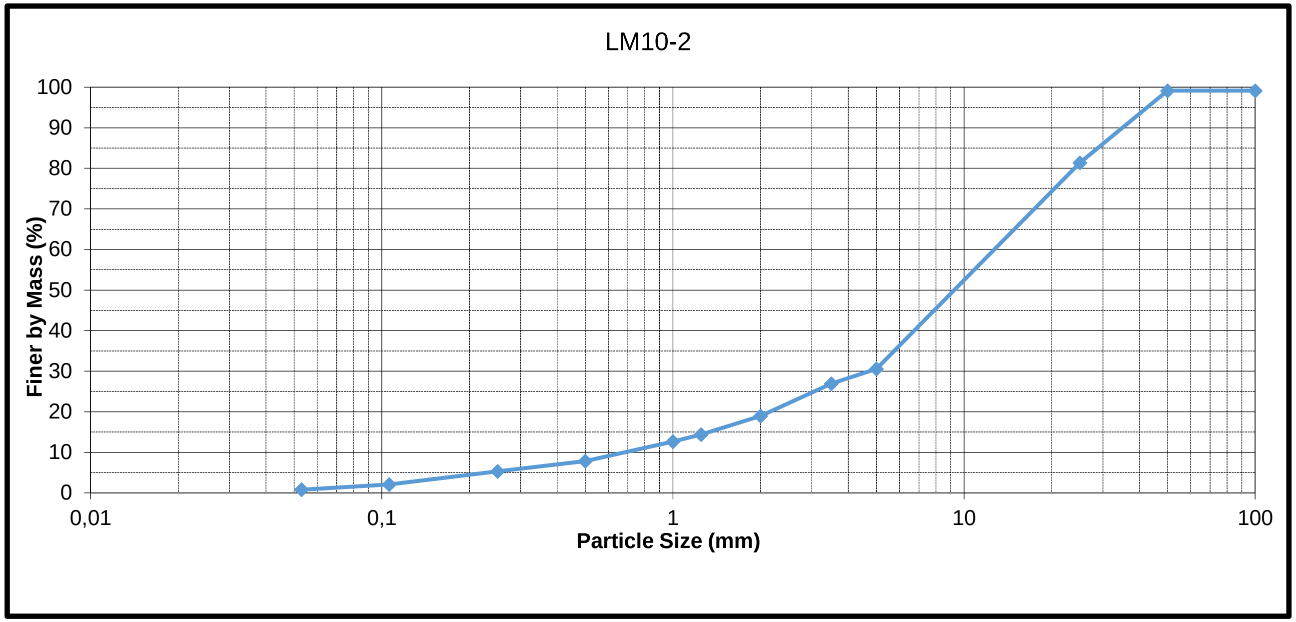


Figure F1-75. Semi-log PSD of Profile M10, layer 2.

LM11-1

Sieve Size/mm	% Passing
100	102,8
50	73,0
25	32,7
5	31,5
3,5	28,5
2	25,9
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

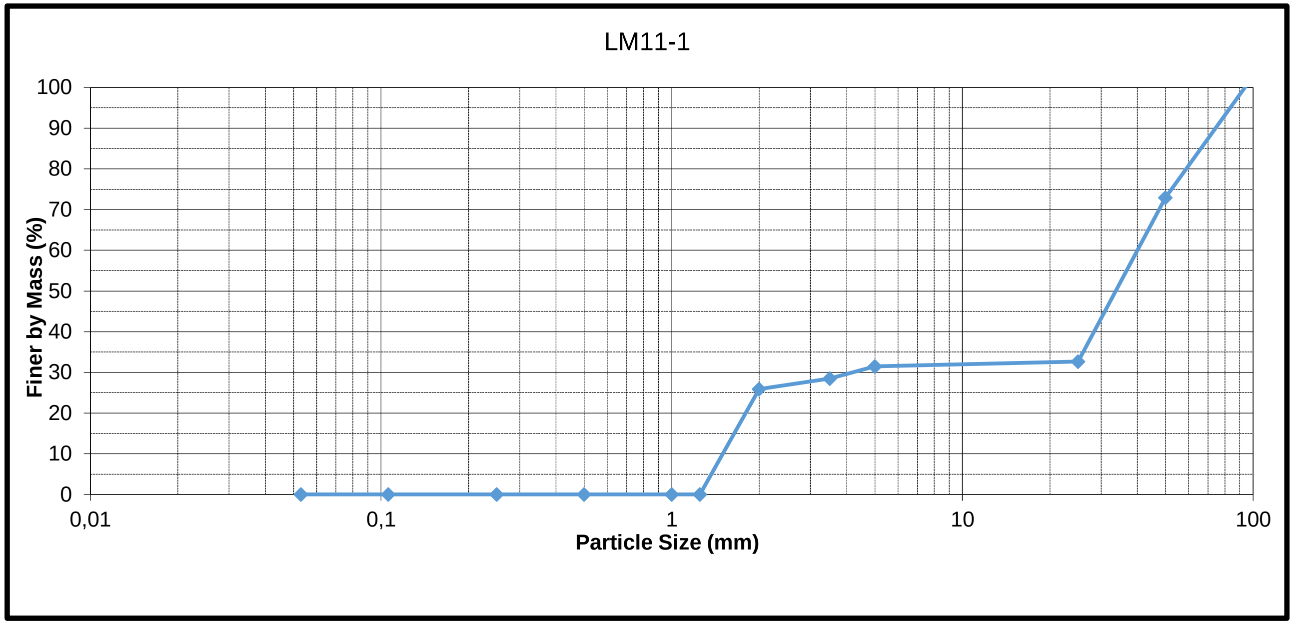


Figure F1-76. Semi-log PSD of Profile M11, layer 1.

LM11-3

Sieve Size/mm	% Passing
100	99,2
50	99,2
25	99,2
5	74,6
3,5	67,2
2	45,2
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

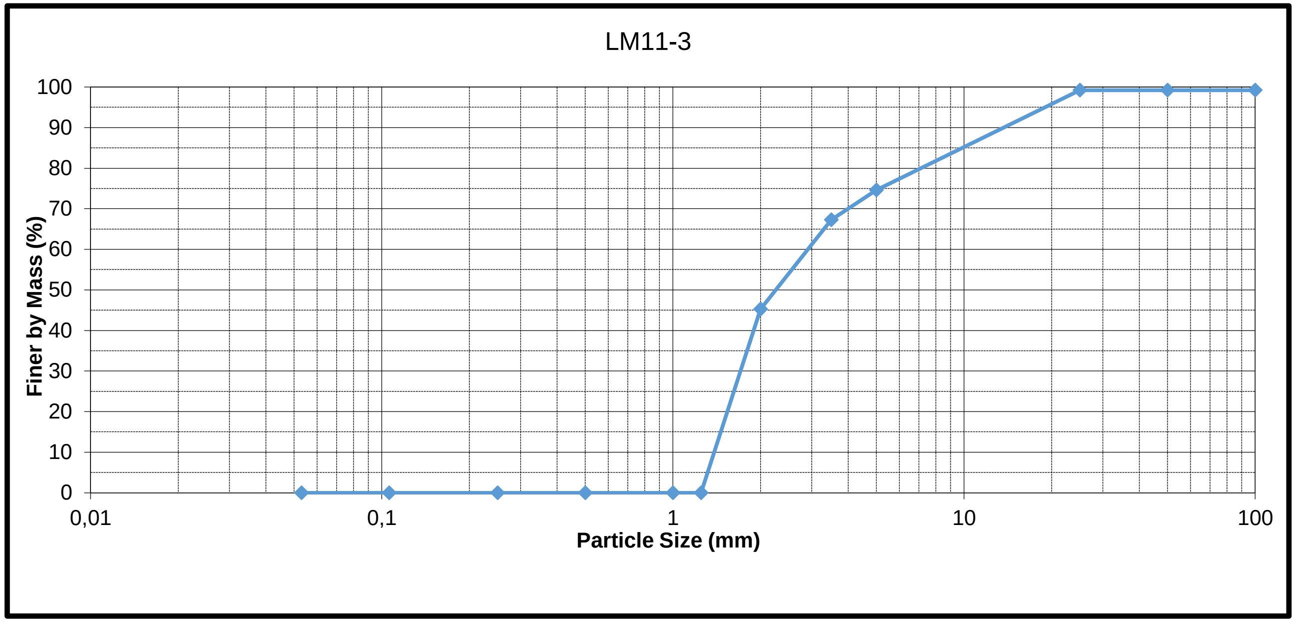


Figure F1-77. Semi-log PSD of Profile M11, layer 3.

LM12-1

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	94,3
5	78,4
3,5	75,4
2	65,4
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

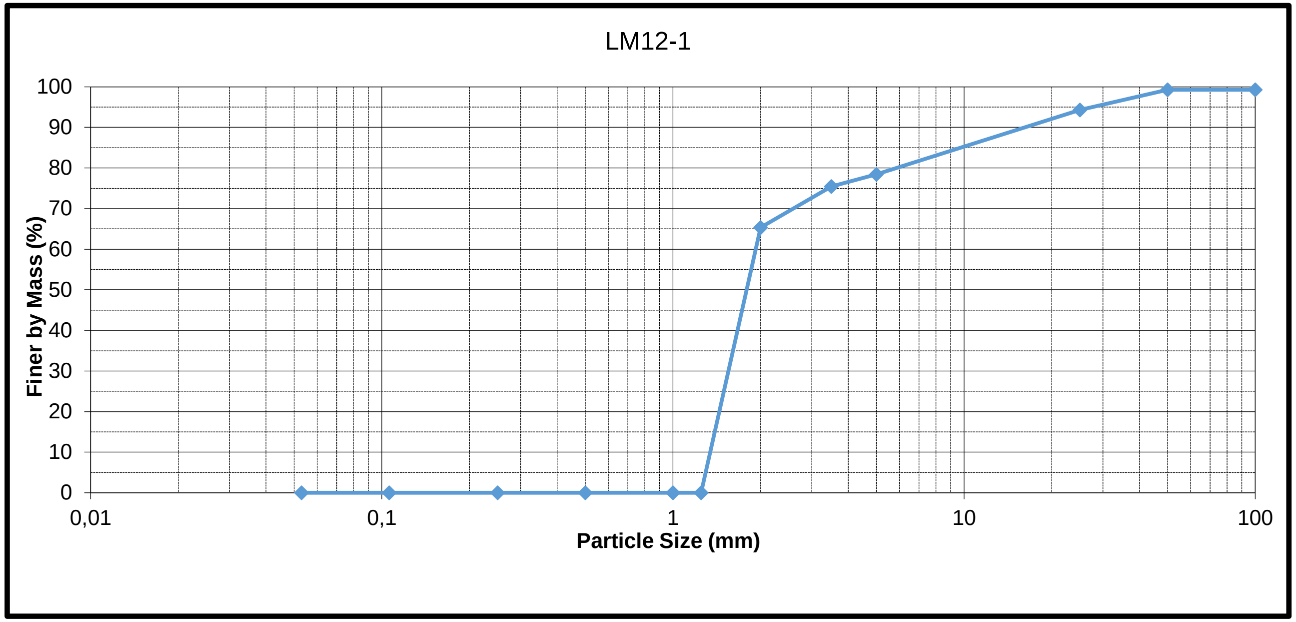


Figure F1-78. Semi-log PSD of Profile M12, layer 1.

LM12-2

Sieve Size/mm	% Passing
100	99,2
50	93,3
25	77,5
5	33,6
3,5	29,2
2	20,6
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

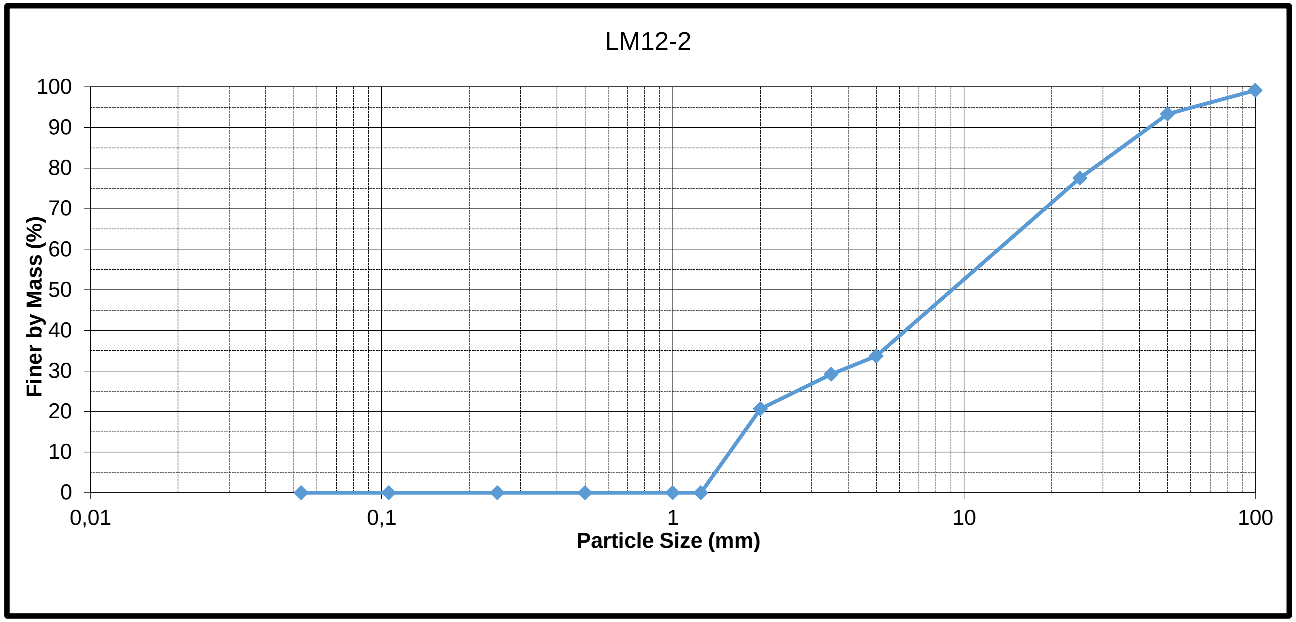


Figure F1-79. Semi-log PSD of Profile M12, layer 2.

LM13-1

Sieve Size/mm	% Passing
100	99,4
50	99,4
25	99,4
5	85,6
3,5	81,6
2	70,7
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

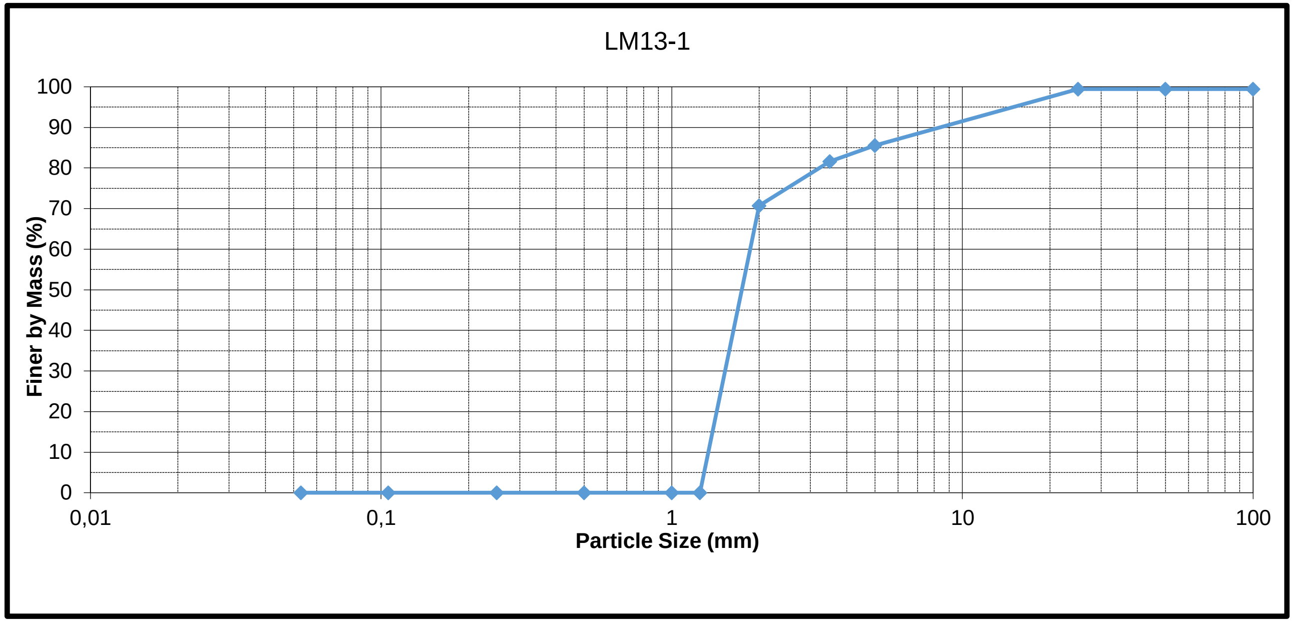


Figure F1-80. Semi-log PSD of Profile M13, layer 1.

LM13-2

Sieve Size/mm	% Passing
100	98,0
50	98,0
25	78,4
5	45,2
3,5	40,5
2	23,4
1,25	14,0
1	11,2
0,5	5,0
0,25	2,1
0,106	0,7
0,053	0,3
0	0,0

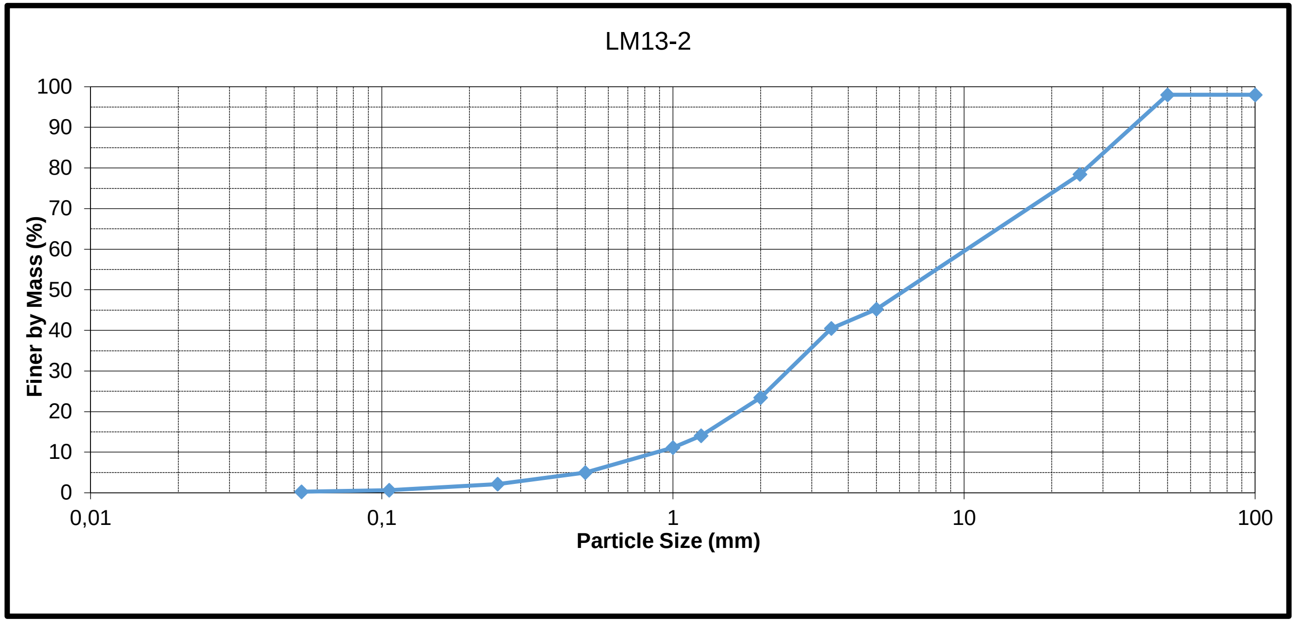


Figure F1-81. Semi-log PSD of Profile M13, layer 2.

LM14-1

Sieve Size/mm	% Passing
100	99,6
50	99,6
25	95,8
5	74,5
3,5	71,9
2	67,9
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

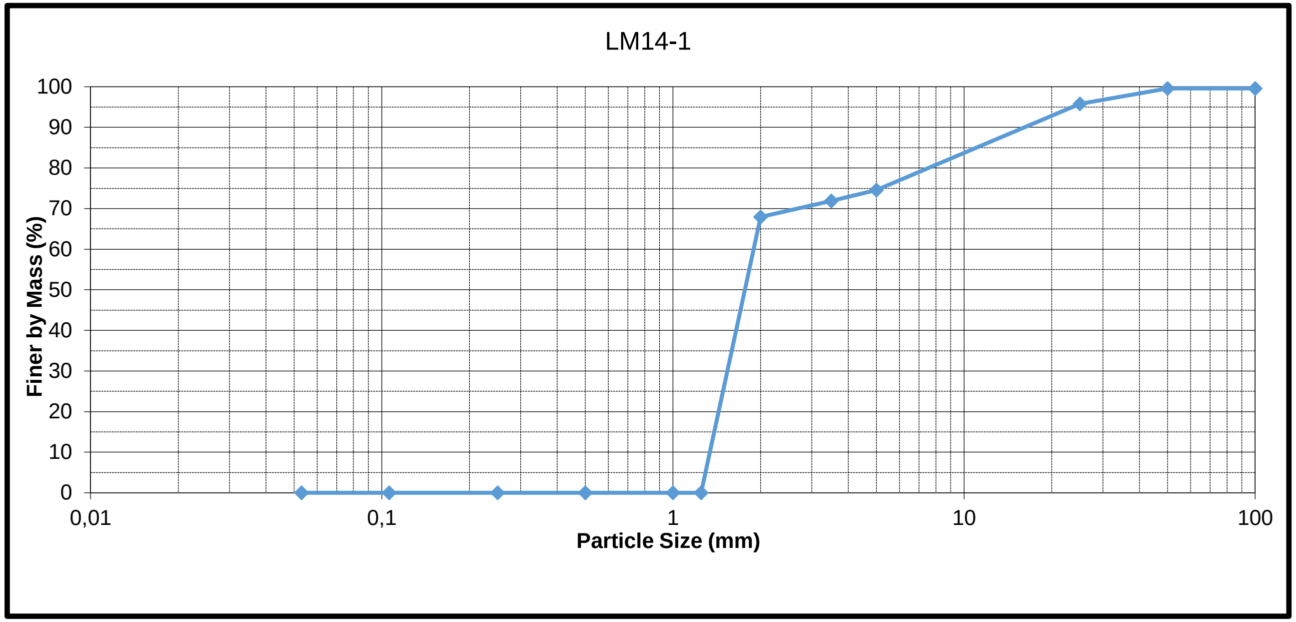


Figure F1-82. Semi-log PSD of Profile M14, layer 1.

LM14-2

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	95,2
5	38,3
3,5	34,8
2	27,0
1,25	23,5
1	22,3
0,5	17,8
0,25	11,6
0,106	4,7
0,053	1,6
0	0,0

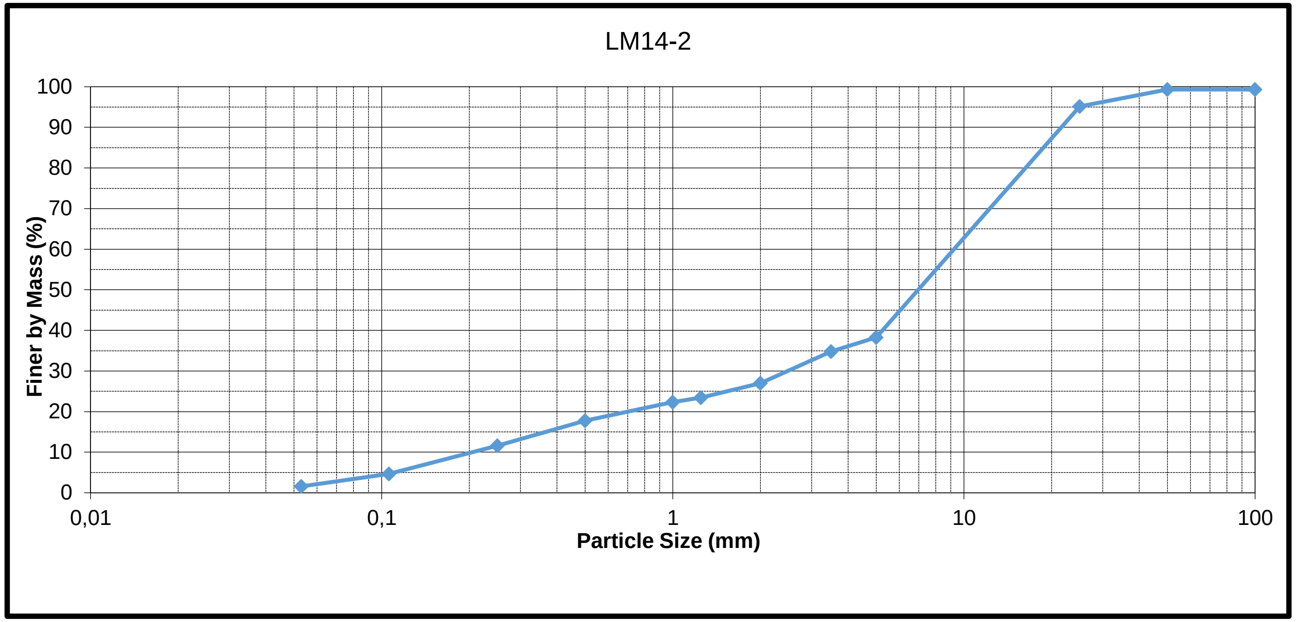


Figure F1-83. Semi-log PSD of Profile M14, layer 2.

LM16-1

Sieve Size/mm	% Passing
100	99,7
50	99,7
25	99,7
5	96,5
3,5	96,0
2	94,5
1,25	0,0
1	0,0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

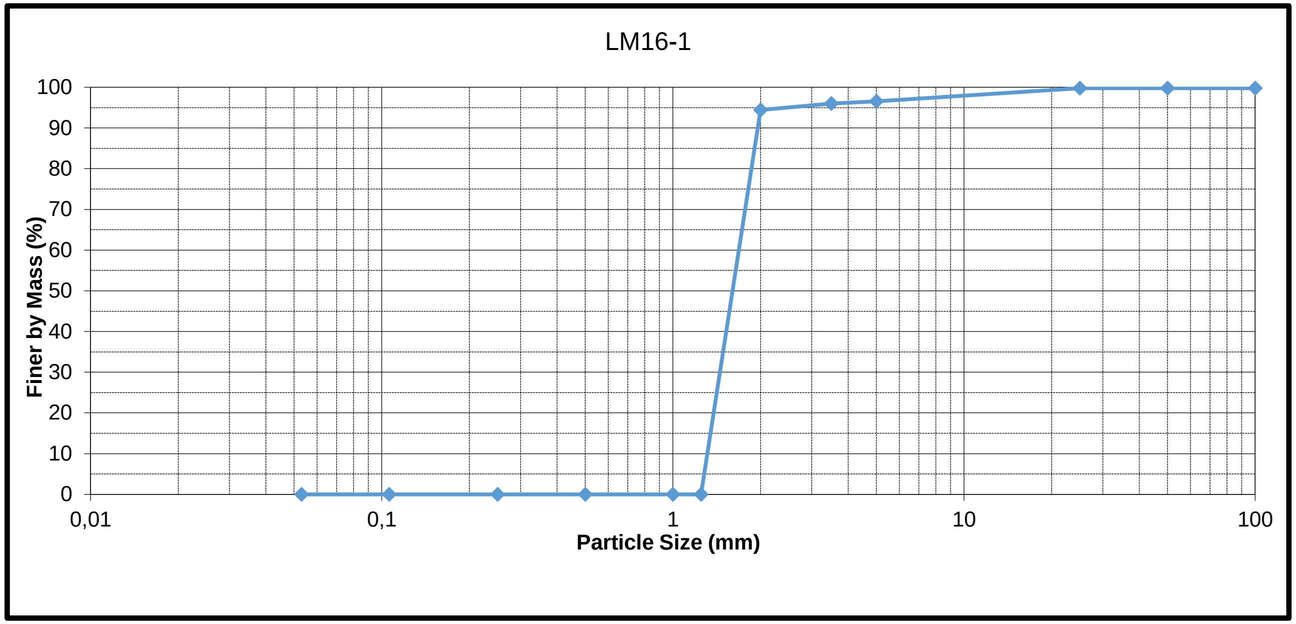


Figure F1-84. Semi-log PSD of Profile M16, layer 1.

LM16-2

Sieve Size/mm	% Passing
100	99,2
50	99,2
25	99,2
5	71,6
3,5	67,6
2	57,4
1,25	50,4
1	46,1
0,5	31,0
0,25	17,6
0,106	6,7
0,053	2,2
0	0

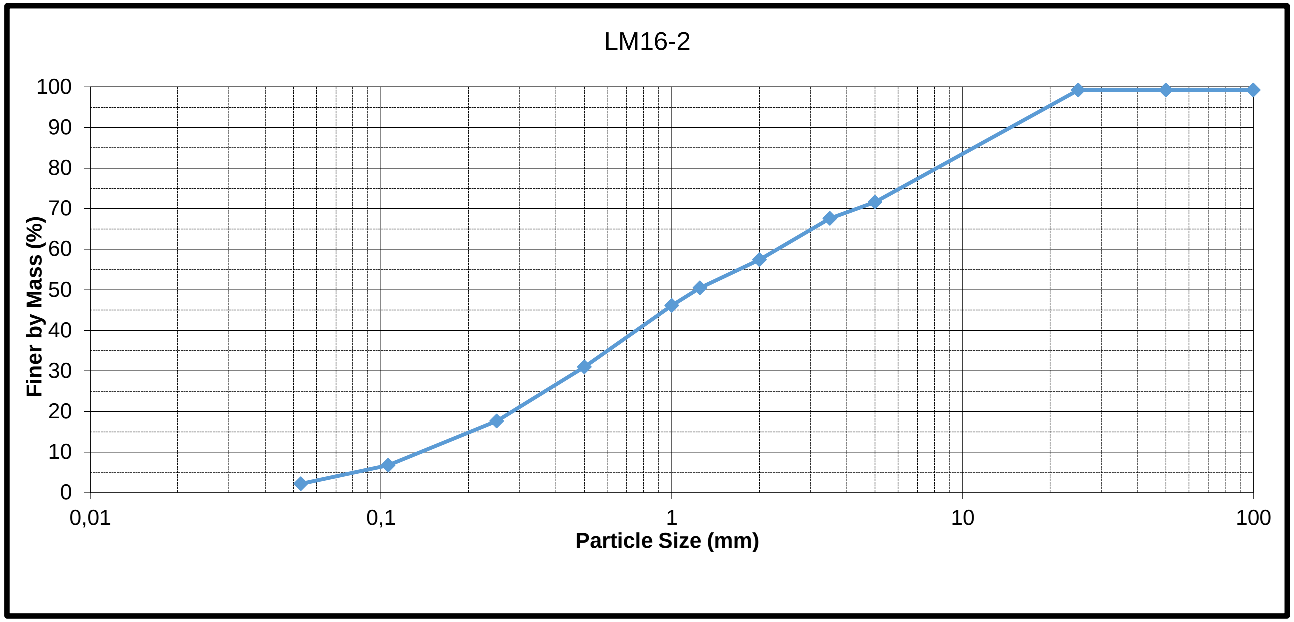


Figure F1-85. Semi-log PSD of Profile M16, layer 2.

LM18-1

Sieve Size/mm	% Passing
100	99,5
50	85,7
25	63,5
5	22,9
3,5	21,6
2	18,7
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

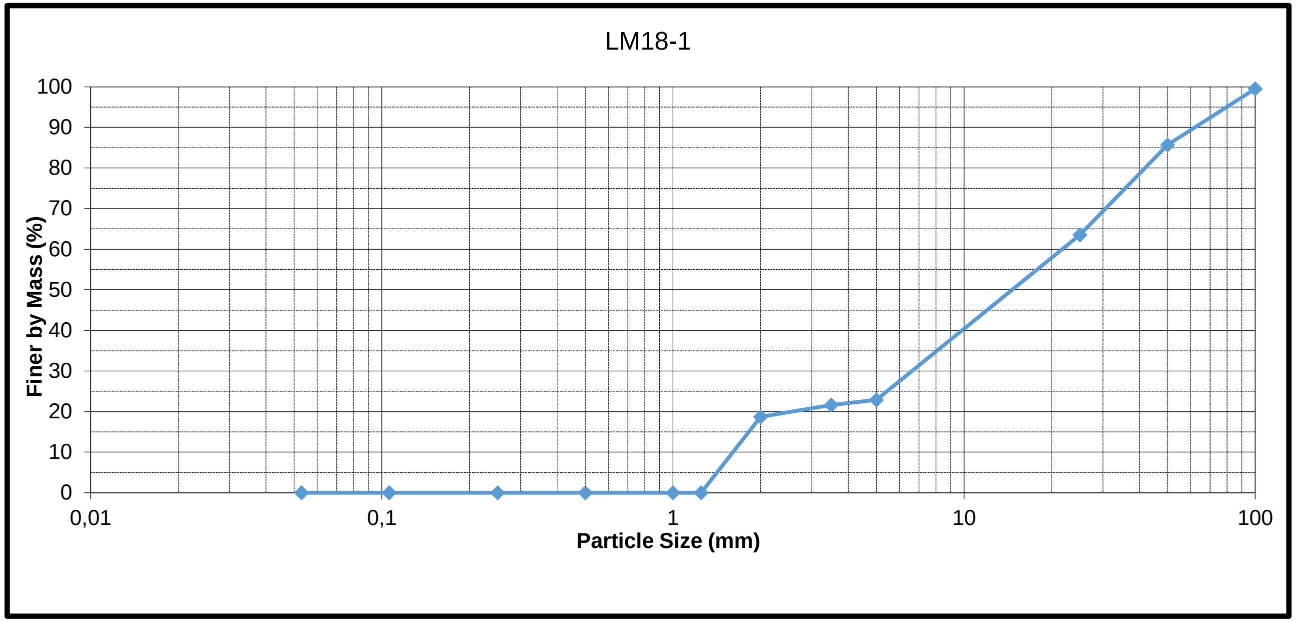


Figure F1-86. Semi-log PSD of Profile M18, layer 1.

LM18-2

Sieve Size/mm	% Passing
100	99,7
50	71,5
25	49,8
5	21,0
3,5	17,3
2	11,7
1,25	10,4
1	9,8
0,5	7,8
0,25	4,8
0,106	1,6
0,053	0,5
0	0,0

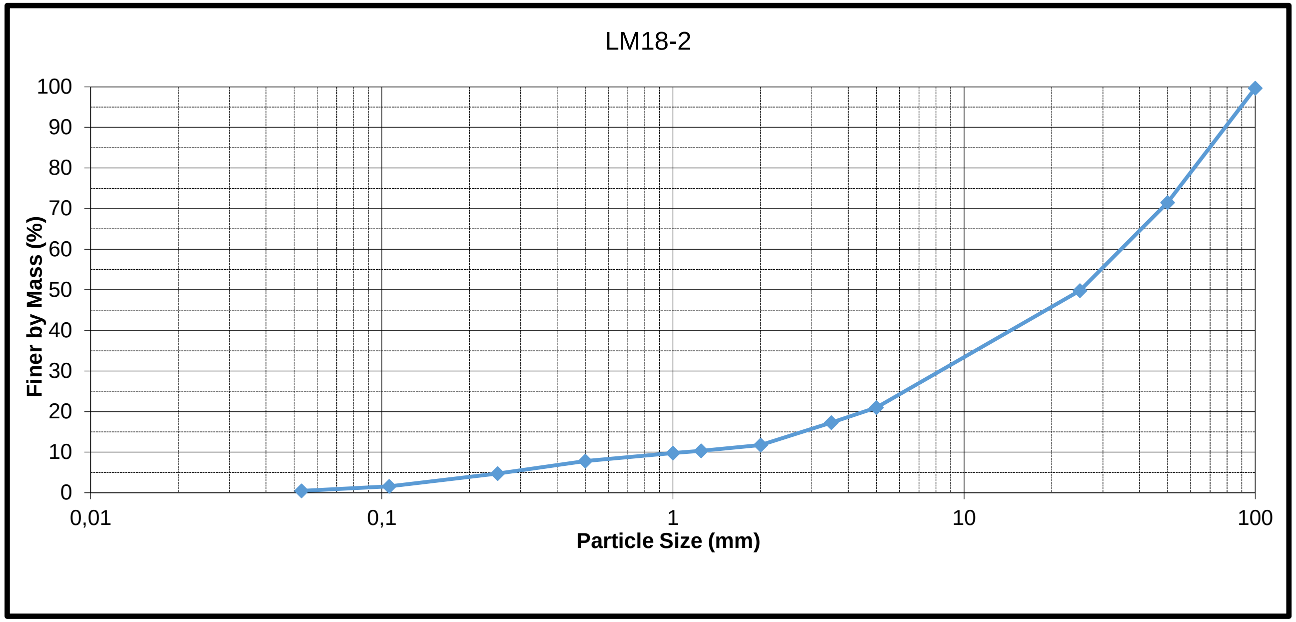


Figure F1-87. Semi-log PSD of Profile M18, layer 2.

LM18-3

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	88,3
5	63,9
3,5	59,3
2	50,7
1,25	0,0
1	0,0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

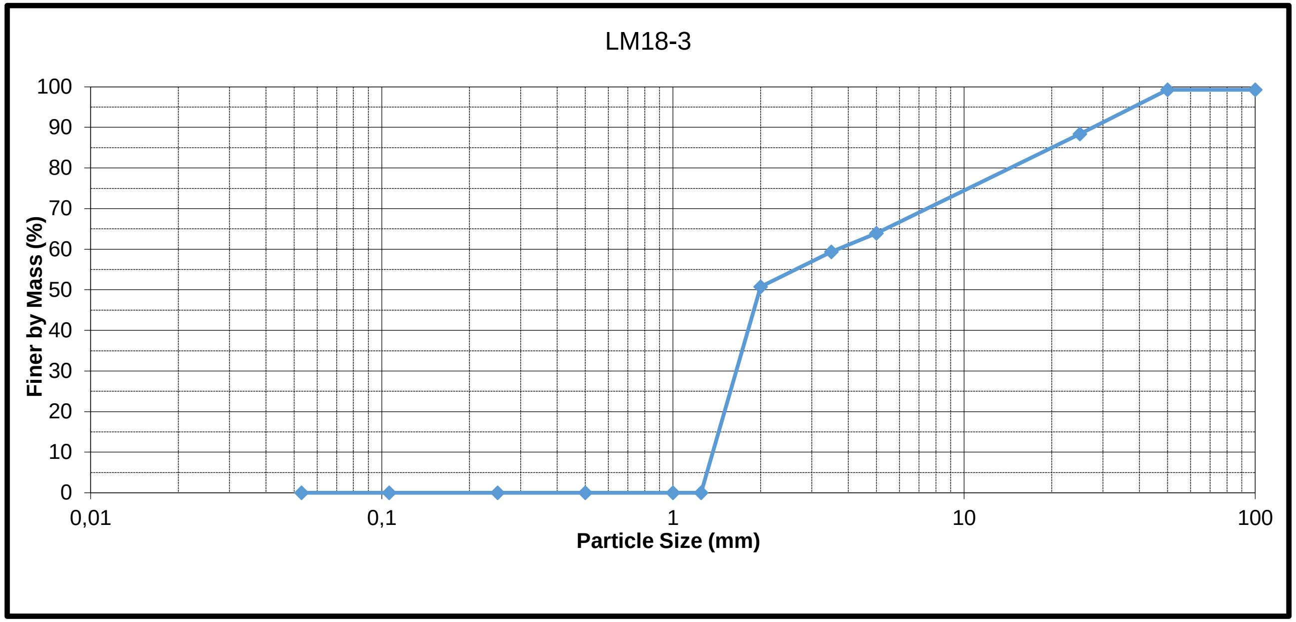


Figure F1-88. Semi-log PSD of Profile M18, layer 3.

LM21-1

Sieve Size/mm	% Passing
100	99,6
50	99,6
25	91,7
5	66,0
3,5	63,8
2	59,0
1,25	0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

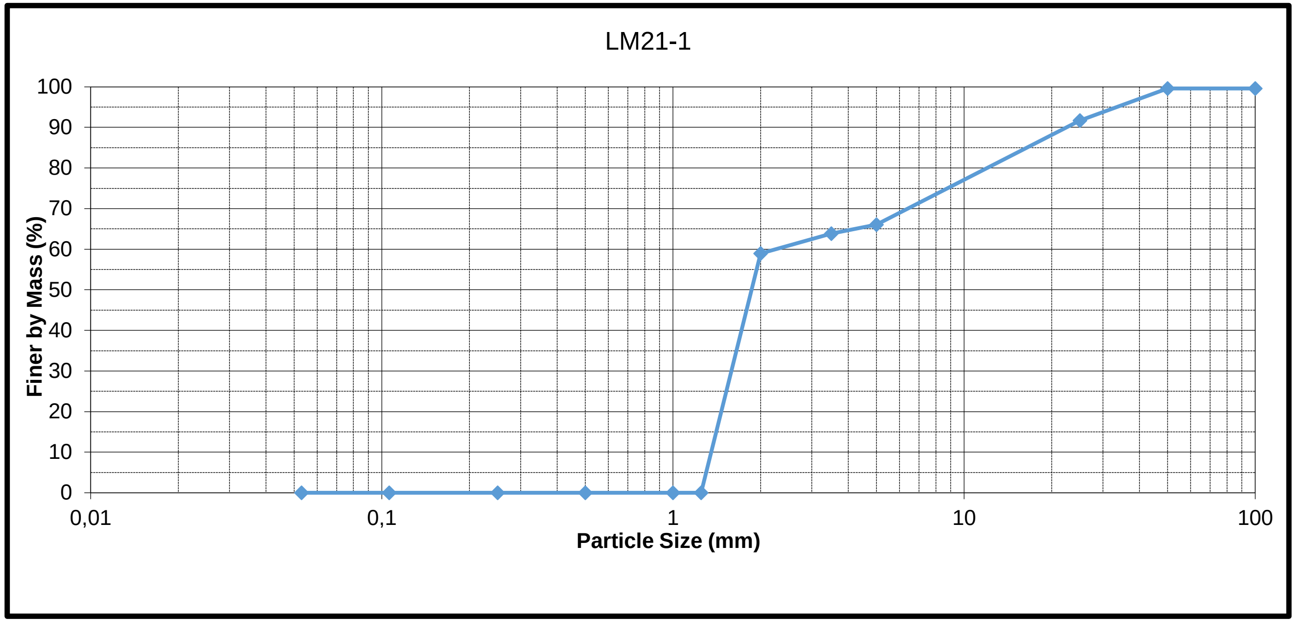


Figure F1-89. Semi-log PSD of Profile M21, layer 1.

LM21-2

Sieve Size/mm	% Passing
100	98,9
50	98,9
25	73,0
5	38,2
3,5	34,7
2	27,3
1,25	22,5
1	20,9
0,5	15,8
0,25	10,4
0,106	3,7
0,053	1,0
0	0

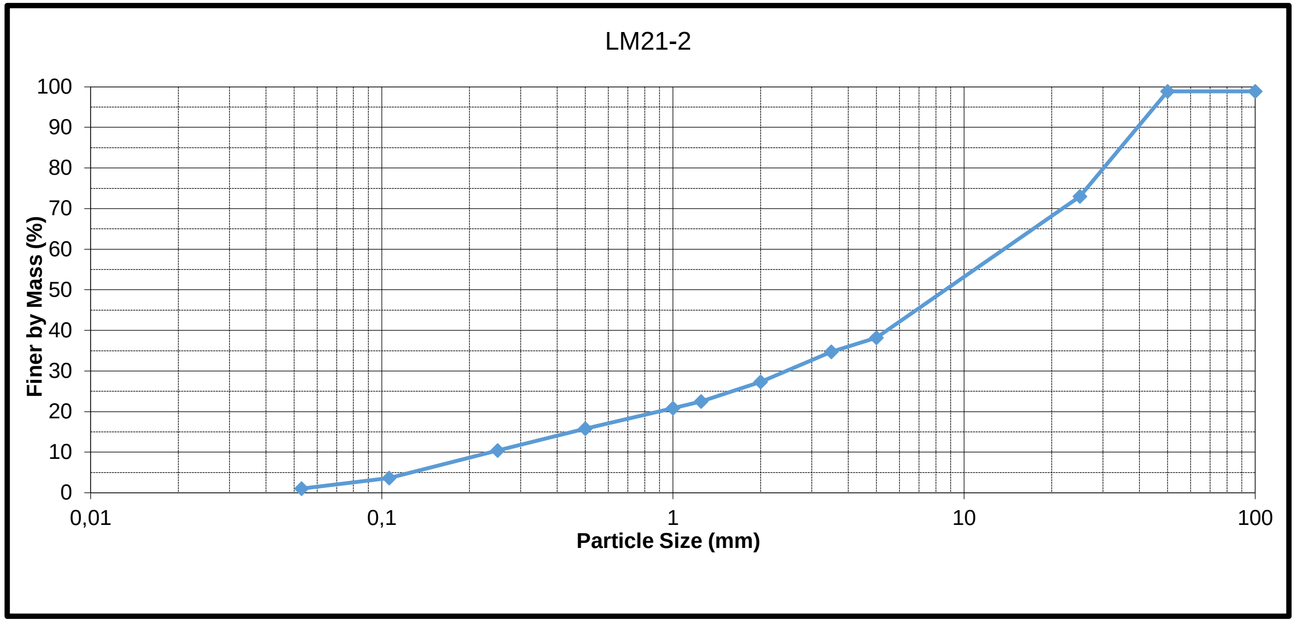


Figure F1-90. Semi-log PSD of Profile M21, layer 2.

LM21-3

Sieve Size/mm	% Passing
100	98,8
50	98,8
25	94,7
5	61,4
3,5	55,5
2	38,2
1,25	28,8
1	25,8
0,5	19,1
0,25	12,9
0,106	6,0
0,053	2,5
0	0

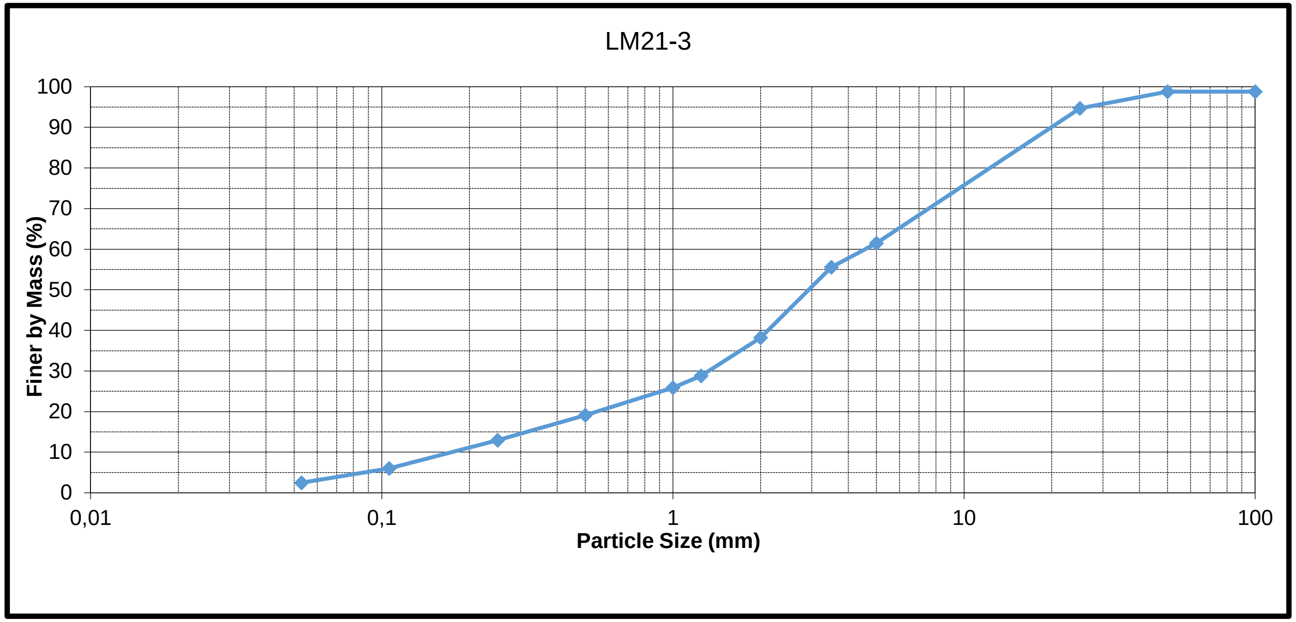


Figure F1-91. Semi-log PSD of Profile M21, layer 3.

LM22-1

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	84,9
5	57,8
3,5	54,2
2	46,5
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

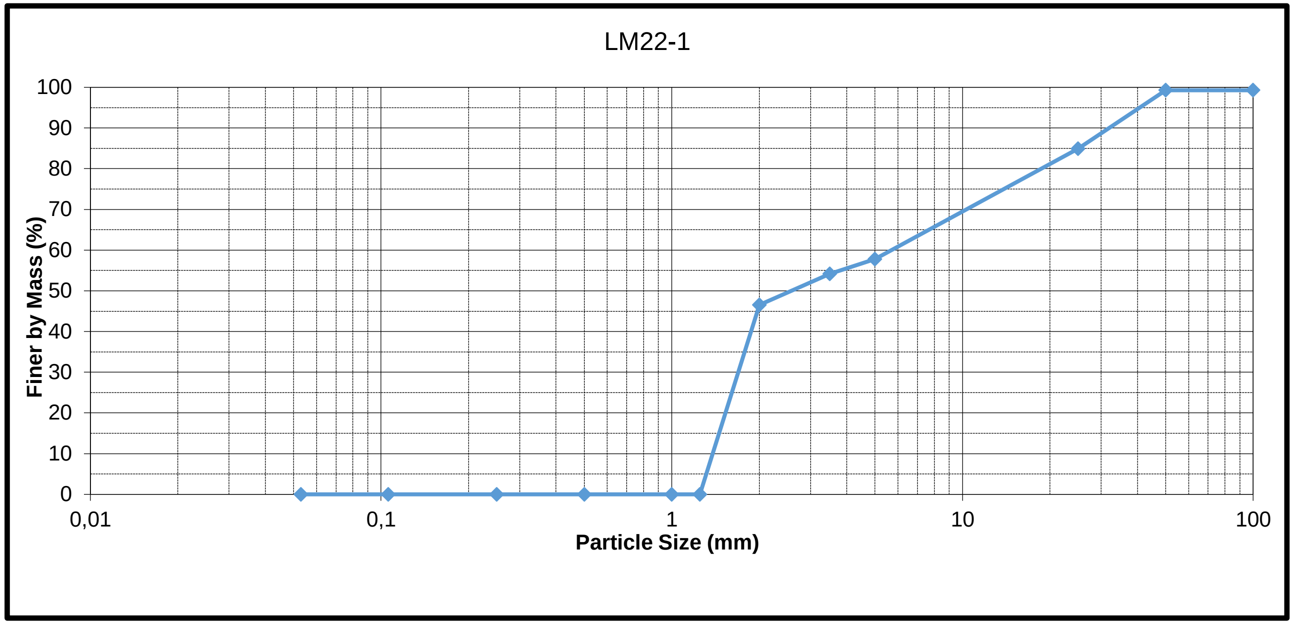


Figure F1-92. Semi-log PSD of Profile M22, layer 1.

LM22-2

Sieve Size/mm	% Passing
100	99,4
50	80,9
25	51,9
5	18,5
3,5	16,3
2	11,8
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

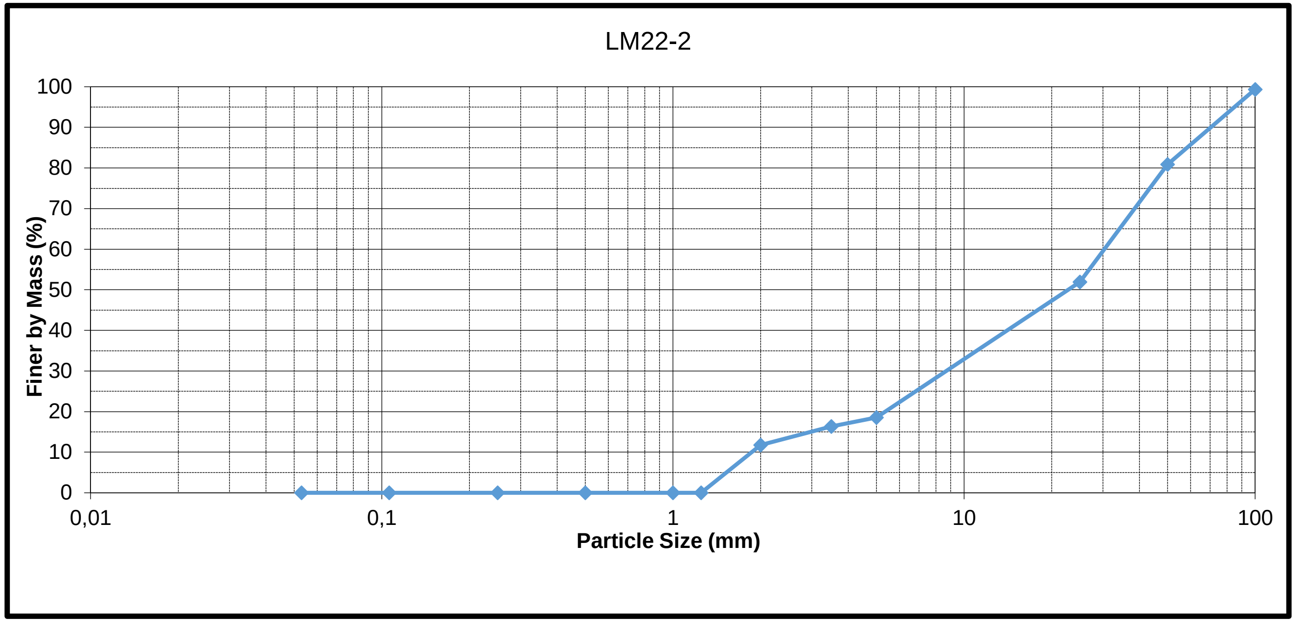


Figure F1-93. Semi-log PSD of Profile M22, layer 2.

LM23-1

Sieve Size/mm	% Passing
100	99,1
50	99,1
25	92,3
5	74,1
3,5	72,6
2	65,2
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

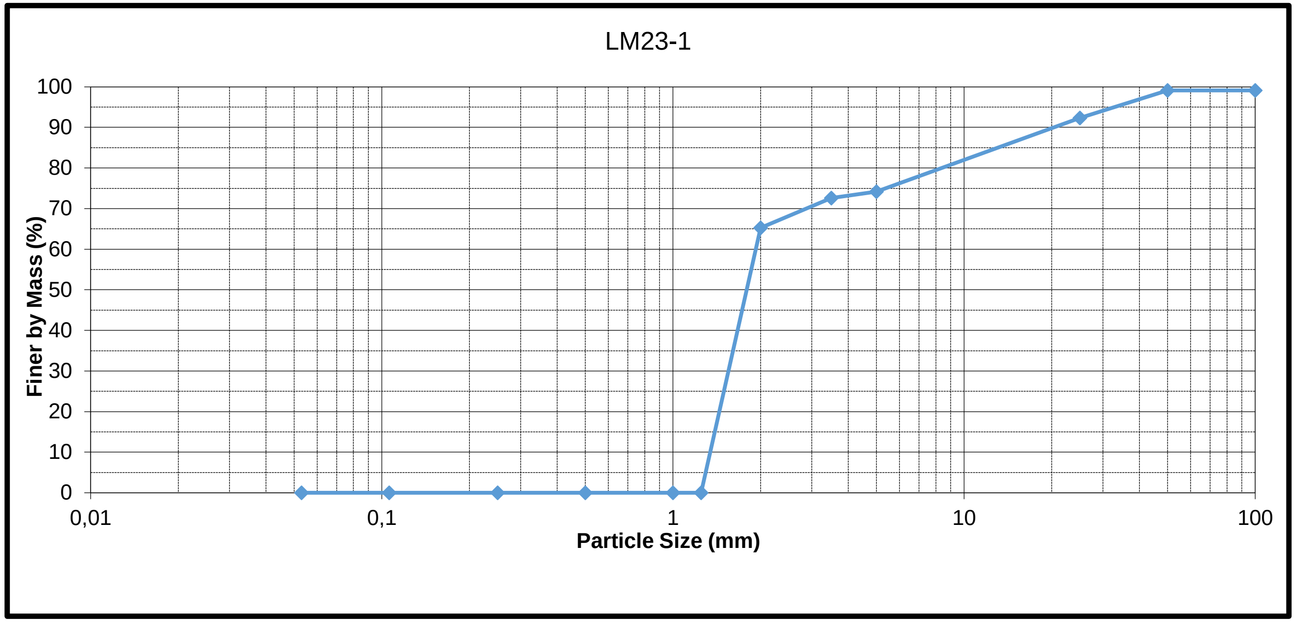


Figure F1-94. Semi-log PSD of Profile M23, layer 1.

LM23-2

Sieve Size/mm	% Passing
100	99,2
50	94,1
25	71,3
5	45,8
3,5	42,3
2	32,2
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

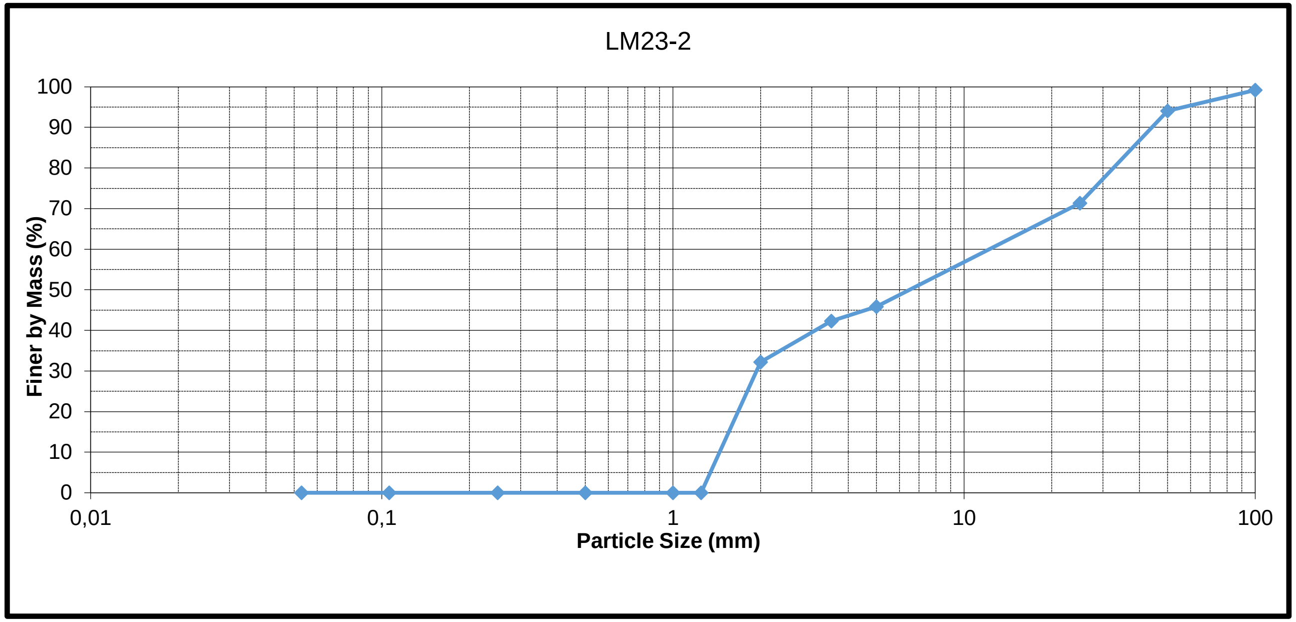


Figure F1-95. Semi-log PSD of Profile M23, layer 2.

LM24-1

Sieve Size/mm	% Passing
100	99,1
50	86,3
25	69,0
5	52,9
3,5	51,1
2	45,3
1,25	0,0
1	0,0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

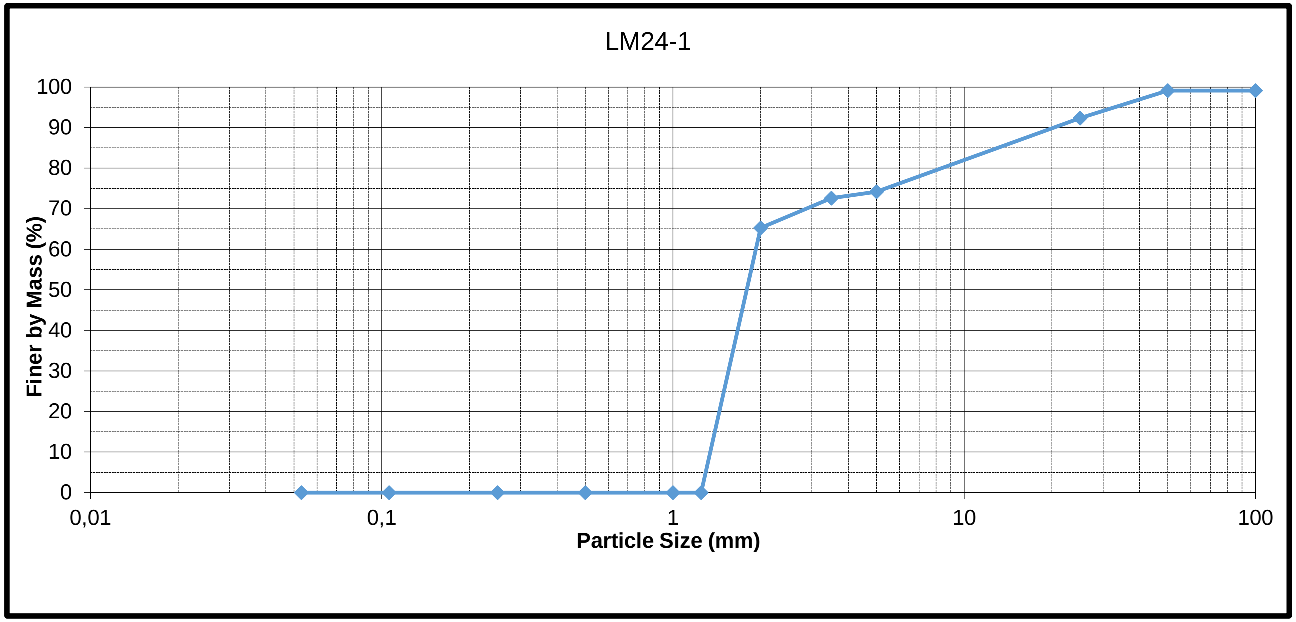


Figure F1-96. Semi-log PSD of Profile M24, layer 1.

LM24-2

Sieve Size/mm	% Passing
100	99,3
50	99,3
25	96,1
5	73,1
3,5	67,9
2	49,6
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

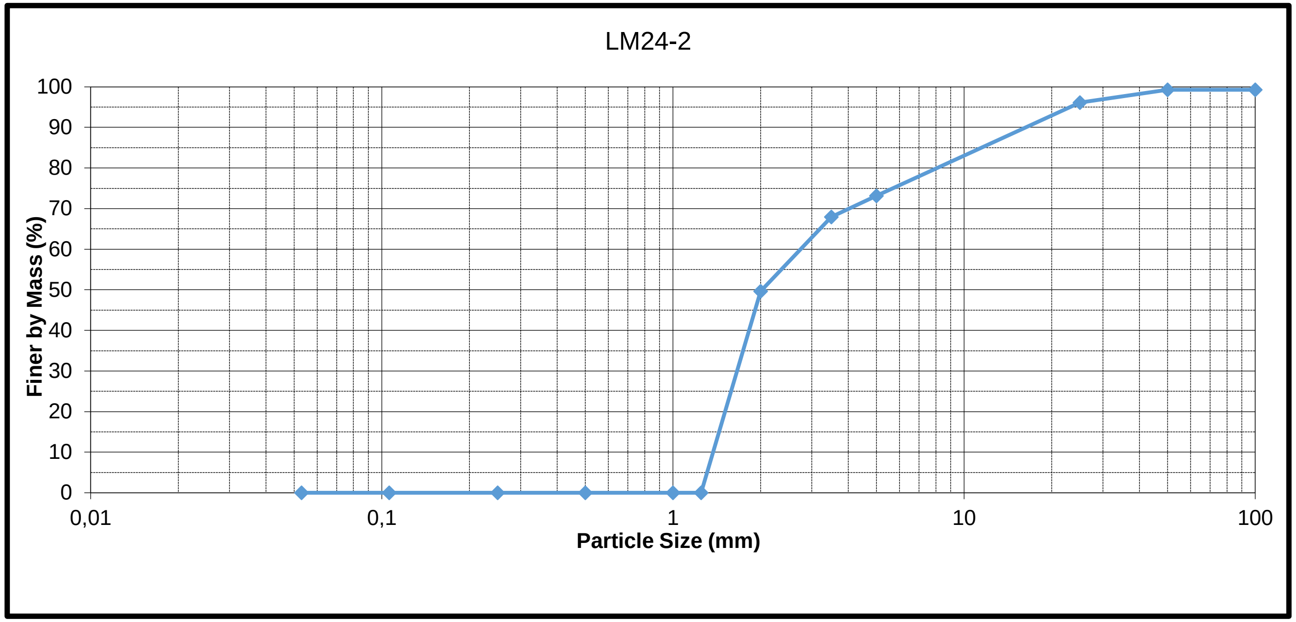


Figure F1-97. Semi-log PSD of Profile M24, layer 2

LM24-3

Sieve Size/mm	% Passing
100	98,8
50	98,8
25	95,2
5	61,2
3,5	51,6
2	32,4
1,25	0,0
1	0
0,5	0
0,25	0
0,106	0
0,053	0
0	0

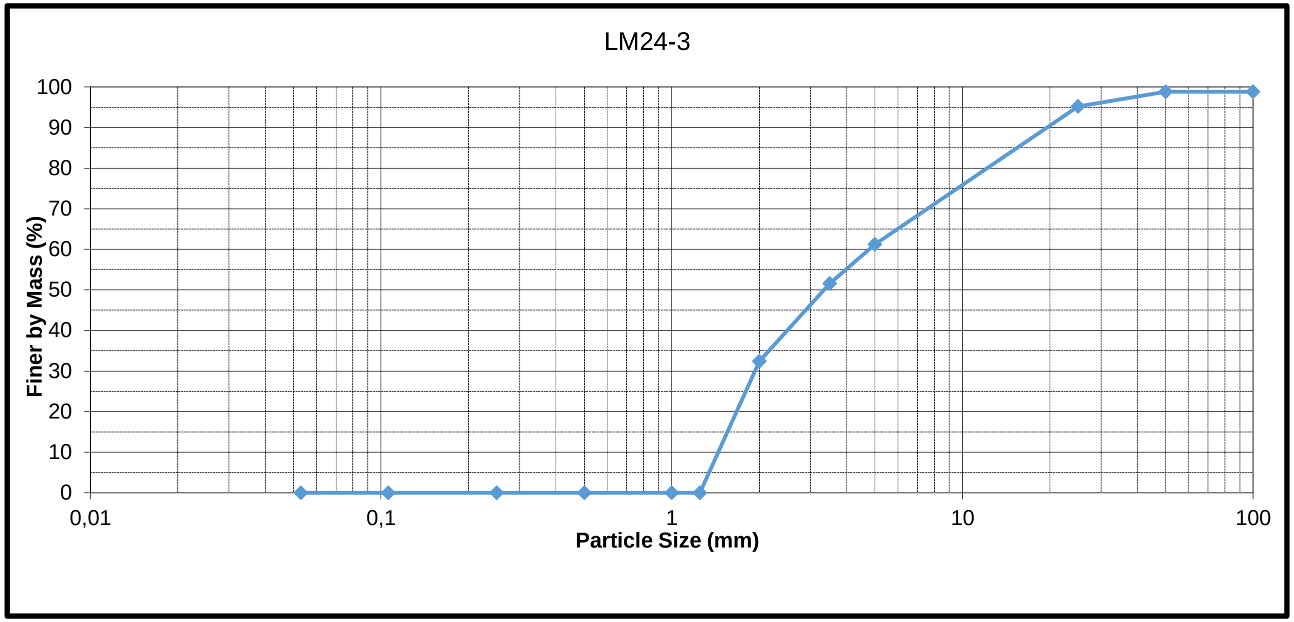


Figure F1-98. Semi-log PSD of Profile M24, layer 3

Salt 2

Sieve Size/mm	% Passing
100	100
50	100
25	100
5	100
3,5	100
2	100
1,25	95,5
1	92,1
0,5	68,4
0,25	33,8
0,106	9,9
0,053	3,4
0	0

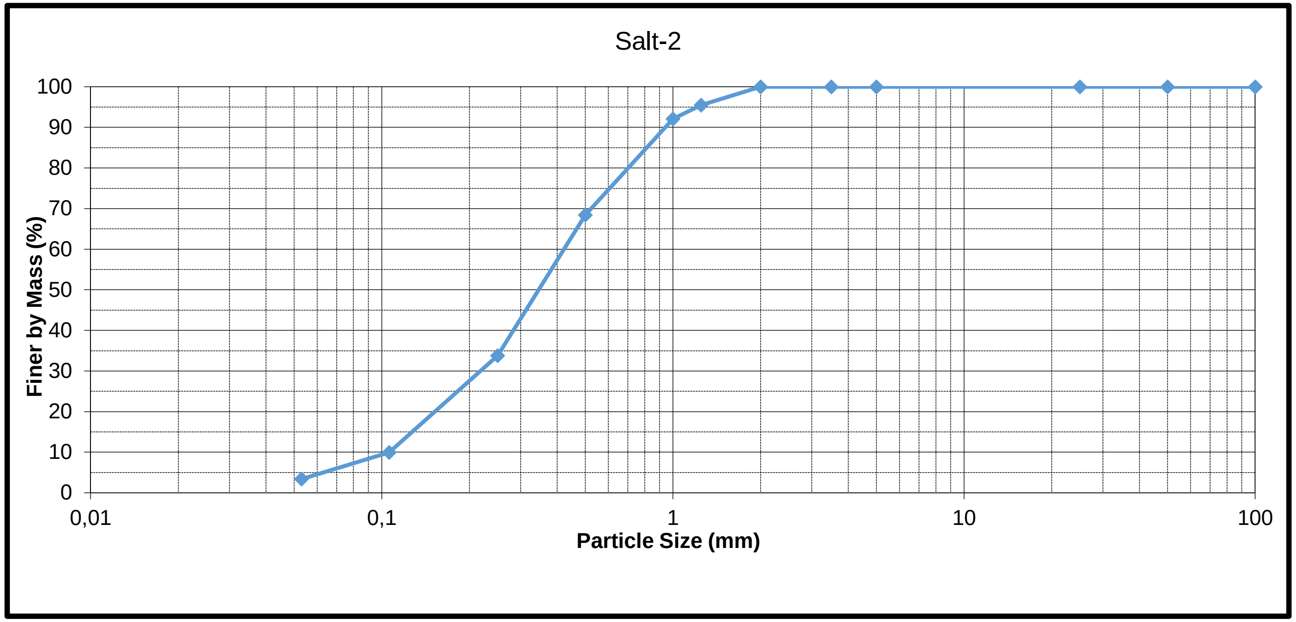


Figure F1-99. Semi-log PSD of soil from Salt river flood plain

Road 3

Sieve Size/mm	% Passing
100	100
50	100
25	100
5	100
3,5	100
2	100
1,25	89,7
1	84,3
0,5	60,0
0,25	32,5
0,106	7,9
0,053	1,6
0	0

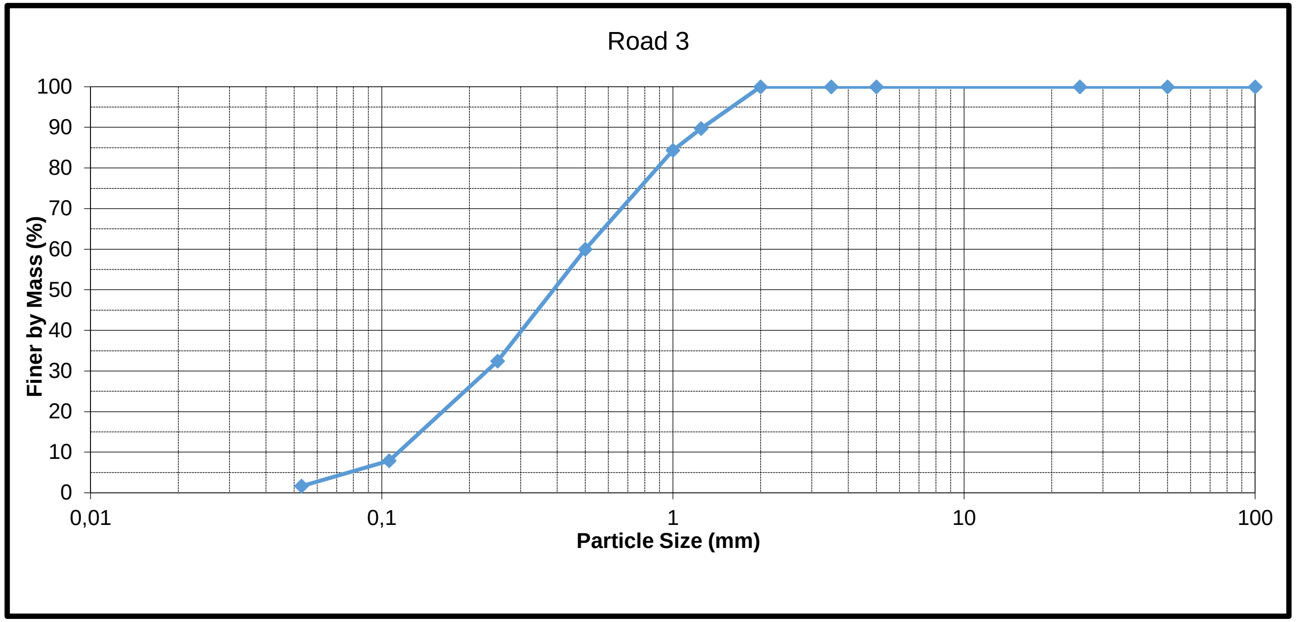


Figure F1-100. Semi-log PSD of soil /dust from road

APPENDIX G: PHOTOS

List of photos:

Photo 1: Profile G1 with soil on soft accrete on weathered gneiss

Photo 2: Quarts outcrops next to Profile G5

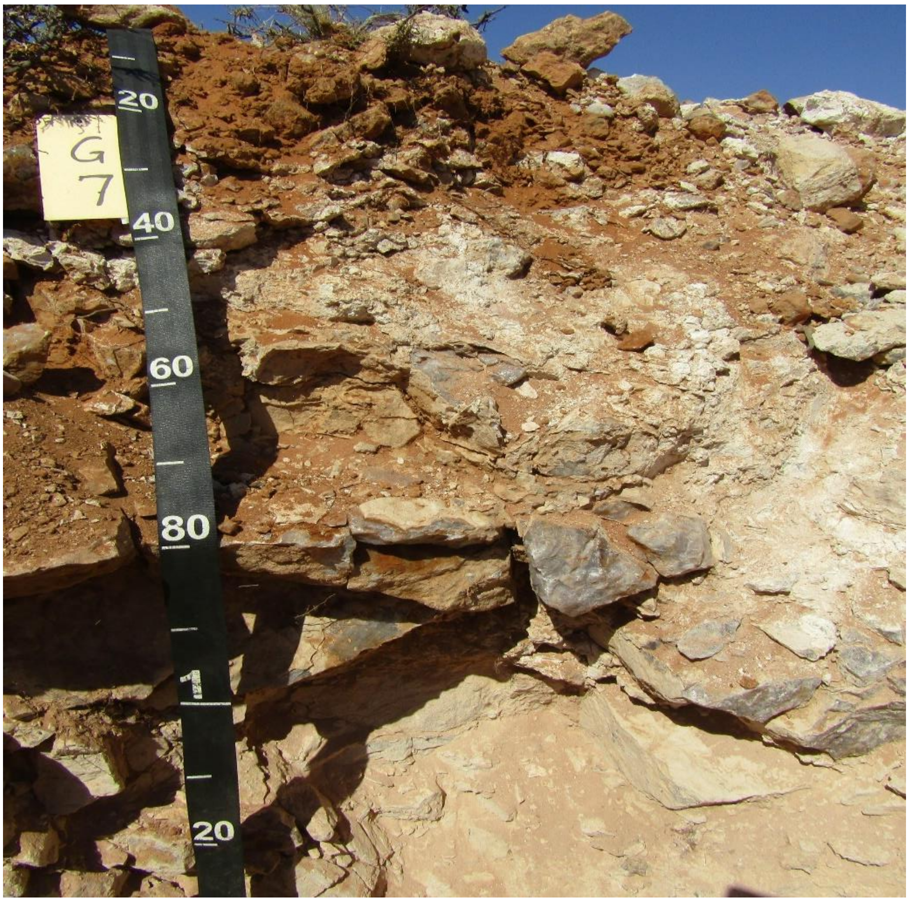


Photo 3: Profile G7 with shallow soil on top of pegmatite/quartz bedrock

Photo 4. Profile G14. Soil of mixed origin on nodular calcrete on soft calcrete

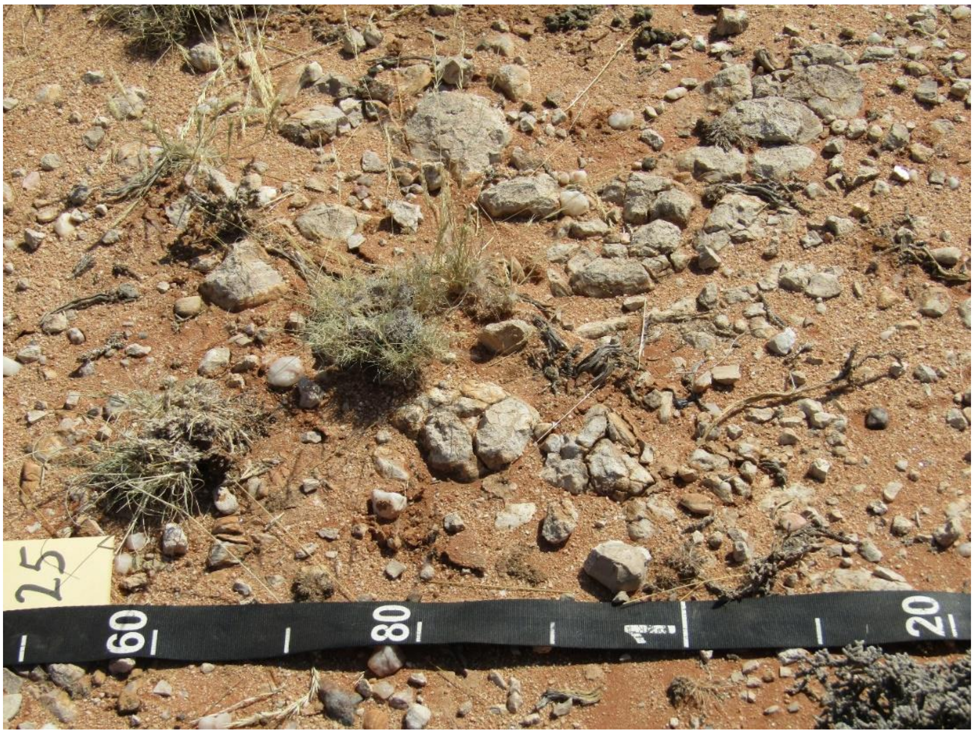


Photo 5. Profile G25: Calcrete outcrops on surface

Photo 6. Profile M6. Gneiss outcrops

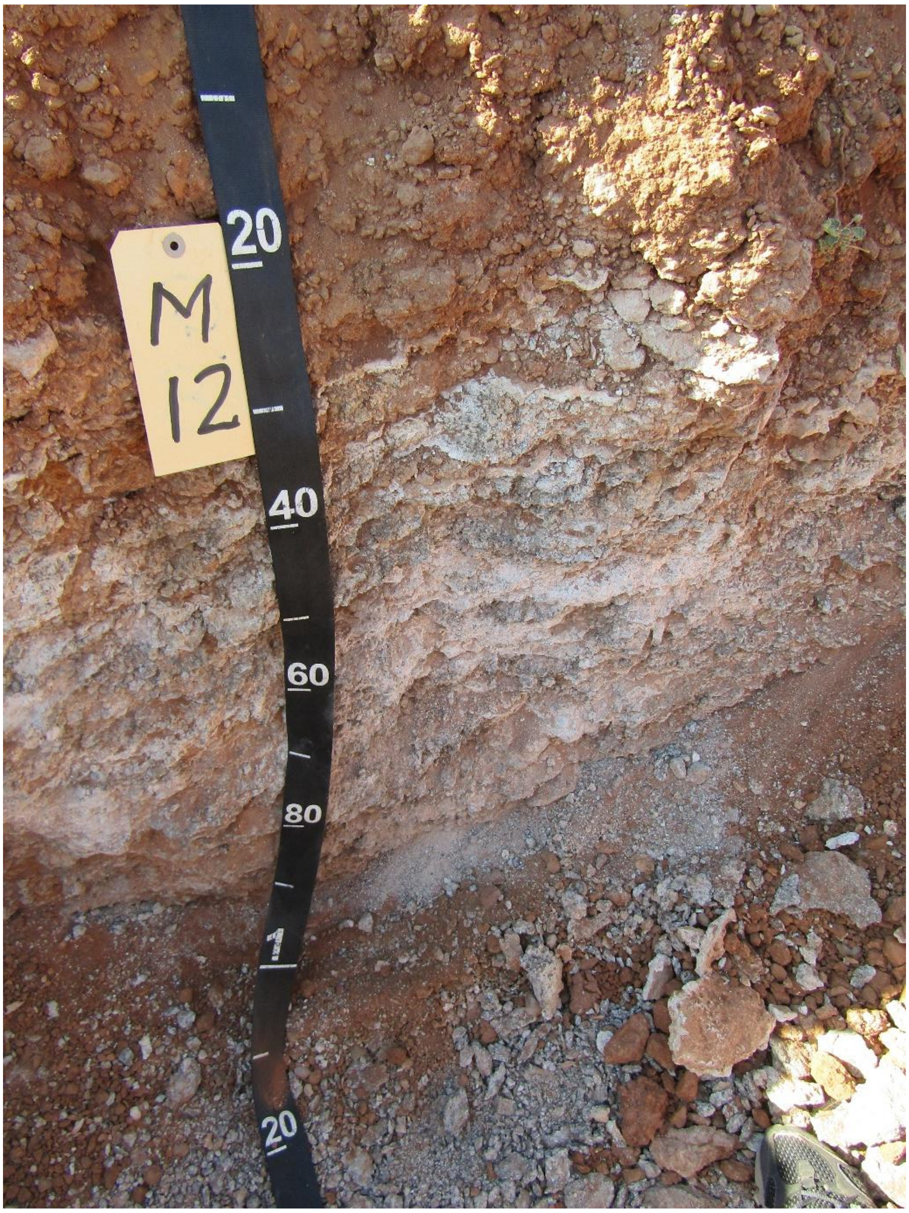


Photo 7. Profile M12. Alluvial soil on top of banded gneiss with calcrete in joints

Photo 8. Profile M23. Metaquartsite outcrops with alluvial lag deposit next to outcrop