forestry, fisheries
& the environment

Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

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SPECIALIST DECLARATION FORM – AUGUST 2023

Specialist Declaration form for assessments undertaken for application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

REPORT TITLE

Geotechnical Assessment Study for the proposed construction and maintenance of New System 1 and associated infrastructure at Rand Water Vereeniging Treatment Works. *Note the report was compiled in 2019 but is still applicable for this project.*

Kindly note the following:

1. This form must always be used for assessment that are in support of applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting, where this Department is the Competent Authority.
2. This form is current as of August 2023. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.dffe.gov.za/documents/forms.
3. An electronic copy of the signed declaration form must be appended to all Draft and Final Reports submitted to the department for consideration.
4. The specialist must be aware of and comply with *'the Procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the act, when applying for environmental authorisation - GN 320/2020)'*, where applicable.

1. SPECIALIST INFORMATION

Title of Specialist Assessment	Geotechnical Assessment Study for the proposed construction and maintenance of New System 1 and associated infrastructure at Rand Water Vereeniging Treatment Works
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2. DECLARATION BY THE SPECIALIST

I, _Michael Plichta_ declare that –

- I act as the independent specialist in this application;
- I am aware of the procedures and requirements for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the National Environmental Management Act (NEMA), 1998, as amended, when applying for environmental authorisation which were promulgated in Government Notice No. 320 of 20 March 2020 (i.e. "the Protocols") and in Government Notice No. 1150 of 30 October 2020.
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing –
    - any decision to be taken with respect to the application by the competent authority; and;
    - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the NEMA Act.

Signature of the Specialist

Knight Piesold

Name of Company:

16 Sept 2025

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, _ ___Michael Plichta_____, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

M Plichta

Signature of the Specialist

_____Knight Piesold_____

Name of Company

_____16 September 2025_____

Date

Signature of the Commissioner of Oaths

16 September 2025

Date

CERTIFIED TRUE COPY OF THE ORIGINAL DOCUMENT
THERE ARE NO INDICATION THAT THE ORIGINAL DOCUMENT HAS BEEN ALTERED BY UNAUTHORISED PERSONS.

Neeva Anne Matthysen: Tender Lead
Reference Number: 31/04/2016
Commissioner of Oaths (RSA)

Signature:.....

Date: 16/09/2025 Place: Sandton

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VEREENIGING PUMPING STATION

225ML SEDIMENTATION TANK, FLOCCULATOR AND ASSOCIATED SYSTEM 1 PIPELINES

GEOTECHNICAL INVESTIGATION

PREPARED FOR:

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MAY 2019

Project No:	30300496/03
Report No:	KHH2488
Rev:	2
Reference Code:	*OGP-DB/KHH2488/Rev.2*

FINAL REPORT

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Project Number
30300496/03

VEREENIGING PUMPING STATION: GEOTECHNICAL INVESTIGATION

225ML SEDIMENTATION TANK, FLOCCULATOR AND ASSOCIATED SYSTEM 1 PIPELINES

Rev	Description	Date
2	Issued as Final	10 May 2019

Knight Piésold CONSULTING

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1. INTRODUCTION

Rand Water (RW) appointed Knight Piésold (KP) to conduct a geotechnical investigation for a 225 ML sedimentation tank and flocculator referred to as System 1 at Vereeniging Pumping Station. The appointment also included the geotechnical investigation for the associated raw water, wash water, recovered water and sludge pipelines.

The old System 1A structures should have been demolished to allow construction of the new sedimentation tank and flocculator. A contractor was appointed for the demolition works but the work was not completed as the contractor was removed from site.

The objectives of the geotechnical investigation were to:

- Confirm the site stratigraphy and the geotechnical properties thereof,
- Determine the nature of the shallow soils,
- Establish the potential for in situ materials to be used in pavement layers, and
- Provide foundation recommendations.

This report presents the findings from the recent fieldwork that supplements the previous geotechnical investigation information from other consultants. This report details the KP findings and provides recommendations for the proposed System 1 development.

2. SITE DESCRIPTION

The Vereeniging Pump Station is located approximately 2km south-west of the Vereeniging Central Business District (CBD), and 1,5km north-west of the Vaal River. The pump station is bounded by the R42 road to the south, a railway line to the east, and by Colenso and Taaibos Streets to the west and north respectively. The location of the site is shown in Figure 1, included at the end of this report.

The site topography is generally flat but the natural ground has been significantly disturbed when the large tank and water treatment structures were constructed. The elevations across the pump station vary between 1446 masl and 1441 masl according to Google Earth imagery. Access is generally from Taaibos street to the north, or from the main gate off the R42 Barrage road to the south.

Surface vegetation typically comprises veld grasses for most of the site. Scattered pine trees occur at the south-western portion of the site together with other indigenous trees.

The Vaal river lies approximately 1,8 km south of the site and a concrete lined tributary canal lies approximately 200 m to the west. Apart from these water courses, no other regional surface drainage features of significance are close to the site.

Reinforced concrete rubble from the old System 1A demolition is stockpiled north of the System 4 sedimentation tanks.

3. AVAILABLE INFORMATION

RW previously provided KP with the following information:

- System 1 geotechnical report dated November 2016, prepared by JG Afrika.
- System 5 geotechnical report dated February 1984, prepared by SRK, Report No. PT3583.
- Pre-wetting of sedimentation tanks at Vereeniging Pump Station, dated February 1986, Report No. PT3583/2.
- Proposed System 1 Drawings, prepared by Bosch Projects.
- Old System 1A drawings.
- System 5 tank drawings.

A geotechnical investigation was conducted at the proposed System 1 sedimentation tank and flocculator by JG Africa in 2016. The investigation comprised the following:

- Six electrical resistivity traverses
- Drilling of 8 rotary core boreholes to depths from 12,5m to 20,4m.
- The excavation of 3 test pits using a TLB.
- The driving of 3 Dynamic Cone Penetrometer (DCP) tests, one at each test pit position.

The borehole information is quite comprehensive although no boreholes were drilled at the north-western portion of the investigation footprint. This is probably due to the presence of ponding water that made this area inaccessible.

4. REGIONAL GEOLOGY

According to the published 1:250 000 scale regional geological map of the West Rand 2626 [1], the site is underlain by residual soils and rocks of Vryheid Formation, in the Ecca Group, Karoo Supergroup. This comprises predominantly of sandstone, gritstone and arkose as well as mudrock and shale interbedded with coal seams. The regional geology is shown in Figure 2, included at the end of this report.

Weathering has produced soil profiles of variable thickness, the upper reaches of which are typically moderately to highly expansive, as decomposition of the feldspar minerals within these rocks form clays from the smectite group, which are present to considerable depth. The assumption that founding conditions typically improve with depth are not necessarily valid for heavy structures as weak strata may underly competent strata [2].

A more detailed overview of the regional geology is presented in the report by JG Afrika (2016).

5. GEOHYDROLOGY

A geohydrological investigation was conducted by GCS Water & Environmental Consultants near the proposed sedimentation tank and flocculator during the same period as the geotechnical investigation. This included a hydro census and the drilling of additional groundwater monitoring boreholes. It was found from the study that a shallow water table was present at approximately 1m below the old System 1A excavation floor level i.e. at the 1435.00 level. Dewatering will therefore be required during construction as the excavation for the sedimentation tank will be below the water table.

Modelling was done by GCS for an assumed 12-month earthworks construction period to determine the water table draw down cone. The modelling showed that the existing sedimentation tanks to the north (System 5 Tanks U and V) will be affected by the dewatering. These tanks are constructed on expansive clay soils which should be kept at a high moisture content to prevent drying out and shrinkage of the clay. This may result in settlement of Tanks U and V taking place. The soil moisture content will increase once the dewatering stops which will result in the clay swelling and may result in upward tank movement. It should be noted that the tank movement due to the drying out and re-wetting of the clay may not be uniform. This will have to be monitored during construction by installing survey points on Tanks U and V and conducting weekly surveys. Movement which is above the values specified by Rand Water and the Engineer may require dewatering to be temporarily stopped until it has stabilised.

A herringbone drain system is proposed by GCS which will drain the water into a sump which will be located at the north-west corner of the excavation. The sump will be pumped to keep the water table at the 1433.00 level which will be the deepest section of the excavation for the new sedimentation tank.

6. CLIMATE

As per JG Afrika's report, regional rainfall for Vereeniging is approximately 560 mm per annum with temperatures varying between 0° C and 28° C. Summers are usually dry and hot with winters typically cold and wet. The site is located within a humid area where Weinert's N-value is less than 5, which indicates that chemical decomposition is the dominant weathering mode [3].

7. SEISMICITY

According to the report by JG Afrika, the site has a peak ground acceleration of 0,15g (gravitational acceleration) with a 10% probability of exceedance within a 50-year period, which may result from either natural or mining induced seismicity and classifies the site as "Ground Type 4" in terms of SANS 10160-4 [4].

8. METHOD OF INVESTIGATION

The geotechnical investigation was sub-divided into two components: pipeline investigations by means of TLB test pit excavation and excavator test pits for the sedimentation tank and flocculator. This is discussed below.

8.1 FIELDWORK

TLB test pits for the pipelines were excavated between 19 and 21 November 2018 using a CAT 422E TLB. Excavator test pits were excavated within the old System 1A area on 22 and 23 November 2018 using a CAT 320D (20-ton) excavator. Both the TLB and excavator were provided by V&S Cat Hire.

Underground service detection information was provided by RW to KP to assist with the planning of the test pit positions. The test pit positions are shown in Figure 3 and the test pit profile logs are given in Appendix A.

Soil profiling was undertaken by an engineering geologist according to standard practice [5]. The test pit positions were recorded with a hand held GPS (accuracy ± 5m). Test pit and site photographs are given in Appendix B. The test pits and borehole logs from the work by JG Afrika have been included for reference purposes in Appendix D.

8.1.1 PIPELINE INVESTIGATION

Test pits TP1 to TP11 were excavated for the pipeline investigation. There were services that were encountered during the test pit excavation that there not indicated on the service detection drawing. It was then decided to use hand excavation for most of the test pits to avoid damaging services.

Thandi Projects is a contractor who was on site since May 2018 and was busy with a large number of trench excavations, which is understood to be mostly for a new fire hydrant pipeline. The trench excavations had prevented access for the TLB at some of the planned test pit positions and in general made access difficult. Only two test pits (TP1 and TP2) could therefore be excavated by the TLB.

Thandi Projects provided labourers to assist KP with the hand excavation. Some of the existing trenches were excavated deeper to provide additional soil profile information. The soils in the open trenches were also profiled.

8.1.2 SEDIMENTATION TANK AND FLOCCULATOR

Excavator test pits TP12 to TP16 and TP16A were excavated by KP for the new System 1 sedimentation tank and flocculator to supplement the JG Africa test pit and borehole information.

8.2 PIPELINE GENERAL SOIL PROFILE

The soil profile along the pipelines is summarized below.

8.2.1 EAST OF FILTER HOUSE NO. 2

The soil profile at TP1 to TP4 is as follows from top to bottom:

- 0,9m to 1,95m thick fill at TP1 to TP3 generally comprising loose to medium dense clayey silty sand with slag and ash. There is thicker fill at TP4, which is at least 2,1m thick and has a higher clay content.
- The fill is underlain by transported soils, interpreted to be alluvial in origin, and comprising soft to firm silty clay to a depth of at least 3,7m, which was the maximum reach of the TLB.

Slight water seepage was encountered in TP4 at a depth of 1,6m below the ground surface.

8.2.2 SYSTEM 3 AND SYSTEM 5 SEDIMENTATION TANKS

The soil profile at TP5 to TP7 comprises highly variable fill, which extends to a depth of at least 2,2m (at TP5) comprising very loose to medium dense sandy silty gravel with building rubble, ash and slag. The fill also contains soft to stiff clayey sand with ash and slag.

Side wall collapse occurred at TP7, which limited the test pit depth to 1,1m due to safety reasons.

A geological section for the proposed sludge pipeline from manhole MH1 to MH16 is shown in Figure 5 All the excavation is expected to be soft according to SANS 1200DB.

8.2.3 EAST OF SYSTEM 5 FLOCCULATOR

The soil profile at TP8 and TP10 is as follows:

- Interlocking paving layer.
- 0,2m to 0,4m thick engineered fill comprising distinct layers of dense to very dense silty sand with gravel.
- Fill extending to depths of between 1m and 1,9m comprising medium dense to dense silty sand with gravel, ash and slag.
- 0,4m to 0,6m thick topsoil layer occurs below the fill material. This means that fill had previously been deposited on top of the topsoil.
- Ferruginous colluvium comprising medium dense silty sand with ferricrete nodules to a depth of at least 2,5m (at TP10).

Highly variable fill comprising of a large variety of materials extends to a depth of 2m at TP9.

At TP11 the topsoil was covered by a 0,2m thick layer of fill. The topsoil was underlain by ferruginous colluvium with nodular ferricrete, which extends to a depth of at least 1,4m.

8.3 OLD SYSTEM 1A SOIL PROFILE (TP12 TO TP16 AND TP16A)

The old System 1A excavation is approximately 3m to 4m deep and 310m in length by 45m to 75m in width and has been fenced off. The area is highly disturbed and the old System 1A structures have only been partially demolished. The excavator test pits were excavated at the floor level of the excavation and these have subsequently been surveyed. Historical satellite imagery corroborates the disturbance in this area, and the origin of the upper expansive soils remains uncertain.

The soil profile at TP12 and TP13 is as follows from top to bottom:

- 2,8m to 3,8m thick fill comprising soft clayey sand.
- The upper reaches of the fill are organic-rich, and the lower reaches comprises very soft to firm clayey sand with sandstone and quartzite cobbles.
- Residual mudstone or shale was encountered from depths of 4,8m and 3,8m at TP12 and TP13 respectively. At TP12 the residual mudstone is overlain by a 2m thick layer of residual carbonaceous shale comprising firm clayey sandy silt.
- Excavator refusal occurred on very soft to soft rock shale from a depth of 5m at TP13.

Slow water seepage was observed in TP12 from a depth of 3,5m.

TP15 was the deepest test pit with a depth of 6m but there was no excavator refusal on residual shale, which comprised stiff to very stiff sandy clayey silt.

Fill was encountered in TP14 from the ground surface to the test pit depth of 4,9m. The fill comprises concrete blocks and builders' rubble within a silty clay or sandy soil matrix.

Shallow excavator refusal occurred on concrete slabs at TP16 and TP16A at depths of 0,2m and 1,4m respectively.

The test pits were positioned by the KP geologist in between the partially demolished System 1A structures. It must be noted that there is still a great deal of remaining concrete that needs to be demolished before the earthworks and construction of the new sedimentation tank and flocculator can commence. The concrete rubble could be stockpiled north of the System 4 sedimentation tanks where material has been stockpiled previously. A mobile crusher could be used to crush the concrete to produce suitable backfill material although there is significant reinforcing in the concrete, which will have to be removed and this can complicate the crushing process.

A summary of the test pit profiles in presented in Table 1.

According to the JG Africa report the rock depth varies from 5,1m to 10,74m below the floor level of the old System 1A excavation. The rock is highly variable and comprises interbedded sandstone, siltstone, mudstone, carbonaceous mudstone and tillite.

9. LABORATORY TESTING

Representative disturbed and undisturbed samples were taken from the test pits, both along the pipeline route and within the proposed sedimentation tank footprint. These were submitted to Civilab in Johannesburg for laboratory testing. The laboratory results are presented in Appendix C and a summary of the results are given in Table 2.

The following tests have been carried out:

- 20 x Foundation indicator (grading, Atterberg limits and clay content)
- 10 x Moisture content
- 5 x Modified AASHTO compaction and CBR
- 3 x Compactibility to determine the suitability of materials for pipe bedding
- 4 x Basson's Index to assess the potential for soils to corrode concrete and steel
- 2 x Falling head permeability on remoulded samples
- 1 x Consolidation test
- 1 x Free swell test

9.1 PIPELINE RESULTS

The transported soils encountered are considered to range in origin from topsoil to colluvium and alluvium. Due to the highly disturbed nature of the site, even along the pipeline route, some uncertainty regarding the origin of the latter exists. The results are presented with reference to the general profile for each of the proposed structures below.

9.1.1 EAST OF FILTER HOUSE NO.2

The fill is encountered in the upper reaches of the profile and varies significantly in grading, viz. gravel (2% to 51%), sand (24% to 48%), silt (11% to 26%) and clay (14% to 24%). The Plasticity Index (PI) varies between 19% and 26%, which results in a low to medium potential expansiveness [6]. The Unified Soil Classification (USC) of the fill varies from, GC (clayey gravel) to CL (clays of low to medium plasticity). The natural moisture content is 17,3% at 1,6 m in test pit TP04, and the fill is regarded as highly corrosive to steel and mildly aggressive towards concrete.

Alluvium underlies the fill and was encountered in TP01 and TP02, and the interpretation of origin is based on the typical composition, viz. gravel (1% to 6%), sand (31% to 39%), silt (18% to 19%) and clay (42% to 44%), with the latter typical of alluvial soils. High liquid limits (LL) of 51% to 66% in combination with the clay content, result in high to very high potential expansiveness and a USC of CH (clays of high plasticity). The natural moisture content varies from 14,7% to 34,6% at depths between 1m to 3,7m.

9.1.2 SYSTEM 3 AND SYSTEM 5 SEDIMENTATION TANKS

In the area between System 3 and 5, the USC for the fill ranges from GM (poorly graded silty gravel) to SC (clayey sands), with the typical composition viz. gravel (21% to 65%), sand (21% to 39%), silt (12% to 15%) and clay (2% to 25%). The PI of the fill varies from slightly plastic (SP) to 33% and the grading moduli from 1,28 to 2,27. The coarse fill (slag and ash) from test pit TP06, qualifies for use as a subbase (G5), with a low maximum dry density of approximately 1500 kg/m^3 and a compactibility factor of 0,316. This indicates that the material is unsuitable for use as pipe bedding or backfill, as per RW specification [8].

9.1.3 EAST OF SYSTEM 5 FLOCCULATOR

The fill encountered near the proposed flocculator, specifically at TP10, is comprised of gravel (34%), sand (34%), silt (15%) and clay (16%), with a PI of 16% and a low potential expansiveness. Compaction tests indicate it has a maximum dry density of 1967 kg/m^3 at 10,9% moisture content. The PI and grading requirements as per RW specification classifies this material as unsuitable for use as backfill or bedding.

The topsoil has typically been profiled as a clayey silty sand with a pin-holed structure, often accompanied by organic material. The one sample tested of this horizon indicates that the composition, viz. gravel (2%), sand (50%), silt (21%) and clay (27%), poses a moderate potential for expansiveness and has a USC of CL (clays of low to medium plasticity). The organic content of these soils makes it unlikely to be suitable for layer works.

Ferruginous colluvium, underlying the proposed flocculator, is of a slightly variable composition, viz. gravel (29% to 36%), sand (31% to 38%), silt (10% to 14%) and clay (20% to 22%). The PI for this horizon varies between 16% and 29%, indicating a low potential for expansiveness. Grading moduli range from 1,31 to 1,68 with the USC of SC (clayey sands).

Neither the topsoil or the ferruginous colluvium qualifies for use as backfill or bedding in accordance with the RW specification [8].

9.2 OLD SYSTEM 1A EXCAVATION RESULTS

Fill encountered within the Old system 1A area varies considerably in grading, viz. gravel (5% to 51%), sand (23% to 42%), silt (8% to 19%), clay (18% to 46%). The PI varies from 31% to 41% with the LL from 55% to 66%. This results in low to medium potential expansiveness in the clayey sand soils (SC) and high to very high potential expansiveness in the high plasticity clays (CH). Grading moduli range from 0,57 to 1,95, and natural moisture contents varying between 23,6% and 31,4% at depths of 0,0 m-2,8 m. The drained shear strength parameters for the fill/alluvium from TP13 are shown below.

Effective Internal friction angle (phi) : 22,8°
Effective cohesion (c') : 24,9 kPa.

The above strength parameters are in line with typical values expected for a sandy clay. This in combination with the noted sidewall collapse, as well as high degree of potential expansiveness, indicates the necessity for battering of sidewalls in excavations, during all phases of work on the pipeline, sedimentation tank and flocculator, where this material may be encountered..

Reworked residual sandstone underlies the transported soils and comprises gravel (3% to 5%), sand (20% to 83%), silt (9% to 41%) and clay (3% to 36%). The PI for the soils varies from 13% to 25% with LL from 31% to 45%, resulting in a low to medium potential expansiveness. Grading moduli range from 0,42 to 1,58 with the former having a USC of CL (clays of low plasticity) and the latter SC (sandy clay). Natural moisture contents vary from 14% to 19,4% at depths between 1,3m to 6m.

Both carbonaceous and non-carbonaceous soils were encountered with grouped compositions, viz. gravel (0% to 5%), sand (22% to 30%), silt (36% to 57%) and clay (13% to 37%), with the former profiled as a sandy silt and the latter as a sandy silty clay. Similar liquid limits of 36% and 39% combined with PI's of 13% and 18% respectively, result in a low degree of potential expansiveness for both soils. The USC for the residual shales varies from CI to CL (clays of low to intermediate plasticity) respectively. The disparities in the results are likely linked to the degree of reworking in the residual shale from TP13.

The Basson's index for all the fill tested indicates that the soils are highly corrosive towards steel and mildly to highly aggressive towards concrete. The fill is not suitable for backfilling around conventional pipes and therefore corrosion protection of steel pipes, or PVC/HDPE pipe materials should be considered.

In addition to the above, one sample of the stockpiled material from north of System 4 sedimentation tanks was also tested (WBA2). The results indicate that the material mostly likely came from below the old System 1A structure and correlates well with the results obtained for the reworked residual sandstone.

10. GEOTECHNICAL EVALUATION

10.1 GENERAL

Design information for the sedimentation tank and flocculator is shown on the former Bosch Stemele PDF drawings R0 21709 to R0 21712 (dated 2012) that were forwarded to KP for information by Rand Water. According to the drawings the flocculator will be 30m in diameter while the sedimentation tank will be 240m in length by 51m in width with a typical wall height of 4,2m. The sedimentation tank will have a sloping floor from east to west with a 0,8m elevation difference over the length of the tank. The underside (i.e. bottom) of the 0,3m thick concrete floor levels vary from 1436.12 to 1436.86. The drawings show that the foundation wall levels are similar to the bottom of the floor levels. The flocculator depth is variable but the deepest central section has a bottom floor level of 1435.91.

The excavation for the removal of the old System 1A structures that was undertaken by the previous contractor is generally close to the founding level of the sedimentation tank. The excavation floor levels typically vary from 1436.5 to 1437.0 although the central portion of the excavation has a higher elevation of 1439.0 as some of the material had not been removed by the contractor. There are still a large number of old System 1A concrete structures remaining in the excavation as they have only been partially demolished. These structures will need to be demolished down to the recommended KP excavation levels. The demolished material could be stockpiled on site and possibly re-used for backfilling if it is crushed to a suitable size using a mobile crusher.

It may be possible for structures that are below the recommended excavation levels to remain behind but this will need to be verified by a geotechnical engineer during construction. Any voids in the old concrete structures will need to be filled with mass concrete. Alternatively, the structures will need to be demolished and removed.

Reference was made to the KP test pit information together with the JG Afrika test pit and borehole information [9] to obtain an understanding of the soil and rock conditions at the old System 1A excavation. The KP test pits and JG Afrika boreholes were surveyed by Delta Plan Professional Land Surveyors in 2019 to obtain ground level information, which allowed a direct correlation to be done between the test pit and borehole information.

The test pit and borehole information show that the area has been highly disturbed during the previous excavation by the contractor and large parts have been covered by fill. The in situ soils below the fill are also highly variable and vary from clayey sands with a low to medium potential expansiveness to clays with a very high potential expansiveness. The soils are typically described as moist to very moist (wet in places), which is indicative of shallow water table conditions. The soil consistencies are loose or soft to firm to a typical depth of 2m. Poorer soil conditions occur at the west side of the excavation where very soft to soft clays are present to a typical depth of 3m.

10.2 EARTHWORKS RECOMMENDATIONS

The soft expansive clays are unsuitable for the founding of the sedimentation tank due to the expected excessive settlement of the soils that will occur under the applied bearing pressure. Movement of the expansive soils may occur during wetting (swell) and drying (shrinkage) of the soils, which may also result in unacceptable differential movement of the sedimentation tank. It is therefore recommended that the soft clay soils are excavated and removed to spoil. The required excavation depths will vary according to the thickness of unsuitable soils that have to be removed. This is summarised in Tables 3 and 4 at the end of the report.

The recommended earthworks for the sedimentation tank are as follows:

- From the east wall of the sedimentation tank to a distance of 135m away from the wall excavate to the 1434.50 level to reach medium dense clayey silty sand.
- From a distance of 135m to 240m from the east wall excavate to the 1433.00 level to reach firm clayey silt.
- Compact the excavation floor to 90% of Modified AASHTO maximum dry density (MDD) at optimum moisture content (OMC).
- Backfill the excavation with imported rockfill up to 0,5m below the tank founding levels. Place the rockfill in maximum 500mm thick layers and compact with a minimum of 5 passes with a 10-ton pad foot roller. The maximum rock size must not exceed 350mm.
- Place imported G6 quality material on the rockfill and compact in maximum 200mm thick layers to 95% of Modified AASHTO MDD at OMC up to the required levels.
- Construct a 50mm thick blinding layer on the engineered backfill. The maximum allowable bearing pressure should not exceed 150kPa to limit settlement to less than 10mm.

The excavation must extend 2,5m beyond the sedimentation tank footprint. The excavation side wall slopes should not exceed 1V:1H but should be flattened to 1V:2H at the west side of the excavation where thicker soft clays are present.

The recommended earthworks for the flocculator are as follows:

- Excavate to the 1435.00 level to reach medium dense clayey sand and remove all material to spoil.
- Compact the excavation floor to 90% of Modified AASHTO MDD at OMC.
- Backfill the excavation with imported rockfill up to 0,5m below the flocculator founding levels. Place the rockfill in maximum 500mm thick layers and compact with a minimum of 5 passes with a 10-ton pad foot roller. The maximum rock size must not exceed 350mm.
- Place imported G6 quality material on the rockfill and compact in maximum 200mm thick layers to 95% of Modified AASHTO MDD at OMC up to the required flocculator floor levels.
- Construct a 50mm thick blinding layer on the engineered backfill. The maximum allowable bearing pressure should not exceed 150kPa to limit settlement to less than 10mm.

The excavation must extend 2m beyond the flocculator footprint. The excavation side wall slopes should not exceed 1V:1H.

A schematic excavation drawing for the sedimentation tank and flocculator is shown in Figure 4. The required excavation depths will vary from 1,9m to 3,3m below the sedimentation tank.

The old System 1A excavation is approximately 3m deep and has side walls that are close to vertical, but appear to be stable. The deeper excavation that will be required for the sedimentation tank and flocculator will be located relatively close to the toe of the old System 1A excavation walls. This may compromise the stability of some of the vertical slopes, which could result in localised slip failure. It is therefore recommended that all the vertical slopes around the perimeter of the old System 1A excavation are flattened to 1V:1H to increase the short-term stability. This must be done first before commencing with the excavation for the sedimentation tank.

10.3 EXCAVATION DEWATERING

Dewatering of the excavations will be required in accordance with the GCS dewatering plan. A system of herringbone drains draining towards a pumped sump located at the north-west side of the sedimentation tank excavation will be used for dewatering. Dewatering should only be done during the earthworks construction period, which is expected to take 1 year to complete. Permanent dewatering post-construction should not be undertaken as the water draw down cone will affect the adjacent System 5 Sedimentation Tanks U and V. The clayey soils below these structures may start to dry out resulting in soil shrinkage and soil settlement. Differential settlement of the structures may then occur, which could lead to leaking joints and also damage to pipework.

A possible method to safeguard the adjacent System 5 Sedimentation Tanks U and V to the north and the System 3 tanks to the west of the sedimentation tank from differential settlement due to de-watering would be to construct a sheet pile wall. The wall would have an approximate length of 280m at the north side of the sedimentation tank and 90m at the west side of the tank. The wall will need to be installed from the floor of the excavation and extend down to the rock level 6m below. The wall will contain the groundwater at the System 5 and System 3 sides and away from the sedimentation tank excavation.

The estimated cost for the wall installation by a specialist geotechnical contractor is in the region of R8 million.

10.4 CONSTRUCTION RECOMMENDATIONS

The excavations must be inspected by a geotechnical engineer during construction. This will include a visual assessment of the side walls and also whether adequate founding conditions have been reached for the sedimentation tank and flocculator before proceeding with backfilling. Deeper over-excavation may be required by the engineer should localised poorer soil conditions be encountered. At least 5 visits should be allowed for by a geotechnical engineer during construction. Backfilling may not commence until the excavations have been inspected and signed off by a geotechnical engineer.

Laboratory testing of the G6 material will be required to ensure that it meets the required COLTO specification. This will include foundation indicator, Modified AASHTO and CBR tests. The test results must be submitted to the geotechnical engineer for approval. Troxler density tests and sand replacement tests must be conducted on the G6 material to ensure that it meets the required 95% of Modified AASHTO compaction specification.

Survey points should be placed on the structures and weekly surveys should be undertaken during construction to monitor movement. Dewatering may need to be stopped should movement occur at Sedimentation Tanks U and V outside the specified values by Rand Water and the Engineer.

It is recommended that the excavation for the sedimentation tank should proceed from east to west (i.e. shallower excavation done first before proceeding with the deeper excavation) to avoid working below the water table for as long as possible.

A large volume of rockfill will be required for backfilling. One possible source of material could be the Seriti New Vaal Colliery which is located approximately 4km east of the Vereeniging Pump Station. This may be more cost effective than importing material from a commercial source.

Spoil and stockpile areas for material removed from the old System 1A excavation need to be identified. Demolished concrete could possibly be stockpiled north of the System 4 sedimentation tanks at the existing demolished concrete stockpile. A designated spoil area for the clay soils needs to be identified at the Vereeniging Pump Station. Alternatively, the material will have to be removed off site.

10.5 PIPELINE RECOMMENDATIONS

All excavations of a temporary nature for installation of pipelines, must be excavated to a slope not steeper than 1H:0,6V for safety reasons. The excavation slope may have to be further flattened to 1H:1V or appropriate shoring must be installed for the required duration of work, should this be required. It is recommended that most of the excavations are made by hand to the required pipe invert levels so as to minimise damage to existing services.

It is likely that pipe trench dewatering will be required to the east of Filter House No.2 as well as east of the System 5 Flocculator, and provision for dewatering equipment must be made. All materials for pipe bedding and backfilling are to be imported as no suitable materials which meet the RW specification were encountered on site. All imported materials and construction of pipelines are to follow RW specifications [8].

Rand Water requires the elastic modulus (E_s) values of subsoil materials along the pipeline route. The results of plate load bearing or triaxial tests provide the parameters to calculate the E-value. These tests were not carried out and estimated ranges of the E-values are provided in Table 2.

It should be noted that the moisture condition of the test pits influences the modulus of elasticity. A cohesive soil that increases in moisture content will decrease in consistency and thus have a decrease in the modulus of elasticity.

11. CONCLUSION

The current geotechnical investigation by KP and previous drilling investigation by JG Afrika in 2016 shows that the soils at the old System 1A excavation are highly variable and comprise from clayey sands with a low to medium potential expansiveness to clays with a very high potential expansiveness. Thicker soft clays are present at the west side of the excavation and typically extend to depths of 3m. The excavation has been highly disturbed and large areas have been covered by fill. There are a number of remaining old System 1A structures, which have been partially demolished and still need to be removed before construction of the sedimentation tank may proceed.

The excavation must be deepened to remove unsuitable soils below the proposed position of the sedimentation tank to the 1434.50 and 1433.00 levels. The required excavation depths will vary from 1,9m to 3,3m below the tank. The excavation must be backfilled with rockfill in maximum 500mm thick layers with G6 material placed in maximum 200mm thick layers compacted to 95% of Modified AASHTO MDD at OMC on the rockfill.

The required excavation level for the flocculator is 1435.00. Backfilling below the structure must be as for the sedimentation tank.

The excavations will need to be dewatered due to the presence of a shallow water table as per the GCS plan. There is a risk of differential settlement of the adjacent System 5 Sedimentation Tanks U and V and the tanks to the west of the sedimentation tank. A sheet pile wall may be considered as an option to mitigate this at an estimated cost of R8 million. The wall will contain the groundwater at the System 5 and System 3 sides and away from the sedimentation tank excavation.

The excavations must be inspected by a geotechnical engineer during construction. This will include a visual assessment of the side walls and also whether adequate founding conditions have been reached for the sedimentation tank and flocculator before the contractor may be allowed to proceed with backfilling. This is a key holding point during the earthworks construction.

Imported backfill materials for pipelines will be required as no suitable backfill material is available on site. Dewatering of pipe trenches will be required in some places. Hand excavation should be used for most of the pipe trench excavations to avoid damaging existing services.

12. REFERENCES

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[4] South African Bureau of Standards SANS 10160 Part 4. *Seismic actions and general requirements for buildings*. Pretoria 2016.

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[7] Hunt, R.E. *Geotechnical Engineering Techniques and Practices*, McGraw-Hill, 1986, ISBN 0-07-031310-5.

[8] Rand Water, *Technical Specification for Pipeline Excavation, Backfilling and Pipe Trenches and Pipe Laying, Special and Testing and Investigations and Returnable Schedules (TS)*, Doc No. SAM DOP 00001 TS, Rev No.1, June 2018.

[9] Rand Water. *Sedimentation and Flocculation Plant at Vereeniging Pumping Station Geotechnical Report.* JG Afrika (Pty) Ltd 2016.

13. CERTIFICATION

This report was prepared and reviewed by the undersigned.

Prepared: 

DEON BESTER Pr.Sci.Nat.
Junior Engineering Geologist

Reviewed: 

MICHAEL PLICHTA PrEng
Senior Geotechnical Engineer

TABLE 1. SUMMARY OF TEST PIT PROFILES

Test Pit No.	Total Depth (m)	Refusal	Thickness of Layers (m) – (m)										Depth to Seepage (m)
			Transported Soil					Residual Soil			Pedogenic	Rock	
			Fill	Topsoil	Colluvium	Hillwash	Alluvium	Reworked Residual Sandstone	Carbonaceous Shale	Reworked Shale/Mudrock	Nodular/ *Honeycomb/ **Hardpan Ferricrete	Shale	
TP01	3,70	T	0,0-1,0	-	-	-	1,0-3,7	-	-	-	-	-	-
TP02	3,65	T	0,0-1,95	-	-	-	1,95-3,65	-	-	-	-	-	-
TP03	1,40	T	0,3-0,9	0,0-0,3	-	-	0,9-1,4	-	-	-	-	-	-
TP04	2,10	T	0,0-2,1	-	-	-	-	-	-	-	-	-	-
TP05	2,20	T	0,0-2,2	-	-	-	-	-	-	-	-	-	-
TP06	1,90	T	0,0-1,9	-	-	-	-	-	-	-	-	-	-
TP07	1,10	T	0,0-1,1	-	-	-	-	-	-	-	-	-	-
TP08	2,10	T	0,0-1,0	1,0-1,6	1,6-2,1	-	-	-	-	-	-	-	-
TP09	2,00	T	0,2-2,0	0,0-0,2	-	-	-	-	-	-	-	-	-
TP10	2,50	T	0,0-1,9	1,9-2,3	2,3-2,5	-		-	-	-	-	-	-
TP11	1,40	T	0,0-0,2	0,2-0,6	-	0,6-1,1	-	-	-	-	1,1-1,4	-	-
TP12	5,20	NR	0,0-2,8	-	-	-	-	-	2,8-4,8	4,8-5,2	-	-	3,5
TP13	5,00	R	0,0-3,8	-	-	-	-	3,8-5,0	-	-	-	5,0+	-
TP14	4,90	T	0,0-4,9	-	-	-	-	-	-	-	-	-	4,0
TP15	6,00	T	0,0-1,3	-	-	-	-	1,3-5,0	-	5,0-6,0	-	-	2,0
TP16	0,15	R	0,0-0,15	-	-	-	-	-	-	-	-	-	-
TP16A	1,40	R	0,0-1,4	-	-	-	-	-	-	-	-	-	-

Notes: NR - Near Refusal
T - Terminated by Geologist
R - Refusal

TABLE 2
SUMMARY OF LABORATORY TEST RESULTS

Sample		Grading %				Atterberg Limits %			GM	PE	USC	Proctor Compaction		Natural Moisture Content (%)	Relative Density (S.G.)	Free Swell (%)	CBR (Modified AASHTO) TMH1 A7							Maximum Dry Density (kg/m³) & OMC	Compact-ibility Factor	Falling Head - Remoulded Avg Permeability (100 KPa)	Basson's Index	Material Description	Estimated Range of Modulus of Elasticity E_s (MPa)
No.	Depth (m-m)	Gravel	Sand	Silt	Clay	LL	PI	LS				MDD (kg/m³)	OMC (%)				% Swell	90%	93%	95%	97%	98%	100%						
TP01/1	1.00 - 1.70	1	39	18	42	51	32	15,5	0,55	High	CH	-	-	14,7	-	-	-	-	-	-	-	-	-	-	-	-	-	Interpreted as Alluvium	2 – 4
TP01/2	1.70 - 3.70	6	31	19	44	64	42	17	0,55	V.high	CH	-	-	34,6	-	-	-	-	-	-	-	-	-	-	-	-	-	Interpreted as Alluvium	2 – 4
TP02/1	0.90 - 1.40	51	24	11	14	49	26	13,5	1,87	Low	GC	1828	14,3	-	-	-	8,4	2	2	2	2	2	2	1828 @ 14.3	-	-	Highly corrosive and mildly aggressive	Fill	6 – 20
TP04/1	1.60 - 2.10	2	48	26	24	32	19	9	0,59	Med	CL	-	-	17,3	-	-	-	-	-	-	-	-	-	-	-	-	-	Fill	8 – 12
TP05/1	1.40 - 2.20	21	39	15	25	55	33	16	1,28	Med	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Fill	-
TP06/1	0.20 - 1.20	65	21	12	2	NA	SP	1	2,27	Low	GM	1497	18,7	-	-	-	0,1	24	38	52	71	83	114	1497 @ 18.7%	0,316	-	-	Fill	-
TP08/1	1.00 - 1.60	2	50	21	27	33	18	9,5	0,64	Med	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Topsoil	10 – 30
TP08/2	1.60 - 2.10	39	31	10	20	50	29	13	1,68	Low	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Ferruginous Colluvium	8 – 20
TP10/1	0.6 - 1.90	34	34	15	17	32	16	8	1,47	Low	SC	1967	10,9	-	-	-	0,8	8	11	15	19	21	27	1967 @ 10.9%	0,333	-	Highly corrosive and mildly aggressive	Fill	15 – 40
TP10/2	2.30 - 2.50	26	38	14	22	34	16	7	1,31	Low	SC	-	-	15,9	-	-	-	-	-	-	-	-	-	-	-	-	-	Ferruginous Colluvium	8 – 20
TP12/1	0.00 - 1.30	10	40	18	32	55	34	16	0,85	High	CH	-	-	23,6	-	-	-	-	-	-	-	-	-	-	-	-	-	Fill	2 – 4
TP12/2	1.90 - 2.80	15	42	19	24	66	36	18	1,16	Med	SC	-	-	31,4	-	-	-	-	-	-	-	-	-	-	-	-	-	Fill	2 – 4
TP12/3	2.80 - 4.80	0	30	57	13	36	13	5	0,24	Low	CI	-	-	23,7	-	-	-	-	-	-	-	-	-	-	-	-	-	Residual Carbonaceous Shale	8 – 20
TP13/1	1.20 - 1.40	5	31	18	46	66	41	17,5	0,57	V.high	CH	-	-	-	2,519	1,91	-	-	-	-	-	-	-	-	-		-	Fill	2 – 4
TP13/2	3.80 - 5.00	5	22	36	37	39	18	9,5	0,5	Low	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Highly corrosive and aggressive	Reworked Residual Shale	8 – 20
TP15/1	0.50 - 1.30	51	23	8	18	60	31	15,5	1,95	Low	SC	1702	16	-	-	-	3,8	2	2	3	3	3	3	1702 @ 16%	-	4,1E-08	-	Fill	-
TP15/2	1.30 - 2.40	3	42	20	35	45	25	11,5	0,61	Med	CL	-	-	19,4	-	-	-	-	-	-	-	-	-	-	-	-	-	Reworked Residual Sandstone	2 – 20
TP15/3	2.40 - 5.00	5	83	9	3	31	13	6,5	1,58	Low	SC	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	Highly corrosive and aggressive	Reworked Residual Sandstone	2 – 20
TP15/4	5.00 - 6.00	3	20	41	36	34	13	7	0,42	Low	CL	-	-	15,3	-	-	-	-	-	-	-	-	-	-	-	-	-	Reworked Residual Sandstone	2 – 20
WBA2	Stockpile	39	32	14	15	41	23	11,5	1,66	Low	SC	1913	12,3	-	-	-	1,9	5	7	8	11	12	15	1913 @ 12.3%	0,366	3,2E-09	-	Fill	-

ABBREVIATIONS

LL	:	Liquid Limit	OMC	:	Optimum Moisture Content
PI	:	Plasticity Index	S.G.	:	Specific gravity
LS	:	Linear Shrinkage	CH	:	Clay with high plasticity
GM	:	Grading Modulus	GC	:	Clayey gravel
PE	:	Potential Expansiveness	CL	:	Low plasticity clay
USC	:	Unified Soil Classification	SC	:	Clayey sand
MDD	:	Maximum Dry Density	GM	:	Silty gravel

TABLE 3. MINIMUM FLOCCULATOR AND SEDIMENTATION TANK EXCAVATION LEVELS

BOREHOLE / TEST PIT NO.	GROUND LEVEL	REQUIRED EXCAVATION DEPTH FROM GROUND SURFACE (m)	MINIMUM EXCAVATION LEVEL	BOTTOM OF STRUCTURE LEVEL	MINIMUM EXCAVATION DEPTH BELOW BOTTOM OF STRUCTURE (m)
BOREHOLES					
BH1*	1438,712	3,50	**1435,210**	1435,910	0,700
BH2	1436,476	N/A (no structure)	**-**	-	-
BH3	1436,505	2,00	**1434,505**	1436,800	2,295
BH4**	1436,500	2,00	**1434,500**	1436,800	2,300
BH5	1439,060	4,25	**1434,806**	1436,650	1,844
BH6	1436,978	2,30	**1434,677**	1436,400	1,723
BH7	1436,888	3,00	**1433,888**	1436,300	2,412
BH8	1436,815	2,70	**1434,115**	1436,250	2,135
TEST PITS					
TP12	1436,535	3,00	**1433,535**	1436,300	2,765
TP13	1436,722	3,50	**1433,222**	1436,200	2,978
TP14	1437,306	2,50	**1434,806**	1436,600	1,794
TP15	1437,077	2,40	**1434,677**	1436,490	1,813
TP16	1436,759	Unknown: shallow test pit	**-**	1436,700	-
TP16A	1436,072	Unknown: shallow test pit	**-**	1436,700	-

Notes:
* Borehole drilled at proposed flocculator.
** No survey data. Estimated ground level.

TABLE 4. RECOMMENDED FLOCCULATOR AND SEDIMENTATION TANK EXCAVATION LEVELS

BOREHOLE / TEST PIT NO.	GROUND LEVEL	REQUIRED EXCAVATION DEPTH FROM GROUND SURFACE (M)	RECOMMENDED EXCAVATION LEVEL	BOTTOM OF STRUCTURE LEVEL	MINIMUM EXCAVATION DEPTH BELOW BOTTOM OF STRUCTURE (M)
BOREHOLES					
BH1*	1438,712	3,71	**1435,00**	1435,910	0,910
BH2	1436,476	N/A (no structure)	**-**	-	-
BH3	1436,505	2,01	**1434,50**	1436,800	2,300
BH4**	1436,500	2,00	**1434,50**	1436,800	2,300
BH5	1439,060	4,56	**1434,50**	1436,650	2,150
BH6	1436,978	2,48	**1434,50**	1436,400	1,900
BH7	1436,888	3,89	**1433,00**	1436,300	3,300
BH8	1436,815	3,82	**1433,00**	1436,250	3,250
TEST PITS					
TP12	1436,535	3,54	**1433,00**	1436,300	3,300
TP13	1436,722	3,72	**1433,00**	1436,200	3,200
TP14	1437,306	2,81	**1434,50**	1436,600	2,100
TP15	1437,077	2,58	**1434,50**	1436,490	1,990
TP16	1436,759	2,26	**1434,50**	1436,700	2,200
TP16A	1436,072	1,57	**1434,50**	1436,700	2,200

Notes:

* Borehole drilled at proposed flocculator.

** No survey data. Estimated ground level.

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VEREENIGING PUMP STATION
SYSTEM 1 GEOTECHNICAL INVESTIGATION

LOCALITY PLAN

PROJECT NO: 30300496/03

FIGURE NO 1

SCALE N.T.S.

GEOLOGICAL LEGEND:

Q : Soil cover, river sand, diamondiferous gravels
Qa : Alluvium
Qs : Aeolian sand
Pv : Shale, sandstone, coal of the Vryheid Formation, Ecca Group, Karoo Supergroup.
Vdp : Quartzite, shale, ferruginous in places of the Daspoort Formation, Pretoria Group, Transvaal Supergroup.
Vmd : Dolomite of the Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup.

REFERENCE MAP
GEOLOGICAL SERIES
WEST RAND GEOLOGY
NOT TO ORIGINAL SCALE

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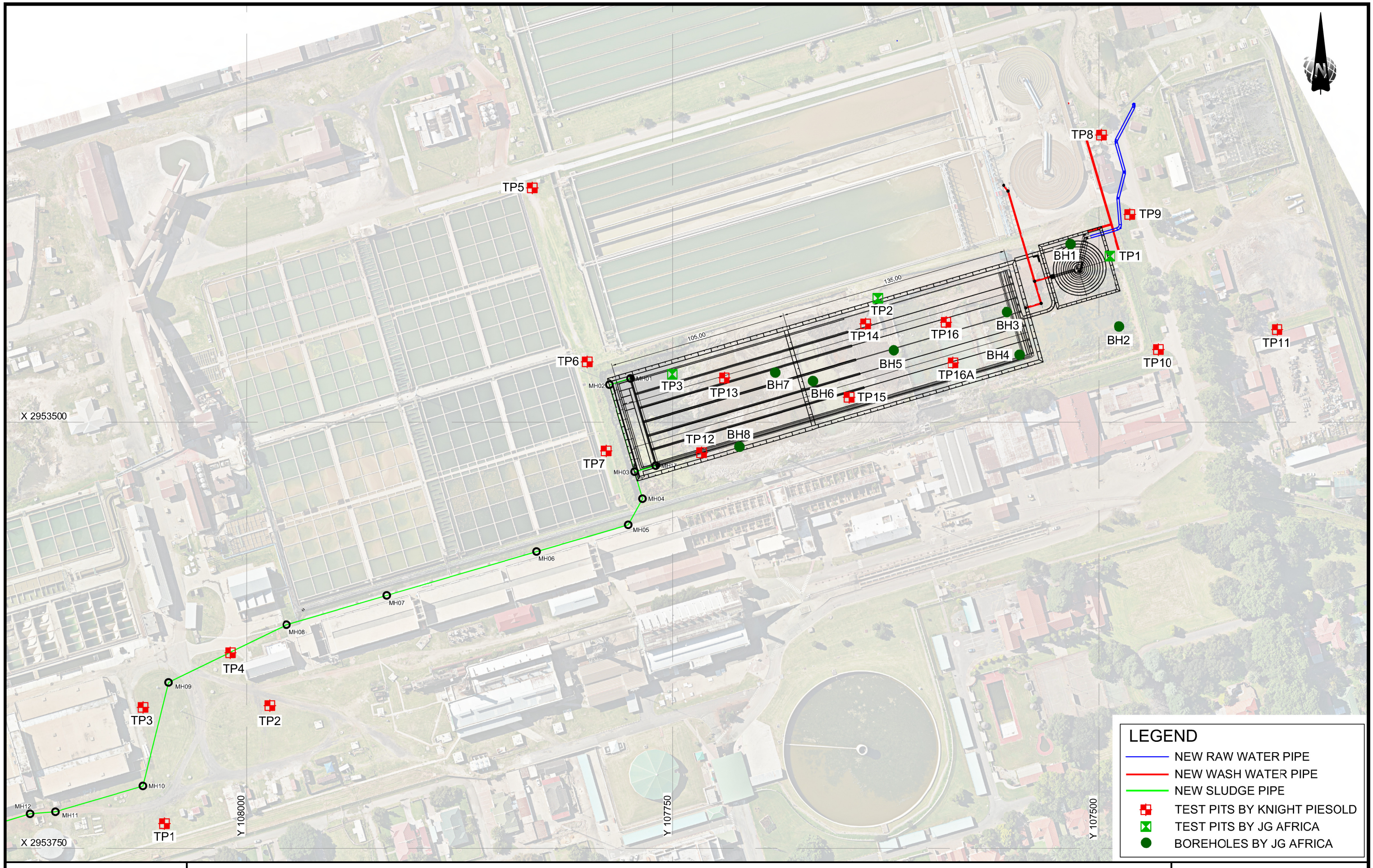
VEREENIGING PUMP STATION
SYSTEM 1 GEOTECHNICAL INVESTIGATION

GEOLOGY PLAN

PROJECT NO: 30300496/03

FIGURE NO 2

SCALE N.T.S.



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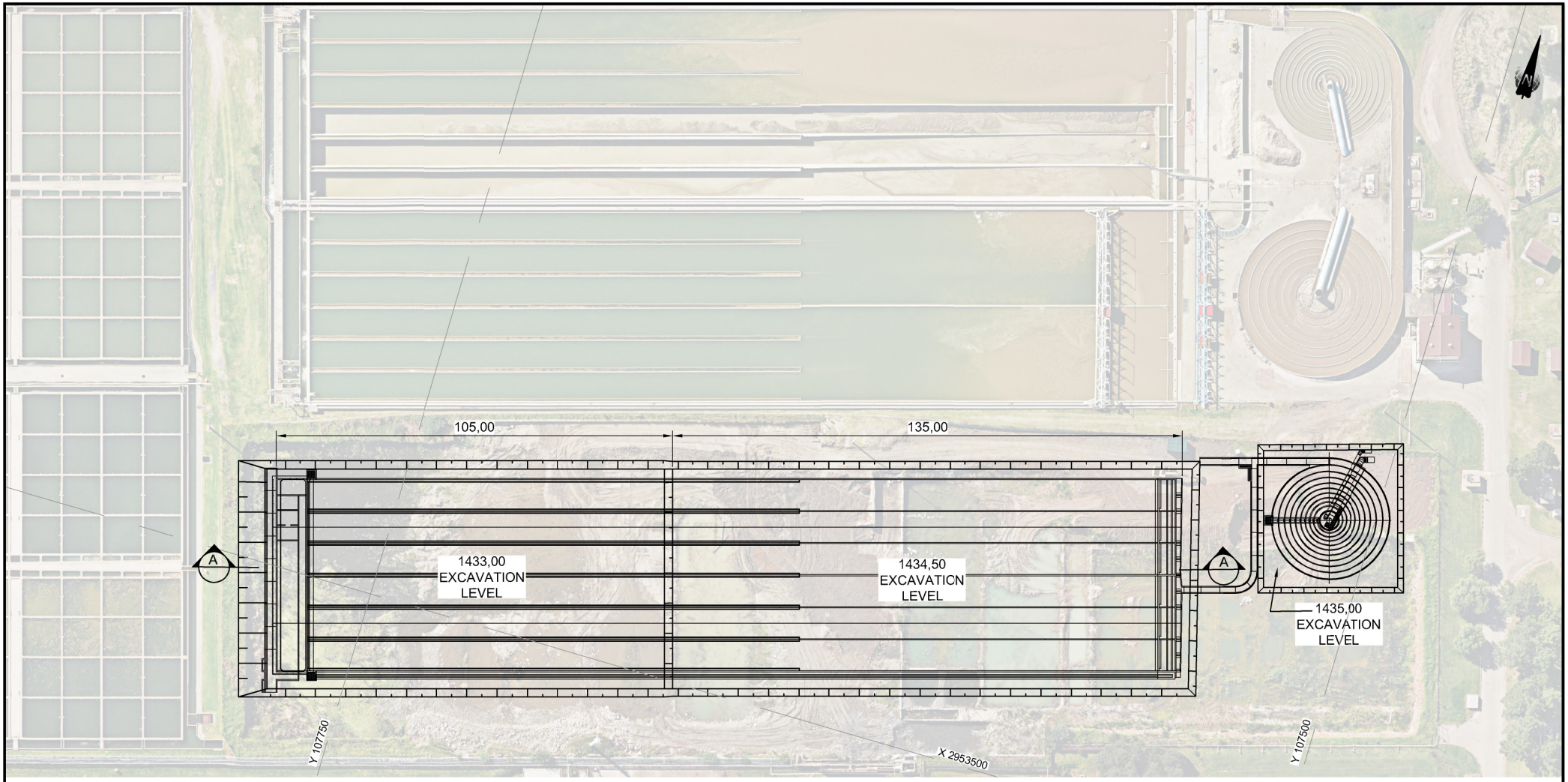
VEREENIGING PUMP STATION
SYSTEM 1 GEOTECHNICAL INVESTIGATION

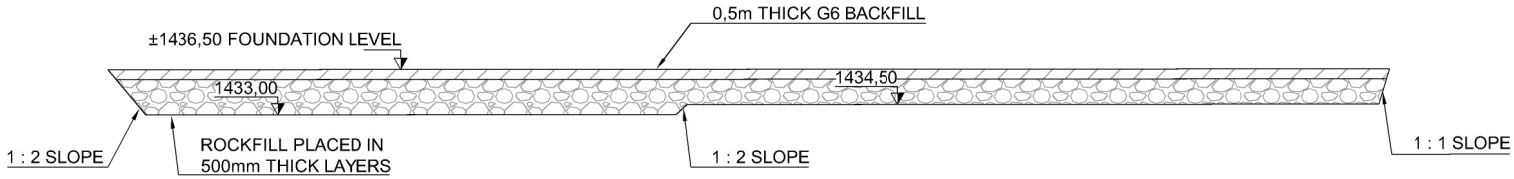
GEOTECHNICAL PLAN

PROJECT NO: 30300496/03

FIGURE NO 3

SCALE 1 : 2000





SECTION A - A
NTS

Knight Piésold CONSULTING

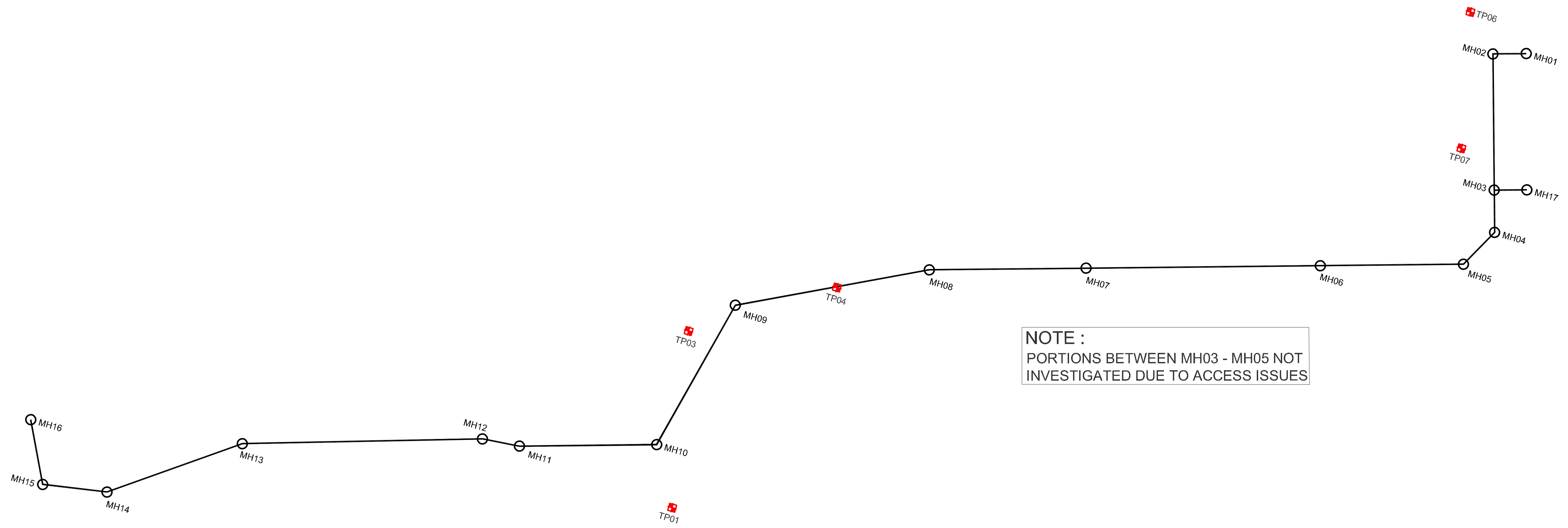
VEREENIGING PUMP STATION
SYSTEM 1 GEOTECHNICAL INVESTIGATION

PROPOSED EXCAVATION PLAN (SCHEMATIC)

PROJECT NO: 30300496/03

FIGURE NO 4

SCALE 1 : 1500



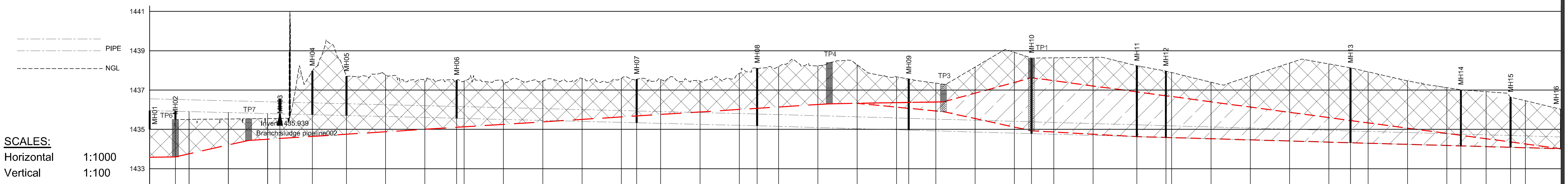
NOTE :
PORTIONS BETWEEN MH03 - MH05 NOT INVESTIGATED DUE TO ACCESS ISSUES

LEGEND

TEST PIT MATERIAL LEGEND
- FILL
- ALLUVIUM

INTERPRETATION BETWEEN BOREHOLES
- GEOLOGICAL BOUNDARY

EXCAVATABILITY:
- FILL : SOFT
- ALLUVIUM : SOFT



SCALES:
Horizontal 1:1000
Vertical 1:100

Datum : 1431m

CHAINAGE (m)	GROUND LEVEL	INVERT LEVEL	DEPTH TO INVERTS
0.000	1435.000	1435.955	0.955
13.058	1435.503	1435.922	0.419
20.000	1435.506	1435.905	0.399
40.000	1435.530	1435.855	0.325
60.000	1435.553	1435.805	0.252
66.250	1435.556	1435.789	0.233
82.736	1437.973	1435.748	-2.225
100.145	1437.701	1435.705	-1.996
120.000	1437.775	1435.655	-2.120
140.000	1437.464	1435.605	-1.859
156.166	1437.502	1435.565	-1.937
160.000	1437.455	1435.555	-1.900
180.000	1437.375	1435.505	-1.870
200.000	1437.458	1435.455	-2.003
220.000	1437.583	1435.405	-2.178
240.000	1437.600	1435.355	-2.245
247.770	1437.552	1435.336	-2.216
260.000	1437.542	1435.305	-2.237
280.000	1437.449	1435.255	-2.194
300.000	1437.846	1435.205	-2.641
309.091	1438.119	1435.182	-2.937
320.000	1438.197	1435.151	-3.046
340.000	1438.233	1435.094	-3.139
360.000	1438.290	1435.037	-3.253
380.000	1437.671	1434.980	-2.691
386.186	1437.567	1434.962	-2.605
400.000	1437.351	1434.923	-2.428
420.000	1438.170	1434.865	-3.305
440.000	1438.917	1434.808	-4.109
448.692	1438.626	1434.783	-3.843
460.000	1438.640	1434.751	-3.889
480.000	1438.663	1434.694	-3.969
502.311	1438.234	1434.630	-3.604
517.055	1437.965	1434.588	-3.377
520.000	1437.892	1434.580	-3.312
540.000	1437.396	1434.523	-2.873
560.000	1437.709	1434.465	-3.244
580.000	1438.373	1434.408	-3.965
600.000	1438.329	1434.351	-3.978
610.975	1438.133	1434.320	-3.813
620.000	1437.924	1434.294	-3.630
640.000	1437.472	1434.237	-3.235
660.000	1437.122	1434.180	-2.942
667.161	1437.012	1434.159	-2.853
680.000	1436.918	1434.123	-2.795
692.466	1436.636	1434.087	-2.549
700.000	1436.456	1434.065	-2.391
718.176	1436.020	1434.013	-2.007

Segment lengths: 13.058m, 53.192m, 16.486m, 17.409m, 56.021m, 91.604m, 61.321m, 77.095m, 62.506m, 53.619m, 14.744m, 93.920m, 56.186m, 25.305m, 25.711m

PIPE GRADES: 1: 400.001 (0.250 %); 1: 350 (0.286 %)

PIPE DETAILS: 600mm HDPE (4kN/m2) Class B rigid pipe bedding

HYDRAULICS

DESIGN: Q (l/s)	DESIGN: V (m/s)	MAX.(0.83D): Q (l/s)	MAX.(0.83D): V (m/s)
187.54	1.39	403.51	1.61
187.68	1.39	403.51	1.61
375.26	1.60	403.51	1.61
375.31	1.60	403.51	1.61
375.46	1.61	403.51	1.61
375.70	1.61	403.51	1.61
375.87	1.61	403.51	1.61
376.08	1.70	431.37	1.72
376.25	1.70	431.37	1.72
376.39	1.70	431.37	1.72
376.43	1.70	431.37	1.72
376.68	1.70	431.37	1.72
376.84	1.70	431.37	1.72
376.90	1.70	431.37	1.72
376.97	1.70	431.37	1.72

MH01 - MH16
Branch: sludge pipeline001

DRAWING PROVIDED BY BOSCH PROJECTS

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
SYSTEM 1 GEOTECHNICAL INVESTIGATION

SIMPLIFIED SECTION AND PLAN OF SLUDGE PIPELINE SHOWING TEST PITS

PROJECT NO: 30300496/03

FIGURE NO 5

SCALE 1 : 2000

APPENDIX A

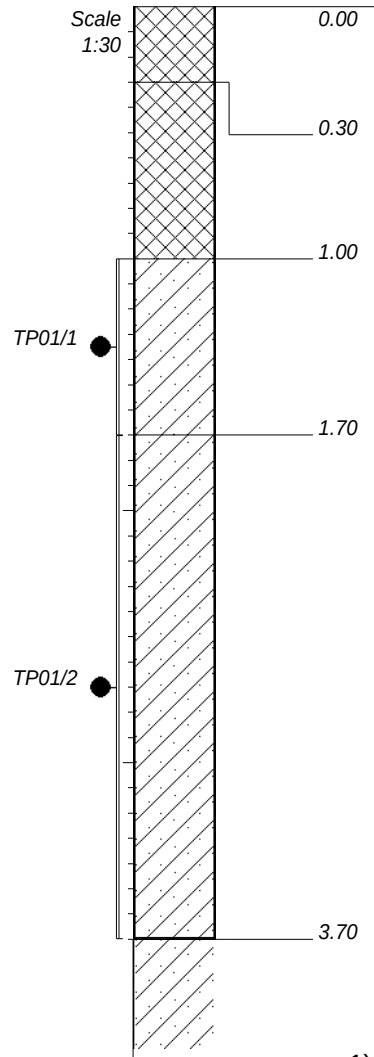
TEST PIT PROFILES

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP01
Sheet 1 of 1

JOB: 3030049603



0.00	Moist, dark grey brown, loose to medium dense, shattered, clayey silty SAND with abundant medium and fine, rounded gravel and minor coarse gravel (aggregate). **FILL**.
0.30	Moist, dark grey brown, medium dense, intact, slightly clayey silty SAND with minor sub-angular ash gravel and traces of roots. **FILL**.
1.00	Moist, dark grey stained orange, soft to firm, micro-shattered and slickensided, sandy CLAY with traces of roots. Possibly **ALLUVIUM**.
1.70	Very moist, light grey, soft, shattered and slickensided, sandy CLAY with traces to minor calcareous nodules. Possibly **ALLUVIUM**.
3.70	EOH: Excavated to maximum reach of TLB, profile continues as above.

NOTES

1) No water encountered.

2) Clay sewer pipe (100mm) and 10mm electrical cable intersected at 1.7m and 0.70m respectively.

3) Test pit moved after intersecting non-functional 50mm steel pipe, 2,5m west of final position.

4) Small bag samples TP01/1 taken from 1.00m--1.70m and TP01/2 from 1,7m--3,7m.

5) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : CAT 422E
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 19/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953735
Y-COORD : 108048

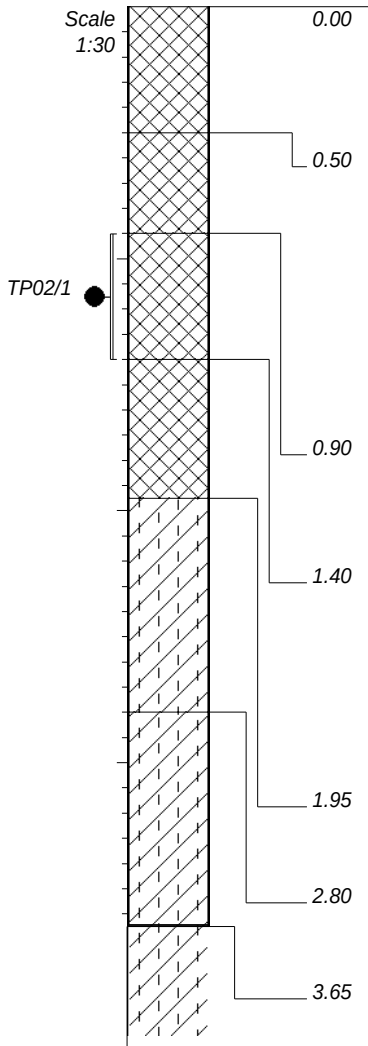
HOLE No: TP01

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP02
Sheet 1 of 1

JOB: 3030049603



0.00 – 0.50	Moist, light grey and orange mottled black, intact and matrix supported, silty sandy GRAVEL comprising coarse medium and fine quartzite gravel (aggregate), slag and ash. Overall consistency is medium dense to dense. **FILL**.
0.50 – 0.90	Moist, light olive brown, intact and matrix supported, silty sandy GRAVEL comprising sub angular dolerite gravel (aggregate). Overall consistency is dense to very dense. **FILL**. Notes: 1. Notes: 1. Possibly compacted G5/G6 layer. 2. 100mm thick paving layer in uppermost portion of horizon.
0.90 – 1.40	Moist, dark grey brown, soft to firm, shattered and slickensided, slightly clayey sandy GRAVEL comprising medium and fine gravel, ash and slag. **FILL**.
1.40 – 1.95	Moist, dark grey to black mottled red brown, soft, shattered and slickensided, slightly sandy silty CLAY with abundant medium and fine, gravel, ash, slag and ferruginous nodules. **FILL**. Note: Scattered ferruginous pockets.
1.95 – 2.80	Moist, dark grey mottled orange, soft, shattered and slickensided, silty CLAY. Possibly **ALLUVIUM**.
2.80 – 3.65	Moist, light grey, very soft to soft, shattered and slickensided, silty CLAY with traces to minor calcareous nodules. Possibly **ALLUVIUM**.
3.65	EOH: Excavated to maximum reach of TLB, profile continues as above.

NOTES

1) No water encountered.
2) Profiled from spoil below 2,8m depth.
3) Two bulk (2x large bags) samples TP02/1 taken from 0.90m--1.40m.
4) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : CAT 422E
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 20/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953666
Y-COORD : 107987

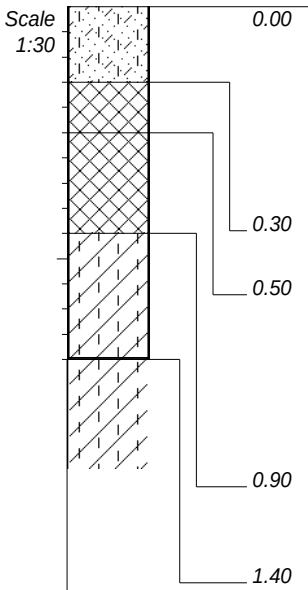
HOLE No: TP02

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP03
Sheet 1 of 1

JOB: 3030049603



Very moist, dark brown, loose, intact slightly clayey silty SAND with scattered quartzite gravel (aggregate) and abundant roots. **TOPSOIL**.

Note:
Thin stringer of gravel, ash and slag at base of horizon, approximately 20mm thick.

Moist, dark reddish brown, loose, intact silty SAND. **FILL**.

Moist, light grey and grey, loose, shattered, clayey silt (ASH) with abundant medium and fine sub-angular gravel and slag. **FILL**.

Note:
Thin lenses of up to 10m wide comprising mostly of slag.

Very moist to wet, dark grey brown mottled orange, soft, shattered and slickensided, slightly sandy silty CLAY. Possibly **ALLUVIUM**.

EOH: Hand excavated and not to refusal, profile continues as above.

NOTES

1) No water encountered.

2) Profiled from side of trench.

3) Water level measured on Nov/19/18 at 1.20m. Approximately 200mm of water in base of pit after two months.

4) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : Hand Excavated
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 20/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953667
Y-COORD : 108061

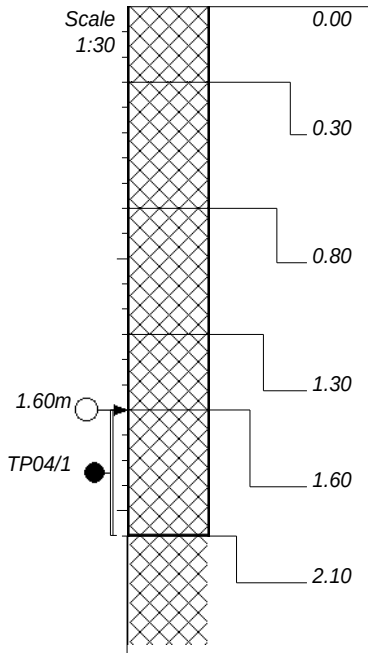
HOLE No: TP03

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP04
Sheet 1 of 1

JOB: 3030049603



0.00 – 0.30	Moist, grey and dark brown, intact and matrix supported, slightly clayey silty sandy GRAVEL comprising medium and coarse quartzite gravel (aggregate). Overall consistency is medium dense to dense. **FILL**.
0.30 – 0.80	Moist, light grey speckled black, pinholed and matrix supported, slightly sandy silty GRAVEL comprising slag in an ash matrix. Overall consistency is loose. **FILL**.
0.80 – 1.30	Very moist to wet, dark brown, firm, micro-shattered, sandy silty CLAY with abundant coarse, medium and fine gravel. Scattered builders rubble. **FILL**.
1.30 – 1.60	Very moist to wet, light grey, soft, shattered and slickensided, silty CLAY. **FILL**.
1.60 – 2.10	Wet, dark grey brown, stiff with pockets of soft, intact, clayey silty SAND. **FILL**.
2.10	EOH: Hand excavated and not to refusal, profile continues as above.

NOTES

1) Very slow water seepage from 1.60m. Approximately 10mm of water at base of pit after two hours.

2) Suspected bulk water mains below position, based on service detection survey to north.

3) Small bag sample TP04/1 taken from 1,6m--2,1m.

4) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : Hand Excavated
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 20/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953635
Y-COORD : 108010

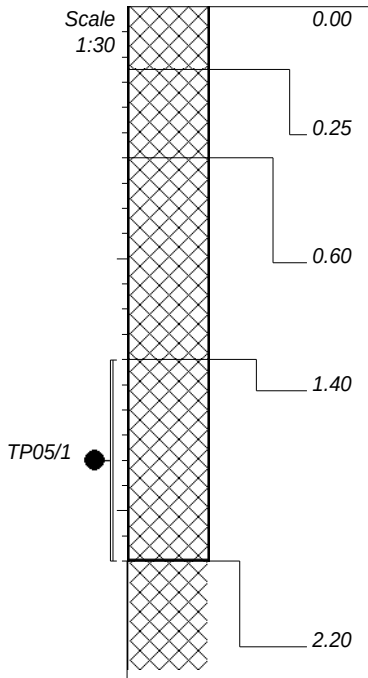
HOLE No: TP04

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP05
Sheet 1 of 1

JOB: 3030049603



0.00 – 0.25: Slightly moist, light to dark grey brown, matrix supported, slightly clayey silty sandy GRAVEL comprising coarse medium and fine gravel (aggregate), ash and slag. Overall consistency is medium dense. **FILL**.

0.25 – 0.60: Slightly moist, dark grey to black, clast supported, sandy silty GRAVEL comprising coarse medium and fine gravel, ash, slag and builders rubble. Overall consistency is loose to medium dense. **FILL**.

0.60 – 1.40: Slightly moist, grey brown stained black, firm to stiff, shattered and slickensided, slightly sandy silty CLAY with abundant medium and fine gravel, ferruginous nodules, ash and slag. **FILL**.

1.40 – 2.20: Very moist, grey brown stained black, soft, shattered and slickensided, clayey SAND with abundant medium and fine gravel, ferruginous nodules, ash and slag. **FILL**.

Note:
Scattered highly weathered, rounded quartzite cobbles and pockets of light grey mottled orange silty clay.

EOH: Hand excavated and not to refusal, profile continues as above.

NOTES

1) No water encountered.

2) Small bag sample TP05/1 taken from 1.40m--2,2m.

3) Excavated adjacent to telecommunication lines, intersected at 1.50m depth on western side of trench.

4) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : Hand Excavated
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 21/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953363
Y-COORD : 107832

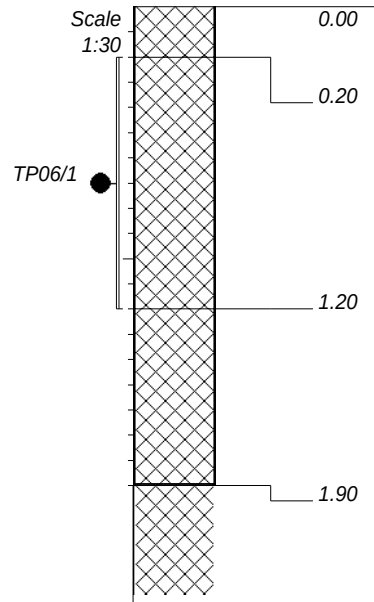
HOLE No: TP05

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP06
Sheet 1 of 1

JOB: 3030049603



0.00 – 0.20: Slightly moist, red-brown to grey brown, medium dense, intact silty SAND with minor gravel (ash and slag). **FILL**.

0.20 – 1.20: Slightly moist, light grey brown mottled black and white, clast supported silty sandy GRAVEL comprising coarse medium and fine slag in an ash matrix. Overall consistency is very loose to loose. **FILL**.

1.20 – 1.90: Moist, dark grey, voided and matrix supported, sandy silty GRAVEL comprising fine slag in an ash matrix. Overall consistency is very loose to loose. **FILL**.
Note:
Minor to abundant coarse ash and slag gravel towards base.

1.90: EOH: Hand excavation refused on concrete slab, dipping approximately 30 degrees NNW. Presumably part of Old System 1 structure.

NOTES

1) No water encountered.

2) Bulk (2x large bags) sample TP06/1 taken from 0.20m--1.20m.

3) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : Hand Excavated
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 21/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953465
Y-COORD : 107800

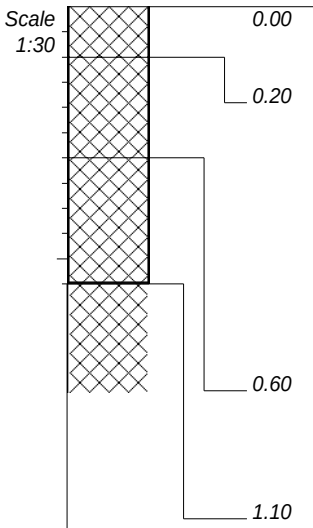
HOLE No: TP06

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP07
Sheet 1 of 1

JOB: 3030049603



0.00 – 0.20	Slightly moist, red-brown to grey brown, medium dense, intact silty SAND with minor gravel (ash and slag). **FILL**.
0.20 – 0.60	Slightly moist, light grey brown mottled black and white, clast supported sandy silty GRAVEL comprising coarse medium and fine slag in an ash matrix. Overall consistency is very loose to loose. **FILL**. Note: 1. Abundant roots. 2. 80mm thick layer at base comprising slightly moist, red brown silty sand.
0.60 – 1.10	Slightly moist, light grey brown mottled black and white, clast supported sandy silty GRAVEL comprising coarse medium and fine slag in an ash matrix. Overall consistency is very loose to loose. **FILL**.
1.10	EOH: Hand excavated and not to refusal, profile continues as above.

NOTES

1) No water encountered.
2) Sidewall collapse.
3) Services density high risk and no access with TLB.
4) Small bund/plinth wall exposed along western side of trench.
5) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : Hand Excavated
DRILLED BY : Patrick
PROFILED BY : DB

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 21/11/2018

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953517
Y-COORD : 107789

HOLE No: TP07

TYPE SET BY :
SETUP FILE : KPTP8.SET

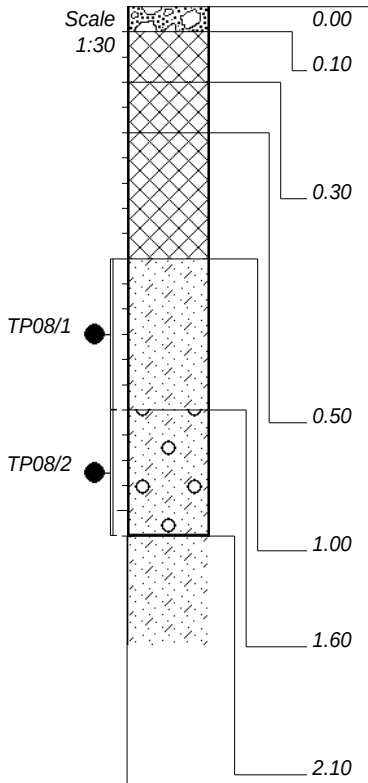
DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP08
Sheet 1 of 1

JOB: 3030049603



Paving.

Layerworks comprising alternating layers of light grey brown silty sand, ash, slightly silty medium sand and dark brown slightly clayey silty sand. Overall consistency is dense to very dense. **FILL**.

Moist, light grey, matrix supported, silty sandy GRAVEL comprising 50-60mm slightly weathered, angular quartzite gravel. Overall consistency is dense to very dense. **FILL**.

Note:
Possibly compacted G4/G5 layer.

Moist, light grey brown mottled black and white, clast supported sandy silty GRAVEL comprising coarse medium and fine slag in an ash matrix. Overall consistency is medium dense to dense. **FILL**.

Moist, dark brown, loose to medium dense, pinholed silty clayey SAND with evidence of biotic action by ants. **TOPSOIL**.

Moist, dark grey brown mottled orange and black, medium dense, intact silty clayey SAND with abundant ferruginous nodules at base. **SLIGHTLY FERRUGINOUS COLLUVIUM**.

EOH: Hand excavated and not to refusal. Excavation stopped in wet, dark grey brown blotched orange, medium dense, intact, silty clayey SAND with abundant medium and fine ferruginous nodules. **FERRUGINOUS COLLUVIUM**.

NOTES

1) Very slow water seepage encountered at base, possibly perched water table. No ponding water after two hours.

2) Small bag samples TP08/1 taken from 1.0m--1.60m and TP08/2 taken from 1,6m--2,1m..

3) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : Hand Excavated
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 21/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953332
Y-COORD : 107499

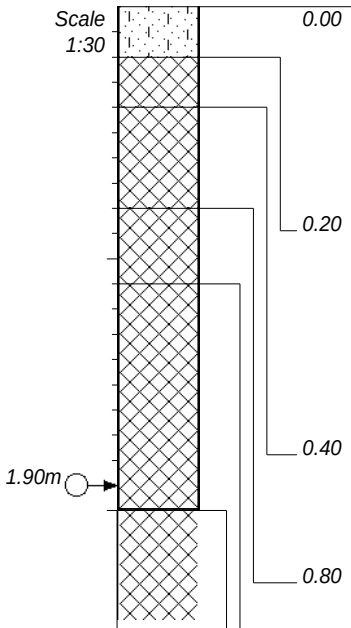
HOLE No: TP08

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP09
Sheet 1 of 1

JOB: 3030049603



0.00	Slightly moist, light brown, loose to medium dense, intact, silty SAND with minor to abundant gravel (aggregate) and ferruginous nodules at base. **FILL**/TOPSOIL Note: Minor roots.
0.20	Slightly moist, grey brown, intact to matrix supported, silty sandy GRAVEL comprising medium and coarse, slag and ash. Overall consistency is medium dense. **FILL**. Note: Minor roots.
0.40	Slightly moist, light orange brown, medium dense to dense, intact, silty SAND with abundant medium and fine ferruginous nodules. Minor coarse medium and fine gravel (aggregate), ash and slag. **FILL**.
0.80	Moist, dark grey brown, soft to firm, shattered, sandy silty CLAY with minor to abundant gravel (aggregate), ash and slag. **FILL**.
1.10	Very moist, dark grey blotched light grey mottled orange, very soft to soft, shattered and slickensided, slightly sandy silty CLAY with minor, medium and coarse gravel (aggregate) and ferruginous nodules. Traces of slag and ash gravel. **FILL**.
2.00	EOH: Hand excavated and not to refusal, profile continues as above.

NOTES

1) Moderate water seepage encountered below 1.90m. Approximately 30mm of water in base of pit after ten minutes.

2) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : Hand Excavated
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 22/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953378
Y-COORD : 107482

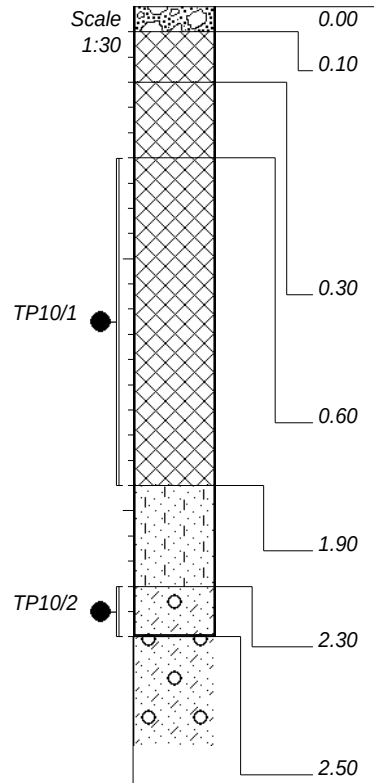
HOLE No: TP09

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP10
Sheet 1 of 1

JOB: 3030049603



0.00 – 0.10	Paving.
0.10 – 0.30	Slightly moist, light grey, matrix to clast supported silty sandy GRAVEL comprising coarse, medium and fine sub-angular, slightly weathered quartzite gravel (aggregate). Overall consistency is very dense. **FILL**. Note: Possibly compacted G5 layer.
0.30 – 0.60	Moist, dark grey brown becoming light brown, dense, intact silty SAND with minor to abundant medium and fine hard ferruginous nodules. Traces to minor medium and fine ash and slag gravel. **FILL**.
0.60 – 1.90	Moist, light brown, medium dense intact, slightly clayey silty SAND with abundant medium and fine hard ferruginous nodules and minor sub-rounded quartzite gravel. **FILL**.
1.90 – 2.30	Moist, dark brown, loose to medium dense, pinholed, silty SAND with scattered ferruginous nodules at base. **TOPSOIL**
2.30 – 2.50	Moist, light orange brown mottled black, intact to matrix supported, clayey gravelly SAND with minor to abundant medium and fine ferruginous nodules. **FERRUGINOUS COLLUVIUM**.
2.50	EOH: Hand excavated and not to refusal, profile continues as above.

NOTES

1) No water encountered.
2) Bulk (2x large bags) sample TP10/1 taken from 0.60m--1.90m.
3) Small bag sample TP10/2 taken from 2,3m--2,5m.
4) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : Hand Excavated
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 22/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953457
Y-COORD : 107465

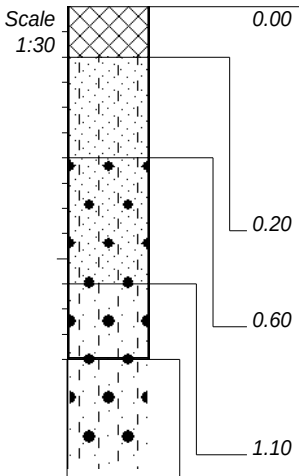
HOLE No: TP10

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP11
Sheet 1 of 1

JOB: 3030049603



0.00 – 0.20	Slightly moist, dark brown and grey brown, very loose, pinholed silty SAND with traces to minor gravel, rubble and ash. **FILL**. Note: Scattered lenses of light brown slightly silty medium sand. Minor roots.
0.20 – 0.60	Slightly moist, dark brown, medium dense, pinholed and voided, silty SAND with minor roots. **TOPSOIL**
0.60 – 1.10	Slightly moist, light orange brown mottled black, medium dense, pinholed and voided, silty SAND with minor to abundant coarse medium and fine ferruginous nodules. **FERRUGINOUS HILLWASH**.
1.10 – 1.40	Moist, light orange brown mottled black, matrix supported silty sandy GRAVEL comprising coarse medium and fine hard ferruginous nodules. Overall consistency is medium dense. **NODULAR FERRICRETE**. Note: Borders on honeycomb ferricrete in places.
1.40	EOH: Hand excavated and not to refusal, profile continues as above.

NOTES

1) No water encountered.

2) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : Hand Excavated
DRILLED BY : Patrick
PROFILED BY : DB

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 22/11/2018

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953518
Y-COORD : 107733

HOLE No: TP11

TYPE SET BY :
SETUP FILE : KPTP8.SET

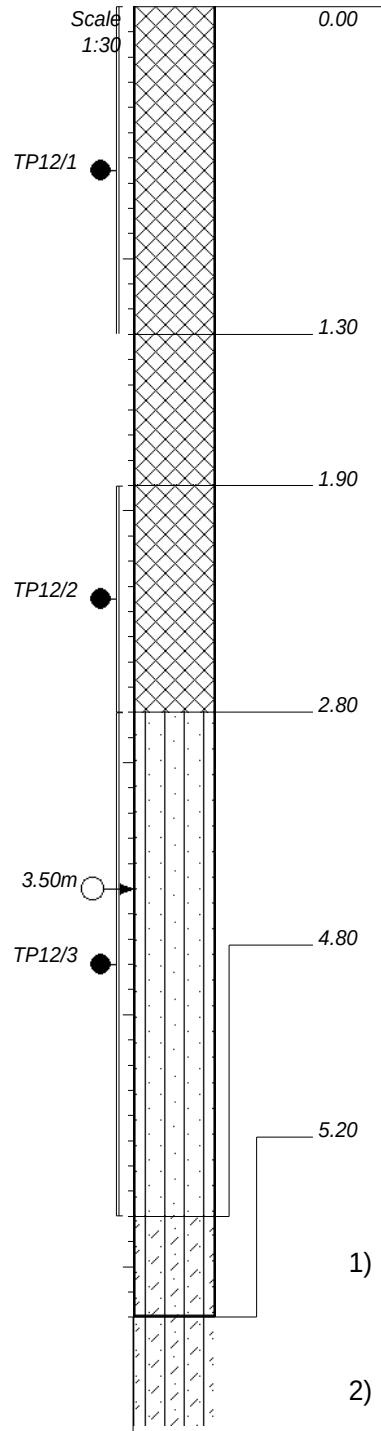
DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP12
Sheet 1 of 1

JOB: 3030049603



0.00	Very moist, dark olive grey, soft, shattered and slickensided, clayey SAND with traces of roots. Interpreted as **FILL**.
1.30	Very moist, light grey blotched white, soft, shattered and slickensided clayey SAND with minor to abundant pockets of calcareous nodules. Possibly **FILL**.
1.90	Very moist to wet, light grey stained black mottled orange, soft to firm, shattered and slickensided, clayey SAND with minor completely to highly weathered sandstone cobbles and rounded quartzite cobbles. Abundant fine ferruginous nodules. Possibly **FILL**.
2.80	Very moist, black, firm, slickensided and relict bedded sandy SILT. **RESIDUAL CARBONACEOUS SHALE**.
4.80	Moist, medium grey stained light brown, very stiff becoming very soft rock, very closely relict jointed, clayey sandy SILT. **RESIDUAL MUDSTONE**. Note: Borders on very soft rock mudstone at base.
5.20	EOH: Maximum reach of excavator, near refusal in layer as above.

NOTES

1) Very slow water seepage from 3.50m on southern side of pit. Approximately 200mm of water in base of pit after one hour and approximately 500mm after eighteen hours.
2) Small bag sample TP12/1 taken from 0,0m--1,3m.
3) Small bag sample TP12/2 taken from 1,9m--2,8m.
4) Small bag sample TP12/3 taken from 2,8m--4,8m..
5) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : CAT 320D
DRILLED BY : Patrick
PROFILED BY : DB

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 22/11/2018

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953474
Y-COORD : 107720

HOLE No: TP12

TYPE SET BY :
SETUP FILE : KPTP8.SET

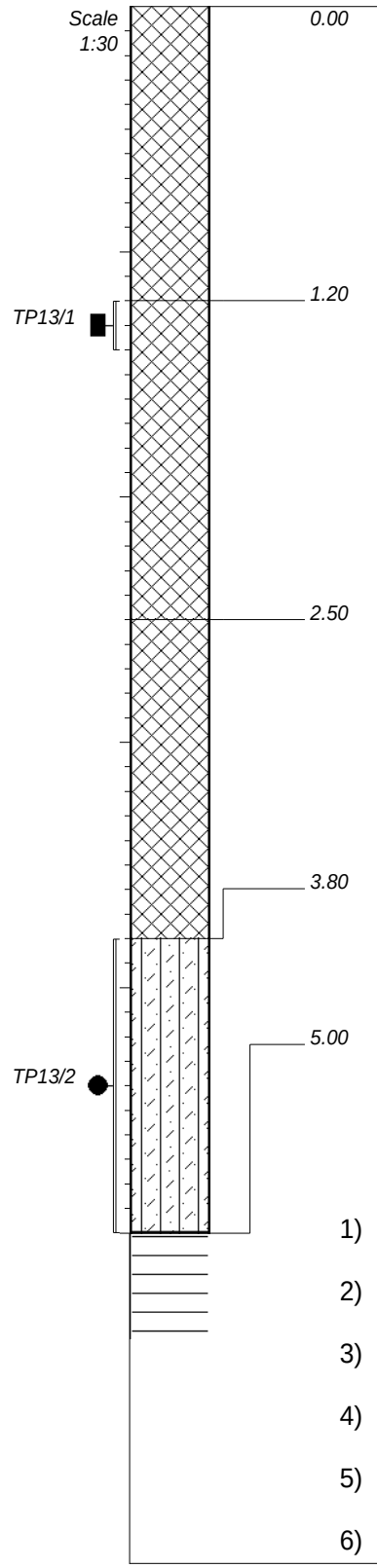
DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP13
Sheet 1 of 1

JOB: 3030049603



0.00
Moist, dark olive grey, soft, shattered and slickensided, silty CLAY with minor roots. **FILL**.

1.20
Very moist, light grey, very soft to soft, shattered and slickensided sandy CLAY with minor coarse medium and fine calcareous nodules. Possibly **FILL**.

2.50
Moist, light grey mottled orange stained black, soft to firm, slickensided, sandy CLAY with abundant to equal amounts of coarse medium and fine round quartzite gravel and traces of cobbles. Abundant completely to highly weathered sandstone cobbles and traces of ferruginous nodules. Possibly **FILL**.

3.80
Moist light grey streaked pinkish brown mottled orange, firm to stiff, shattered and slickensided with pockets of relict bedding at base, clayey sandy SILT. Minor to abundant pockets of ferruginous zones. **REWORKED RESIDUAL SHALE**.

5.00
EOH: Refusal on highly weathered, light pinkish brown streaked light grey stained black, very closely bedded and jointed with iron staining along joints, fine grained, very soft to soft rock SHALE.

NOTES

1) No water encountered.
2) Sidewall collapse of northern sidewall during excavation.
3) Profiled from spoil.
4) Undisturbed sample TP13/1 taken from 1,2m--1,4m.
5) Small bag sample TP13/2 taken from 3,8m--5,0m.
6) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : CAT 320D
DRILLED BY : Patrick
PROFILED BY : DB

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 22/11/2018

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953442
Y-COORD : 107637

HOLE No: TP13

TYPE SET BY :
SETUP FILE : KPTP8.SET

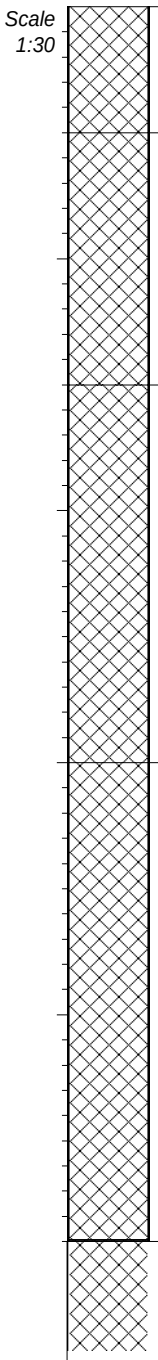
DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP14
Sheet 1 of 1

JOB: 3030049603



0.00

Moist, dark brown, loose to very loose, pinholed silty SAND with abundant coarse medium and fine gravel (aggregate) and builders rubble. **FILL**.

0.50

Slightly moist, light grey brown, voided and matrix supported silty sandy GRAVEL and COBBLES comprising builders rubble, bricks and concrete. Overall consistency is loose. **FILL**.

1.50

Moist, dark grey, intact? and matrix supported clayey sandy COBBLES and small boulders comprising concrete blocks and builders rubble. Overall consistency is stiff. **FILL**.

3.00

Very moist to wet, light grey blotched dark grey, firm to stiff, intact, sandy silty CLAY with abundant to equal amounts of coarse medium and fine gravel. **FILL**.

4.90

EOH: Not to refusal, difficult excavation due to rapid water seepage.

NOTES

1) Rapid water seepage encountered from southern wall, through old disused pipes intersected with excavator.

2) Approximately four 50mm plastic pipes intersected between 4,00m and 4,50m. Water level stabilised at 4,00m from surface.

3) Southern sidewall undermined and collapsed due to rapid water seepage and low consistency of bedding and backfill. Profiled from spoil.

4) Strong smell emanated from test pit, possibly standing water and sludge from within disused pipe system.

5) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : CAT 320D
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 23/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953485
Y-COORD : 107646

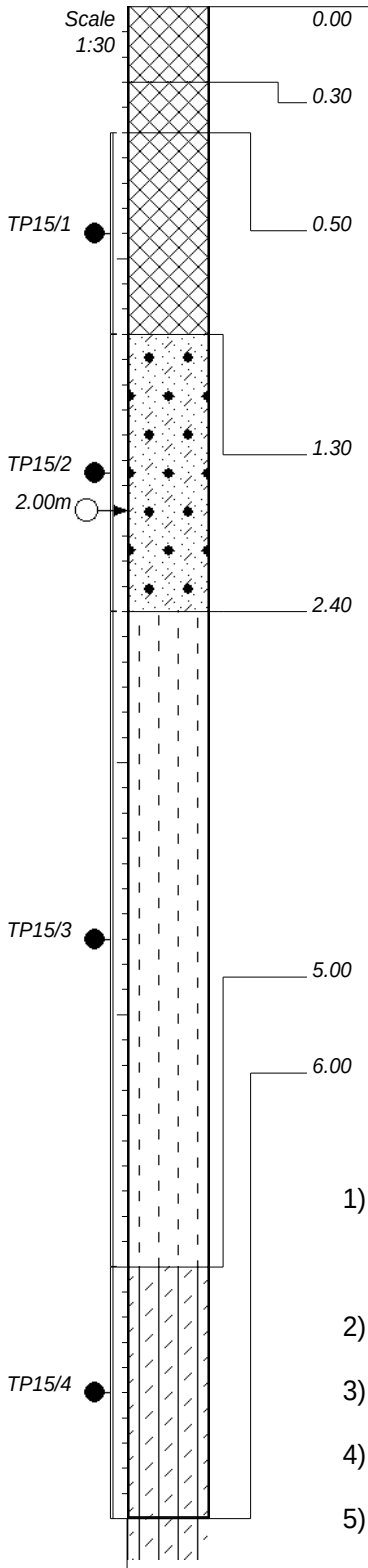
HOLE No: TP14

Knight Piésold CONSULTING

VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP15
Sheet 1 of 1

JOB: 3030049603



0.00 – 0.30	Moist, dark brown, very loose to loose, pinholed, silty SAND with traces to minor gravel and scattered builders rubble. **FILL**.
0.30 – 0.50	Moist, dark grey brown, firm, intact, clayey silty SAND with scattered pockets of light grey silty clay and minor ferruginous nodules at base. **FILL**.
0.50 – 1.30	Moist, light grey mottled orange and black, overall dense, matrix supported with pockets of micro-shattered, clayey sandy GRAVEL comprising abundant medium and fine ferruginous nodules. **FILL**. Note: Scattered coarse and medium, rounded quartzite gravel.
1.30 – 2.40	Moist, light grey mottled orange and black, stiff to very stiff, intact with pockets of micro-shattered, clayey SAND with abundant medium and fine soft ferruginous nodules. **REWORKED RESIDUAL SANDSTONE**.
2.40 – 5.00	Very moist to wet, orange brown stained black, dense becoming medium dense at base, intact silty medium SAND with minor to abundant sub-rounded, medium and coarse, highly weathered quartzite gravel at base. **REWORKED RESIDUAL SANDSTONE**.
5.00 – 6.00	Very moist, light purplish grey, stiff to very stiff, micro shattered, slightly sandy clayey SILT. **REWORKED RESIDUAL SHALE**.
6.00	EOH: Maximum reach of excavator, near refusal in material as above.

NOTES

1) Slow water seepage encountered from 20mm runnel at 2,00m depth on western sidewall. Approximately 100mm of water in base of pit after twenty minutes.
2) Bulk (2x large bags) disturbed sample TP15/1 taken from 0.50m--1.30m.
3) Small bag sample TP15/2 taken from 1,3m--2,4m.
4) Small bag sample TP15/3 taken from 2,4m--5,0m.
5) Small bag sample TP15/4 taken from 5,0m--6,0m.
6) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : CAT 320D
DRILLED BY : Patrick
PROFILED BY : DB

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 23/11/2018

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953441
Y-COORD : 107590

HOLE No: TP15

TYPE SET BY :
SETUP FILE : KPTP8.SET

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

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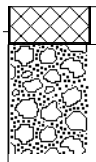
VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP16
Sheet 1 of 1

JOB: 3030049603

Scale 1:30



0.00

Slightly moist, light brown, loose to medium dense, intact, silty SAND with minor to abundant gravel (aggregate) and ferruginous nodules, and with minor roots. **FILL**

0.15

EOH: Abrupt refusal on concrete slab.

NOTES

1) No water encountered.

2) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : CAT 320D
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 23/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953446
Y-COORD : 107395

HOLE No: TP16

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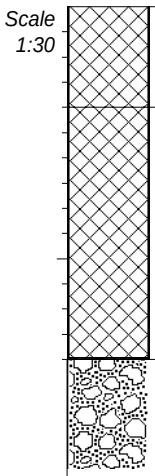
VEREENIGING PUMP STATION
GEOTECHNICAL INVESTIGATION
CLIENT: RAND WATER

HOLE No: TP16A
Sheet 1 of 1

JOB: 3030049603



0.00	Slightly moist, light brown, loose to medium dense, intact, silty SAND with minor to abundant gravel (aggregate) and minor concrete cobbles, and with minor roots. **FILL**.
0.40	Wet, dark grey, very soft, intact, gleyed slightly sandy clayey SILT with abundant sub-rounded to sub-angular gravel, cobbles and small boulders of concrete. **FILL**.
1.40	EOH: Abrupt refusal on concrete slab.

NOTES

1) No water encountered.

2) Co-ordinates and elevations were recorded using a hand held GPS.

CONTRACTOR : V&S Plant Hire
MACHINE : CAT 320D
DRILLED BY : Patrick
PROFILED BY : DB

TYPE SET BY :
SETUP FILE : KPTP8.SET

INCLINATION :
DIAM : 650mm
DATE : 02/05/2018
DATE : 23/11/2018

DATE : 04/03/2019 09:31
TEXT : ..tation3030049603rev1.txt

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2953465
Y-COORD : 107585

HOLE No: TP16A

APPENDIX B

SITE PHOTOGRAPHS

VEREENIGING PUMPING STATION SITE PHOTOGRAPHS

Plate 1. TP1 excavation with a TLB in progress.

Plate 2.
Trench excavation TP3 soil profile.

Plate 3.
View of TP15 soil profile.

Plate 4.
View of typical trench excavation on site, which is partially filled with water.

Plate 5.
View of trench excavation near TP4.

Plate 6.
Large number of services visible in one of the trench excavations.

Plate 7. North-western corner of old System 1A excavation, which is partially filled with water.

APPENDIX C

LABORATORY TEST RESULTS

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E-mail: jhb@civilab.co.za•Website: www.civilab.co.za

sanas Testing Laboratory T0062

Civilab

Civil Engineering Testing Laboratories

Client	:	KNIGHT PIESOLD (PTY) LTD			
Address	:	P O BOX 221	**Client Reference**	:	
	:	RIVONIA	**Order No.**	:	KHH 551/18
	:	2128			
Attention	:		**Date Received**	:	28/11/2018
Facsimile	:	011 806 7100	**Date Tested**	:	28/11/2018 - 06/02/2019
E-mail	:	sdeen@knightpiesold.com	**Date Reported**	:	28/02/2019
Project	:	Vereeniging Pump Station			
Project No.	:	2018-B-2286	**Report Status**	:	Final
			Page	:	1 of 20

Herewith please find the test report(s) pertaining to the above project. All tests were conducted in accordance with prescribed test method(s). Information herein consists of the following:

Test(s) conducted / Item(s) measured	Qty.	Test Method(s)	Authorized By**	Page(s)
Moisture Density Relationship	5.000	SANS3001: GR30	S Pullen	13-17
Relative density of soil (SG)	1.000	TMH1 A12T	J Marques	2-12
Moisture Content as received	10.000	SANS 3001: GR20	J Marques	2-12
Atterberg Limits <0.425mm	20.000	SANS3001: GR10	S Pullen/B Mvubu/J Marques	2-12, 18-20
Sieve Analysis 0.075mm	20.000	SANS3001: GR1	S Pullen/J Marques	2-12, 18-20
California Bearing Ratio (CBR)	5.000	SANS3001: GR40	S Pullen/J Marques	18-20
Hydrometer Analysis	20.000	ASTM D422	S Pullen/J Marques	2-12

Any test results contained in this report and marked with * in the table above are "not SANAS accredited" and are not included in the schedule of accreditation for this laboratory.

Any information contained in this test report pertain only to the areas and/or samples tested. Documents may only be reproduced or published in their full context.

While every care is taken to ensure that all tests are carried out in accordance with recognised standards, neither Civilab (Proprietary) Limited nor its employess shall be liable in any way whatsoever for any error made in the execution or reporting of tests or any erroneous conclusions drawn therefrom or for any consequences thereof.

All interpretations, Interpolations, Opinions and/or Classifications contained in this report falls outside our scope of accreditation.

The following parameters, where applicable, were excluded from the classification procedure: Chemical modifications, Additional fines, Fractured Faces, Soluble Salts, pH, Conductivity, Coarse Sand Ratio, Durability (COLTO: G4-G9).

The following parameters, where applicable, were assumed: Rock types were assumed to be of an Arenaceous nature with Siliceous cementing material.

Unless otherwise requested or stated, all samples will be discarded after a period of 3 months.

Deviations in Test Methods:

**All results are authorized electronically by approved managers and/or technical signatories.

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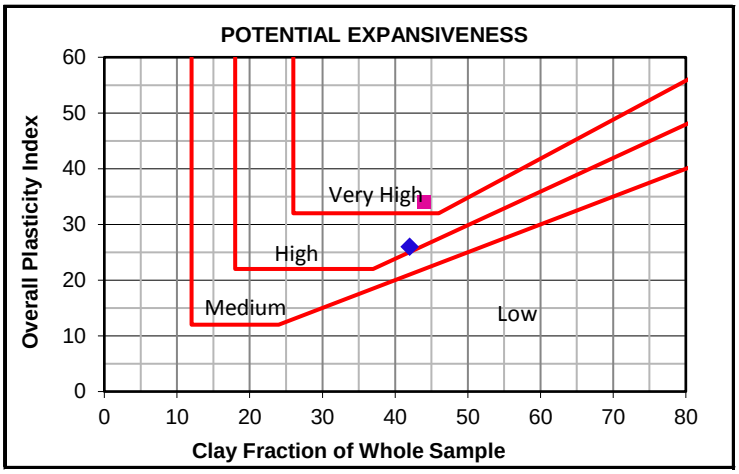
Civil Engineering Testing Laboratories

Client	:	KNIGHT PIESOLD (PTY) LTD	Date Received:	28/11/2018
Project	:	Vereeniging Pump Station	Date Reported:	14/02/2019
Project No	:	2018-B-2286	Page No. :	2 of 20

FOUNDATION INDICATOR

Laboratory Number		1 ◆	2 ■
Field Number		TP01	TP01
Client Reference			
Depth (m)		1.00-1.70	1.70-3.70
Position			
Coordinates	X		
	Y		
Description			
Aditional Information		Alluvium	Alluvium
Calcrete / Crushed			
Stabilizing Agent			

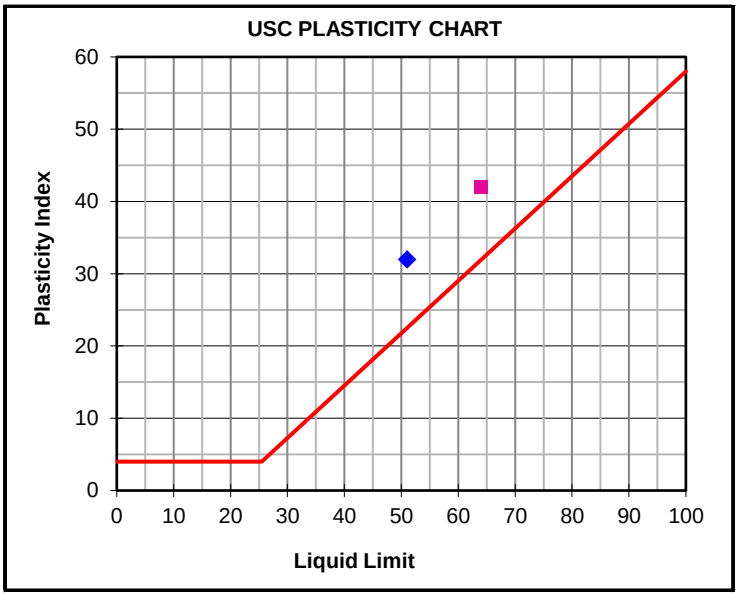


Moisture Content & Relative Density

Moisture Content (%)	14.7	34.6
Relative Density (S.G.)		

Sieve Analysis (Wet Prep) — **SANS3001: GR1**

Percentage Passing	100 mm	100	100
	75 mm	100	100
	63 mm	100	100
	50 mm	100	100
	37.5 mm	100	100
	28 mm	100	100
	20 mm	100	100
	14 mm	100	100
	5 mm	100	96
	2 mm	99	94
	1 mm	95	91
	0.425 mm	80	81
	0.250 mm	76	78
	0.150 mm	69	72
	0.075 mm	66	70
Grading Modulus		0.55	0.55



Hydrometer Analysis — **ASTM D422**

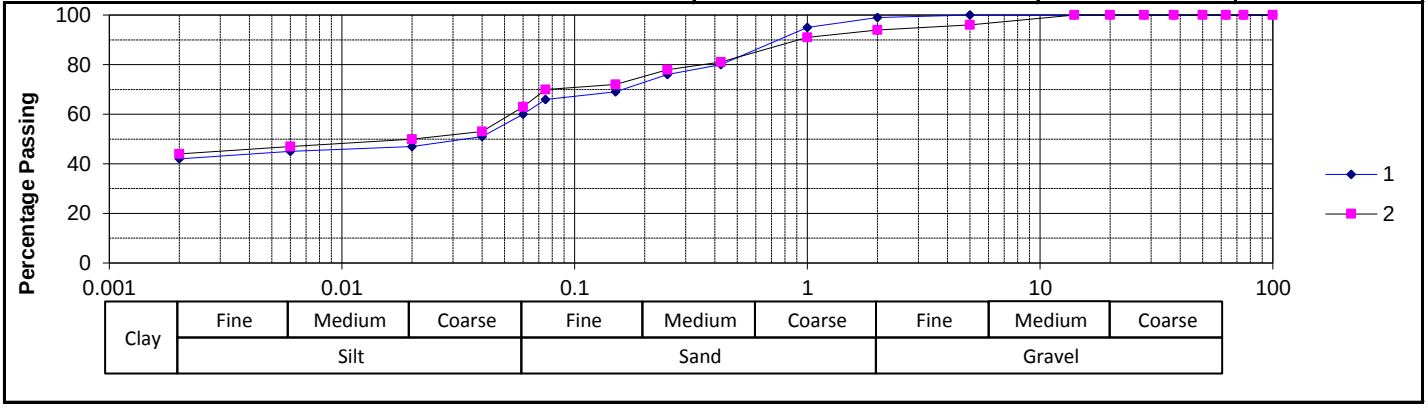
Percentage Passing	0.060 mm	60	63
	0.040 mm	51	53
	0.020 mm	47	50
	0.006 mm	45	47
	0.002 mm	42	44
Gravel	%	1	6
Sand	%	39	31
Silt	%	18	19
Clay	%	42	44

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		1 ◆	2 ■
Atterberg Limits -425µ		**SANS3001: GR10**	
Liquid Limit	%	51	64
Plasticity Index	%	32	42
Linear Shrinkage	%	15.5	17.0
Overall PI	%	26	34

Classifications

HRB (AASHTO)	A-7-6(19)	A-7-6(20)
Unified (ASTM D2487)	CH	CH
Weston Swell @ 1 kPa	4.1	1.5



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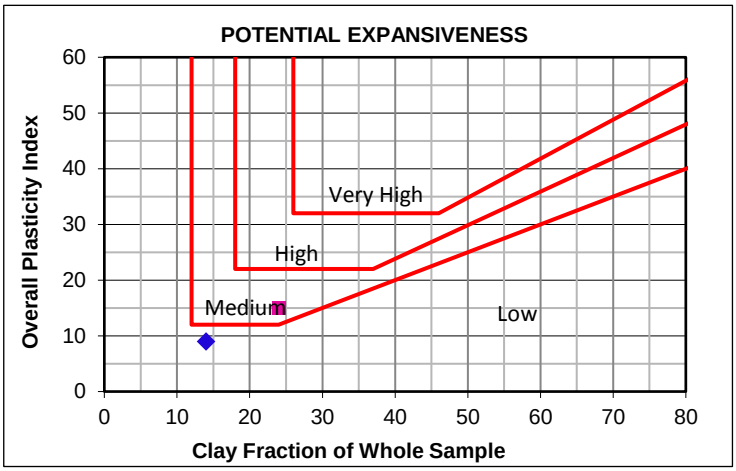
Civil Engineering Testing Laboratories

Client	:	KNIGHT PIESOLD (PTY) LTD	Date Received:	28/11/2018
Project	:	Vereeniging Pump Station	Date Reported:	14/02/2019
Project No	:	2018-B-2286	Page No. :	3 of 20

FOUNDATION INDICATOR

Laboratory Number		3 ◆	4 ■
Field Number		TP02	TP04
Client Reference			
Depth (m)		0.90-1.40	1.60-2.10
Position			
Coordinates	X		
	Y		
Description			
Aditional Information		Fill	Alluvium
Calcrete / Crushed			
Stabilizing Agent			

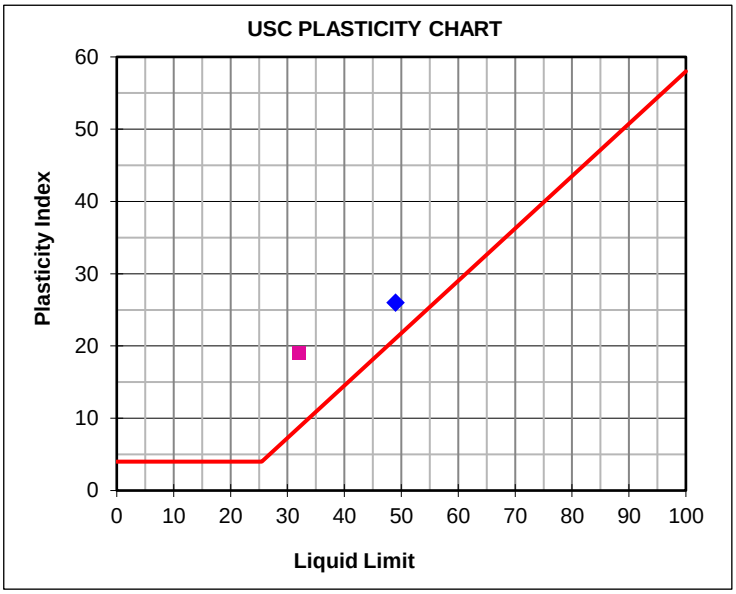


Moisture Content & Relative Density — **SANS3001: GR30**

Moisture Content (%)		17.3
Relative Density (S.G.)		

Sieve Analysis (Wet Prep) — **SANS3001: GR1**

Percentage Passing	100 mm	100	100
	75 mm	100	100
	63 mm	100	100
	50 mm	100	100
	37.5 mm	93	100
	28 mm	83	100
	20 mm	72	100
	14 mm	65	100
	5 mm	55	99
	2 mm	49	98
	1 mm	44	95
	0.425 mm	35	81
	0.250 mm	33	74
	0.150 mm	30	66
	0.075 mm	29	62
Grading Modulus		1.87	0.59



Hydrometer Analysis — **ASTM D422**

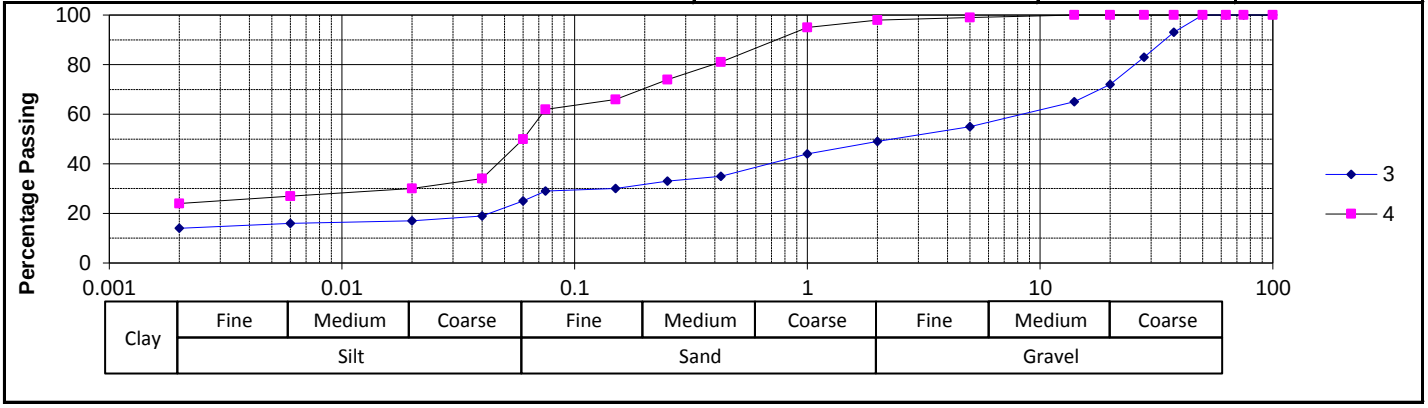
Percentage Passing	0.060 mm	25	50
	0.040 mm	19	34
	0.020 mm	17	30
	0.006 mm	16	27
	0.002 mm	14	24
Gravel	%	51	2
Sand	%	24	48
Silt	%	11	26
Clay	%	14	24

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		3 ◆	4 ■
Atterberg Limits -425µ		**SANS3001: GR10**	
Liquid Limit	%	49	32
Plasticity Index	%	26	19
Linear Shrinkage	%	13.5	9.0
Overall PI	%	9	15

Classifications

HRB (AASHTO)	A-2-7(2)	A-6(9)
Unified (ASTM D2487)	GC	CL
Weston Swell @ 1 kPa		0.4



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sanas Testing Laboratory T0062

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Civil Engineering Testing Laboratories

Client	:	KNIGHT PIESOLD (PTY) LTD	Date Received:	28/11/2018
Project	:	Vereeniging Pump Station	Date Reported:	14/02/2019
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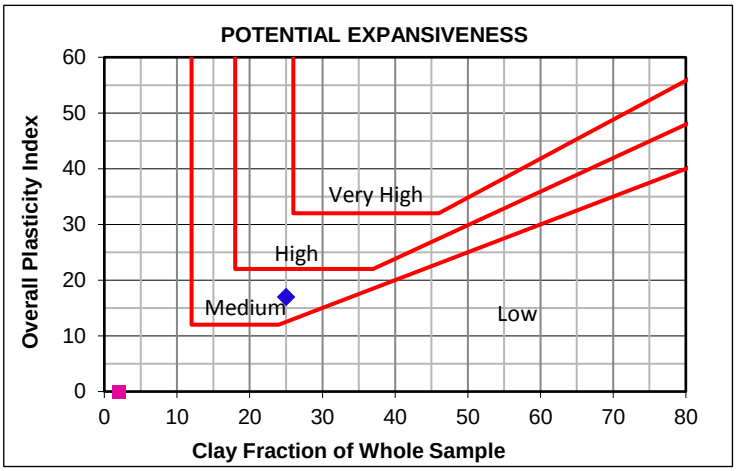
FOUNDATION INDICATOR

Laboratory Number		5 ◆	6 ■
Field Number		TP05	TP06
Client Reference			
Depth (m)		1.40-2.20	0.20-1.20
Position			
Coordinates	X		
	Y		
Description			
Aditional Information		Fill	Fill
Calcrete / Crushed			
Stabilizing Agent			

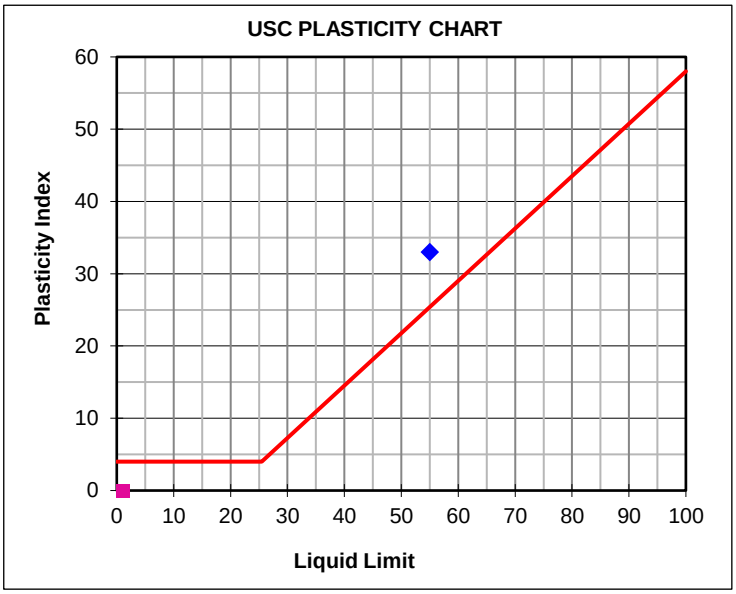


Moisture Content & Relative Density

Moisture Content (%)		
Relative Density (S.G.)		

Sieve Analysis (Wet Prep) — **SANS3001: GR1**

Percentage Passing	100 mm	100	100
	75 mm	100	100
	63 mm	100	100
	50 mm	100	100
	37.5 mm	100	100
	28 mm	100	100
	20 mm	100	100
	14 mm	95	75
	5 mm	87	46
	2 mm	79	35
	1 mm	71	28
	0.425 mm	50	20
	0.250 mm	48	19
	0.150 mm	45	19
	0.075 mm	43	18
Grading Modulus		1.28	2.27



Hydrometer Analysis — **ASTM D422**

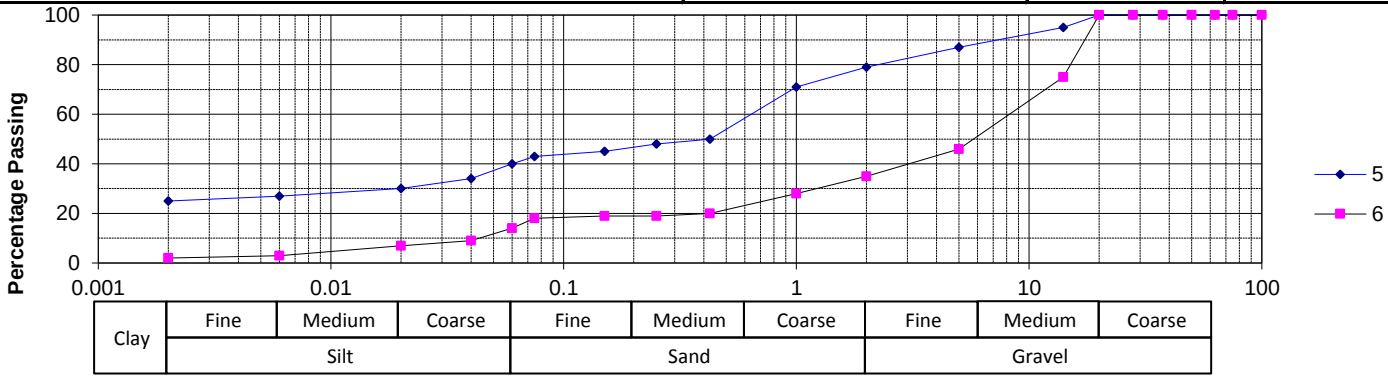
Percentage Passing	0.060 mm	40	14
	0.040 mm	34	9
	0.020 mm	30	7
	0.006 mm	27	3
	0.002 mm	25	2
Gravel	%	21	65
Sand	%	39	21
Silt	%	15	12
Clay	%	25	2

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		5 ◆	6 ■
Atterberg Limits -425µ		**SANS3001: GR10**	
Liquid Limit	%	55	
Plasticity Index	%	33	SP
Linear Shrinkage	%	16.0	1.0
Overall PI	%	17	

Classifications

HRB (AASHTO)	A-7-6(9)	A-1-b(0)
Unified (ASTM D2487)	SC	GM
Weston Swell @ 1 kPa		



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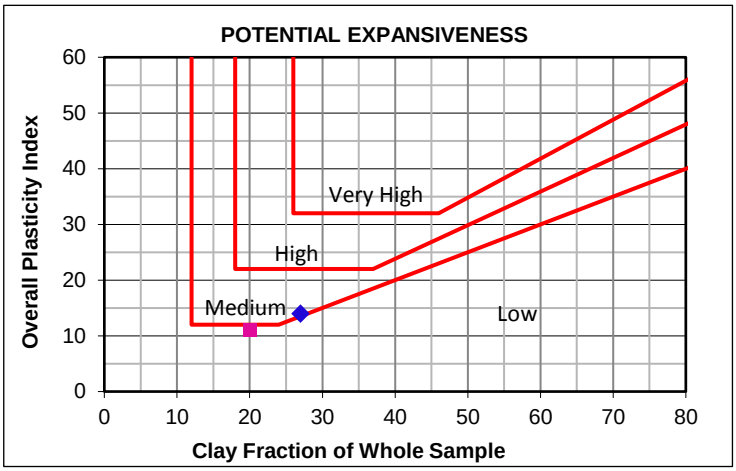
FOUNDATION INDICATOR

Laboratory Number		7 ◆	8 ■
Field Number		TP08	TP08
Client Reference			
Depth (m)		1.5	1.60-2.10
Position			
Coordinates	X		
	Y		
Description			
Aditional Information		Topsoil	Slightly Ferruginious
Calcrete / Crushed			
Stabilizing Agent			

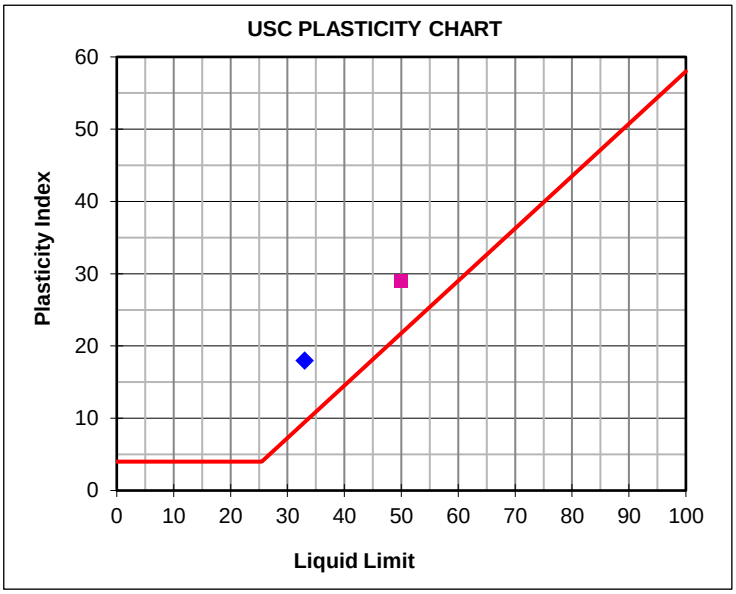


Moisture Content & Relative Density

Moisture Content (%)		
Relative Density (S.G.)		

Sieve Analysis (Wet Prep) — **SANS3001: GR1**

Percentage Passing	100 mm	100	100
	75 mm	100	100
	63 mm	100	100
	50 mm	100	100
	37.5 mm	100	100
	28 mm	100	100
	20 mm	100	100
	14 mm	100	100
	5 mm	100	78
	2 mm	98	61
	1 mm	93	52
	0.425 mm	80	38
	0.250 mm	71	36
	0.150 mm	61	33
	0.075 mm	58	33
Grading Modulus		0.64	1.68



Hydrometer Analysis — **ASTM D422**

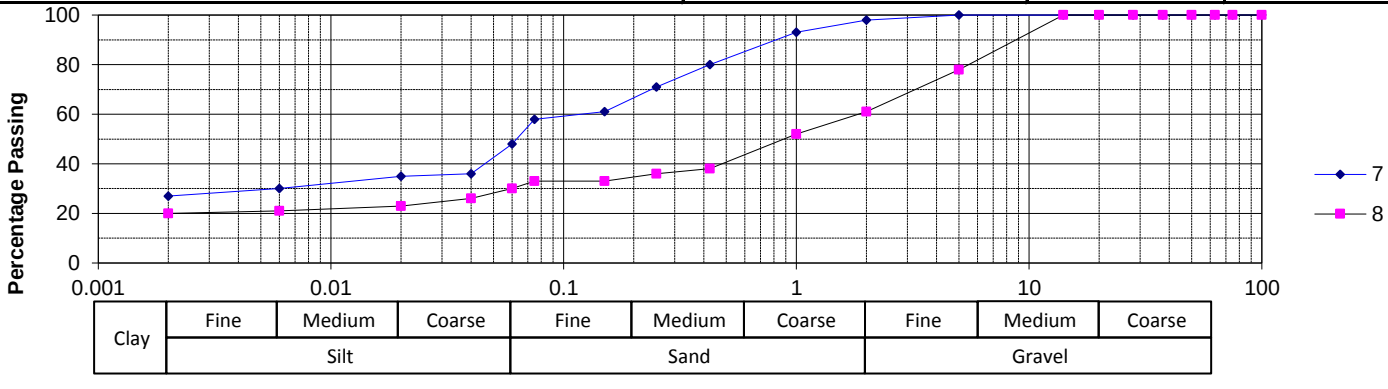
Percentage Passing	0.060 mm	48	30
	0.040 mm	36	26
	0.020 mm	35	23
	0.006 mm	30	21
	0.002 mm	27	20
Gravel	%	2	39
Sand	%	50	31
Silt	%	21	10
Clay	%	27	20

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		7 ◆	8 ■
Atterberg Limits -425µ		**SANS3001: GR10**	
Liquid Limit	%	33	50
Plasticity Index	%	18	29
Linear Shrinkage	%	9.5	13.0
Overall PI	%	14	11

Classifications

HRB (AASHTO)	A-6(7)	A-2-7(3)
Unified (ASTM D2487)	CL	SC
Weston Swell @ 1 kPa		



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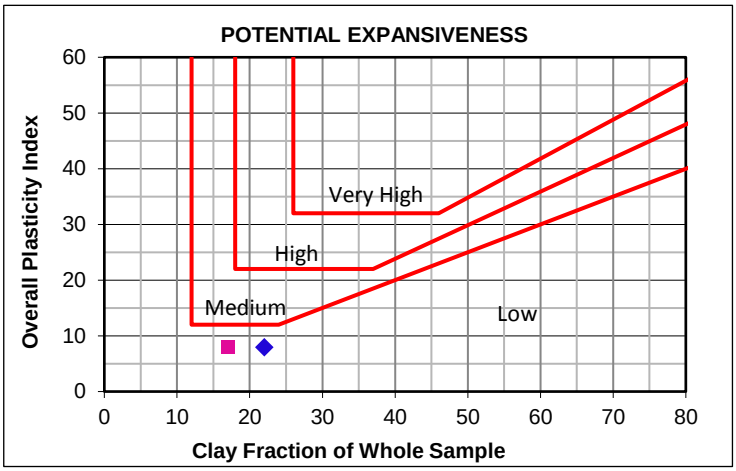
FOUNDATION INDICATOR

Laboratory Number		10 ◆	11 ■
Field Number		TP10	TP10
Client Reference			
Depth (m)		2.30-2.50	0.60-1.90
Position			
Coordinates	X		
	Y		
Description			
Aditional Information		Ferruginious Colluvium	Fill
Calcrete / Crushed			
Stabilizing Agent			

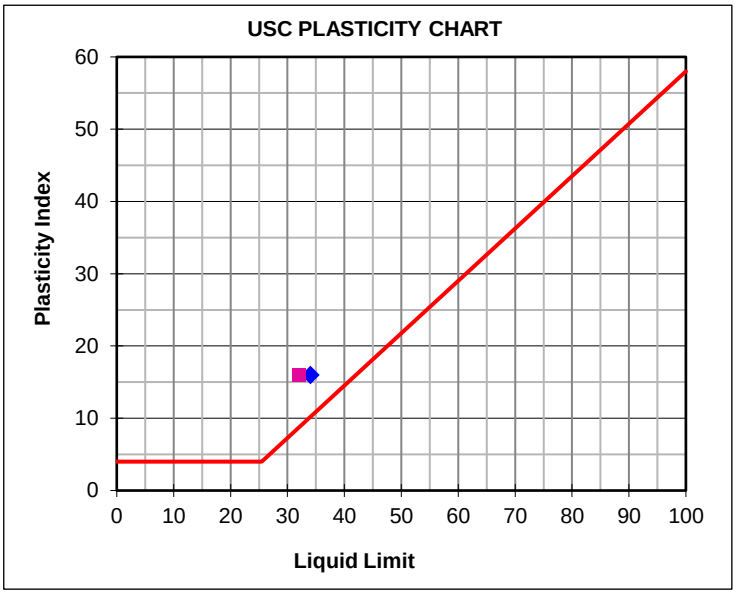


Moisture Content & Relative Density

Moisture Content (%)	15.9	
Relative Density (S.G.)		

Sieve Analysis (Wet Prep) — **SANS3001: GR1**

Percentage Passing	100 mm	100	100
	75 mm	100	100
	63 mm	100	100
	50 mm	100	100
	37.5 mm	100	100
	28 mm	100	100
	20 mm	100	100
	14 mm	100	97
	5 mm	82	75
	2 mm	74	66
	1 mm	68	61
	0.425 mm	53	49
	0.250 mm	49	45
	0.150 mm	44	40
	0.075 mm	42	38
Grading Modulus		1.31	1.47



Hydrometer Analysis — **ASTM D422**

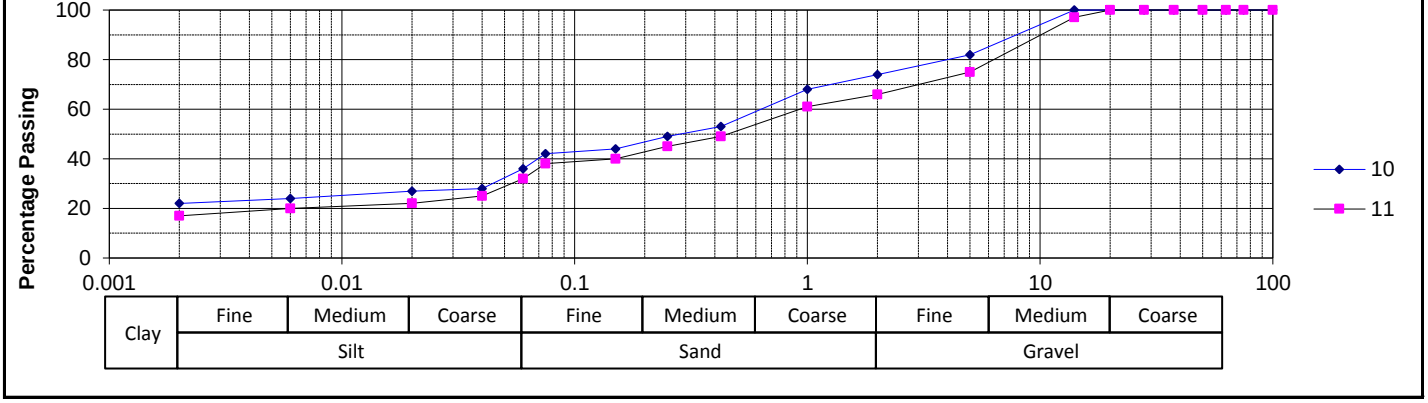
Percentage Passing	0.060 mm	36	32
	0.040 mm	28	25
	0.020 mm	27	22
	0.006 mm	24	20
	0.002 mm	22	17
Gravel	%	26	34
Sand	%	38	34
Silt	%	14	15
Clay	%	22	17

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		10 ◆	11 ■
Atterberg Limits -425µ		**SANS3001: GR10**	
Liquid Limit	%	34	32
Plasticity Index	%	16	16
Linear Shrinkage	%	7.0	8.0
Overall PI	%	8	8

Classifications

HRB (AASHTO)	A-6(3)	A-6(2)
Unified (ASTM D2487)	SC	SC
Weston Swell @ 1 kPa	0.1	



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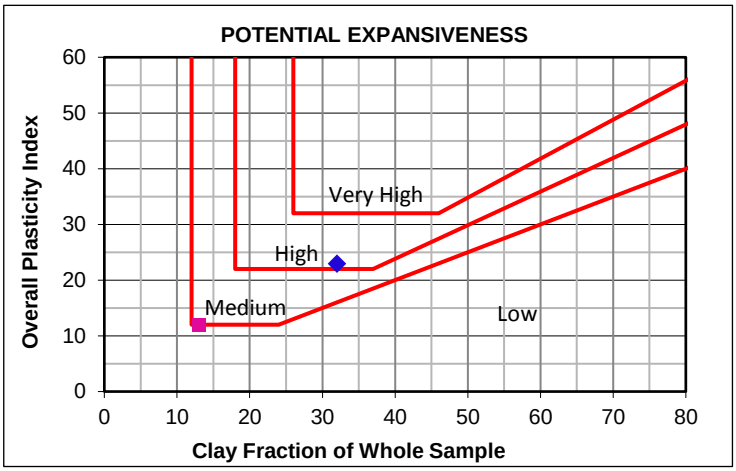
FOUNDATION INDICATOR

Laboratory Number		12 ◆	14 ■
Field Number		TP12	TP12
Client Reference			
Depth (m)		0.00-1.30	2.80-4.80
Position			
Coordinates	X		
	Y		
Description			
Aditional Information		Organic Rich Vlei Deposit	Residual Carbonaceou
Calcrete / Crushed			
Stabilizing Agent			

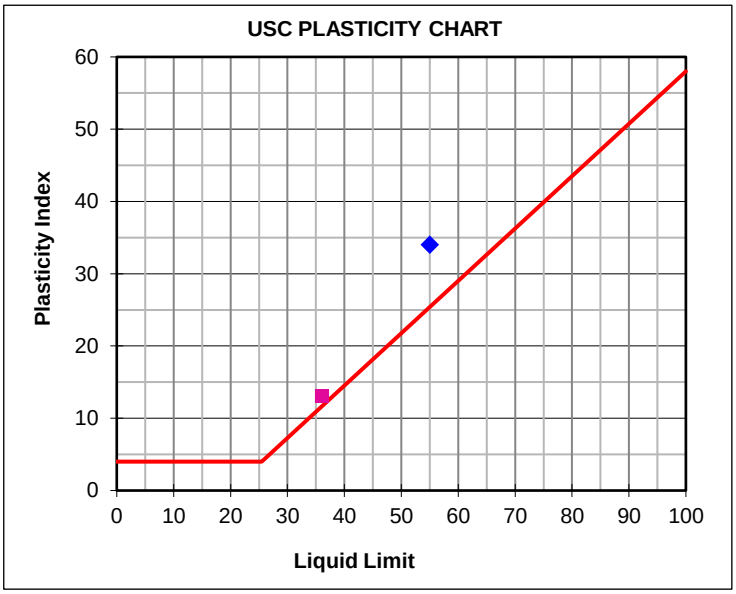


Moisture Content & Relative Density

Moisture Content (%)	23.5	23.7
Relative Density (S.G.)		

Sieve Analysis (Wet Prep) — **SANS3001: GR1**

Percentage Passing	100 mm	100	100
	75 mm	100	100
	63 mm	100	100
	50 mm	100	100
	37.5 mm	100	100
	28 mm	100	100
	20 mm	100	100
	14 mm	100	100
	5 mm	97	100
	2 mm	90	100
	1 mm	84	99
	0.425 mm	69	93
	0.250 mm	65	91
	0.150 mm	59	85
	0.075 mm	56	83
Grading Modulus		0.85	0.24



Hydrometer Analysis — **ASTM D422**

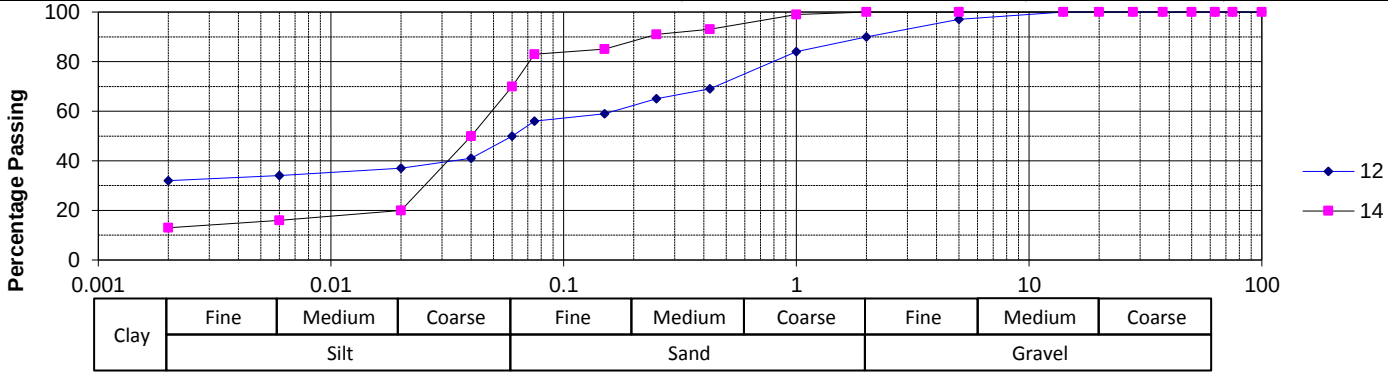
Percentage Passing	0.060 mm	50	70
	0.040 mm	41	50
	0.020 mm	37	20
	0.006 mm	34	16
	0.002 mm	32	13
Gravel	%	10	
Sand	%	40	30
Silt	%	18	57
Clay	%	32	13

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		12 ◆	14 ■
Atterberg Limits -425µ		**SANS3001: GR10**	
Liquid Limit	%	55	36
Plasticity Index	%	34	13
Linear Shrinkage	%	16.0	5.0
Overall PI	%	23	12

Classifications

HRB (AASHTO)	A-7-6(16)	A-6(11)
Unified (ASTM D2487)	CH	CL
Weston Swell @ 1 kPa	1.0	0.6



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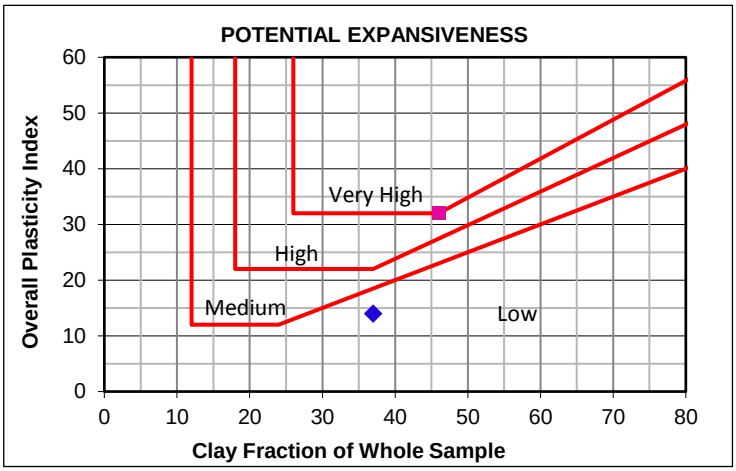
FOUNDATION INDICATOR

Laboratory Number		15 ◆	16 ■
Field Number		TP13	TP13
Client Reference			
Depth (m)		3.80-5.00	1.20-1.40
Position			
Coordinates	X		
	Y		
Description			
Aditional Information		Slightly Ferruginous	Alluvium
Calcrete / Crushed			
Stabilizing Agent			

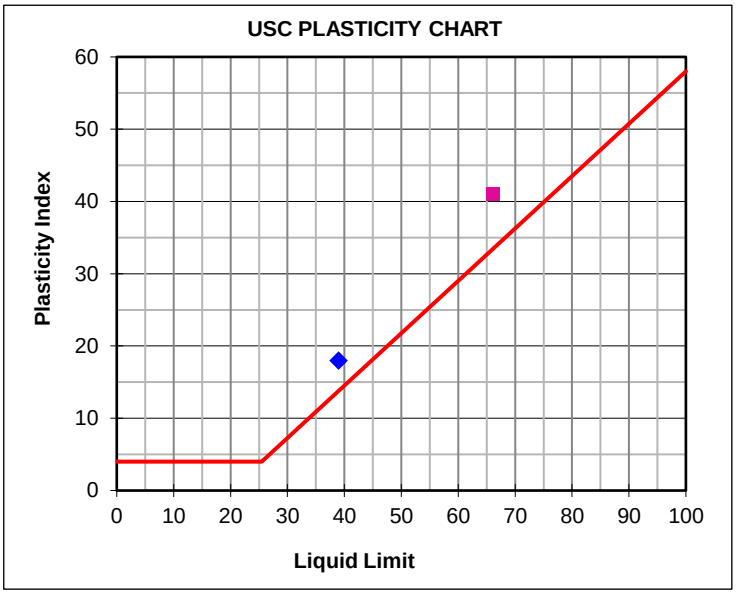


Moisture Content & Relative Density

Moisture Content (%)		
Relative Density (S.G.)		2.519

Sieve Analysis (Wet Prep) — **SANS3001: GR1**

Percentage Passing	100 mm	100	100
	75 mm	100	100
	63 mm	100	100
	50 mm	100	100
	37.5 mm	100	100
	28 mm	100	100
	20 mm	100	100
	14 mm	100	100
	5 mm	99	99
	2 mm	95	95
	1 mm	90	91
	0.425 mm	79	79
	0.250 mm	78	76
	0.150 mm	76	71
	0.075 mm	76	69
Grading Modulus		0.50	0.57



Hydrometer Analysis — **ASTM D422**

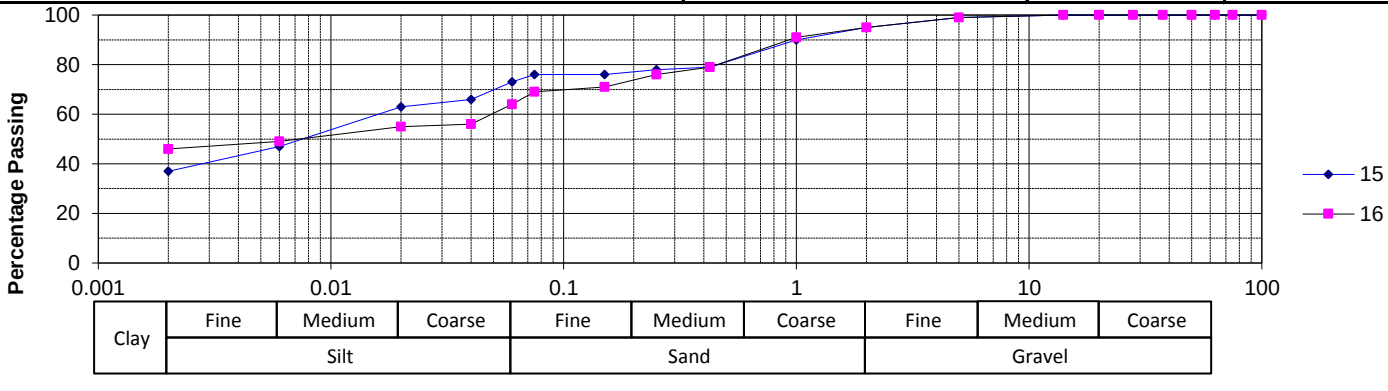
Percentage Passing	0.060 mm	73	64
	0.040 mm	66	56
	0.020 mm	63	55
	0.006 mm	47	49
	0.002 mm	37	46
Gravel	%	5	5
Sand	%	22	31
Silt	%	36	18
Clay	%	37	46

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		15 ◆	16 ■
Atterberg Limits -425µ		**SANS3001: GR10**	
Liquid Limit	%	39	66
Plasticity Index	%	18	41
Linear Shrinkage	%	9.5	17.5
Overall PI	%	14	32

Classifications

HRB (AASHTO)	A-6(13)	A-7-6(20)
Unified (ASTM D2487)	CL	CH
Weston Swell @ 1 kPa		



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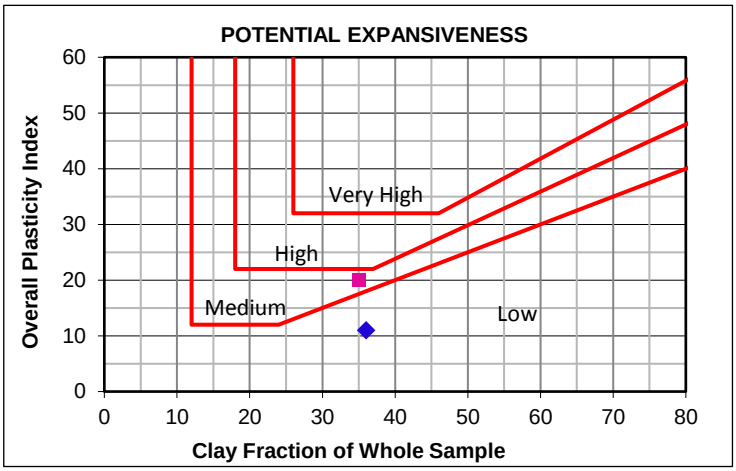
FOUNDATION INDICATOR

Laboratory Number		17 ◆	18 ■
Field Number		TP15	TP15
Client Reference			
Depth (m)		0.50-1.30	1.30-2.40
Position			
Coordinates	X		
	Y		
Description			
Aditional Information		Reworked Residual	Slightly Ferruginous
Calcrete / Crushed			
Stabilizing Agent			

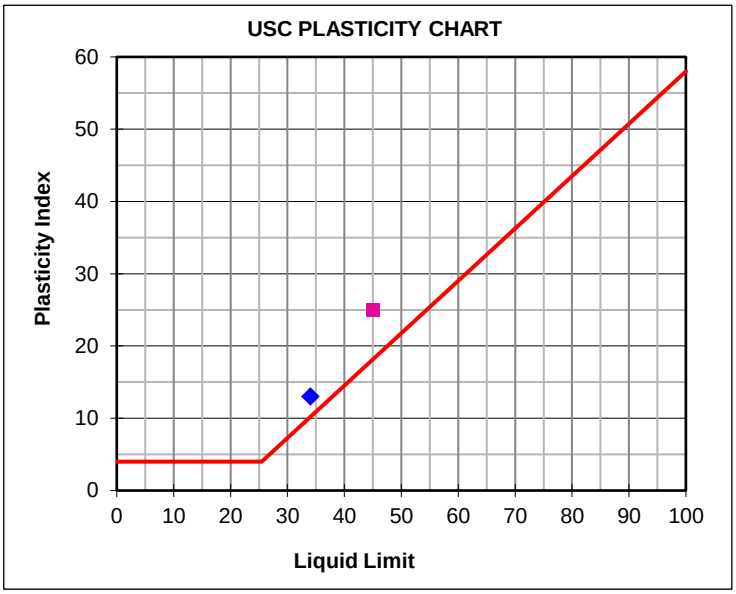


Moisture Content & Relative Density

Moisture Content (%)	15.3	19.4
Relative Density (S.G.)		

Sieve Analysis (Wet Prep) — **SANS3001: GR1**

Percentage Passing	100 mm	100	100
	75 mm	100	100
	63 mm	100	100
	50 mm	100	100
	37.5 mm	100	100
	28 mm	100	100
	20 mm	100	100
	14 mm	100	100
	5 mm	99	100
	2 mm	97	97
	1 mm	93	93
	0.425 mm	82	80
	0.250 mm	81	72
	0.150 mm	80	65
	0.075 mm	79	62
Grading Modulus		0.42	0.61



Hydrometer Analysis — **ASTM D422**

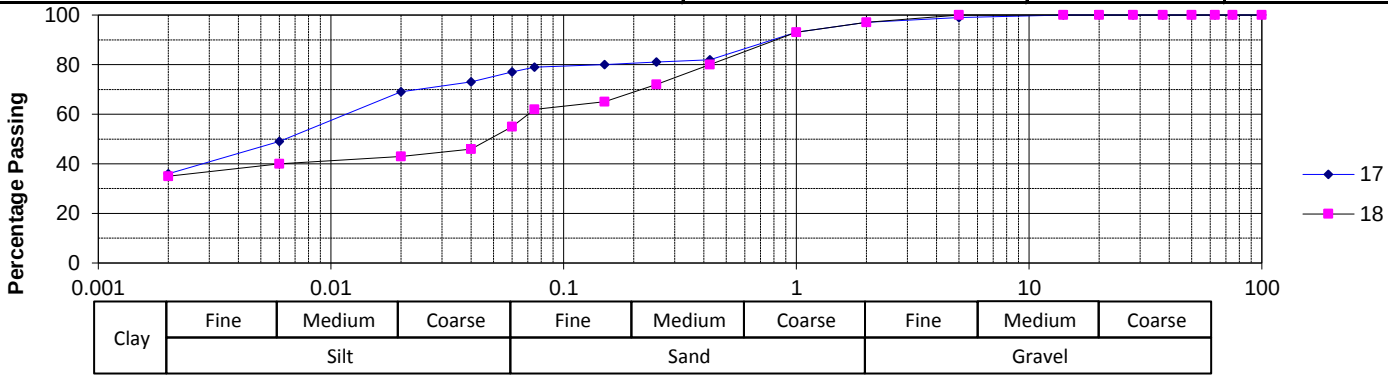
Percentage Passing	0.060 mm	77	55
	0.040 mm	73	46
	0.020 mm	69	43
	0.006 mm	49	40
	0.002 mm	36	35
Gravel	%	3	3
Sand	%	20	42
Silt	%	41	20
Clay	%	36	35

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		17 ◆	18 ■
Atterberg Limits -425µ		**SANS3001: GR10**	
Liquid Limit	%	34	45
Plasticity Index	%	13	25
Linear Shrinkage	%	7.0	11.5
Overall PI	%	11	20

Classifications

HRB (AASHTO)	A-6(9)	A-7-6(13)
Unified (ASTM D2487)	CL	CL
Weston Swell @ 1 kPa	0.8	1.3



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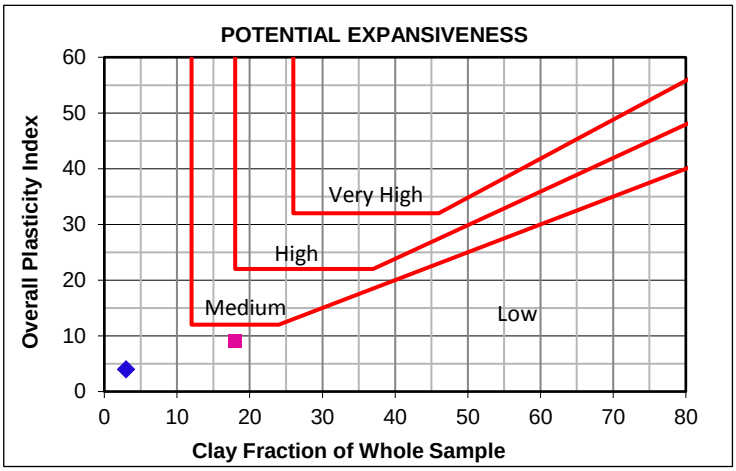
FOUNDATION INDICATOR

Laboratory Number		19 ◆	20 ■
Field Number		TP15	TP15
Client Reference			
Depth (m)		2.6	0.50-1.30
Position			
Coordinates	X		
	Y		
Description			
Aditional Information			Fill
Calcrete / Crushed			
Stabilizing Agent			

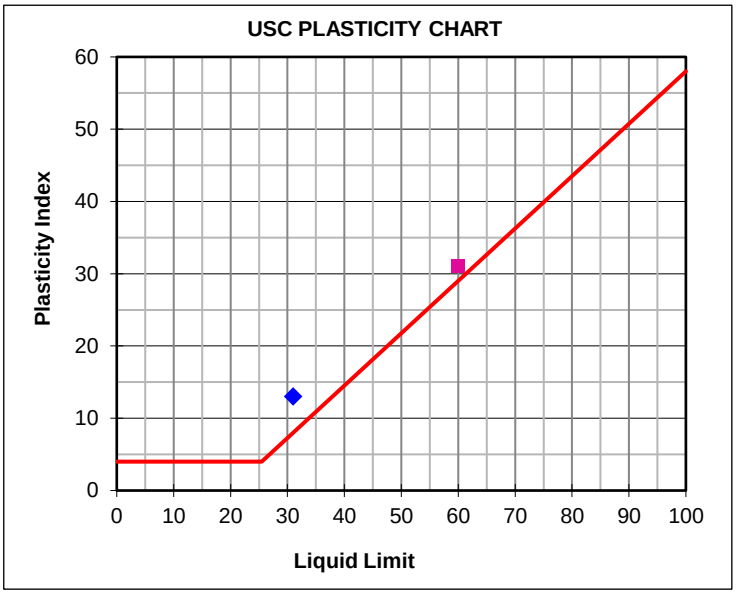


Moisture Content & Relative Density

Moisture Content (%)	14	
Relative Density (S.G.)		

Sieve Analysis (Wet Prep) — **SANS3001: GR1**

Percentage Passing	100 mm	100	100
	75 mm	100	100
	63 mm	100	100
	50 mm	100	100
	37.5 mm	100	100
	28 mm	100	100
	20 mm	100	100
	14 mm	100	98
	5 mm	100	66
	2 mm	95	49
	1 mm	82	41
	0.425 mm	33	29
	0.250 mm	16	28
	0.150 mm	14	27
	0.075 mm	14	27
Grading Modulus		1.58	1.95



Hydrometer Analysis — **ASTM D422**

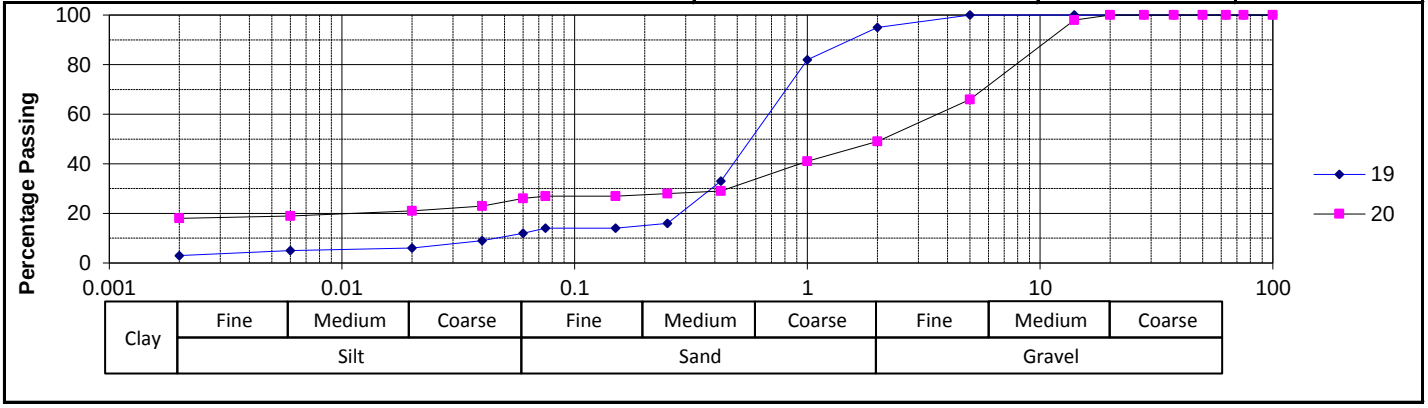
Percentage Passing	0.060 mm	12	26
	0.040 mm	9	23
	0.020 mm	6	21
	0.006 mm	5	19
	0.002 mm	3	18
Gravel	%	5	51
Sand	%	83	23
Silt	%	9	8
Clay	%	3	18

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		19 ◆	20 ■
Atterberg Limits -425µ		**SANS3001: GR10**	
Liquid Limit	%	31	60
Plasticity Index	%	13	31
Linear Shrinkage	%	6.5	15.5
Overall PI	%	4	9

Classifications

HRB (AASHTO)	A-2-6(0)	A-2-7(3)
Unified (ASTM D2487)	SC	SC
Weston Swell @ 1 kPa	0.0	



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Project	:	Vereeniging Pump Station	Date Reported:	14/02/2019
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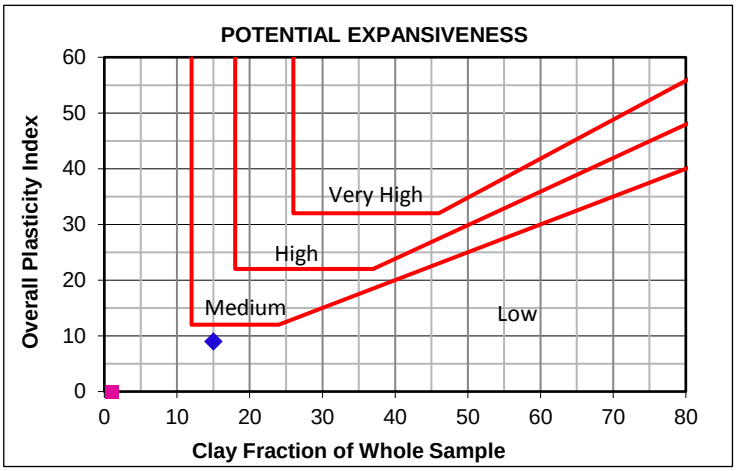
FOUNDATION INDICATOR

Laboratory Number		21 ◆	■
Field Number		WBA2	
Client Reference			
Depth (m)		Stockpile	
Position			
Coordinates	X		
	Y		
Description			
Aditional Information		Fill- Nodular Ferricrete	
Calcrete / Crushed			
Stabilizing Agent			

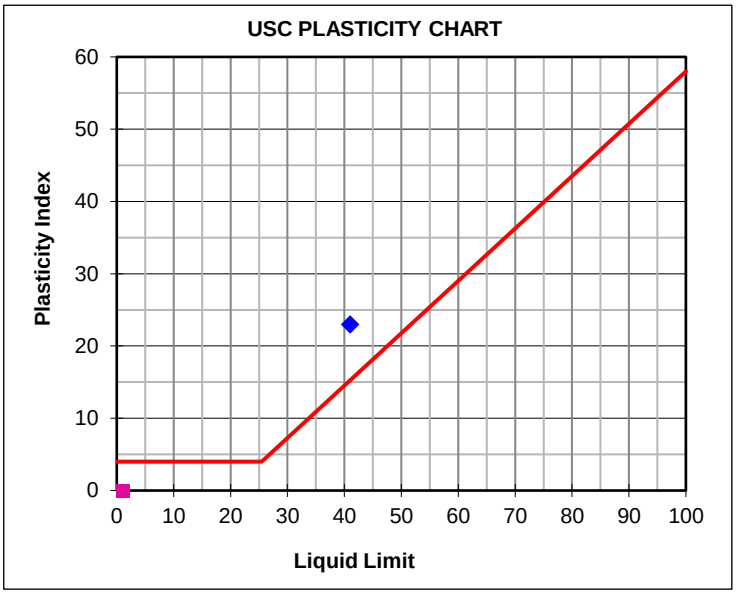


Moisture Content & Relative Density — **SANS3001: GR30**

Moisture Content (%)	
Relative Density (S.G.)	

Sieve Analysis (Wet Prep) — **SANS3001: GR1**

Percentage Passing	100 mm	100
	75 mm	100
	63 mm	100
	50 mm	100
	37.5 mm	100
	28 mm	100
	20 mm	100
	14 mm	96
	5 mm	69
	2 mm	61
	1 mm	55
	0.425 mm	41
	0.250 mm	37
	0.150 mm	34
	0.075 mm	32
Grading Modulus		1.66



Hydrometer Analysis — **ASTM D422**

Percentage Passing	0.060 mm	29
	0.040 mm	24
	0.020 mm	21
	0.006 mm	17
	0.002 mm	15
Gravel	%	39
Sand	%	32
Silt	%	14
Clay	%	15

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

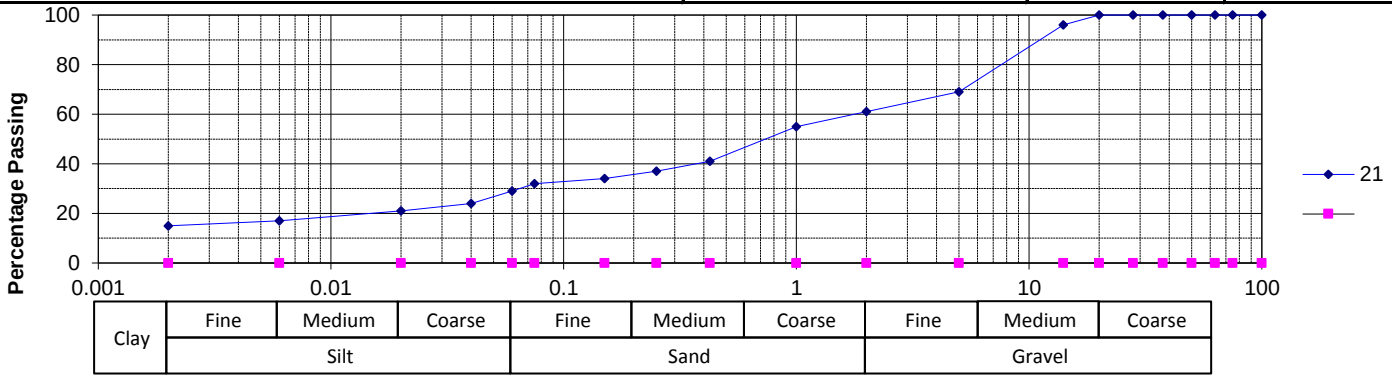
Laboratory Number	21 ◆	■

Atterberg Limits -425µ — **SANS3001: GR10**

Liquid Limit	%	41	
Plasticity Index	%	23	
Linear Shrinkage	%	11.5	
Overall PI	%	9	

Classifications

HRB (AASHTO)	A-2-7(2)	
Unified (ASTM D2487)	SC	
Weston Swell @ 1 kPa		



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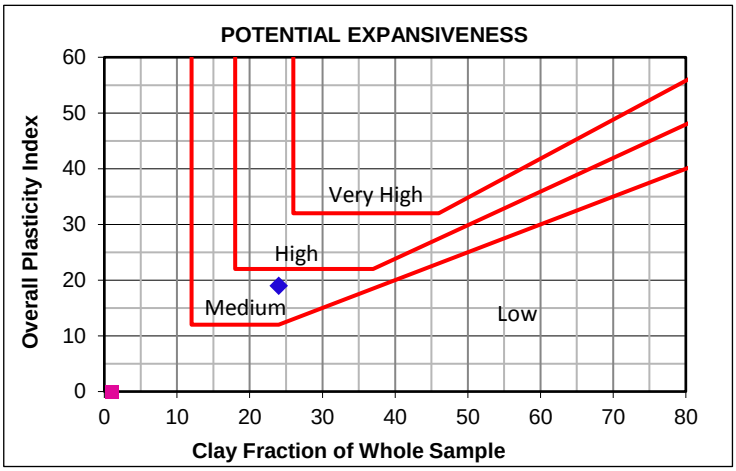
FOUNDATION INDICATOR

Laboratory Number		13 ◆	■
Field Number		TP12	
Client Reference			
Depth (m)		1.90-2.80	
Position			
Coordinates	X		
	Y		
Description			
Aditional Information		Ferruginous Alluvium	
Calcrete / Crushed			
Stabilizing Agent			

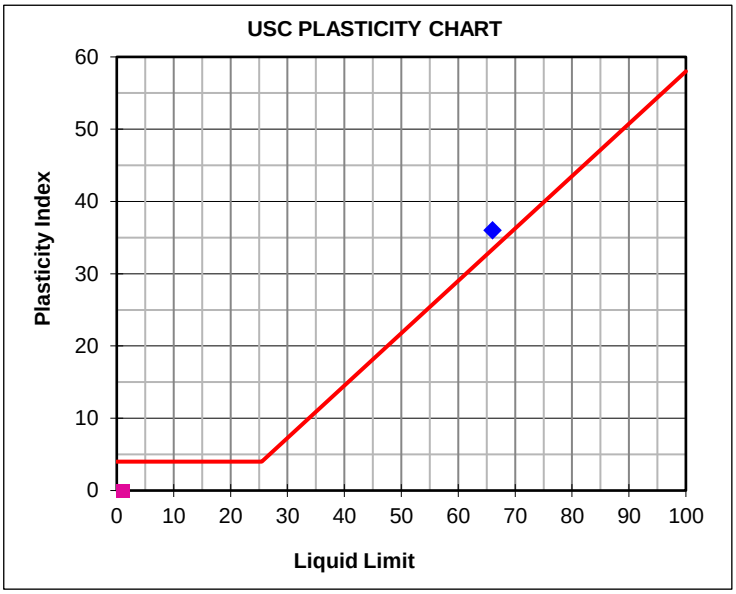


Moisture Content & Relative Density

Moisture Content (%)	31.4
Relative Density (S.G.)	

Sieve Analysis (Wet Prep) **SANS3001: GR1**

Percentage Passing	100 mm	100
	75 mm	100
	63 mm	100
	53 mm	100
	37.5 mm	100
	26.5 mm	100
	19 mm	100
	13.2 mm	100
	4.75 mm	96
	2 mm	85
	0.85 mm	73
	0.425 mm	52
	0.250 mm	50
	0.150 mm	47
	0.075 mm	47
Grading Modulus		1.16



Hydrometer Analysis **ASTM D422**

Percentage Passing	0.060 mm	43
	0.040 mm	36
	0.020 mm	31
	0.006 mm	26
	0.002 mm	24
Gravel	%	15
Sand	%	42
Silt	%	19
Clay	%	24

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

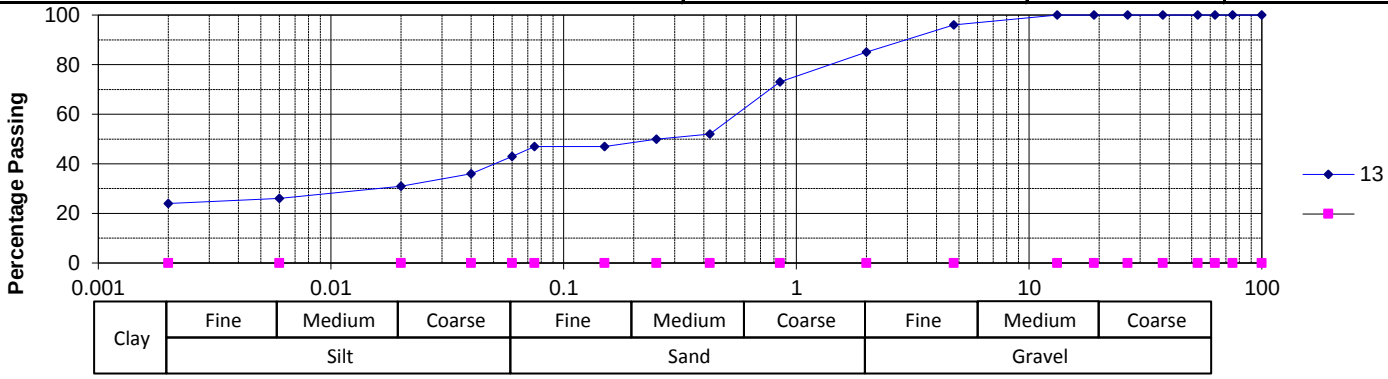
Laboratory Number	13 ◆	■

Atterberg Limits -425µ **SANS3001: GR10**

Liquid Limit	%	66
Plasticity Index	%	36
Linear Shrinkage	%	18.0
Overall PI	%	19

Classifications

HRB (AASHTO)	A-7-5(12)
Unified (ASTM D2487)	SC
Weston Swell @ 1 kPa	0.3



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MOISTURE DENSITY RELATIONSHIP

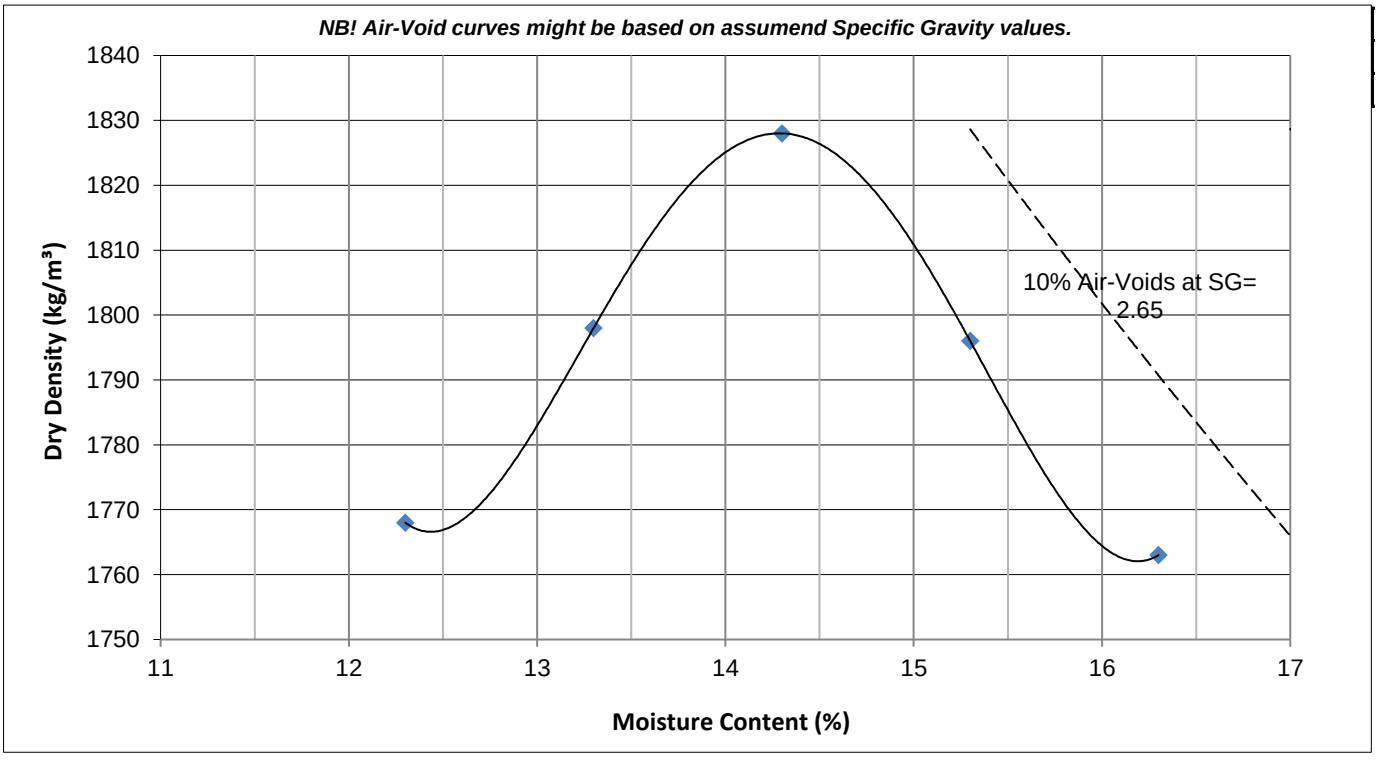
Laboratory Number		3
Field Number		TP02
Client Reference		
Depth (m)		0.90-1.40
Position		
Coordinates	X	
	Y	
Description		
Additional Information		Fill
Calcrete / Crushed Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - SANS3001: GR30

Compactive Effort:	Modified AASHTO

Dry Density	kg/m³	1768	1798	1828	1796	1763	
Moisture Content	%	12.3	13.3	14.3	15.3	16.3	

Max. Dry Density	kg/m³	1828
Optimum Moisture	%	14.3



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MOISTURE DENSITY RELATIONSHIP

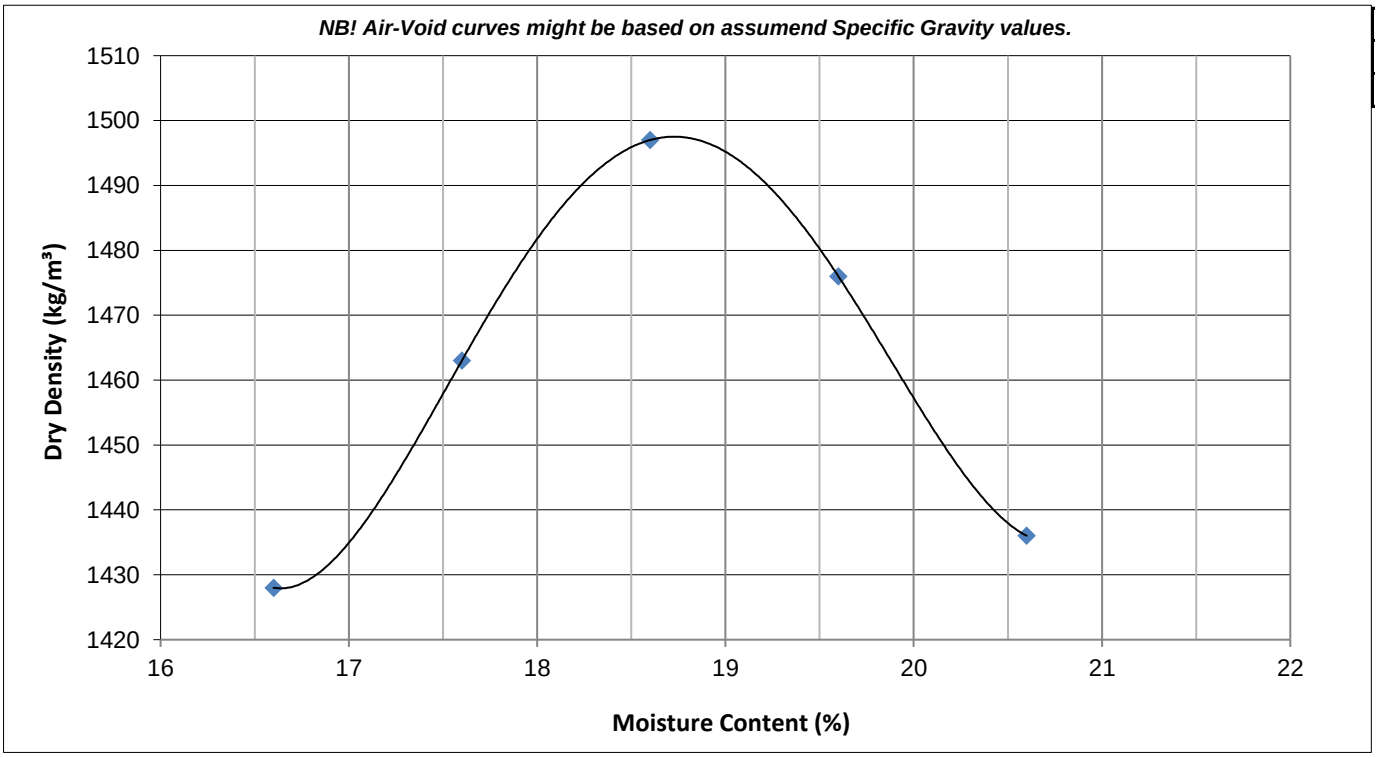
Laboratory Number		6
Field Number		TP06
Client Reference		
Depth (m)		0.20-1.20
Position		
Coordinates	X	
	Y	
Description		
Additional Information		Fill
Calcrete / Crushed		
Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - SANS3001: GR30

Compactive Effort:	Modified AASHTO

Dry Density	kg/m³	1428	1463	1497	1476	1436	
Moisture Content	%	16.6	17.6	18.6	19.6	20.6	

Max. Dry Density	kg/m³	1497
Optimum Moisture	%	18.7



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MOISTURE DENSITY RELATIONSHIP

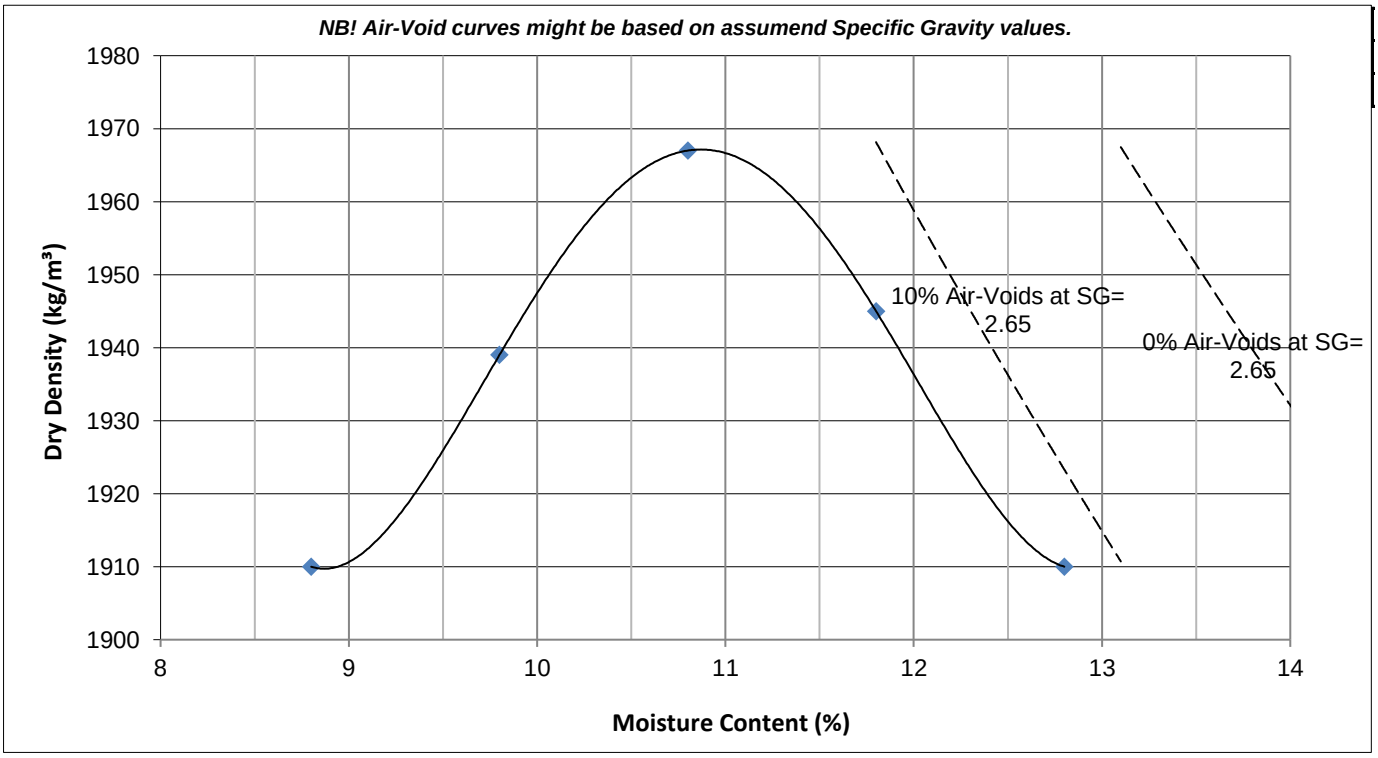
Laboratory Number		11
Field Number		TP10
Client Reference		
Depth (m)		0.60-1.90
Position		
Coordinates	X	
	Y	
Description		
Additional Information		Fill
Calcrete / Crushed		
Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - SANS3001: GR30

Compactive Effort:	Modified AASHTO

Dry Density	kg/m³	1910	1939	1967	1945	1910	
Moisture Content	%	8.8	9.8	10.8	11.8	12.8	

Max. Dry Density	kg/m³	1967
Optimum Moisture	%	10.9



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MOISTURE DENSITY RELATIONSHIP

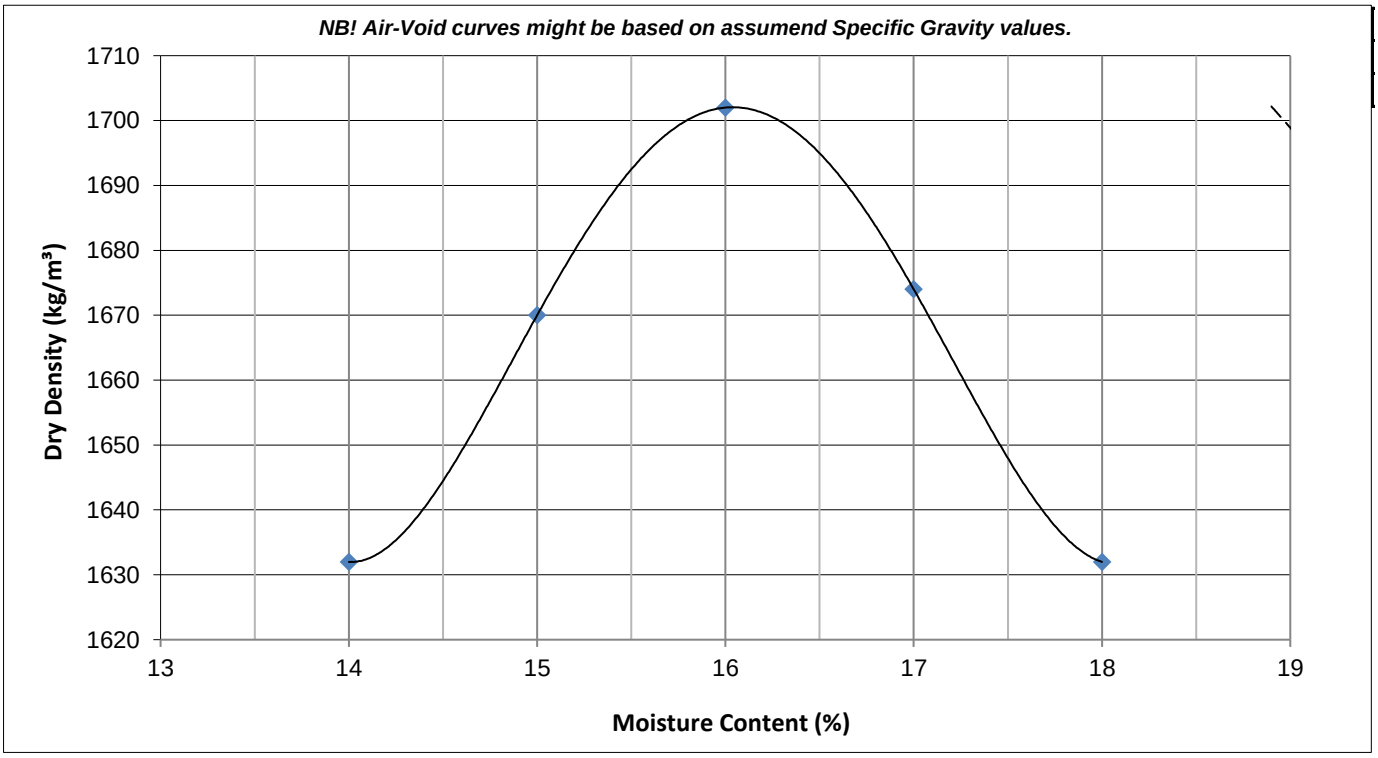
Laboratory Number		20
Field Number		TP15
Client Reference		
Depth (m)		0.50-1.30
Position		
Coordinates	X	
	Y	
Description		
Additional Information		Fill
Calcrete / Crushed		
Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - SANS3001: GR30

Compactive Effort:	Modified AASHTO

Dry Density	kg/m³	1632	1670	1702	1674	1632	
Moisture Content	%	14	15	16	17	18	

Max. Dry Density	kg/m³	1702
Optimum Moisture	%	16



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MOISTURE DENSITY RELATIONSHIP

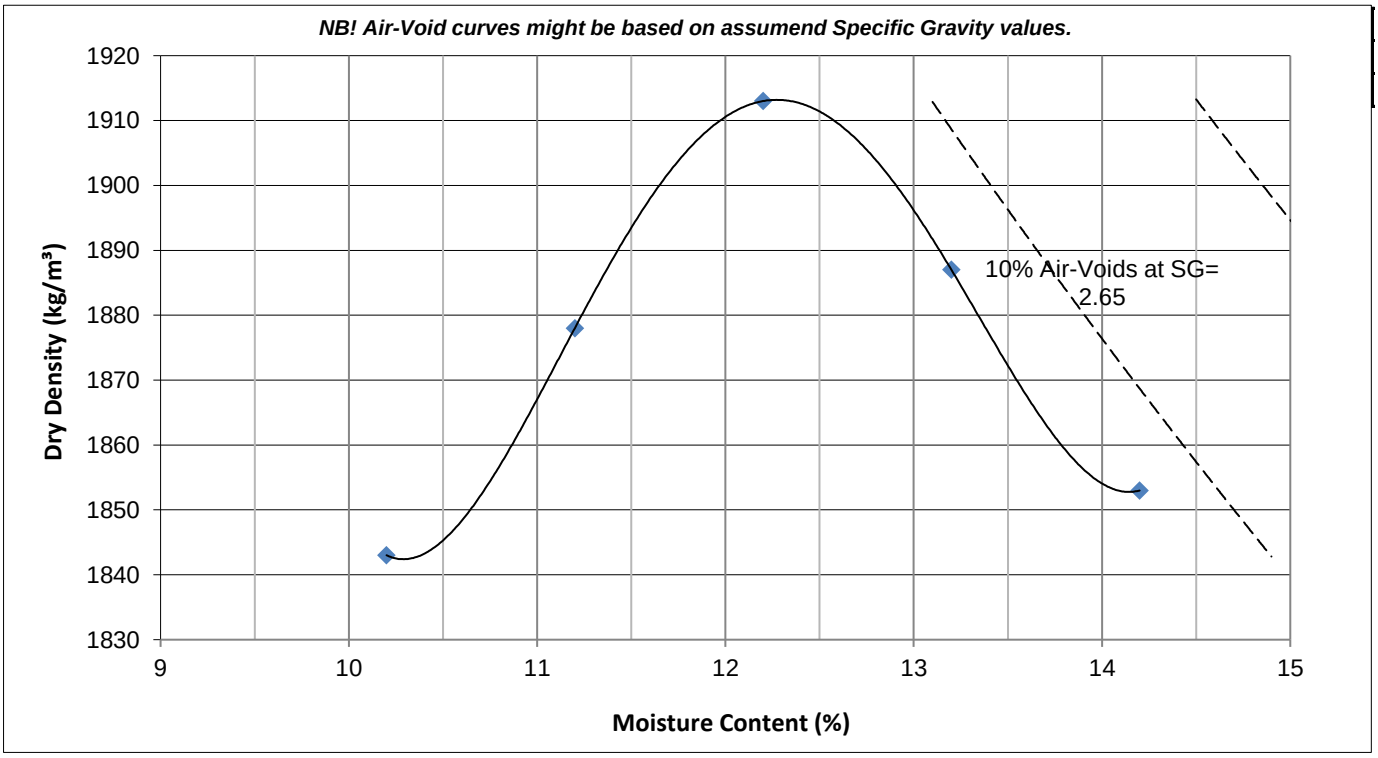
Laboratory Number		21
Field Number		WBA2
Client Reference		
Depth (m)		Stockpile
Position		
Coordinates	X	
	Y	
Description		
Additional Information		Fill- Nodular Ferricrete
Calcrete / Crushed		
Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - SANS3001: GR30

Compactive Effort:	Modified AASHTO

Dry Density	kg/m³	1843	1878	1913	1887	1853	
Moisture Content	%	10.2	11.2	12.2	13.2	14.2	

Max. Dry Density	kg/m³	1913
Optimum Moisture	%	12.3



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CALIFORNIA BEARING RATIO (CBR) & ROAD INDICATOR REPORT

Laboratory No.		3 ◆	6 ■
Field Number		TP02	TP06
Client Reference			
Depth (m)		0.90-1.40	0.20-1.20
Position			
Coordinates	X		
	Y		
Description			
Additional information		Fill	Fill
Calcrete/Crushed			
Stabilizing Agent			

Sieve Analysis (Wet preparation) — SANS3001: GR1

Percentage Passing	100 mm	100	100
	75 mm	100	100
	63 mm	100	100
	50 mm	100	100
	37.5 mm	93	100
	28 mm	83	100
	20 mm	72	100
	14 mm	65	75
	5 mm	55	46
	2 mm	49	35
	1 mm	44	28
	0.425 mm	35	20
	0.250 mm	33	19
	0.150 mm	30	19
	0.075 mm	29	18
Grading Modulus		1.9	2.3

Soil Mortar Analysis

Coarse Sand	29	43
Coarse Fine Sand	5	2
Medium Fine Sand	5	2
Fine Fine Sand	3	
Silt and Clay	59	53

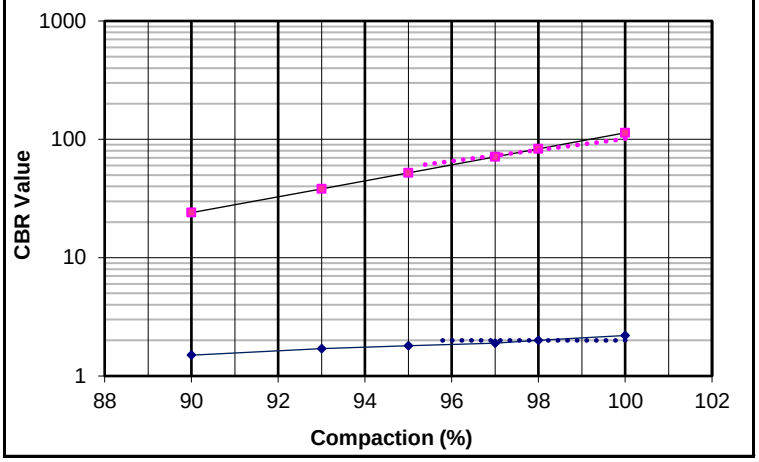
Atterberg Limits — SANS3001: GR10

Liquid Limit (%)	49	
Plasticity Index (%)	26	SP
Linear Shrinkage (%)	13.5	1.0

Laboratory No.		3 ◆	6 ■
Maximum Dry Density & Optimum Moisture Content			**SANS3001: GR30**
MDD	kg/m³	1828	1497
OMC	%	14.3	18.7

California Bearing Ratio — SANS3001: GR40

Compaction Data							
Moisture	%	14.4			18.8		
Dry Density	kg/m³	1833	1752	1639	1499	1427	1349
Compaction	%	100.0	95.6	89.4	100.0	95.2	90.0
Penetration Data							
CBR at	2.50 mm	2	2	1	101	60	24
	5.00 mm	2	2	1	125	67	27
	7.50 mm	2	2	1	130	69	29
Swell	%	7.4	8.2	8.4	0	0.1	0.1
Final Moisture (%)		22.2	23.9	27.5	20.6	23.6	26.9

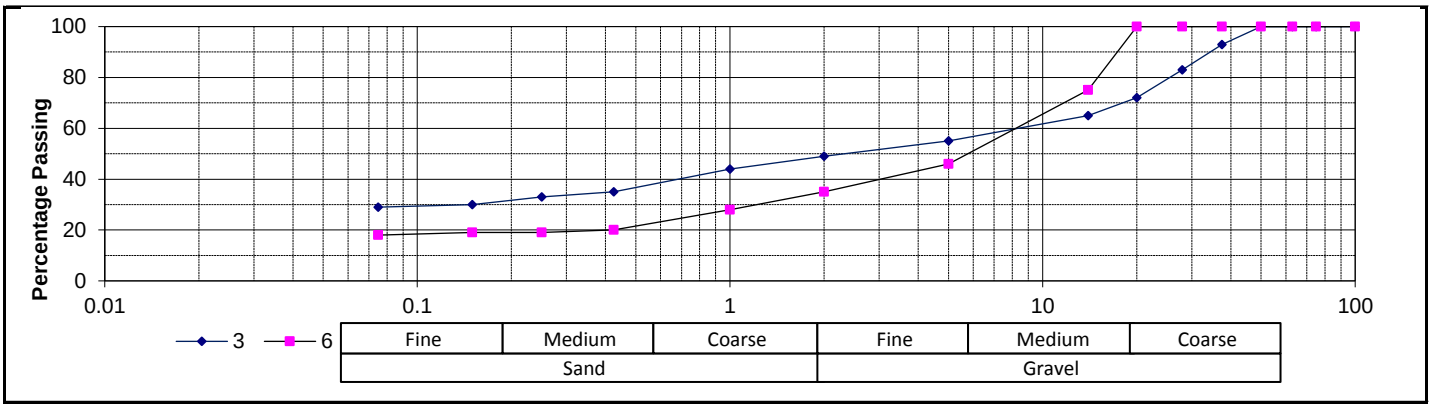


Interpolated CBR Data

CBR	@ 100%	Mod. AASHTO	2	114
	@ 98%		2	83
	@ 97%		2	71
	@ 95%		2	52
	@ 93%		2	38
	@ 90%		2	24
	@ SANS3001 Midpoint		2	78

Classifications

HRB (AASHTO)	A-2-7(2)	A-1-b(0)
COLTO	None	G5
TRH14	None	G5



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CALIFORNIA BEARING RATIO (CBR) & ROAD INDICATOR REPORT

Laboratory No.		11 ◆	20 ■
Field Number		TP10	TP15
Client Reference			
Depth (m)		0.60-1.90	0.50-1.30
Position			
Coordinates	X		
	Y		
Description			
Additional information		Fill	Fill
Calcrete/Crushed			
Stabilizing Agent			

Sieve Analysis (Wet preparation) — SANS3001: GR1

Percentage Passing	100 mm	100	100
	75 mm	100	100
	63 mm	100	100
	50 mm	100	100
	37.5 mm	100	100
	28 mm	100	100
	20 mm	100	100
	14 mm	97	98
	5 mm	75	66
	2 mm	66	49
	1 mm	61	41
	0.425 mm	49	29
	0.250 mm	45	28
	0.150 mm	40	27
	0.075 mm	38	27
Grading Modulus		1.5	2.0

Soil Mortar Analysis

Coarse Sand	26	41
Coarse Fine Sand	6	1
Medium Fine Sand	8	2
Fine Fine Sand	3	1
Silt and Clay	57	55

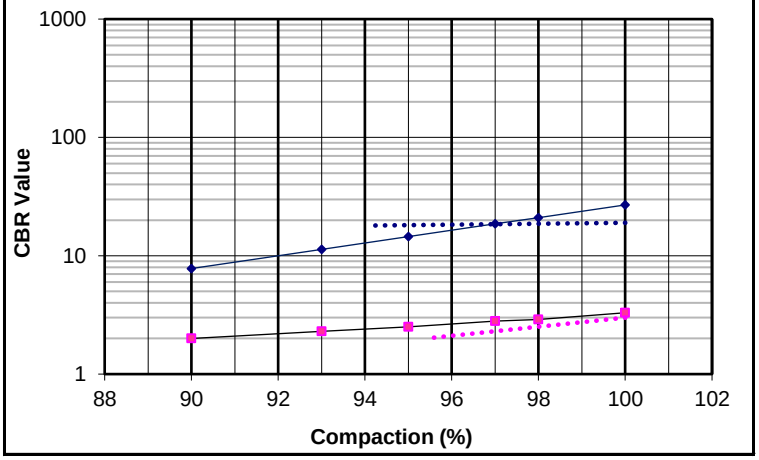
Atterberg Limits — SANS3001: GR10

Liquid Limit (%)	32	60
Plasticity Index (%)	16	31
Linear Shrinkage (%)	8.0	15.5

Laboratory No.		11 ◆	20 ■
Maximum Dry Density & Optimum Moisture Content			**SANS3001: GR30**
MDD	kg/m³	1967	1702
OMC	%	10.9	16

California Bearing Ratio — SANS3001: GR40

Compaction Data							
Moisture	%	10.9			16.1		
Dry Density	kg/m³	1983	1866	1770	1702	1623	1552
Compaction	%	100.0	94.1	89.3	100.0	95.4	91.2
Penetration Data							
CBR at	2.50 mm	19	18	7	3	2	2
	5.00 mm	17	16	6	3	3	2
	7.50 mm	16	14	6	3	2	2
Swell	%	0.5	0.7	0.8	2.5	3	3.8
Final Moisture (%)		13.2	18	20.6	24.7	26.4	30.6

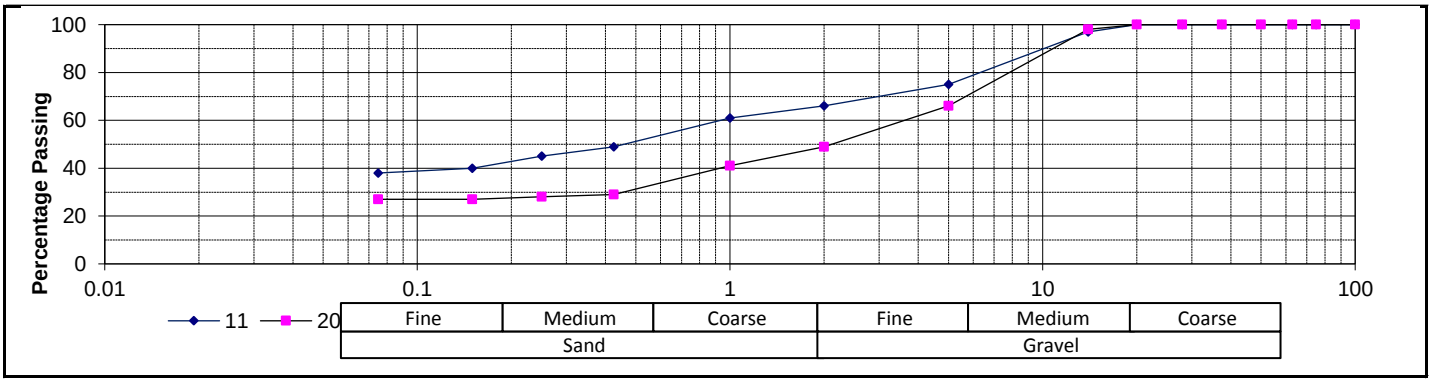


Interpolated CBR Data

CBR	@ 100%	Mod. AASHTO	27	3
	@ 98%		21	3
	@ 97%		19	3
	@ 95%		15	3
	@ 93%		11	2
	@ 90%		8	2
	@ SANS3001 Midpoint		19	3

Classifications

HRB (AASHTO)	A-6(2)	A-2-7(3)
COLTO	None	None
TRH14	G9	None



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CALIFORNIA BEARING RATIO (CBR) & ROAD INDICATOR REPORT

Laboratory No.		21 ◆	■
Field Number		WBA2	
Client Reference			
Depth (m)		Stockpile	
Position			
Coordinates	X		
	Y		
Description			
Additional information		Fill- Nodular Ferricrete	
Calcrete/Crushed			
Stabilizing Agent			

Sieve Analysis (Wet preparation) — SANS3001: GR1

Percentage Passing	100 mm	100
	75 mm	100
	63 mm	100
	50 mm	100
	37.5 mm	100
	28 mm	100
	20 mm	100
	14 mm	96
	5 mm	69
	2 mm	61
	1 mm	55
	0.425 mm	41
	0.250 mm	37
	0.150 mm	34
	0.075 mm	32
Grading Modulus		1.7

Soil Mortar Analysis

Coarse Sand		33
Coarse Fine Sand		6
Medium Fine Sand		6
Fine Fine Sand		3
Silt and Clay		52

Atterberg Limits — SANS3001: GR10

Liquid Limit (%)		41
Plasticity Index (%)		23
Linear Shrinkage (%)		11.5

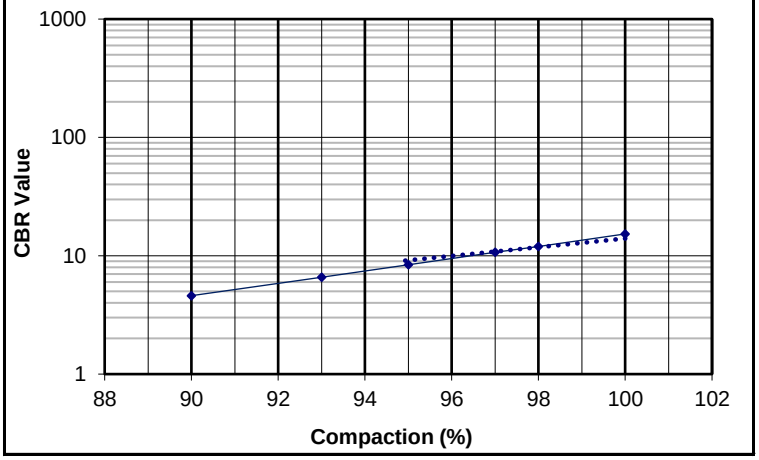
Laboratory No.		21 ◆	■

Maximum Dry Density & Optimum Moisture Content — SANS3001: GR30

MDD	kg/m³	1913	
OMC	%	12.3	

California Bearing Ratio — SANS3001: GR40

Compaction Data							
Moisture	%	12.2					
Dry Density	kg/m³	1918	1819	1725			
Compaction	%	100.0	94.8	89.9			
Penetration Data							
CBR at	2.50 mm	14	9	5			
	5.00 mm	14	7	4			
	7.50 mm	14	7	4			
Swell	%	1.5	1.6	1.9			
Final Moisture (%)		16.8	19.4	22			

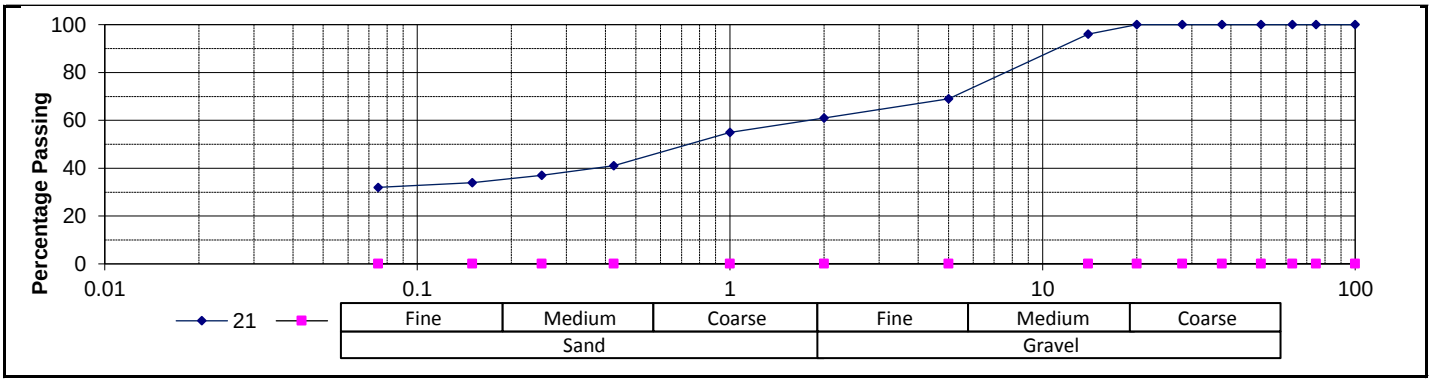


Interpolated CBR Data

CBR	@ 100%	Mod. AASHTO	15
	@ 98%		12
	@ 97%		11
	@ 95%		8
	@ 93%		7
	@ 90%		5
	@ SANS3001 Midpoint		11

Classifications

HRB (AASHTO)		A-2-7(2)
COLTO		None
TRH14		G10



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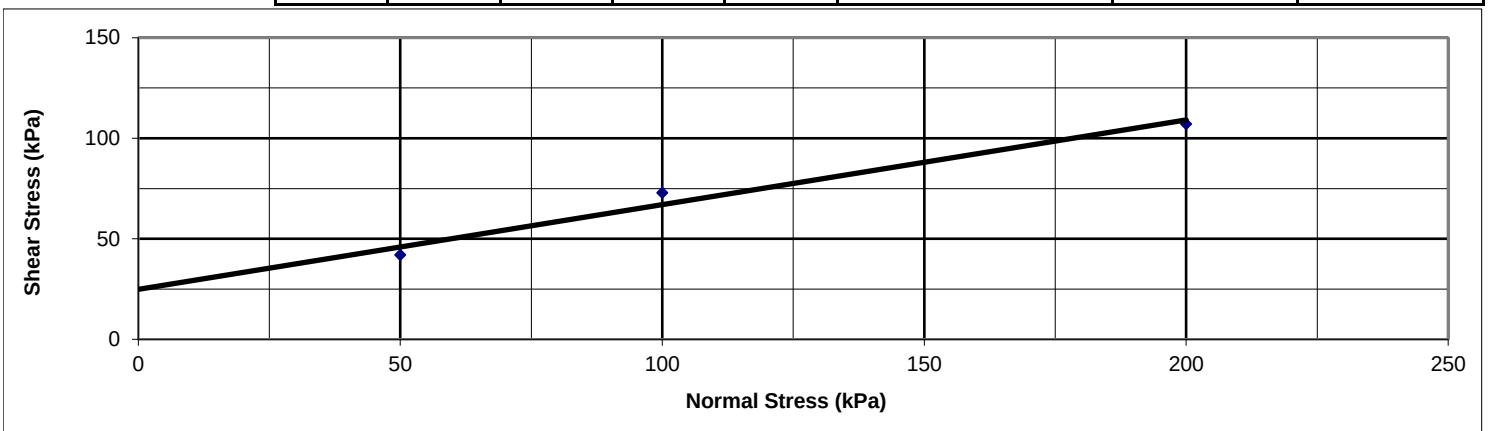
Direct Shear Test Results

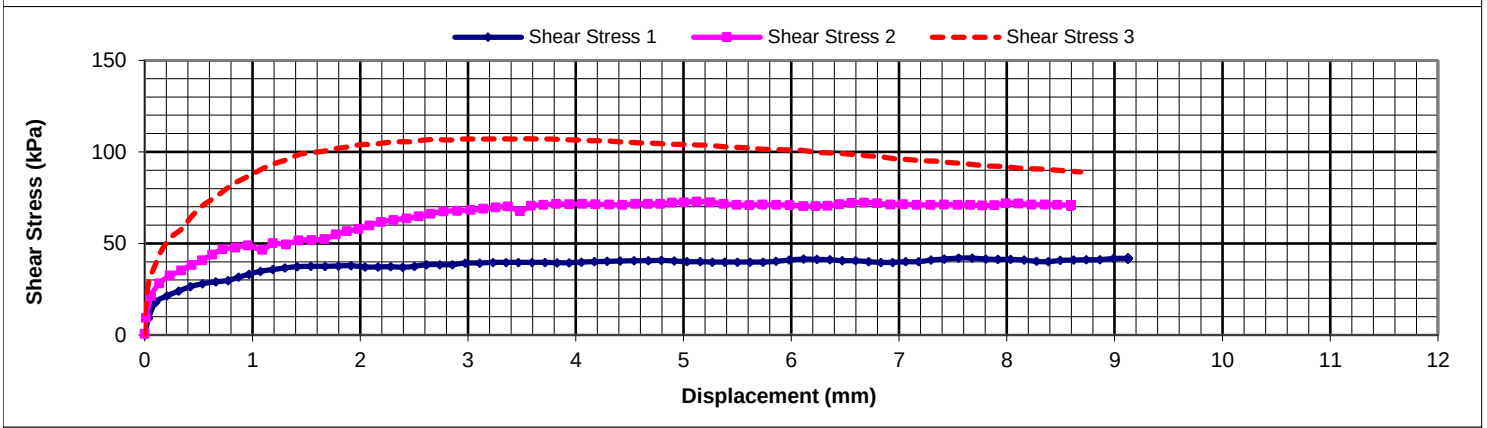
Project: **VEREENIGING PUMP STATION**	Date Tested: **4/12/2018**
Batch No.: **2018-B-2286**	Laboratory Number: **16**
Field Sample Number: **TP 13**	Depth (m): **1.2 - 1.4**

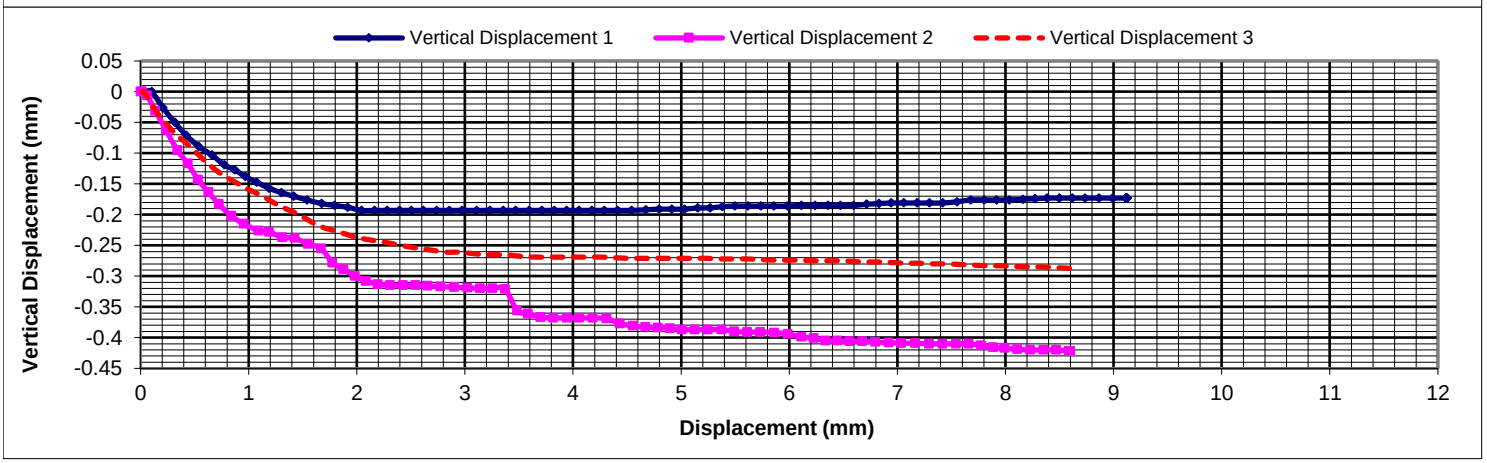
Remark: **A slow drained test on an undisturbed sample.**

		Height mm	Area mm^2	Moisture Content %	Dry Unit Weight	Void Ratio e	Saturation %	Normal Stress kPa	Peak Shear Stress kPa	Peak Shear Displacement mm
Test 1	Initial	17.77	2807.68	25.1	1.26	0.996	63.4	50.0	42.0	7.68
	Final			34.9						
Test 2	Initial	17.77	2807.68	27.2	1.35	0.864	79.4	100.0	72.9	5.12
	Final			32.1						
Test 3	Initial	17.77	2807.68	26.2	1.47	0.710	93.0	200.0	107.2	3.54
	Final			29.9						

Box Type	Rate of shear (mm/min) Test 1	Test 2	Test 3		Specific Gravity	**Internal Friction (deg)**	**Cohesion (kPa)**
ROUND	0.0585	0.0569	0.0564		2.519	**22.8**	**24.9**







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Falling Head Permeability Test Results

Project:	VEREENIGING PUMP STATION		
Project No:	2018-B-2286	Date:	21-Jan-19

Lab. Sample Reference	Field Sample Reference	Depth (m)	Moisture Contents		Dry density Kg/m^3		Coefficient of Permeability (m/s)		
			Before Test (%)	After Test (%)	Initial	As tested	Range Minimum	Range Maximum	Average
2286-20	TP 15	5.0 - 6.0	17.6	26.2	1576	1639	3.8E-08	4.8E-08	**4.1E-08**
2286-21	WBA 2	Stockpile	15.1	22.6	1774	1781	3.0E-09	3.9E-09	**3.2E-09**

Remarks: Samples remoulded to approximately 95% Mod.AASHTO
Saturated and tested under a load of 100kPa.
Densities reported are under a load of 100kPa.

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COMPACTIBILITY FACTOR

Project : **VEREENIGING PUMP STATION**	
Project No. : 2018-B-2286	Date : 15 JANUARY 2019

Lab. Sample Ref.	Field Sample Ref.	Depth (m)	Compaction Moisture Content %	Compactibility Factor
2286-6	TP 06	0.2 – 1.2	12.6	0.316
2286-11	TP 10	0.6 – 1.9	8.0	0.333
2286-21	WBA	STOCKPILE	10.1	0.366

REMARKS:

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CERTIFICATE OF ANALYSES
BASSON INDEX

Date received: 2019-01-14 | **Report number: 80018** | **Date completed: 2019-02-05**
Project number: 150 | **Order number: PTA06279**

Client name: Soillab | **Contact person: Ms C Edwards**
Address: PO Box 72928, Lynnwood Ridge, 0040 | **Email: edwardsc@soillab.co.za**
Telephone: 012 813 4914 / 082 553 1297 | **Fax: 086 721 3827**

Analyses in mg/ℓ (Unless specified otherwise)	Sample Identification:	
	TP02	**TP10**
Sample Number	**52060**	**52061**
pH Value at 25°C	7.8	7.9
pHs Value at 20°C (calc)	7.9	8.2
Electrical Conductivity in mS/m at 25°C	88.0	30.9
Total Dissolved Solids* (calc)	590	207
Total Alkalinity as $CaCO_3$	64	64
Total Hardness as $CaCO_3$ (calc)	343	125
Calcium Hardness as $CaCO_3$ (calc)	244	92
Calcium as Ca	98	37
Magnesium as Mg	24	8
Free & Saline Ammonia	<0.1	<0.1
Ammonium as NH_4 (calc)	<0.3	<0.3
Sulphate as SO_4	375	62
Chloride as Cl	6	<2
Langelier Index at 20°C (calc)	-0.1	-0.3
Ryznar Index at 20°C (calc)	7.9	8.6
Corrosivity Ratio (calc)	6.2	1.1
Leaching Index [LCSI] (calc)	**346**	**636**
Spalling Index [SCSI] (calc)	**43**	**8**
Aggressiveness Index [N_c] (calc)	**388**	**644**

***TDS Calculated EC X 6.7**
2:1 Distilled Water : Soil Extract

S. Laubscher
Geochemistry Project Manager

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Analyses in mg/ℓ (Unless specified otherwise)	Sample Identification:	
	TP13	TP15
Sample Number	**52062**	**52063**
pH Value at 25°C	7.5	6.5
pHs Value at 20°C (calc)	8.2	9.8
Electrical Conductivity in mS/m at 25°C	9.2	2.6
Total Dissolved Solids* (calc)	62	17
Total Alkalinity as $CaCO_3$	56	16
Total Hardness as $CaCO_3$ (calc)	192	20
Calcium Hardness as $CaCO_3$ (calc)	100	7
Calcium as Ca	44	3
Magnesium as Mg	20	3
Free & Saline Ammonia	0.2	0.1
Ammonium as NH_4 (calc)	0.3	<0.3
Sulphate as SO_4	67	5
Chloride as Cl	61	6
Langelier Index at 20°C (calc)	-0.7	-3.3
Ryznar Index at 20°C (calc)	8.9	13.2
Corrosivity Ratio (calc)	2.9	0.9
Leaching Index [LCSI] (calc)	**870**	**2782**
Spalling Index [SCSI] (calc)	**12**	**2**
Aggressiveness Index [N_c] (calc)	**881**	**2783**

***TDS Calculated EC X 6.7**
2:1 Distilled Water : Soil Extract

Important notes (see table for corrections on p.4):

1. The above aggressiveness index is only applicable for conditions of laminar flow at a mean annual temperature of 20°C.
2. For stagnant/turbulent conditions the aggressiveness index must be corrected.
3. For wet/dry cycling conditions (for example in tidal zones) the aggressiveness index must be corrected.
4. For mean annual temperatures lower/higher than 20°C the aggressiveness index must be corrected.

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Guidelines for assessing overall aggressiveness (N_c):

N_c	Aggressiveness
Not greater than 300	None to mild
400-700	Mild to moderate
800-1000	High
= or > 1 100	Very high

Aggressiveness Towards *Concrete and Fibre Cement Pipes*			
Index	**Aggressive**	**Neutral**	**Non- Aggressive**
a) Stability pH (pHs)	>Ph	= pH	<pH
b) Langelier Index	Neg. Value	Zero	Pos. Value
c) Ryznar Index	>7.5	6-7	<6

Corrosiveness Towards metals	
Corrosivity	>0.2

Sample Name	Sample Number	Corrosivity Indices	Basson Index
TP02	52060	Corrosive	Aggressive
TP10	52601	Corrosive	Aggressive
TP13	52062	Corrosive	Aggressive
TP15	52063	Corrosive	Aggressive

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To correct for:	Multiply	By: (see Notes 2 to 5 below)
Turbulence	LCSI	1.75
Stagnance	LCSI	0.5
Temperature	LCSI, SCSI, N7 Where N7=0.2 x Cl in mg/l	(1+ [0.05 x (T-20)])
Wet-dry cycles	SCSI	0.23×10^{-6} x TDS x DTF x CPA Where: DTF = Dry Time Fraction CPA = wet-dry cycles per annum

Note 1: Only if the concrete contains embedded steel.
Note 2: To preserve the correct logical relationships when dealing with the negative sub indices (ie LCSI or SCSI having minus values) they should be multiplied by the reciprocal of the relevant factor indicated in this column
Note 3: If more than one correction is required, multiply by the product of the individual correction factors
Note 4: Use subscript c to indicate that the index has been corrected, eg for turbulent conditions $LCSI_c$ = LCSI x 1.75
Note 5: Round off corrected indices to the nearest 100.

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CONSOLIDATION TEST RESULTS - BS 1377: Part 5

Project	VEREENIGING PUMP STATION	Date Tested:	30/11/2018
Project No.	2018-B-2286	Laboratory Number:	16
Field Sample Reference	TP 13	Depth (m):	1.2 - 1.4

Test No.	1	
Test Type	Swell	
Remarks	Swell: 1.91%	

Specimen-, Preparation- & Test Conditions

Specimen Type	Undisturbed	
Moulding Dry Density		
Moulding Moisture		
Testing Moisture	Soaked @ 10kPa	

Equipment Detail

Machiene No.		OED18	
Ring	No.	G	
	Mass (g)	79.3	
	Height (mm)	18.79	
	Diameter (mm)	69.96	

Specimen Parameters

Stage	Initial	Final (Unloaded)	Initial	Final (Unloaded)
Relative density (S.G.)	2.519			
Moisture Content (%)	24.8	30.0		
Dry Density (kg/m^3)	1227	1537		
Void Ratio, e	1.054	0.639		
Degree of Saturation (%)	59	118		

Test Data

Test 1

Cycle	No.	1	2	3	4	5	6	7	8	9	10	11					
Total time	min	14109	1394	1429	228	1129	515.3	1544	1246	1467	2809	4186					
Stress	kPa	10	10	51	100	198	398	787	1571	395	100	10					
Strain	%	6.14	4.23	6.35	9.65	13.60	17.81	22.41	29.45	27.96	25.94	20.20					
Void Ratio	e	0.928	0.967	0.923	0.856	0.775	0.688	0.594	0.449	0.480	0.521	0.639					
Mv (1/MPa)		0.000		0.517	0.674	0.402	0.211	0.118	0.090	0.013	0.068	0.638					
t90	min																
Cv	m^2/year																

Test 2

Cycle	No.																
Total time	min																
Stress	kPa																
Strain	%																
Void Ratio	e																
Mv (1/MPa)																	
t90	min																
Cv	m^2/year																

The t90 values reported, if any, which are used to calculate the coefficient of consolidation at different loads are selected by the operator conducting the test and checked by the appropriate technical signatories. They may however not reflect an engineer's interpretation of the time settlement graphs and are by no means final.

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CONSOLIDATION TEST RESULTS - BS 1377: Part 5

Project	VEREENIGING PUMP STATION	Date Tested	30/11/2018
Project No.	2018-B-2286	Laboratory Number	16
Field Sample Reference	TP 13	Depth (m)	1.2 - 1.4

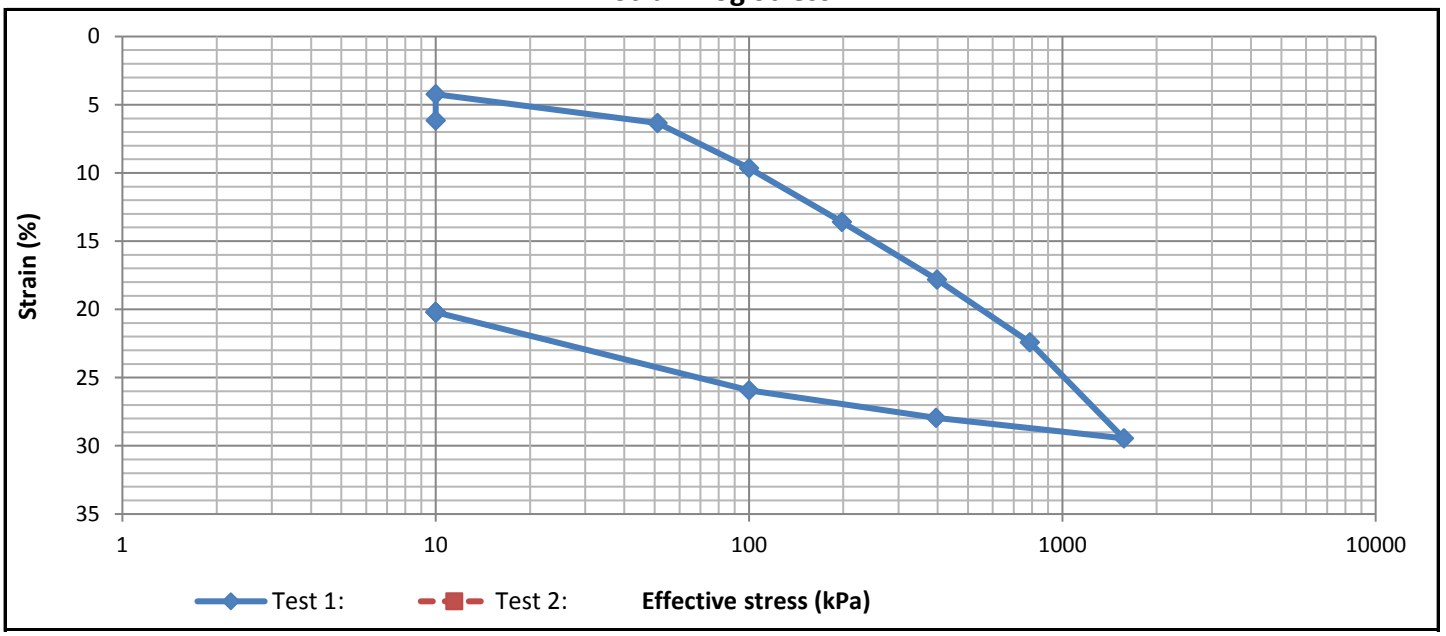
Test 1: **Specimen: Undisturbed , Testing Moisture: Soaked @ 10kPa**

Cycle	1	2	3	4	5	6	7	8	9	10	11					
Stress (kPa)	10	10	51	100	198	398	787	1571	395	100	10					
Strain (%)	6.14	4.23	6.35	9.65	13.60	17.81	22.41	29.45	27.96	25.94	20.20					
Void Ratio, e	0.928	0.967	0.923	0.856	0.775	0.688	0.594	0.449	0.480	0.521	0.639					

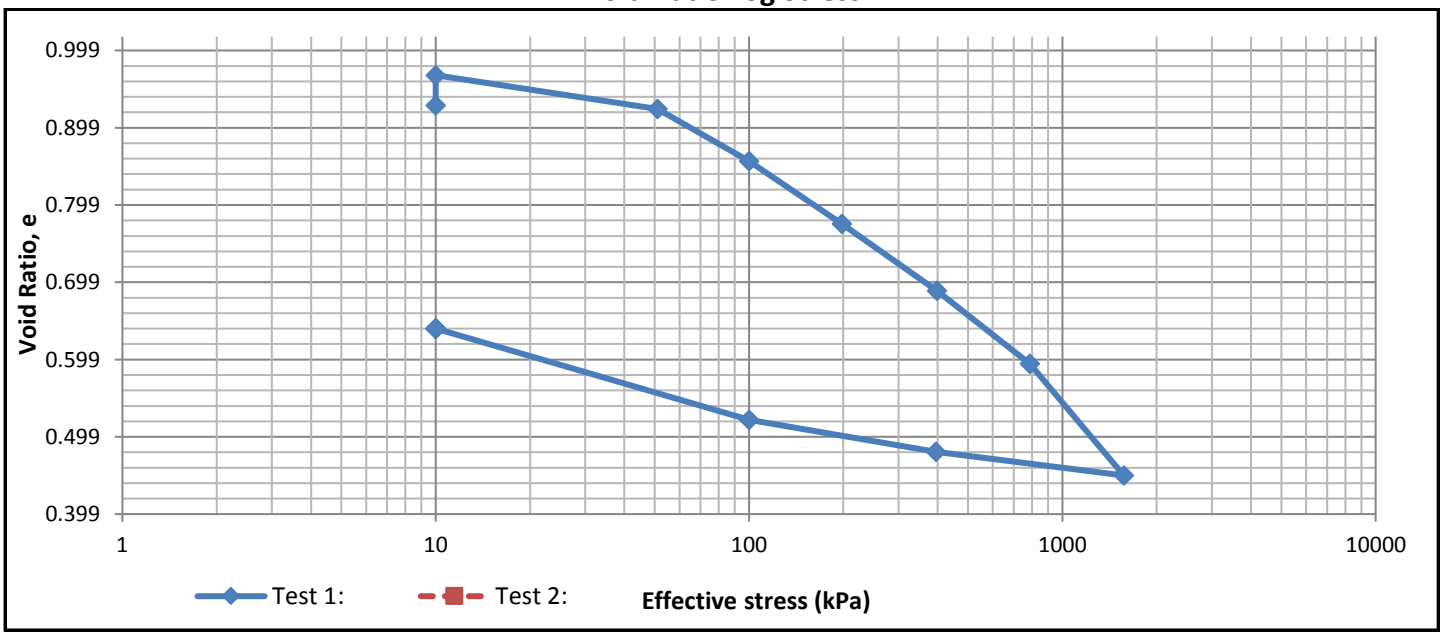
Test 2:

Cycle																
Stress (kPa)																
Strain (%)																
Void Ratio, e																

Strain Log Stress



Void Ratio Log Stress



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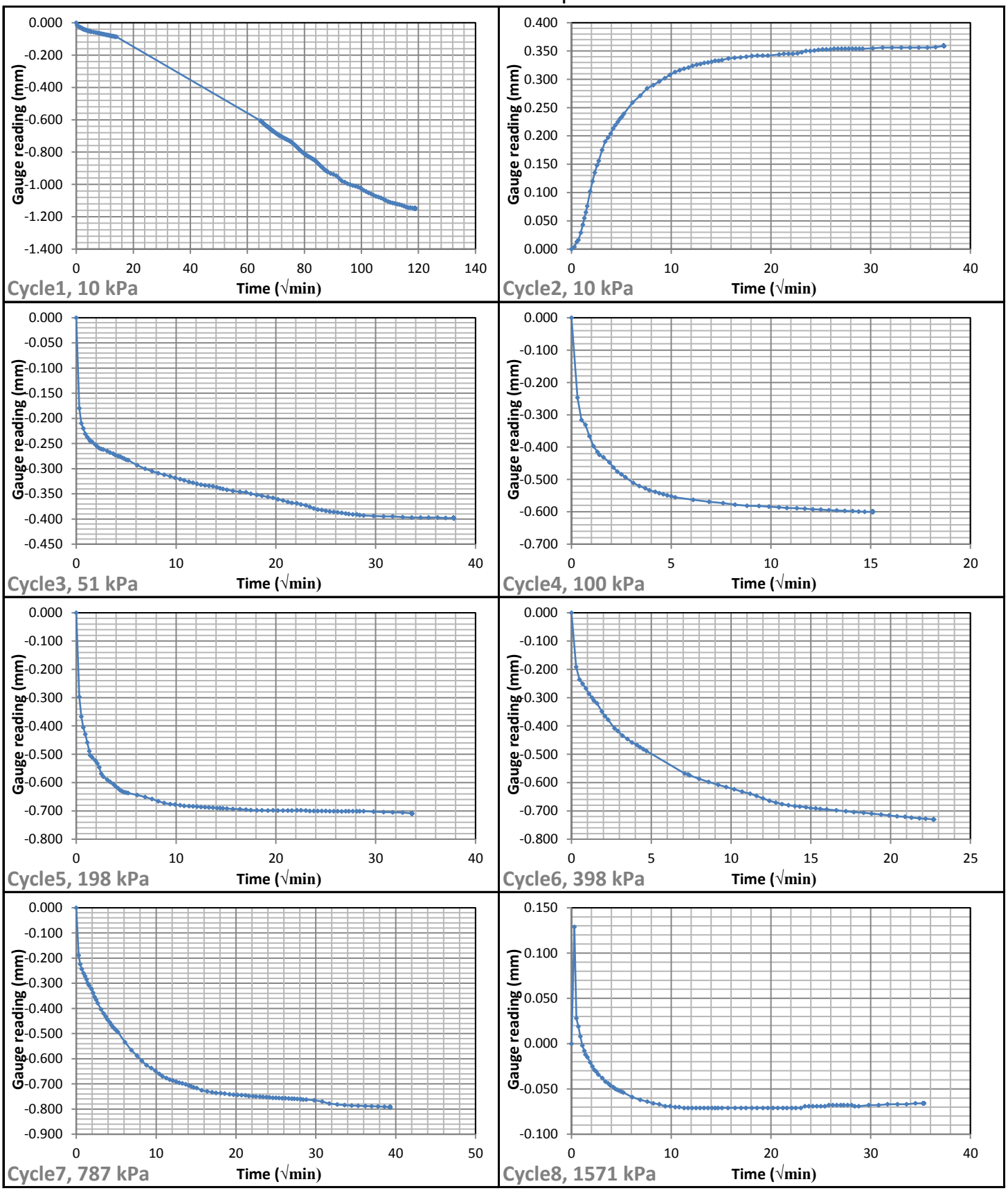
CONSOLIDATION TEST RESULTS - BS 1377: Part 5

Project	VEREENIGING PUMP STATION	Date Tested:	30/11/2018
Project No.	2018-B-2286	Laboratory Number:	16
Field Sample Reference	TP 13	Depth (m):	1.2 - 1.4

Test 1 - Consolidation vs Square Root Time



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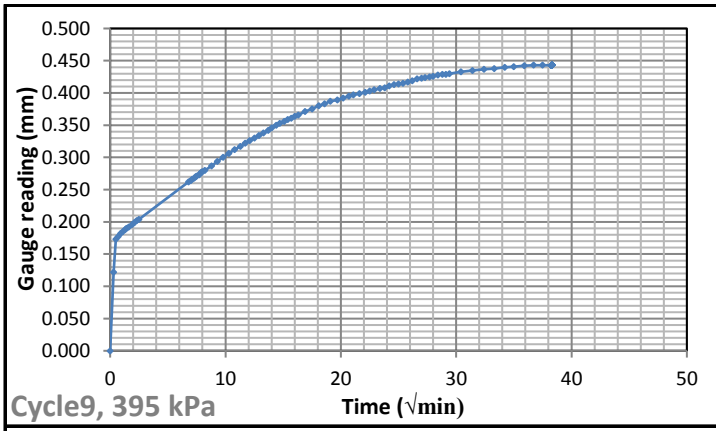
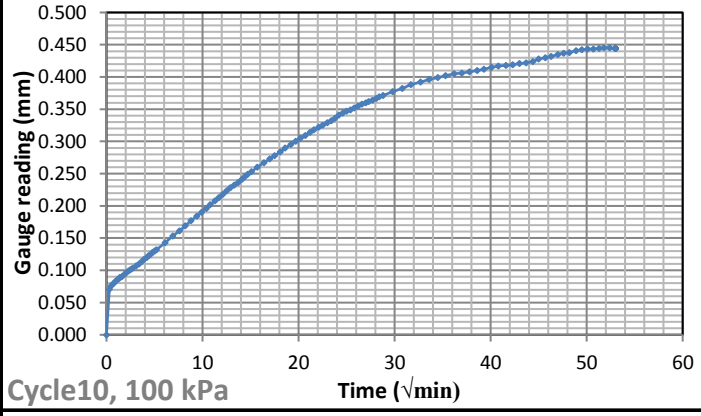
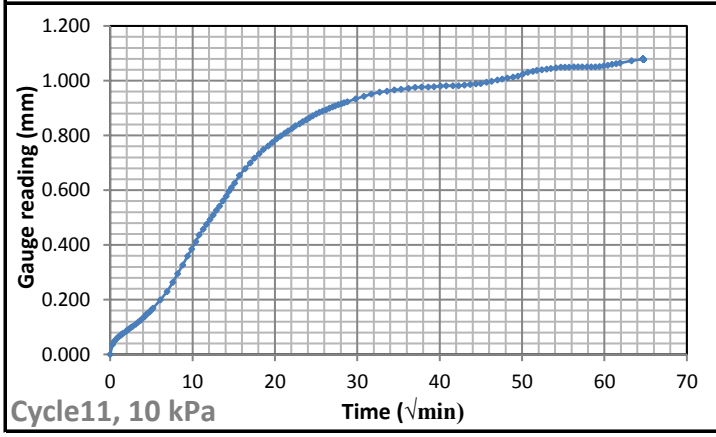
CONSOLIDATION TEST RESULTS - BS 1377: Part 5

Project	VEREENIGING PUMP STATION	Date Tested:	30/11/2018
Project No.	2018-B-2286	Laboratory Number:	16
Field Sample Reference	TP 13	Depth (m):	1.2 - 1.4

Test 1 - Consolidation vs Square Root Time







APPENDIX D

JG AFRIKA TEST PIT AND BOREHOLE LOGS

JG AFRIKA

FAST MOVE
VEREENIGING PUMPING STATION

HOLE No: TP01
Sheet 1 of 1

JOB NUMBER: 4256

0.00	Slightly moist to moist, greyish black, soft, shattered and slickensided, silty CLAY with scattered fine to course gravel: Fill.
0.20	Moist, dark brown speckled black and orange, loose, voided, clayey SAND with abundant fine to course gravel: Fill.
0.90	Slightly moist, olive speckled black streaked orange, loose, voided, silty sandy gravelly CLAY with gravel comprised medium to course ferricrete: Fill.
2.00	Moist, dark brown speckled red yellow and black blotched olive streaked orange, voided, gravelly silty sandy CLAY: Fill.
2.70	Moist, dark brown speckled black streaked orange, loose to medium dense, voided, clayey silty SAND with pockets of sandy clay and minor scattered ferricrete nodules: Hillwash.
3.00	

NOTES

1) Electric cable intercepted at 0.60m.
2) No groundwater seepage.
3) No sidewall collapse.
4) No refusal.
5) CBR sample taken 0.90--2.00 m.
6) Indicator sample taken 2.00--2.70 m.
7) Indicator sample taken 2.70--3.00 m.

CONTRACTOR :
MACHINE : BELL
DRILLED BY :
PROFILED BY : S. KULLEN

TYPE SET BY : S. KULLEN
SETUP FILE : TP-JGA-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 14/07/2016

DATE : 17/11/2016 15:43
TEXT : ..256VEREENIGINGTPLOGS.TXT

ELEVATION :
X-COORD : 27 55 12.0 E
Y-COORD : 26 41 13.1 S

HOLE No: TP01

JG AFRIKA

FAST MOVE
VEREENIGING PUMPING STATION

HOLE No: TP02
Sheet 1 of 1

JOB NUMBER: 4256

0.00	Moist, grey speckled black and orange blotched olive, soft, fissured and slickensided, gravelly silty CLAY with fine to medium grained gravel and small to medium cobbles: Fill.
0.33	Moist, light brown, loose, voided, medium to coarse grain SAND with scattered medium cobbles: Fill.
0.40	Greyish black speckled black and white, loose, friable, SLAG: Fill.
0.75	Slightly moist, dark brown speckled black olive and red, loose, voided, gravelly clayey SAND with abundant fine to medium gravel: Fill.
1.45	Slightly moist, dark brown, loose, voided, clayey silty SAND with abundant medium to large boulders: Fill.
2.35	Moist, olive speckled black streaked and stained olive, soft, intact, silty gravelly sandy CLAY with pockets of clay and scattered gravel and ferricrete nodules: Fill.
3.10	Moist becoming wet, dark grey speckled black, loose to medium dense, intact, silty SAND with scattered ferricrete nodules: Fill.
3.50	

NOTES

1) Pipe intercepted at 1.20 m.
2) Groundwater seepage from 3.10 m.
3) Minor sidewall collapse.
4) No refusal.
5) Indicator sample taken 2.35--3.10 m.
6) Indicator sample taken 3.10--3.50 m.

CONTRACTOR :
MACHINE : BELL
DRILLED BY :
PROFILED BY : S. KULLEN

TYPE SET BY : S. KULLEN
SETUP FILE : TP-JGA-A4.SET

INCLINATION :
DIAM :
DATE :
DATE : 14/07/2016

DATE : 17/11/2016 15:43
TEXT : ..256VEREENIGINGTPLOGS.TXT

ELEVATION :
X-COORD : 27 55 07.1 E
Y-COORD : 26 41 13.9 S

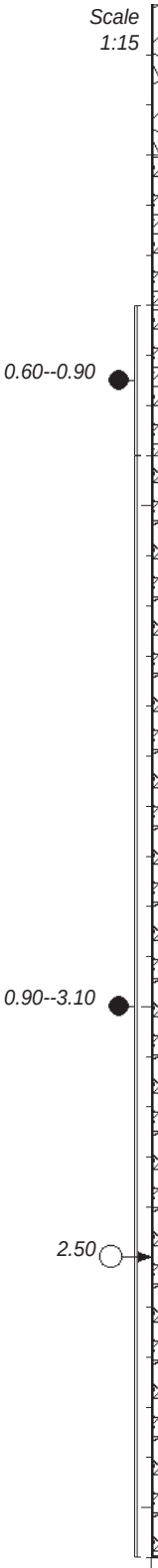
HOLE No: TP02

JG AFRIKA

FAST MOVE
VEREENIGING PUMPING STATION

HOLE No: TP03
Sheet 1 of 1

JOB NUMBER: 4256



0.00 BUILDING RUBBLE.

0.30 Moist, dark grey streaked orange, soft, slickensided sandy CLAY: Residual sandstone.

0.60 Moist, grey speckled black, soft, slickensided, sandy silty CLAY: Residual sandstone.

0.90 Moist becoming wet, olive grey becoming stained orange with depth, soft, shattered and slickensided (large slickenside planes), silty sandy CLAY with small boulders of completely weathered sandstone with depth: Residual sandstone.

3.10

NOTES

1) Groundwater seepage from 2.50 m.
2) Major sidewall collapse from 2.00 m.
3) No refusal.
4) Indicator sample taken 0.60--0.90 m.
5) Indicator sample taken 0.90--3.10 m.

CONTRACTOR :
MACHINE : BELL
DRILLED BY :
PROFILED BY : S. KULLEN

INCLINATION :
DIAM :
DATE :
DATE : 14/07/2016

ELEVATION :
X-COORD : 29 35 27.6 E
Y-COORD : 26 03 34.0 S

HOLE No: TP03

TYPE SET BY : S. KULLEN
SETUP FILE : TP-JGA-A4.SET

DATE : 17/11/2016 15:43
TEXT : ..256VEREENIGINGTPLOGS.TXT

HOLE No: BH1
Sheet 1 of 2

JOB NUMBER: 4256

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

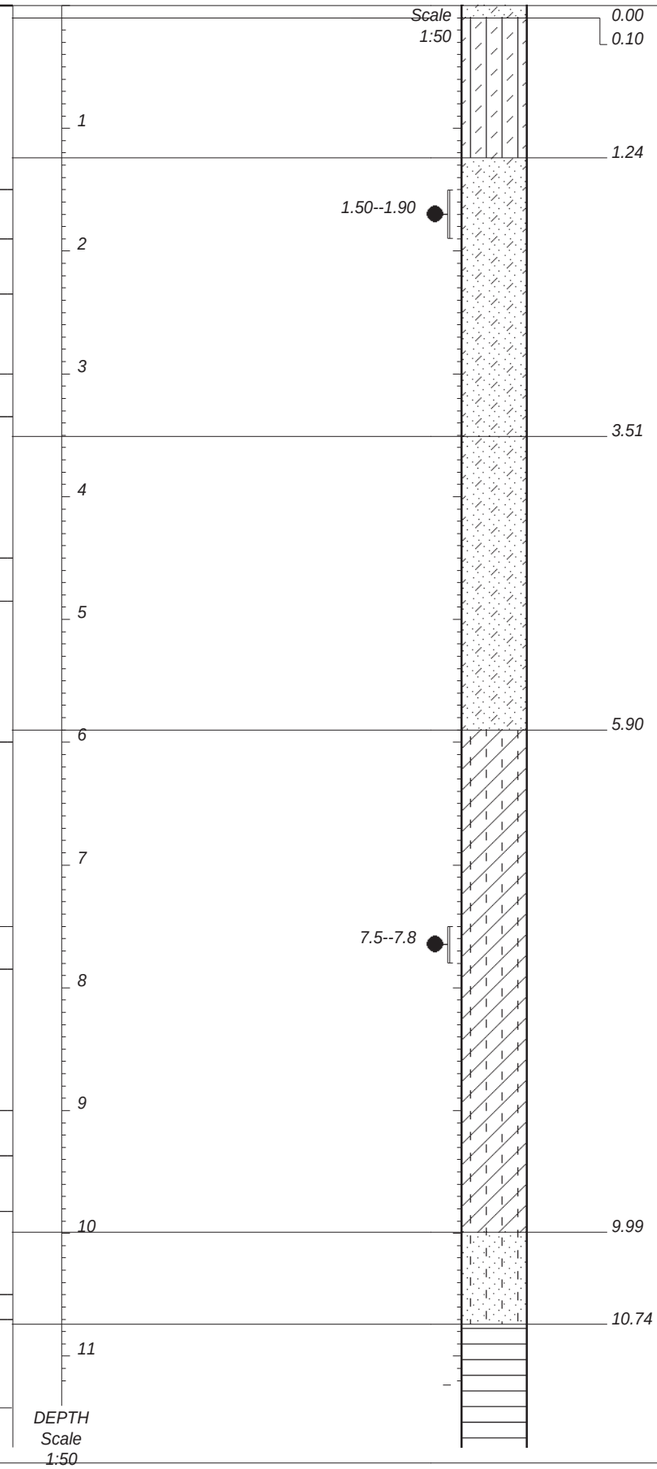
JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

HOLE No: BH1
Sheet 1 of 2

JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency
				NWD4	
				NWD4	
			51	NWD4	
				NWD4	
			Refusal	NWD4	
35				NWD4	
66			Refusal	NWD4	
35				NWD4	
27				NWD4	
231				NWD4	
35				NWD4	
100				NWD4	
89			46	NWD4	
59				NWD4	
100			Refusal	NWD4	



0.00 "Yellowish brown speckled white and grey, dense, intact, slightly clayey SAND. Fill."

0.10 "Dark brown, soft, intact, slightly clayey SILT. Fill."

1.24 "Mottled dark and light orange brown, light grey and black, medium dense, intact, CLAYEY SAND with well rounded ferricrete nodules. Fill."

3.51 "Light orange brown, loose to medium dense, intact, clayey medium grained SAND with occasional gravel. Hillwash."

5.90 "Khaki and light grey with occasional light orange seams, firm, intact, silty CLAY. Residual."

9.99 "Light pinkish beige, loose, intact, SILTY fine SAND. Residual."

10.74

HOLE No: BH1
Sheet 2 of 2

JOB NUMBER: 4256

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JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

HOLE No: BH1
Sheet 2 of 2

JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency	DEPTH Scale 1:50		
103	97	21		NWD4		12	11.80	"Grey speckled light brown and streaked blackish grey, with occasional light orange brown zones, highly to moderately weathered, fine grained, closely fractured, soft to medium hard rock SILTSTONE. Vryheid Formation. Fractures mostly bedding separation with occasional sub horizontal joints, wide, orange staining and clay infill, smooth planar dipping at 0-10 deg and 45 deg. Highly weathered, very closely fractured, clay zones at 11.41 to 11.5"
67	67	11		NWD4		13	12.60	"Slightly pinkish light brown and grey, highly to moderately weathered, fine grained, close to very closely fractured, soft to medium hard rock SILTSTONE. Vryheid Formation. Fractures mostly bedding separation with occasional sub horizontal joints, wide, orange staining and clay infill, smooth planar dipping at 0-10 deg and 55 deg."
37	27			NWD4		14	13.50	"Slightly pinkish light brown and grey, highly weathered, fine grained, very closely fractured, soft to medium hard rock SANDSTONE. Vryheid Formation. Fracturtes mostly bedding separation with occasional sub horizontal joints, wide, orange staining and clay infill, smooth planar dipping at 0-10 deg and 55 deg."
95	91	25		NWD4		15	14.00	"Light orange brown with white and pinkish blotches with dark grey, highly to completely weathered, coarse grained, very closely fractured soft rock TILLITE. Dwyka Group. Fractures, narrow with orange staining, rough planar dipping at 0-10 and 65 deg"
						16		"Black with occasional light brown and shiny black streaks, moderately weathered, very closely to closely fractured, very soft to soft rock COAL. Vryheid Formation. Fractures, narrow, minor staining, smooth planar, dipping at 0-10 and 45 deg."
100	100	63		NWD4			16.09	
88	88	54		NWD4		17	16.27	"Black moderately weathered, very fine grained with occasional very coarse grains, closely fractured, soft to medium hard rock CARBONACEOUS MUDSTONE. Vryheid Formation. Fractures, narrow, minor staining, smooth planar, dipping at 0-10 and 45 deg."
							16.65	"Dark grey with white and pinkish blotches with dark grey, highly to moderately weathered, coarse grained, very closely fractured soft rock TILLITE. Dwyka Group. Fractures, narrow with orange staining, rough planar dipping at 0-10 and 65 deg."
101	101	90		NWD4		18	17.17	"Black moderately weathered, very fine grained with occasional very coarse grains, closely fractured, soft to medium hard rock CARBONACEOUS MUDSTONE. Vryheid Formation. Fractures, narrow, minor staining, smooth planar, dipping at 0-10 and 45 deg."
							17.60	"Dark grey, moderately weathered, fine grained, medium fractured, medium hard rock SANDSTONE. Vryheid Formation."
						19	19.04	"Slightly light pinkish grey, slightly weathered, medium grained, medium to widely fractured, medium hard rock SANDSTONE/TILLITE with occasional well rounded inclusion Vryheid Formation. Fractures, narrow, clean, smooth planar, dipping at 0-10 deg"
							19.20	"Khaki Beige, light greyish brown, slightly to moderately weathered, VERY fine grained, medium fractured, medium hard rock SILTSTONE. Vryheid Formation."
							19.50	"Khaki Beige, light greyish brown, slightly to moderately weathered, fine grained, medium fractured, medium hard to hard rock SANDSTONE. Vryheid Formation."

NOTES

1) Water table encountered at (pending measurement)

2) Shelby samples retrieved at 1.50--1.90 and 7.5--7.8

CONTRACTOR : GEOMECHANICS
MACHINE : YWE - D8
DRILLED BY :
PROFILED BY : KDI

TYPE SET BY : KDI
SETUP FILE : BH-JGA-A3.SET

INCLINATION : Vertical
DIAM :
DATE : 16-17/08/2016
DATE : 15/09/2016

DATE : 17/11/2016 15:21
TEXT : ..56BH\4256VPSBH001LOG.TXT

ELEVATION :
X-COORD : 26deg41'12.9"S
Y-COORD : 27deg55'11.20"E

HOLE No: BH1

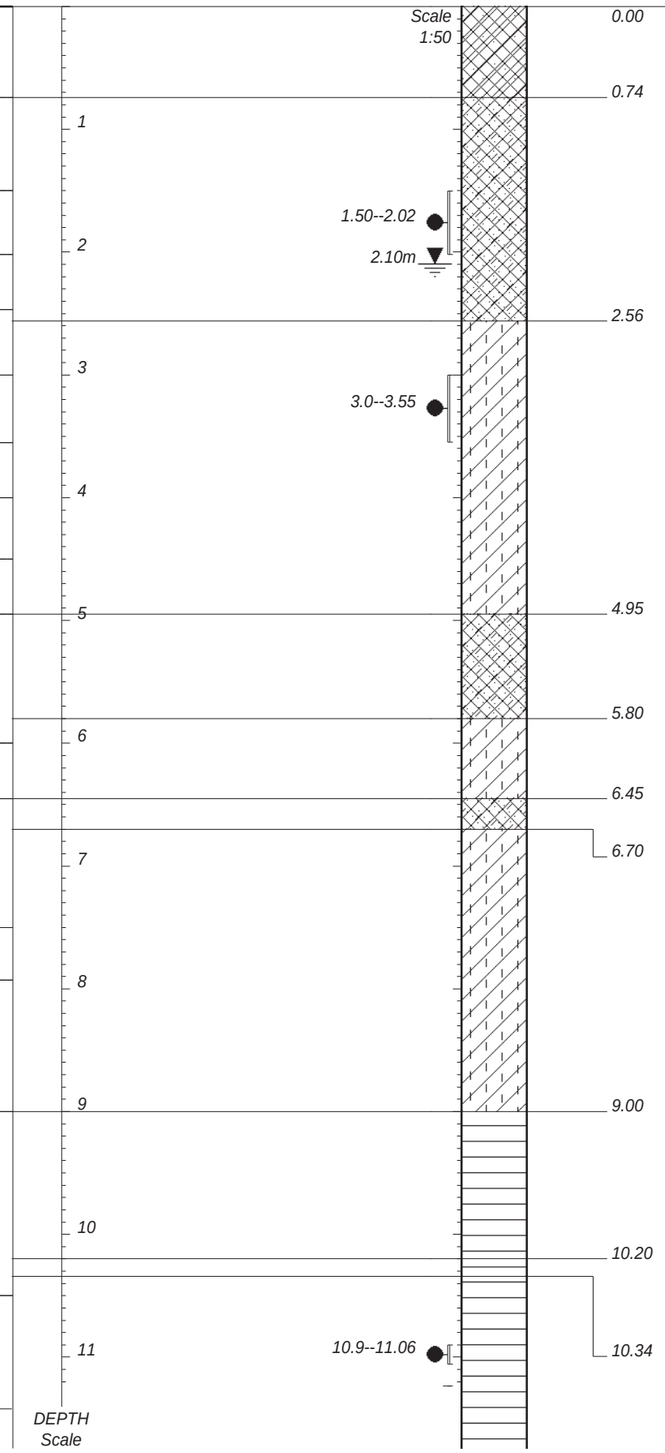
HOLE No: BH2 Sheet 1 of 2	ROCK FABRIC	GRAIN SIZE	JOINT ROUGHNESS	ROCK HARDNESS
JOB NUMBER: 4256	MF -massive BF -bedded FF -foliated CF -cleaved SF -schistose GF -gneissose LF -laminated	FG -fine grained MG -medium grain CG -coarse grain JOINT SPACING VCJ-very close spacg CJ -close spacing MJ -medium spacing WJ -wide spacing VWJ-very wide spacng	SLJ-slickensided SJ -smooth RJ -rough JOINT SHAPE CUR-curvilinear PLA-planar UND-undulating STE-stepped IRR-irregular	EHR-extremely hard rock VHR-very hard rock HR -hard rock MHR-medium hard rock SR -soft rock VSR-very soft rock

JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

HOLE No: BH2 Sheet 1 of 2
JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency
68				NWD4	
37				NWD4	
77				NWD4	
89			31	NWD4	
102				NWD4	
73				NWD4	
89			23	NWD4	
56	10			NWD4	
89			38	NWD4	
56				NWD4	
89			18	NWD4	
67				NWD4	
100			Refusal	NWD4	
35				NWD4	
79	68			NWD4	



0.00	"Light orange brown, mottled dark orange brown, light grey and black, firm, intact, slightly SANDY CLAY with occasional gravel FILL."
0.74	"Light orange brown, speckled yellow, orange and black, loose, intact CLAYEY SAND. FILL."
2.56	"Light yellow and orange, soft, intact and pinkish grey, silty CLAY. Residual with occasional cobbles which have deemed to have dropped from top of hole."
4.95	"Light brown speckled dark orange, white and black, loose, intact, clayey SAND. FILL. (Possibly hole collapse)"
5.80	"Pinkish grey and maroon, soft, intact, silty CLAY. Residual."
6.45	"Light brown speckled dark orange, white and black, loose, intact, slightly clayey SAND. FILL. (Possibly hole collapse)"
6.70	"Pinkish dark brown with light pink mottles, firm, intact slightly silty CLAY. Residual."
9.00	"Grey and khaki, moderately to highly weathered, very fine grained, very closely fractured, soft rock MUDSTONE. Vryheid Formation. Fractures are mostly bedding separation with cross bedding joints, wide, with clay infill, smooth planar dipping at 0-10deg, 60 and 45 deg. Very thinly bedded (discs) and highly weathered zone between 9.23-9.55."
10.20	"Grey and khaki, moderately to highly weathered, very fine grained, very closely fractured, soft to medium hard rock MUDSTONE. Vryheid Formation. Fractures are mostly bedding separation with cross bedding joints, wide, with clay infill, smooth planar dipping at 0-10deg, 60 and 45 deg. "
10.34	

HOLE No: BH2
Sheet 2 of 2

JOB NUMBER: 4256

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
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JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
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VSR-very soft rock

JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

HOLE No: BH2
Sheet 2 of 2

JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency	DEPTH Scale 1:50		
100	100	67		NWD4		12	12.18	"Dark grey moderately weathered, very fine grained, medium fractured, soft rock MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, very wide, stained orange with clay infill, smooth planar, dipping at 0-5 and 10-15 deg. Clay zone at 11.26-11.33"
98	98	63		NWD4		12.36--12.55	12.88	"Brownish light grey blotched white, grey, pink, green, light orange, moderately weathered, fine and coarse grained, moderately fractured, medium hard rock to hard rock TILLITE. Dwyka Group. Fractures, narrow, clean, rough undulating, dipping at 0-5 deg."
97	97	78		NWD4		13		"Black with occasional light brown and shiny black streaks, moderately weathered, very closely to closely fractured, very soft to soft rock COAL. Vryheid Formation. Fractures, narrow, minor staining, smooth planar, dipping at 0-10 and 45 deg."
100	100	67		NWD4		14		
						15	15.28	"Black moderately weathered, very fine grained with occasional very coarse grains, closely fractured, soft to medium hard rock CARBONACEOUS MUDSTONE. Vryheid Formation. Fractures, narrow, minor staining, smooth planar, dipping at 0-10 and 45 deg."
100	100	100		NWD4		16	15.72	"Black streaked beige brown, moderately weathered, medium grained, close to medium fractured, medium hard rock SANDSTONE. Vryheid Formation. Fractures, narrow, clean, smooth planar, dipping at 0-5 deg. Coarse grained zones encountered at 15.84-15.90 and 15.99-16.1"
							16.50	
						17	16.73	"Brown streaked black, moderately weathered, medium grained, close to medium fractured, medium hard rock SANDSTONE. Vryheid Formation. Fractures, narrow, clean, smooth planar, dipping at 0-5 deg. Coarse grained zones encountered at 15.84-15.90 and 15.99-16.1"
100	100	99		NWD4		18	17.51	"Light grey streaked dark grey, moderately weathered, very fine grained medium to widely fractured SILTSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow, clean, rough planar, dipping at 0-10 deg."
							18.62	"Brown streaked black, moderately weathered, medium grained, close to medium fractured, medium hard rock SANDSTONE. Vryheid Formation. Fractures, narrow, clean, smooth planar, dipping at 0-5 deg. "
						19	19.20	Intercalated sandstone and siltstone (transition zone)
100	100	100				20	20.12	"Light grey streaked dark grey, moderately weathered, very fine grained medium to widely fractured, medium hard to possibly hard rock SANDSTONE and interbedded SILTSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow, clean, rough planar, dipping at 0-10 deg."

NOTES

1) Water table encountered at 2.10m.
2) Core samples retrieved at 10.9--11.06 and 12.36--12.55.
3) Shelby samples retrieved at 1.50--2.02 and 3.0--3.55

CONTRACTOR : GEOMECHANICS
MACHINE : YWE - D8
DRILLED BY :
PROFILED BY : KDI

TYPE SET BY : KDI
SETUP FILE : BH-JGA-A3.SET

INCLINATION : Vertical
DIAM :
DATE : 20-21/07/2016
DATE : 15/09/2016

DATE : 17/11/2016 15:22
TEXT : ..56BH\4256VPSBH002LOG.TXT

ELEVATION :
X-COORD : 26deg 41'14.50"S
Y-COORD : 27deg 55'12.20"E

HOLE No: BH2

HOLE No: BH3
Sheet 1 of 2

JOB NUMBER: 4256

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
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GRAIN SIZE
FG -fine grained
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JOINT SHAPE
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UND-undulating
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IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
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JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

HOLE No: BH3
Sheet 1 of 2

JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency
38	28			NWD4	
48	28		Refusal	NWD4	
27				NWD4	
65				NWD4	
100				NWD4	
99				NWD4	
98				NWD4	
100				NWD4	
92	92	8		NWD4	
87	89			NWD4	

DEPTH Scale 1:40

Scale 1:40

2.70m

0.00	Concrete
1.28	
1.50	Concrete and gravel (poor core recovery). FILL.
	"Light orange brown, with light grey, loose, intact, gravelly sandy CLAY. Hillwash (Poor recovery)"
3.55	
	"Dark brown, mottled light orange, firm, intact, slightly silty CLAY. Residual."
4.22	
	"Light brown mottled light orange, firm, intact, slightly silty CLAY. Residual."
4.42	
	"Pinkish light brown, soft to firm, intact, slightly silty CLAY. Residual."
5.57	
	"Beige to light grey streaked pinkish white, highly to moderately weathered, very fine grained, very closely and occasional closely fractured, very soft to soft rock MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, very wide, stained orange with clay/Silt infill, smooth planar, dipping at 0-10, 30 and 65 deg."
7.67	
	"Slightly orange light brown, soft intact, silty CLAY with occasional very soft rock mudstone fragments. Residual."
8.44	
	"Beige and light orange brown, very dense, intact, slightly clayey slightly silty medium grained SAND. Residual with occasional relic bedding planes."

HOLE No: BH3
Sheet 2 of 2

JOB NUMBER: 4256

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JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

HOLE No: BH3
Sheet 2 of 2

JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency	DEPTH Scale 1:40		
29	5			NWD4		9		
						10	10.35	"Black, soft, intact, CLAY. Residual."
92	92	69		NWD4			10.60	"Black, moderately weathered, very fine to fine grained, closely fractured, soft rock CARBONACEOUS MUDSTONE. Vryheid Formation. Fractures, narrow, minor silt infill, rough undulating, dipping at 30deg."
						11	10.81	"Light beige grey matrix with light grey, dark grey, pink and orange and whitish clast, medium grained, moderately to highly weathered, soft to medium hard rock TILLITE. Dwyka Group. Fractures, narrow, slightly stained, smooth planar dipping at 15 deg."
							11.19	"Black, soft, intact, CLAY. Residual."
100	100	100		NWD4		12	11.26	"Black, moderately weathered, very firm to fine grained, closely fractured, soft rock CARBONACEOUS MUDSTONE. Vryheid Formation. Fractures, narrow, minor silt infill, rough undulating, dipping at 30deg."
							11.46	"Beige streaked dark brown and dark brown streaked beige, moderately to highly weathered, medium grained to coarse grained, medium fractured, soft to medium hard rock SANDSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow, minor staining, rough planar, dipping at 10 deg."
						13	12.16	"Beige and greyish brown with occasional black streaks, moderately weathered, very fine grained, medium fractured, medium hard to hard rock intercalated SILSTONE/ MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow, minor staining, rough planar, dipping at 10 deg."
100	100	95		NWD4			12.63	"Beige streaked black, moderately weathered, fine grained, medium fractured, soft to medium hard rock SANDSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow, minor staining, rough planar, dipping at 10 deg."
						14	13.41	"Beige streaked black, moderately weathered, very fine grained, medium fractured, soft to medium hard rock SILTSTONE with intercalated fine grained SANDSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow, minor staining, rough planar, dipping at 10 deg. A highly weathered, very closely fractured zone at 14.93-15.12"
100	78	63		NWD4		15	15.12	
							15.22	"grey, moderately weathered, very fine grained, medium fractured, soft rock MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow, minor staining, rough planar, dipping at 10 deg. "
92	85	57		NWD4		16	16.42	"Light grey matrix with green, pink, dark grey white and khaki clasts, moderately weathered, coarse grained, medium fractured, medium hard rock to hard rock TILLITE. Fractures , narrow, minor staining, rough planar, dipping at 10 deg. "

NOTES

1) water table encountered at 2.70m.
2) No Shelby samples retrieved.
3) No core samples retrieved.

CONTRACTOR : GEOMECHANICS
MACHINE : YWE - D8
DRILLED BY :
PROFILED BY : KDI
TYPE SET BY : KDI
SETUP FILE : BH-JGA-A3.SET

INCLINATION : Vertical
DIAM :
DATE : 22-26/07/2016
DATE : 15/09/2016
DATE : 17/11/2016 15:23
TEXT : ..56BH\4256VPSBH003LOG.TXT

ELEVATION :
X-COORD : 26deg 41'14.02"S
Y-COORD : 27deg 55'09.8"E

HOLE No: BH3

HOLE No: BH4
Sheet 1 of 2

JOB NUMBER: 4256

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JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

HOLE No: BH4
Sheet 1 of 2

JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency	DEPTH Scale 1:50		
						Scale 1:50	0.00	"Dark brown,firm, intact, slightly gravelly sandy SILT. Fill/Colluvium."
42				NWD4			0.08	CONCRETE. (Small aggregate) FILL.
						1	0.32	"Mottled orange black and dark orange, dense, intact, slightly clayey slightly gravelly SAND. FILL."
						0.90m ▼		
32				NWD4			1.28	"Dark grey, loose, intact, GRAVEL. (Aggregate) FILL."
26				NWD4			1.50	"Mottled orange black and dark orange, dense, intact, slightly clayey slightly gravelly SAND. FILL."
						2	1.85	"Dark grey, loose, intact, GRAVEL. (Aggregate) FILL."
62				NWD4			2.28	"Dark grey, loose, intact, GRAVEL with concrete FILL."
23				NWD4		3		
							3.67	
33	29			NWD4		4		"Light pink, highly weathered, medium fractured, medium to coarse grained, very soft rock SANDSTONE. Vryheid Formation. Fractures, narrow to wide, stained orange with clay infill, rough planar, dipping at 5-10deg and 15-20deg."
						5	5.00	
97	97	8		NWD4			5.58	"Light pink and light orange brown, highly weathered, medium fractured, medium to coarse grained, soft rock SANDSTONE. Vryheid Formation. Fractures, narrow, stained orange with clay infill, rough planar, dipping at 5-10deg and 15-20deg."
						6		"Dark brown mottled orange with maroon zones, very stiff, slickensided CLAY. Residual."
						6.57-6.90 ●		
91				NWD4				
100			54	NWD4		7		
36	36			NWD4				
						8		
100	54	39		NWD4			8.86	
						9		"Light beige grey stained black and orange, highly to moderately weathered, very fine grained, close to moderately fractured, very soft to soft rock MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow to wide, stained black and orange with clay infill, smooth planar, dipping at 20 deg and 0-10 deg."
							9.81	
97	95	41		NWD4		10		"Light beige with pinkish grey , moderately to highly weathered, very fine grained, closely fractured very soft rock MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, wide, clay infill with orange staining, smooth planar dipping at 0-10 and 20 deg."
						11	11.10	

HOLE No: BH4
Sheet 2 of 2

JOB NUMBER: 4256

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IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

JG AFRIKA

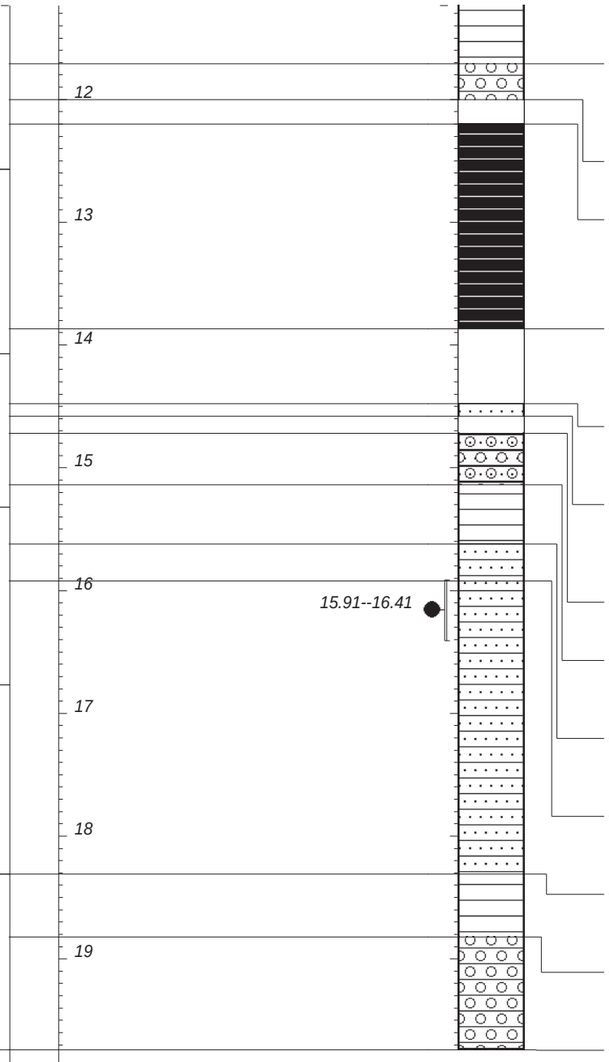
RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

HOLE No: BH4
Sheet 2 of 2

JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency
87	87	55		NWD4	
100	63	7		NWD4	
100	91	51		NWD4	
100	102	100		NWD4	
100	100	100		NWD4	
100	100	90		NWD4	

DEPTH Scale 1:50



11.71	"Grey, highly weathered, closely fractured, very fine grained, very soft rock MUDSTONE. Vryheid Formation. Fractures, narrow to wide, clay infill, rough undulating, dipping at 20deg and 0-10deg."
12.00	"Light orange brown blotched grey and dark orange white, beige, moderately weathered, moderately fractured, hard rock TILLITE.Dwyka Group. Fractures, narrow, stained orange with minor silt infill, rough undulating dipping at 0-10 deg. Highly weathered mudstone at 11.88-11.96"
12.20	"Dark marron and dark red, closely fractured, very fine grained, very soft rock CARBONACOUES MUDSTONE. Vryheid Formation."
13.87	"Black, highly weathered, very fine grained, close to very closely fractured, very soft rock COAL. Vryheid Formation. Fractures are mostly bedding separation, narrow, clean, smoot planar, dipping at 0-10deg, occasional vertical joints."
14.48	"Black, highly weathered, very fine grained, closely fractured, very soft rock CARBONACEOUS MUDSTONE. Vryheid Formation. Fractures are mostly bedding separation, narrow, clean, smooth planar, dipping at 0-10deg, occasional vertical joints."
14.58	"Light orange brown blotched grey and dark orange white, beige, moderately weathered, moderately fractured, hard rock SANDSTONE. Vryheid Formation. Fractures, narrow, stained orange with minor silt infill, rough undulating dipping at 0-10 deg."
14.72	"Black, highly weathered, very fine grained, closely fractured, very soft rock CARBONACEOUS MUDSTONE. Vryheid Formation. Fractures are mostly bedding separation, narrow, clean, smooth planar, dipping at 0-10deg, occasional vertical joints."
15.14	"Dark grey and light beige grey, moderately weathered, coarse grained, medium fractured, medium hard to hard rock SANDSTONE/CONGLOMERATE. Vryheid Formation. "
15.62	"Dark grey to black, moderately to slightly weathered, very fine to fine grained, widely fractured, soft rock SILTSTONE. Vryheid Formation. Fractures, narrow, clean, smooth planar, dipping at 80 and 0-10deg."
15.92	"Khaki streaked black moderately weathered, medium grained, widely fractured, soft rock SANDSTONE. Vryheid Formation. Fractures, narrow, clean, smooth planar, dipping at 80 and 0-10deg."
18.31	"Khaki grey, moderately weathered, medium grained, widely fractured, medium hard rock SANDSTONE. Vryheid Formation. Fractures, narrow, clean, rough undulating, dipping at 80 and 0-10deg."
18.82	"Cream to light grey, moderately to highly weathered, very fine grained, very closely fractured, medium hard rock with minor soft rock zones SILTSTONE. Vryheid Formation. Fractures, narrow, clean, rough undulating, dipping at 80 and 0-10deg."
19.74	"Light grey streaked black and dark grey, blotched and speckled khaki and light pink, coarse and fine grained, widely fractured, medium hard rock to hard rock TILLITE. Dwyka Formation. Fractures, narrow, clean, rough undulating, dipping at 80 and 0-10deg."

NOTES

1) water table encountered at 0.90m.
2) Core samples retrieved at 15.91--16.41.
3) Shelby samples retrieved at 6.57-6.90

CONTRACTOR : GEOMECHANICS
MACHINE : YWE - D8
DRILLED BY :
PROFILED BY : KDI
TYPE SET BY : KDI
SETUP FILE : BH-JGA-A3.SET

INCLINATION : Vertical
DIAM :
DATE : 27-28/07/2016
DATE : 15/09/2016
DATE : 17/11/2016 15:24
TEXT : ..56BH\4256VPSBH004LOG.TXT

ELEVATION :
X-COORD : 26deg 41'15.00"S
Y-COORD : 27deg 55'10.10"E

HOLE No: BH4

HOLE No: BH5
Sheet 1 of 1

JOB NUMBER: 4256

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

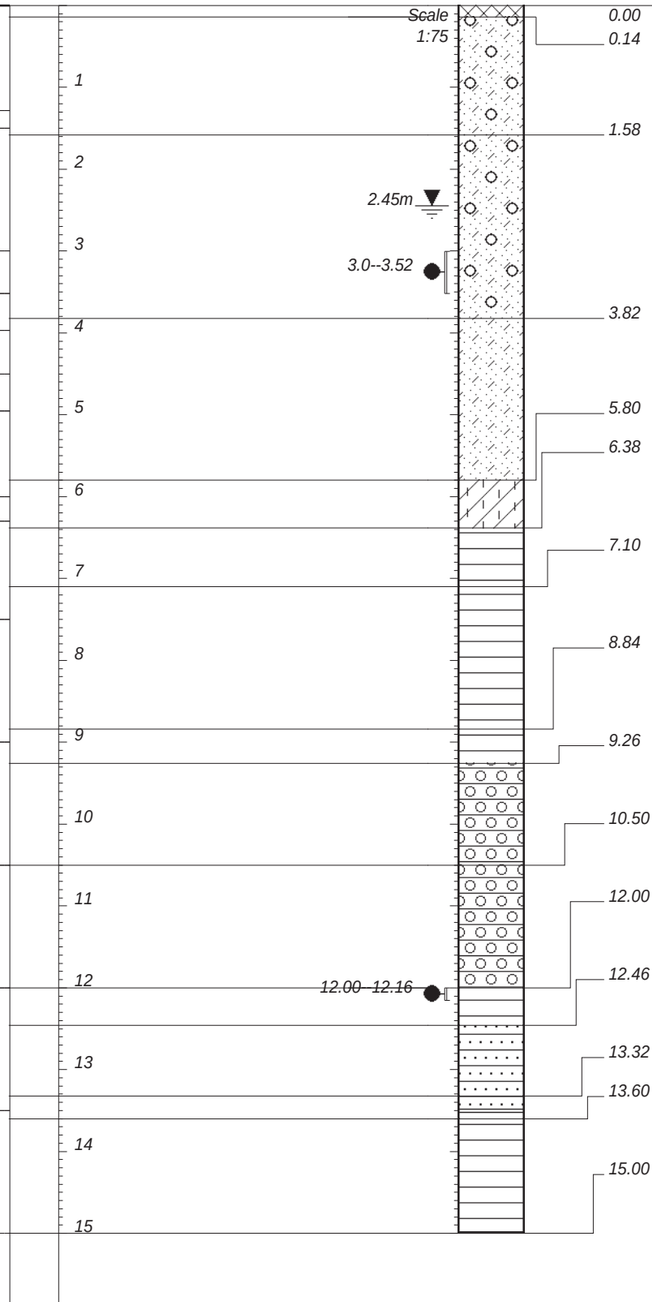
JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

HOLE No: BH5
Sheet 1 of 1

JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency
23	5			NWD4	
127				NWD4	
94				NWD4	
100				NWD4	
100			31	NWD4	
77				NWD4	
178			37	NWD4	
38				NWD4	
363			Refusal	NWD4	
125	53			NWD4	
88	100	43		NWD4	
50	82	55		NWD4	
102				NWD4	
96	102	102		NWD4	
	96	95		NWD4	



DEPTH Scale 1:75

0.00	Grey gravel and Boulders. FILL.
0.14	"Dark brown, loose, intact, GRAVELLY CLAYEY SAND. Colluvium/Fill."
1.58	"Mottled dark grey, light orange, light grey, dark orange and black, very dense, intact, slightly clayey gravelly fine SAND. Fill."
3.82	"Orangish brown, mottled occasionally black and dark grey, loose to medium dense, intact, slightly clayey SAND. Residual."
5.80	"Mottled light pink, light orange beige and dark grey, soft, intact, SILTY CLAY. Residual."
6.38	"Cream and light pink, highly weathered, very fine grained, closely fractured, very soft rock MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, wide to very wide, stained orange with clay infill, smooth planar, dipping at 0-10 deg."
7.10	"Grey streaked light pink, moderately to highly weathered, very fine grained, closely fractured, soft rock MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, wide, stained orange with clay infill, smooth planar, dipping at 0-10 deg with occasional 80 deg."
8.84	"Cream and light pink, highly weathered, very fine grained, closely fractured, very soft rock MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, wide to very wide, stained orange with clay infill, smooth planar, dipping at 0-10 deg."
9.26	"Pink and light orange brown, blotched cream, light grey and orange, highly weathered, widely fractured, soft rock TILLITE. Vryheid Formation. Fractures, narrow, with silt infill, rough undulating, dipping at 0-10 deg."
10.50	"Light grey and beige, highly weathered, fine grained, widely fractured, very soft rock to soft hard rock TILLITE. Vryheid Formation. Fractures, wide, clay infill, dipping at 70 and 0-10deg."
12.00	"Light khaki grey streaked black and dark grey, medium to slightly weathered, very fine grained, widely fractured, soft to medium hard rock SILTSTONE. Vryheid Formation. Fractures occur as bedding separations, narrow, clay infill stained orange, rough planar, dipping at 0-10 deg."
12.46	"Light khaki grey streaked black and dark grey, medium to slightly weathered, fine grained, widely fractured, medium hard rock SANDSTONE. Vryheid Formation. Fractures occur as bedding separations, narrow, clean, rough planar, dipping at 0-10 deg."
13.32	Transition zone between sandstone and siltstone -INTERCALATED SANDSTONE and SILTSTONE.
13.60	"Light grey with occasional dark grey streaks, moderately weathered, fine grained, widely fractured, soft to medium hard rock SILTSTONE. Vryheid Formation. Fractures occur as bedding separations, narrow, clean, rough planar, dipping at 0-10 deg."
15.00	NOTES 1) Water table encountered at 2.45m. 2) Shelby sample retrieved at 3.0--3.52 3) Core sample retrieved at 12.00--12.16

CONTRACTOR : GEOMECHANICS
MACHINE : YWE - D8
DRILLED BY :
PROFILED BY : KDI

TYPE SET BY : *KDI*
SETUP FILE : *BH-JGA-A3.SET*

INCLINATION : Vertical
DIAM :
DATE : 28-29/07/2016
DATE : 15/09/2016

DATE : *17/11/2016 15:24*
TEXT : *..56BH\4256VPSBH005LOG.TXT*

ELEVATION :
X-COORD : 26deg 41'15.2"S
Y-COORD : 27deg 55'07.5"E

HOLE No: BH5

HOLE No: BH6
Sheet 1 of 1

JOB NUMBER: 4256

ROCK FABRIC	GRAIN SIZE	JOINT ROUGHNESS	ROCK HARDNESS
MF -massive	FG -fine grained	SLJ-slickensided	EHR-extremely hard rock
BF -bedded	MG -medium grain	SJ -smooth	VHR-very hard rock
FF -foliated	CG -coarse grain	RJ -rough	HR -hard rock
CF -cleaved			MHR-medium hard rock
SF -schistose	JOINT SPACING	JOINT SHAPE	SR -soft rock
GF -gneissose	VCJ-very close spacg	CUR-curvilinear	VSR-very soft rock
LF -laminated	CJ -close spacing	PLA-planar	
	MJ -medium spacing	UND-undulating	
	WJ -wide spacing	STE-stepped	
	VWJ-very wide spacng	IRR-irregular	

JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

HOLE No: BH6
Sheet 1 of 1

JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency
94	18			NWD4	
100				NWD4	
91				NWD4	
100			33	NWD4	
100				NWD4	
100			Refusal	NWD4	
86				NWD4	
75				NWD4	
80				NWD4	
100	98	17	Refusal	NWD4	
89	81	17		NWD4	
49	35	35		NWD4	
119	11			NWD4	
93	93	23		NWD4	
99	99	95		NWD4	

DEPTH Scale 1:75

Scale 1:75

1.5--2.05

2.70m

4.50--5.0

0.00	Concrete
0.23	"Mottled light grey, light orange and black, stiff, intact, slightly gravelly SANDY CLAY. Fill."
2.05	"Light orange and brown, mottled light grey with occasional black zones, dense, intact, slightly clayey SAND. Fill."
4.50	"Beige streaked light pinkish orange, moderately to highly weathered, very fine grained, closely fractured, very soft to soft rock MUDSTONE. Vryheid Formation. Fractures mostly separation of bedding with occasional joints, wide, clay infill, smooth planar, dipping at 70, 45 and 0-10 deg. Slight gravelly clay seams encountered 5.4-5.46, 5.52-5.56, 6.85-6.9. Very closely fractured, highly weathered zone encountered at 6.32-6.54."
7.41	"Light orange brown, soft, intact, slightly silty CLAY with occasional very soft rock zones. Residual Mudstone. "
9.06	"Pinkish brown and black, stiff, intact, SILTY CLAY. Residual Mudstone. "
9.39	"Dark brown to black stiff, intact. CLAYEY SILT. Residual Siltstone. "
9.42	"Black, moderately weathered, very fine grained, closely fractured, soft rock COAL. Vryheid formation."
9.54	"Pinkish brown, firm, intact, slightly clayey SILT. Residual."
9.77	"Light grey speckled dark grey, red, white, cream, moderately weathered, fine and coarse grained, soft to medium hard rock TILLITE. Dwyka Group. Fractures, narrow, clean, rough planar, dipping at 0-10deg."
9.94	"Dark grey to black, highly weathered to completely weathered, very fine grained, closely fractured, very soft rock SILTSTONE. Fractures mostly bedding separation, narrow, clean, rough planar, dipping at 0-10deg."
10.03	"Black speckled beige, highly weathered, fine to medium grained with occasional clast, medium fractured soft rock TILLITE. Vryheid Formation. "
10.37	"Black, soft, intact, clayey SILT with occasional gravel. Residual."
10.43	"Pinkish beige, moderately to highly weathered, very fine grained, closely fractured, soft rock SILTSTONE. Vryheid Formation."
10.52	"Pinkish beige blotched grey, highly weathered, very fine grained, closely fractured, soft rock TILLITE. Vryheid Formation."
10.67	"Pinkish grey and beige, streaked light grey, highly weathered, very fine grained, closely fractured, very soft to soft rock SILTSTONE. Vryheid Formation."
10.92	"Beige light grey streaked light orange and pink , moderately weathered, medium to widely fractured, soft to medium hard rock SANDSTONE. Vryheid Formation."
11.74	Transition Zone between siltstone and sandstone -Intercalated SILSTONE and SANDSTONE.
11.95	"Beige streaked light grey, moderately weathered, medium fractured, fine grained, soft rock to medium hard rock SILTSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow to wide, clay infill and iron staining, smooth planar, dipping at 0-10 deg."
12.50	

NOTES

1) Water table encountered at 2.70m
2) Shelby sample retrieved at 1.5--2.05 and 4.50--5.0
3) No core sample retrieved

CONTRACTOR : GEOMECHANICS
MACHINE : YWE - D8
DRILLED BY :
PROFILED BY : KDI

TYPE SET BY : KDI
SETUP FILE : BH-JGA-A3.SET

INCLINATION : Vertical
DIAM :
DATE : 8-10/08/2016
DATE : 15/09/2016

DATE : 17/11/2016 15:25
TEXT : ..56BH\4256VPSBH006LOG.TXT

ELEVATION :
X-COORD : 26deg 41'15.4"S
Y-COORD : 27deg 55'5.8"E

HOLE No: BH6

HOLE No: BH7
Sheet 1 of 2

JOB NUMBER: 4256

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

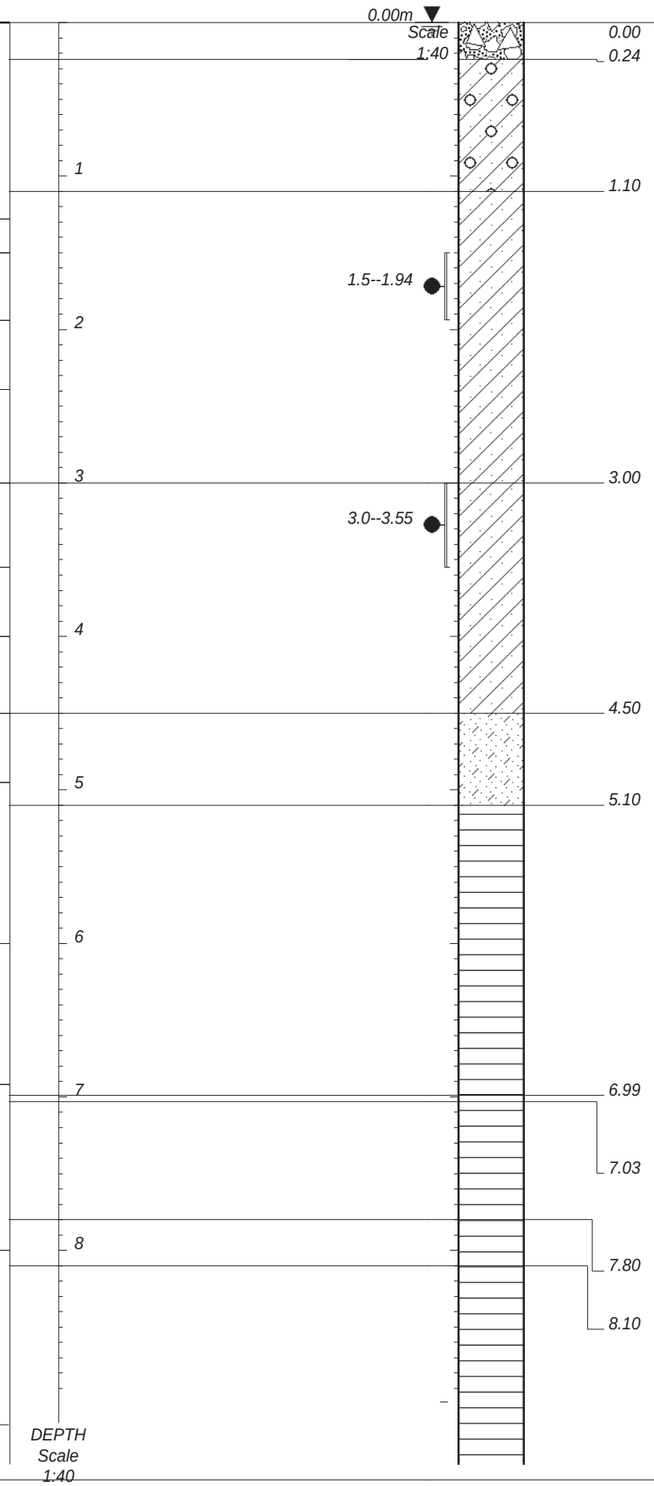
ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION AND FLOCCULATION PLANT

HOLE No: BH7
Sheet 1 of 2

JOB NUMBER: 4256



%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency	DEPTH Scale 1:40		
89	19			NWD4		0.00	0.24	Concrete "Beige to grey mottled, light orange and black and dark grey, stiff, intact, slightly gravelly slightly sandy CLAY. Fill."
86				NWD4		1.10		"Light orange brown blotched beige and light grey, loose, intact, sandy CLAY with occasional light bluish grey clay zones. Residual Sandstone."
100				NWD4				
67			12	NWD4				
115				NWD4		3.00		"Light orange brown blotched beige and light grey, soft, intact SANDY CLAY with occasional light bluish grey clay zones. Residual Mudstone."
100				NWD4				
78			10	NWD4				
100				NWD4		4.50		"Brown speckled white, light orange, pink and black, loose, intact, CLAYEY SAND. Residual Sandstone."
98			44	NWD4		5.10		"Dark grey with thin black and orange brown streaks, highly to moderately weathered, very fine grained, very closely fractured, soft rock MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, very wide, filled with orange brown gravelly clay, smooth planar, dipping at 0-10 deg and 80 deg."
90	45			NWD4				
79	57			NWD4		6.99		"Red and khaki, moderately weathered, very fine grained, closely fractured, MUDROCK. Vryheid Formation. Fractures mostly bedding separation, very wide, filled with orange brown gravelly clay, smooth planar, dipping at 0-10 deg and 80 deg."
94	94	24		NWD4		7.03		"Slightly pinkish brown, highly weathered, very fine to fine grained, very closely fractured, very soft to soft rock SILTSTONE. Vryheid Formation. Fractures mostly bedding separation, very wide, filled with orange brown gravelly clay, smooth planar, dipping at 0-10 deg and 80 deg."
65	3	3		NWD4		7.80		"Yellowish brown, highly to completely weathered, very fine grained, very closely fractured, very soft rock MUDSTONE. Vryheid Formation."
						8.10		"Slightly pinkish grey brown, highly to completely weathered, very fine grained, very closely fractured, very soft rock MUDSTONE. Vryheid Formation."

HOLE No: BH7
Sheet 2 of 2

JOB NUMBER: 4256

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION AND FLOCCULATION PLANT

HOLE No: BH7
Sheet 2 of 2

JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency	DEPTH Scale 1:40		
						9		
							9.37	"Yellowish beige, highly weathered fine to medium grained, closely fractured, soft rock SANDSTONE. Vryheid Formation."
113	113	23		NWD4			9.60	"Blackish dark brown with occasional light pinkish specks, soft, intact, slightly silty CLAY . Residual."
						10	9.86	"Blackish dark brown with occasional light pinkish specks, soft, intact, silty CLAY with occasional rock fragments. Residual."
							10.05	"Black, moderately to highly weathered, fine grained, closely fractured, very soft to soft rock CARBONACEOUS MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow, no infill, smooth planar, dipping at 0-10 deg."
99	99	64		NWD4			10.39	"Black streaked dark grey, highly to moderately weathered, fine grained, medium fractured, fine grained, soft rock SILTSTONE. Vryheid Formation. "
						11	10.50	"Light grey blotched dark grey, highly to moderately weathered, medium grained, close to moderately fractured, soft to medium hard rock TILLITE. Vryheid Formation."
							10.96	"Black, moderately to highly weathered, fine grained, closely fractured, very soft to soft rock CARBONACEOUS MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow, no infill, smooth planar, dipping at 0-10 deg."
						12	11.23	"Black streaked dark grey, highly to moderately weathered, fine grained, medium fractured, fine grained, soft rock SILTSTONE. Vryheid Formation. "
98	98	91		NWD4			11.55	"Black, moderately to highly weathered, fine grained, closely fractured, very soft to soft rock CARBONACEOUS MUDSTONE. Vryheid Formation. Fractures mostly bedding separation, narrow, no infill, smooth planar, dipping at 0-10 deg."
						13	11.63	"Black streaked dark grey, highly to moderately weathered, fine grained, medium fractured, fine grained, soft rock SILTSTONE. Vryheid Formation. "
							11.74	"Light khaki grey, moderately weathered, fine grained, moderately to widely fractured, soft rock SANDSTONE. Vryheid Formation, Fractures mostly bedding separation, very narrow, clean, smooth planar, dipping at 0-10deg."
							12.41	"Light khaki grey, moderately weathered, very fine to fine grained, moderately to widely fractured, soft rock to medium hard rock SILTSTONE with intercalated sandstone. Vryheid Formation, Fractures mostly bedding separation, very narrow, clean, smooth planar, dipping at 0-10deg."
							13.50	

NOTES

1) Water table encountered at 0.00m

2) Shelby sample retrieved at 1.5--1.94 and 3.0--3.55

3) No Core sample retrieved.

CONTRACTOR : GEOMECHANICS
MACHINE : YWE - D8
DRILLED BY :
PROFILED BY : KDI

TYPE SET BY : KDI
SETUP FILE : BH-JGA-A3.SET

INCLINATION : Vertical
DIAM :
DATE : 10-11/08/2016
DATE : 15/09/2016

DATE : 17/11/2016 15:26
TEXT : ..56BH\4256VPSBH007LOG.TXT

ELEVATION :
X-COORD : 26deg 41'15.3"S
Y-COORD : 27deg 55'04.9"E

HOLE No: BH7

HOLE No: BH8
Sheet 1 of 2

JOB NUMBER: 4256

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
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VSR-very soft rock

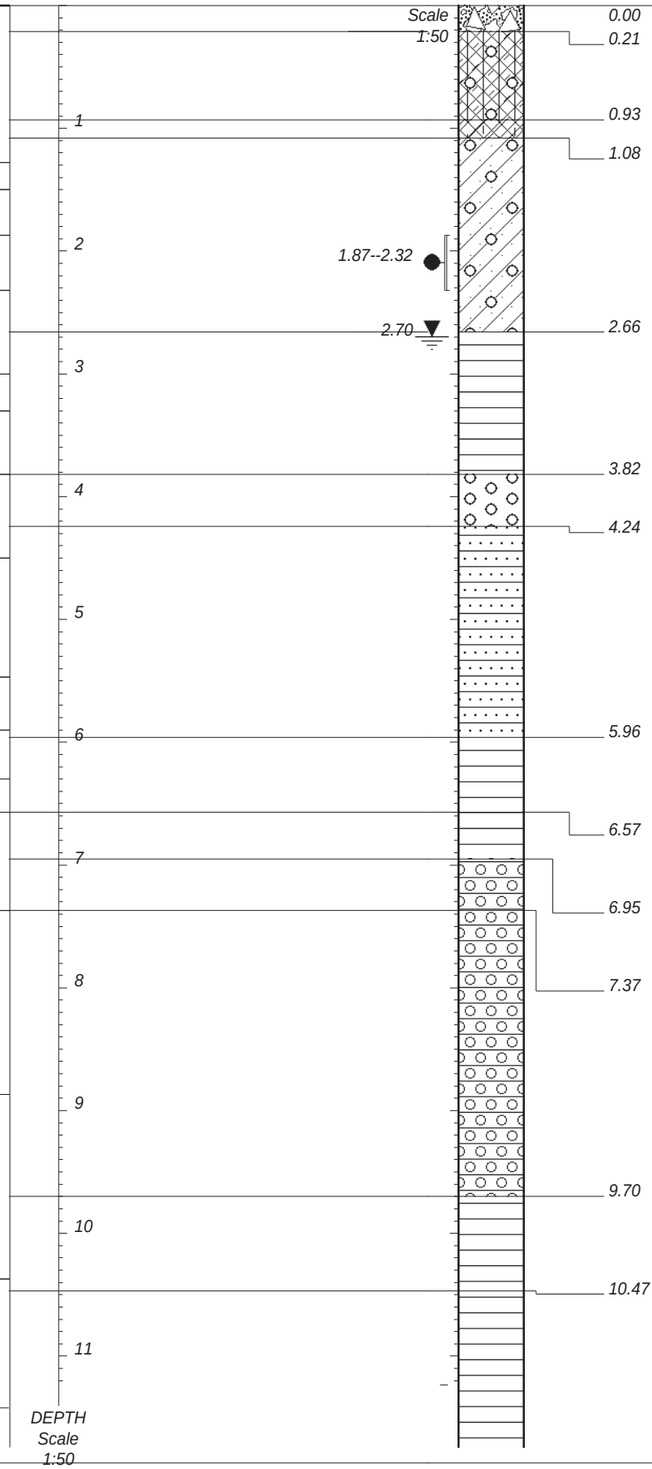
JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

HOLE No: BH8
Sheet 1 of 2

JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency
94	16	16		NWD4	
100				NWD4	
100				NWD4	
78			20	NWD4	
75				NWD4	
100			Refusal	NWD4	
92	56			NWD4	
88	132			NWD4	
100	41			NWD4	
100				NWD4	
93	15			NWD4	
93				NWD4	
94	76	35		NWD4	
42	3			NWD4	
52				NWD4	
31	62			NWD4	



0.00 – 0.21	Concrete
0.21 – 0.93	"Light grey mottled light orange and black, stiff, intact, occasionally gravelly CLAYEY SILT. FILL."
0.93 – 1.08	"Light grey mottled light orange and black, stiff, intact, GRAVELLY silty CLAY. FILL."
1.08 – 2.66	"Light grey mottled beige, light orange and black, firm, intact, slightly gravelly sandy CLAY. Residual Sandstone."
2.66 – 3.82	"Beige light grey, stained orange and black, highly weathered, fine grained, very closely fractured, very soft rock SILTSTONE with occasional completely weathered zones. Fractures mostly horizontal bedding separations with occasional joints at 75deg and 45 deg. Joints are smooth planar with <1mm clay and silt infill. "
3.82 – 4.24	"Brown mottled black, bluish grey and light orange medium dense, intact, clayey GRAVEL. Completely weathered mudstone."
4.24 – 5.96	"Khaki beige speckled white, light grey and black highly weathered, fine grained, very closely fractured, very soft rock SANDSTONE. Vryheid Formation. Fractures mostly bedding separations with occasional 85deg and 55 deg joints. Fractures are narrow, stained with slickensides and clay infill, smooth planar."
5.96 – 6.57	"Dark grey stained black and orange, highly weathered, very fine grained, very closely jointed, very soft rock MUDSTONE. Vryheid Formation. Fractures, mostly bedding separation, narrow, stained orange smooth planar, dipping at 0-10 degrees with occasional 75 deg joints."
6.57 – 6.95	"Dark grey stained black and orange, highly weathered, very fine grained, closely jointed, soft rock MUDSTONE. Vryheid Formation. /Fractures mostly bedding separation, narrow, stained orange smooth planar, dipping at 0-10 degrees with occasional 75 deg joints."
6.95 – 7.37	"Dark and light grey speckled and blotched cream, highly weathered, fine and course grained, closely fractured, soft to very soft rock TILLITE. Dwyka Group. Fractures very narrow, clean, smooth planar, dipping at 0-10deg and 65 deg."
7.37 – 9.70	"Dark and light grey speckled and blotched cream, highly weathered, fine and course grained, very closely fractured, soft to very soft rock TILLITE. Dwyka Group. Fractures very narrow, clean, smooth planar, dipping at 0-10deg , 45 deg, 65 deg, and 85 deg. (poor quality sample recovered)"
9.70 – 10.47	"Dark beige brown, highly weathered, fine grained, very closely fractured, very soft rock SILTSTONE. Vryheid formation. Fractures mostly bedding separation, narrow, stained orange and black filled with clay and sand, dipping at 45 and 0-10 degrees."
10.47 –	"Light beige greyish brown, highly weathered, very fine grained, very closely fractured, very soft rock, SILTSTONE . Vryheid Formation. Fractures, wide to very wide with clay infill, smooth planar, dipping at 0-10, 45deg and 75deg."

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ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

JG AFRIKA

RAND WATER
VEREENIGING SEDIMENTATION & FLOCCULATION PLANT

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JOB NUMBER: 4256

%Mater recov	%Core recov	%RQD	SPT	Drilling Method	Frac Frequency	DEPTH Scale 1:50		
						12	12.10	"Light grey, with black and light orange mottles, loose, intact, slightly clayey fine grained SAND. Completely weathered sandstone. "
76	44			NWD4			12.34	"Light grey with occasional orange streaks and black magnesium dendrites, highly weathered, fine grained, very closely to closely fractured SILTSTONE. Vryheid formation. Fractures mostly bedding separation, narrow, stained orange and black with minor clay infill, smooth planar, dipping at 0-10 deg and 35 deg."
32	32			NWD4		13		
32	27			NWD4		14	14.85	"Beige light orange brown, highly weathered, fine grained, closely fractured, soft rock SILTSTONE. Vryheid Formation. Fractures mostly bedding separations, narrow, stained orange and black (magnesium dendrites), smooth undulating, dipping at 0-10deg, 45 deg."
96	96	29		NWD4		15	15.94	"Light grey, highly weathered, very fine grained, very closely fractured, soft rock SILTSTONE. Vryheid Formation. Fractures, narrow, with clay infill, smooth planar, dipping at 45 and 0-10 deg."
217	117			NWD4		16	16.37	"Beige, highly to moderately weathered, very fine grained, very closely fractured, soft rock MUDSTONE. Vryheid Formation. Fractures, narrow stained orange, smooth planar, dipping at 0-10 and 80 deg."
58	58	58				17	16.60	Weathered Contact
							16.67	"Dark grey speckled and blotched red, green, pink, white, light grey, moderately weathered, fine grained (matrix) and very coarse grained (clasts) medium to widely fractured, medium hard rock TILLITE with highly weathered zones at 16.77 -16.8 and 18.42 to 18.45. Dwyka Group. Fractures, narrow, clean, rough undulating, dipping at 0-10 degrees."
						18	18.69	"Light green speckled and blotched red, pink, white, light grey, moderately weathered, fine grained (matrix) and very coarse grained (clasts) medium to widely fractured, medium hard rock to possibly hard rock TILLITE. Dwyka Group. Fractures, narrow, clean, rough undulating, dipping at 0-10 degrees."
							19.24	"Dark grey speckled and blotched red, green, pink, white, light grey, moderately weathered, fine grained (matrix) and very coarse grained (clasts) medium to widely fractured, soft to medium hard rock TILLITE.Dwyka Group. Fractures, narrow, clean, rough undulating, dipping at 0-10 degrees."
104	104	62				19	19.70	"Light grey, medium weathered, very fine grained, very closely fractured, medium hard rock to possibly hard rock SILTSTONE. Vryheid Formation. Fractures, narrow, with clay infill, smooth planar, dipping at 45 and 0-10 deg."
						20	19.84	"Dark grey to black, moderately to highly weathered, very fine grained, moderately fractured, medium hard rock to possibly hard rock MUDSTONE with highly to completely weathered zones. Fractures mostly bedding separation, wide, clay infill, smooth planar dipping at 0-10 deg."
							20.42	NOTES 1) Water table encountered at 2.70 m 2) Shelby sample retrieved at 1.87--2.32 3) No Core samples retrieved.

CONTRACTOR : GEOMECHANICS
MACHINE : YWE - D8
DRILLED BY :
PROFILED BY : KDI

TYPE SET BY : KDI
SETUP FILE : BH-JGA-A3.SET

INCLINATION : Vertical
DIAM :
DATE : 11-15/08/2016
DATE : 15/09/2016

DATE : 17/11/2016 15:27
TEXT : ..56BH\4256VPSBH008LOG.TXT

ELEVATION :
X-COORD : 26deg 41'16.70"S
Y-COORD : 27deg 55'4.1"E

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