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R E P O R T

to

MESSRS. P.G.J. MEIRING AND PARTNERS INC.  
Consulting Civil & Process Engineers

on

SITE INVESTIGATION FOR THE PROPOSED  
SEWAGE PURIFICATION WORKS,  
BUSHKOPPIE, TRANSVAAL

on behalf of

THE CITY ENGINEER'S DEPARTMENT, DESIGN BRANCH,  
CITY OF JOHANNESBURG

by

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REPORT NO. J46/1

FEBRUARY, 1978



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## A P P E N D I X



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### REPORT ON SITE INVESTIGATION FOR PROPOSED SEWAGE PURIFICATION WORKS, BUSHKOPPIE, TRANSVAAL.

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#### 1. INTRODUCTION

This report presents the results and observations on a seismic survey and foundation drilling and testing investigation conducted on the site for the proposed Sewage Purification Works, Bushkoppie, Transvaal.

The investigation was conducted on behalf of the City Engineer's Department, Design Branch, City of Johannesburg under the auspices of Messrs. P.G.O. Meiring and Partners, Inc., Consulting Civil and Process Engineers, Pretoria.

#### 2. TERMS OF REFERENCE

The objectives of the investigations were:

- a) at the site for the proposed Module Nos. 1 to 4 and adjacent Sedimentation tanks,
  - i) to establish existing subsoil and geological conditions,
  - ii) to provide information on the nature and engineering parameters of the soil and rock materials encountered,
  - iii) to establish groundwater conditions and
- b) over...../2

- b) over the entire site, to determine depth to bedrock and excavation characteristics of the subsurface materials.

### 3. AVAILABLE INFORMATION

The following information was available:

- a) Report No. DC-0013-01-00-0574 (Authors Reference LOC B 181(b) ) entitled "Report on Site Investigation for Proposed Bushkoppie Sewage Treatment Facility South of Johannesburg", to the City Engineer's Department, Design Branch, Johannesburg by A.B.A. Brink and Associates, Johannesburg, dated 16 May 1974. The report presents the soil profiles revealed by 24 test pits, laboratory testing and aerial photographic interpretation within and beyond the present site;
- b) Report No. DC-0013-01-A1-0877 entitled "First Addendum to the Geotechnical Report on the Bushkoppie Sewage Works Site" by S.G. Grobler of the City Engineer's Department, Design Branch, Johannesburg, dated August 1977, describing the soil profiles of an additional eight trial holes excavated;
- c) Drawing No. 1062-V-1, entitled "Bushkoppie Sewage Purification Works, Site Investigation Site Plan", to a scale of 1:1250 prepared by P.G.J. Meiring and Partners, Consulting Engineers, Pretoria, dated October 1977.
- d) Geological Plan of the West Rand, Sheet No. 2626, to a scale of 1:250 000 produced by the Geological Survey Department, dated 1967.
- e) Discussions were held with Messrs. P.G.J. Meiring and Partners Inc., on the size, nature and design founding levels of the proposed structures.

### 4. SITE DESCRIPTION

The site, situated approximately 15km south of Johannesburg City Centre, covers some 40ha. in area, measuring approximately 600m in an east-west

direction ...../3

direction by 650m in a north-south direction.

The physiography of the site has previously been described in some detail by Messrs. A.B.A. Brink and Associates in their Report Reference LOC B 181 (b). From an elevation of 1562m in the northern corner down to about 1540m in the southern corner, the site has a uniform gradient of about seven per cent towards a southward flowing stream which forms the eastern boundary.

A Site Plan, Drawing No. J46/1 to a scale of 1:1250, showing the proposed structures, borehole positions, seismic survey positions and previous trial hole positions is given in the Appendix to this report.

## 5. SITE EXPLORATION

### 5.1 Seismic Survey

Using a Huntco FS-3 portable seismograph, a total of 128 geophone stations from 64 reversed traverses were completed between December 9, 1977 and January 20, 1978. Seismic wave velocities, depths and thickness of various soil and rock materials were determined on a grid system of geophone stations, as shown on the Site Plan.

A greater density of seismic traverses were conducted in the area occupied by proposed Module Nos. 1 to 4, 11 and 12 and adjacent Sedimentation Tanks, where it is anticipated that development will initially take place.

The graphs obtained in the field from each geophone station have been retained on the Project File for reference should they be required.

A summary of the seismic survey test results is included in the Appendix of this report on Sheet Nos. 1 to 9.

### 5.2 Diamond Core Drilling

Between December 10, 1977 and December 19, 1977, nine TNW-size, diamond drill holes were drilled by Messrs. Rodio (SA) (Pty) Ltd.,

at ...../4

at the positions indicated on the Site Plan. Hole Nos. 30 to 32 were terminated at approximately 12m and hole Nos. 33 to 38 at about 9m or at shallower depths where a minimum of 3m of bedrock had already been encountered. A total of 83,35m was drilled, a summary of which appears in Table 1 below.

TABLE 1  
DRILLING SUMMARY

Borehole No.	Soft Material m	Hard Material m	Boulders m	Total Depth m	Total Core Recovery %
30	5,70	5,30	0,70	11,00	66,6
31	6,65	5,35	-	12,00	83,2
32	5,90	5,60	2,45	11,50	67,1
33	4,50	4,65	1,55	9,15	59,9
34	6,80	2,30	-	9,10	78,6
35	6,00	3,45	0,85	9,45	53,2
36	3,20	3,15	0,70	6,35	84,3
37	2,80	3,50	1,15	6,30	69,8
38	2,00	6,50	0,60	8,50	64,9
TOTAL	43,55	39,80	8,00	83,35	69,5

Drilling operations were supervised by an engineering geologist, who visited the site at regular intervals. Two drilling machines, a Boyles BBS 10 and a SECO 12, both mounted on skids, were used to recover TNW-size cores (61mm Ø) in rock and boulders. Where the absence of medium and large gravel, cobbles and boulders permitted, standard penetration tests were carried out in the boreholes at intervals of approximately 1,5m.

Water rest levels in the boreholes were measured by the driller 24 hours after completion of the holes.

Two Shelby tube samples were recovered. The samples were extruded on site, wrapped in polythene sheets, sealed and packed into cardboard tubes and submitted to a soils laboratory for testing. In

addition ...../5

addition, representative disturbed soil samples were also removed from the cored material for subsequent laboratory testing.

Overburden soils and gravels, decomposed rock and bedrock cores were sealed in polythene sheeting and placed directly into wooden core boxes on site before examination by an engineering geologist. Cores were described in terms of soil consistency or rock hardness, moisture condition, colour and texture, rock quality, degree of weathering and soil or rock type.

Detailed descriptions of the soil and rock materials encountered are provided on the Drilling Record Sheet Nos. 10 to 21 in the Appendix.

## 6. LABORATORY TESTING

Soil grading tests and Atterberg limit tests were conducted on six disturbed samples by Messrs. Civilab (Pty) Ltd. and were subsequently classified in terms of the Unified Classification System. Expansive potential was determined according to the procedure laid down by Van der Merwe (Reference 1).

Consolidated undrained triaxial tests, with pore water pressure measurement for determination of total and effective strength parameters, together with grading, Atterberg limit, moisture content and dry density tests were carried out on the two Shelby samples by Messrs. Geotechnical Engineering and Mining Laboratory Services (Pty) Ltd.

A summary of sample types and location, soil types and type of tests carried out is given in Table 2 below.

Laboratory test results are shown on the Laboratory Test Results Sheet Nos. 22 and 23 in the Appendix to this report.

TABLE 2 ...../6

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REFERENCE 1: Van der Merwe, D.H.: "The Prediction of Heave from the Plasticity Index and Percentage Clay Fraction of Soils" *Trans. S.A. Inst. Civ. Engrs.*, June 1964.

TABLE 2  
SUMMARY OF SOIL SAMPLES AND LABORATORY TESTS CONDUCTED

BH No.	Depth (m)	Soil Type	Sample Type	Indicator Test	Consolidated Un-drained Triaxial, Dry Dens. & Moist. Content Tests
30	2,0	Silty CLAY(CH). Colluvium.	Disturbed	x	
	4,0	Clayey SILT(MH). Decomposed andesite.	Disturbed	x	
32	1,8	Silty CLAY(CL). Colluvium.	Disturbed	x	
	2,8-3,3	Silty CLAY(CH). Decomposed andesite.	Shelby	x	
33	2,1	Clayey ferruginous GRAVEL (GC). Colluvium.	Disturbed	x	x
	2,7	Silty CLAY(CL). Decomposed andesite.	Disturbed	x	
35	2,4-2,8	Silty CLAY(CL). Decomposed andesite.	Shelby	x	x
	4,5	Clayey SILT(MH). Decomposed andesite.	Disturbed	x	

## 7. SITE GEOLOGY

### 7.1 Soils and Bedrock

The results of the drilling investigation confirm the findings of the previous reports and show that the site is located on Recent colluvial soils overlying residual soils derived from Andesite Lavas, Ventersdorp System.

An Engineering Geological Map to a scale of 1:2500 contained in Messrs. A.B.A. Brink and Associates' report, shows faulted Black Reef Series quartzites outcropping along the crest of a steep slope at least 50m to the south of the present site. Beyond the Black Reef quartzite outcrop, dolomite, chert and dolomitic limestones of the Dolomite Series occur. Both the Black Reef Series and the Dolomite Series belong to the Transvaal System and are

younger ...../7

younger than the Ventersdorp Lavas and do not therefore, underlie the Bushkoppie Sewage Works site.

Two parallel faults are indicated as trending across the south-eastern portion of the present site in a northeasterly direction. The faults are Post-Ventersdorp System in age, probably involving relatively minor displacements and are considered to be inactive.

In the vicinity of Modules 1 to 4, 11 and 12, the transported topsoils generally comprise a sequence of stiff, slightly moist, dark brown, intact, silty, fine and medium gravelly clays, approximately 300mm in thickness, overlying firm, moist, dark red, intact, sandy, silty clay colluvium with some ferruginous nodules and occasional quartzite gravel. In Borehole 30, two additional layers, approximately 2m in total thickness, comprising loose, wet, dark red, slightly clayey and silty, fine and medium sand were recognised within the colluvial sequence. Medium dense, dry to moist, red, brown or yellowish brown, gravel and cobbles in a silty clay matrix, some 900mm in thickness, often forms a pebble marker horizon near the base of the transported soils layer. From the borehole results, the colluvial layers show a decrease in thickness towards the north, from an average depth of 3,2m below the most southerly row of proposed Sedimentation Tanks down to approximately 1,8m thick below the area for the proposed Modules.

Below the base of the transported soils is a zone of stiff, moist, red mottled yellow streaked black, fissured silty clay, with occasional hard rock gravel and cobble corestones derived from decomposed andesite. At an average depth of 4,8m below natural ground level in the area of the proposed Sedimentation Tanks, decreasing to about 2,7m below the positions proposed for Modules 1 to 4, 11 and 12, the material changes gradually with depth to dense and then very dense, moist, yellow streaked red and black, fissured, hard rock gravel and cobble corestones with occasional boulders in a stiff clayey silt matrix. The above two layers are residual soils and gravels derived from decomposed andesite lava.

According to the Report by Messrs. A.B.A. Brink and Associates,

hardpan ...../8

hardpan ferricrete of local extent occurs in the residual decomposed andesite lavas. Although not identified in any of the drill cores, a hard rock, red, well cemented, ferricrete gravel deposit is exposed in the banks of the stream, in the southeast corner of the site.

Andesite bedrock, generally inclined in a southerly direction, underlies the entire site. Information from Borehole Nos. 30 to 32, 34 and 35 indicates that very soft rock to hard rock, light yellowish brown and grey stained red on joints, fine grained, shattered and fractured, highly weathered to weathered andesite lava forms a transition zone some 0,8m to 2,7m thick between the overlying residual soils and the underlying, less weathered bedrock, which occurs at an average depth of about 8,2m below surface in this area.

The underlying less weathered bedrock, comprising hard rock and very hard rock, grey and brown, stained black and red on joints, fine grained fractured and jointed, weathered and slightly weathered andesite, occurs at depths ranging from 3,2m to 7,2m below ground surface in Borehole Nos. 33 and 36 to 38 where the highly weathered andesite zone is absent. Bedrock is shallowest on the northern sides of Modules 1 to 4 and generally occurs at deeper levels in southerly and southwesterly directions.

Interpreted Geological Sections E-E', F-F' and G-G' through the southern half of the site are shown on Drawing No. J46/2 in the Appendix. The location of sections drawn are indicated on the Site Plan, Drawing No. J46/1.

## 7.2 Seismic Survey Results

The interpreted seismic profiles, indicating depth changes of material type and average seismic wave velocities of different soil and rock horizons encountered are shown on Results of Seismic Surveys, Drawing No. J46/3 of the Appendix.

Over the entire site a low velocity layer, extending to an average depth of 1,8m below surface and having an average seismic wave

velocity...../9

velocity of 370mps, is regarded as corresponding to the upper, transported soil horizons of the subsoil profile. A contoured plan showing the depths of material having a seismic wave velocity of less than 750mps is shown on the Depth to Rippable Material, Drawing No. J46/4 in the Appendix.

From the Geological Sections E-E', F-F' and G-G', shown on Drawing No. J46/2, there appears to be a good correlation between the depth of the interface between transported and residual soils as observed in the drill cores, compared with the depth to the base of the shallowest seismic wave velocity layer. The differences indicated by adjacent boreholes and seismic traverses rarely exceed 600mm.

The seismic layer immediately underlying the low seismic velocity layer described above, with an average seismic wave velocity of 1050mps, corresponds to the residual, decomposed andesite soils and very soft rock and soft rock andesite, which is likely to contain very hard rock, large diameter boulders of less weathered andesite at depth. Having an average depth of approximately 5.3m, this intermediate layer is absent along the northern and central portions and at small isolated areas of the site, as shown by the sections on Drawing No. J46/3.

Depth to bedrock, classified as having a seismic wave velocity greater than 1500mps, is shown on Depth to Blast Material, Drawing No. J46/5 in the Appendix.

The depth to bedrock, calculated from the seismic investigation may vary considerably with that deduced from cores of adjacent boreholes. As observed in the access cut for the tunnel under construction to the northwest of the site, fresh andesite weathers in an irregular manner leaving a blocky, undulating bedrock profile which varies by several metres in elevation over relatively short horizontal distances. For this reason, the seismic survey results are considered to provide a more realistic assessment over large areas.

Two seismic layers are generally indicated within the bedrock profile. A lower velocity layer, having an average seismic wave velocity of 2180mps, which corresponds to soft rock and hard rock, shattered to fractured, highly weathered to weathered andesite with decomposed zones is underlain by a higher velocity layer, generally some 9m to 13m depth below surface, with an average seismic wave velocity of 5290mps. This layer probably represents hard rock and very hard rock, jointed to fissured, slightly weathered to fresh andesite as intersected at depth in Borehole Nos. 30, 32, 33 and 35.

During the course of the field work for the seismic investigation hard rock andesite boulders were observed in the vicinity of traverses 54 and 55 in the northeast corner of the site. The seismic survey indicated the presence of bedrock at depths ranging from 0,7m to 2,0m below surface in this area.

Depth to Blast Material, Drawing No. J46/5, indicates deep weathered zones in the southeast portion along two sub-parallel trending lines, where bedrock contours are deflected in a northeasterly direction. These linear bedrock depressions are coincident with, and probably due to the existence of the faults described earlier. Seismic results indicate that lower velocity bedrock has been degraded into residual soils, due to advanced preferential weathering of brecciated zones adjacent to the dislocations.

### 7.3 Seismic Survey Accuracy

Where a hard layer, such as bedrock, occurs below a softer layer, the Huntco FS-3 portable seismograph provides the depth to the hard layer with an accuracy of approximately 5 to 10 per cent for depths greater than 1,5m. A hard layer, such as well-cemented ferricrete, overlying a softer, decomposed bedrock layer, will tend to mask the underlying softer material and could lead to misinterpretation of depths.

## 8. GEOTECHNICAL CONSIDERATIONS

### 8.1 Soil ...../11

#### 8.1 Soil and Rock Excavation Characteristics

In terms of excavation characteristics, the colluvial soils, with an average seismic wave velocity of 370mps, may be stripped off by dozing or removed by scrapers down to an average depth of 1,8m.

The residual decomposed andesite soils and clayey gravels having an average seismic wave velocity of 1050mps, will generally require easy ripping with a D8H or equivalent sized tractor for removal. Conditions are likely to vary however, according to the size and number of boulders encountered at depth within this layer. Hard rock and very hard rock boulders of andesite greater than about 750mm in diameter in a clayey silt matrix may require blasting.

Bedrock, with an average seismic wave velocity of 2180mps generally occurring at depth between 3,2m and 7,7m below surface, will require blasting for removal.

#### 8.2 Groundwater Conditions

Relatively shallow groundwater conditions exist over the southern half of the site and also in the lower lying areas, adjacent to the natural stream at the eastern boundary of the site.

Water rest levels in the open boreholes ranged from depths of 2,2m to 3,8m below surface, with an average depth below ground level of about 2,8m. Over the remainder of the site, groundwater seepage was encountered in eight out of a total of 21 trial holes at an average depth of 1,9m below surface. Natural groundwater conditions are likely to vary seasonally and according to the degree of artificial irrigation the site receives.

Where structures are to be founded at or below the groundwater surface, dewatering of foundation excavations may be necessary.

In view of the high water level conditions prevailing at this site, light basin-type structures, constructed below the water

level, could experience hydrostatic uplift before the completed structures are filled or when subsequently drained for maintenance. A system of underdrains should be considered to lower the water table.

### 8.3 Expansive Soils

Soil grading and Atterberg limit test results on the soil samples tested, show that both the colluvial soils and residual decomposed andesite soils are predominantly very active silty clays or clayey silts. (CH, CL and MH) and that they classify as high or medium in degree of potential expansiveness.

Predicted heave values at surface for Hole Nos. 30, 32, 33 and 35, where soil sample test results are available, are respectively 35, 20, 35 and 30mm, with an average predicted heave of say 30mm over the entire area initially proposed for development. The high water table, which occurs at an average depth of 2.8m below existing ground surface, must be taken into account, since all clayey material below the water table should be in a saturated condition. Predicted heave at surface then reduces to an average of approximately 20mm.

Soil profiles with a predicted heave range of between 15mm and 50mm are classified as "fair". Buildings constructed on such profiles should adopt the split construction building technique. (Reference 2). Adequate surface drainage facilities should be installed.

### 8.4 Shear Strength Parameters

Consolidated undrained triaxial shear strength tests, conducted on the shelly tube samples recovered from Hole Nos. 32 and 35 are presented in Table 3.

For design purposes, particularly where the stability of slopes after drawdown is taken into account, the effective stress values of  $C=18\text{kPa}$  and  $\phi=34^\circ$  should be applied. (Reference 3)

8.5 Allowable ...../13

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REFERENCE 2: Jennings J.E. and Evans G.A. "Practical Procedures for Building in Expansive Soil Areas", S.A. Builder, October 1962.

TABLE 3  
TRIAXIAL TEST RESULTS

Hole No.:	32	35
Sample Depth (m)	2,8 - 3,3	2,4 - 2,8
Initial Dry Density (kg/m <sup>3</sup> )	1433	1448
Initial Moisture Content (%)	40,3	36,8
Final Moisture Content (%)	31,0	30,2
Cohesion c (kPa)	39	51
Int. Friction Angle $\phi$ (degrees)	25 <sup>0</sup>	22,6 <sup>0</sup>
Effective Cohesion C' (kPa)	18	19
Effective Int. Friction Angle $\phi'$ (degrees)	33,7 <sup>0</sup>	34,3 <sup>0</sup>

#### 8.5 Allowable Bearing Pressures

The transported gravelly clays, clayey sands and gravels vary considerably in consistency, but tend to decrease from stiff at surface down to firm at depth. The upper residual andesite silty clays and clayey silts are firm, changing with increasing depth to stiff and then dense to very dense as the gravel and cobble content increases.

Design bearing pressures for structures founded in the transported or upper residual soils, down to an average depth of 3,0m below surface should not exceed 100 kPa.

From depths of 3,0m to 5,0m below surface, design bearing values should not exceed 200 kPa. Below an average depth of 5,0m, allowable bearing pressures of 350 kPa may be adopted. The highly weathered bedrock has an allowable safe bearing pressure of 700 kPa.

#### 8.6 Settlement

Settlement computations for structures to be founded at this site have not been made as factors such as loads, footing sizes and founding depths were not known at the time of writing.

It ...../ 14

It is important to note however, that settlements of structures may be differential due to the varying thicknesses of the soil and weathered rock materials encountered at varying levels beneath ground surface.

No settlement is anticipated where structures, such as the Module Tanks, are to be founded at depth since a net decrease in load should result by the removal of the existing soils and their replacement by the proposed structures.

#### 8.7 Site Grading

Most of the colluvial clays and residual clayey soils from decomposed andesite on site are expansive and are not suitable for use as fill material. However, the colluvial clayey sands and the residual clayey gravels, derived from decomposed andesite, should provide stable fill material which should compact to the required densities. Other possible sources of fill material may be located along the Black Reef Quartzite outcrop or obtained from the ferricretes in the southeast corner of the site.

Site grading plans are not available and the proposed depths of cut and fill are not known. However, based on the existing topography and reasonable grading assumptions, the following general observations are presented.

Prior to the start of any grading, all vegetation, weeds, debris and existing fill should be removed. Removal of some loose alluvial soils and soft clayey topsoils may be necessary before any fill is placed.

In areas of cut, where expansive clays are exposed, the clay should be over excavated to a depth of 1.0m below the desired cut level, removed and replaced by selected, approved, stable material which should be brought to approximately optimum moisture content and then compacted to at least 90% Mod. AASHO maximum dry density. These measures should minimise to the effects of the expansive clays.

In areas of fill, the natural soil should be scarified, brought to approximately optimum moisture content and compacted to at least 90% of maximum density to a minimum depth of at least 20cm. All approved fill materials, excluding boulders, should be placed in lifts not exceeding 20cm in compacted thickness, brought to approximately optimum moisture content and then compacted to at least 90% Mod. AASHO maximum dry density.

In order to obtain sufficient suitable material for subsequent use as fill, it may be necessary to control stripping and excavation operations and to select material exposed for stock piling.

9. SUMMARY

The site is located on Recent gravelly clays, clayey sands and gravel and cobble layers of colluvial origin, overlying gravelly clays and clayey gravels from decomposed andesite, changing with increasing depth to soft rock, highly weathered to hard rock weathered andesite.

Drill hole results from the area proposed for development show the colluvial layers decrease in thickness towards the north from an average depth of 3,2m down to an average depth of 1,8m.

Below the colluvial material, down to average depths ranging from between 2,7m and 4,8m, is firm to stiff silty clay containing gravel and cobbles from andesite. Below the gravelly clay is dense to very dense, clayey gravel, cobbles and occasional boulders from decomposed andesite. Hard rock andesite bedrock occurs at average depths ranging from 3,2m to 7,7m below ground surface.

Over the whole site, seismic survey results show that an upper, low seismic wave velocity layer, averaging 370mps, extends down to an average depth of 1,8m below surface. An intermediate seismic wave velocity layer, with an average velocity of 1050mps, often underlies the upper layer. Bedrock, with an average seismic velocity of 2180mps, occurs at depths ranging from 0,2m to 11,2m below surface, with an average depth, over the entire site, of approximately 5,3m.

The upper low velocity layer can be stripped off by dozing or scrapers. The intermediate layer will require ripping with a D8 or equivalent sized tractor for removal. Bedrock will require blasting for excavation.

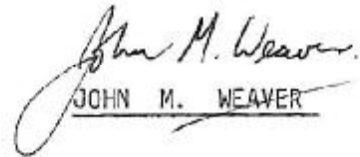
10. GENERAL

The above observations and recommendations are based on the project as described and on the assumption that the foundation materials and conditions throughout the site are not significantly different from those encountered during the field investigation.

In the case of shallow footings, after the excavations have been taken down to the depths to be specified, it is essential that these be examined by your Structural Engineer, who must satisfy himself that the material exposed is not at variance with the material described and that its bearing capacity is adequate for the loads contemplated.



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## APPENDIX

## SUMMARY OF SEISMIC SURVEY RESULTS

Traverse No.	Depth m	Seismic Wave Velocity(m/s)	Material Type	Excavation Classification
1F*	0,0 - 3,3	440	Topsoil & colluvium	Doze
	3,3 - 8,5	1150	Decomposed andesite & boulders	Hard rip
	8,5+	3340	Very hard rock andesite	Blast
1R*	0,0 - 3,1	270	Topsoil & colluvium	Doze
	3,1 - 8,0	1150	Decomposed andesite & boulders	Hard rip
	8,0+	3530	Very hard rock andesite	Blast
2F	0,0 - 2,9	360	Topsoil & colluvium	Doze
	2,9+	1000	Decomposed andesite	Easy rip
2R	0,0 - 3,0	400	Topsoil & colluvium	Doze
	3,0 - 11,9	670	Decomposed andesite	Easy rip
	11,9+	3000	Hard rock andesite	Blast
3F	0,0 - 2,7	480	Topsoil & colluvium	Doze
	2,7 - 10,0	1250	Decomposed andesite & boulders	Hard rip
	10,0+	2500	Hard rock andesite	Blast
3R	0,0 - 0,4	390	Topsoil & colluvium	Doze
	0,4 - 5,5	480	Colluvium & gravel	Doze
	5,5 - 10,3	1500	Decomposed andesite & boulders	Blast
	10,3+	5000	Very hard rock andesite	Blast
4F	0,0 - 2,0	440	Topsoil & colluvium	Doze
	2,0 - 7,6	600	Colluvium & gravel	Doze
	7,6+	3750	Very hard rock andesite	Blast
4R	0,0 - 3,2	350	Topsoil & colluvium	Doze
	3,2 - 7,9	830	Decomposed andesite	Easy rip
	7,9+	3000	Very hard rock andesite	Blast
5F	0,0 - 1,4	440	Topsoil & colluvium	Doze
	1,4 - 5,0	830	Decomposed andesite	Easy rip
	5,0+	2000	Soft rock & hard rock andesite	Blast
5R	0,0 - 1,5	330	Topsoil & colluvium	Doze
	1,5 - 6,2	700	Decomposed andesite	Easy rip
	6,2+	1580	Soft rock andesite & boulders	Blast
6F	0,0 - 1,8	430	Topsoil & colluvium	Doze
	1,8 - 5,9	910	Decomposed andesite	Easy rip
	5,9+	2000	Soft rock & hard rock andesite	Blast
6R	0,0 - 2,1	410	Topsoil & colluvium	Doze
	2,1 - 7,5	810	Decomposed andesite	Easy rip
	7,5+	4290	Very hard rock andesite	Blast
7F	0,0 - 1,3	450	Topsoil & colluvium	Doze
	1,3 - 7,7	910	Decomposed andesite	Easy rip
	7,7+	3750	Very hard rock andesite	Blast
7R	0,0 - 2,2	340	Topsoil & colluvium	Doze
	2,2 - 7,7	1150	Decomposed andesite & boulders	Hard rip
	7,7+	2860	Soft rock & hard rock andesite	Blast

\*F = Forward traverse

\*R = Reverse traverse

Traverse No.	Depth m	Seismic Wave Velocity(m/s)	Material Type	Excavation Classification
8F	0,0 - 1,2	360	Topsoil & colluvium	Doze
	1,2 - 8,8	970	Decomposed andesite	Easy rip
	8,8+	3330	Very hard rock andesite	Blast
8R	0,0 - 2,9	370	Topsoil & colluvium	Doze
	2,9 - 9,8	1150	Decomposed andesite & boulders	Hard rip
	9,8+	3340	Very hard rock andesite	Blast
9F	0,0 - 2,0	360	Topsoil & colluvium	Doze
	2,0 - 4,5	950	Decomposed andesite	Easy rip
	4,5+	2850	Soft rock & hard rock andesite	Blast
9R	0,0 - 2,1	380	Topsoil & colluvium	Doze
	2,1 - 5,7	1180	Decomposed andesite & boulders	Hard rip
	5,7+	3000	Soft rock & hard rock andesite	Blast
10F	0,0 - 2,1	410	Topsoil & colluvium	Doze
	2,1+	870	Decomposed andesite	Easy rip
10R	0,0 - 2,5	380	Topsoil & colluvium	Doze
	2,5 - 6,0	840	Decomposed andesite	Easy rip
	6,0+	2070	Soft rock & hard rock andesite	Blast
11F	0,0 - 0,8	470	Topsoil & colluvium	Doze
	0,8 - 4,1	1070	Decomposed andesite	Easy rip
	4,1+	2140	Soft rock & hard rock andesite	Blast
11R	0,0 - 1,3	410	Topsoil & colluvium	Doze
	1,3 - 3,9	1070	Decomposed andesite	Easy rip
	3,9+	2220	Soft rock & hard rock andesite	Blast
12F	0,0 - 1,1	450	Topsoil & colluvium	Doze
	1,1 - 3,5	820	Decomposed andesite	Easy rip
	3,5+	2220	Soft & hard rock andesite	Blast
12R	0,0 - 1,3	410	Topsoil & colluvium	Doze
	1,3 - 4,3	1430	Decomposed andesite & boulders	Hard rip
	4,3+	2720	Hard rock andesite	Blast
13F	0,0 - 1,8	370	Topsoil & colluvium	Doze
	1,8 - 4,8	1200	Decomposed andesite & boulders	Hard rip
	4,8+	3340	Very hard rock andesite	Blast
13R	0,0 - 1,6	400	Topsoil & colluvium	Doze
	1,6 - 5,0	1150	Decomposed andesite & boulders	Hard rip
	5,0+	3000	Hard rock andesite	Blast
14F	0,0 - 3,2	580	Topsoil & colluvium	Doze
	3,2+	2500	Soft rock & hard rock andesite	Blast
14R	0,0 - 2,8	540	Topsoil & colluvium	Doze
	2,8 - 11,0	2000	Soft rock & hard rock andesite	Blast
	11,0+	4610	Very hard rock andesite	Blast

Traverse No.	Depth m	Seismic Wave Velocity(m/s)	Material Type	Excavation Classification
15F	0,0 - 1,6	380	Topsoil & colluvium	Doze
	1,6 - 5,0	1760	Soft rock andesite & boulders	Blast
	6,0+	2860	Soft rock & hard rock andesite	Blast
15R	0,0 - 1,6	410	Topsoil & colluvium	Doze
	1,6 - 5,8	1730	Soft rock andesite & boulders	Blast
	5,8+	2500	Soft rock & hard rock andesite	Blast
16F	0,0 - 0,5	740	Decomposed andesite	Easy rip
	0,5 - 5,9	1300	Decomposed andesite & boulders	Blast
	5,9+	4260	Very hard rock andesite	Blast
16R	0,0 - 2,4	860	Decomposed andesite	Easy rip
	2,4 - 6,8	2000	Soft rock & hard rock andesite	Blast
	6,8+	4260	Very hard rock andesite	Blast
17F	0,0 - 1,2	600	Topsoil & colluvium	Doze
	1,2 - 4,1	970	Decomposed andesite	Easy rip
	4,1+	3750	Very hard rock andesite	Blast
17R	0,0 - 1,6	400	Topsoil & colluvium	Doze
	1,6 - 5,7	1670	Soft rock andesite & boulders	Blast
	5,7+	5440	Very hard rock andesite	Blast
18F	0,0 - 0,9	380	Topsoil & colluvium	Doze
	0,9 - 4,1	600	Decomposed andesite	Easy rip
	4,1+	1580	Soft rock andesite & boulders	Blast
18R	0,0 - 3,2	430	Topsoil & colluvium	Doze
	3,2 - 11,2	1300	Decomposed andesite & boulders	Hard rip
	11,2+	4000	Very hard rock andesite	Blast
19F	0,0 - 2,1	400	Topsoil & colluvium	Doze
	2,1 - 7,1	1150	Decomposed andesite & boulders	Hard rip
	7,1+	6000	Very hard rock andesite	Blast
19R	0,0 - 1,6	380	Topsoil & colluvium	Doze
	1,6 - 6,9	1250	Decomposed andesite & boulders	Hard rip
	6,9+	4200	Very hard rock andesite	Blast
20F	0,0 - 2,4	310	Topsoil & colluvium	Doze
	2,4 - 6,4	1700	Soft rock andesite & boulders	Blast
	6,4+	5300	Very hard rock andesite	Blast
20R	0,0 - 1,7	370	Topsoil & colluvium	Doze
	1,7 - 9,4	1090	Decomposed andesite	Easy rip
	9,4+	5080	Very hard rock andesite	Blast
21F	0,0 - 2,0	340	Topsoil & colluvium	Doze
	2,0 - 9,3	1520	Soft rock andesite & boulders	Blast
	9,3+	2750	Soft rock & hard rock andesite	Blast
21R	0,0 - 2,6	310	Topsoil & colluvium	Doze
	2,6 - 9,8	1200	Decomposed andesite & boulders	Hard rip
	9,8+	4550	Very hard rock andesite	Blast

Traverse No.	Depth m	Seismic Wave Velocity(m/s)	Material Type	Excavation Classification
22F	0,0 - 1,7	430	Topsoil & colluvium	Doze
	1,7 - 8,9	790	Decomposed andesite	Easy rip
	8,9+	7320	Very hard rock andesite	Blast
22R	0,0 - 1,5	420	Topsoil & colluvium	Doze
	1,5 - 7,9	820	Decomposed andesite	Easy rip
	7,9+	8110	Very hard rock	Blast
23F	0,0 - 1,7	420	Topsoil & colluvium	Doze
	1,7 - 9,5	1490	Decomposed andesite & boulders	Hard rip
	9,5+	3750	Very hard rock andesite	Blast
23R	0,0 - 1,0	320	Topsoil & colluvium	Doze
	1,0 - 10,7	1420	Decomposed andesite & boulders	Hard rip
	10,7+	3800	Very hard rock andesite	Blast
24F	0,0 - 1,3	320	Topsoil & colluvium	Doze
	1,3 - 13,7	1360	Decomposed andesite & boulders	Hard rip
	13,7+	6250	Very hard rock andesite	Blast
24R	0,0 - 3,0	360	Topsoil & colluvium	Doze
	3,0 - 13,6	1820	Soft rock & andesite boulders	Blast
	13,6+	6820	Very hard rock andesite	Blast
25F	0,0 - 2,7	400	Topsoil & colluvium	Doze
	2,7 - 5,3	1230	Decomposed andesite & boulders	Hard rip
	5,3+	2630	Soft and hard rock andesite	Blast
25R	0,0 - 2,4	350	Topsoil & colluvium	Doze
	2,4 - 10,8	1470	Decomposed andesite & boulders	Hard rip
	10,8+	4920	Very hard rock andesite	Blast
26F	0,0 - 0,8	270	Topsoil & colluvium	Doze
	0,8 - 4,5	740	Decomposed andesite	Easy rip
	4,5 - 10,9	1690	Soft rock andesite & boulders	Blast
	10,9+	4700	Very hard rock andesite	Blast
26R	0,0 - 2,3	350	Topsoil & colluvium	Doze
	2,3 - 7,1	1640	Soft rock andesite & boulders	Blast
	7,1+	4760	Very hard rock andesite	Blast
27F	0,0 - 0,1	380	Topsoil & colluvium	Doze
	0,1 - 2,7	1140	Decomposed andesite & boulders	Hard rip
	2,7+	3570	Very hard rock andesite	Blast
27R	0,0 - 0,4	380	Topsoil & colluvium	Doze
	0,4 - 3,7	1130	Decomposed andesite & boulders	Hard rip
	3,7+	3260	Very hard rock andesite	Blast
28F	0,0 - 2,5	410	Topsoil & colluvium	Doze
	2,5 - 9,4	1300	Decomposed andesite & boulders	Hard rip
	9,4+	6250	Very hard rock andesite	Blast
28R	0,0 - 2,2	380	Topsoil & colluvium	Doze
	2,2 - 9,1	1380	Decomposed andesite & boulders	Hard rip
	9,1+	5080	Very hard rock andesite	Blast

Traverse No.	Depth m	Seismic Wave Velocity(m/s)	Material Type	Excavation Classification
29F	0,0 - 1,3	280	Topsoil & colluvium	Doze
	1,3 - 5,6	1060	Decomposed andesite	Easy rip
	5,6+	4170	Very hard rock andesite	Blast
29R	0,0 - 0,4	270	Topsoil & colluvium	Doze
	0,4 - 2,7	790	Decomposed andesite	Easy rip
	2,7+	3190	Very hard rock andesite	Blast
30F	0,0 - 0,3	300	Topsoil & colluvium	Doze
	0,3 - 3,4	1020	Decomposed andesite	Easy rip
	3,4+	5080	Very hard rock andesite	Blast
30R	0,0 - 0,2	320	Topsoil & colluvium	Doze
	0,2 - 4,0	960	Decomposed andesite	Easy rip
	4,0+	4620	Very hard rock andesite	Blast
31F	0,0 - 0,5	210	Topsoil & colluvium	Doze
	0,5 - 3,1	860	Decomposed andesite	Easy rip
	3,1+	7500	Very hard rock andesite	Blast
31R	0,0 - 0,8	310	Topsoil & colluvium	Doze
	0,8 - 3,4	920	Decomposed andesite	Easy rip
	3,4+	10000	Very hard rock andesite	Blast
32F	0,0 - 0,1	290	Topsoil & colluvium	Doze
	0,1 - 4,2	940	Decomposed andesite	Easy rip
	4,2+	5080	Very hard rock andesite	Blast
32R	0,0 - 0,3	380	Topsoil & colluvium	Doze
	0,3 - 4,7	830	Decomposed andesite	Easy rip
	4,7+	4230	Very hard rock andesite	Blast
33F	0,0 - 0,8	250	Topsoil & colluvium	Doze
	0,8 - 9,0	1420	Decomposed andesite & boulders	Hard rip
	9,0+	6980	Very hard rock andesite	Blast
33R	0,0 - 0,5	270	Topsoil & colluvium	Doze
	0,5 - 6,2	1480	Decomposed andesite & boulders	Hard rip
	6,2+	4050	Very hard rock andesite	Blast
34F	0,0 - 2,5	310	Topsoil & colluvium	Doze
	2,5 - 10,9	1630	Soft rock andesite & boulders	Blast
	10,9+	6820	Very hard rock andesite	Blast
34R	0,0 - 2,7	340	Topsoil & colluvium	Doze
	2,7 - 11,3	1520	Soft rock andesite & boulders	Blast
	11,3+	6520	Very hard rock andesite	Blast
35F	0,0 - 2,1	370	Topsoil & colluvium	Doze
	2,1 - 5,8	1270	Decomposed andesite & boulders	Hard rip
	5,8+	2340	Soft rock & hard rock andesite	Blast
35R	0,0 - 1,3	350	Topsoil & colluvium	Doze
	1,3 - 6,0	1030	Decomposed andesite	Easy rip
	6,0+	2630	Soft rock & hard rock andesite	Blast

Traverse No.	Depth m	Seismic Wave Velocity(m/s)	Material Type	Excavation Classification
36F	0,0 - 1,9	340	Topsoil & colluvium	Doze
	1,9 - 7,0	1490	Decomposed andesite & boulders	Hard rip
	7,0+	4840	Very hard rock andesite	Blast
36R	0,0 - 1,7	320	Topsoil & colluvium	Doze
	1,7 - 7,3	900	Decomposed andesite	Easy rip
	7,3+	3700	Very hard rock andesite	Blast
37F	0,0 - 1,9	330	Topsoil & colluvium	Doze
	1,9 - 5,4	3000	Hard rock andesite	Blast
	5,4+	5880	Very hard rock andesite	Blast
37R	0,0 - 1,3	260	Topsoil & colluvium	Doze
	1,3 - 8,4	1060	Decomposed andesite	Easy rip
	8,4+	5000	Very hard rock andesite	Blast
38F	0,0 - 1,3	340	Topsoil & colluvium	Doze
	1,3 - 7,7	980	Decomposed andesite	Easy rip
	7,7+	9380	Very hard rock andesite	Blast
38R	0,0 - 1,4	300	Topsoil & colluvium	Doze
	1,4 - 6,4	1110	Decomposed andesite	Easy rip
	6,4+	7690	Very hard rock andesite	Blast
39F	0,0 - 3,1	430	Topsoil & colluvium	Doze
	3,1 -11,9	1780	Soft rock & hard rock andesite	Blast
	11,9+	7500	Very hard rock andesite	Blast
39R	0,0 - 2,7	460	Topsoil & colluvium	Doze
	2,7 -12,1	2080	Soft rock & hard rock andesite	Blast
	12,1+	8110	Very hard rock andesite	Blast
40F	0,0 - 1,5	380	Topsoil & colluvium	Doze
	1,5 -11,1	1720	Soft rock andesite & boulders	Blast
	11,1+	6250	Very hard rock andesite	Blast
40R	0,0 - 1,5	350	Topsoil & colluvium	Doze
	1,5 - 6,2	610	Decomposed andesite	Easy rip
	6,2+	7140	Very hard rock andesite	Blast
41F	0,0 - 1,4	340	Topsoil & colluvium	Doze
	1,4 - 6,0	930	Decomposed andesite	Easy rip
	6,0+	5360	Very hard rock andesite	Blast
41R	0,0 - 0,1	340	Topsoil & colluvium	Doze
	0,1 - 8,7	930	Decomposed andesite	Easy rip
	8,7+	6250	Very hard rock andesite	Blast
42F	0,0 - 3,3	400	Topsoil & colluvium	Doze
	3,3+	4290	Very hard rock andesite	Blast
42R	0,0 - 3,2	390	Topsoil & colluvium	Doze
	3,2+	5450	Very hard rock andesite	Blast

Traverse No.	Depth m	Seismic Wave Velocity(m/s)	Material Type	Excavation Classification
43F	0,0 - 0,2	310	Topsoil & colluvium	Doze
	0,2 - 12,5	1880	Soft rock & hard rock andesite	Blast
	12,5+	7320	Very hard rock andesite	Blast
43R	0,0 - 0,7	320	Topsoil & colluvium	Doze
	0,7 - 12,8	2470	Soft and hard rock andesite	Blast
	12,8+	6670	Very hard rock andesite	Blast
44F	0,0 - 1,0	280	Topsoil & colluvium	Doze
	1,0 - 5,9	850	Decomposed andesite	Easy rip
	5,9+	4920	Very hard rock andesite	Blast
44R	0,0 - 0,4	420	Topsoil & colluvium	Doze
	0,4 - 5,3	870	Decomposed andesite	Easy rip
	5,3+	4550	Very hard rock andesite	Blast
45F	0,0 - 1,5	300	Topsoil & colluvium	Doze
	1,5 - 9,1	1760	Soft rock andesite & boulders	Blast
	9,1+	9380	Very hard rock andesite	Blast
45R	0,0 - 1,5	280	Topsoil & colluvium	Doze
	1,5 - 9,3	1660	Soft rock andesite & boulders	Blast
	9,3+	8570	Very hard rock andesite	Blast
46F	0,0 - 2,8	450	Topsoil & colluvium	Doze
	2,8+	3490	Very hard rock andesite	Blast
46R	0,0 - 2,4	470	Topsoil & colluvium	Doze
	2,4+	2650	Soft rock & hard rock andesite	Blast
47F	0,0 - 0,3	260	Topsoil & colluvium	Doze
	0,3 - 4,2	1410	Decomposed andesite & boulders	Hard rip
	4,2+	2700	Soft rock & hard rock andesite	Blast
47R	0,0 - 1,8	400	Topsoil & colluvium	Doze
	1,8+	5880	Very hard rock andesite	Blast
48F	0,0 - 1,6	320	Topsoil & colluvium	Doze
	1,6 - 7,5	1420	Decomposed andesite & boulders	Hard rip
	7,5+	4760	Very hard rock andesite	Blast
48R	0,0 - 1,6	380	Topsoil & colluvium	Doze
	1,6 - 8,2	1580	Soft rock andesite & boulders	Blast
	8,2+	4050	Very hard rock andesite	Blast
49F	0,0 - 0,9	330	Topsoil & colluvium	Doze
	0,9 - 5,7	830	Decomposed andesite	Easy rip
	5,7+	4920	Very hard rock andesite	Blast
49R	0,0 - 0,6	360	Topsoil & colluvium	Doze
	0,6 - 7,8	1380	Decomposed andesite & boulders	Hard rip
	7,8+	2750	Soft rock & hard rock andesite	Blast
50F	0,0 - 1,0	360	Topsoil & colluvium	Doze
	1,0 - 4,7	760	Decomposed andesite	Easy rip
	4,7+	6980	Very hard rock andesite	Blast
50R	0,0 - 1,6	360	Topsoil & colluvium	Doze
	1,6 - 5,3	1430	Decomposed andesite & boulders	Hard rip
	5,3+	4920	Very hard rock andesite	Blast

Traverse No.	Depth m	Seismic Wave Velocity(m/s)	Material Type	Excavation Classification
51F	0,0 - 0,8	540	Topsoil & colluvium	Doze
	0,8+	3530	Very hard rock andesite	Blast
51R	0,0 - 0,6	440	Topsoil & colluvium	Doze
	0,6+	3090	Soft & hard rock andesite	Blast
52F	0,0 - 2,1	340	Topsoil & colluvium	Doze
	2,1 - 5,4	980	Decomposed andesite	Easy rip
	5,4+	3700	Very hard rock andesite	Blast
52R	0,0 - 1,1	300	Topsoil & colluvium	Doze
	1,1 - 3,1	640	Decomposed andesite	Easy rip
	3,1+	6520	Very hard rock andesite	Blast
53F	0,0 - 1,3	350	Topsoil & colluvium	Doze
	1,3 - 7,0	1400	Decomposed andesite & boulders	Hard rip
	7,0+	6670	Very hard rock andesite	Blast
53R	0,0 - 0,5	320	Topsoil & colluvium	Doze
	0,5 - 5,7	850	Decomposed andesite	Easy rip
	5,7+	6120	Very hard rock andesite	Blast
54F	0,0 - 0,5	340	Topsoil & colluvium	Doze
	0,5 - 4,0	1090	Decomposed andesite	Easy rip
	4,0+	6520	Very hard rock andesite	Blast
54R	0,0 - 0,8	440	Topsoil & colluvium	Doze
	0,8 - 1,8	1260	Decomposed andesite & boulders	Hard rip
	1,8+	4050	Very hard rock andesite	Blast
55F	0,0 - 1,2	270	Topsoil & colluvium	Doze
	1,2 - 3,0	1110	Decomposed andesite	Easy rip
	3,0+	6820	Very hard rock andesite	Blast
55R	0,0 - 0,9	280	Topsoil & colluvium	Doze
	0,9 - 8,4	2010	Soft & hard rock andesite	Blast
	8,4+	6120	Very hard rock andesite	Blast
56F	0,0 - 2,1	330	Topsoil & colluvium	Doze
	2,1 - 9,4	630	Decomposed andesite	Easy rip
	9,4+	3800	Very hard rock andesite	Blast
56R	0,0 - 2,7	320	Topsoil & colluvium	Doze
	2,7 - 10,5	700	Decomposed andesite	Easy rip
	10,5+	8570	Very hard rock andesite	Blast
57F	0,0 - 2,9	350	Topsoil & colluvium	Doze
	2,9 - 8,1	2050	Soft & hard rock andesite	Blast
	8,1+	5080	Very hard rock andesite	Blast
57R	0,0 - 3,1	350	Topsoil & colluvium	Doze
	3,1 - 9,6	2170	Soft & hard rock andesite	Blast
	9,6+	7320	Very hard rock andesite	Blast

Traverse No.	Depth m	Seismic Wave Velocity(m/s)	Material Type	Excavation Classification
58F	0,0 - 1,8	390	Topsoil & colluvium	Doze
	1,8 - 14,2	1620	Soft rock andesite & boulders	Blast
	14,2	7140	Very hard rock andesite	Blast
58R	0,0 - 2,0	340	Topsoil & colluvium	Doze
	2,0 - 12,2	1970	Soft & hard rock andesite	Blast
	12,2+	4920	Very hard rock andesite	Blast
59F	0,0 - 1,7	420	Topsoil & colluvium	Doze
	1,7 - 9,2	1790	Soft rock andesite & boulders	Blast
	9,2+	5260	Very hard rock andesite	Blast
59R	0,0 - 2,6	380	Topsoil & colluvium	Doze
	2,6 - 5,8	2970	Soft & hard rock andesite	Blast
	5,8+	3850	Very hard rock andesite	Blast
60F	0,0 - 1,5	320	Topsoil & colluvium	Doze
	1,5 - 6,8	530	Decomposed andesite	Doze
	6,8+	5560	Very hard rock andesite	Blast
60R	0,0 - 1,8	270	Topsoil & colluvium	Doze
	1,8 - 7,0	580	Decomposed andesite	Doze
	7,0+	5660	Very hard rock andesite	Blast
61F	0,0 - 2,4	390	Topsoil & colluvium	Doze
	2,4 - 12,0	1880	Soft and hard rock andesite	Blast
	12,0+	6670	Very hard rock andesite	Blast
61R	0,0 - 2,4	410	Topsoil & colluvium	Doze
	2,4 - 10,5	1840	Soft and hard rock andesite	Blast
	10,5+	9680	Very hard rock andesite	Blast
62F	0,0 - 2,5	400	Topsoil & colluvium	Doze
	2,5 - 8,9	2380	Soft & hard rock andesite	Blast
	8,9+	6120	Very hard rock andesite	Blast
62R	0,0 - 2,5	320	Topsoil & colluvium	Doze
	2,5 - 8,5	2040	Soft and hard rock andesite	Blast
	8,5+	6820	Very hard rock andesite	Blast
63F	0,0 - 3,0	350	Topsoil & colluvium	Doze
	3,0 - 11,1	2610	Soft & hard rock andesite	Blast
	11,1+	7320	Very hard rock andesite	Blast
63R	0,0 - 2,5	330	Topsoil & colluvium	Doze
	2,5 - 10,8	2560	Soft & hard rock andesite	Blast
	10,8+	6670	Very hard rock andesite	Blast
64F	0,0 - 1,8	350	Topsoil & colluvium	Doze
	1,8 - 7,7	1820	Soft & hard rock andesite	Blast
	7,7+	5170	Very hard rock andesite	Blast
64R	0,0 - 1,5	400	Topsoil & colluvium	Doze
	1,5 - 5,7	1570	Soft rock andesite & boulders	Blast
	5,7+	4920	Very hard rock andesite	Blast

# DRILLING RECORD

Sheet N° 10

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CLIENT PGJ Meiring & Partners  
PROJECT Sewage Works  
SITE Bushkoppie  
LOGGED BY AMT on 15/12/77  
DRILLER Radio

JOB N° J46  
HOLE N° 30  
ELEVATION ± 1556,7m  
WATER TABLE 3,0m  
DATE STARTED 10/12/77

DRILLING METHOD	% CORE RECOVERY	% ROCK QUALITY	FRACTURE FREQUENCY	FRACTURE SPACING	SAMPLING AND TESTING	DEPTH (m)	PROFILE	MATERIAL DESCRIPTION
SPT	50				14	0,30		Firm, moist, dark reddish brown, mottled black, intact silty CLAY(CL). Topsoil with roots.
SPT	17				22	1		Firm to stiff with depth, moist, dark red, intact silty CLAY(CL). Colluvium.
	44					1,30		Stiff, slightly moist, dark red intact medium-sandy CLAY(CL). Colluvium.
						1,60		Loose, wet, dark red slightly clayey and silty medium SAND(SP). Colluvium.
SPT	36	N/A	N/A			2		No core, suspect loose, wet, dark red slightly clayey and silty medium SAND(SP). Colluvium.
						2,65		Stiff, slightly moist, dark red, intact slightly sandy, silty CLAY(CL) with up to 5% ferruginous pisoliths, 3-5mm in size. Colluvium.
						3,10		Loose, wet, dark red, fine and medium SAND (SW). Colluvium.
						3,90		No core. Suspect loose, wet dark red fine and medium SAND(SW). Colluvium.
SPT	47				28	4		Stiff, slightly moist, yellow streaked black fissured, clayey SILT(ML). Decomposed ANDESITE VENTERSDORP LAVA.
	10					5,30		Stiff, slightly moist, yellow streaked black, fissured, clayey SILT(ML) with up to 10% hard rock, light grey, 20-50mm in size GRAVEL CORESTONES. Decomposed ANDESITE VENTERSDORP LAVA.
	16					6,65		Hard rock and very hard rock, grey stained brown and black, fine grained, 20-80mm in size ANDESITE VENTERSDORP LAVA BOULDERS in very stiff and soft rock clayey SILT(ML) matrix. Highly weathered ANDESITE VENTERSDORP LAVA.
	34	0	> 50			7,80		Very hard rock, grey stained brown and black on joints, fractured, fine grained, weathered ANDESITE VENTERSDORP LAVA. Red speckled white silty CLAY(CH) 1-2mm thick, commonly developed on joints.
	100	19	28			8		
	100	0	39			9		
	100	0				10		
	100	0						

FRACTURE SPACING (mm)

	< 30
	30 - 100
	100 - 300
	300 - 1000
	> 1000

Fracture frequency or N° of joints per metre

ROD ROCK QUALITY (%)

100 x Core lengths 100mm and longer  
Length of run

EXPLANATION

- Ground level
- Standard penetration test
- Water table
- End of drilling

- Indicator or disturbed soil sample
- Core sample
- Approx. material change
- Unconformable material change

## Sheet No. 11

Tel. 78-2397

CLIENT \_\_\_\_\_  
PROJECT Sewage Works  
SITE \_\_\_\_\_  
LOGGED BY \_\_\_\_\_  
DRILLER \_\_\_\_\_

JOB N° 146  
HOLE N° 30 Cont.  
ELEVATION \_\_\_\_\_  
WATER TABLE \_\_\_\_\_  
DATE STARTED \_\_\_\_\_

DRILLING METHOD	% CORE RECOVERY	% ROCK QUALITY	FRACTURE FREQUENCY	FRACTURE SPACING	SAMPLING AND TESTING	DEPTH (m)	PROFILE	MATERIAL DESCRIPTION
TNW	100	42	30			11		Very hard rock, grey stained brown and black on joints, fractured, fine grained, weathered ANDESITE VENTERSDORP LAVA. Red speckled white silty CLAY(CH) 1-2mm thick, commonly developed on joints.
	100	0						
	100	0						
	100	0						

**FRACTURE SPACING (mm)**

	< 30
	30 - 100
	100 - 300
	300 - 1000
	> 1000

Fracture frequency or N° of joints per metre

**ROD ROCK QUALITY (%)**

100 X Core lengths 100 mm and longer  
Length of run

**EXPLANATION**

	Ground level		Indicator or disturbed soil sample
	Standard penetration test		Core sample
	Water table		Approx. material change
	End of drilling		Unconformable material change

# DRILLING RECORD

Sheet No. 12

JOHN M. WEAVER  
Engineering Geologist

364 MAIN STREET,  
WATERKLOOF,  
PRETORIA, 0161

Tel. 75-2397

CLIENT PGJ Meiring & Partners

PROJECT Sewage Works

SITE Bushkoppie

LOGGED BY AMT 15/12/77

DRILLER Rodio

JOB No 346

HOLE No 31

ELEVATION  $\pm$  1553.6m

WATER TABLE 3.8m

DATE STARTED 10/12/77

DRILLING METHOD	% CORE RECOVERY	% ROCK QUALITY	FRACTURE FREQUENCY	FRACTURE SPACING	SAMPLING AND TESTING	DEPTH (m)	PROFILE	MATERIAL DESCRIPTION
A NXC TNM	N/A				26	0.30		Stiff, slightly moist, dark brown, fine sandy silty CLAY(CL). Topsoil with roots.
						1		Stiff, slightly moist, dark reddish brown, slightly sandy, with up to 30% 30-200mm quartzite gravel and cobbles in silty CLAY (CL). Colluvium.
	SPT				22	1.20		Firm, moist, dark red mottled, black, poorly ferruginized sandy silty CLAY(CL). Colluvium.
	60					2		Medium dense, moist, red, mottled yellow and black, clayey sandy 2-4mm GRAVEL(GP). Colluvium.
	48	N/A	N/A					Stiff, moist, red, silty CLAY(CL) with occasional 2-4mm ferruginous pisoliths. Colluvium.
	SPT				10	2.90		Stiff, moist, red mottled yellow and black, intact, silty CLAY(CL). Decomposed ANDESITE VENTERSDORP LAVA.
	49					4		
	SPT				16	4.65		Stiff, moist, yellow streaked black, fissured clayey SILT(ML). Decomposed ANDESITE VENTERSDORP LAVA. Occasional hard rock, light yellowish brown and grey ANDESITE cobbles. SPT unreliable - hit gravel.
	100					5		
	100					6		
	SPT				R			
	16					6.60		Poor core recovery. Dense, light grey, very hard rock, 250mm in size COBBLES(GP) in stiff to soft rock, light yellow, fissured, clayey SILT(ML) matrix. Decomposed ANDESITE VENTERSDORP LAVA.
	83	83				7		
	58	0				7.65		Soft rock and hard rock, light yellowish brown and grey, stained black and red on joints, fractured, highly weathered ANDESITE VENTERSDORP LAVA. Up to 10mm thick silty CLAY (CL) on joints.
	81	0	30			8		
	100	12				8.90		Very hard rock, grey and light brownish grey stained red on joints, fractured, fine grained, weathered ANDESITE VENTERSDORP LAVA. Up to 3mm thick light yellow silty CLAY(CL) developed on joints.
	100	11	28			9		
						10		

FRACTURE SPACING (mm)

	< 30
	30 - 100
	100 - 300
	300 - 1000
	> 1000

Fracture frequency or No of joints per metre

EXPLANATION

RQD ROCK QUALITY (%)

Core lengths 100mm and longer  
100 X Length of run

- Ground level
- Standard penetration test
- Water table
- End of drilling

- Indicator or disturbed soil sample
- Core sample
- Approx. material change
- Unconformable material change

# DRILLING RECORD

Sheet N° 13

JOHN M. WEAVER  
Engineering Geologist

354 MAIN STREET,  
WATERKLOOF,  
PRETORIA, 0181  
Tel. 78-2397

CLIENT \_\_\_\_\_  
PROJECT Sewage Works  
SITE \_\_\_\_\_  
LOGGED BY \_\_\_\_\_  
DRILLER \_\_\_\_\_

JOB N° 046  
HOLE N° 31 Cont.  
ELEVATION \_\_\_\_\_  
WATER TABLE \_\_\_\_\_  
DATE STARTED \_\_\_\_\_

DRILLING METHOD	% CORE RECOVERY	% ROCK QUALITY	FRACTURE FREQUENCY	FRACTURE SPACING	SAMPLING AND TESTING	DEPTH (m)	PROFILE	MATERIAL DESCRIPTION
TNW	100	13	27			11		Very hard rock, gray and light brownish grey stained red on joints, fractured, fine grained, weathered ANDESITE VENTERSDOORP LAVA. Up to 3mm thick light yellow silty CLAY(CL) developed on joints.
	86	10						
	85	18	16					
						12		

**FRACTURE SPACING (mm)**

	< 30
	30 - 100
	100 - 300
	300 - 1000
	> 1000

Fracture frequency or N° of joints per metre

**ROD ROCK QUALITY (%)**

Core lengths 100 mm and longer

100 X Length of run

**EXPLANATION**

	Ground level		Indicator or disturbed soil sample
	Standard penetration test		Core sample
	Water table		Approx. material change
	End of drilling		Unconformable material change

# DRILLING RECORD

Sheet No. 14

JOHN M. WEAVER  
Engineering Geologist  
364 MAIN STREET,  
WATERKLOOF,  
PRETORIA, 0181  
Tel. 78-2397

CLIENT PGJ Meiring & Partners  
PROJECT Sewage Works  
SITE Bushkoppie  
LOGGED BY AMT on 16/12/77  
DRILLER Rodio

JOB No. J46  
HOLE No. 32  
ELEVATION ±1549,3  
WATER TABLE Hole blocked  
DATE STARTED 13/12/77

DRILLING METHOD	% CORE RECOVERY	% ROCK QUALITY	FRACTURE FREQUENCY	FRACTURE SPACING	SAMPLING AND TESTING	DEPTH (m)	PROFILE	MATERIAL DESCRIPTION
NXC SPT Shelby sample SPT 30 10 33	15	N/A	N/A		5 44	0.30	49.20	Stiff, dry, dark brown, silty 6-80mm gravelly CLAY(CL). Topsoil with roots.
	30					1		Medium dense, dry to moist at depth, dark red, 6-250mm size GRAVEL and COBBLES(GW) in 50% silty CLAY(CL) matrix.
	36					1.50		
	SPT					2		Soft to firm at depth, moist, dark red, sandy silty CLAY(CL). Colluvium
	Shelby sample					2.70		
	SPT					3		Stiff, slightly moist, light yellow streaked black, fissured, clayey SILT(ML). Decomposed ANDESITE VENTERSDORP LAVA with small boulders and gravel size corestones at depth. SPT unreliable, hit gravel.
	30					4		
	10					4.50		Poor core recovery. Stiff, slightly moist, light yellow streaked black, fissured, clayey 10-100mm gravelly SILT(ML). Decomposed ANDESITE VENTERSDORP LAVA becoming very soft rock and highly weathered at depth.
	33					5.60		
	0					6		Soft rock, yellowish brown stained black on joints, fractured fine grained, weathered, ANDESITE VENTERSDORP LAVA with hard rock corestones.
92	0		65			6.40		
83	0					7		Very hard rock, light grey, stained brown and black on joints, fractured, fine grained weathered ANDESITE VENTERSDORP LAVA with 2-3mm thick silty CLAY(CL) on joints.
90	19		55			7.90	41.50	
100	0		50			9		Hard rock, light yellowish brown stained dark brown on joints, fractured, fine grained weathered ANDESITE VENTERSDORP LAVA, with 5 to 10m soft rock zones adjacent to joints.
100	24					9.20		
88	16		20			10		Very hard rock, light grey stained black and brown on joints, fractured to jointed at depth, fine grained slightly weathered ANDESITE VENTERSDORP LAVA.

FRACTURE SPACING (mm)

	< 30
	30 - 100
	100 - 300
	300 - 1000
	> 1000

Fracture frequency or No of joints per metre

RQD ROCK QUALITY (%)

Core lengths 100 mm and longer  
100 X Length of run

EXPLANATION

- Ground level
- Standard penetration test
- Water table
- End of drilling

- Indicator or disturbed soil sample
- Core sample
- Approx. material change
- Unconformable material change



# DRILLING RECORD

Sheet N° 16

JOHN M. WEAVER  
Engineering Geologist

364 MAIN STREET,  
WATERKLOOF,  
PRETORIA. 0181  
Tel. 78-2397

CLIENT PGJ Meiring & Partners  
PROJECT Sewage Works  
SITE Bushkoppie  
LOGGED BY AMT on 15/12/77  
DRILLER Rodio

JOB N° J46  
HOLE N° 33  
ELEVATION ±1557,8  
WATER TABLE 2,65m  
DATE STARTED 13/12/77

DRILLING METHOD	% CORE RECOVERY	% ROCK QUALITY	FRACTURE FREQUENCY	FRACTURE SPACING	SAMPLING AND TESTING	DEPTH (m)	PROFILE	MATERIAL DESCRIPTION
SPT	46				26	0,40		Stiff, moist, dark brown, fine gravelly silty CLAY(CL). Topsoil with roots. SPT unreliable. hit gravel.
						0,90		Stiff, moist, dark red, 30% 10-200mm quartzite gravel in silty CLAY(CL) matrix. Colluvium.
SPT	47				6	1		Firm, moist, dark red, silty CLAY(CL) with up to 20% 2-6mm feruginous pisoliths. Colluvium.
						2,10		Stiff, moist, dark red, fissured silty CLAY (CL). Decomposed ANDESITE VENTERSDORP LAVA.
SPT	26				84	2,35		Stiff, slightly moist, light yellow streaked black and brown, fissured clayey SILT(ML). Decomposed ANDESITE VENTERSDORP LAVA.
	32					3		
	20					3,45		Poor core recovery. Very stiff, moist, light yellow and reddish brown, 20% 20-60mm hard rock, light grey gravelly, fissured clayey SILT(ML). Decomposed ANDESITE VENTERSDORP LAVA.
	0	N/A	N/A			4		
	37					5		
	42					5,70		
	100					6		Stiff, dry, light yellow and reddish brown, fissured, clayey SILT(ML). Decomposed ANDESITE VENTERSDORP LAVA.
	100					7		
	44	0				7,15		
	100	0	45			8		Very hard rock, grey, weathered brown on joints, fractured fine grained, weathered ANDESITE VENTERSDORP LAVA.
	100	20	29			9		
	91	0				9,15		

FRACTURE SPACING (mm)		EXPLANATION	
	< 30		Ground level
	30 - 100		Standard penetration test
	100 - 300		Water table
	300 - 1000		End of drilling
	> 1000		Indicator or disturbed soil sample
Fracture frequency or N° of joints per metre			Core sample
			Approx. material change
			Unconformable material change

# DRILLING RECORD

Sheet No. 17

JOHN M. WEAVER  
Engineering Geologist  
364 MAIN STREET,  
WATERKLOOF.  
PRETORIA. 0181  
Tel. 78-2397

CLIENT PGJ Meiring & Partners  
PROJECT Sewage Works  
SITE Bushkoppie  
LOGGED BY JMW on 20/12/77  
DRILLER Rocio

JOB No. J46  
HOLE No. 34  
ELEVATION ± 1554,1m  
WATER TABLE 2,25m  
DATE STARTED 16/12/77

DRILLING METHOD	% CORE RECOVERY	% ROCK QUALITY	FRACTURE FREQUENCY	FRACTURE SPACING	SAMPLING AND TESTING	DEPTH (m)	PROFILE	MATERIAL DESCRIPTION
SPT	33				16	1		Medium dense, moist, dark yellowish-red clayey SAND(SC) with abundant GRAVEL and occasional COBBLES(GW) of ANDESITE, QUARTZ and QUARTZITE.
SPT	77				14	2		Stiff, wet, light yellow, speckled and stained black, fissured silty CLAY(CL) with scattered GRAVEL(GW) from decomposed ANDESITE.
SPT	100	N/A	N/A		36	3		Very stiff, moist, yellowish brown, speckled and stained black, fissured clayey SILT(ML) with GRAVEL and COBBLES(GW) from decomposed ANDESITE VENTERSDORP LAVA.
SPT	100					4		
SPT	61					5		
SPT	100					6		
SPT	22					6,80		Soft rock, yellowish brown stained dark brown and black, fractured to shattered at base, highly weathered ANDESITE VENTERSDORP LAVA.
SPT	100	0	45			7,45		Hard rock, greenish grey stained dark red and black on joints, fractured, weathered ANDESITE VENTERSDORP LAVA.
SPT	100	0				8		
SPT	100	0	50			8,55		Soft rock, yellowish brown stained dark red and black on joints, shattered, highly weathered ANDESITE VENTERSDORP LAVA.
SPT						9,10		

FRACTURE SPACING (mm)



Fracture frequency or No of joints per metre

EXPLANATION

ROD ROCK QUALITY (%)

Core lengths 100 mm and longer  
100 X Length of run

- Ground level
- Standard penetration test
- Water table
- End of drilling

- Indicator or disturbed soil sample
- Core sample
- Approx. material change
- Unconformable material change

# DRILLING RECORD

Sheet No. 18

JOHN M. WEAVER  
Engineering Geologist  
354 MAIN STREET,  
WATERKLOOF.  
PRETORIA. 0181  
Tel. 78-2397

CLIENT PGJ Meiring & Partners  
PROJECT Sewage Works  
SITE Bushkoppia  
LOGGED BY AMT on 18/12/77  
DRILLER Rodin

JOB No. 346  
HOLE No. 35  
ELEVATION  $\pm$  1550.0m  
WATER TABLE 2.20m  
DATE STARTED 15/12/77

DRILLING METHOD	% CORE RECOVERY	% ROCK QUALITY	FRACTURE FREQUENCY	FRACTURE SPACING	SAMPLING AND TESTING	DEPTH (m)	PROFILE	MATERIAL DESCRIPTION
SPT						0.15		Stiff, slightly moist, dark brown fine gravelly CLAY(CL). Topsoil with roots.
22						1		Loose, dry, dark red, 70% 2-100mm GRAVEL and CBBLES(GW) average size 7mm of QUARTZITE and weathered ANDESITE in silty CLAY(CL) matrix. Colluvium.
SPT						1.30		Firm, moist, dark red mottled yellow, silty CLAY(CL). Decomposed ANDESITE VENTERSDORP LAVA.
NXC	Shalby Sample	N/A	N/A			2		
SPT						2.10		Stiff, slightly moist to moist with depth, light yellow streaked red and black, fissured clayey SILT(ML). Decomposed ANDESITE VENTERSDORP LAVA with occasional hard rock core-stones.
42						3		
53						4		
43						5		
30	0	100				6		Very soft rock, light yellowish brown and reddish brown, shattered, highly weathered and decomposed ANDESITE VENTERSDORP LAVA with up to 20% hard rock corestones.
35	0	100				7		
100	0	100				7.65		Soft rock, light yellowish brown streaked dark brown and black, shattered, highly weathered ANDESITE VENTERSDORP LAVA with 15% very hard rock corestones up to 40mm in size.
			50			8		Hard rock, dark yellowish brown stained black and dark red on joints, fractured, fine grained, weathered ANDESITE VENTERSDORP LAVA.
						8.75		
						9		
						9.45		

FRACTURE SPACING (mm)



Fracture frequency or No of joints per metre

ROD ROCK QUALITY (%)

Core lengths 100mm and longer  
100 X Length of run

EXPLANATION

- Ground level
- Standard penetration test
- Water table
- End of drilling

- Indicator or disturbed soil sample
- Core sample
- Approx. material change
- Unconformable material change

# DRILLING RECORD

Sheet N° 19

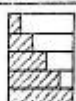
JOHN M. WEAVER  
Engineering Geologist  
364 MAIN STREET,  
WATERKLOOF,  
PRETORIA. 0181  
Tel. 78-2397

CLIENT PGJ Meiring & Partners  
PROJECT Sewage Works  
SITE Bushkoppie  
LOGGED BY AMT on 16/12/77  
DRILLER Rodia

JOB N° J46  
HOLE N° 36  
ELEVATION ± 1558,4m  
WATER TABLE 3,00m  
DATE STARTED 15/12/77

DRILLING METHOD	% CORE RECOVERY	% ROCK QUALITY	FRACTURE FREQUENCY	FRACTURE SPACING	SAMPLING AND TESTING	DEPTH (m)	PROFILE	MATERIAL DESCRIPTION
NXC	N/A					0.20		Stiff, slightly moist, dark brown, silty CLAY (CL). Topsoil with roots and 20% 30mm gravel.
	54	N/A	N/A			1.10		Medium dense, dry, dark brown, 70% 5-40mm GRAVEL(GW) in silty CLAY(CL) matrix. Colluvium
SPT						1.10		
50						2		Stiff, moist, light red, mottled yellow, fissured silty CLAY(CL). Decomposed ANDESITE VENTERSDORP LAVA with occasional hardrock corestones. SPT unreliable, hit gravel.
82						250		
33						320		Very dense, moist, light yellow streaked red, fissured clayey SILT matrix containing up to 70% very hard rock GRAVEL and COBBLES(GW). Decomposed ANDESITE VENTERSDORP LAVA.
80						320		
36	36		13			4		Very hard rock, light grey, weathered brown and black on joints, fractured, fine grained slightly weathered ANDESITE VENTERSDORP LAVA with a hard rock, weathered zone from 5,20m to 5,90m.
100	0		14			5		
100	0		24			6		
71	0					635		
100	22							

FRACTURE SPACING (mm)



Fracture frequency or N° of joints per metre

EXPLANATION

RQD ROCK QUALITY (%)

Core lengths 100 mm and longer  
100 X Length of run

- Ground level
- Standard penetration test
- Water table
- End of drilling

- Indicator or disturbed soil sample
- Core sample
- Approx. material change
- Unconformable material change

# DRILLING RECORD

Sheet No. 20

JOHN M. WEAVER  
Engineering Geologist  
364 MAIN STREET,  
WATERKLOOF.  
PRETORIA. 0181  
Tel. 78-2397

CLIENT PGJ Meiring & Partners  
PROJECT Sewage Works  
SITE Bushkoppie  
LOGGED BY JMW on 20/12/77  
DRILLER Rodio

JOB No. J46  
HOLE No. 37  
ELEVATION ± 1554.3m  
WATER TABLE 3.00m  
DATE STARTED 18/12/77

DRILLING METHOD	% CORE RECOVERY	% ROCK QUALITY	FRACTURE FREQUENCY	FRACTURE SPACING	SAMPLING AND TESTING	DEPTH (m)	PROFILE	MATERIAL DESCRIPTION
SPT	17	N/A	N/A			228		Medium dense, slightly moist, dark greyish brown silty SAND(SM) with abundant GRAVEL(GW) Colluvium.
						065		
						1		Medium dense, moist, dark yellowish brown, speckled light olive, clayey SAND(SC) with abundant small angular GRAVEL(GP). Colluvium.
						165		
						2		Dense, moist, hard rock GRAVEL and COBBLES of ANDESITE and QUARTZITE(GW) in matrix of dark yellowish red clayey SAND(SC). Colluvium.
						280		
						3		Dense, wet, yellowish red clayey SAND(SC) with abundant small GRAVEL(GP) from decomposed ANDESITE.
						325		
						4		Hard rock, dark grey speckled white stained dark and light brown on joints, fractured, weathered ANDESITE VENTERSDOORP LAVA.
						465		
SPT	100	80	20			5		Very hard rock, dark grey with light brown clayey SILT(ML) developed on joints, jointed to fractured at base, weathered ANDESITE VENTERSDOORP LAVA.
						6		
SPT	82	27				630		

FRACTURE SPACING (mm)



Fracture frequency or No of joints per metre

ROD ROCK QUALITY (%)

100 X Core lengths 100mm and longer  
Length of run

EXPLANATION

± Ground level  
± Standard penetration test  
W Water table  
End of drilling

Indicator or disturbed soil sample  
Core sample  
Approx. material change  
Unconformable material change

# DRILLING RECORD

Sheet No. 21

JOHN M. WEAVER  
Engineering Geologist

364 MAIN STREET,  
WATERKLOOF,  
PRETORIA. 0181

Tel. 76-2397

CLIENT PGJ Meiring & Partners

PROJECT Sewage Works

SITE Bushkoppie

LOGGED BY AMT on 17/12/77

DRILLER Rodio

JOB No. J46

HOLE No. 38

ELEVATION + 1550,4

WATER TABLE 3,0m

DATE STARTED 16/12/77

DRILLING METHOD	% CORE RECOVERY	% ROCK QUALITY	FRACTURE FREQUENCY	FRACTURE SPACING	SAMPLING AND TESTING	DEPTH (m)	PROFILE	MATERIAL DESCRIPTION
NXC	SPT	N/A	N/A			14	Q20	Stiff, dry, dark brown, 2-8mm gravelly silty CLAY(CL). Topsoil with roots.
	43					0.80	1	Medium dense, moist reddish brown 40% 6-200mm GRAVEL and COBBLES(GW) in a silty CLAY(CL) matrix.
	SPT					30	2	Firm, moist, yellowish orange, mottled red and brown, 6-12mm gravelly silty CLAY(CL). Colluvium.
	36					1.80	2	Stiff, moist, light yellow mottled red streaked black, fissured clayey SILT(ML) with up to 30% hard rock, light brownish grey gravel and boulder sized corestones. Decomposed ANDESITE VENTERSDORP LAVA.
		0	51			3	3	
	39					3.60	4	Hard rock, light brownish grey, fractured, fine grained weathered ANDESITE VENTERSDORP LAVA with occasional soft rock light yellowish brown zones, and with 4-5cm silty CLAY (CL) on joints.
	90					5	5	
	100					5.25	6	Poor core recovery. Hard rock, light brownish grey, shattered and fractured, highly weathered and decomposed ANDESITE VENTERSDORP LAVA with up to 60% stiff, light yellow, clayey SILT(ML)
	90	0	60			6.50	7	Hard rock, light greyish brown, stained brown on joints, fractured, fine grained, weathered ANDESITE VENTERSDORP LAVA with 3-4cm silty CLAY(CL) on joints.
	39					7.95	8	Very hard rock, light grey, stained brown on joints, fractured becoming jointed at depth, fine grained, slightly weathered ANDESITE VENTERSDORP LAVA.
TNW	100					8.50		
	100	0	26					
	100							
	81	12						

FRACTURE SPACING (mm)



Fracture frequency or No of joints per metre

RQD ROCK QUALITY (%)

Core lengths 100 mm and longer  
100 X Length of run

EXPLANATION

- Ground level
- Standard penetration test
- Water table
- End of drilling

- Indicator or disturbed soil sample
- Core sample
- Approx. material change
- Unconformable material change

## LABORATORY TEST RESULTS

SITE Proposed Bushkoppie Sewage Works Site

BAG N°						
BOREHOLE N°	30	30	32	32	33	33
DEPTH	2,0	4,0	1,8	2,8-3,3	2,1	2,7
DESCRIPTION OF MATERIAL	Silty CLAY(CH) Colluvium	Clayey SILT(MH) Dec. andesite	Silty CLAY(CL) Colluvium	Silty CLAY (CH) Dec. andesite	Clayey FER- RUGINOUS GRAVEL(GC) Colluvium	Silty CLAY (CL) Dec. andesite

## SIEVE ANALYSIS (% PASSING)

MAXIMUM SIZE (mm)						
53 mm						
37,5 mm					100	
26,5 mm					74	
19,0 mm			100		67	
13,2 mm	100		99		66	
4,75 mm	94		96	100	63	100
2,0 mm	85	100	86	96	55	95
0,425 mm	82	99	79	93	45	79
0,075 mm	71	97	67	87	34	73
0,002 mm	40	29	35	48	18	28

## SOIL CONSTANTS AND PROPERTIES

LIQUID LIMIT	51	61	49	56	51	45
PLASTICITY INDEX	30	28	25	30	27	21
LINEAR SHRINKAGE (%)	12,0	12,0	11,5	15,0	12,0	10,0
EXPANSIVENESS	High	High	Medium	High	Medium	Medium
NATURAL DENSITY						
NATURAL MOIST. CONTENT (%)				40,3		
PARTICLE REL. DENSITY (kg/m <sup>3</sup> )						
DRY DENSITY (kg/m <sup>3</sup> )				1433		
pH						
SULPHATES						