PSA7 SUMS STATED PROVISIONALLY (Clause 8.5)

PSA7.1 Contingencies

A Provisional Sum shall be included in the Summary of Schedules for contingencies. No percentage mark up will be applicable to any payments made using contingency money other than the mark up included in prices for variations determined in terms of the Conditions of Contract.

PSA7.2 Contract Price Adjustment

A Provisional Sum shall be included for Contract Price Adjustment in the Summary of Schedules to make provision for contract price adjustment in terms of the Conditions of Contract. The value of the Provisional Sum shall be based on the percentage of the subtotal value as specified in the Summary of Schedules. No percentage mark up will be applicable to any payments made in this regard.

PSA7.3 Salary for Labour Desk Officer and Community Liaison Officer

A Provisional Sum has been included in Schedule 2 for a salary to be paid to the Labour Desk Officer and Community Liaison Officer.

In addition to the abovementioned amount, provision is made in Schedule 2 for a mark-up on the amount to be paid. The mark-up shall be regarded as full compensation for overheads, charges and profits as provided for in the Conditions of Contract.

PSA7.4 Artisans and Skills Training

A Provisional Sum has been included in Schedule 2 for payments to be made to specialists for the training of unskilled or semi-skilled persons in industry accredited management and generic skills. Payment to the Contractor will be based on invoices certified by the Engineer and issued by training specialists to the Contractor for work undertaken in terms of this item.

In addition to the above amount, provision is made in Schedule 2 for a mark-up on any payments made by the Contractor in this regard. The mark-up shall be regarded as full compensation for overheads, charges and profits as provided for in the Conditions of

Contract.

PSA7.5 Telephone Calls and Rental

A Provisional Sum has been included in Schedule 2 for telephone calls and facsimile transmissions for the Engineer's Representative. The Engineer's representative will provide his own cellular telephone for the contract. Payment will be based on call and rental costs, but excluding any deposits and installation costs which shall be priced under the preliminary and general items.

In addition to the above amount, provision is made in Schedule 2 for a mark-up on any payments made by the Contractor. The mark-up shall be regarded as full compensation for overheads, charges and profits as provided for in the Conditions of Contract.

PSA7.6 Acceptance Control Testing

A Provisional Sum has been included in Schedule 2 for acceptance control testing ordered by the Engineer to be undertaken by a commercial laboratory. Payment will be based on the actual invoicing by the laboratory to the Contractor.

In addition to the abovementioned amount, provision is made in Schedule 2 for a mark-up on any payments made by the Contractor in this regard. The mark-up shall be regarded as full compensation for overheads, charges and profits as provided for in the Conditions of Contract.

PSA7.7 Office Consumables for Engineer's Site Facility

A Provisional Sum has been included in Schedule 2 for the appointment and payment of office consumables for Engineer's site facility.

In addition to the abovementioned amount, provision is made in Schedule 2 for a mark-up on the amount to be paid. The mark-up shall be regarded as full compensation for overheads, charges and profits as provided for in the Conditions of Contract.

PSA7.8 Electronic equipment for Engineer's office

A Provisional Sum has been included in Schedule 2 for the appointment and payment of a specialist sub-contractor for electronic equipment for Engineer's site office.

In addition to the abovementioned amount, provision is made in Schedule 2 for a mark-up on the amount to be paid. The mark-up shall be regarded as full compensation for overheads, charges and profits as provided for in the Conditions of Contract.

PSA8 PRIME COST ITEMS (Clause 8.6)

PSA8.1 Materials for Dayworks

A Provisional Sum has been included in Schedule 2 for materials to be used during the execution of dayworks. In addition to the abovementioned amount, provision is made in Schedule 2 for a mark-up on the materials used during the execution of the dayworks by the Contractor. Payment made shall be regarded as full compensation for overheads, charges and profit on the materials that are used when executing dayworks.

PSAB ENGINEER'S OFFICE

PSAB1 NAME BOARDS (Clause 3.1)

Two name boards conforming to the standard requirements of the South African Association of Consulting Engineers and as shown on drawing 01A003. must be provided and erected at points to be designated by the Engineer.

PSAB2 OFFICE BUILDING (Clause 3.2 and Clause 5.2))

Office accommodation has already been provided for the Engineer under the contract for the construction of the first phase of the internal civil engineering services. This accommodation will be used by the Engineer for the duration of the project and no additional accommodation is required for the Engineer under this contract. The office facility has been furnished as per Drawing No. 01A005 and Drawing No. 01A006.

The Contractor shall provide cleaning and maintenance for the duration of the contract, as well as 24 hour security for the office. The Contractor shall provide insurance for the buildings as well as the contents of the buildings at the replacement cost for new buildings and contents.

PSAB3 TELEPHONE (Clause 4.1 and 5.4)

The Contractor shall arrange for the installation of four telephone lines. Provisional sums have been allowed under item PSA7 for all telephone rental and associated costs.

PSAB4 TESTING

PSAB4.1 General

No laboratory building or fittings are required by the Engineer. The Engineer will arrange separately with a commercial laboratory of designate specialists to carry out all acceptance control testing, excepting for density control test and moisture content determinations. The Contractor shall remain responsible to carry out the process control testing required by the Standardised, Particular and Project Specifications.

PSAB4.2 Laboratory Equipment

The Contractor shall supply the following equipment for the duration of the Contract.

(a) A Troxler nuclear system, complete with accessories and stored in a suitable transit case as supplied by the manufacturer. A detailed description of the unit and principals of operation should be given in the manual for the nuclear instrument.

(b) Dinamic cone penetrometer

(c) Six concrete cube moulds, 150mm nominal size, as well as a suitable concrete cube curing basin to keep all concrete cubes submerged in water for at least 28 days.

PSAB5 SURVEY ASSISTANTS (Clause 5.5)

One suitably educated Survey Assistant shall be made available for the sole use of the Engineer's Representative for the duration of the Contract. Transport shall be supplied for the Survey Assistant by the Contractor for the duration of the Contract should he be requested to do so.

A full time gate guard and camp assistant for the sole use of the Engineer must be provided.

PSAB6 SURVEY EQUIPMENT

The survey equipment listed below shall be made available and be maintained in good condition for the exclusive use of the Engineer or his Representative for the duration of the Contract. Payment will be made as provided for in the Time Related Items included in Schedule 1.

(a)	Automatic surveyor's level complete with tripod and leather carry case such as Zeiss N1-2 or equivalent	1 No
(b)	20-second tachometer with optical plumbob complete with tripod and leather carry case such as Sokkisha TM20C or equivalent.	1 No.
(c)	Nylon-coated steel surveyor's tape 100m long and 10mm wide	1 No.

(d)	5m long steel tape	1 No.
(e)	5m long three-piece telescopic survey staves (metric double-face) complete with angle bracket level	2 No
(f)	Survey books: Level	3 No.
(g)	2kg hammer with rubber handle	1 No.
(h)	Steel pegs, 300mm long and 12mm dia	120 No.
(i)	Aluminium tags, 100mm long, 15mm wide and 2mm thick	120 No.
(j)	Reverse polar notation pocket calculator (Hp32SII or similar)	1 No
(k)	Change point	2 No
(l)	Measuring wheel	1 No
(m)	Tripod holders for ranging rods (heavy duty)	2 No.
(n)	Optical square (Sokkisha or Wild), complete with telescopic aluminium rod and bubble	1 No.
(o)	"Rabone" steel tape 10 meters long and 13mm wide	1 No.
(p)	Triangular change plate with chain	2 No.
(q)	100m long 50 kg strength fish line	1 No.
(r)	One metre long spirit level	1 No.
(s)	Three metre aluminium straight edge	1 No.

PSAB7 CARPORTS

The Contractor shall provide and maintain carports as indicated on the detailed on the drawing mentioned in PSAB2 for the duration of the Contract. The floor shall consist of crushed aggregate to alleviate dusty and muddy conditions.

PSC SITE CLEARANCE

PSC1 DISPOSAL OF MATERIAL (Sub-clauses 3.1 and 8.2.1)

Materials arising form clearing and grubbing shall be disposed of at a suitable spoil site. The Contractor shall be responsible to make his own arrangements for a suitable spoil site. Trees and stumps necessarily removed shall not be burnt unless authorised by the Engineer but shall be cut and stacked at areas designated by the Engineer.

PSC2 AREAS TO BE CLEARED AND GRUBBED (Clause 5.1)

The areas to be cleared and grubbed will be indicated by the Engineer. Should a portion or the whole of the site have been cleared and grubbed by others prior to the start of construction then no clearing and grubbing will be ordered or payment made with respect to the applicable portion of the site.

PSC3 PRESERVATION OF TREES (Sub-clause 5.2.3)

The penalty in respect of every individual tree, designated as a tree to be preserved, that is damaged or removed unnecessarily by the Contractor, shall be R500. Trees that fall within areas upon which the Works are to be constructed or within areas that the Contractor must occupy for the proper construction of the Works will not be designated for preservation.

PSC4 FREEHAUL AND OVERHAUL

Refer to clause PSD7 in this regard.

PSD EARTHWORKS

PSD1 CLASSIFICATION FOR EXCAVATION PURPOSES (Clause 3.1.2)

Delete clause 3.1.2 (a) and clause 3.1.2 (b) and replace with the following:

3.1.2 (a) Soft excavation:

"All material that is not classified as hard rock excavation in terms of clause 3.1.2 (c), boulder excavation class A in terms of clause 3.1.2 (d) or boulder excavation class B in terms of clause 3.1.2 (e) shall be classified as soft excavation"

In clause 3.1.2 (c) (1), replace the words "equivalent to that specified in (b) (1) above" with the words "of mass approximately 35 t, fitted with a single-tine ripper suitable for heavy ripping and of fly wheel power approximately 220 kW."

In the last sentence of clause 3.1.2 (d), replace the words "intermediate excavation" with the words "soft excavation."

In the last sentence of clause 3.1.2 (e), replace the words "or intermediate excavation, according to the nature of the material" with the word "excavation."

PSD2 SAFEGUARDING OF EXCAVATIONS (Sub-Clause 5.1.1.2)

Any cost the Contractor may undergo in ensuring the safety of excavations or any additional excavation and backfilling he may have to undertake due to the unstable sides of excavations and trenches shall be held to his account and the various rates for excavation and trenching included in the Schedule of Quantities shall include full compensation therefore.

PSD3 EXPLOSIVES (Sub-Clause 5.1.1.3)

Add the following to the sub-clause:

"The Contractor shall record for the information of the Engineer the spacing and loading of the charge in each blast. Compliance with this requirement will not relieve the Contractor of any responsibility as provided for in this sub-clause".

PSD4 DISPOSAL OF SURPLUS MATERIAL (Sub-Clause 5.1.4.3 and 5.2.2.3)

Add the following to the sub-clause:

"All surplus or unsuitable materials arising from trench excavations shall be spoiled and neatly spread and levelled along the route of the pipeline so as not to interfere with future works nor to disrupt the natural overland flow of storm runoff. Rocks, trees, debris and other unsightly material from trench excavations shall be disposed of at a suitable spoil site. Where the pipeline is laid within a road reserve the route of the pipeline shall be finished neatly to be flush with the natural ground level or finished sidewalk level as may be applicable.

The Contractor shall be responsible to make his own arrangements for a suitable spoil site".

PSD5 ACCOMMODATION OF TRAFFIC (Sub-Clause 5.1.6)

The Contractor shall tender a lump sum in Schedule 3 for accommodating traffic during the duration of the Contract, which sum shall cover all his obligations in this regard, including but not limited to temporary barricades; the erection and re-erection of existing and/or temporary traffic signs; lights and flagmen for the guarding and protection of the Works; and for making all necessary arrangements with the applicable traffic authorities. Payment shall be made monthly pro-rata to the overall progress of the Works.

PSD6 BORROW PITS (Sub-Clause 5.2.2.2)

One designated borrow pit is available on site as indicated on drawing 1396.10.ZA.02P001. Additional material will be required from commercial sources. The Contractor shall be responsible for making his own arrangement regarding the provision of material, from commercial borrow pits where required in the Bill of Quantities. The Contractor shall provide in his tender prices for all royalties payable and for the transport of the material to site.

PSD7 HAUL AND SPOIL ROADS (Sub-Clause 5.2.2.2)

The Contractor shall be responsible for the opening up and closing down of designated borrow pits. The Engineer will obtain the necessary permissions and authority to utilise such borrow pits. The Contractor in turn shall in all respect comply with the various requirements of SABS 1200D and of the Minerals Act (No 50 of 1991 in relation to the

opening up, closing down and utilisation of borrow pits. Except for the crushing or screening of materials in accordance with the written instructions of the Engineer, and for royalties should such become payable, no additional payment will be made for excavating or processing material from designated borrow pits, regardless of the hardness or other properties of the material.

PSD8 FREEHAUL (Sub-Clause 5.2.5.1) AND OVERHAUL (Sub-Clause 5.2.5.2)

No overhaul will be payable on site and from the designated borrow pits.

END OF SECTION

PSDB EARTHWORKS (PIPE TRENCHES)

PSDB1 ACCOMMODATION OF TRAFFIC (Sub-Clause 5.1.3)

See Clause PSD5.

PSDB2 EXISTING SERVICES (Sub-Clauses 5.1.4)

Where any existing service occurs within the specified trench excavation, and the presence of such service is known before being uncovered, then the protection of the service will be scheduled and measured as provided for in Clause 8.3.5 of 1200DB. Only known services (as defined in Clause 5.4 of 1200A) shall be measured for payment.

Where an unknown existing service is damaged during construction, and the Engineer orders that the Contractor should undertake the repair of such service, then such repair will either be measured and paid as dayworks or alternatively as a contractual variation in terms of the Conditions of Contract.

No construction activity which may affect the integrity of telephone or electrical poles or stays may be carried out without the prior written approval of the Engineer, which approval shall only be given subject to the acceptance of a modus operandi that will ensure the integrity of such structures during construction.

PSDB3 TRENCH WIDTHS (Sub-Clauses 4.1 and 5.2)

Trenches in general shall not exceed the widths laid down in Sub-Clause 8.2.3. If trenches exceed the specified width the Contractor shall be liable for the cost of any thicker pipes or more expensive bedding which may be required as a result of the additional trench width.

PSDB4 TRENCH BOTTOMS (Sub-Clause 5.5)

Replace the first paragraph of this sub-clause "Material that ..... compacted as directed" with the following :-

Where a firm foundation cannot be obtained at the grade indicated due to soft or unsuitable material, the Engineer may instruct the Contractor to remove such unsuitable material and to backfill the excess depth with approved selected material or concrete, as

directed by the Engineer in each particular case, at the cost of the Employer. Backfill other than concrete, shall be placed in layers of 100mm un-compacted thickness, each layer thoroughly compacted to the entire satisfaction of the Engineer, to provide adequate support for the pipe bedding to be placed on top of it.

Should the Contractor remove more ground than is required to secure the proper grade of the pipeline, the Contractor must, at his own cost, backfill the excess excavation with approved selected material or concrete, as directed by the Engineer in each particular case.

PSDB5 DISPOSAL OF EXCAVATED MATERIAL (Sub-Clauses 5.6.3 and 5.6.4)

All surplus or unsuitable materials arising from excavation shall be spoiled and spread within or adjacent to the Site of the Works or when ordered by the Engineer be spoilt at a spoil site established by Contractor.

PSDB6 FREEHAUL AND OVERHAUL (Sub-Clause 5.6.8)

No overhaul will be payable on earthworks for pipe trenches.

PSDB7 AREAS SUBJECTED TO TRAFFIC LOADS (Clause 5.7.2)

The requirements of Clause 5.7.2 shall apply only to pipes and sleeves crossing streets or paved areas and pipes running parallel to the road as described below.

All service trenches running parallel to the road of which the roadside edge of the trench is located less than 1,4m away from the edge of the travelled way, will be subject to the requirements for the above mentioned clause.

The measurement and payment will apply to the full trench width. Pipes and sleeves crossing streets or paved areas will be measured and paid for to a length equal to the width of road or length of pavement crossed plus 1,4 m either side of the travelled edges.

Compaction of other pipe trenches running parallel to the roadway shall be considered areas subject to traffic loads only where instructed by the Engineer in writing. The volume will be computed from the minimum base width determined in accordance with Sub-Clause 5.2 and the depth from the top of the back fill to the top of the bedding as specified in Sub-Clause 8.3.3.1.

PSDB8 REINSTATEMENT OF EXISTING BITUMEN SURFACED ROADS (Clause 3.6 and 5.9.4)

Pipe trenches through the existing bitumen surfaced roads shall be reinstated with a 150mm upper selected subgrade layer compacted to 93 % mod AASHTO density, followed by a 150mm subbase layer compacted to 95 % mod AASHTO density and a 150mm graded crushed stone base compacted to 98 % of mod AASHTO density. The road shall be provided with a 25mm thick asphalt seal.

The upper selected subgrade layer shall have a CBR of at least 15, a grading modulus of at least 0,75 and a maximum PI of 12. The subbase shall conform to SABS 1200 ME and the base to SABS 1200 MF.

PSDB9 MEASUREMENT AND PAYMENT (Clause 8.3.2)

PSDB9.1 Basic Principles (Clause 8.1)

Add the following to the sub-clause 8.1.2(a):

Payment for the excavation and backfilling of trenches shall be made at the tendered rates and at the following stages of the construction:

i) upon completion and approval of the trench bottom, prior to bedding : 40 %
i) upon completion and approval of top of selected backfill: 70% (cumulative)
ii) upon completion and approval of the main fill: remaining 30 %.

PSDM EARTHWORKS (Roads, subgrade)

PSDM1 OVERHAUL

No overhaul will be payable on earthworks.

PSDM2 ACCOMMODATION OF TRAFFIC

Refer to clause PSD5 in this regard.

PSDM3 DISPOSAL OF SURPLUS MATERIAL

All surplus material removed from the road reserve shall be used to backfill the borrow pit on site. Material shall be temporary stockpiled until all usable material has been removed from the borrow pit. Thereafter the borrow pit shall be backfilled in layers not exceeding 200mm thickness and compacted to 90% mod AASHTO density. All surplus material that cannot be used for the backfilling of borrow pits, as well as rocks, trees debris and other unsightly material shall be removed to a suitable spoil area. The Contractor shall make his own arrangements for a spoil area.

PSDM4 BORROW PITS

Refer to clause PSD5 in this regard.

PSDM5 ROLLING BY SPECIFIED NUMBER OF PASSES (Sub-clause 5.2.3.3)

PSDM5.1 General

Where shown on the drawings or ordered by the Engineer, the road-bed shall be subjected to a specified number of passes using a designated type of roller.

PSDM5.1.1 Pneumatic-tyred roller

A pneumatic-tyred roller shall consist of pneumatic-tyred wheels mounted on a rigid frame with a loading platform or body suitable for ballast loading to produce a load of at least 70kN on each wheel and arranged in a manner that allows all wheels to bear equally while operating on uneven surfaces.

The total load on any axle line shall not exceed 300kN. Tyres shall be uniformly inflated under operating conditions to a pressure within the rage 500-800 kPa.

PSDM5.1.2 Vibratory roller

The vibratory roller shall be capable of exerting a combined static and dynamic force of not less than 120 kN/m width for every metre of loose-layer thickness at an operating frequency not exceeding 25 Hz and shall move at a speed not exceeding 4 km/h.

PSDM5.1.3Grid roller

A grid roller shall have a mass of at least 13 t when ballasted, and shall be operated at this mass.

PSDM5.1.4Impact roller

◊ Type 1

Impact roller type 1 shall be a single multifaced roller having a maximum of five flat or nearly flat faces and a mass of over 8 t. The roller shall be of the free fall type, and the roller and towing mechanism shall be so designed that all the energy applied in lifting the roller to the position in which it is supported on an edge between consecutive faces, is dissipated on impact when the roller drops again. The roller shall be towed by a tractor of engine power not less than 160kW and towed within 20 % of its optimum towing speed.

◊ Type 2

Impact roller type 2 shall be an impact compactor or roller delivering impact energy per blow of not less than 25 kilojoules, of the HEIC Series 600 type supplied by Compaction Technology (Pty) Limited or equal approved. The roller shall be towed by a tractor of engine power not less than 160kW and towed within 20 % of its optimum towing speed.

PSDM5.2 Roller Compaction

Any layer which is shown on the drawings or is specified or is prescribed by the Engineer to be rolled by a specified number of passes shall be prepared by shaping if necessary and then be compacted with a specified roller which complies with the requirements specified in subclause PSDM5.1.

A pass for a double drum roller is hereby defined as two passes of the roller over a suitable lane width such that one drum of the roller during its second passage travels in the inter drum space created by the first passage of the roller. Adjacent lanes shall not overlap or have a gap exceeding 250mm.

Except where otherwise authorised by the Engineer, compaction shall comprise not less than the required number of complete coverage by the wheels of the roller, specified or ordered, over every portion of the area being compacted. Although it is not the intention that water be applied to the roadbed by the Contractor under this class of compaction and no rigid control of the moisture content will be exercised during compaction, the Contractor shall nevertheless satisfy the Engineer that every possible endeavour is being made to take advantage of favourable soil- moisture conditions and to carry out such compaction in so far as is possible during periods when the roadbed is neither excessively dry not excessively wet. The Engineer shall instruct the Contractor to water the roadbed at the Contractor's expense where, in the opinion of the Engineer, the Contractor has failed to comply with these requirements.

PSDM5.3 Payment

Payments for roller compaction shall be measured as follows:

(a)	Heavy pneumatic-tyred roller	.....m².pass
(b)	Vibratory roller	.....m².pass
(c)	Grid roller	.....m².pass
(d)	Tamping roller	.....m².pass
(e)	Impact roller	.....m².pass

PSGA CONCRETE (Small Works)

PSGA1 CEMENT (Sub-clause 3.2.1)

All cement material used in concrete shall comply with the following standards:

SABS ENV 197-1:1992 Cement B composition, specifications and conformity criteria B Part 1: Common cements

PSGA2 CONCRETE FINISHES (Sub-clauses 4.4.2)

Concrete against which earth will be backfilled shall be finished rough. All exposed concrete surfaces shall be finished smooth to degree of accuracy II.

PSGA3 STRENGTH CONCRETE (Sub-clause 5.4.1.7)

The grade of concrete and nominal size of aggregate shall be as specified on the Drawings. The successful tenderer will be required to submit samples of the coarse and fine aggregate which he proposes using, to the Engineer's Representatives for tests regarding the suitability of such aggregates. The Contractor shall prepare trial mixes of the grades of concrete required for the Contract to establish acceptable design mixes. These mixes shall be designed for vibration. All data and reports prepared by the Contractor shall be submitted to the Engineer for information and approval prior to the commencement of concreting operations.

PSGA4 ANCHOR AND THRUST BLOCKS

At tees, bends, terminal valves, end caps, and where otherwise directed, anchor/thrust blocks shall be constructed to dimensions ordered, shown on the Drawings or agreed to by the Engineer. Unless otherwise specified, anchor/thrust blocks and pedestals shall be constructed of prescribed mix 25MPa/19 mm concrete.

The concrete shall be well punned round the pipe and, if in trenches, against the undisturbed faces and bottom of the trench. Backfilling behind or under thrust faces will not be permitted. Excess excavation shall be replaced with the prescribed mix concrete given above for anchor/thrust blocks at the Contractor’s expense, unless an item is scheduled to cover payment for over break. Care shall be taken to leave the joints accessible. No anchor/thrust blocks and pedestals shall be concreted until the approval of the Engineer has been obtained.

Anchor and thrust blocks will be measured by volume of concrete; the rate tendered shall include for any formwork required to construct the block.

PSL MEDIUM PRESSURE PIPELINES

PSL1 MATERIALS - WATER SUPPLY MAINS (Clauses 3.1 to 3.7)

(a) Steel fittings and specials shall be manufactured in accordance with the requirement of BS 534 but to the dimensions shown on the detailed layouts. Steel pipe sections shall be 6mm thick grade A complying with the requirements of SANS 719.

(b) Cast iron fittings and specials shall be, manufactured in accordance with the requirements of 1200L, clause 3.3.

(c) Flexible slip-on type Viking Johnson couplings shall be complete with removable centre registers (locating lugs). The area surrounding the locating lug shall be built up to prevent damage to the female thread on the Viking Johnson coupling.

(d) uPVC pipes shall confirm to SANS 966.

(d) PVC-O pipes shall confirm to SANS 16422.

(e) HDPE pipes shall confirm to SANS 533.

PSL2 CORROSION PROTECTION (Clause 3.9)

Protective coatings described in this sub-section shall not be measured for payment but shall be included in the rates tendered for piping, fittings, couplings and specials.

a) All cast iron valves, cast iron or steel fittings and cast iron or steel specials shall receive a two component solvent borne epoxy pipe coating and lining such as Copon KSIR 88 from Plascon or similar approved equivalent.

Surface preparation, application, testing and performance shall comply with the requirements of SANS 1217 type 1A, except that the minimum total dry film thickness shall be 300 micron.

Materials shall be applied in accordance with SANS 1217 and in accordance with the manufacturer's data sheet. Attention is drawn to the need for strict observance

of the manufacturer's minimum and maximum coating thickness and time interval between coats relative to ambient and steel temperatures.

The coating shall be applied in either two or three coats with either one or two coats being applied in the workshop. After installation any scratch or chip marks shall be touched up and the whole item covered with a further coat (or two coats) of copon to give a total thickness of not less than 250 micron.

b) All bolts, nuts and washers used for flanges and couplings shall be heavy duty galvanised (clause 3.9.5 of 1200L)

c) All steel fittings and specials indicated for encasing in concrete shall be wire

d) brushed externally and left uncoated for encasing in concrete. Lining shall be as described in (a) above.

e) Steel fittings that are partly enclosed in concrete shall be coated internally as well as the exposed external part of the fitting up to 100 mm into the concrete encasement as described in (a) above.

PSL3 VALVES (Clause 3.10)

(a) Gate valves shall be cast iron flanged waterworks pattern resilient seal valves of the class shown on the drawings and manufactured in accordance with the requirements of SANS 664. Valves shall have non-rising spindles, cap-top and be clockwise closing. Valves shall be provided with a spur gear if specified on the detailed fittings lists and with a mechanism to indicate the percentage closure of the valve. An arrow on the valve shall indicate the direction of flow.

(b) Valves 150mm and smaller shall be provided with a plain thrust collar. All of the valves shall be provided with ball thrust collars.

PSL4 MANHOLES, DRAW BOXES AND SURFACE BOXES (Clause 3.11)

Valve boxes shall confirm to the details as indicated on drawing 05.D004.

PSL5 HANDLING AND RIGGING (Clause 4.1)

PSL5.1 Transportation

Fittings, specials and valves shall be protected during transportation and handling against damage caused by impact, dropping, etc.

PSL5.2 Off-loading and storage

Pipes, fittings and specials shall at no time be laid, stacked or rolled directly onto the ground but shall be supported on suitable padded cradles or other approved material near each end of the pipe, fitting or special. Particular care shall be taken where pipes with fitted couplings are handled or stacked to prevent any pressure on the couplings.

PSL5.3 Inspection on delivery

The Engineer's Representative will thoroughly inspect all pipes, fittings and specials delivered to the site but his acceptance of same as being in good condition shall not relieve the Contractor of any of his obligations or responsibilities under this contract.

Materials rejected by the Engineer shall be removed from the site within 30 days and shall be replaced by other approved materials by the Contractor at his own expense.

PSL6 STANDARD HYDRAULIC PIPE TEST (Clause 7.3)

PSL 6.1 Acceptance Test

All water pipelines shall be tested as specified in Clause 7.3 after the erf connections have been installed before a Certificate of Practical Completion will be issued for a phase as specified in Clause C3.5.1.3. Field test pressures shall be 13,5 Bar in the lowest laying point of the pipeline or pipe network being tested.

Compensation for the acceptance testing of water pipes shall be included in the rate for the supply and lay of the pipeline.

PSL 6.2 Re-testing of Pipe Networks

After all civil engineering services, including the water reticulation for a phase as specified in Clause C3.5.1.3. have been tested and accepted a Certificate of Practical Completion will be issued for the phase and it will then be handed to the Electrical Contractor for the installation of the electrical work. During the period which the Site is handed over to the Electrical Contractor the water network will be kept under normal working pressure. Any visible leaks occurring during this period shall be repaired by the Civil Contractor. The repair cost of the leaks caused by the Electrical Contractor will be paid to the Contractor on daywork basis.

After completion of the electrical work, the existing pipelines shall be tested in the isolating zones as indicated on the drawings. Before an isolating zone is tested it shall be put under pressure from the water reticulation for at least 7 days. The test section shall be isolated by means of the existing isolating valves and shall be tested in accordance with clause PSL7.2. If the test section does not pass the initial test, the Contractor shall leave the testing equipment in place and locate and repair all leaks until the test section passes the prescribed test.

The leaks shall be located by digging exploratory holes at positions on the pipeline agreed with the Engineer

When the isolation zone passes the test the Contractor shall invite the Engineer's Site Representative and an official of the Sol Plaatje Local Municipality to witness the test. No section will be accepted as tested before it is signed off by the Engineer's Site Representative and the official of the Sol Plaatje Local Municipality.

PSL7 MEASUREMENT AND PAYMENT (Clause 8)

PSL7.1 Protective coatings and linings described in this sub-section shall not be measured for payment separately but shall be included in the rates tendered for piping, fittings and specials.

PSL 7.2 Re-testing and repairing of existing water reticulation..

The re-testing of existing water reticulation shall be measured per phase specified in clause PSL6.2. Each phase will be measured once only after all isolating zones in the phase have passed the prescribed hydraulic test.

The rate shall include for the isolating of the test sections, including all temporary fittings, the filling of the pipes with water and keeping the pipes full of water by means of a water tanker truck and the testing of the section until all leaks are repaired. Please note that the testing of sub-Phase 3 and sub-Phase 4 will be done during the Defects Liability Period. The Contractor shall allow in his rates to return to Site to do the testing.

All excavations to locate and repair leaks caused by the Electrical Contractor will be measured under SANS 1200A Clause 8.8.4: Excavation in soft material to expose existing services. (Item 3 43)

Repair cost of the leaks caused by the Electrical Contractor will be measured on daywork basis. Labourers engaged in the repairing of leaks shall not be used for any earthworks measured separately as specified above.

PSLB BEDDING (PIPES)

PSLB1 BEDDING (Sub-Clause 3.3)

PSLB1.2 Rigid Pipes

All concrete pipes shall be laid on a class B bedding as shown on Drawing LB-1 of SABS 1200LB.

PSLB1.3 Flexible pipes

All steel, PVC and polyethylene pipes will be regarded as being flexible and shall be bedded as per Drawing LB-2 of SABS 1200 LB.

PSLB2 MATERIAL NOT AVAILABLE FROM TRENCH EXCAVATION (Clause 3.4.2)

Material for the selected granular material for sewer pipes as well as PVC-O pipes shall be imported from a commercial source designated by the Contractor. Imported selected granular material shall conform to Clause 3.1, with the exception that the compactibility factor shall not exceed 0,1.

Bedding for other water pipes and stormwater pipes will be available from trench excavations, other excavations on site or from the designated borrow pit for subgrade material.

PSLB3 CLASS A BEDDING (Sub-Clause 5.2.1)

Concrete to be used in class A bedding to pipes shall be of grade 25MPa/19mm.

PSLB4 CONCRETE CASING TO PIPES (Sub-Clause 5.4)

Concrete to be used in the casing of pipes shall be of grade 25MPa/19mm.

PSLB5 TOLERANCE ON COMPACTION OF BEDDING MATERIAL

Degree of accuracy II shall prevail.

PSLB6 VOLUME OF BEDDING MATERIAL (SUB-CLAUSE 8.1.3)

The cross sectional area of the pipe shall be deducted from the area of the bedding calculated in terms of Drawing LB-4.

PSLB7 STONE BEDDING (Sub-Clause 8.2.6)

Add the following new sub-clause:

Stone bedding will be measured per cubic metre under the appropriate item in SABS 1200LB.

PSLC CABLE DUCTS - SABS 1200 LC

PSLC1 MATERIALS (Subclause 3.1)

Cable ducts for electrical cables shall be 110 mm diameter single or multiple Kabelflex ducts.

PSLC2 INSTALLATION (Subclause 5.3)

Ducts shall be laid, bedded, proved and marked according to the details contained in the specification drawing LC-1 (SABS 1 200LC).

PSLC2.1 In addition to painted marking on kerbs, cable ducts shall be provided with UV stabilized plastic service markers on both ends as specified for sewer erf connection. Refer to drawings 06D002.

PSLD SEWERS

PSLD1 PIPE MATERIAL (Sub-Clause 3.1)

Sewers shall be constructed using heavy duty uPVC structured wall sewer pipes in accordance with SABS 1601.

PSLD2 MANHOLES (Sub-Clause 3.5.2)

Manholes shall be constructed of precast concrete sections in accordance with the details that are shown in Drawing.D001.

Drop manholes shall conform to the details shown on Drawing.D005.

PSLE STORMWATER DRAINAGE

PSLE1 SKEWED ENDS (Subclause 3.1)

Skew ends shall be obtained from the manufacturer.

PSLE2 SOILCRETE LINING AND BACKFILL (New clause)

Soilcrete lining and backfill shall consist of an approved soil or gravel, 9 % OPC in channel linings and 5 % OPC in culvert backfill, calculated as a percentage of the dry mass of the soil used, a sand filler if required by the Engineer and a suitable volume of water, determined to ensure the correct slump and consistency. The exact mix proportions shall be determined in association with the Engineer after suitable trials. Soilcrete shall be mixed in a mechanical mixer and all constituents properly batched. Cubes manufactured form the approved mix shall be crushed in an approved laboratory and a proof strength determined. This proof strength and the average deviation obtained on cubes manufactured form batches controlled by the Engineer will be used to establish the strength of soilcrete produced during construction of the Works.

The aggregate used for soilcrete shall be sandy material, but may contain particles of diameter up to 38 mm and shall have a PI of less than 10. Material containing detrimental amounts of silt or clay shall not be used for soilcrete. The aggregate shall be obtained from an approved source.

The soilcrete shall be placed and then thoroughly compacted by means of vibrators so that all voids are filled. Stones or other approved formwork shall be packed at culvert ends to prevent the soilcrete from flowing outside the required limits.

The height to which the backfill in soilcrete is done shall be determined by the Engineer or shown on the Drawings and any remaining backfilling shall be carried out with a granular material as specified.

Payment for soilcrete shall be made per m3. The volume will be calculated form the authorised plan dimensions of the excavations and the height of the backfilling in soilcrete. The volume occupied by the conduits or other structures will not be included in the quantities measured.

The rate shall cover the cost of constructing soilcrete backfilling or channel linings complete, including OPC.

Overhaul will not be paid on any cement, water, or aggregate used for soilcrete.

PSLF ERF CONNECTIONS

PSLF1 MATERIALS

PSLF1.1 The following types of material shall be used for erf connections:

- Plasson uPVC saddles
- HDPE type IV class 10 pipes and compression fittings.
- GMS medium duty piping to SABS 62 for water meter installations.

PSLF2 CONSTRUCTION

Erf connections shall be constructed to the specifications and dimensions as set out on drawing 1396.10ZA.05D001. Water meters together with the remaining fittings shall be installed by the housing Contractor.

PSLF3 MARKING

Erf connections shall be marked with UV stabilised indicator tags as specified on drawing 05D001

PSLF4 MEASUREMENT AND PAYMENT

PSLF4.1 Supply, install and test erf connections as shown on the drawings. This rate also includes all pipes, fittings, excavations, bedding and backfill. Unit No.

PSLF4.2 Extra over the standard erf connections for supplying, laying in silty sand obtained from excavations, coupling and testing additional lengths of Type IV class 10 HDPE piping to SABS 533 for long and cross-street erf connections including excavation and backfill. m

The price shall include for the excavating and backfill, supplying, laying, coupling and testing of additional HDPE Type IV class 10 piping to extend the erf connections across and along the street.

PSM ROADS (GENERAL)

PSM1 SOURCES OF MATERIAL (Sub-clause 3.5.1)

Materials for road pavement layers shall be obtained from excavations and the designated borrow pits on site or from commercial sources

No overhaul will be payable for road materials.

PSME SUBBASE

PSME1 REGIONAL FACTOR (Subclause 3.2.1)

A regional factor of 0,4 is applicable to the area of the Works.

PSME2 THICKNESS OF LAYERS (Sub-clauses 5.4.1 and 6.1.4)

The thickness of the layers shall be as indicated on the Drawings.

PSMJ SEGMENTED PAVING

PSMJ1 CLASS (Sub-clause 3.1.2)

Class 35 blocks are required for bus routes. Type A, S-A blocks as shown in Figure 17 of UTG2 shall be used.

PSMJ2 SAND FOR BEDDING AND JOINTING (Sub-clause 3.3)

Add the following to the first paragraph of the clause:

Sand for bedding shall conform to the relevant requirements of SANS 1083 for fine concrete aggregate, with the exception of the grading which shall conform to the specification below.

PSMJ3 LAYING OF UNITS (Sub-clause 5.4)

Units will be laid in the herringbone pattern.

PSMJ4 DEGREE OF ACCURACY

Paving shall be constructed to a degree of accuracy I.

PSMM ANCILLARY ROADWORKS - SABS 1200 MM

PSMM1 SCOPE OF THE WORKS: ROAD MARKINGS

Distributor streets shall receive full centre-line marking. Access collectors, access loops and cul-de-sac shall be marked at intersections only. Typical markings at these intersections are shown on the drawings. Access courts shall not be marked.

PSMM2 MECHANICAL EQUIPMENT FOR ROAD MARKINGS (Subclause 4.2.1)

The mechanical road-painting machine shall be provided with clearly visible amber warning flashing lights which shall always be in operation when the machine is on the road.

PSMM3 SCHEDULED ITEMS FOR PERMANENT ROAD SIGNS (Subclause 8.3)

Road signs will be measured per number which price shall include for signs manufactured from sheet steel, painting of background, symbols, characters, etc., retro-reflective materials where applicable, painted sign supports, all bolts, nuts and washers, excavation, backfilling and concreting, all as specified and detailed, complete.

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PORTION 2: CONTRACT

Section C3.4.3
Particular Specifications

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C3.4.3 PARTICULAR SPECIFICATIONS

The following additional specifications for work not covered by the SABS 1200 Standardised Specifications are required for the Contract and are bound in hereafter:

- PSF: Structural, Finishes and Wet Service Specifications
- PWA: Fencing
- Health and Safety Specifications

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PWA : FENCING

INDEX

PWA FENCING

PWA1 SCOPE

This specification includes all work in connection with the erection of fencing and taking down and re-erection of fencing as required. The standard of fencing, the positioning of the gates and the quantities shown in the Schedule of Quantities against each item under this section, may be subject to variation and the Contractor shall ascertain, from the Engineer, the exact location of, and specification to which the fencing shall be constructed, before placing any order for materials.

PWA2 MATERIALS

PWA2.1 Vermin, Stock Proof and Residential Fencing

Straining posts and stays, standards and droppers shall be either of timer or steel sections. All sections shall be to the dimensions and masses indicated on the Drawings. Timber sections shall be of creosote impregnated hardwood. Steel sections shall be either galvanised or painted to the specifications that are indicated on the Drawings.

All plain wire, barbed wire, wire netting, diamond mesh and blinding wire shall be according to the diameters and specifications indicated on the Drawings.

PWA2.2 Security Fencing

All posts, standards and droppers for security fencing shall be galvanised steel sections to the dimensions and details indicated on the Drawings. Plain and diamond wire and other fencing material shall all be according to the details indicated on the Drawings. All gates shall be to the details indicated on the Drawings and components shall either be galvanised or painted according to the specifications on the Drawings.

PWA2.3 Bolts

Bolts shall be galvanised steel bolts of the required length and diameter which shall not be less than 12mm. Eyebolts to gates of 18mm diameter. All the necessary bolts together with nuts and workers, shall be supplied with each post or gate.

PWA3 CORROSION PROTECTION

PWA3.1 General

All component of the security fence, excluding concertina barbed tape coils, shall be hot dip galvanised to the following requirements:

PWA3.2 Fencing Posts

Fabricate all posts from mild steel with due attention to Clause 6. After fabrication, fencing posts shall be hot dip galvanised to comply with SABS 763. The bottom of fencing posts to be buried in soil shall be cleaned in accordance with PSL 6.1.4 then coated with one coat water based vinyl chloride-vinylidene chloride copolymer primer, containing zinc phosphate, to a dry fill thickness of 16 hours drying, then apply two coats bituminous aluminium paint, complying with SABS 802, allowing a minimum of 16 hours between coats and a minimum of 3 days before burial.

The coating shall cover the whole of the base plate and upwards to a height of not less than 800mm above ground. The total dry film thickness of a primer and bituminous aluminium shall not be less than 80 micrometers.

PWA3.3 Straining wires, fencing wire, tie wires and barbed wire

Shall not be hot dip galvanised to comply with SABS 675 Class A, or SABS 935, as appropriate.

PWA4 CONSTRUCTION

PWA4.1 Clearing of Fence Site

All brush and other obstructions which may interfere with the proper construction of the fences shall be removed and surface irregularities shall be graded so that the fence will conform to the general contour of the ground.

No separate payment will be made for this clearing and full provision for these coats must be made in the tender.

PWA4.2 Connections

Existing cross fences shall be connected to the new fences. Straining posts with stays for every direction of strain shall be placed at the junction with existing fences and the wires of both fences properly fastened to the posts.

PWA4.3 Placing of Posts

All posts, struts and standards shall be firmly planted into the natural ground, be it soil, gravel or rock to the depths detailed. Gate posts and struts shall be erected at all gates and straining posts and struts shall be erected at all ends and corners or bends in the line of the fence and at all junctions with other fences. Intermediate straining posts and struts, and standards shall be spaced at the intervals indicated on the Drawings. All posts (excepting struts), standards and droppers shall be placed in a vertical position except in unusual locations where, in the opinion of the Engineer, it will be more satisfactory to place such member perpendicular to the slope of the ground. All posts, struts, standards and droppers shall be set in holes dug to the specified depth even in rock where blasting might be necessary to obtain the required depth. All gate posts shall be set in concrete and other members shall either be set in concrete or in well compacted backfill as indicated on the Drawings. No concreting or backfilling shall be done until all members have been properly aligned. All posts and struts for security fencing shall be set in concrete as shown on the Drawings. Steel members, not required to be set in concrete, may be driven into the ground provided such members are not buckled or otherwise damaged after being driven in, and provided further that correct alignment on the driven members is maintained.

PWA4.4 Attaching Wire

After all posts, struts and standards have been set firmly and after all concrete has hardened for at least four days the fence wire shall be attached accordingly to the details indicated on the Drawings. All wire shall be attached to the sides of the posts and standards furthest from the object being fenced. Wire shall be carefully stretched and strung in true alignment and without sag. Wire shall be attached to each post and standard by one of the following methods:

(a) By notching the member and securing the wire by means of binding wire or;

(b) By drilling holes through the member and strapping the wire with plain iron samples passing completely through the member or;

(c) Where iron members are used, by securing the wire by means of binding wire which must pass through the hole in the standard. Droppers shall be placed parallel to the standard at the intervals detailed on the drawings. Droppers shall be fixed to each fence wire with binding wire in such a manner as to prevent any slipping.

PWA4.5 Attaching Wire Netting or Diamond Mesh

Wire netting and diamond mesh covering shall be securely fixed to the fence according to the details on the drawings. In addition the wire netting on vermin proof fencing shall be fixed according to the Engineer's instruction by one of the following methods:

(a) By packing stones, placed end to end, on both sides of the fence so that no gap exist beneath the fence, or

(b) By folding back the bottom 150mm of wire netting so that it lies flat on the ground, and packing stones end to end on this flap, or

(c) By embedding the lower part of the wire netting at least 100mm into the ground and ramming the earth thoroughly to secure the netting.

PWA4.6 Installing Gates

Gates shall be installed in the position indicated by the Engineer. The gates shall be erected so as to swing in a horizontal plane at right angles to gate post clear of the ground in all positions.

PWA5 FINISHING: TRIMMING AND PAINTING

Where timber posts have been used, the tops of the posts shall be trimmed after the fencing has been erected, such that the top of the completed fence has a pleasing profile. The cuts shall be literally painted with creosote. All ungalvanised metal components of fencing shall be painted according to the specifications on the Drawings. After the fencing has been erected, any chipped or damaged paint work shall be touched up according to the same paint specifications.

PWA6 MEASUREMENT AND PAYMENT

PWA6.1 Vermin Proof, Stock Proof, Residential and Security Fencing

This fencing shall be measured in metres between the centres of gate and end posts along the general slope of the ground. Payment shall include full compensation for the clearing of the line, for the supply, painting and erection of all standards, intermediate straining posts and stays, droppers, plain wire, blinding wire, and all other components on the drawings but shall specifically exclude corner, end and gate posts and their stays. Payment shall also include for the concreting of posts where specified.

PWA6.2 Corners, Bends and Ends

Corners, ends and bends shall be measured by the number and shall include compensation for the supply, painting and erection of all posts and stays required at such ends, corners or bends shall also include for any concreting where so specified.

PWA6.3 Gates

Gates shall be measured by the number. A double gate as required for security fencing shall be measured as on number double gate. Payment shall include full compensation for the supply, painting and erection of the gate and ancillary components, as well as for the supply, painting and erection of gate posts and struts and for the concreting of such posts and struts (where required).

PWA6.4 Pay Items

1.	Vermin proof fencing	:	m
2.	Stock proof fencing	:	m
3.	Residential fencing	:	m
4.	Security fencing	:	m
5.	Corners, bends and ends (Shall distinguish between the different		

	types of fencing)	:	No
6.	Gates (shall distinguish between the different types and dimensions of gates)	:	No
7.	Taking down and re-erection of fencing (shall distinguish between the different types of fencing)	:	m
8.	Taking down an re-erection of corners, bends and ends	:	No
9.	Taking down and re-erection of Gates	:	No
10.	Maintenance of fence for the duration of contract. (Shall distinguish between the different types of fencing)	:	m
11.	Taking down fence at the end of the contract and hand materials to the Employer	:	m

END OF SECTION

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PORTION 2: CONTRACT

Section C3.5

Management

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LERATO PARK INTEGRATED HOUSING DEVELOPMENT

CONTRACT 2334-10-05/ID01

INTERNAL CIVIL ENGINEERING SERVICES: PHASE 5

C3.5 MANAGEMENT

C3.5.1 Management of the Works

C3.5.1.1 Applicable Specifications

The Standard Specifications for Civil Engineering Construction SANS 1200 published by the South African Bureau of Standards and referred to as the "Standard Specifications", including the variations and additions specified in Section C3.4.2, shall be applicable to this project.

C3.5.1.2 Concurrent Construction Contracts

The Contractor's attention is drawn to the fact that other contiguous works will be executed concurrently by independent Contractor's under separate contracts in the vicinity of the Site.

The other Works which will be in progress or will come into operation on or adjacent to the Site of the Works during the progress or tenancy of this Contract are likely to include, **but are not limited to the following**:

a) Construction of internal civil engineering services of adjacent phases in Lerato Park
b) Construction of internal electrical engineering services of adjacent phases in Lerato Park
c) Construction of Houses, community rental units and other buildings within Lerato Park
d) Upgrade of bulk water, sewer, roads and electrical infrastructure

The Contractor shall ensure that neither his operations nor those of his subcontractors nor the activities of his employees shall interfere with or hinder the operations of the Employer or of other Contractors and he shall indemnify the Employer against all claims arising through default of this requirement.

The Contractor shall hand over portions of the Site of the Works (whether completed or not), or completed portions of the Works, to these Contractors when required by the Employer or detailed elsewhere in this document. The Contractor shall cause no interference with or delays in the execution of these contiguous contracts.

No discount or commission for the Contractor is allowed on these contracts, and it will be assumed that he has fully allowed in the Contract Price for the presence of these Contractors on Site. Any service rendered or assistance given by the Contractor to these Contractors, save as are provided for in the Project Specifications, shall be for their accounts only since the Employer shall in no way be responsible to the Contractor for any payments in this respect.

The Contractor shall protect all known existing services as well as all work being carried out and structures being erected on the Site by other Contractors. Any damage caused to these services or structures, or any obstructions or hindrance caused to other contractors by the Contractor, and all claims arising there from, will be the sole responsibility of the Contractor.

All repair work shall be carried out at the Contractor's expense to the entire satisfaction of the Engineer.

The same obligations shall be imposed on the Employer and on other Contractors in respect of the Works being executed under this Contract.

C3.5.1.3 Contractor's Project Management Plan

The Contractor is required to prepare and submit a project management plan for the construction. The particular contents that should be included in the Contractor's Project Management Plan are listed below:

- Project structures and agreements

The Contractor shall indicate how responsibility for the various work packages will be divided between joint venture partners (where applicable) and sub-contractors. A contract organogram shall be provided showing work apportionment and project management responsibilities. The particular division of work shall match the established capabilities and capacities of each particular partner or subcontractor.

- Plant, materials and equipment

  The Contractor shall prepare a Plant and Materials procurement plan, indicating the source of key Plant and Materials designated for inclusion in the Works, and demonstrating that such Plant and Materials have a proven track record of successful maintenance support in South Africa.

  The Contractor shall also prepare a plan of Contractor's Equipment, indicating the source and details of construction equipment planned for use on the Contract and based on the Contractor's particular approach.

- Staffing plan

  The Contractor shall prepare a detailed staffing plan showing in an organogram all key members of the Contractor's Personnel, providing a detailed CV for each such key position. The Contractor shall also show the numbers and source of all non key staff and indicating the particular local content offering of the Contractor.

- Method statements

  The Contractor shall clearly describe the overall methodology proposed for construction of the Works and include particular method statements for each work discipline included in the Works.

C3.5.1.4 Construction Programme

The Contractor shall submit within the period stated in the Contract Data a suitable and realistic construction programme for the consideration of the Engineer.

The programme shall be divided into four phases

The specified time for completion for each phase, all phases measured from the commencement date, shall be as follows:

Phase 5.1	:	95 days
Phase 5.2	:	150 days
Phase 5.3	:	220 days
Phase 5.4	:	300 days
Completion of all Works	:	300 days

Please note that the penalty for delay specified in the Contract Data will be applicable to each phase.

The programme shall be in the form of a Gantt chart and shall include the following details:

- A work breakdown structure, identifying the major activity groups.
- For each activity group further details shall be provided with regard to the scheduled start and end dates of individual activities.
- The linkages between activities shall be clearly indicated and the logical network upon which the programme is based shall be separately submitted to the engineer if requested. Any constraints shall be classified as being time-related or resource-related.
- The critical path(s) shall be clearly indicated and floats on non-critical activities shall be shown.
- The Contractor shall indicate the working hours per day, night, week and month allowed for in the programme.
- Where relevant the Contractor shall state the production rates for key activities, e.g. earthworks, etc.

Together with the programme as detailed above the contractor shall submit to the engineer a cash flow projection, indicating projected monthly invoice amounts. The cash flow projection shall be updated at monthly intervals to reflect actual payments to date and anticipated further payments.

The programme will be reviewed at the monthly site meetings at which the Contractor shall provide sufficient detail that will allow the comparison of completed work per

activity that has fallen behind. The updated programme shall be submitted to the Engineer at least two days prior to the monthly meetings.

If the programme has to be revised by reason of the Contractor falling behind his programme, he shall produce a revised programme showing how he intends to regain lost time in order to ensure completion of the Works within the time for completion or any granted extension of time. Any proposal to increase the tempo of work must be accompanied by positive steps to increase production by providing more labour and plant on site, or by using the available labour and plant in a more efficient manner.

Failure on the part of the Contractor to submit the programme or to work according to the programme or revised programmes shall be sufficient reason for the Engineer to take steps as provided in the General Conditions of Contract.

The approval by the Engineer of any programme shall have no contractual significance other than that the Engineer will be satisfied that the work is carried out according to such programme and that the Contractor undertakes to carry out the work in accordance with the programme. It shall not limit the right of the Engineer to instruct the Contractor to vary the programme if required by circumstances.

C3.5.1.5 Quality Assurance

The Contractor shall institute a quality assurance system and provide experienced personnel as well as all the necessary transport, instruments and equipment, to ensure adequate supervision and positive control of the works at all times in order to comply with the requirements. The Contractor shall deliver to the Engineer, for his consideration, quality assurance programmes prior to the Contractor's appointment of any suppliers or commencement of the Works. Failure to comply with these requirements shall be just cause for the Engineer to order supervision of the Works without additional remuneration or for him to recommend termination to the Employer in terms of the Conditions of Contract.

The Contractor shall do at least the quality control tests at the frequencies specified in the Scope of Works. If the scale of the works, construction methods or any other circumstances dictates, the Contractor shall do more tests when required for quality assurance purposes.

The Contractor shall keep systematic records of the test results and all worksheets relating thereto. All test results obtained by the Contractor in the course of his process

control of the Works shall be submitted to the Engineer or his Representative prior to requesting inspection of the relevant portions of the Works. Any request for inspection shall be submitted on the prescribed forms.

The employer is at liberty to carry out such tests as he deems necessary to determine compliance with the contract requirements and will make available the results of all tests to the contractor.

Acceptance control, record keeping and payment certificates shall be done in accordance with the Engineer's standard system except if the Engineer approves that the Contractor's standard system may be used. An index to the Engineer's standard site administration forms is appended as Annexure A to section C3.5.1.

C3.5.1.6 Site Administration

- Daily Site Diary

  The daily site diary in accordance with the pro forma appended in Annexure A to section C3.5.1 shall be kept up to date by the Contractor's Site Agent and will be signed on a daily basis by the Engineer's Representative.

- Information in Respect of Plant

  Information relating to plant on Site shall be recorded in the daily site diary. In addition, the Contractor shall deliver to the Engineer, on a monthly basis, a detailed summary of construction plant kept on the Site, full particulars given for each day of the month. Distinction shall be made between plant in working order and plant out-of-order. Such inventory shall be submitted by the first day of the month following the month to be reported.

- Information in Respect of Employees

  Information relating to labour and management on Site shall be recorded in the daily site diary. In addition, the Contractor shall deliver to the Engineer, on a monthly basis, a detailed summary of supervisory staff, labour employed (own and local labour) by category, and sub-contractors (both local and imported) for each day of the month. Such return shall be submitted by the first day of the month following the month to be reported.

- Rainfall Records

  Rainfall records for the period of construction shall be taken on Site and recorded in the daily site diary. The Contractor shall provide and install all the necessary equipment for accurately measuring the rainfall. The Contractor shall also provide, erect and maintain a security fence plus gate, padlock and keys at each measuring station, all at his own cost. The Engineer or his Representative shall take and record the daily rainfall readings. The Contractor shall be permitted to attend these readings, in the company of the Engineer's Representative. Access to the measuring gauge(s) shall at all times be under the Engineer's control.

C3.5.1.7 Site Instructions

Site instructions by the Engineer, addressed to the Contractor at his office on the Site, will be numbered consecutively and will be deemed to have been received by the Contractor's Representative unless a break in the sequence of numbers is brought to the notice of the Engineer in writing immediately.

C3.5.1.8 Site Meetings

The Contractor and his authorised representative shall attend all meetings held on the Site with the Employer and the professional team at dates and times to be determined by the Engineer. Such meetings will be held to evaluate the progress of the Contract, and to discuss matters pertaining to the Contract which any of the parties represented may wish to raise. It is not the intention to discuss day-to-day technical matters at such meetings.

C3.5.1.9 Payment Certificates

Monthly Progress Payment Certificates shall be submitted to the Engineer's Representative on Site not later than the 20th of each month (or on the last working day prior to this date) in order to allow for checking and reconciliation of all quantities, rates, extensions and additions in the certificate. Each progress payment certificate shall include work executed or reasonably expected to be executed up to the 30th day of the specific month. The Engineer's Representative shall have a period of five (5) calendar days to review the draft certificate in collaboration with the Contractor. All quantity calculations and certificates submitted by the Contractor for checking shall be in accordance with the Engineer's standard site administration forms and formats as referred to in C3.5.1.5.

Upon agreement by the Engineer's Representative by not later than the 25th of each month, the certificate shall be submitted by the Contractor in a neat typed form in accordance with the prescribed format, and with the correct spelling, to the Engineer by not later than the 28th of each month (or on the first working day thereafter), together with four additional copies, for certification.

Where dayworks have been instructed by the Engineer, the Contractor shall submit the returns to the Engineer for signature and approval within twenty-four (24) hours of the

end of the working day on which the work was executed. Daywork returns shall be submitted on forms according to the Engineer's standard format as referred to in Section C3.5.1.5. Failure to comply with the terms of this clause ill result in non-payment for such dayworks.

The tax invoice submitted with the certificate shall be dated the 1st of the month following the period certified. All costs for the preparation and submission of progress certificates shall be borne by the Contractor.

C3.5.1.10 Drawings, Operation and Maintenance Manuals

All information in the possession of the Contractor that is required by the Engineer's Representative in order to complete the As-Built drawings and to prepare a completion report for the Employer must be submitted to the Engineer's Representative before a Certificate of Practical Completion will be issued for the Works. Similarly, the Contractor will be required to submit full details of all pipes, valves, meters and specials in a suitable loose bound format, including any special operational and maintenance procedures related thereto, for incorporation in the overall operation and maintenance manual for the Scheme prior to the issue of a Certificate of Completion for the Works.

Only figured dimensions on the Drawings may be used in the interpretation thereof, and the Drawings shall not be scaled unless the Contractor is so instructed by the Engineer in writing. The Contractor shall notify the Engineer in writing of any lack of information or conflict in the information on the Drawings. The Engineer will upon written request provide any dimensions that may have been omitted from the Drawings.

C3.5.1.11 Environmental Management Plan

The Contractor shall comply with all the conditions of the Record of Decision and the Environmental Management Plan included in Section C4 – Site Information.

Northern Cape Department of Co-operative Governance, Human Settlement and Traditional Affairs

LERATO PARK INTEGRATED HOUSING DEVELOPMENT

CONTRACT 2334-10-05/ID01

INTERNAL CIVIL ENGINEERING SERVICES: PHASE 5

Annexure A
LIST OF SITE ADMINISTRATION FORMS

The following site administration forms are available in the Engineer's office for inspection:

(a) Site Diary,

(b) Site Instruction book,

(c) Rainfall Report,

(d) Re-instatement of fences form,

(e) Payment Certificate,

(f) Daywork return form,

(g) Inspection Request Sheet,

(h) Blasting Checklist,

(i) Concrete

- Excavation to Structures
- Request for checking prior to pouring of Concrete
- Pre-Concrete Inspection Checklist
- Post Concrete Inspection Report for Civil Works
- Concrete Cube Test Report

(j) Roads

- Requisition for checking Earthworks up to Base Course
- Evaluation of Road Levels
- Requisition for checking Road Signs & Traffic Marking

(k) Stormwater drainage

- Requisition for checking earthworks: Stormwater
- Requisition for checking pipelines, culverts, kerb inlets, junction boxes
- Requisition for checking kerbs and channels

(l) Sewers

- Requisition for checking earthworks: Sewers
- Requisition for checking the laying of sewer pipes
- Requisition for air testing sewers
- Inspection Request – Pipework - Sewer

(m) Water reticulation

- Requisition for checking earthworks
- Requisition for checking pipelines, valve chambers, fire hydrants, pipeline markers, yard connections
- Requisition for hydraulic testing of water pipes
- Inspection Request – Pipework - Water

(n) Snag List

END OF SECTION

Northern Cape Department of Co-operative Governance, Human Settlement and Traditional Affairs

LERATO PARK INTEGRATED HOUSING DEVELOPMENT

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INTERNAL CIVIL ENGINEERING SERVICES: PHASE 5

PORTION 2: CONTRACT

Part C4
Site Information

Northern Cape Department of Co-operative Governance, Human Settlement and Traditional Affairs

LERATO PARK INTEGRATED HOUSING DEVELOPMENT

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SITE INFORMATION

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LERATO PARK INTEGRATED HOUSING DEVELOPMENT

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INTERNAL CIVIL ENGINEERING SERVICES: PHASE 5

SITE INFORMATION

C4.1 Site Information

C4.1.1 Geological and Geotechnical Aspects

According to published information the site is underlain by shale of the Prince Albert Formation, Ecca Group, Karoo Supergroup. The shale has been extensively intruded by post Karoo dolerite, especially along the southern portions of the study area.

Messer's Southern Geotechnical Engineering in their findings of the geotechnical investigations conducted of the proposed development site, (**Refer Annexure A**), found that the site can be divided into two broad geological zones namely:

- Areas underlain by shallow, very soft rock shale and minor mudstone and,
- Areas underlain by shallow, soft rock or harder dolerite rock.

The majority of the study area is covered by a thin, surface layer of potentially expansive, transported soils. Within areas underlain by very soft rock shale or mudstone at depth, the transported soils are underlain by calcareous, residual shale or mudstone. Calcareous residual shale/mudstone soils are in turn typically underlain by highly weathered, very highly fractured, soft rock or harder shale.

Northern Cape Department of Co-operative Governance, Human Settlement and Traditional Affairs

LERATO PARK INTEGRATED HOUSING DEVELOPMENT

CONTRACT 2334-10-05/ID01

INTERNAL CIVIL ENGINEERING SERVICES: PHASE 5

SITE INFORMATION

C4.1 Site Information

C4.1.1 Geological and Geotechnical Aspects

ANNEXURE A

LERATO PARK PHASE 1
Geotechnical investigation report

Southern Geotechnical Engineering

Report Number 358/02

July 2009

TITLE	**LERATO PARK PHASE 1 SITUATED WITHIN THE SOL PLAATJE LOCAL MUNICIPALITY** Geotechnical Investigation Report
CLIENT	**BIGEN AFRICA SERVICES (PTY) LTD** P.O. Box 29 The Innovation Hub Persequor 0087
PREPARED BY :	**SOUTHERN GEOTECHNICAL ENGINEERING** P.O. Box 1687 BROOKLYN SQUARE 0075
DATE	27 July 2009
REFERENCE NUMBER	358/02
PROJECT TEAM	
Fieldwork and reporting:	**Pieter Oosthuizen**_____ *Pr.Eng.* *Geotechnical Engineer*
STATUS	*Draft for comment*

EXECUTIVE SUMMARY

1. *Southern Geotechnical Engineering was appointed by Bigen Africa Services (Pty) Ltd, to undertake a geotechnical investigation, for township establishment purposes, of the proposed Lerato Park Phase 1 area which is situated within the Sol Plaatjes Local Municipality area in the Northern Cape Province.*
2. *The Phase 1 area constitutes a surface area of 108.1 hectares and is mostly undeveloped. The southern, approximately one-third of the study area is covered by an informal settlement.*
3. *The field investigation comprised the excavation of 52 test pits with a TLB-type excavator. All the test pits were entered and profiled by a geotechnical engineer according to current methods and procedures (Brink and Bruin, 1990).*
4. *According to published information the site is underlain by shale of the Prince Albert Formation, Ecca Group, Karoo Supergroup. The shale has been extensively intruded by post Karoo dolerite, especially along the southern portions of the study area.*
5. *The Phase 1 area can be divided into two broad geological zones namely:*
   - *Areas underlain by shallow, very soft rock shale and minor mudstone and,*
   - *Areas underlain by shallow, soft rock or harder dolerite rock.*
6. *The majority of the study area is covered by a thin, surface layer of potentially expansive, transported soils. Within areas underlain by very soft rock shale or mudstone at depth, the transported soils are underlain by calcareous, residual shale or mudstone. Calcareous residual shale/mudstone soils are in turn typically underlain by highly weathered, very highly fractured, soft rock or harder shale.*
7. *A good proportion of the study area is underlain by shallow, soft rock or harder dolerite formations.*
8. *No standing groundwater levels or evidence of earlier groundwater levels were encountered within any of the test pit excavations.*
9. *Very shallow excavations conditions can generally be expected in the east and south-eastern sector of the site. Shallow excavation conditions can generally be expected within isolated, small zones throughout the site. Deeper excavation conditions can generally be expected within the northern, approximately one-third of the site as well as the south-western sector of the site.*
10. *All of the soils tested were rated as LOW in potential expansiveness with associated low plasticity index and liquid limit values. Maximum heave values of around 4mm and 14mm were calculated for the transported and calcareous residual soil layers, respectively.*

11. *Very soft rock mudstone recorded poor strength and compaction characteristics. Very soft rock shale recorded 'average' strength and compaction characteristics and where generally rated as G6 quality. Weathered dolerite recorded 'good' strength and compaction characteristics and were rated as G5 to G6 quality.*
12. *None of the soils tested were rated as corrosive.*
13. *The entire area was divided into two residential site classes namely:*
    - *Site class R implying stable foundation conditions with negligibly movements for areas mostly underlain by either very soft rock shale or soft rock dolerite and,*
    - *Site class H1 implying expansive soils with expected soil movements around 7.5mm to 15mm for areas mostly underlain by calcareous residual soils and minor areas of shallow mudstone.*
14. *'Modified normal' construction procedures are recommended for the Site Class H1 areas, typically consisting of lightly reinforced strip footings, articulation joints at all internal/external doors and openings, light reinforcement in masonry and adequate site drainage and service/plumbing precautions.*
15. *Normal' construction procedures are recommended for Site Class R areas, typically consisting of unreinforced strip or slab-on-the-ground type foundations and aadequate site drainage and service/plumbing precautions.*
16. *The following allowable bearing capacities are recommended :*
    - *Upper surface layer of transported soils:* *NOT to be used as a founding layer.*
    - *Calcareous residual shale/mudstone:* *100kPa*
    - *Very soft rock shale:* *200kPa*
    - *Soft rock or harder dolerite:* *650kPa*
17. *It will be required to remove the upper, surface layer of transported soils over the entire footprint areas to be covered by surface beds and fills. Suitable fill material must be placed in thin layers (typically 150mm thick), and each layer compacted to at least 93% Mod. AASHTO at OMC.*
18. *The following generic steps are recommended in the construction of the access roads.*
    - *Remove all vegetation and the upper, surface layer of transported soils over the entire road footprint area.*
    - *If rock is exposed, clean the surface and place road layerworks directly onto rockhead. The shale/mudstone rockhead must be covered as soon as possible after exposing to the atmosphere*

as this material is prone to 'slaking'. If the base of the undercut excavation is situated within soil, rip the exposed, in-situ subgrade to a minimum depth of 150mm and re-compact to a density of at least 90% Mod AASHTO at a moisture content close to optimum.

- *Subsequent layerworks must be placed on a moist (and not dry), compacted soil surface.*
- *As surfacing it may be considered to use either an asphalt application, concrete slab on stabilised subbase or interlocking paving blocks.*

19. *The following guidelines pertain to possible sources of construction materials that will be encountered on site:*
    - *Very soft rock mudstone and its weathering products should NOT be used as a construction material.*
    - *Very soft rock or harder shale formations is deemed potentially suitable for use within lower and upper selected, subgrade layers as well as general fill material.*
    - *Soft rock or harder dolerite formations are expected to have varied application as a construction material, both within road layerworks as well as fills. The primary problem foreseen with the use of this source is the excavatibility of the material.*

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1. TERMS OF RERERENCE

Southern Geotechnical Engineering c.c. (SGE) was requested by Bigen Africa Services (Pty) Ltd, to submit a cost estimate for a geotechnical investigation of both the proposed Phases 1 and 2 areas of the Lerato Park Integrated Housing Development. The proposed Development is situated within the Sol Plaatjes Local Municipality area, Kimberley, Northern Cape Province. A cost estimate was prepared and submitted to Bigen Africa. Confirmation to proceed with the geotechnical investigation was received from Bigen Africa via a letter of appointment with reference number 7801-21-12, dated 25 May 2009.

The Phase 1 geotechnical investigation, which is the subject of this report, was undertaken for township establishment purposes and in particular aimed at supplying information on the soil conditions in terms of:

- Published and site-specific geology,
- Groundwater conditions,
- General excavation conditions applicable to foundations and buried services,
- Depth to rock (if encountered) and anticipated excavation conditions,
- The potential use of in situ materials available on site as construction materials,
- Assigning residential site classes with proposed foundation systems for each class,
- Any other constraining geological/geotechnical aspects that may influence the proposed development.

The Phase 1 area constitutes a sub-portion of a larger area, the remainder of which is covered under the Lerato Park Phase 2 geotechnical investigation with report number 358/03.

2. SOURCES OF INFORMATION

The following sources of information were consulted during this investigation:

- 1:250 000 scale geological map, 2824 Kimberley,

- Geotechnical investigation report prepared by SGE (Ref. No. 358/01, dated 6 July 2009) *"Lerato Park, Kimberley, Fast Track Road construction – Geotechnical Investigation".*
- Geotechnical investigation report prepared by Simlab (Ref. No. SL/1575 dated Jan. 2006) *"Sol Plaatjes Municipality – Proposed Housing Development on the Remainder or Portion 59 of the Farm Roodepan No. 70 Kimberley - Geotechnical Investigation".*
- Google Earth images obtained from *www*.earth.google.com.

3. SITE DESCRIPTION

3.1. General site locality

A general site locality map for both the Phases 1 and 2 areas are given in Figure 1 below. The Phases 1 and 2 areas are situated approximately 8 kilometres north-west of the Kimberley CBD in the Northern Cape Province.

As indicated in Figure 2 below, the Phase 1 area constitutes a surface area of 108.1 hectares. The site is bordered by:

- North: Eagle Street of the Roodepan Township,
- South: Barkley road and commercial development,
- East: Diggings and mining operation consisting of large excavations and stockpiles,
- West: Open, undeveloped fields (Phase 2 area).

The southern, approximately one-half of the Phase 1 area constitutes an informal settlement characterised by a random to semi-structured arrangement of informal housing units and access roads. The remainder of the study area (the northern, approximately one-half), is flat, undeveloped and constitutes an open to medium dense distribution of thorny shrubs and grass fields. The general area is very flat with only minor gradients.

Apart from minor dolerite outcrops and surface boulders (see section on excavation conditions to follow) no other salient geological features were observed within the Phase 1 area.

Figure 1: General site locality map for the Phases 1 and 2 areas of Lerato Park

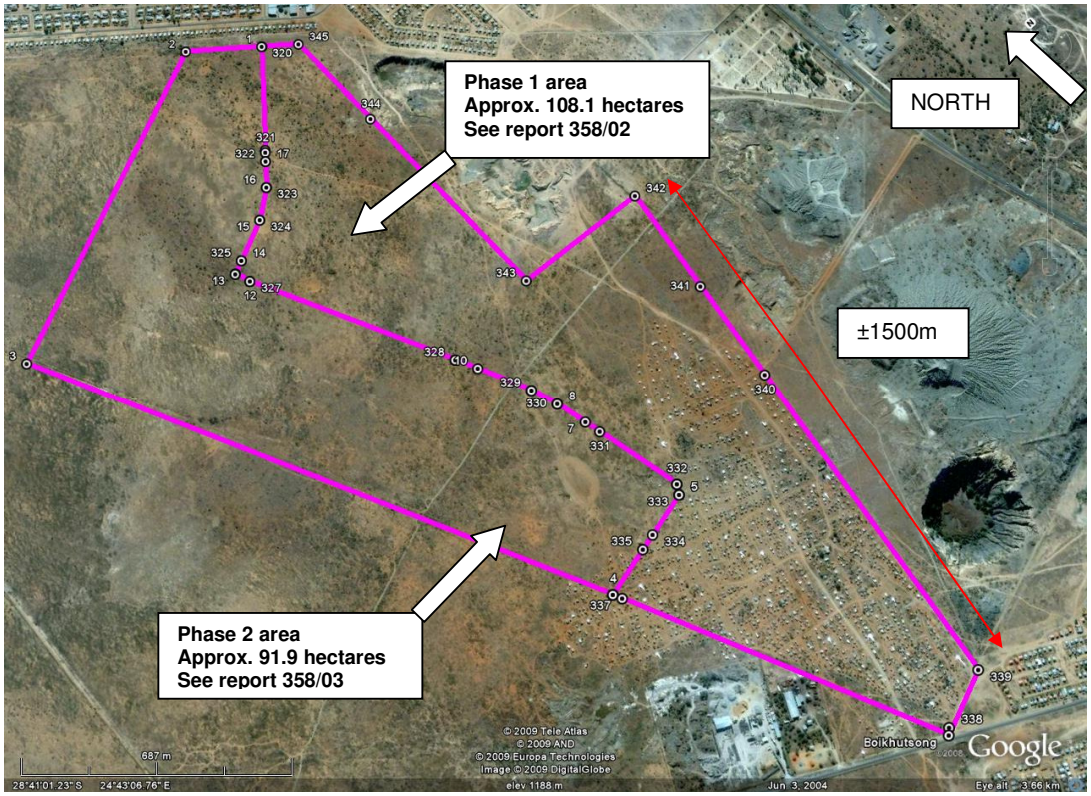

Figure 2: Phases 1 and 2 areas of the proposed Lerato Park Development

4. METHOD OF INVESTIGATION

The field investigation for the Phase 1 area was undertaken on 9 and 10 June 2009. A total of 52 test pits were excavated with a Terex 820 TLB-type excavator. Test pits were numbered 1-1 to 1-52 to distinguish them from test pits excavated within the Phase 2 area (which were numbered 2-1 onwards). Test pits were excavated to the maximum depth reach of the TLB (around 2.6 to 2.8m deep), or until reaching refusal conditions. All the test pits were entered and profiled by a geotechnical engineer according to current methods and procedures (Brink and Bruin, 1990). The detailed soil profiles are included in Appendix A. Test pit positions were determined with a hand-held GPS unit to an accuracy of better than 5m. The approximate test pit positions are indicated in Appendix C**.**

Representative samples were tested in a commercial soils laboratory for the following:

- Soil moisture content (total of 30 samples),
- Sieve and hydrometer analysis (total of 30 samples),
- Atterberg Limits (total of 30 samples),
- Maximum dry density / optimum moisture content (total of 13 samples),
- California Bearing Ratio (CBR) test (total of 13 samples),
- pH value (total of 17 samples),
- Electrical conductivity (total of 17 samples).

The results of the laboratory testing are included in Appendix B**.**

5. RESULTS OF THE INVESTIGATION

5.1. Published regional geology

According to the 1:250 000 scale geological map **2824 KIMBERLEY,** the site is underlain by shale of the Prince Albert Formation, Ecca Group, Karoo Supergroup. The shale has been

extensively intruded by post Karoo dolerite, especially along the southern portions of the study area.

The Ecca Group, which follows concordantly on the Dwyka, consist almost exclusively of deep-water, fine-grained clastic sediments and the lithological monotony of the sequence is only interrupted by the characteristic black, carbonaceous shale of the Whitehill Formation which is underlain and overlain respectively by dark-grey mudstone and shale of the Prince Albert and Tierberg Formations (Explanation: Sheet 2824, Kimberley).

The Prince Albert Formation has a maximum thickness of approximately 90m in the general area of Kimberley. The Formation is characterised by weathered outcrops of shale, mostly covered by wind-blown sands. Kleynhans (1979) is of the opinion that the so-called '*shale*' is in fact '*mudstone*'. At the contact zones with intrusive dolerite formations, the Prince Albert shale is typically altered to a dense, black hornfels or dark blue to black, baked shale. Dolerite occurs widely spread as dykes, sills and funnel-shaped bodies in the area (Explanation: Sheet 2824, Kimberley).

Economically the area is of considerable importance due to the diamonds mined in kimberlite pipes and fissures occurring around Kimberley. In some areas limestones are quarried for the manufacture of cement. Salt is extracted from groundwater in the vicinity of pans. Considerable reserves of gypsum are present in the area (Taken from Explanation: Sheet 2824, Kimberley).

5.2. Site specific geology

The Phase 1 area can be divided into two broad geological zones namely:

- Areas underlain by shallow shale and/or mudstone and,
- Areas underlain by shallow dolerite rock.

5.2.1. Areas underlain by shale and/or mudstone

The following typical soil layers were predominantly encountered within the area underlain by shallow shale/mudstone formations.

5.2.1.1. Transported surface layer (cohesive soils)

The area is covered by a thin (avg. 0.4m; max. 0.7m; min. 0.1m), surface layer of transported soils that were typically described as:

Slightly moist, light to dark brown, FIRM TO STIFF, slightly cracked to cracked, sandy CLAY to clayey SAND.

This particular layer was visually assessed as potentially expansive. The assessment of the potentially expansive nature of this layer was further strengthened by the observation of a cracked soil surface in certain areas. This particular layer was not visually assessed as open-structured and hence potentially collapsible.

5.2.1.2. Calcareous residual shale/mudstone

The thin layer of transported soils as described above is mostly underlain (not encountered at all test pits), by a layer that was termed (for the sake of consistency), as a '*calcareous residual shale/mudstone'*. The average thickness of this particular layer is around 1.2m (min. 0.5m; max. 2.5m). This particular layer was typically described as:

Dry to slightly moist, light orange brown blotched white and dark grey, MEDIUM DENSE TO DENSE, intact, silty to clayey SAND containing minor 'pockets' of white, fine, calcareous gravel and dark grey, highly to completely weathered, angular shale fragments.

This particular layer was not visually assessed as highly expansive and/or collapsible.

5.2.1.3. Weathered shale

The *calcareous residual shale/mudstone* layer is typically underlain by highly weathered, very highly fractured, soft rock or harder shale/mudstone. This material was typically described as:

Light to dark grey stained orange along bedding planes, highly weathered, very fine to fine-grained, horizontally bedded, very highly fractured, very soft rock shale/mudstone.

Weathered shale rock with a hardness approaching 'very soft rock' (UCS between 700kPa and 3.0MPa), were encountered at an average depth around 0.7m to 1.0m below the existing ground level. The depth to rock however varies considerably from a shallow as 0.1m to as deep as 1.8m.

5.2.2. Areas underlain by shallow dolerite rock

The following typical soil layers were predominantly encountered within the area underlain by shallow dolerite rock formations.

5.2.2.1. Transported surface layer (non cohesive)

The area is covered by a very thin (200mm to 300mm thick) surface layer of non-cohesive, transported soils that were typically described as:

Dry to slightly moist, light to dark brown, LOOSE TO MEDIUM DENSE, slightly open-structured, silty to clayey SAND.

This layer was visually assessed as slightly open-structured and hence potentially collapsible. The layer is however always thin and mostly overlies very shallow, dolerite rock. The potentially collapsible nature of this particular layer is thus not thought of any major consequence.

5.2.2.2. Soft rock or harder dolerite

The thin, transported layer described above is underlain by dolerite rock that was typically described as:

Dark grey streaked white, highly to moderately weathered, medium to coarse-grained, massive, moderately fractured, soft rock or harder dolerite rock sometimes interlaced with minor, hard calcrete.

5.2.3. Summary of geological conditions encountered within test pits.

A summary of the geological conditions encountered at every test pit is given in Table 1 below. The information in this Table is used to delineate the site into various geological and geotechnical zones that are eventually related to residential site classes and ultimately recommended foundation layouts for the housing units.

Table 1: Summary of geological conditions across the Phase 1 area

0.9 Indicates depth of refusal or near-refusal (defined by very slow rate of excavation).

TP. No.	DEPTH RANGE ENCOUNTERED (m below existing GL)				
	Transported Soils (cohesive)	Transported Soils (non-cohesive)	Calcareous residual shale / mudstone	Very soft rock shale	Soft rock or harder dolerite
1-1	0 – 0.3			0.3 – ***0.9***	
1-2	0 – 0.4		0.4 – 2.7		
1-3	0 – 0.5		0.5 – 1.4	1.4 – 2.8	
1-4	0 – 0.5		0.5 – 1.4	1.4 – 2.8	
1-5	0 – 0.6			0.6 – ***1.2***	
1-6	0 – 0.4			0.4 – ***1.6***	
1-7	0 – 0.6			0.6 – ***2.4***	
1-8	0 – 0.7		0.7 – 1.8	1.8 – 2.8	
1-9	0 – 0.5			0.5 – ***1.5***	
1-10	0 – 0.4		0.4 – 0.9	0.9 – ***2.2***	
1-11	0 – 0.4		0.4 – 1.1	1.1 – 2.8	
1-12	0 – 0.7		0.7 – 1.8	1.8 – 2.7	
1-13[1]	0 – 0.4			0.4 – ***2.5***[1]	
1-14[1]	0 – 0.25			0.25 – ***1.8***[1]	
1-15	0 – 0.4			0.4 – ***1.5***	
1-16	0 – 0.6		0.6 – 1.3	1.3 – 2.7	
1-17	0 – 0.3			0.3 – ***1.7***	
1-18	0 – 0.2		0.2 – 0.5	0.5 – ***1.4***	
1-19	0 – 0.2			0.2 – ***0.6***	
1-20	0 – 0.2				0.2 – ***0.4***
1-21	0 – 0.3			0.3 – ***1.2***	
1-22	0 – 0.1		0.1 – 1.2	1.2 – 2.7	
1-23	0 – 0.1		0.1 – 1.2	1.2 – 2.7	
1-24	0 – 0.3				0.3 – ***0.7***
1-25	0 – 0.3				***0.3 +***
1-26		0 – 0.5			0.5 – ***1.1***

TP. No.	DEPTH RANGE ENCOUNTERED (m below existing GL)				
	Transported Soils (cohesive)	Transported Soils (non-cohesive)	Calcareous residual shale / mudstone	Very soft rock shale	Soft rock or harder dolerite
1-27		0 – 0.3			0.3 – ***0.5***
1-28	0 – 0.3			0.3 – ***0.9***	
1-29	0 – 0.2		0.2 – 2.7		
1-30		0 – 0.4			0.4 – ***0.8***
1-31		0 – 0.4			0.4 – ***1.0***
1-32		0 – 0.3			0.3 – ***0.4***
1-33		0 – 0.4			0.4 – ***1.0***
1-34	0 – 0.4		0.4 – 2.7		
1-35	0 – 0.5		0.5 – 2.7		
1-36	0 – 0.3				0.3 – ***0.8***
1-37	0 – 0.3				0.3 – ***0.5***
1-38	0 – 0.3			0.3 – ***1.1***	
1-39	0 – 0.4			0.4 – ***2.0***	
1-40	0 – 0.3				0.3 – ***0.6***
1-41	0 – 0.6			0.6 – 2.6	
1-42	0 – 0.1			0.1 – ***1.2***	
1-43		0 – 0.3			0.3 – ***0.8***
1-44	0 – 0.4				0.4 - ***1.3***
1-45	0 – 0.3			0.3 – ***0.4***	
1-46	0 – 0.4			0.4 – 2.6	
1-47					0 – ***0.2***
1-48	0 – 0.4			0.4 – 2.6	
1-49	0 – 0.9		0.9 – 1.5	1.5 – 2.6	
1-50	0 – 0.4	0.4 – 1.5		1.5 – 2.6	
1-51	0 – 0.4		0.4 -1.4	1.4 -2.7	
1-52	0 – 0.5		0.5 – 1.1	1.1 – 2.7	

0.9 Indicates depth of refusal or near-refusal (very slow rate of excavation).

Note 1 See test pits 1-13 and 1-14. The material uncovered at depth is probably rather mudstone than shale.

5.3. Ground and surface water conditions

No standing groundwater levels or evidence of earlier groundwater levels were encountered within any of the test pit excavations. It is thus not expected that large volumes of groundwater will be encountered during excavations on this site. The formation of seasonal; (perched), groundwater levels, especially forming after heavy rainfall events, cannot be excluded completely (although thought to be unlikely).

Accumulation or ponding of precipitation on top of the cohesive, relatively impermeable, surface layer will probably be more of a consideration during the detailed design stage. Possible accumulation and ponding is exacerbated by the very flat gradients within the study area. It is thus recommended that all roads, parking areas and surface beds be elevated slightly above the surrounding ground levels to prevent ponding against these structures. As good construction practice it is also recommended that all structures be protected against rising damp.

During the fieldwork light rain was experienced which resulted in a very slippery surface in places, especially within the informal settlement area where all or most of the natural vegetation have been removed.

5.4. Excavation conditions

Table 2 below summaries the ***average*** excavation conditions that were encountered at every test pit excavation. The information contained in Table 2 was plotted graphically to get an overview of the expected, average excavation conditions (see Appendix C). From this figure it can be seen that:

- ***Very shallow*** excavations conditions (possible refusal within the upper 1.0m of the soil profile), can generally be expected in the east and south-eastern sector of the site.
- ***Shallow*** excavation conditions (refusal possible between 1.0m and 2.0m deep), can generally be expected within isolated, small zones throughout the site.

- ***Deeper*** excavation conditions (refusal reached in excess of 2.0m below existing ground level), can generally be expected within the northern, approximately one-third of the site as well as the south-western sector of the site.

Table 2: Summary of excavation conditions encountered at each test pit

'***Very shallow***' excavation conditions[1]	'***Shallow***' excavation conditions[2]	'***Deeper***' excavation conditions[3]
1-1; 1-19; 1-20; 1-24; 1-25 1-27; 1-28; 1-30; 1-31; 1-32; 1-33; 1-36; 1-37 1-40; 1-43; 1-45; 1-47	1-5; 1-6; 1-9; 1-14; 1-15 1-17; 1-18; 1-21; 1-26; 1-38; 1-39; 1-42; 1-44	1-2; 1-3; 1-4; 1-7; 1-8; 1-10; 1-11; 1-12; 1-13 1-16; 1-22; 1-23; 1-29 1-34; 1-35; 1-41; 1-46 1-48; 1-49; 1-50; 1-51; 1-52

Notes:

1. ***Very shallow*** excavation conditions.
   'Refusal' expected within upper 1.0m below current ground level.

2. ***Shallow*** excavation conditions.
   'Refusal' expected between 1.0m and 2.0m below current ground level.

3. ***Deeper*** excavation conditions.
   'Refusal' expected in excess of 2.0m below current ground level.

In addition to the expected excavation conditions as set out above, the Figure contained in Appendix C also indicates where dolerite boulders and/or rock outcrop were noted during the field investigation. In these areas difficult excavation conditions, possibly even requiring blasting, must be expected.

Two important provisos are relevant to the information given in this section namely:

- It must be considered that the excavation of test pits with a TLB is essentially a 'restricted' type of excavation and
- The highly fractured and horizontally bedded nature of shale and mudrock formations will greatly assist with the excavation effort (even if ripping is required), into these formations.

It can thus generally be expected that open, bulk excavations in areas underlain by shale/mudrock formations will be able to penetrate substantially deeper than the depths indicated in this report. In some areas it may however be required to assist in the excavation effort with more powerful excavation equipment, ripping and/or hydraulic hammering.

In areas underlain by shallow dolerite formations, 'boulder' and 'hard' excavation conditions are expected, probably requiring, in addition to conventional excavation equipment, also ripping, hydraulic hammering and probably even blasting.

5.5. Laboratory test results

5.5.1. Expansive soil conditions

Table 3 below summarises the relevant engineering properties relating to the potential expansiveness of the various soils tested.

Table 3: Expansiveness parameters within the Phase 1 area

TP NO.	DEPTH (m)	MATERIAL TYPE	PI[1]	LL[2]	% PASSING 0.425mm SIEVE	% PASSING 0.002mm SIEVE	HEAVE CLASSIFICATION (After vd Merwe)
1-1	0.3 – 0.9	Very soft rock shale/mudstone	13	34	26	1	Low
1-2	1.0	Calcareous residual shale/ mudstone	18	45	72	5	Low
1-3	0.4	Transported soils	15	35	78	5	Low

TP NO.	DEPTH (m)	MATERIAL TYPE	PI[1]	LL[2]	% PASSING 0.425mm SIEVE	% PASSING 0.002mm SIEVE	HEAVE CLASSIFICATION (After vd Merwe)
1-5	0.5	Transported soils	20	38	85	8	Low
1-6	0.5 – 1.6	Very soft rock shale/mudstone	11	33	33	2	Low
1-7	0.5	Transported soils	14	28	94	6	Low
1-8	0.6	Transported soils	18	38	96	7	Low
1-8	1.2	Calcareous residual shale/ mudstone	18	38	87	5	Low
1-11	0.5	Calcareous residual shale/ mudstone	20	42	77	7	Low
1-11	1.1 – 2.8	Very soft rock shale/mudstone	16	37	39	2	Low
1-12	0.6	Transported soils	22	46	79	6	Low
1-13	1.0 – 1.8	Very soft rock shale/mudstone	16	37	21	1	Low
1-14	1.0 – 1.8	Very soft rock shale/mudstone	25	51	36	3	Low
1-16	0.7	Calcareous residual shale/ mudstone	19	42	81	7	Low
1-19	0.2 – 0.6	Very soft rock shale/mudstone	18	40	29	1	Low
1-22	0.6	Calcareous residual shale/ mudstone	19	48	74	6	Low
1-26	0.5 – 1.1	Weathered dolerite	10	26	23	1	Low
1-29	0.6	Calcareous residual shale/ mudstone	20	38	77	7	Low
1-33	0.4 – 1.0	Weathered dolerite	10	29	24	1	Low
1-34	1.0	Calcareous residual shale/ mudstone	26	47	63	5	Low

TP NO.	DEPTH (m)	MATERIAL TYPE	PI[1]	LL[2]	% PASSING 0.425mm SIEVE	% PASSING 0.002mm SIEVE	HEAVE CLASSIFICATION (After vd Merwe)
1-35	0.5 – 2.7	Calcareous residual shale/ mudstone	16	40	24	1	Low
1-38	0.4 – 1.1	Very soft rock shale/mudstone	14	35	35	2	Low
1-41	0.5	Transported soils	4	19	92	5	Low
1-42	0 – 1.2	Very soft rock shale/mudstone	13	38	29	1	Low
1-44	0.4 – 1.3	Weathered dolerite	10	27	35	2	Low
1-48	1.0 – 2.5	Very soft rock shale/mudstone	13	35	29	1	Low
1-49	1.0	Calcareous residual shale/ mudstone	23	46	78	4	Low
1-50	0.8	Transported soils	22	39	96	8	Low
1-51	1.0	Calcareous residual shale/ mudstone	28	51	96	9	Low
1-52	0.4	Transported soils	23	48	91	8	Low

1 PI = Plasticity index value; 2 LL = Liquid limit value

From the information contained in the Table above it can be seen all the soil samples tested were rated as **LOW** in heave potential. Plasticity index and liquid limit values are generally low and range from 4 to 28 and 19 to 51, respectively.

5.5.1.1. Illustrative heave values based on the Van der Merwe (1964) method

The following 'typical' soil profile is derived from the average layer thicknesses reported in the test pit profiles and are used in the heave calculations:

- 0 – 0.4m Transported soils,
- 0.4 – 1.6m Calcareous residual shale/mudstone (average layer thickness 1.2m),
- 1.6m and deeper Very soft rock shale and/or mudstone.

Table 4: Average parameters used in heave calculations (Van der Merwe 1964).

MATERIAL	Average layer thickness	Average Plasticity index	Average % passing 0.425mm sieve	Average % passing 0.002mm sieve
Transported soils	400mm	19	89	7
Calcareous residual soils	1200mm	22	78	6

Based on the values explained above as well as the Van der Merwe (1964) method, maximum 'theoretical' heave values of 4mm (upper, transported soils) and 8mm (underlying calcareous residual soils), can be calculated for a total, maximum theoretical heave of 12mm.

5.5.1.2. Illustrative heave values based on the Weston (1979) method

Calculated heave values using the Weston method are based on the same typical soil profile as stated in section 5.5.1.1. above. In addition the following average values were used:

Table 5: Average parameters used in heave calculations (Weston 1979).

MATERIAL	Average layer thickness	Average initial moisture content	Average weighted liquid limit	Percentage vertical swell under 60kPa[1] pressure
Transported soils	400mm	12%	39	1%
Calcareous residual soils	1200mm	13%	44	1.2%

1 60kPa used as 'average' soil pressure exerted by single storey residential structure.

From the Table above the transported and calcareous residual soils are predicted to have vertical swell values of 1% and 1.2% respectively. Based on the average layer thickness and percentage heave, total heave of around 4mm plus 14mm = 18mm, is predicted.

5.5.1.3. Illustrative heave values for areas underlain by dolerite

Assuming that foundations will be placed on soft rock or harder dolerite (which will generally be encountered near-surface), negligible foundation movements are expected.

5.5.2. Collapsible and compressible soils

Minor areas of potential collapsible soils were identified during the field investigation. Thin layers of slightly open-structured, transported soils generally mantle soft rock or harder dolerite formations that occur near-surface (dolerite rock will be used as the founding medium).

Potentially collapsible soils are thus not seen as a major geotechnical constraint for the development of this site due to the fact that the extent of these soils is limited and the degree of collapse is not expected to be excessive. It is similarly not expected that any highly compressible soils will be encountered on site.

5.6. Compaction and strength properties

Table 5 below summarises the results of the laboratory testing programme that was undertaken that consisted of California Bearing Ration (CBR), Maximum Dry Density (MDD) / Optimum Moisture Content (OMC) and Foundation Indicator testing.

Table 6: Strength and compaction characteristics of near-surface soils in Phase 1 area

TP NO	SAMPLE DEPTH (m)	MATERIAL TYPE	LL	GM	PI	CBR VALUES AT % MOD AASHTO			COLTO
						93%	95%	98%	
1-1	0.3 – 0.9	Very soft rock Shale	34	2.15	13	27	31	39	**G6**
1-6	0.5 – 1.6	Very soft rock Shale	33	1.92	11	53	67	70	**G6**
1-11	1.1 – 2.8	Very soft rock mudstone	37	1.77	16	3	3	4	**< G9**
1-13	1.0 – 1.8	Very soft rock mudstone	37	2.15	16	5	6	8	**< G9**
1-14	1.0 – 1.8	Very soft rock shale/mudstone	51	1.97	25	22	27	36	**< G9**
1-19	0.2 – 0.6	Very soft rock shale/mudstone	40	2.08	18	35	35	37	**< G9**
1-26	0.5 – 1.1	Weathered Dolerite	26	2.23	10	61	89	92	**G5**
1-33	0.4 – 1.0	Weathered Dolerite	29	1.97	10	29	40	57	**G6**
1-35	0.5 – 2.7	Calcareous residual shale grading into very soft rock	40	2.25	16	30	31	33	**G7**
1-38	0.4 – 1.1	Very soft rock Shale	35	1.97	14	52	56	62	**G6**
1-42	0 – 1.2	Very soft rock Shale	38	2.02	13	28	36	46	**G6**
1-44	0.4 – 1.3	Weathered Dolerite	27	2.25	10	56	62	70	**G5**
1-48	1.0 – 2.5	Very soft rock Shale	35	2.1	13	29	31	35	**G6**

LL = Liquid limit; GM = Grading Modulus; P.I = Plasticity Index; COLTO = Standard Specifications for Road and Bridge Works for State Road Authorities; Committee of Land Transport Officials.

The information contained in Table 5 above suggests the following:

5.6.1. **Very soft rock mudstone** (typically dark grey in colour)

Very low CBR values in conjunction with relatively high PI and LL values resulted in poor strength and compaction characteristics. The material was generally rated as less than G9 quality (according to the COLTO specification). From the laboratory test results it appears as if the material breaks down completely under high compactive efforts. Very soft rock mudstone materials are thus not recommended as a suitable construction material.

5.6.2. Very soft rock shale (typically light grey in colour)

'Average' strength and compaction characteristics in all cases resulted in a material with a G6 classification. The results thus suggest that very soft rock shale can potentially be utilised as G6 quality material but careful selection of materials will be required on site (so as not to use mudrock which has much poorer strength and compaction characteristics). The suitability of candidate materials out of this geological group must be confirmed during the construction stage with appropriate laboratory testing.

5.6.3. Weathered dolerite

Samples of weathered dolerite that were tested recorded 'good' strength and compaction characteristics and were rated as G5 to G6 quality. This material can thus be recommended as a potential construction material. The biggest potential problem foreseen with the use of this source is the excavatibility of the material, partly due to soft rock or harder formations that will be encountered near surface and/or the presence of abundant hard rock dolerite boulders.

5.7. Soil corrosivity

Table 6 below summarises the pH and conductivity values that were measured to assess the potential corrosivity of the in situ soils.

Table 7: Soil corrosivity of in-situ soils within the Phase 1 area

TP NO.	DEPTH (m)	MATERIAL	pH	ELECTRICAL CONDUCTIVITY (µS/m)	RATED CORROSIVITY OF SOIL[1]
1-2	1.0	Calcareous residual shale/ mudstone	7.2	4.9	Not corrosive
1-3	0.4	Transported soils	7.64	5.8	Not corrosive
1-5	0.5	Transported soils	7.95	5.4	Not corrosive
1-7	0.5	Transported soils	7.72	3.6	Not corrosive
1-8	0.6	Transported soils	7.73	5.7	Not corrosive
1-8	1.2	Calcareous residual shale/ mudstone	8.17	3.5	Not corrosive
1-11	0.5	Calcareous residual shale/ mudstone	8.22	4.5	Not corrosive
1-12	0.6	Transported soils	8.31	5.0	Not corrosive
1-16	0.7	Calcareous residual shale/ mudstone	8.43	8.4	Not corrosive
1-22	0.6	Calcareous residual shale/ mudstone	7.82	7.1	Not corrosive
1-29	0.6	Calcareous residual shale/ mudstone	8.4	3.2	Not corrosive
1-34	1.0	Calcareous residual shale/ mudstone	8.46	20.8	**Mildly corrosive**
1-41	0.5	Transported soils	8.84	1.2	Not corrosive
1-49	1.0	Calcareous residual shale/ mudstone	8.14	21.5	**Mildly corrosive**
1-50	0.8	Transported soils	8.41	9.1	Not corrosive
1-51	1.0	Calcareous residual shale/ mudstone	8.5	28.9	**Corrosive**
1-52	0.4	Transported soils	8.84	1.2	Not corrosive

1 Low cost housing, CSIR Division of building technology 1987.

The majority of samples are rated as non-corrosive with low electrical conductivity values. The measured pH values indicate soils that are slightly alkaline. One sample extracted at test pit 1-51 recorded a high electrical conductivity value and was hence rated as corrosive. It must however be considered that this sample was extracted from within an area that is currently inhabited. It is thus thought highly probable that this one measured value is rather a function of land use that an inherent character of the in-situ soils.

It is concluded that none of the in-situ soils that will be encountered on site are considered highly corrosive such as to necessitate extensive remedial measures. The present land use in certain regions of the study area may however result in localised areas where this aspect may be problematic.

6. RESIDENTIAL SITE CLASSES

The residential site classes are derived from the publication: "Code of Practice – Foundations and Superstructures for single storey residential buildings of masonry construction" The Joint Structural Division of SAICE and IstructE, 1995.

The different founding horizons, their expected foundation behaviour and expected range of soil movements (corresponding to a particular site class), are summarised in Table 7 below.

Table 8: Expected foundation behaviour and corresponding site classes

Soil/rock type	Principal character of founding material	Expected range of soil movement	Site class
Transported soils[1]	Expansive	Less than 7.5mm	**H**
Calcareous residual shale/mudstone	Expansive	7.5mm to 15.0mm	**H1**
Very soft rock mudstone	Potentially expansive	Less than 7.5mm	**H**

Soil/rock type	Principal character of founding material	Expected range of soil movement	Site class
Very soft rock shale[2]	Stable	Negligible	**R**
Soft rock or harder dolerite	Stable	Negligible	**R**

1 Although classified in the Table above, it is recommended that this particular layer be removed from below all foundations and surface beds. As this is generally a relatively thin, surface layer, this stipulation is not considered onerous.

2 Assuming that the exposed shale or mudstone is not left for long periods to degrade excessively prior to the casting of foundations.

Table 8 below summarises the anticipated site class for each of the test pit excavations based on 'shallow' foundations. The information given assumes that the foundation level will be established around 0.5m to 0.6m below the current ground level. It is recommended that the surface layer of transported soils mantling the site be removed from below all foundations and surface beds.

Deeper foundation levels (in excess of 0.5m to 0.6m deep as qualified above), may encroach onto materials with a different foundation characteristic.

Table 9: Residential site classes according to test pit excavations

Site class	Applicable test pit numbers
R	1-1; 1-5; 1-6; 1-7; 1-9; 1-13; 1-14; 1-15; 1-17; 1-18; 1-19; 1-20; 1-21; 1-24; 1-25; 1-26; 1-27; 1-28; 1-30; 1-31; 1-32; 1-33; 1-36; 1-37; 1-38; 1-39; 1-40; 1-41; 1-42; 1-43; 1-44; 1-45; 1-46; 1-47; 1-48
H1	1-2; 1-3; 1-4; 1-8; 1-10; 1-11; 1-12; 1-16; 1-22; 1-23; 1-29; 1-34; 1-35; 1-49; 1-50; 1-51; 1-52

The information contained in Table 8 is graphically illustrated in the site classes drawing contained in Appendix C.

7. RECOMMENDATIONS

7.1. Foundations for one to two storey structures

The recommended founding arrangements for one to two storey structures are based on the guidelines given in SAICE and IstructE (1995) for the various site classes that were identified.

7.1.1. Site class H1

Preparatory work:

- Remove the upper surface layer of transported soils from below all foundations and covering surface beds.
- Avoid dissimilar foundation conditions, i.e. ensure foundations are underlain by similar materials.
- Undertake appropriate compaction along the bases of the foundation excavations.
- Do not allow the exposed foundation soils to dry out prior to casting of foundation concrete. If required, artificially wet to moisture content as close as possible to optimum.

Recommended foundation system:

- 'Modified normal' construction consisting of:
    - Lightly reinforced strip footings,
    - Articulation joints at all internal/external doors and openings,
    - Light reinforcement in masonry,
    - Adequate site drainage and service/plumbing precautions.

7.1.2. Site class R

Preparatory work:

- Remove the upper surface layer of transported soils from below all foundations and covering surface beds.
- Excavate foundations onto at least very soft rock shale or dolerite.

- Avoid dissimilar foundation conditions, i.e. ensure foundations are underlain by similar materials.
- Thoroughly clean foundation excavations prior to the casting of concrete.
- Cast foundation concrete as soon as possible after completion of excavations.

Recommended foundation system:

- 'Normal' construction consisting of:
    - Unreinforced strip, or slab-on-the-ground type foundations,
    - Adequate site drainage and service/plumbing precautions.

7.2. Allowable bearing capacities

All structures must be designed so as not to exceed the following, allowable bearing capacities:

(Applicable to 600mm wide strip footings at least 500mm deep).

- Upper surface layer of transported soils: **NOT** to be used as a founding layer.
- Calcareous residual shale/mudstone: 100kPa
- Very soft rock shale[1]: 200kPa
- Soft rock or harder dolerite[2]: 650kPa

1 One third of 'average' UCS for very soft rock (0.7 to 3.0MPa), with factor of safety of 3.0.

2 One third of 'average' UCS for soft rock (3.0 to 10.0MPa), with factor of safety of 3.0.

7.3. Construction of surface beds and fills

7.3.1. Site class 'H1' area

It will be required to remove the upper, surface layer of transported soils over the entire footprint areas to be covered by surface beds and fills. The in-situ soils at this reduced level must be ripped to at least 150mm deep and re-compacted, at a moisture content close to optimum (OMC) and a minimum density of 90% Mod. AASHTO. The compacted base must NOT be allowed to dry out prior to the placement of fill and if required, must be artificially wetted. Fill must be placed in thin layers (typically 150mm thick), and each layer compacted to at least 93% Mod. AASHTO at OMC.

7.3.2. Site class 'R' area

It will be required to remove the upper, surface layer of transported soils over the entire footprint areas to be covered by surface beds and fills. The base must be established on at least very soft rock shale or dolerite. If required the top of the rockhead must be manually cleaned prior to the placement of fill. To prevent excessive degradation of the rockhead, especially in the case of shale, fill must be placed as soon as possible. Fill must be placed in thin layers (typically 150mm thick), and each layer compacted to at least 93% Mod. AASHTO at OMC.

7.4. Pavement layerworks

The following generic steps are recommended in the construction of the access roads.

- Remove all vegetation over the entire footprint area of the road to stockpile for later use.
- Remove the upper, surface layer of transported soils over the entire road footprint area.
- If the base of the resultant undercut excavation is situated within at least very soft rock or harder material, thoroughly clean the surface of the rockhead and place road layerworks directly onto rockhead. Avoid any traffic driving directly on the rockhead level as thus may break-down the very soft rock structure into a fine, powdery material, especially in the case of shale and/or mudstone. The shale/mudstone rockhead must be covered as soon as possible after exposing to the atmosphere as this material is prone to 'slaking'.
- If the base of the undercut excavation is situated within soil, rip the exposed, in-situ subgrade to a minimum depth of 150mm and re-compact to a density of at least 90% Mod AASHTO at a moisture content close to optimum.
- Subsequent layerworks must be placed on a moist (and not dry), compacted soil surface. If required the exposed surface must be artificially wetted to a moisture content near optimum.
- The following tentative foundation layering system can be considered but the final layout will be dependent on the type, speed and frequency of traffic that will use the access roads:
  - Place and compact a minimum 150mm thick layer of G9 material to form the ***lower selected subgrade*** layer. A minimum compaction specification of 93% Mod AASHTO density is recommended.

- Place and compact a minimum 150mm thick layer of G7 material to form the ***upper selected subgrade*** layer. A minimum compaction specification of 95% Mod AASHTO density is recommended.
- Place and compact the remainder of the road layerworks (subbase, base and surfacing), based on an analysis of the type and frequency of traffic that will use the road.

- The following surfacing options are recommended:
  - An asphalt application or concrete slab on a stabilised subbase layer.
  - A layer of sand on top of a stabilised subbase layer followed by the placement of interlocking paving blocks, contained between kerbs or other non-movable structures.

7.5. Sources of construction materials

Construction materials for use within roads and parking area layerworks, fill below surface beds and general fills can be chosen based on the information given in Section 5.6 above (strength and compaction characteristics). The following summarised recommendations are given:

- Very soft rock mudstone and its weathering products should NOT be used as a construction material.
- Very soft rock or harder shale formations are generally expected to comply with G6 quality and is deemed potentially suitable for use within lower and upper selected, subgrade layers as well as general fill material. Careful selection of material will be required to ensure that shale is in fact sourced and not mudstone, which is closely associated with shale. It may be considered to stabilise or treat shale material with a suitable stabilising agent in order to produce a stabilised subbase (C4) material. This operation must be assessed during the construction phase with appropriate laboratory testing.
- Soft rock or harder dolerite formations are expected to generally comply with G5/G6 quality and hence can have varied applications as a construction material, both within road layerworks as well as fills. The primary problem foreseen with the use of this source is the excavatibility of the material, partly due to soft rock or harder formations that will be encountered near surface and/or the presence of abundant hard rock dolerite boulders.

8. REERENCES

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APPENDIX A
SOIL PROFILES

TEST PIT NO. 1 - 1

Logged by: *PH Oosthuizen*

Project: *Lerato Park Phase 1 area*

Date logged: *9 June 2009*

Client: *Bigen Africa*

Coordinates: *25 Y0027455 X3173070*

Southern Geotechnical Engineering
P.O. Box 1687
Brooklyn Square
0075
Tel: 012 430 2081

Depth (m)	LEGEND	DESCRIPTION	SAMPLING	GROUND WATER LEVEL
0.0		Current NGL		
0.1		**TRANSPORTED SOILS** Dry, red brown, cracked, FIRM, sandy CLAY to clayey SAND		Not encountered
0.3		**VERY SOFT ROCK SHALE** Light grey, highly weathered, fine-grained, horizontally bedded, very highly fractured, very soft rock	Bulk	
0.9				
1.0				
3.1				

Excavation method: *Test pit with Terex 820 TLB*

Groundwater conditions: *Not encountered*

Base of test pit: *0.9m - refusal reached*

General remarks 1: *Refuse on very soft to soft rock*

General remarks 2: *shale/mudstone*

General remarks 3:

TEST PIT NO. 1 - 10

Logged by: *PH Oosthuizen*

Project: *Lerato Park Phase 1 area*

Date logged: *9 June 2009*

Client: *Bigen Africa*

Coordinates: *25 Y0027714 X3173704*

Southern Geotechnical Engineering
P.O. Box 1687
Brooklyn Square
0075
Tel: 012 430 2081

Depth (m)	LEGEND	DESCRIPTION	SAMPLING	GROUND WATER LEVEL
0.0		Current NGL		
0.1 – 0.4		**TRANSPORTED SOILS** Slightly moist, dark reddish brown, slightly cracked, DENSE/STIFF, clayey SAND to sandy CLAY		Not encountered
0.4 – 0.9		**CALCAREOUS RESIDUAL SHALE/MUDSTONE** Dry, light orange brown blotched white and dark grey, MEDIUM DENSE TO DENSE, intact, silty to clayey SAND containing 'lenses' of white, fine, calcareous gravel and dark grey, highly to completely weathered, angular shale fragments.		
0.9 – 2.2		**VERY SOFT ROCK SHALE** Light grey, highly weathered, fine-grained, very highly fractured, very soft rock grading into soft rock towards base of test pit		
2.2 – 3.1				

Excavation method: *Test pit with Terex 820 TLB*

General remarks 1: *Slow rate of excavation / near refusal*

Groundwater conditions: *Not encountered*

General remarks 2:

Base of test pit: *2.2m - near refusal*

General remarks 3:

TEST PIT NO. 1 - 11

Logged by: *PH Oosthuizen*

Project: *Lerato Park Phase 1 area*

Date logged: *9 June 2009*

Client: *Bigen Africa*

Coordinates: *25 Y0027643 X3173825*

Southern Geotechnical Engineering
P.O. Box 1687
Brooklyn Square
0075
Tel: 012 430 2081

Depth (m)	LEGEND	DESCRIPTION	SAMPLING	GROUND WATER LEVEL
0.0		Current NGL		
0.1 – 0.4		**TRANSPORTED SOILS** Slightly moist, dark brown, cracked, STIFF, sandy CLAY to clayey SAND		Not encountered
0.5 – 1.1		**CALCAREOUS RESIDUAL SHALE/MUDSTONE** Dry, light orange brown blotched white and dark grey, DENSE, intact, silty to clayey SAND containing 'lenses' of white, fine, calcareous gravel and dark grey, highly to completely weathered, angular shale fragments.	Disturbed	
1.1 – 2.8		**VERY SOFT ROCK SHALE/MUDSTONE** Dark grey, completely to highly weathered, fine-grained, very highly fractured, very soft rock	Bulk	
2.8 – 3.1				

Excavation method: *Test pit with Terex 820 TLB*

General remarks 1: *Not yet refusal*

Groundwater conditions: *Not encountered*

General remarks 2:

Base of test pit: *2.8m - maximum reach*

General remarks 3:

TEST PIT NO. 1 - 12

Logged by: *PH Oosthuizen*

Project: *Lerato Park Phase 1 area*

Date logged: *9 June 2009*

Client: *Bigen Africa*

Coordinates: *25 Y0027487 X3173734*

Southern Geotechnical Engineering
P.O. Box 1687
Brooklyn Square
0075
Tel: 012 430 2081

Depth (m)	LEGEND	DESCRIPTION	SAMPLING	GROUND WATER LEVEL
0.0		Current NGL		
0.1 – 0.7		**TRANSPORTED SOILS** Slightly moist, dark brown, cracked, STIFF, sandy CLAY to clayey SAND	Disturbed (0.4–0.5) Disturbed (0.6–0.7)	Not encountered
0.7 – 1.8		**CALCAREOUS RESIDUAL SHALE/MUDSTONE** Dry, light orange brown slightly blotched white, DENSE TO VERY DENSE, intact, silty to clayey SAND containing 'lenses' of white, fine, calcareous gravel and dark grey, highly to completely weathered, angular shale fragments.		
1.8 – 2.7		**VERY SOFT ROCK SHALE/MUDSTONE** Dark grey, highly weathered, very fine-grained, very highly fractured, very soft rock		
2.7 – 3.1				

Excavation method: *Test pit with Terex 820 TLB*

Groundwater conditions: *Not encountered*

Base of test pit: *2.7m - maximum reach*

General remarks 1: *Not yet refusal*

General remarks 2: *Cracked surface observed*

General remarks 3:

TEST PIT NO. 1 - 13

Logged by: *PH Oosthuizen*

Project: *Lerato Park Phase 1 area*

Date logged: *9 June 2009*

Client: *Bigen Africa*

Coordinates: *25 Y0027421 X3173829*

Southern Geotechnical Engineering
P.O. Box 1687
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0075
Tel: 012 430 2081

Depth (m)	LEGEND	DESCRIPTION	SAMPLING	GROUND WATER LEVEL
0.0		Current NGL		
0.1 – 0.4		**TRANSPORTED SOILS** Dry, light brown, slightly cracked, LOOSE to MEDIUM DENSE, clayey SAND to sandy CLAY		Not encountered
0.4 – 2.5		**VERY SOFT ROCK SHALE** Light grey to dark grey with depth, highly weathered, very fine-grained, very highly fractured, very soft rock with minor 'lenses' of white, soft calcareous gravel. Excavates as angular small 'plates'.	Bulk	
2.6 – 3.1				

Excavation method: *Test pit with Terex 820 TLB*

General remarks 1: *Slow rate of excavation*

Groundwater conditions: *Not encountered*

General remarks 2:

Base of test pit: *2.5m - near refusal*

General remarks 3:

TEST PIT NO. 1 - 14

Logged by: *PH Oosthuizen*

Project: *Lerato Park Phase 1 area*

Date logged: *10 June 2009*

Client: *Bigen Africa*

Coordinates: *25 Y0027567 X3173901*

Southern Geotechnical Engineering
P.O. Box 1687
Brooklyn Square
0075
Tel: 012 430 2081

Depth (m)	LEGEND	DESCRIPTION	SAMPLING	GROUND WATER LEVEL
0.0		Current NGL		
0.1		**TRANSPORTED SOILS** Dry, light brown, cracked, FIRM, clayey SAND to sandy CLAY		Not encountered
0.2				
0.3		**VERY SOFT ROCK SHALE** Light grey, very highly weathered, very fine-grained, very highly fractured, very soft rock. Excavates as angular 'chips'.		
0.4				
0.5				
0.6				
0.7				
0.8				
0.9				
1.0				
1.1			Bulk	
1.2				
1.3				
1.4				
1.5				
1.6				
1.7				
1.8				
1.9				
2.0				
2.1				
2.2				
2.3				
2.4				
2.5				
2.6				
2.7				
2.8				
2.9				
3.0				
3.1				

Excavation method: *Test pit with Terex 820 TLB*

General remarks 1: *Slow rate of excavation*

Groundwater conditions: *Not encountered*

General remarks 2:

Base of test pit: *1.8m - near refusal*

General remarks 3: