ADDENDUM TO PW 371

DEPARTMENT OF PUBLIC WORKS

APPROPRIATE DEVELOPMENT OF INFRASTRUCTURE ON DOLOMITE:

GUIDELINES FOR CONSULTANTS

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DEPARTMENT OF PUBLIC WORKS

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APPROPRIATE DEVELOPMENT OF INFRASTRUCTURE ON DOLOMITE: GUIDELINES FOR CONSULTANTS.

1. INTRODUCTION

This document serves as a guideline on appropriate development and risk management of infrastructure located on dolomite in South Africa. These guidelines are aimed at informing principal agents and other consultants of the minimum requirements of the Department of Public Works concerning the upgrading, extension and development of new infrastructure on dolomite, thereby promoting safe, sustainable development.

The objective of applying a **risk management strategy** to infrastructure is to ensure the safety of personnel and visitors, protection of property and to avoid fruitless expenditure. Avoiding sinkholes is not only important from a safety point of view, rehabilitating sinkholes and repairing buildings/infrastructure is costly.

In a climate of increasing awareness of individual rights, it is apparent that failure to pro-actively manage dolomite risk may constitute dereliction of duty and may expose the Department of Public Works, its officials, its principal agents and other consultants involved, to recourse through a number of avenues, including the Occupational Health and Safety Act of 1993. It should be clearly understood that principal agents and consultants are not absolved of their responsibilities and cannot claim ignorance in the event of damage or loss of life in a sinkhole.

In terms of bona mores, the criterion of reasonableness, it is essential that the Department of Public Works and its consultants "act" and are seen to act positively in order to prevent harm. Infrastructure must be appropriately designed, constructed, and serviced to facilitate management of the dolomite risk. To this end the Department of Public Works has adopted a Centralised Dolomite Risk Management Strategy for infrastructure located on all dolomitic land. This strategy aims to ensure appropriate:

- site selection,
- development design
- building design
- design of services, material selection, maintenance friendly systems etc.
- ongoing risk management.

The principal agent and other consultants play a crucial role in ensuring that this strategy is successfully implemented. Background information and appropriate planning, water precautionary and remedial measures are outlined below.

2. BACKGROUND INFORMATION

This section is devoted to providing a rudimentary background perspective on the dolomite issue.

2.1 Definition of dolomitic land

The term 'dolomitic land' is used to describe areas in South Africa underlain directly or at shallow depth (i.e. <100m) by the rock type dolomite. Dolomitic rock is composed of the mineral dolomite, which is a carbonate of calcium and magnesium.

2.2 Why is dolomitic land problematical?

Dolomite is soluble, i.e. dissolves in water. Rainwater and percolating ground water gradually dissolve the rock over time as it seeps through joints, fractures and fault zones in the rock. The dissolution of the dolomite gives rise to cave systems and voids in the rock. Soils covering the rock can collapse into these caves or voids resulting in catastrophic ground movement on the surface such as sinkholes or dolines.

2.2.1 Sinkholes

Sinkholes result from the hollowing out of a space below the earth surface which eventually breaks through and 'daylights' at the surface. Sinkholes are usually cylindrical to conical in shape and can be 1 m to 100 m in diameter and 1 m to 150 m deep. Sinkholes are catastrophic and can cause property damage or loss of life (see Plates 1 to 7).

Sinkholes:

- may be catastrophic, as they occur unexpectedly with little or no warning.
- may cause property damage or loss of life, if they are sufficiently large.
- are usually precipitated by human activity such as:
  * dewatering, due to mining activity,
  * water extraction from aquifers,
  * leakage of wet services such as water and sewer bulk services, reticulation and connections,
  * interference with natural drainage patterns by development and disturbance of superficial soil materials leading to concentrated water ingress.

2.2.2 Dolines

Dolines are less sharply defined than sinkholes, occur slowly and not catastrophically (see effect on structures in Plates 8 and 9). These features may be large ranging from tens of metres to kilometres in diameter or length. Typical visual observations at small dolines are shallow earth depressions and surface cracks in a circular or semi circular pattern.

It should be noted that in South Africa the terms sinkhole and doline are currently used to refer to geomorphological features and are no longer distinguished by the mechanism of formation.

2.2.3 Triggering mechanisms for sinkhole and doline formation

Sinkholes and dolines are mostly caused by water seepage or a lowering of the ground water table. Seepage of water most commonly occurs from leaking water bearing services such as sewers, waters pipes, storm water systems etc. The leaking water erodes the soil covering the dolomite rock and carries the material down into the underlying cave systems resulting in a hollowing out of a space (cavity) below ground surface. When this void daylights a sinkhole results. (See Figure 2).

The ground water level drops when boreholes are used to pump water from below ground surface. The ground water level can also be lowered when mines pump water out of ground water compartments to keep their underground workings dry. Ground water level lowering leads to lowering of pore water pressure which lowers ground bearing capacities or draining of subsurface cavities which may result in sinkhole or doline formation.

2.2.3.1 Sinkholes are generated by a change in the moisture regime in the soils constituting the arch over the upward migrating void. This change in the state of the soil leads to the arch ravelling and the void moving towards ground surface. Eventually the void will daylight and manifesting in a sinkhole. Often paleo sinkholes are re-activated by groundwater level draw down. Paleo sinkholes are ancient features, in

filled over time by transported soil material, e.g. wind blown, aeolian sands. These materials may extend below the original ground water level. In such instances a fall in the ground water level leads to a change in the moisture regime of the soils that re-activates the sinkhole.

The dolomitic environment is often characterised by zones of deep weathering and preferential leaching. This process of preferential weathering is particularly well advanced within the shear zones of faults. Subsurface karst valleys up to 200 m in depth may develop in these shear zones. Spectacular representations of these features can be seen on the Far West Rand.

In many of these areas, the water table is located above the bedrock, in residual soils. These residual materials are essentially composed of wad and ferroan soil. The artificial lowering of the water table may produce significant ground movement at the surface. This process manifests as a doline at ground surface.

2.3 Negative Consequences of Inappropriate Development on Dolomite

To date 38 people have died in sinkholes that have occurred under sports clubs, factories and homes and financial losses have exceeded R1,0 billion. In excess of 1000 sinkholes have occurred on the West Rand, 800 south of Pretoria, Centurion and Atteridgeville and approximately 150 on the East Rand.

Sinkholes and dolines may occur immediately after installation of services because of poor workmanship or use of inferior materials or after a period of time due to deterioration of the materials. Obviously, as the water bearing services deteriorate, the frequency of leaks increases and so does the likelihood of a sinkhole occurring.

2.4 Risk Characterisation of Dolomite Land

Broadly, the geotechnical investigation of the dolomite site culminates in the expression of the stability of the area in three risk categories, namely l**ow**, **medium** and **high** risk.

The following reference to incidences, gives a perspective of the magnitude of problems encountered in each of the risk zones in research areas. It is important to note that these figures are largely derived from developments not effectively and appropriately designed or maintained.

RISK CHARACTERISATION	**GROUND MOVEMENT EVENTS ANTICIPATED PER HECTARE IN A 20 YEAR PERIOD** (STATISTICS BASED ON INAPPROPRIATE AND POOR SERVICE DESIGN AND MAINTENANCE)
LOW	Typically 0 events per hectare anticipated but occurrence of events cannot be totally excluded therefore up to 0,1 events/hectare
MEDIUM	0.1 to 1 events per hectare
HIGH	> 1,0 events or more anticipated per hectare

Table 1: Dolomite Risk Characterisation Zone definition

2.5 Distribution of Dolomite in South Africa

Dolomite land occupies up to 25 percent of Gauteng and underlies some of the most densely populated areas such as Bekkersdal, Katorus, Centurion, Dobsonville, Deapmeadow etc. The distribution of dolomitic land in South Africa is shown on the attached Figure 1.

3. DEPARTMENTAL REQUIREMENTS FOR DEVELOPING SITES ON DOLOMITE

In order to prevent costly development of inappropriate sites it is proposed that the Department institute a strict land acquisition and development policy.

3.1 Appropriate Development Planning

The safe development of a site involves careful geotechnical assessment of the delineated area, appropriate planning and appropriate design of structures and services. These aspects are elaborated on below:

3.1.1 Proclamation Stage Circulation or purchase of new property

At the Proclamation Stage Circulation of a new township layout to the department or in the event of purchasing new properties in a dolomitic region the following information should be sought:

- Consult a dolomite risk specialist and the Dolomite Risk Management database of the department to establish whether the property is located on dolomite or close to the dolomite contact zone

- The full proclamation stage geotechnical report for the township in which the property is located.

- The developer/land owner should be required to submit a standard form completed by the geotechnical consultant who undertook the township/property investigation. This form should request information concerning the broadly anticipated geotechnical conditions on the proposed sites. A pro forma of this document is enclosed in Appendix 1.

- Consult the departmental Dolomite Risk Manager as well as a dolomite risk specialist for a review of the above report. Written recommendations on the feasibility to develop the site economically needs to be obtained prior to acceptance or purchase of the property.

- The above relevant information, reports and recommendations must be forwarded to the departmental Dolomite Risk Manager for capturing on the dolomite geographical information system (GIS). It should also be forwarded, with written confirmation of receipt, to the division responsible for further development of the site. This information should be refer to in any future procurement instruction (PI) issued.

- See also section 3.1.2.2 below and PRM 011 in Appendix 8

3.1.2 Design of additions to existing infrastructure and planning of new infrastructure by departmental officials or consultants.

The following section contains a brief outline of the responsibilities and prerequisite actions for the development of infrastructure on dolomite.

3.1.2.1 Briefing of Principal Agent by Project Managers

On being appointed to undertake the design and construction of new infrastructure or upgrading of existing infrastructure the principal agent/project manager (engineer, architect or quantity surveyor) must undertake the following actions ensuring that the general criteria outlined below are applied (To be read in conjunction with standard departmental investigation, briefing and reporting formats as per PRM 006, 007, 011, 012, 017 and 018 as per Appendix 8). Particular attention is to be given to Inception Check List (PRM007) to ensure that the consultant is properly briefed

- Consult a dolomite risk specialist and the Dolomite Risk Management database of the department to establish:

  * whether the infrastructure is located on dolomite or close to the dolomite contact zone,
  * in the case of existing infrastructure, establish the anticipated risk characterisation.

- A dolomite risk specialist should brief the principal agent with regard to:

  * available information of the area in general
  * site-specific information as well as
  * the need for and minimum requirements of detailed site investigations

- Once it is confirmed that the site is located on dolomite, the principal agent shall ensure that a geotechnical investigation is conducted and that the consultant team (all disciplines) are briefed in writing thereof. This site-specific detail geotechnical report shall be referred to a dolomite risk specialist for comments and each discipline shall be informed of the results. The dissemination of this information will ensure that services and structures are designed and routed according to the recommendations of the geotechnical report and ensure that departmental precautionary measures as outlined below are applied. (see section 4 below).

3.1.2.2 Site selection and development criteria

The principal agent shall inform the department after completion of the geotechnical investigation if the following criteria are met and whether it is financially feasible to continue with the project:

- All new sites should have at least an anticipated or extrapolated yield of 50 % medium or low risk land. This medium or low risk portion of the total area must be sufficient in extent for the erection of all structures and related facilities of the proposed new development. If this yield is not feasible, due to the widespread occurrence of high risk land, then from the outset it should be noted that stringent remedial and water precautionary measures will be required, as well as rationally designed sub- and superstructures. The financial implications of such measures may place the cost of the project outside the norms and standards of the department. The appointed principal agent should immediately discuss this aspect with the project manager of the Department of Public Works. The

principal agent needs to furnish the department with expected extraordinary cost estimates, based on geotechnical constraints of sites, before detail design work commences. Revision of the standard cost units (SCU) should be based on this additional information if applicable.

- It is essential that the Department follow a policy of not developing/purchasing sites until it is sure that such sites can be developed economically.

3.1.2.3 Geotechnical investigation

A site-specific geotechnical investigation, involving both a dolomite stability and soils assessment, should be carried out on a site to ensure appropriate planning and design of the development. Such an investigation must meet minimum requirements and the requested format (refer to Appendix 2) including:

- Infrastructure located within 1000 m of the dolomite outcrop contact should be carefully evaluated to assess the need for a full dolomite stability assessment.

- The completion of geophysical work, usually gravity.

- The drilling of boreholes on anomalies.

- The logging and presentation of boreholes according to current practice.

- The excavation, profiling and sampling of representative test holes. Where necessary samples should be appropriately tested in a soils laboratory. This aspect of work should conform to current practice, i.e. Profiling according to Jennings, Brink and Williams 1973. Also follow Guidelines for Urban Engineering Geological Investigations and the SAICE Code of Practice (1995).

- The dolomite stability of the site must be described in terms of risk zones according to current practice (see table 6 of **Proposed method for dolomite land hazard and risk assessment in South Africa**, SAICE Journal Vol 43(2) 2001, paper 462 pages 27-36, Buttrick et.al.).

- The report drawings (preferably on a scale of 1:500) should clearly indicate the following:

  Site information:

  * site locality map (scale: not smaller than 1:50 000),
  * site boundary (superimposed on current cadastral grid),
  * relevant area features such as drainage, neighbouring developments, roads, etc.,
  * site contours – if available,
  * existing services – water, sewer, storm water, electricity etc
  * existing water boreholes.

Geotechnical investigation information of current and all past investigations:

* sinkholes, dolines, paleo features, areas of fill, areas of borrow, rock outcrop etc.,
* existing and new boreholes,
* existing and new soil testing trial holes,
* residual gravity contours in mgals (indicate also survey station grid).

Dolomite risk zonation:

* demarcate low, medium and high risk areas with specific development notes of each,
* other geotechnical problematic areas with specific descriptions thereof.

Proposed site development:

* indicate proposed best site for erection of structures,
* areas for limited development,
* areas for no development.

3.1.2.4 Conclusion and recommendation of the geotechnical report

The geotechnical investigator must indicate:

- in which zones the erection of structures are permissible
- where sports facilities/parking lots/parade grounds/radio masts, etc. (structures and wet services) may be developed

- provide appropriate (site specific) comments of subsurface remedial work

- anticipated foundation problems

- water precautionary measures for each stability zone.

- Comment in general on earthworks to be conducted (borrow/fill/surficial soil disturbances, etc.)

3.1.2.5 General principals to be incorporated in the conclusions of the geotechnical report and the principal agent's site development plan

- Wherever feasible avoid high-risk areas. Locate buildings on low and medium risk areas and place sports facilities/parking lots/parade grounds/radio masts, etc. on medium to high-risk land with the exception of swimming pools. Grassed facilities to be placed on the most favourable portions of medium to high risk land whilst dry facilities such as surfaced parking etc., can be placed on most problematic land, providing no structures are erected and depending on the specific geological conditions. Swimming pools may only be placed on low risk or medium risk land with special precautions.

- Additions to existing infrastructure or buildings, particularly in high-risk areas, require the same level of investigation procedures as for new infrastructure. When linking structures, potential differential settlement between old and new

components must not be permitted as it may induce failure of or leaks in any linking wet services. (NB - see also section 4.1.12 for blasting requirements)

- Where an entire site is located in a high-risk area and the development of a high-risk site is unavoidable, stringent water precautionary and remedial measures will be applied.

- It is essential that the Preliminary Site Investigation of the principal agent and his proposed development site plan (sketch plan: see PRM 017/1 for check list) be compared with the Geotechnical Report. Matters such as topographical constraints, position of service connections and building restrictions should be compared with the stability zones on the site. The geotechnical dolomite stability risk zones must be indicated on the site plan and the principal agent shall call for written comments from all members of the consultant team to indicate the influence thereof on the design, construction and cost of services and structures. The combination of these various factors will determine the suitability of a site for development.

  See Appendix 3 for compulsory information on the Principal Agent's development site plan. The geotechnical report, site development plan and services criteria to be implemented as well as budgeting thereof shall be referred to a dolomite specialist for comment.

3.1.2.6 When designing infrastructure on dolomitic land in general

Avoid:

- gardens within 5m of buildings
- water features such as garden or fish ponds within 15 metres of buildings. Water features with automatic replenishment systems should not be permitted
- courtyards that necessitate sub-floor level drainage systems
- construction of buildings or services over natural watercourses
- construction of buildings over wet services
- creating unlined rerouting of natural drainage paths
- concentration or disposal of storm water onto high risk land
- avoid wet services running parallel and close to buildings
- high concentrations of subsurface services near buildings
- using rigid, short length piping (promote long, unjointed, flexible piping)
- subsurface water storage tanks
- disturbance of surficial soil whenever feasible (ensure disturbed areas are properly compacted and reinstated)
- septic tanks, soak-aways or pit latrines
- boreholes for water abstraction
- site features with poor drainage characteristics

Incorporate:

- Appropriate water precautionary measures as outlined below (see section 4 below)

4. APPROPRIATE WATER PRECAUTIONARY MEASURES FOR DEVELOPMENT ON DOLOMITIC LAND

Water precautionary measures are outlined below in the context of the minimum standards required with respect to each dolomite stability zone (see table 1). In general discourage placing of buildings on and traversing of high-risk areas with wet services. The cost implication of routing wet services around high-risk areas should be motivated in addition to normal cost norms:

4.1 Low Risk Areas

The risk of sinkhole and doline formation is adjudged to be such that only general water precautionary measures, which are intended to prevent the concentrated ingress of water into the ground, are required.

4.1.1 General design of services

a. Underground wet services shall be designed and constructed so as to minimise maintenance requirements avoid potential leakage points. In addition wet services shall be designed (i.e. place in water tight structures) to avoid possible disturbance of the underground environment.

b. The relevant specifications of SABS 1200 DB, L, LB, LC, LD and LE shall be observed in the installation of all underground services.

c. The backfilling to service trenches and other excavations shall, except in rock, be less permeable than the surrounding material. (General minimum compaction standard of 93 % Mod AASHTO). The use of non-cohesive single size graded sand or crusher sand for bedding, surround blankets and backfill shall not be allowed.

d. Water, sewer and non-concrete storm water pipes shall have a minimum cover of 600 mm outside vehicle traffic areas and a minimum cover of 1000mm in vehicle traffic areas. Where required, protect pipes with appropriately designed concrete slabs above the pipework.

e. Water, sewer and storm water piping should, wherever possible, not be placed parallel to buildings unless it is at least 5 meters away from the structure. Single direct connections to buildings are preferred. This precaution also applies to electricity and communication cables.

f. Where feasible, provisions for future connections to all services should be made in order to minimize cutting into pipes to provide such connections at a later stage.

g. Provision should be made in all water bearing pipelines to accommodate potential differential movements without causing pipelines or joints to leak.

4.1.2 General construction activities

a. All trenches and open works are to be inspected by a competent person to assess if adverse ground conditions are present. This procedure allows for the adjustment of construction methods, i.e. special bedding requirements, additional excavation and compaction, or pipe protection measurements.

b. Construction excavations should be opened and closed as rapidly as

possible. Avoid leaving trenches open over weekends or holidays.

c. Berms should be constructed on either side of the trenches to prevent the inflow of water during rainstorms.

d. Provisions shall be made in tender documentation for the supply of pumping equipment to keep excavations dry.

e. Construction site camp services shall also be subject to the precautionary measures as above and below.

4.1.3 Storm water

a. The site and surrounding area shall be shaped (if required) to permit the rapid drainage of surface water and to prevent ponding on the site. Careful attention is to be given to the drainage of areas with gradients less than 1:100.

b. Drainage ports should be incorporated in boundary walls, particularly at the lowest point of the site, to permit the passage of surface runoff. Drainage ports shall be provided with a concrete apron slab, 1,0 m wide and 100 mm thick, on both the inlet and outlet sides of the wall or fence. The slab needs to be extended 400 mm beyond the sides of the port to prevent vegetation growth. The minimum slope on the slab is to be 1:15. Security outlet grids need to be designed not to clog.

c. Drainage onto the property shall not be allowed to accumulate against boundary walls. Drainage towards the site shall preferably be diverted away from the site by means of earth berms. Unlined cut- off trenches should be avoided if possible.

d. Natural ponds and watercourses located within 10 m of any structure shall be rendered impervious within and to a distance of 30 m from the building. (Design criteria: 1 in 5 year flood capacity minimum) The complete diversion of natural watercourses to a minimum distance of 30 m away from buildings is advised.

e. Storm water drainage around buildings and up to 10 meters away shall preferably be kept on the surface or in open canals at slopes of not less than 1:50 for surfaced areas and canals, and 1:20 minimum for unsurfaced areas. All surfaces shall slope away from buildings. Drainage in passages or between buildings needs to slope away from structures and drain along the centre of the open space. No drainage toward a structure is to be allowed. The placing of small diameter (300 mm) concrete storm water canals next to and parallel to buildings is not recommended. Preferably use 1,0 m or wider v-shaped concrete drains.

f. To facilitate drainage of grassed areas such as sports fields should have a minimum slope of 1:80.

g. Storm water drainage conduits and open canals shall be constructed at gradients, which will not permit the deposition of soil from the catchment area (Design criteria: 1 in 2 year flood capacity minimum depending on the local conditions. Additional specific infrastructure design requirements are outlined in Section 6)

h. The storm water drainage system shall incorporate measures to ensure water tightness of conduits, canals and other compartments. All

pipes should be tested for leakage using standard SABS air or water tests. All pipes and structures to be tested to show zero percent leakage.

i Concrete non-pressure pipes should be of the spigot and socket type with rubber ring seals. Joints in box culverts and manholes etc. should be sealed. Ensure sufficient compaction of foundation excavations to preclude any consolidation settlement. Allow for 200 mm thick 1:12 soilcrete slab extending 200 mm beyond the structure foundation if unusually soft soil conditions are encountered. Inlet grids to subsurface systems shall preferably be locked and not allow the passing of any item larger than 40 mm in diameter. Minimum internal pipe size to be 400 mm.

j. Open drains are preferably to be shallow, 1000 mm (min) wide, cast in-situ, V - shaped drains with sealed key type construction and expansion joints. Steel reinforcement (if applicable) is to be continuous over joints to preclude horizontal displacement.

k. Subsurface materials should be as follow:

Pipe: Concrete with spigot and socket rubber ring joint: **If approved by departmental engineer**. (SABS 677)
PVC with spigot and socket rubber ring joint :**If approved by departmental engineer.**
HDPE: Structured wall pipes with ring stiffness of kN/m^2 or solid wall pipes of class PN 10 minimum. Pipe material to conform to type PE 100 in terms of SABS ISO 4427. Supply pipe in 12 m (minimum) lengths. To ensure water tightness, use hot-gas welding (SABS 0268 – Part 3) or hot-gas extrusion welding (SABS 0268 – Part 4) internally and externally, or butt-welded joints (SABS 0268 – Part 1) for small diameter pipes, or electro-fusion welding (SABS 0268 – Part 2) where gas or butt-welding is impossible. Joints of solid or structured wall pipes with a diameter of 400 mm or larger could be improved by means of 300 mm wide HDPE collar (to manufacturers specification) fitted over the joint and welded to both pipes. Alternatively can this collar be factory fitted. The use of long-sleeve spigot and socket joints with rubber rings are to be **approved by departmental engineer**. Use a manhole when linking different pipe material types.

Manholes: The use of pre-manufactured HDPE manholes is advised near buildings and structures or areas not trafficked by vehicles. Alternatively use concrete manholes **if approved by departmental engineer**.
HDPE manholes: All material for HDPE manholes to conform to HDPE: Type PE 100 SABS ISO 4427 specifications and all welding to SABS 0268, SABS 0269, SABS method 1269, SABS 0270, SABS 1655 and SABS 1671. Manhole shafts to be structured or solid wall HDPE pipes with 8,0 kN/m^2 ring stiffness or alternatively manufactured to same standard. HDPE pipes to be welded to manhole. Manhole to be similar to HDPE sewer manholes (detail TYPE NO DT 04/D) and welding details as per included detail (TYPE NO DT 20/SW).

Concrete manholes and inlet structures: Design as water retaining structures. Inlet pipes to be provided with puddle flange or key joint (detail TYPE NO DT 12/W) to ensure watertight fixing into walls or construct structure with flexible watertight inlets.

4.1.4 Sewer

a. Sanitation systems shall not incorporate soakaways. Use conservancy tanks with low flush volumes where sewer connections are not available. Pit latrines are not acceptable in high and medium risk areas. If no alternative is available, pit latrines may be utilized in low risk areas provided correctly constructed to preclude storm water gaining access. Example: Construct a 0.5 m high earth berm around the up slope side of the pit latrine or place floor slab 500 mm proud of natural ground level with the door facing down slope. The pit latrine should be placed as far away as possible from any permanent structures. Annual relocation of pit latrines is advised. Obviously other matters such as pollution of water resources should be considered e.g. where infrastructure relies on a borehole for its water supply. The utilization of PVC or HDPE holding tanks with chemical digestion for pit latrines should be investigated. Design and material selection for such tanks to be in accordance with relevant material specifications and **approved by the departmental engineer**.

b. Subsurface pipe materials should be as follow:

- HDPE: **Within 15 m of building**.

Pipe: HDPE:Type PE 100, PN 10 pipes to SABS ISO 4427. Supply pipe in 12 m (minimum) lengths
Joints: To ensure water tightness, use butt-welded joints (SABS 0268 – Part 1) in general or electro-fusion welding (SABS 0268 – Part 2) where butt-welding is impossible. Joints of solid or structured wall pipes with a diameter of 400 mm or larger could be improved by means of 300 mm wide HDPE collar (to manufacturers specification) fitted over the joint and welded to both pipes. Alternatively can this collar be factory fitted. The use of long-sleeve spigot and socket joints with rubber rings for pipes larger than 300 mm are to be **approved by departmental engineer**. Use a manhole when linking different pipe material types.
Manholes: The use of pre-manufactured HDPE manholes is advised. Alternatively use concrete manholes, designed as water retaining structures, **if approved by departmental engineer**.
HDPE manholes: All material for HDPE manholes to conform to HDPE: Type PE 100 SABS ISO 4427 specifications and all welding to SABS 0268, SABS 0269, SABS method 1269, SABS 0270, SABS 1655 and SABS 1671. Manhole shafts to be structured or solid wall HDPE pipes with 8,0 kN/m^2 ring stiffness or alternatively manufactured to same standard. See detail TYPE NO DT 04/D and TYPE DT 09/D. HDPE pipes to be welded to manholes.
Concrete manholes: Design as water retaining structures **if departmental engineer approves use**.

Inlet pipes to be provided with puddle flange or key joint (detail TYPE NO DT 12/W) to ensure watertight fixing into walls or construct structure with flexible watertight inlets.

- PVC **Only to be used beyond 15 m from structures**.
  Pipe: SABS 791 Heavy duty - Class 34 (solid wall).
  Use of PVC to be approved by departmental engineer.

c. All connections to manholes shall be flexible and watertight.

d. All sewerage pipes and fittings must be watertight. All laid drainage and sanitary sewer pipes should be tested for leakage using the standard SABS water test on installation. Welded HDPE pipe systems to be pressure tested to relevant pipe pressure class and manufacturer's specification.

e. All sewers and structures to be tested to zero percent leakage for water tests.

f. Avoid using rodding and cleaning eyes and rather use small HDPE manholes (multi directional collecting pots) that are pre-manufactured small size (300, 500 and 700 mm diameter) manholes with factory fitted HDPE benching. Piping from the manhole to surface level shall consist of HDPE pipes and long radius bends with electro fusion/butt welded connections. All HDPE material to be Type PE 100 as per SABS ISO 4427 and all welding to conform to SABS 0268, SABS 0269, SABS method1269, SABS 0270, SABS 1655 and SABS 1671. Manhole shafts to be structured or solid wall HDPE pipes with 8,0 kN/m^2 ring stiffness or alternatively manufactured to same standard.

g. The planting of trees or general gardening within 5 meters of sewer lines should be avoided.

4.1.5 Swimming pools

a. Backwash and other water from swimming pools, shall be discharged via HDPE (HDPE: Type PE 100, PN 10 as per SABS ISO 4427) piping into either the storm water or drainage systems as required by the local authority. Discharge points shall not to be closer than 20 meter from the pool or any other structure.

b. The area surrounding the swimming pool shall be totally impervious (concrete paving) for a distance of at least 5 meters with provision of a drainage canal to collect splashed water.

c. The pool shall not have an automatic water replenishment system.

d. A Dolomite Risk Specialist should advise on the placing of the pool (not closer than 40 meters from buildings).

4.1.6 Electricity and Communication

a. The sleeve and draw box systems for electrical and communication cables shall also be water tight, flexible and constructed to avoid water entering the system. HDPE piping and small diameter manholes as described for sewers above are ideally suited for this purpose. Design and material selection to be similar as for sewer reticulation described

above.

b. Trenching, backfilling and compaction of trenches to be similar as for wet services.

c. The use of non-cohesive, single size, graded sand or crusher sand for bedding, surround blankets and backfilling of trenches is not permitted. Construction details are to be similar to water and sewer pipes.

4.1.7 Water

a. The piping used in bulk supply, ring mains and secondary reticulation should be flexible. Joints should be minimal in number and of the flexible, self anchoring type, i.e. not reliant on thrust blocks or friction for their anchorage.

b. Subsurface pipe materials should be one or more of the following:

- Pipes of 75 mm and larger diameter:

  * **Preferred pipe type: HDPE**
  Pipe: HDPE: Type PE 100, PN 12,5 (or higher pressure class if required) to SABS ISO 4427.
  Supply lengths: Supply pipe in 12 m (minimum) lengths.
  Joints: Butt-welded joints (SABS 0268 – Part 1) in general or electro-fusion welding (SABS 0268 – Part 2) where butt-welding is impossible.
  Fittings: Manufactured from HDPE: Type PE 100, PN 12,5 (or higher) to SABS ISO 4427
  Welding: All welding to relevant SABS 0268, SABS 0269, SABS method 1269, SABS 0270, SABS 1655 and SABS 1671 codes.

  * Alternative: High impact PVC pipes (SABS 966, class 12) with victaulic joints **only if approved by departmental engineer.**

  * Exceptional circumstances and above ground installations: Steel pipes with suitable internal and external corrosion protection and flexible, self-anchoring connections. **Reasons for use to be approved by departmental engineer.**

- Pipes having a diameter of less than 75mm:

  * **Preferred pipe type: HDPE**
  Pipe: HDPE: Type PE 100, PN 16 (or higher pressure class if required) to SABS ISO 4427.
  Supply lengths: Supply pipe in 100 m (minimum) lengths.
  Joints: Butt-welded joints (SABS 0268 - Part 1) in general or electrofusion welding (SABS 0268 – Part 2) where butt-welding is impossible. No compression fittings are allowed except if in watertight manholes.
  Welding: All welding to relevant SABS 0268, SABS 0269, SABS method 1269, SABS 0270, SABS 1655 and SABS 1671 codes.

c. Piping from main reticulation to the building is **unjointed** HDPE: Type-PE 100, PN 16 (or higher class if required) pipes to SABS ISO 4427.

d. Underground valves are to be placed in watertight concrete or HDPE manholes. HDPE manholes are to be manufactured to same standard as sewer manholes described above. Concrete manholes for valve are to be designed as water retaining structures.

e. No high-pressure compression connections are to be allowed below ground level. All such connections are to be placed in watertight manholes.

f. Shut-off valves and water meters shall be supplied at main supply with permanently fixed pressure gauge on the building side of the main shut-off valve (for regular systems testing).

g. All site services to be tested to zero per cent leakage.

4.1.8 Roads

a. Roadways, which have a gradient of less than 1:80, shall be surfaced/sealed.

b. The velocity of the 1 in 20 year storm water, flowing along un-surfaced roadways shall not exceed 1,5 m/s.

c. Ensure that surfaced roadways and parking areas are in fact placed below site level so as to facilitate drainage.

4.1.9 Plumbing

a. Unjointed flexible HDPE (HDPE: Type PE 100, PN 16, or higher pressure class if required, to SABS ISO 4427.) water piping from the main supply to 100 mm above natural ground level for entry into the buildings. Place 1,0 x 1,0 m concrete slab at entry point if area is not paved.

b. Pipes through walls, at entry points to buildings, shall be sleeved to permit relative movement up to 25 mm. Seal annulus with water tight, compressible and rodent resistant material.

c. All connections between flexible and rigid pipes shall be provided with flexible, self-anchoring joints. Such connections must be in watertight structures or above ground level.

d. No water pipes shall be placed under floor slabs. If unavoidable, provide service ducts, which are watertight and can be inspected, above or below floor slab.

e. The use of surface mounted GMS water pipes on external walls and from the roof downward is preferred for all building water reticulation. The chasing of water piping into walls should be kept to a minimum. The placing, protection and support of exposed pipes are to be designed to ensure serviceability during fires.

f. The selection of piping material shall take cognisance of corrosion (both external and internal). Preferably use welded HDPE or alternatively PVC with victaulic joints if approved by departmental

engineer.

4.1.10 Drainage

a. The collection of sewer and waste pipes from multiple adjoining toilets or washbasins should be externally surface mounted. These pipes should feed into a single down pipe draining into the subsurface systems.

b. Areas of high concentrations of sewer outlets on buildings should be surfaced with concrete or paving bricks to avoid later covering of services with soil or vegetation growth and to ensure that blockages are detected early.

c. All sewer pipes and fittings shall be provided with flexible, watertight joints.

d. No sewer or waste pipes shall be placed under floor slabs. If unavoidable provide above or below floor slab level service ducts which are watertight and can be inspected.

e. Pipes through walls shall be sleeved to permit relative movement up to 25 mm. Seal annulus with water tight, compressible and rodent resistant material

f. WC pans shall be provided with a flexible connection at the junction with the outlet pipe.

4.1.11 Storm water/rainwater drainage

a. Downpipes, if provided, shall discharge into concrete lined drainage channels, which discharge the water at least 5m away from buildings. Discharge area shall have a slope of 1:20 minimum to a point 15 meters away from the building.

b. V-shaped concrete canals should be used to route all storm water towards and from buildings to an area where natural surface drainage will allow free drainage away from structures. These canals should be placed at least 5 m away from structures.

c. Construct a 2m wide impervious apron slab around the building where guttering is not provided.

d. The ground immediately against buildings shall be shaped to fall in excess of 75 mm over the first 1,5 m beyond the perimeter of the buildings, from where it will drain freely away from the structures. Concrete apron slabs or brick paving shall have a minimum of 1:20 fall away from buildings.

e. Drainage canals traversing walkways shall not be piped under walkways. Use impervious canals and grids.

f. Brick and precast concrete courtyard walls etc. must be so designed as to provide drainage ports at ground level to permit the passage of water.

4.1.12 Blasting

a. Experience on dolomite indicates that blasting may lead to severe

disturbance of the metastable dolomite environment, giving rise to sinkhole formation. Consequently, if blasting is necessary it is essential that appropriately experienced blasters be approached to determine the particular method and specification for blasting, regarded as appropriate in the context of the geological conditions.

b. PPV to be recorded for each blasting sequence.

4.1.13 Boreholes for ground water abstraction

a. Careful consideration, as a control on dewatering, to be given before permission is granted to sink boreholes for water abstraction. If the water table is above bedrock, a blanket ban on exploitation of the ground water should be imposed. Approval should be subject to an evaluation of the implications by an engineering geologist specialising in dolomitic related matters.

b. Where data is available concerning existing boreholes, for water abstraction within 50 meters of the site, comment should be made concerning this data in the geotechnical report and on the site plan.

4.1.14 Foundations

a. Foundation excavations need to be inspected to ascertain if surficial soil problems such as collapsible soil materials and geotechnical conditions such as shallow rock outcrops, sharp soil strata changes, paleo structures etc. are present. A dolomite specialist should conduct this inspection.

b. Ensure backfilling around structures are properly backfilled with suitable material that will have a density after compaction of not less than the in–situ soil (no building rubble or course aggregate exceeding 63 mm in diameter shall be allowed). Compact to a minimum of 93 % Mod AASHTO density.

c. Termite poisoning shall be introduced around all structures

d. Sub structure design will be appropriate in terms of the surficial soil condition and the dolomite stability conditions.

Water is a triggering mechanism, in the majority of cases, of distress in dolomitic/limestone areas. It is therefore imperative that the concentrated ingress of water into the ground be avoided at all times, including the construction period.

4.2 Medium Risk Areas

The risk of sinkhole and doline formation is adjudged to be such that only general water precautionary measures, which are intended to prevent the concentrated ingress of water into the ground, are required to permit the construction of the infrastructure.

4.2.1 The precautionary measures as **detailed above for Low Risk areas** shall apply **as well as** amendments thereof and additional requirements listed below.

a. Discourage the construction of any ponds, water features and swimming pools. (Departmental approval required)

b. All water retaining structures are to have foundations on 250 mm thick soilcrete raft (1:8 mix) extended 300 mm beyond the structure.

Introduce backwater stops and internal water stops to all expansion and construction joints (not only those below water level)

c. Sanitation systems shall not incorporate soakaways or pit latrines. Use watertight conservancy tanks where sewer connections are not available.

d. Backwash and other water from swimming pools, shall only be discharged into either an impervious storm water or drainage systems as required by the local authority (HDPE piping or lined discharge systems to be provided).

e. Earth backfilling compaction standards are to be observed and SABS 1200 requirements must be fully met.

f. Earthworks on pipes: SABS 1200 LB: Bedding and selected fill - Clause 3.1 is amended to allow the maximum aggregate size, not to exceed 6 mm. Material should not be free draining as described in this particular clause. It shall have a density, after compaction, of not less than the in-situ soil.

g. Special attention is to be given to drainage of all areas with gradients less than 1:80. Absolutely no ponding of water on site shall be allowed.

h. No piped storm water systems are allowed within 15 meters of buildings or under any structure. Open culverts with grating covers should be used to traverse any trafficked area in or around buildings.

i. Storm water canals should have a 250 micron HDPE lining and continuous light steel mesh reinforcement over sealed key construction and expansion joints that preclude any vertical movement.

j. The placing of small diameter storm water gulleys parallel to buildings is not allowed. Use 1,2m wide V-shaped concrete drains where drainage parallel and close to buildings is required. Joints between structures and canals to be sealed as in the case of canal expansion joints.

k. All roadways, which act as storm water collectors, shall be surfaced.

l. All brick paving shall incorporate a 250 micron HDPE lining.

m. All courtyards or narrow (< 4 m) spaces between structures are to be paved with brick paving or concrete apron slabs and 2,5 metre wide paving shall be introduced around all structures with no gutters.

n. All storm water from down pipes shall discharge into concrete lined channels which in turn will discharge the water at least 10 metres away from structures onto areas that permit free surface drainage away from structures.

o. Where necessary, use earth berms to enhance site drainage.

p. All concentrated storm water entering the site shall be diverted away from any structure or developed area by means of concrete lined channels.

q. The use of welded HDPE piping systems for water, sewer and storm

water is required as the material is more tolerant of movement. The above ground mounting of a GMS water reticulation on steel pedestals is preferred. **Alternative materials only to be used if approved by departmental engineer**. All material for HDPE pipes, structures and fittings must be in accordance with SABS ISO 4427 for type PE 100 and all welding and manufacturing to be in accordance with SABS 0268, SABS 0269, SABS method 1269, SABS 0270, SABS 1655 and SABS 1671 codes. All joints to be welded, unless joint is installed for future dismantling. Such joints are to be installed in water retaining structures that can be inspected.

r. No groundwater abstraction will be allowed.

s. The responsible regional manager should have a system whereby follow up tests for leakages of wet services are carried out and the results monitored.

t. The need for reinforced foundation design, building articulation and special foundation earth works (i.e. extended excavation and compacted backfilling, soil rafts etc.) should be investigated and reported on in the context of the site geotechnical report.

4.3 High Risk Areas

The risk of sinkhole and doline formation is adjudged to be such that precautionary measures, in addition to those pertaining to the prevention of concentrated ingress of water into the ground are required to permit the construction of the infrastructure.

4.3.1 The water precautionary **measures listed above for Low and Medium Risk areas are applicable** in High Risk areas with the **additional measures and amendments outlined below**. These measures are also applicable where development on high risk areas is unavoidable e.g. where the additions are made to existing infrastructure in a high risk area or where an entire site is regarded as a high risk area.

a. Use only HDPE piping for water (Class PN 12,5 and higher), sewer (Class PN 10 minimum) and storm water (8 kN/m^2 ring stiffness) in high-risk areas or where services traverse high-risk areas. All material for HDPE pipes, structures and fittings must be in accordance with SABS ISO 4427 for type PE 100 and all welding and manufacturing to be in accordance with SABS 0268, SABS 0269, SABS method 1269, SABS 0270, SABS 1655 and SABS 1671 codes.

b. In extremely problematic areas water reticulation may be placed above ground or all services may be placed in ducts or sleeves where within fifteen metres of a building. Sleeves to be provided with inspection chambers at both ends and must comply with the requirements of a sewer system for high risk areas. All sleeve systems must be constructed to **designed slopes** that permit drainage to predetermined inspection manholes.

c. Ablution facilities should not be included in the principal buildings or infrastructure. These facilities should be isolated in such a manner as to avoid damage to other parts of the development in the event of service failure and sinkhole/doline formation.

d. Use aprons of large (5,0 m min width) impervious paved areas around structures to enhance drainage. If rapid drainage (slopes 1:15 and steeper) away from structures is possible apron slabs may be reduced

to 3,0 m width.

e. Blanketing of geotechnical problematic areas with impervious material (clayey soil and/or HDPE sheeting), concrete or paving bricks need to be introduced if such areas could influence the structural integrity of buildings.

f. Contouring of site to achieve a fall of least 1:40 in general and to 1:15 away from structures within a distance of 8m of a structure are required.

4.3.2 Proposed remedial and General Precautionary Measures for Consideration on High Risk Sites.

a. In areas of very poor stability with historical evidence of ground movement, especially in ground water compartments undergoing dewatering monitor points shall be installed on buildings and at strategic locations on the property, e.g. on towers, plinths, manholes, etc. Accurate levels of these points should be gathered and kept as baseline data (e.g. three cycles of data). At any stage when concerns arise with respect to the stability of the site or portions thereof new levels can be taken for comparative purposes permitting the identification of problem areas.

b. In areas of shallow dolomite bedrock the highly susceptible nature of the subsurface profile to erosion necessitates the consideration of using a mattress of enhanced earth. This mattress has the dual purpose of improving founding conditions (negating differential movement) and reducing the permeability of the subsurface profile. This method involves the removal and replacement of incompetent, problematic soil beneath and for 3m beyond the periphery of buildings. The specification for the earth mattress/soil raft will be dependent on bedrock depth and the nature of the local soil materials.

c. In high-risk areas use should preferably be made of the following structure types:

- Light raft (e.g. waffle raft) foundations.
- Prefabricated or lightweight designed superstructure (PWD approved prefabricated building system).

d. Fencing of high-risk areas where sinkholes or dolines have already occurred. Personnel should not be allowed to traverse such areas.

e. No gardens are to be created within a distance of 5 m of any structure or service.

f. Water bearing services should be inspected at least twice per year preferably before and towards the end of the rainy season.

5. APPROPRIATE ENGINEERING DESIGN DETAILS AND CONDITIONS OF CONTRACT FOR WORK ON DOLOMITIC LAND

Typical, minimum standard, details for engineering designs are included in Appendix 5 and relevant Particular Specifications are given in Appendix 6. These details and specifications are to be extended/improved to suit the site-specific conditions. All drawings and specifications used, shall be the responsibility of the appointed project engineer. Typical information to be gathered/observed during site investigations of engineering services on

dolomitic land is outlined in Appendix 4

The latest revision of the Conditions of Contract (as issued by the Department. See Appendix 7 to be updated later) and particular clauses referring to work in the dolomitic environment should be discussed with the departmental engineer. Particular attention is to be given to **Special Risk Insurance**, particularly if the work involves excavation, demolition, blasting and/or sinkhole related repairs.

The **design engineer** must specify, in detail, all precautionary and safety measures to be taken in the event of work related to sinkhole and doline repairs.

6. DESIGN AND TENDER DOCUMENT STANDARDS FOR UPGRADING OF INFRASTRUCTURE ON DOLOMITIC LAND (Revision 5 of 21 August 2003)

6.1 General

The designs shall be based on the documents listed in Table 2 hereunder.

The Design Criteria for Dolomitic areas: Appropriate Development of Infrastructure on Dolomite: Guidelines for Consultants (**THIS DOCUMENT**)	ADDENDUM TO OW 371 August 2003
Manual of Procedure of Consulting Engineers	DPW Version 3 Dec 1996 (Revision pending)
Human Settlement Planning and Design (Red Book	CSIR April 2000
Water Supply and Drainage for Buildings (Part 1 and Part 2)	SABS 0252-1-1994, SABS 0252-2-1994
Code of Practice for Community Protection against Fire	SABS 090-1972
The Application of the National Building Regulations	SABS 0400-1990
Specifications of Materials and Methods to be used	OW 371 1993

Table 2: List of documents for design of engineering services in dolomitic areas.

6.2 Status of Documents

6.2.1 Should there be any conflict between the requirements of the various documents; they shall have preference in the order as listed.

6.2.2 The Consultant's attention is specifically drawn to the fact that his/her practice will accept ***full responsibility*** for the design, detail(s), specifications and drawings. The Department's input is given to ensure basic compliance with minimum statutory-, regulatory- and legislative requirements, with the specific aim of achieving best practice details/specifications in conjunction with the Consultant's expertise.

6.3 Project Standards

6.3.1 General

New infrastructure shall be located as far as possible on the lowest risk dolomitic soil.

The Project Requirements below have preference above all the listed

documents.

The prescriptions of the local fire fighting authority shall prevail.

The basic design standards of the Department are as follows (in addition to the requirements of the documents listed in item 6.1).

6.3.2 Water Supply

6.3.2.1 Replace all waterlines with:
HDPE - Type PE 100, Class PN 16 for 63 mm diameter and smaller.
HDPE - Type PE 100, Class PN 12,5 for 75 mm diameter and larger.
(If the design requires pressures in excess of the above, such class shall be specified)

6.3.2.2 HDPE pipe material is to be in accordance to SABS ISO 4427.

6.3.2.3 Sleeve all waterlines of 160 mm diameter and smaller in waterproof welded HDPE sleeves with HDPE terminating manholes over High Risk Dolomite Zones. Sleeves shall be of Type PE 100 Class PN 10 HDPE pipes.

6.3.2.4 All manholes and valve chambers to be watertight heavy duty welded HDPE (material type PE 100) with minimum ring stiffness 8 kN/m^2 or cast in-situ watertight reinforced concrete manholes (if approved by departmental engineer) with HDPE puddle flanges welded to the HDPE pipes. (See details TYPE DT 11-1/W, TYPE DT 12/W, TYPE DT 04/D, TYPE DT 09/D. In non-dolomitic classified areas, conventional concrete manholes with mastic sealed joints may be used.

6.3.2.5 All HDPE pipes to be butt-welded (SABS 0268 – Part 1) unless specifically otherwise approved by the Department. Electrofusion welding (SABS 0268 – Part 2) will only be allowed in special circumstances.

6.3.2.6 Primary and secondary water loops shall be closed as far as feasible except where otherwise approved by the Department.

6.3.2.7 Design water monitoring system with bulk supply flow meters and flow meters at each secondary branch. Logging shall be facilitated by means of a portable logger for all automatic water meters to be supplied under the contract(s).

6.3.2.8 The layout of secondary mains is to be in accordance with The South African Standard Code of Practice: The Management of Potable Water in Distribution Systems SABS 0306: 1999.

6.3.2.9 Old mains that are to be abandoned must be removed and the trenches backfilled and compacted to a soil density in excess of the in-situ soil. Where old mains are under surfacing and where removal would be uneconomical, pipes are to be grouted using a suitably designed soil-cement

(12:1) mixture.

6.3.2.10 Water pipes, where permitted above ground shall be of hot dipped heavy-duty galvanized steel pipes to SABS 763. Screw threads shall be cut as far as possible prior to galvanizing. No welding will be permitted after galvanizing. All screw threads, pipe ends and joints shall be treated with a mastic compound in accordance with the Manufacturer's Specifications on completion of the installation.

6.3.2.11 All valves on water mains to be clockwise closing.

6.3.2.12 Valves shall be flanged resilient seal gate valves and fitted to flange adaptors. They are also to be housed in watertight manholes.

6.3.2.13 Standard water meters shall be installed at each house, building, facility etc.

6.3.2.14 Pipelines are to be designed to ensure zero percent leakage and shall be hydraulically tested to a pressure of between 1.50 and 1.75 times the maximum designed working pressure for a minimum period of three hours.

6.3.2.15 Fire Fighting Design shall be in accordance with the National Building Regulations, SABS 0400 1990 and as required by the appropriate Metropolitan Council and shall be officially approved by the local fire fighting authority.

6.3.2.16 Fire hydrants are to be above ground, tamper proof, right angled and in accordance with SABS 1128 and the local fire fighting authorities requirements.

6.3.2.17 When water is required by the local fire fighting authority; the Fire Hydrant Criteria shall be as follows or as required by the local fire fighting authority:

Risk Zone	**Areas Covered**	**Flow**	**Residual head (kPa)**
High	Aircraft hangars, fuelling areas, fuel stores and munitions stores	200l/s from all hydrants within 270m radius	300 Unless otherwise approved by the Departmen t
Mediu m	Admin, maintenance facilities and passenger terminals	100l/s from all hydrants within a 270m radius (maximum of 4 hydrants per fire)	150
Low	Residential areas	8l/s from any one (1) hydrant	60

6.3.2.18 The average daily water demand, is as follows:

a	Offices	40 λ/10m²/d
b	Residential areas	1 275 λ/erf/d
c	Hangers, warehouses etc	0 λ/d
d	Ablutions	25 λ/c/d
e	Hostels and single quarters	150 λ/c/d
f	Factories and workshops	100 – 150 λ/c/d
g	Restaurants and kitchens	65 – 90 λ/c/d
h	Recreational areas	65 λ/c/d
i	Schools	15-20 λ/c/d
j	Sport grounds and parks	10-15 kλ/ha/d

6.3.2.19 The peak factors are as follows:

a	For commercial, office and industrial areas	5
b	For residential areas	As per Fig 9.9: Water Supply: Red Book

6.3.2.20 Minimum residual pressure head at any point of consumption (without fire flow)

a	For commercial, office and industrial areas	300 kPa
b	For residential areas	240 kPa

6.3.2.21 The minimum distance of mains from buildings, is as follows:

a	High and medium risk dolomite areas	15 m
b	Low risk dolomite areas	5 m

6.3.2.22 Friction coefficient for HDPE pipes:

a	Colebrook White	k = 0,1 mm
b	Manning	n = 0,010

6.3.2.23 Cover to water pipes

a	Average	0.75 m
b	Outside traffic areas	0,75 m (min)
c	In traffic areas	1,0 m (min)

6.3.2.24 All buildings are assumed to be fully occupied for hydraulic design.

6.3.2.25 No direct connections shall be allowed on primary mains, unless approved by the Department.

6.3.2.26 All valves, meters, fire hydrants, pressure reducing valves, manholes and junction boxes shall be clearly marked with numbers to be supplied by the project manager. Marking shall be by numbering cast into the concrete on top of structures. Marking symbols and numbers to be approved by

the Department.

6.3.3 Sewerage Design

6.3.3.1 Replace all sewers with Type PE 100, PN 10 HDPE pipes to SABS ISO 4427.

6.3.3.2 All manholes to be watertight heavy duty welded HDPE (Type PE 100) with minimum ring stiffness 8 kN/m^2 and with sewer pipes welded to the manholes. Where approved by the Department, cast in-situ watertight dolomite aggregate reinforced concrete manholes with HDPE puddle-flanges welded to the HDPE pipes may be used. (See details TYPE DT 11-1/W, TYPE DT 12/W, TYPE DT 04/D, and TYPE DT 09/D)

6.3.3.3 In non-dolomitic classified areas conventional concrete manholes with mastic sealed joints can be used.

6.3.3.4 HDPE pipes are to be joined by butt-welding unless otherwise approved by the Department. Electrofusion welding will only be allowed in special circumstances.

6.3.3.5 Where possible, all pump stations and septic tanks are to be eliminated.

6.3.3.6 Designs are to ensure zero percent leakage and sewers shall be water pressure tested at a pressure of between 100 and 150 kPa for a minimum period of two hours. Testing to be as otherwise specified in Clause 7 of SABS 1200 LD.

6.3.3.7 All existing buildings are assumed to be fully occupied for hydraulic design.

6.3.3.8 Provide special measuring manholes suitable for installation of portable sewage flow meters where sewage enters municipal areas or feeds into local sewage treatment works. (Venturi type is preferred for average flows in excess of approximately 10 λ/s.)

6.3.3.9 The average daily design sewage flow, is as follows:

a	For offices	35 λ/10m²/d
b	For residential areas	750 λ/erf/d
c	For hangers, warehouses etc	0 λ/d
d	For ablutions	25 λ/c/d
e	Hostels and single quarters	140 λ/c/d
f	Factories and workshops	90 - 140 λ/c/d
g	Restaurants and kitchens	60 λ/c/d
h	Recreational areas	60 λ/c/d
i	Schools	13 - 18 λ/c/d

6.3.3.10 Applicable Peak Factor……3.0

6.3.3.11 Applicable friction coefficients:

(a) Colebrook White ……0,6 mm

(b) Manning ……0,012

6.3.3.12 Where contours permit the minimum gradient for any sewer shall be such that the following minimum velocity is obtained 0,6 m/s at peak design flow

6.3.3.13 In flatter terrain, the sewer gradient may be reduced to obtain the following minimum velocity 0,7 m/s at full bore flow

6.3.3.14 Maximum spacing between manholes…….100 m

6.3.3.15 Cover to pipes

a	Average	0.75 m
b	Outside traffic areas	0,60m (min)
c	Inside traffic areas	1,0 m (min)

6.3.3.16 Minimum sewer diameter (nominal diameter)……..160 mm

6.3.3.17 Minimum diameter for sewer house connections (nominal diameter) ……...160 mm

6.3.3.18 Minimum diameter for pump station rising mains (nominal diameter)……110 mm

6.3.3.19 Minimum pump flow velocity in rising mains……...1,0m/s

6.3.3.20 Maximum pump flow velocity in rising mains……..2.0m/s

6.3.3.21 Sewage pump stations shall be equipped with dry well sewage pumps, a “Muncher” and a diesel electric emergency standby generator and an alarm system as approved by the Department.

6.3.3.22 Storm water infiltration into sewers……..0 λ/s

6.3.4 Storm water Design

6.3.4.1 When existing concrete pipes are to be sleeved, HDPE Type PE 100, class PN10 SABS ISO 4427 pipes are to be used.

6.3.4.2 Replace all other concrete storm water pipes with either HDPE (Type PE 100) solid (class PN10) or structured wall (8 kN/m^2) pipes up to 900 mm diameter or suitable, protected open channels where approved by the Department.

6.3.4.3 Provide items to repair or replace storm water pipes larger than 900 mm with HDPE or concrete spigot and socket pipes with rubber rings. Include both types in Schedule of Quantities in 30:70 ratio.

6.3.4.4 Existing concrete pipes with rubber rings larger than 900 mm diameter that have sagged are to be replaced with HDPE or open channels as approved by the Department.

6.3.4.5 It is critically important that open areas be reshaped and areas of ponding be identified to ensure positive storm water drainage.

6.3.4.6 Joint seals in concrete channels, box culverts and manholes are to be cleaned and re-sealed watertight with polysulphide to manufacturer's specifications.

6.3.4.7 Cable ducts shall be provided in accordance with user requirements. Draw boxes and sleeves shall be similarly watertight constructed and tested as for sewers.

6.3.4.8 Old abandoned civil engineering services and sleeves without cables are to be removed or grouted with suitably designed soil-cement (12:1) mixture to prevent the ingress of water.

6.3.4.9 All HDPE pipes shall be butt-welded unless otherwise approved by the Department. Electrofusion welding will only be allowed in special circumstances.

6.3.4.10 Storm water manholes and junction boxes shall be of welded HDPE (Type PE 100) with ring stiffness 8kN/m^2. Where approved by the Department, watertight cast-in-situ reinforced concrete manholes with HDPE puddle flanges welded to the HDPE pipes may be used. Storm water manholes and junction boxes are to be sealed and tested for 0 % leakage. See also item 8.9.

6.3.4.11 Where pipe directions change under trafficked areas, a junction box is to be used. If it occurs outside trafficked areas, manholes are to be used.

6.3.4.12 Open channels in residential areas and near traffic zones shall be properly covered/protected as approved by the Department.

6.3.4.13 The Rational Method is to be used for design flood calculations.

6.3.4.14 Design minor systems for a storm with recurrence time of…...
……1:2 years

6.3.4.15 Design major systems for a storm with recurrence time of…...
……1:25 years

6.3.4.16 Minimum pipe diameter (excluding gutter and similar connections)……450mm

6.3.4.17 Slopes of storm water pipes shall preferably be steeper than.
……1 %

6.3.4.18 Cover to pipes:

a	Average	0.75 m
b	Outside traffic areas	0,60m (min)
c	Inside traffic areas	1,0 m (min)

6.3.4.19 Friction coefficients:

a	Colebrook White friction coefficient (including secondary losses)

i	Plastic pipes	k = 0.6 mm
ii	Concrete pipes	k = 1.5 mm

b	Manning friction coefficient (including secondary losses)	
i	Plastic pipes	0,012
ii	Concrete pipes	0,013

6.3.5 Pipe work design at or near buildings

Water pipe work above ground shall be of Hot Dipped Galvanized Heavy Duty steel to SABS 763 and be fixed above ground against the building. Manifold(s) shall be above ground with single HDPE feeds from below ground, where applicable.

The sewer pipe work above ground shall be solid wall class 34 heavy-duty uPVC to SABS 791 fixed against the building. Manifold(s) shall be **above** ground connecting with Kimberly Sockets to below ground HDPE pipes.

6.4 Requirements for HDPE piping and fittings

6.4.1 Scope

This material specification outlines the requirements for the manufacture of PE-HD (High Density Polyethylene) Pipes & Fittings to be utilised.

6.4.2 Quality assurance

It is the responsibility of the manufacturer/supplier to establish Quality Assurance by means of quality control procedures, which shall ensure that the product will meet the requirements of this specification. The manufacturer/supplier shall maintain a quality system that conforms to the requirements of the SABS ISO 9001:2000 or national equivalent. Applicable standard for manufacture of pipe shall be SABS ISO 4427.

It is the responsibility of the design engineer to ensure that all material and manufacturing details of all pipes, fittings and structures are appropriately specified in terms of the relevant SABS (or equivalent) specifications in the tender documents and that the contractor supply and install all material to the required SABS standards on site. Tender documentation must include or refer to all relevant requirements, certification or testing that may be necessary for quality insurance of raw material supply, manufacturing standards, equipment used in manufacturing or tests to ensure standards are met. Refer to SABS ISO 4427, SABS 0268, SABS 0269, SABS 0270, SABS method 1269, SABS 1655, SABS 1671 and relevant specifications. Tender documentation must allow for relevant quality control testing either by means of an appropriate clause (stating type of test and quantity) or by inclusion (specific stipulation of test requirements) in the price of the manufactured/installed item.

6.4.3 Inspection

The design engineer must ensure that pre-delivery tests are conducted at the manufacturer's/supplier's works.

Tender documentation must stipulate that the contractor will arrange with the supplier access to his works for the purpose of inspecting either during

the course of manufacturing or when completed and shall permit the design engineer all reasonable access to conduct such inspections.

Copies of all test schedules and manufacturer's quality control records as called for in the relevant SABS (or similar) specifications and tender specifications shall be submitted by the contractor for examination by the design engineer.

6.4.4 General product requirements

The finished product shall be free from cracks, voids, foreign inclusions and other defects, which would impair the overall performance. It shall be smooth walled on inside and outside and shall conform to the requirements (characteristics) outlined below.

6.4.5 Characteristics

Raw material composition for pipes, fittings (e.g. stubs) and other elements (e.g. sheeting for benching) shall be **PE 100 pre-compounded black.**

6.4.5.1 Technical considerations for raw material and finished product:

Physical/Chemical Property	**Standard**	**Value**	**Unit**
Density	ISO 1183	0.949-0.960	g/cm^3
Melt Flow Index (190°C/5Kg)	ISO 1133	0.25-0.35	g/10min.
Vicat Softening Point	ISO 306	64-68	°C
Crystalline Melting Range	ISO 3146-85	130-135	°C
Viscosity Number	ISO 1628-3	390	cm^3/g

Mechanical Property	**Standard**	**Value**	**Unit**
Shore D, Hardness	ISO 868	61	-
Elastic Modulus	ISO 527	∞900	MPa
Tensile @ Yield	ISO 527/ISO 6259	24	MPa
Ultimate Tensile	ISO 527/ISO 6259	35	MPa
Ultimate Elongation	ISO 527/ISO 6259	>600	%
Flexural Stress (3.5% Deflection)	ISO 178	19	MPa
Thermal Stability (OIT @ 210°C)	ISO 10837	>40	minutes
Carbon Black Content	ASTM D 1603/ISO 6964	2.25 +/- 0.25	%

6.4.5.2 Pipe characteristics

Characteristics	**Applicable Standard**
Outer Diameter	ISO 11922-1 (Grade B)
Min Wall Thickness @ any point	ISO 11922-1 (Grade U) – ISO 4065
Ovality	ISO 11922-1 (Grade N)

6.4.6 Welding requirements

PE-HD pipes and fittings welders to be certified under the Thermoplastics Welding Institute of South Africa (TWISA)

The following standards shall apply:

SABS 0268 Part 1	Welding of thermoplastics - Welding processes - Heated tool welding
SABS 0268 Part 2	Welding of thermoplastics - Welding processes - Electrofusion welding
SABS 0268 Part 3	Welding of thermoplastics - Welding processes - Hot gas welding
SABS 0268 Part 4	Welding of thermoplastics - Welding processes - Hot-gas extrusion welding
SABS 0286 Part 10	Welding of thermoplastics - Welding processes - Weld defects
SABS 0269	Welding of thermoplastics - Testing & approval of welders
SABS 0270	Welding of thermoplastics - Approval of welding procedures and welds
SABS method 1269	Welding of thermoplastics – Test methods for welded joints
SABS 1655	Welding of thermoplastics – Weding rods, fillers and solvents
SABS 1671 Part 1	Welding of thermoplastics – Machines and equipment – Heated tool welding
SABS 1671 Part 2	Welding of thermoplastics – Machines and equipment – Electrofusion welding
SABS 1671 Part 3	Welding of thermoplastics – Machines and equipment – Hot-gas welding
SABS 1671 Part 4	Welding of thermoplastics – Machines and equipment – Hot-gas extrusion welding

6.4.7 Raw material acceptance tests:

The material used for the production of the pipe and fittings or structures shall be a high-density polyethylene (PE-HD) PE 100. To ascertain the quality of this product the following tests shall be performed.

- Density
- Melt Flow Index
- Carbon Black Content
- Thermal Stability

6.4.8 Testing of pipes

Testing as contained in the SABS ISO 4427 specification shall apply. Tests shall also be conducted ad-hoc by a registered and authorised testing body as determined by the Department of Public Works.

6.4.9 Documents to be submitted by pipe manufacturer:

Certificate of Registration – SABS ISO 9001:2000 or National Equivalent
Permit Certification – SABS ISO 4427 for PE 100
Quality Control Plan (QCP shall include Raw Material and Product Test Certificates)
SABS or National Equivalent Quality Systems Audit Reports – Last 2 Audits

6.4.10 Pipe marking

All PE-HD Pipes shall be indelibly marked at 1 meters intervals with the following details:

Reference item	**Mark printed**
Trade name	Manufacturer/Supplier Name
Specification	SABS ISO 4427
Pipe OD	e.g. 160
Pipe OD tolerance	Grade B
Wall thickness	e.g. 7.7
Nominal pressure	e.g. PN 10
Material designation	PE 100
Batch no.	Manufacturer/Supplier Trace ability

Typical example: " **SUPPLIER-A SABS ISO 4427 160 B X 7.7 PN 10 PE 100 BATCH NO. 123456**

7. GENERAL CONTRACT CONDITIONS, APPENDICES AND ANNEXURES

These shall be strictly in accordance with the Department of Public Works requirements in letter, format and sequence. This also applies to the contract document cover and index.

8. SPECIFICATIONS, CONSTRUCTION REQUIREMENTS AND SCHEDULE OF QUANTITIES

8.1 The General Conditions of Contract for Civil Engineering Construction 1990 (GCC 1990) shall be applicable. Refer to latest copy of specials/amendments.

8.2 Tender document and Schedule of Quantities shall be drawn up in accordance with SABS 1200 Specification except where amended by the Department.

8.3 No dumping is allowed on Site other than at the designated and approved fill areas. Dumping will only be allowed for filling sinkholes and dolines and may not be detrimental to the natural storm water drainage of the area. Only soil, rock and clean masonry and concrete rubble may be dumped in the designated dump areas.

8.4 No borrow pits are allowed on Site.

8.5 No overhaul is payable on any material whether on site or off site.

8.6 All backfill for trenches, manholes etc, shall be composed of material which, after compaction, will be less permeable than the in-situ soil. This applies to pipe bedding, blanket and surround material as well.

8.7 Rate-only items shall as far as possible not be used. Balance quantities out to allow a reasonable quantity of each item, which may be required on Site.

8.8 All storm water pipe work shall also be HDPE pipes except where otherwise approved by the Department. Provide therefore also items with quantities for HDPE storm water pipes up to the maximum available in the RSA, in addition to concrete pipes with rubber rings for the larger storm water pipes.

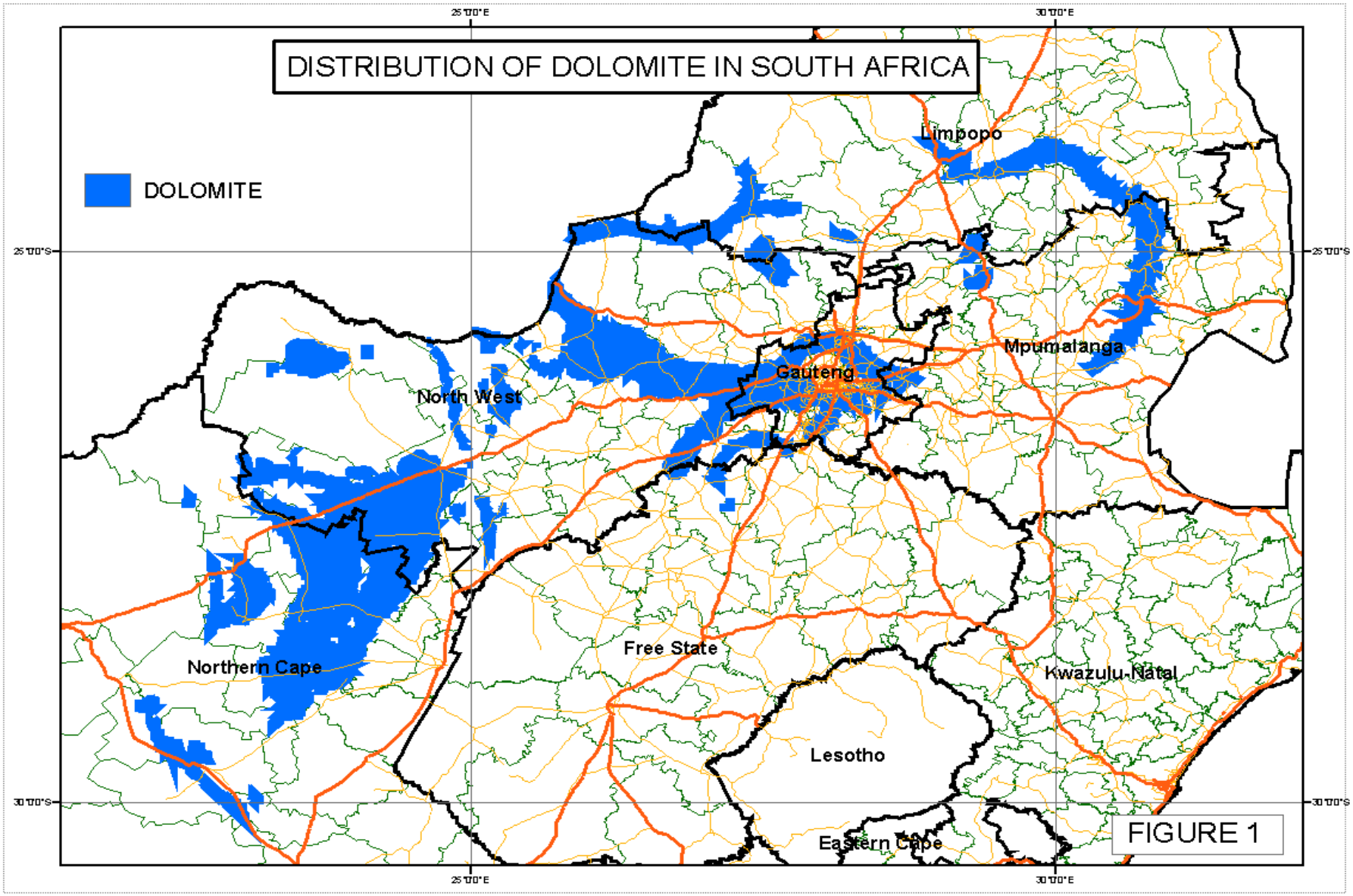
8.9 Each manhole and junction box shall be sealed and then filled to the brim and independently tested for zero leakage over a minimum period of 48 hours.

8.10 No contingency sums/items are allowed.

8.11 Where trench excavated material is utilized for bedding, surround and backfill materials, the materials shall be compacted to at least 93 % Mod AASHTO or the density of the in-situ soil, whichever is higher. Where imported materials are used for trench bedding, surround or backfill materials, laboratory permeability and density tests shall be conducted on both the in-situ trench material and the imported materials to ensure that the bedding, surround and backfill materials are less permeable than the in-situ soil after placement and compaction to at least 93 % Mod AASHTO. Suitable bill items shall be provided in the Schedule of Quantities for all the above work.

8.12 Bedding material shall conform to SABS 1200LB subject to the maximum aggregate not exceeding 6mm and the permeability to be lower than the in-situ soil.

8.13 Tender specifications in terms of HDPE pipes, fittings and structures shall include or refer to all relevant specifications as per this document. The tender must specifically state that the tender acceptance shall be subject to the submission (one submission only) and approval of the HDPE product manufacturer/s or supplier/s to be used by the tenderer. Such submission may be called for during evaluation of tenders. The Department reserves the right to reject a tender if the proposed manufacturer or supplier of HDPE products does not meet the requirements as stipulated in the relevant SABS (or similar) specifications.


DISTRIBUTION OF DOLOMITE IN SOUTH AFRICA
DOLOMITE
25°00'E
30°00'E
25°00'S
30°00'S
Limpopo
Mpumalanga
Gauteng
North West
Northern Cape
Free State
Kwazulu-Natal
Lesotho
Eastern Cape
FIGURE 1

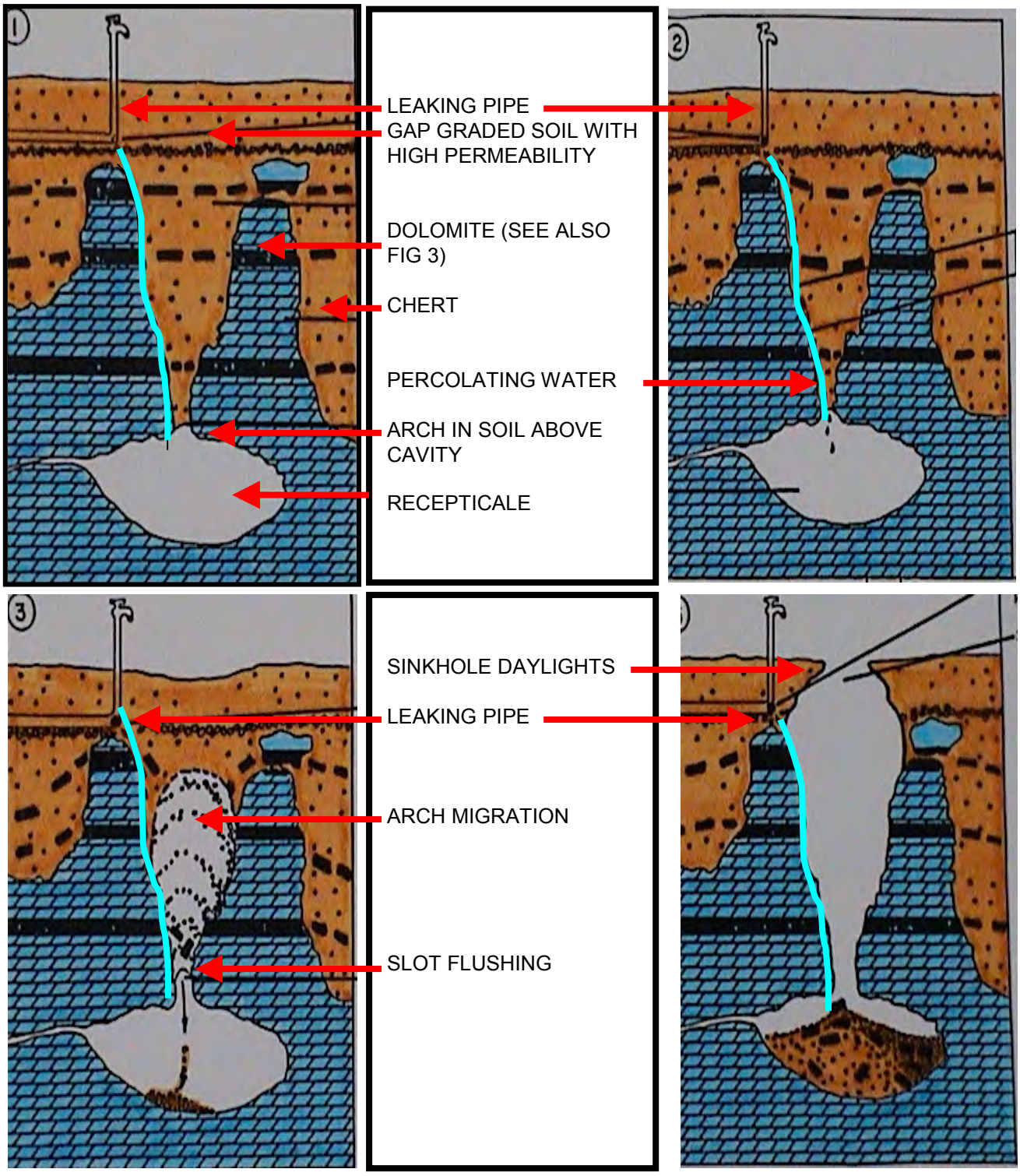


FIGURE 2: MECHANISM OF SINKHOLE FORMATION

FIGURE 3: SUBSURFACE DOLOMITE PROFILE SHOWING PINNACLES AND SOIL FILLED FRACTURE ZONES

PLATE 1: TYPICAL SINKHOLE (50 M DEEP)

PLATE 2: SINKHOLE AS RESULT OF LEAKING STORM WATER CANAL

PLATE 3: SINKHOLE ON HIGHWAY (AS RESULT OF LEAKING WATER PIPE)

PLATE 4: SINKHOLE AS RESULT OF STORM WATER INGRESS

PLATE 5: SINKHOLE AS RESULT OF LEAKING WATER MAINS

PLATE 6: SINKHOLE AS RESULT OF LEAKING WET SERVICE

PLATE 7: LARGE SINKHOLE AS RESULT OF DEWATERING

PLATE 8: BUILDING MOVEMENT AS RESULT OF DOLINE

PLATE 9: BUILDING MOVEMENT AS RESULT OF DOLINE FORMATION

APPENDIX 1

PRO FORMA GEOTECHNICAL INFORMATION SHEET FOR TOWNSHIP PROCLAMATION STAGE CIRCULATION OR PROCUREMENT OF NEW SITES

The following format and relevant clauses are to be incorporated in the documentation to be submitted by any developer seeking approval for proclamation or wishing to sell property to GOVERNMENT DEPARTMENTS for the purpose of erecting police/court/community or other state facilities on dolomitic land.

PROPOSED GENERAL PLAN OF ..... (township name) FOR TOWNSHIP ESTABLISHMENT

PROVIDE TITLE / REFERENCE NO / DATE / AND AUTHOR OF GEOTECHNICAL REPORT FOR TOWNSHIP PROCLAMATION OR SITE TO BE SOLD:

STANDS ALLOCATED FOR THE DEPARTMENTS OF CORRECTIONAL SERVICES/ JUSTICE/POLICE/DEFENCE OR PUBLIC WORKS FOR ERECTION OF FACILITIES

GEOTECHNICAL CONDITIONS ON PROPOSED SITE

The township applicant/seller hereby certifies that the geotechnical engineer/engineering geologist has certified that the layout and land allocation complies with the recommendations set out in his/her geotechnical report which was compiled in terms of current engineering geological practice.

ALLOCATED STANDS

1. **POLICE** (stand no:_____/ size _____)
   Dolomite stability risk zonation as portion (%) of total site: Inherent Risk Class 1:…...…%, Inherent Risk Class 2,3 and 4:…..…..%, Inherent Risk Class 5,6,7 and 8:…...….%
2. **JUSTICE** (stand no:_____/ size _____)
   Dolomite stability risk zonation as portion (%) of total site: Inherent Risk Class 1:…...…%, Inherent Risk Class 2,3 and 4:…..…..%, Inherent Risk Class 5,6,7 and 8:…...….%
3. DEFENCE (stand no:_____/ size _____)
   Dolomite stability risk zonation as portion (%) of total site: Inherent Risk Class 1:…...…%, Inherent Risk Class 2,3 and 4:…..…..%, Inherent Risk Class 5,6,7 and 8:…...….%
4. **CORRECTIONAL SERVICES** (stand no:_____/ size _____)
   Dolomite stability risk zonation as portion (%) of total site: Inherent Risk Class 1:…...…%, Inherent Risk Class 2,3 and 4:…..…..%, Inherent Risk Class 5,6,7 and 8:…...….%
5. **PUBLIC WORKS** (stand no:_____/ size _____)
   Dolomite stability risk zonation as portion (%) of total site: Inherent Risk Class 1:…...…%, Inherent Risk Class 2,3 and 4:…..…..%, Inherent Risk Class 5,6,7 and 8:…...….%

DRAWINGS ATTACHED

Township layout and site with dolomite risk zoning indicated as well as position of boreholes and test pits.

DOCUMENT ATTACHED

Detail geotechnical report compiled in terms of current practice.

SPECIAL DEVELOPMENT CONDITIONS OR SITE SPECIFIC COMMENTS

Comments to be furnished by geotechnical engineer.

SPECIAL CLAUSE TO FORM PART OF CONDITIONS

The developer shall ensure that nor borrow, fill or surficial soil disturbances occur during the township construction/development phase.

Storm water alterations due to development shall not negatively impact on current natural drainage of the proposed property.

No site camp for construction purposes shall be allowed on the properties.

Special conditions hereto shall form part of the construction contract documentation.

.....	.....	.....	.....
DEVELOPER	DATE	TEL.	FAX

APPENDIX 2

MINIMUM REQUIREMENTS FOR A GEOTECHNICAL INVESTIGATION ON A DOLOMITIC SITE

1. THE GEOTECHNICAL INVESTIGATION TO BE UNDERTAKEN SHALL INCORPORATE AND REPORT ON THE:

- geophysical investigation
- borehole work
- geological investigation
- geohydrological data
- Dolomite risk characterisation procedure
- surficial soils mantling the site and comment on the immediate environs
- Dolomite stability zonation

2. THE SITE SHALL BE DEMARCATED INTO RISK ZONES ACCORDING TO CURRENT PRACTICE.

3. OTHER FEATURES TO BE INCORPORATED AND COMMENTED ON WITH REGARD TO SPECIAL SITE CONDITIONS ARE:

- Previous investigations
- Old borrow pits
- Rehabilitated areas
- Dumpsites
- Water boreholes
- Permanent or temporary natural water drainage features traversing the site

4. REPORT FORMAT

The geotechnical report shall be structured as follows:

4.1 Terms of reference

4.2 Existing information

4.3 General location and description of site

4.4 Procedures used in the investigation:

- Desk studies
- Gravity survey
  (Note: Only drilling will be required if the footprint of building is fixed).
- Drilling programme
- Trail holes
- The visual inspection procedures used shall be referenced, i.e. Jennings et al (1973).
- Laboratory Testing. The original lab reports shall be incorporated in the report

4.5 Geology and geohydrology

4.6 Dolomite stability characterisation:

- Describe and reference the methodology used in the risk characterisation of the site.
- Current practice requires discussion of stability conditions in terms of: **Proposed method for dolomite land hazard and risk assessment in South Africa**, SAICE Journal Vol 43(2) 2001, paper 462 pages 27-36., Buttrick et.al.).

- Provide the risk characterisation of the site
- Outline the motivation for the risk characterisation of each zone.

4.7 Additional Geotechnical Considerations

- Potential problematic soils at surface level
* Active soils
* Collapsible soils
* Disturbed natural profiles (borrow, fill)

4.8 Conclusions and recommendations

- Risk characterisation
- Indicate remedial Work
- Indicate specific/special site development criteria
- Recommendation concerning appropriate development of site.
- Precautionary measures.

5.0 DATA CAPTURING IN REPORTS

The Department requires standardised data capturing forms as to ease evaluation of consultants information. The following information needs to be provided in standardised format:

- Site layout: 1:500 scale drawings showing the exact positions of:

  * Test pits
  * Boreholes (old and new)
  * Gravimetric survey
  * Specific site features
  * Risk zones
  * Proposed optimum location of buildings
  * Boreholes for water
  * Site contours (if available)

- The following information (where applicable) needs to be provided on departmental soil laboratory standardised formats:

  * Characterisation of borehole data
  * Percussion borehole drilling report
  * Test pit profiling report
  * Foundation indicator report
  * Consolidation test report
  * CBR reports

  Note: Consultant to contact departmental soil laboratory to obtain standard forms for the above.

APPENDIX 3

PRELIMINARY SITE INVESTIGATION BY THE PRINCIPAL AGENT: DOLOMITE STABILITY RELATED MATTERS

Reports presented to the Department for the development of a site (as per PRM 17) should on a minimum have the following information:

- Cadastral information

- Site contours

- Services
  * Existing services that traverse the site
  * Comprehensive reporting on condition and upgrading requires or shifting thereof)

- Roads
  * Township roads (surfaced/gravel/non existing)

- Water
  * Municipal connection
    Size
    Pressure
    Type
    Exact location of connection

- Storm water
  * Natural drainage features
  * Drainage of the surrounding area
  * Canals (lined, unlined, general condition)

- Sewer
  * Municipal connection
    Location
    Size
    Type
    Possible connections

- Electricity and communication

- **Geotechnical risk zonation**

APPENDIX 4

ENGINEERING SITE INVESTIGATION OF INFRASTRUCTURE ON DOLOMITE: SCOPE OF WORK

CONTENTS:

1. SITE LAYOUT DRAWINGS

Base information
Water - Drawing number.....
Sewer - Drawing number.....
Storm water - Drawing number.....
Roads - Drawing number.....
Paving - Drawing number.....
Building Layout - Drawing number.....

2. GENERAL INVESTIGATION INFORMATION

Building number:	
Base / unit	
Responsible person	
Alternative building name	
Previous name (if any)	
Physical location	
Stand number	
Farm portion	
x-y coordinates of known	
Age	

General comments from site representative regarding the following:

Ponding of storm water on the site.
Repairs to water pipes.
Blockages of sewer system.
Cracks in buildings.
Known incidences of dolines or sinkholes on the site or in the surrounding area

Names of all contractors that do regular maintenance on the site:

Service	**Contractor**	**Tel. no**
Water		
Sewer		
General Building		
Storm water		

Information of occupants (date / /).

Description	Now	Future
Number of persons present.		
Number of total staff.		
Maximum capacity required.		
Maximum personnel capacity		
Maximum number of persons during special events.		

Information regarding services.

- Monthly water consumption for the last 12 months.
- Municipal account number

3. GENERAL INFORMATION REGARDING SURROUNDING AREA

Indicate the following on site layout drawing:
- General drainage of surrounding area onto the site.
- Type of roads surrounding the site.
- Type of storm water system surrounding the site.

4. WATER

Position of water meter
- Indicate on site layout (type, condition, shut-off valve, leakages, valve box, lockable, condition)

Pressure test
- Results, pressure and leakages

Approximate route of main water supply.
- Inspect routes for:
  Depressions
  Trees (5m zone)
  Unnatural green grass patches
  Wet patches
  Excavate and report on condition of pipe

External reticulation
- Fire hydrants
- Garden taps
- Sports fields (size, type of irrigation, frequency of irrigation)

Building reticulation
- Indicate position of pipe distribution around building and inspect this route for any visible leakages, depressions etc.

Internal fittings (Check for leakages, damages and general condition)
- Washbasins
- Toilets

- Urinals
- Drinking fountains (excess water drainage facility)
- Fire hose reels

Pipes above natural ground level for entry into the buildings
- Pipes through walls (allowance for movement)
- All connections between flexible and rigid pipes shall be provided with flexible, self-anchoring joints.
- Pipes under floor slabs (service ducts, inspect able)

The selection of piping material and corrosion factors (both external and internal – i.e. galvanised to copper etc.).

5. SEWER

Pit latrines
- Indicate position, number, can storm water ingress, type of structure, position of previous pit latrines, duration in use.

Soak-away
- Describe condition and size of septic tank and indicate position. Indicate position of subsurface soak-away, evidence of overflowing)

Conservancy tank
- Position, size, general condition, empty cycle, contractor currently employed to empty, evidence of overflowing)

Sewerage works
- Type, condition, age
- Discharge
- Reed beds, maturation ponds etc.

Water borne system
- Manholes (position, type, condition, dept, type of pipe, size of pipe, indicate regular overflowing, silt deposits etc.)
- Route (type of pipe, recent modifications, inspect line for depressions or unnatural green patches and trees or vegetation on the route).

Outlets from buildings
- Position, accumulation route, cleaning and rodding eyes, valleys, inspect for general condition and indicate which portion is above and which below ground level, leakages, regular overflowing, general condition of surrounding area, paving, grass, etc.)
- Pipes above natural ground level for entry into the buildings
- Pipes through walls (allowance for movement)
- All connections between flexible and rigid pipes shall be provided with flexible, self-anchoring joints.
- Pipes under floor slabs (service ducts, inspection possible)
- Area of high concentration of sewer outlets out of buildings (condition)
  WC pans (provided with a flexible connection).

6. STORM WATER

General drainage onto site
- Water courses, location, ponding against boundary, entry at drive ways etc., canals, general slopes, position, etc.

Drainage system of surrounding area

The diversion of drainage onto the site
- Earth berms, cut off trenches etc.

Diversions of natural watercourses on the site

Natural ponds and watercourses located within 30m of any structure.
- Type, lining material, etc.

Drainage of site and surrounding area
- Free drainage of surface water
- Areas of ponding on the site
- Indicate any areas with gradients less than 1:100

Site fence
- Type of fence, position of storm water in/outlets, conditions of outlets, ease of draining, clogging, vegetation etc.

Lowest point of the site.

Storm water canals on the site.
- Gradients, type, size, position, condition, joint sealant, cracking, displacement, panel lengths, expansion joints, depositing of silt, or sand

Storm water pipes
- Gradients, type, position, size, location, age, general condition, inlet structures

Storm water drainage around buildings and up to 10 metres away.
- On surface, open canals, surfaced areas).

Sloping of surfaces around buildings.

Drainage in passages or between buildings
- Slope and direction of flow)

Drainage towards a structure.

Storm water pipes and gulleys next to, under or parallel to buildings.

Drainage of grassed areas such as sports fields (minimum of 1:80)

Water tightness of all conduits.
- Tests for leakage.

Concrete non-pressure pipes
- Type, size, condition.

Joints in box culverts, manholes and inlet grids to subsurface systems

Gutters
- Condition of gutters
- Position of down pipes
- Canals from down pipes

Drainage away from structure
- No gutters
- Investigate the site drainage efficiency.

- Apron slabs (type width, position, condition)

7. GARDENING

Indicate all gardening and flower boxes in between or around structures

Inspect for type of gardening activity
- Excessive watering, algae, moss growth, type gardening and general condition

8. PAVED AREAS

Indicate on drawings all paved areas (e.g. drive ways and parking areas)

Type and current state

Accumulation of debris

Gradients

Purpose to facilitate drainage.

9. FOUNDATIONS

Foundation type

Exposed foundation or lowering of surrounding ground is causing exposure.

Termite activity

10. BUILDINGS

Building (original structure) (indicate in black ink)

Date of additions or alterations (indicate in red ink)

Comment on each structure individually and if known on the type foundation, bricks used etc.)
Inspect each individual structure and indicate on drawings exactly position of all cracks and magnitude of deformation.
- Mark origin and end of all crack on date of inspection and give indication of size.
- All cracks in excess of 1 mm and longer than 1 metre must be inspected on a regular basis and propagation thereof reported immediately.

Indicate all construction and expansion joints in buildings.

Indicate whether cracks are related to normal stress relieve, foundation settlement or heave, inadequate design or originate where different material types match, etc.

Compile exact diagrams of crack survey.

11. SWIMMING POOLS AND FISH PONDS/WATER FEATURES

Location, size, type, age, general condition

Replenishment system,

Surrounding paving

Waste/backwash and other water from swimming pools discharged system (piping or open drainage systems).

Splash drainage (impervious, brick paving, concrete paving, grass, distance). Drainage canal to collect splashed water.

Discharge point (not closer than 20 metres from pool)

Storm water drainage of area surrounding the swimming pool

Gardening of area surrounding the swimming pool

12. WATER TANKS

Type, location, condition, depth, height.

13. ELECTRICITY AND COMMUNICATION

Sleeve and draw box systems
- Condition and type. (watertight?)

Position

Trenching, backfilling and compaction of trenches

14. SITE MAINTENANCE

General condition of site and building surrounds (general upkeep)

Presence of ash/dump pits and storm water drainage in that area

Sandpits or areas of soil removal

15. BOREHOLES FOR GROUND WATER ABSTRACTION

Position

Permission to sink boreholes as a control on dewatering.

Capacity (pump equipment).

16. GEOLOGICAL

Risk classification of the site
Indicate on the layout known geological zones
Note site conditions (surficial soils, rock outcrop, sudden changes in soil profile, and soil consistency/type)

Sinkholes, dolines or any other depression

APPENDIX 5

TYPICAL ENGINEERING DETAILS FOR SERVICES ON DOLOMITIC LAND

Typical, minimum standard, details for engineering designs on dolomitic land are included in this section. These details and specifications are to be extended/improved to suit the site-specific conditions. All drawings and specifications are to be checked by the design engineer.

CONTENTS:

Special Note: (Not for printing)

Insert drawings schedule after this page.
For separate drawings visit the Department of Public Works website at:

http://www.publicworks.gov.za/docs/consultants/

APPENDIX 6

PARTICULAR SPECIFICATIONS

The following specifications deals with the particular requirements of work to be executed in dolomitic areas.

PA: PARTICULAR SPECIFICATION: DYNAMIC COMPACTION

PB: PARTICULAR SPECIFICATION: BLASTING REQUIREMENTS

PC: PARTICULAR SPECIFICATION: REPAIR OF SINKHOLES

PD: PARTICULAR SPECIFICATION: EXPLORATORY DRILLING FOR ENGINEERING GEOLOGICAL INVESTIGATION

PE: PARTICULAR SPECIFICATION: SUBSURFACE GROUTING

PF: PARTICULAR SPECIFICATION: DEMOLISHING OF STRUCTURES

PA: PARTICULAR SPECIFICATION FOR DYNAMIC COMPACTION

Note: * Values indicated to be changed to suit project

PA 1 TENDERER' S EXPERIENCE

Tenderer is to submit in appropriate Annexure details regarding experience in field of dynamic compaction or shall reference experience of the Subcontractor who will be responsible for the execution of this work.

PA 2 EQUIPMENT

Equipment shall comprise of the following mobile unit/s:

1. Mobile Crane (* 60 tons) fitted with boom and appropriate cable, clutch and braking system to handle *12 tons free falling square tamper with face not to exceed 1,0x1,0 m as well as a 12-ton ball type tamper of 900 mm diameter face and a 3,0 m diameter 12-ton ironing tamper.

2. The Boom configuration shall allow drop height of *18 metres measured from normal ground level whilst closest portion of the crane is a minimum of 13 metres away from point of impact. Furthest point of impact to be possible shall be a minimum of 20 metres

3. Crane to stay stable in the event of weight dropping into a cavity beyond its normal cable and braking configuration.

4. Cable shall allow for accidental dropping to a depth of 20 metres below ground level.

Details of equipment to be furnished on appropriate Annexure

PA 3 ADDITIONAL EQUIPMENT AND LOSS OF EQUIPMENT

Compaction is carried out in areas of highly compressible material in which subsurface cavities do exist. The Contractor shall provide for replacement of the tamper in the event of losing it.

The Employer or Engineer shall not be responsible or liable for any damages or loss of equipment. Tenderer shall take note of the adverse soil conditions as described previously.

PA 4 CONTRACTOR'S SUPERINTENDENCE

No work shall be executed unless supervised by a Suitable Representative of the Contractor who shall be made known, in writing, to the Engineer for his approval prior to commencement of the work.

PA 5 SETTING OUT OF THE WORKS

The Engineer shall set out the external boundaries of the compaction area with the Contractors' representative present.

PA 6 PRIORITY OF COMPACTION SEQUENCE

The Engineer reserves the right to determine priorities regarding the sequence of compaction at different sites.

PA 7 STANDING TIME

No provision or claims for standing time shall be heard or allowed. In the event of insufficient information to continue compaction due to lack of information or uncertainty regarding compaction sequence or the location of marked compaction positions the Contractor shall inform the Engineer 6 hours (normal business hours) in advance of planned execution of work.

PA 8 LOCATION, PROTECTION AND DAMAGES TO EXISTING SERVICES

The Engineer shall furnish the Contractor with position of sub surface services. The Contractor shall excavate up to a depth of 1,5 metres to expose such services if deemed necessary by the Engineer.

Repair of damages to under/above ground services shall be for the account of the Contractor once the position of such service was known to the Contractor or indicated by the Engineer.

All damages to be reported to the Engineer within 1(one) hour of occurrence. The Contractor needs to submit a full damage report within 24 hours.

PA9 INITIAL SITE ESTABLISHMENT AND TIME RELATED COST

PA9.1 SITE ESTABLISHMENT

Site establishment shall include provision on the site of required equipment ready for work at the first site of work. It shall also include removal from the site the aforementioned equipment and all costs related thereto. The Engineer reserves the right to terminate the Dynamic Compaction work at any time, or change the tamper size or drop height, if to his discretion the required effect is not obtained. In the event of termination shall the cost of Site Establish plus the completed work measured in m2, be deemed as full payment of work executed. No other claims for this stoppage of work shall be heard from or claimed by the Contractor.

PA9.2 MOVEMENT ON SITE

Movement on the site shall include the full cost of moving and downtime related costs of all crew and machinery between any two sites. It shall further include setting up the equipment and setting out the desired compaction grid as per engineering drawings (ref **TYPE DT 07/SH).**

Please note the movement on the site is restricted and road travelling of the crane may not always be possible. Rates for movement of the crane, between sites, under own power as well as per truck are allowed for in the Bills of Quantity.

PA10 DYNAMIC COMPACTION

PA10.1 PREPARATION WORK

The sinkhole or doline needs to be excavated to depth as directed by Engineer. Base of excavated area to be levelled off using the excavator bucket if required.

PA10.2 COMPACTION

Compaction to be executed by dropping the weight from an *18 metre height in the desired pre-marked pattern to result in an even distribution of

a. Primary compaction *15 blows per 25 m2 (engineer to specify)

b. Secondary compaction *15 blows per 25 m2 (engineer to specify)

c. Ironing/finishing compaction *2 blows per m2 (engineer to specify)

The compaction imprints shall be filled once it exceeds 700 mm in depth and between each compaction phase. The Contractor needs to record the settlement of each blow or number of blows as may be required by the Engineer.

PA10.3 MEASURED QUANTITY IN BILLS

Tenderer to note that the quantity allowed for in the Schedule of Quantities are provisional and could change depending on the site conditions encountered.

PA11 FIELD REPORT

The Contractor to provide marked drawings showing location of pre-marked grid and subsequent compaction imprints as well as the settlement per blow.

PA 12 TESTING

Plate load testing is measured in the bills of quantity as well as a provisional sum for the ordering of tests as required by the Engineer.

PA13 MEASUREMENT AND PAYMENT

PA 13.1 SITE ESTABLISHMENT AS PER CLAUSE PA 9.1

Unit rate: Sum

PA 13.2 DISMANTLING AND RE-ERECTION FOR MOVEMENT ON THE SITE UNDER OWN POWER AS PER CLAUSE PA 9.2

Unit rate: No

PA 13.3 DISMANTLING AND RE-ERECTION FOR MOVEMENT ON THE SITE PER TRUCK AS PER CLAUSE PA 9.2

Unit rate: No

PA 13.4 MOVEMENT ON THE SITE UNDER OWN POWER AS PER CLAUSE PA 9.2

Unit rate: km

PA 13.5 PROTECTION TO PAVED SURFACES WHILST MOVING ON THE SITE UNDER OWN POWER AS PER CLAUSE PA 9.2

The rate shall cover all costs to protect and repair if required all paved surfaces traversed in movements between sites.

Unit rate: m

PA 13.6 MOVEMENT ON THE SITE PER TRUCK AS PER CLAUSE PA 9.2

Unit rate: No

PA 13.7 DYNAMIC COMPACTION AS PER CLAUSES PA 10 AND 11

Rate to cover work described in Clauses PA 10 and 11 as well as all related hiring, operational and overhead costs for the plant and related personnel on site for duration of execution. Rate to be paid as the area (m2) treated but shall be measured on the site as the number of blows counted to suit requirements of Clause PA 10.2, namely *……(number of) **blows represent 1,0 m2 treated.** One blow shall be calculated as the dropping of a *12-ton weight from *18 metres and shall be proportionally adjusted for different height and tamper weights as requested by the Engineer as follow:

$$\text{One blow} = \frac{\text{actual drop height (m)}}{*18} \times \frac{\text{actual tamper weight (ton)}}{*12}$$

Unit: rate: m2

PA 13.8 PLATE LOAD TESTING AS PER CLAUSE PA 12

The rate includes load testing up to *1000 KPa on *600 mm diameter plate.

Unit rate: No

PB: PARTICULAR SPECIFICATION FOR BLASTING

PB1: BLASTING OPERATIONS

General recommendations hereunder to be read with all SABS and related specifications regarding blasting. Applicable anywhere in dolomitic areas

a. Inter-shot delay between rows to be minimum of 25 ms
b. Charge per delay should be in accordance with AECI specification for blasting adjacent to private property
c. **All underground services to be treated as structures**
d. PPV not to exceed 12 mm/s at frequency not less than 10 Hertz
e. Preference to be given to handidets system

PC PARTICULAR SPECIFICATION: REPAIR OF SINKHOLES

PC1 SPECIAL SAFETY REQUIREMENTS

Personnel executing work in or around dolines and sinkholes are to be strapped into harnesses and safety ropes secured away from the sinkhole or suspended from crane or excavator parked at a safe position.

Personnel shall be informed of the hazardous conditions pertaining to working in or around sinkholes (Contractor to keep records of information sessions) and be made aware of the need to report any:

a. Surface cracks
b. Cavities (irrespective of size)
c. Any ground movement
d. Any sudden variation in soil profiles

Should any of the above occur or be noticed, stop work immediately and clear the site of all personnel until the Engineer inspects the site.

PC 2 METHOD OF REPAIR

Generally the Inverted Filter Method of repair as illustrated in drawing DT 01/SH shall be used for repair. See also drawings DT 02/SH to DT 06/SH

Repair of sinkholes and dolines shall consist primarily of the following operations:

a. Opening up the sidewalls of the sinkhole at 60 Degrees to the horizontal or excavating into the doline (to a depth indicated by Engineer) and a further 2 to 4 m wide by 1 m deep margin at the surface, extending from the initial excavation outward.

b. Chocking the throat of the sinkhole with boulders of 500 mm and larger (no fines allowed) or with a mass or reinforced concrete slab or a combination of all these solutions.

c. Dynamic compaction of the sinkhole or doline base before chocking or compaction of backfilled soil and building rubble placed on top of chocked area (see Particular specification PA for detail of Dynamic Compaction).

d. Backfilling of excavated sinkhole area will be as follows depending on the success and thus the stability of c above:

    1. Backfill to depth, as indicated on the site by the Engineer, with course material (building rubble from demolished buildings can be used but no tin, wood, or other degrade able materials are allowed) not exceeding 400 mm in diameter (measured in any direction) with a mixture of fines not exceeding 30% of mix and compact in 500 mm layers by means of tamping with excavator (min. 32 ton machine) bucket.

    2. Backfill as above and compact by means of dynamic compaction.

e. Further filling to be done with finer material compacted in 200 mm layers to 93% Mod AASHTO density by means of rammers, walk behind vibrating roller of minimum 900

mm wheel width up to 10 ton vibrating roller depending on the area to be filled. The contact zone between fill and natural material is to be compacted by rammer to ensure full compaction. Selected material shall have typical consistency of roads sub-grade (G8) material and maximum particle size to be 125 mm in diameter

f. Filling of the sinkhole to continue, as above, to a depth of 1,0 metre below ground level. From 1,0 to 0,5 m below ground level the compaction density needs to be 95% Mod AASHTO density. Compact in layers not exceeding 150 mm in thickness and the maximum course size material to be 63 mm in diameter. Selected material shall have typical consistency of roads sub-grade (G8) material.

g. Final 500 mm to be filled to specified height above ground level with material generally classified in the range of silty sand to clay (particle size 1,55 and smaller) and compacted to 95% mod AASHTO density. This layering shall continue to a height suitable to allow a minimum of 1: 60 sloping in all directions, falling away from the centre of the filled area in order to form a positive relief feature. The area to be finished of in smooth surfaces preventing water ponding.

PC3 INSURANCE OF THE WORKS AND PERSONNEL OF EMPLOYER AND CONTRACTOR

See the Special Conditions of Contract Clause 38. **CURRENTLY UNDER REVISION – DISCUSS WITH DEPARTMENTAL PROJECT MANAGER**

PD: PARTICULAR SPECIFICATION: EXPLORATORY DRILLING FOR ENGINEERING GEOLOGICAL INVESTIGATION

GENERAL

This section deals with the drilling of exploratory rotary-percussion boreholes for an **Engineering Geological investigation** as well as preparation for subsurface grouting. The Contractor shall be liable for any work not executed as per specification and shall redo faulty work at own expense if ordered to do so. The Employer is not liable for any losses or damages to any equipment or personnel.

PD 1 TENDERER' S EXPERIENCE

Only offers from Tenderers with proven past experience of drilling for Engineering Geological assessments in dolomitic areas will be considered. Tenderer to submit on **Annexure I** full details regarding past experience of drilling for Engineering Geological assessments in **dolomitic** areas.

Tenderer to indicate all past experience with reference to previous work (give project/site name) for the Department of Public Works, Department of Mineral and Energy Affairs: Geoscience and individual Consultants.

PD 2 EQUIPMENT

Drilling equipment shall comprise of the following mobile unit/s:

1. A compressor unit with measured and calibrated constant air delivery rating (800cfm minimum) at 16 Bar minimum.
2. Pneumatic rotary-percussion drilling rig with 165 mm nominal diameter button bit capable of drilling in all soil types up to 80 m and at any inclination up to 30 degrees to the vertical.
3. Additional spares: 1 x drill bit, 60 metres of drilling rods, 60 metres of 150 mm steel casing.

Tenderer shall submit a Safety Certificate (attach it to Annexure J) issued by the manufacturer or SABS/ISO accredited firm for the complete compressor unit.

Details of equipment to be furnished on appropriate **Annexure J.**

PD 3 ALTERNATIVE EQUIPMENT

Tenderer to submit details, on **Annexure J,** of alternative equipment of similar nature available to him. Further the Tenderer shall state the down time duration of replacement, in the event of equipment on site becoming unserviceable or experience major mechanical failure. Maximum of 4 hours down time will be allowed for minor mechanical repairs/failures per 40 hours of drilling.

PD 4 CONTRACTOR'S SUPERINTENDENCE

No work shall be executed unless supervised by a Suitable Representative of the Contractor that shall be made known, in writing, to the Engineer for his approval prior to commencement of the work. Any faulty work executed in the absence of the Contractors representative shall

be for the account of the contractor.

PD 5 SETTING OUT OF THE WORKS

The Engineer shall set out and furnish the Contractor with drilling positions. Positions shall be marked with 0,6 m Y-fencing standards painted white.

Payment: Payment shall include the surveying cost of the surveyor as appointed by the Engineer.

Unit rate: Provisional

PD6 PRIORITY OF DRILLING SEQUENCE

The Engineer reserves the right to determine priorities regarding the sequence of drilling. The Contractor shall receive a drilling sequence before commencing drilling. No deviation from afore mentioned drilling sequence shall be allowed unless instructions to do so is issued by the Engineer.

PD 7 STANDING TIME

No provision or claims for standing/idle time shall be heard, allowed, or paid for. In the event of insufficient information to continue drilling operations due to lack of information or uncertainty regarding the drilling sequence or the location of marked drilling positions, the Contractor shall inform the Engineer 6 hours (normal business hours) in advance.

PD 8 LOCATION, PROTECTION AND DAMAGES TO EXISTING SERVICES

The Engineer shall furnish the Contractor with position of subsurface services. The Contractor shall excavate up to a depth of 1,5 metres to expose such services if deemed necessary by the Engineer. Repair of damages to under/above ground services shall be for the account of the Contractor if the position of such services were previously made known to the Contractor or indicated by the Engineer. All damages are to be reported to the Engineer within 1(one) hour of occurrence. The Contractor to submit a full damage report within 24 hours.

PD 9 SITE ESTABLISHMENT AND SETTING UP OF DRILLING RIG

PD 9.1 SITE ESTABLISHMENT

Site establishment shall cover the provision of the drilling equipment, as previously described, and personnel on the site ready to commence setting up of equipment for the drilling of any number of boreholes.

Payment: Rate shall cover all cost to provide, maintain in working order and remove equipment from the site for the drilling phase. The site establishment shall be paid once only and no claims for standing time shall be heard or paid for.

Unit rate: no

PD 9.2 SETTING UP AND REMOVAL OF DRILLING RIG

Setting up shall include setting up the drill vertical or at any inclination and the movement of

the complete drilling rig between boreholes, anywhere on the site, as per drilling sequence or as directed by the Engineer.

Payment: Payment shall include setting up complete drilling equipment, for drilling to any depth as well as taking down and movement between two boreholes.

Unit rate: no

PD10 ROTARY-PERCUSSION DRILLING (165 mm Button bit)

PD10.1 DEPTH OF DRILLING

Drilling shall be to the depth as indicated by the Engineer. The Engineer shall be notified immediately of the following:

1. Drilling into rock for more than 7 metres (stop at 7 metre and notify Engineer for further instructions).
2. Drilling through cavities or highly compressible material.
3. Encountering of water, abnormally wet soil or abnormal odours.
4. Excessive air loss

PD10.2 DRILLING CLASSIFICATION

For the purpose of this contract drilling shall be categorised, and paid for, in depth ranges of:

1. 0 to 30 metre
2. 30 to 60 metre
3. 60 to 100 metre

The drilling shall further be categorised, and paid for, in categories of soil types classified as:

1. Hard - Solid, unweathered, hard rock
2. Soft - All other soil types and disseminated cavities
3. Cavity - No resistance or hammer action recorded

Payment: The applicable rate for drilling in the above classified depths and soil types shall cover all costs for the supply and maintenance of drilling equipment, expendable materials, drilling, recovery of samples at 1,0 metre intervals, addition of water as material to enhance sample recovery, completion of Driller's field report and delivery of samples to the Engineers' laboratory in ..... on three (3) day intervals.

Unit rate: m

PD10.3DRILLING AT INCLINATION

The inclination of boreholes, to be noted in degrees, shall be measured as the deviation from the vertical. The Driller's log shall indicate the direction of propagation and inclination.

Payment: Drilling at any inclination (larger than 0 degrees), as indicated by the Engineer, shall be rated as an **extra over** cost to the cost per metre drilled as per PD10.2, irrespective of depth or type of material. No additional payment shall be allowed for setting up at an inclination.

Unit rate: m

PD10.4 DRILLERS FIELD REPORT

Field data to be recorded on standard drilling log sheets as required by the Engineer. Reports to be submitted to the Engineers' laboratory in (name of town)…….…… with recovered samples. The compilation of field reports to be inclusive of drilling rates.

PD10.5 SAMPLE RECOVERY

Samples shall be recovered of each metre drilled and placed in sequential order at a suitable location near the borehole and be left undisturbed until inspected by the Engineer.

The Driller shall, from each metre drilled, recover two 300 ml uncontaminated samples, sealed in plastic bags (clearly marked - Hole no. and recovery depth) **directly** after drilling of each metre and place it in sequential order in a plastic sausage in order to provide two sample sets of each borehole. One set of samples is to be delivered to the laboratory of the Engineer on a three-day interval. Samples to be accompanied by Driller's field report. The other sample set is to be kept on the site with a copy of the field report at the site facility provided for the Engineer. The recovery, compilation and delivery of samples to be inclusive of drilling rates.

PD10.6 FOAM/DRILLING MUD USED

Drilling fluid shall include drill foam and those compounds that are normally used to improve sample recovery with air-flush down the hole hammer percussion drilling. The depth range of drilling fluid application shall be clearly indicated on Driller's field report. Application of water shall be covered by standard drilling rates.

Payment: Drilling foam shall be paid for as foam used on the basis of metres drilled using drilling fluid.

Unit rate: litre

PD11 CASING

PD11.1 TEMPORARY STEEL CASING

Temporary steel casing of 170 mm nominal diameter is to be installed only if instructed by the Engineer. Casing left behind due to inability of recovery, shall be for the account of the Contractor.

Payment: The rate for this work shall cover insertion and recovery of casing.

Unit rate: m

PD11.2 PERMANENT CASING

Permanent steel casing of 170 mm nominal diameter is to be installed only if instructed by the Engineer. The annulus between the casing and the borehole walls should be backfilled and a 500 mm diameter (150 mm thick) concrete collar shall be provided at ground level. Boreholes to be sealed with suitable water tight metal caps. The borehole number, depth, inclination and direction of propagation as well as drilling date should be marked in the wet concrete of the collar.

Payment: The rate for this work shall cover cost of supply of casing, insertion, concrete collar and sealing with a metal cap.

Unit rate: m

PD11.3 PERMANENT (1,5 M) CASING FOR GROUTING

Permanent steel casing of 170 mm nominal diameter is to be installed, to a depth of 1,5 m measured from normal ground level, as indicated by the Engineer, in boreholes which are to be grouted. The annulus between the casing and the borehole walls should be grouted with a 1:6 cement: sand mixture to full depth of casing. A suitable steel collar is to be provided to prevent casing from sliding down the borehole. The borehole is to be sealed with a suitable metal cap to prevent water ingress.

Payment: The rate for this work shall cover cost of supply of casing, insertion, grouting of annulus, concrete collar and cap as described.

Unit rate: no

PD11.4 CONCRETE GROUTING SURFACE PLUG

After insertion of the down-the-hole 50 mm steel grout pipe(s) shall the space between the grout pipe and sleeve pipe be plugged for a depth of 400 mm, with concrete (1:2:3 mix) if required. This shall be deemed as exclusive to the price of the steel sleeve.

Payment: The rate for this work shall cover cost of supply of concrete and work involved.

Unit rate: no

PD12 WATER LEVEL AFTER 24 HOURS

Boreholes are to be left open until the Engineer issue instructions for backfilling. A suitable watertight cover shall be provided to prevent debris or water entering the borehole. Water levels are to be taken by the Engineer, 24 hours after completion of drilling.

PD13 BACKFILLING OF BOREHOLE

Boreholes are to be backfilled with soil, recovered from drilling, suitably wetted to form flowing slurry. Back filling and plugging shall be executed only after written instruction to do so is issued by the Engineer.

Payment: Payment shall include supply of water, mixing of slurry and filling of borehole.

Unit rate: m

PD14 STABILISED GROUTING OF BOREHOLE

If directed by the Engineer the entire or last 3,0 metre of boreholes shall be backfilled using 1:10 cement: sand mix with just sufficient water to allow mixture to flow. Note that this is to plug the hole.

Payment: Payment shall include supplying of cement, sand, water, mixing of slurry and filling of borehole.

Unit rate: m

PD 15 SEAL AND MARKING OF BOREHOLES

Driller to provide a 400 x 400 x 150 mm 15 MPa wood floated concrete cap with 200 mm concrete down the hole. The concrete cap is to be installed 100 mm below ground surfaces. A steel rod, 10 mm in diameter, 500 mm in length and protruding 10 mm from concrete is to be placed centrally of the cap. The soil is to be reinstated and compacted over the concrete cap when it has cured. The backfilling is to be slightly proud to prevent the ponding of storm water over the borehole. The borehole number, drilling date and direction of inclination shall be marked in the wet concrete.

Payment: Payment shall include supplying of cement, steel rod, wooden floating and inscriptions.

Unit rate: no

PD 16 STOPPING OF WORK DUE TO INCLEMENT WEATHER

It is at the discretion of the Engineer to stop drilling operations temporarily if weather conditions may interfere with the desired drilling results. No standing time shall be paid for such stoppages.

PE: PARTICULAR SPECIFICATION: SUBSURFACE GROUTING

GENERAL

This section deals with the grouting of subsurface cavities with a pumpable concrete or soilcrete mixture. Work comprises of the pumping of grout mix directly from the mixing truck or stationary mixer into 50 mm HDPE housing connected to 50 mm steel piping down a previously drilled borehole to depths as indicated by the Engineer. Execution of each pumping operation shall be continuous and thus shall the contractor provide for instances where grouting continues after normal working hours. The contractor shall be liable for any work not executed as per specification and shall redo faulty work at own expenses if ordered to do so. The Employer will not be liable for any losses or damages to any equipment.

PE 1 TENDERER' S EXPERIENCE

Only offers from Tenderers with proven past experience of grouting of subsurface cavities in dolomitic areas will be considered. Tenderer to submit on Annexure K full details regarding past experience of execution of subsurface grouting in dolomitic areas.

Tenderer to indicate all past experience with particular reference to previous work (give project/site name) for the Department of Public Works, Department of Mineral and Energy Affairs: Geological Survey and individual Consultants.

PE 2 EQUIPMENT

Grouting equipment shall comprise of the following:

PE 2.1 MOBILE/MOVEABLE PUMPING UNITS

A mobile concrete pump/pumping truck (type pump - Putzmeister or similar) with 20 m3 pump capacity per hour, equipped with suitable hoses and connectors for the required pumping pressures. The pump shall be equipped with suitable, calibrated (calibration certificate required) pressure gauges to record pumping pressures up to 1,5 MPa. The Contractor shall provide sufficient personnel as required to set-up equipment and execute grouting.

Tenderer shall submit a Safety Certificate (attach it to Annexure L) issued by the manufacturer or SABS/ISO accredited firm for the complete pump unit. Details of equipment to be furnished on appropriate **Annexure L.**

PE 2.2 GROUT VISCOSITY MEASURING INSTRUMENTS.

The Contractor needs to provide an appropriate flow metre on the site for the duration of the contract.

PE 3 ALTERNATIVE EQUIPMENT

Tenderer to submit details, on **Annexure L,** of alternative equipment of similar nature available to him. Furthermore, he shall state the down time duration of replacement, in the event of equipment on site becoming unserviceable or experiencing major mechanical failure. Maximum of 4 hours down time will be allowed for minor mechanical repairs/failures per 40 hours of grouting.

PE 4 CONTRACTOR'S SUPERINTENDENCE

No work shall be executed unless supervised by a Suitable Representative of the Contractor that shall be made known, in writing, to the Engineer for his approval prior to commencement of the work.

PE 5 SETTING OUT OF THE WORKS

The Engineer shall determine the grouting depth ranges of each borehole.

PE 6 PRIORITY OF GROUTING SEQUENCE

The Engineer reserves the right to determine priorities regarding the sequence of grouting. The Contractor shall receive a grouting sequence before commencing grouting. No deviation from aforementioned grouting sequence shall be allowed unless an instruction to do so is issued by the Engineer.

PE 7 STANDING TIME

No provision or claims for standing time during the execution of grouting shall be heard, allowed, or paid for. In the event of insufficient information to continue grouting operation, due to lack of information or uncertainty regarding grouting sequence or depth, the Contractor shall inform the Engineer thereof before commencing grouting.

PE 8 LOCATION, PROTECTION AND DAMAGES TO EXISTING SERVICES

The Engineer shall furnish the Contractor with the position of sub surface services. Repair of damages to under/above ground services shall be for the account of the Contractor if the position of such services were made known to the Contractor or indicated by the Engineer. All damages to be reported to the Engineer within 1(one) hour of occurrence. The Contractor needs to submit a full damage report within 24 hours.

PE 9 SITE ESTABLISHMENT AND SETTING UP OF GROUTING EQUIPMENT

PE 9.1 SITE ESTABLISHMENT

Site establishment shall cover the provision of the grouting equipment, previously described, and personnel on the site ready to commence setting up of equipment for any number of boreholes to be grouted.

Payment: The rate shall cover all cost to provide, maintain in working order and remove equipment from the site for the grouting phase. The site establishment shall be paid once only and no claims for standing time shall be heard or paid for.

Unit rate: Sum

PE 9.2 SETTING UP OF GROUTING EQUIPMENT AT EACH HOLE

The Contractor shall provide sufficient personnel as required to set-up equipment at each borehole to be grouted. After completion of grouting at a particular borehole all grout spilled on the surface shall be removed. Each borehole shall be defined as one set-up station irrespective of the number of grouting stages to be executed

Payment: Set-up rates shall include all costs to set-up the equipment, attaching of reusable couplings to grout pipes and decommissioning it, movement to next hole and clearing the site of the completed borehole.

Unit rate: no

PE10 GROUTING

PE 10.1 DEPTH OF GROUTING

No rate provision shall be made for grouting at different depths. The maximum grouting depth beneath normal ground level is less than 60 metres.

PE 10.2 GROUT CLASSIFICATION/SPECIFICATION

Grout of a particular borehole shall comprise of one of the mixes as described below. Ordering/batching quantities shall be continuous. The grout of each grouting phase per set-up shall be supplied and pumped continuously.

The grout provided shall be free of stones, lumps, foreign soils or any other debris. In the event of premature chocking of the grout pipe as a result of negligence on the part of the contractor, the contractor shall be ordered to re-drill and equip the hole at own expense.

The consistency/viscosity of the grout mixture must not exceed 400 mm on the Colcrete Flow metre and if possible be limited to 350 mm. Consistency measurement must be recorded at intervals of 12m3 and supplied to the Engineer. The flow meter shall be on the site at all times. The Contractor shall provide sufficient water on the site to correct grout slump requirements if needed.

The boreholes must be pumped to capacity at a pressure proportional to 0,5 MPa per 15 m depth up to a maximum of 1,5 MPa.

Special requirement: Mining slimes may not be used

PE10.3 GROUT TYPES TO BE SUPPLIED AS FOLLOW

Grout type 1: 1,0-2,0 MPa / 70:30 OPC:FA self-compacting concrete utilising a mixture of crusher- and filler sand.
Grout type 2: 20:1 filler sand:cement
Grout type 3: 50 kg:1m3 Cement: Soil. (Soil to be silty sand with PI not exceeding 14. Material of this nature is available on site. See site plans, mid eastern section of base, east of building 239A (old borrow area indicated for rehabilitation).

Payment: The rate shall cover supply, handling, slump rectification, continuous delivery and pumping of grout as per specified type, to required depths and pressure as well as reporting. It also includes the excavation, loading and transport of any material from excavations on site.

Grout type 1: 1,0-2,0 MPa / 70:30 OPC:FA concrete.
Unit rate: m3

Grout type 2: 20:1 filler sand:cement

Unit rate: m3

Grout type 3: 50 kg:1m3 Cement: Soil

Unit rate: m3

PE 10.4 GROUTING FIELD REPORT

The Contractor shall provide a field report containing the grout mix, viscosity measurement, volume, depth of grouting stages, method of grouting and finishing pressures for each borehole. Report to be submitted to Engineer at completion of each borehole. The compilation of the field report to be inclusive of grouting rate.

PE11 DOWN THE HOLE GROUT PIPES

The grout pipes shall consist of 50 mm high-pressure seamless steel pipes, to suit the required pumping pressures, lowered to the desired depth into the borehole. The surface end shall be provided with a collar or crossbar to prevent the pipe from slipping into the borehole as well as a reusable coupling to fit that of the pumping unit

.

Payment: The rate shall cover supply, insertion, anchoring to the surface, fitting and removal of the coupling unit.

Unit rate: m

PE12 SPECIAL SAFETY REQUIREMENTS

Personnel executing grouting are to be strapped into harnesses and safety ropes secured away from the cavity/borehole.

Personnel shall be informed of the hazardous conditions pertaining to this type of work (Contractor to keep records of information sessions) and be made aware to report any:

a. Surface cracks
b. Cavities (irrespective of size)
c. Any ground movement

Should any of the above occur or are noticed, stop work immediately and clear the site of all personnel until the Engineer inspects the site.

PF: PARTICULAR SPECIFICATION: DEMOLISHING OF STRUCTURES

* Engineer is to provide detail descriptions.

PF 1: TENDERERS EXPERIENCE

Tenderer to indicate in Annexure H experience regarding demolishing of buildings of this magnitude.

PF 2: INSPECTION OF STRUCTURE

The Tenderer needs to inspect the structure prior to tendering and sign the appropriate portion of the Bill of Quantities.

PF 3: GEOLOGICAL SETTING OF BUILDING

* Engineer is to provide detail descriptions of Geotechnical conditions as well as the least unsafe areas for movement of equipment and personnel.

PF 4: USE OF EXPLOSIVES

The use of explosives will be limited due to the metastable subsurface conditions. The use of explosives to implode or weaken the structure(s) to such an extent that more than 5% of the structure collapses at any time shall not be allowed. Demolishing methods using explosives shall be subject to the same requirements as prescribed in Particular Specification PB: Blasting Requirements. Ground vibrations generated by the blasting operation and the collapsing structural elements shall be subject to the conditions of Particular Specification PB.

PF 5: PROPOSED DEMOLISHING METHOD

PF 5.1: OFFICE BLOCKS/GENERAL SINGLE STOREY

Use normal demolishing methods except for those areas that should not be traversed with heavy construction machinery as marked on drawing *…….(drawing no)

Payment: Rate shall include the complete demolishing and removal of the super structure, foundations and foundation slabs and dispose of material in approved dumpsite. Fill of areas below floor level to be measured elsewhere.

Unit rate: m2

Payment: Rate includes the complete removal of extended steel rail section and demolishing of concrete footing and beams.

Unit rate: m2

PF 5.4: HANGERS/MULTI-STOREY

It is proposed that the superstructure(s) be demolished using excavators equipped with long reach booms and demolishing tools such as grapples, hydraulic hammers and hydraulic crushers.

As alternative to long reach booms, a rolling soil stockpile may be used to reach the roof structure.

All columns and ground beams shall be demolished to 100 mm below the surrounding floor slab level.

Payment: Rate includes the demolishing and removal of all material to …….. dumpsite.

Unit rate: Sum

PF 6: SAFETY

The Contractor needs to provide proper barricade or security and safety signs around the building to prevent any person from entering whilst demolishing activities are in progress. The same shall apply for after hours and over weekends.

Payment: Rate includes all measures to be introduced to prevent persons from entering the site.

Unite rate: Sum

ANNEXURE I: PREVIOUS EXPERIENCE OF TENDERER (OR SUBCONTRACTOR) OF EXPLORATORY DRILLING FOR ENGINEERING GEOLOGICAL INVESTIGATION

Indicate only experience of drilling exploratory boreholes in **Dolomitic** areas for the purpose of an Engineering Geological Investigation of subsurface conditions.

PROJECTS BY TENDERER

PROJECT	DATE	VALUE	CLIENT	ENGINEER	TEL. NUMBER

PROJECTS BY SUBCONTRACTOR: _____

(name) ……

PROJECT	DATE	VALUE	CLIENT	ENGINEER	TEL. NUMBER

Signature of Tenderer ……

ANNEXURE J: PLANT AVAILABLE/OWNED BY TENDERER (OR SUBCONTRACTOR) FOR EXPLORATORY DRILLING FOR ENGINEERING GEOLOGICAL INVESTIGATION

Indicate only plant that meets the specified requirements as stated in the applicable Particular Specification: Exploratory Drilling for Engineering Geological Investigation.

PLANT OWNED BY TENDERER

DESCRIPTION	NO	AGE	SPECIFICATION/RATING

PLANT OWNED BY SUBCONTRACTOR

(name) ……

DESCRIPTION	NO	AGE	SPECIFICATION/RATING

NB: Attach Safety Certificates to this page.
Indicate also alternative plant available.

Signature of Tenderer ……

ANNEXURE K: PREVIOUS EXPERIENCE OF TENDERER (OR SUBCONTRACTOR) OF SUBSURFACE GROUTING

Indicate only experience that meets the description of work as stated in the applicable Particular Specification: Subsurface Grouting

PROJECTS BY TENDERER

PROJECT	DATE	VALUE	CLIENT	ENGINEER	TEL. NUMBER

PROJECTS BY SUBCONTRACTOR: ___

(name) ……

PROJECT	DATE	VALUE	CLIENT	ENGINEER	TEL. NUMBER

Signature of Tenderer ……

ANNEXURE L: PLANT AVAILABLE/OWNED BY TENDERER (OR SUBCONTRACTOR) FOR SUBSURFACE GROUTING

Indicate only plant that meets the specified requirements as stated in the applicable Particular Specification: Subsurface Grouting.

PLANT OWNED BY TENDERER

DESCRIPTION	NO	AGE	SPECIFICATION/RATING

PLANT OWNED BY SUBCONTRACTOR

(name) ……

DESCRIPTION	NO	AGE	SPECIFICATION/RATING

NB: Attach Safety Certificates to this page.

Signature of Tenderer ……

ANNEXURE M: PREVIOUS EXPERIENCE OF TENDERER (OR SUBCONTRACTOR) OF DYNAMIC COMPACTION

Indicate only experience that meets the description of work as stated in the applicable Particular Specification: Dynamic Compaction

PROJECTS BY TENDERER

PROJECT	DATE	VALUE	CLIENT	ENGINEER	TEL. NUMBER

PROJECTS BY SUBCONTRACTOR: _____

(name) _____

PROJECT	DATE	VALUE	CLIENT	ENGINEER	TEL. NUMBER

Signature of Tenderer _____

ANNEXURE N: PLANT AVAILABLE/OWNED BY TENDERER (OR SUBCONTRACTOR) FOR DYNAMIC COMPACTION

Indicate only plant that meets the specified requirements as stated in the applicable Particular Specification: Dynamic Compaction.

PLANT OWNED BY TENDERER

DESCRIPTION	NO	AGE	SPECIFICATION/RATING

PLANT OWNED BY SUBCONTRACTOR

(name) ……

DESCRIPTION	NO	AGE	SPECIFICATION/RATING

NB: Attach Safety Certificates to this page.

Signature of Tenderer …… _____

APPENDIX 7

SPECIAL CONDITIONS OF CONTRACT

Amended clause related to Special Risk Insurance related to work in dolomitic areas is currently under revision by the department. To be included in future

APPENDIX 8

DEPARTMENTAL PROJECT MANAGEMENT FORMS (PRM)

CONTENTS:

The above PRM forms should be obtained from the Project Manager.

PRELIMENARY LIST OF MUNICIPALITIES LOCATED (OR PARTLY LOCATED) ON DOLOMITE		
NO	NEW NAME	OLD NAME
1	**City of Johannesburg**	**Johannesburg**
2	**Dan-Lime Municipality**	**Danielskuil**
3	**Delmas**	**Delmas**
4	**Diamondfields**	**Diamondfields**
5	**DMA Lowveld**	**DMA Lowveld**
6	**Drakensberg Municipality**	**Hoedspruit**
7	**Emfuleni Local Municipality**	**Vereeniging**
8	**Greater East Rand Metro**	**East Rand**
9	**Greater Groblersdal Municipality**	**Groblersdal**
10	**Greater Marble Hall Municipality**	**Marble Hall**
11	**Greater Taung Local Municipality**	**Reivilo**
12	**Greater Tubatse Municipality**	**Burgersfort/Ohrigstad/Eastern Tubatse**
13	**Greater Tzaneen Municipality**	**Tzaneen**
14	**Highlands**	**Belfast**
15	**Kalahari CBDC**	**Kalahari CBDC**
16	**Kareeberg Municipality**	**Carnarvon**
17	**Klerksdorp Local Municipality**	**Klerksdorp**
18	**Kungwini Local Municipality**	**Bronkhorstspruit**
19	**Kuruman-Mothibistad Municipality**	**Kuruman**
20	**Lepelle-Nkumpi**	**Lebowakgomo**
21	**Lichtenburg Local Municipality**	**Lichtenburg**
22	**Mafikeng Local Municipality**	**Mafikeng**
23	**Mankwe-Madikwe Local Municipality**	**Mogwase**
24	**Merafong City Local Municipality**	**Carletonville**
25	**Metsimaholo Local Municipality**	**Sasolburg**
26	**Midvaal Local Municipality**	**Meyerton**
27	**Modimolle**	**Nylstroom**
28	**Mogalakwena**	**Potgietersrus**
29	**Mogale City Local Municipality**	**Krugersdorp**
30	**Molopo Local Municipality**	**Pomfret**
31	**Mookgopong**	**Naboomspruit**
32	**Naledi Local Municipality**	**Vryburg**
33	**NW374 Local Municipality**	**Koster**
34	**Polokwane**	**Pietersburg**
35	**Potchefstroom Local Municipality**	**Potchefstroom**
36	**Priemanday Municipality**	**Prieska**
37	**Randfontein Local Municipality**	**Randfontein**

Continued

PRELIMENARY LIST OF MUNICIPALITIES LOCATED (OR PARTLY LOCATED) ON DOLOMITE (continued)		
NO	NEW NAME	OLD NAME
38	**Schuinsdraai Nature Reserve**	**Schuinsdraai Nature Reserve**
39	**Schweizer-Reneke Local Municipality**	**Schweizer-Reneke**
40	**Segonyana Municipality**	**Kgalagadi**
41	**Siyancuma Municipality**	**Griekwastad**
42	**Thaba Nchu**	**Sabie**
43	**Thabazimbi**	**Thabazimbi**
44	**Tshwane Metropolitan Municipality**	**Pretoria**
45	**Umjindi**	**Barberton**
46	**Ventersdorp Local Municipality**	**Ventersdorp**
47	**Westonaria Local Municipality**	**Westonaria**

PRELIMENARY LIST OF MAGISTERIAL DISTRICTS WITH STATE LAND LOCATED (OR PARTLY LOCATED) ON DOLOMITE			
NO	DISTRICT NAME	N0	DISTRICT NAME
1	**ALBERTON**	**39**	**PHALABORWA**
2	**BARBERTON**	**40**	**PHOKWANI**
3	**BENONI**	**41**	**PIETERSBURG**
4	**BOKSBURG**	**42**	**POSTMASBURG**
5	**BRAKPAN**	**43**	**POTCHEFSTROOM**
6	**BRITSTOWN**	**44**	**POTGIETERSRUS**
7	**BRONKHORSTSPRUIT**	**45**	**PRETORIA**
8	**CAROLINA**	**46**	**RANDBURG**
9	**DELAREYVILLE**	**47**	**RANDFONTEIN**
10	**DELMAS**	**48**	**RUSTENBURG**
11	**GERMISTON**	**49**	**SASOLBURG**
12	**GROBLERSDAL**	**50**	**SCHWEIZER-RENEKE**
13	**HARTSWATER**	**51**	**SEKHUKHUNELAND**
14	**HEIDELBERG**	**52**	**SPRINGS**
15	**JOHANNESBURG**	**53**	**THABAZIMBI**
16	**KEMPTON PARK**	**54**	**VANDERBIJLPARK**
17	**KLERKSDORP**	**55**	**VENTERSDORP**
18	**KROONSTAD**	**56**	**VEREENIGING**
19	**KRUGERSDORP**	**57**	**VREDEFORT**
20	**KUDUMANE**	**58**	**VRYBURG**
21	**KURUMAN**	**59**	**WARMBAD**
22	**LETABA 1**	**60**	**WATERVAL-BOVEN**
23	**LETABA 2**	**61**	**WESTONARIA**
24	**LICHTENBURG**	**62**	**WITRIVIER**
25	**LYDENBURG**		
26	**MADIKWE**		
27	**MMABATHO**		
28	**MOKERONG 2**		
29	**MOKERONG 3**		
30	**MOUTSE 3**		
31	**NAPHUNO 1**		
32	**NAPHUNO 2**		
33	**NEBO**		
34	**NELSPRUIT**		
35	**NIGEL**		
36	**OBERHOLZER**		
37	**PARYS**		
38	**PELGRIM'S REST**		