



public works

Department:
Public Works
REPUBLIC OF SOUTH AFRICA

VOLUME 1

**APPROPRIATE DEVELOPMENT OF INFRASTRUCTURE
ON DOLOMITE:**

MANUAL FOR CONSULTANTS

**STANDARD SPECIFICATIONS APPLICABLE TO DOLOMITE
STABILITY INVESTIGATIONS (DSI) AND THE PLANNING,
ENGINEERING REQUIREMENTS AND MANAGEMENT OF
DEVELOPMENT ON DOLOMITE LAND**

Directorate: Civil & Structural Engineering Dolomite
Risk Management Unit
Ndinaye Building 5031
188 Schoeman Street
Pretoria

AUGUST 2017

TABLE OF CONTENTS

Page

| | |
|--|-----------|
| TABLE OF CONTENTS | 2 |
| PAGE | 2 |
| CHAPTER 1: INTRODUCTION | 1 |
| 1.1 Background | 1 |
| 1.2 Approach to managing risk on dolomite land | 3 |
| 1.3 Distribution of dolomite in South Africa | 3 |
| 1.4 Risks associated with dolomitic land | 3 |
| 1.5 Dolomite Risk Management concept with respect to a Departmental project | 5 |
| 1.6 Departmental Administrative Arrangements | 8 |
| 1.7 Land Procurement, Servitudes and Development Planning | 14 |
| 1.8 Building and Facilities hired/leased | 17 |
| 1.9 Dolomite Stability Peer Review Function | 18 |
| CHAPTER 2: GENERAL PRINCIPLES AND REQUIREMENTS | 19 |
| 2.1 Introduction | 19 |
| 2.2 Quantitative Requirements for Land Safety and Usage | 19 |
| 2.3 Repair of Sinkholes | 20 |
| 2.4 Compliance with Requirements | 20 |
| CHAPTER 3: GEOTECHNICAL INVESTIGATIONS AND DETERMINATIONS | 21 |
| 3.1 Introduction | 21 |
| 3.2 Requirements | 21 |
| CHAPTER 4: DESIGN AND CONSTRUCTION OF BUILDINGS, STRUCTURES AND INFRASTRUCTURE | 27 |
| 4.1 Introduction | 27 |
| 4.2 Precautionary Measures in Dolomite Areas designated as D1 | 28 |
| 4.3 Precautionary Measures in Dolomite Areas Designated as D2 or D3 | 29 |
| 4.4 Requirements for Wet and Dry Engineering Services | 41 |
| 4.5 Additional Precautionary Measures for Wet Engineering Services in Dolomite Area Designation D3 Sites | 57 |
| 4.6 Additional Precautionary Measures for Wet Engineering Services in Dolomite Area Designation D4 Sites | 58 |
| 4.7 Design and Construction of Infrastructure | 58 |
| CHAPTER 5: RISK MANAGEMENT | 65 |
| 5.1 Introduction | 65 |
| 5.2 Requirements for Risk Management | 65 |
| CHAPTER 6: DEPARTMENTAL PROCEDURES, APPROPRIATE ENGINEERING DESIGN DETAILS AND CONDITIONS OF CONTRACT FOR WORK ON DOLOMITE LAND | 73 |
| 6.1 Introduction | 73 |
| 6.2 Concept and Preliminary Design Reports | 73 |
| 6.3 Design considerations | 76 |
| 6.4 Design standards | 81 |
| 6.5 Project Standards | 82 |

6.6 Upgrading of existing engineering infrastructure 84

6.7 Design standards for new developments and upgrading of Infrastructure on Dolomite
Land 84

6.8 Tender Documents and Conditions of Contract 85

Index PW344/2017

| | |
|--|---|
| acceptable | 17, 36, 79 |
| accounting authority..... | 9, 89 |
| accounting officer..... | 9 |
| angle of draw | 9 |
| borehole profile | 9 |
| borrow pit..... | 9, 54, 107 |
| building. 9, 10, 27, 29, 34, 47, 50, 51, 55, 62, 63, 64, 65, 68, 72, 76, 77, 78, 80, 81, 85, 86, 89, 93, 96, 97, 98, 109 | |
| buildings..... | 84 |
| bulk pipelines | 9 |
| client..... | 9, 34, 39, 40, 41, 63, 85 |
| competent geophysicist | 9 |
| competent person | 9, 10, 28, 29, 37, 51, 52, 54, 55, 57 |
| conservancy tank..... | 9 |
| construction works | 9, 12 |
| data | 9, 10, 11, 19, 39, 48, 51, 85 |
| dolomite | 5, 7, 28 |
| dolomite area designation..... | 9, 51, 75, 78, 79, 82 |
| Dolomite Area Designation | 31, 33, 36, 44, 45, 50, 59, 60, 65, 66, 67, 69, 70, 71, 72, 73, 74, 75, 76, 79, 82 |
| dolomite land | 5, 6, 7, 8, 9, 11, 16, 17, 18, 19, 25, 28, 29, 32, 36, 38, 49, 51, 54, 83, 89, 99 |
| dolomite risk management strategy..... | 9, 42, 44, 83, 86 |
| Dolomite Risk Management Strategy | 18, 26 |
| dry services..... | 10, 45, 46, 52 |
| dwelling house | 10 |
| dwelling unit..... | 10 |
| engineering service..... | 10, 11, 12, 108 |
| erf (stand) | 63 |
| evapotranspirative bed | 10 |
| event | 10, 18, 31, 34, 42, 43, 55, 58, 78, 79, 81, 103 |
| factual data | 10 |
| french drain..... | 10 |
| geotechnical..... | 7, 9, 10, 17, 19, 29, 38, 40, 41, 42, 43, 46, 79 |
| Geotechnical..... | 13, 19, 29 |
| geotechnical site investigation..... | 7, 9, 10, 40, 46 |
| gravity survey..... | 10, 39, 40, 42, 43 |
| groundwater compartments (dolomite aquifer)..... | 10, 20 |
| groundwater level (original groundwater level (owl))..... | 20 |
| hazard | 5, 7, 9, 10, 11, 16, 17, 18, 19, 36, 40, 42, 78, 84, 85 |
| hazard rating..... | 9, 10, 36 |
| infrastructure..... | 7, 10, 17, 18, 19, 27, 28, 33, 38, 41, 42, 44, 46, 47, 49, 51, 78, 79, 87, 91, 92, 94, 100, 101 |
| Infrastructure..... | 18, 33, 44, 49, 54, 58 |
| inherent hazard | 7 |
| Inherent hazard..... | 10 |
| Inherent Hazard Class | 36, 42, 43, 44 |
| Inherent Hazard Classes (inherent hazard class) | 19, 40 |
| (inherent hazard class) | 19 |
| (inherent hazard class) | 41 |
| inspection..... | 10, 30, 46, 55, 67, 71, 76, 85, 87, 89, 93 |
| inspections (inspection) | 7 |
| interconnected complex..... | 10 |
| interpretative data | 9, 11 |

| | |
|---|---|
| investigator | 7, 38, 39, 40, 41 |
| likelihood..... | 9, 11, 12, 20 |
| maintenance 5, 6, 11, 18, 24, 25, 26, 27, 28, 32, 33, 34, 42, 44, 45, 48, 49, 53, 63, 78, 83, 84, 86, 87, 88, 89, 94 | |
| major stormwater system..... | 11 |
| minor stormwater system..... | 11 |
| monitor | 11 |
| monitoring area designation | 11 |
| opinion | 9, 38 |
| organization | 9, 10, 11, 83 |
| original groundwater level (OWL)..... | 11 |
| outcrop dolomite | 11 |
| palaeo structures | 11 |
| parcel of land | 11, 36, 41, 92 |
| performance..... | 10, 11, 16, 19 |
| performance parameter | 11 |
| permeability | 11, 59, 80 |
| population | 11 |
| qualitative performance requirements | 11 |
| quantitative performance (quantitative performance requirements)..... | 11 |
| quantitative performance requirements | 7 |
| quarry..... | 11, 54 |
| recurrence interval..... | 11 |
| reliability | 11 |
| return period | 11 |
| risk 5, 6, 9, 11, 12, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 31, 32, 33, 34, 36, 40, 41, 42, 44, 45, 46, 52, 57, 58, 72, 78, 81, 82, 83, 84, 86, 87, 88, 89, 92, 93, 94, 100, 102, 103, 104, 105 | |
| risk management | 9, 11, 19, 40, 41, 42, 44, 83, 86 |
| Risk management..... | 19 |
| risk reduction | 11, 12 |
| rock | 9, 10, 11, 12, 59, 80 |
| Services | 58 |
| settlement | 11, 53, 60, 79, 84, 85, 86 |
| shallow dolomite | 12 |
| sinkhole..... | 5, 9, 10, 11, 12, 16, 17, 18, 19, 20, 58, 79, 87, 103 |
| soil..... | 7, 9, 10, 11, 12, 20, 21, 29, 31, 38, 48, 55, 59, 64, 65, 71, 74, 78, 79, 80, 107 |
| stormwater | 11, 72, 76 |
| stormwater system (major/minor stormwater system)..... | 47 |
| (major/minor stormwater system) | 49 |
| structure | 10, 12, 30, 50, 51, 63, 64, 72, 75, 76, 78, 81, 82, 85, 93, 100 |
| suitable..... | 29, 65, 66, 67, 69, 80, 92 |
| wet service..... | 20 |

PW344/2017 - Foreword

The objective of PW344/2017 is to provide a means for developing dolomite land in a manner that ensures that people live and work in an acceptably safe environment, with damages to and loss of assets within tolerable limits; and to ensure cost-effective and sustainable land usage. It also contains the policies, procedures and requirements for the implementation and management of the Department's Dolomite Risk Management Strategy. The Department's Dolomite Risk Management Strategy was originally implemented by the late Minister Stella Sigcau and approved by Cabinet in 2000.

Dolomite Land is defined as land underlain by dolomite or limestone residuum and or bedrock, within the Malmani Subgroup and Campbell Rand Subgroup, typically at depths of no more than:

- a) 60m in areas where no de-watering has taken place and the local authority has jurisdiction, is monitoring and has control over the groundwater levels over the areas under consideration; or
- b) 100 m in areas where de-watering has taken place or where the local authority has no jurisdiction or control over groundwater levels.

Dolomite land is characterized in terms of eight (1 being Low and 8 being High – Refer to SANS 1936-1) Inherent Hazard Classes based on

- a) the sinkhole size;
- b) the Inherent Hazard for sinkhole formation;
- c) the Inherent Hazard of subsidence formation;
- d) the assumption that all sites have a low Inherent Hazard for sinkhole formation of any size unless it is determined that the Inherent Hazard is medium or high.

Dolomite Risk Management Strategy

Dolomite Risk Management refers to the process of utilising scientific and engineering procedures and methods to manage an environmental hazard.

The Dolomite Risk Management Strategy of the Department of Public Works encompasses the policies and procedures set in place to reduce the likelihood of sinkholes and subsidences occurring in dolomite areas of South Africa under its jurisdiction. These procedures and policies govern all facets of development on dolomite including planning, design and installation of water bearing infrastructure, maintenance of infrastructure and enforcement of any other special precautions, restrictions and provisions deemed necessary in the geological setting. The objective is to ensure appropriate development and maintenance strategies in relation to the dolomite risk, thereby avoiding fruitless expenditure and protecting life and state assets. The policies involve proactive, multifaceted intervention, to actively counter the dolomite risk, involving both operational and management components of the Department.

Consequently, the Minister instructed that every operational, resource and financial management decision within the Department of Public Works with respect to dolomite areas, including all planning, maintenance, usage and financial decisions is to be executed in the context of a structured, holistic Risk Management Strategy. Decisions made within the context of the Dolomite Risk Management Strategy should lead to appropriate development, application of appropriate precautionary measures, pro-active maintenance, appropriate design and density of services, etc. The result of these actions is increased safety, minimising of fruitless expenditure, effective asset management, targeted expenditure, reducing the likelihood of sinkhole generation and fulfilling the legal obligations of the Department of Public Works.

Implementation of the Dolomite Risk Management Strategy

The **Management Strategy** involves:

- a) The creation of a Database System that stores relevant geotechnical and infrastructural data. This system can be manipulated in an interactive manner providing data that significantly underpins all operational and management decisions within the Department.
- b) Setting up of appropriate Departmental Standards, Guidelines and Policies e.g. appropriate land use purchase/alienation policies in relation to dolomite risk, updated manuals, e.g. PW344/2017.
- c) Undertaking of education drive within the Department on the dolomite issue.
- d) Creating increased awareness within the Department at all levels of management.
- e) Constant consideration of the legal situation.
- f) Dolomite risk assessment of National Department of Public Works of more than 1775 properties located on dolomite and completion of a value assessment of infrastructure in the context of risk and useful future lifespan.
- g) Implementation of projects to rehabilitate life threatening open sinkholes and demolishing of unsafe structures.
- h) Investigation of wet engineering services for current serviceability state and appropriateness of design in relation to the dolomite setting.
- i) Introduction of a Wet Services Master Planning were required to define the budget requirements of individually prioritised and targeted wet services upgrading projects. This plan defines the cost implications as well as the targeted and prioritised systematically phased upgrading programme in terms of dolomite risk and strategic importance of facilities.
- j) Execution of infrastructure status quo investigations to ensure a prioritised engineering upgrading programme targeting expenditure on facilities viable from a long-term maintenance and functional requirement level.
- k) Appointment of Competent Persons (geo-professional/engineer) and other contractors on a continuous basis to execute prioritised projects.
- l) Using the dolomite hazard characterisation of National Department of Public Works properties to formulate appropriate strategies to safely manage these assets in future.
- m) Investigations to assess the current state, value, utilisation, and strategic importance of facilities.
- n) Development of an Emergency Reaction Plan
- o) Formulation of guideline policies for the appropriate development and management of infrastructure on dolomite. These guidelines are used to assess the status of current infrastructure and obtain budget costs to upgrade engineering services to appropriate standards.
- p) Undertaking studies to assess the current and future level of facility utilisation in relation to the core function of the various user Departments and subgroups.
- q) Conducting detailed status quo investigations to ascertain the current and future maintenance cost of all infrastructure in order to enhance strategic land utilisation decisions and the financial viability of upgrading service to these facilities.
- r) Devising detailed upgrading programmes for services in key installations.

Dolomite Stability Investigations (DSI) are conducted to determine the Inherent Hazard characterisation of dolomite land as well as the Dolomite Area Designations and shall be undertaken under the direction of one or more Competent Persons (geo-professionals). Geotechnical site investigations on dolomite land shall comprise investigations, as relevant, relating to:

- a) the identification of hazards that impact upon the development of the land;
- b) the determination of the Inherent Hazard;
- c) the stability of the dolomite land for various types of development; and the foundations for buildings and structures.

The general requirements for such investigations are described in SANS 1936-2 and comprise the following:

a) **Feasibility-level Dolomite Stability Investigation**

The first phase of investigation requires fieldwork to enable the land to be characterized in terms of its stability. This phase of investigation forms the basis of development planning.

b) **Design-level Dolomite Stability Investigation**

Such investigation, including footprint investigation, where necessary, entails further investigations to provide specific information for design purpose of structures, facilities, infrastructure or bulk services.

c) **Investigations during Installation of Services**

This investigation is undertaken during the installation of services and entails observations and further investigations as are necessary to confirm the Inherent Hazard characterization of dolomite land or Dolomite Area Designations (or both) determined during the feasibility-level investigation.

Near surface soil horizon investigations for township developments are not part of the Dolomite Stability Investigation and should be undertaken in accordance with the requirements of the Specification for Geotechnical Investigations for Township Development.

The **safe development** of a site located on dolomite involves:

- a) careful geotechnical assessment of the delineated area,
- b) appropriate planning and appropriate design of structures and services as well as
- c) the perpetual management thereof.

The intended purpose of PW344/2017 is to provide performance based as well as prescriptive technical specifications and requirements of the Department regarding development on dolomite land and consists of:

- a) **Chapter 1** – Introduction and general guidance related to development on dolomite land as well as Departmental administrative arrangements regarding the procurement and development of dolomitic land;
- b) **Chapter 2** – Establishes qualitative and quantitative performance requirements for the development of dolomite land with respect to land safety and Land Usage, to ensure:
 - i. a tolerable hazard;
 - ii. that the current Land Usage does not compromise the future use of such land.

It also provides the means by which compliance with the performance requirements may be established.

- c) **Chapter 3** – Sets out the requirements for geotechnical investigation of dolomite land, the determination of the Inherent Hazard classification and requirements for inspections and verifications required during the implementation stage of a development on dolomite land. This chapter does not cover preliminary geotechnical investigations aimed at making initial determinations regarding the suitability of land for development. Refer to Appendix 2: Specification for Geotechnical Investigations for Township Development for the requirements of such investigations.
- d) **Chapter 4** – Establishes requirements for the design and construction of permanent or temporary buildings, structures and infrastructure including wet and dry engineering services on dolomitic land, identified for the purpose of development requiring precautionary measures to support sustainable development.

- e) **Chapter 5** – Establishes requirements for the development of an appropriate Dolomite Risk Management system to manage to within acceptable limits, the risks associated with developments or the provision of infrastructure (or both) on dolomite land.
- f) **Chapter 6** – Provides guidance and requirements in terms of Department procedures for engineering design, site investigations and contract documentation for the development of dolomite land.

PW344/2017 serves as a guideline for the design and construction of civil engineering utility services (water, sewerage, stormwater and diverse cabling to be installed in conduits or ducts) in the dolomite environment and does not exclude or prohibit rational design.

Definitions

For the purposes of this document, the following terms and definitions apply:

1. **accountable authority:** board or other controlling body in charge of an organization.
2. **accountable officer:** chief executive officer or other person in charge of an organization.
3. **angle of draw:** slope with respect to the horizontal in a soil horizon which represents the critical slope above which material within that soil horizon will become unstable and might flow or travel towards a receptacle.
4. **borehole profile:** record of the description of the vertical succession of the different soil or rock (or both) horizons as they occur at any particular location on site as intercepted by a borehole.
5. **borrow pit:** excavation made for the procurement of material.
6. **building:** any structure, whether of a temporary or permanent nature and irrespective of the materials used to construct it and for what purpose it is used.
7. **bulk pipelines:** pipelines that has a nominal diameter of 300 mm or more.
8. **client:** individual or organization commissioning the geotechnical site investigation.
9. **Client Department:** Other state Departments and or organizations that utilise the property of the National Department of Public Works on a permanent or temporary basis.
10. **competent geophysicist:** geophysicist with suitable working experience in dolomite environments in South Africa.
11. **Competent person:** person who is qualified by virtue of his experience, qualifications, training and in depth contextual knowledge of development on dolomite land to:
 - plan and conduct geotechnical site investigations for the development of dolomitic land, evaluate factual data, develop a geological model, establish interpretative data and formulate an opinion relating to the outcomes of such investigations;
 - develop and inspect for compliance, the necessary precautionary measures required on dolomite land to enable safe and sustainable developments to take place;
 - develop dolomite risk management strategies;
 - investigate the cause of an event and participate in the development of the remedial measures required.
12. **conservancy tank:** covered tank used for the reception and temporary retention of sewage, and which requires emptying at intervals.
13. **construction works:** everything that is constructed or results from construction operations.
14. **data:** information collected and assembled during the geotechnical site investigation.
15. **Department(al, 's):** the National Department of Public Works.
16. **dolomite:** rock composed of the mineral dolomite, which is a carbonate of calcium and magnesium.
17. **dolomite area designation:** classification of dolomite areas in terms of the extent of mitigation required to achieve and maintain a tolerable hazard.
18. **dolomite land:** land underlain by dolomite or limestone residuum and/or bedrock, within the Malmani Subgroup and Campbell Rand Subgroup, typically at depths of no more than:
 - 60m in areas where no de-watering has taken place and the local authority has jurisdiction, is monitoring and has control over the groundwater levels in the areas under consideration;
 - 100m in areas where de-watering has taken place or where the local authority has no jurisdiction or control over groundwater levels.
19. **dolomite risk management strategy (DRMS):** process of utilizing scientific, planning, engineering and social processes, procedures and measures to manage an environmental hazard and encompasses policies and procedures set in place to reduce the likelihood of events occurring on dolomite land.

20. **dry services:** system to convey air, data or electricity that comprises cables and ducts and their supports, but excludes pylons and other such supporting structures.
21. **engineering service:** stormwater management, road or water supply system or main conduits of the sanitation system within a township or interconnected complex.
22. **evapotranspirative bed:** effluent disposal system that comprises a shallow sand filled excavation covered with topsoil and planted over with suitable vegetation.
23. **event:** occurrence of a sinkhole or subsidence.
24. **factual data:** materials, statistics and properties that can be seen, measured or identified by means of accepted or standardized criteria, classifications and tests.
25. **french drain:** trench filled with suitable material which is used for the disposal of liquid effluent from a septic tank or waste water.
26. **geotechnical:** pertaining to the nature, condition and physical properties of the earth's crust (whether soil or rock and including water and gases therein) which affect its performance in civil engineering and building works.
27. **geotechnical site investigation:** process of evaluating the geotechnical character of a site in the context of existing or proposed works or Land Usage, which may include one or more of the following:
 - evaluation of the geology and hydrogeology of the site;
 - examination of existing geotechnical information pertaining to the site;
 - excavating or boring in soil or rock and systematic description of the soil and rock profile;
 - determine the depth of any fill that may be present;
 - in situ assessment of geotechnical properties of materials;
 - recovery of samples of soil or rock for examination, identification, recording, testing or display;
 - testing of soil or rock samples to quantify properties relevant to the purpose of the investigation;
 - evaluation of geotechnical properties of tested soils;
 - reporting of results.
28. **gravity survey:** survey in which variations in the earth's gravity field are measured in order to locate and delineate geological formations of different densities.
29. **groundwater compartments (dolomite aquifer):** an aquifer that is developed in geological formations consisting predominantly of dolomite and chert as a result of fracturing, faulting, dissolution or the formation of cavernous textures or structures (or both), that store water, and permit appreciable water movement, yielding economical quantities of water to boreholes or springs, often bound by impervious vertical or near vertical dykes, thereby compartmentalizing the groundwater.
30. **hazard:** source of potential harm.
31. **hazard rating:** the number of events that can potentially occur per hectare over a 20 year period due to development.
32. **infrastructure:** roads, railway lines, runways, liquid retaining structures, stormwater system, power lines, pipelines and associated structures, including water, sewer, fuel and gas lines, reservoirs, public swimming pools, attenuation and retention ponds for stormwater management, dams, reservoirs and artificial lakes or similar constructed works.
33. **inherent hazard:** potential for an event to develop in a particular ground profile on dolomite land.
34. **inspection:** general inspection by a competent person during the erection, construction or installation of a building, structure, and infrastructure, or part thereof, at such intervals as might be necessary in accordance with accepted professional practice to enable such competent person to be satisfied that the design is being correctly interpreted and that the work is being executed generally in accordance with the designs, appropriate construction techniques and good engineering practice but excludes detailed supervision and day-to-day inspection.
35. **interconnected complex:** complex of multiple dwelling units, such as terraced or multi-storey complexes, or cluster or retirement village type developments, where management of common property usually exercised by (but is not limited to) a management body (organization).

36. **interpretative data:** information derived from factual data using accepted and proven techniques, or from reasonable judgment exercised in the assessment of geological conditions or processes evident at the site.
37. **likelihood:** description of the probability or frequency of occurrence.
38. **maintenance:** combination of all technical and associated administrative actions during the service life of an item to retain it in a state in which it can perform its required function.
39. **major stormwater system:** stormwater system that is designed to cater for severe, infrequent storm events.
40. **minor stormwater system:** stormwater system that is designed to cater for frequent storms of a minor nature.
41. **monitor:** to check, supervise, observe critically and record the progress of an activity, action or system on a regular basis in order to identify change.
42. **monitoring area designation:** descriptor of a delineated area of dolomite land based on selected risk reduction measures and the frequency of such measures, based on factors such as metastable subsurface conditions or latent sinkhole formation, highly susceptible conditions, poor subsurface conditions, previous sinkhole or subsidence formation, palaeo-sinkhole or palaeo-subsidence structures, geological contact areas, fault zones, anticipated ground settlement or ponding water.
43. **organization:** organ of state, including local municipality (authority), company, firm, enterprise or association, body corporate or other legal entity or part thereof, whether incorporated or not, public or private, that has its own function(s) and administration.
44. **original groundwater level (OWL):** mean groundwater level in the dolomite aquifer, expressed as a depth below natural ground level or elevation above sea level (or both) about which the seasonal natural fluctuation occurs.
45. **outcrop dolomite:** dolomite bedrock that occurs at ground surface.
46. **palaeo structure:** ancient karst feature of variable dimensions infilled by younger material, especially Quaternary Period (1,65 Ma 0,01 Ma) deposits, typically red and of sandy composition, which may be a manifestation of an ancient sinkhole (palaeo-sinkhole) or subsidence (palaeo-subsidence).
47. **parcel of land:** tract of land, comprising one or more farm portions or properties registered in a deeds registry, identified for the purpose of development.
48. **performance:** behaviour related to use.
49. **performance parameter:** expression of quantitative performance requirements applicable to an engineering service.

Note: Performance parameters provide qualitative design criteria and, as such, establish constraints which impact on the solution that is adopted to comply with the performance requirements.
50. **permeability:** measure of the rate at which water passes through a material under the influence of a differential head of pressure.
51. **population:** population determined in accordance with regulation A21 of the National Building Regulations.
52. **qualitative performance requirement:** a performance requirement stated in qualitative terms.
53. **quarry:** any excavation, irrespective of size, where rock is removed for construction or other purposes.
54. **reliability:** ability of an engineering service to fulfil the specified requirements for which it has been designed.
55. **return period:** also known as a recurrence interval which is an estimate of the average interval of time between events of a certain size.
56. **risk:** effect of uncertainty on objectives and is often expressed in terms of the consequences of an event and the associated likelihood of occurrence.
57. **risk management:** logical and systematic iterative method of establishing the context, identifying, analysing, evaluating, treating, monitoring and communicating risk associated with any activity, function or process in a way that will enable losses to be minimized and opportunities to be maximized.

58. **risk reduction:** selective application of suitable techniques and management principles to reduce the likelihood of an occurrence or its consequences (or both).
59. **shallow dolomite:** dolomitic land where the average bedrock surface is less than 8m below natural ground level.
60. **sinkhole:** subsidence that occurs suddenly and manifests itself as a hole in the ground.
61. **soil:** product of rock disintegration and decomposition by weathering, transportation and modification by biological agents.
62. **structure:** organized combination of connected parts designed to provide some measure of rigidity, or construction works that have such an arrangement.
63. **subsidence:** shallow, enclosed depressions in the ground surface.
64. **suitable:** capable of fulfilling or having fulfilled the intended function, or fit for its intended purpose.
65. **user requirements:** statement of needs to be fulfilled by an engineering service.
66. **wet service:** engineered or constructed system that conveys fluids or gasses from a point of bulk storage to an end user, or from a point of collection to a point of discharge into a natural water course, retention pond or sewerage treatment works and that comprises equipment, pipes or channels and all related system elements, as well as their supporting structures.

Note: Wet services include water pipe networks, waterborne sewer pipe networks, stormwater conduits and channels, fuel pipelines and gas pipelines, and any other liquid carrying system.

Referenced documents

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- a) Joint Structural Division of the Institution of Structural Engineers and the South African institution of Civil Engineering. Code of Practice for Foundations and Superstructures for Single Storey Residential Buildings of Masonry Construction. 1995
- b) Specification for the Repair of Sinkholes (refer to Annex M)
- c) National Department of Housing Generic Specification GFSH-2: Geotechnical site investigations for housing developments
- d) SANS 633, Profiling, percussion borehole and core logging in Southern Africa
- e) SANS 634, Geotechnical investigations for township development
- f) Specification for Below ground Water Installations for Buildings (refer to Annex N)
- g) Specification for Sewers for Buildings (refer to Annex O)
- h) SANS 10400P, The application of the National Building Regulations – Part P: Drainage
- i) SANS 10400Q, The application of the National Building Regulations – Part Q: Non-waterborne means of sanitary disposal
- j) SANS 10400W, The application of the National Building Regulations – Part W: Fire installation
- k) SANS 1200, Civil Engineering Construction – Part AA: General (small works)
- l) SANS 1200, Civil Engineering Construction – Part AD: General (small dams)
- m) SANS 1200, Civil Engineering Construction – Part AH: General (structural)
- n) SANS 1200, Civil Engineering Construction – Part C: Site clearance
- o) SANS 1200, Civil Engineering Construction – Part D: Earthworks
- p) SANS 1200, Civil Engineering Construction – Part DA: Earthworks (small works)
- q) SANS 1200, Civil Engineering Construction – Part DB: Earthworks (pipe trenches). (Alt: SANS 2001DP1, Construction works – Part DP1: Earthworks for buried pipelines and culverts.)
- r) SANS 1200, Civil Engineering Construction – Part DE: Small earth dams
- s) SANS 1200, Civil Engineering Construction – Part DK: Gabions and pitching
- t) SANS 1200, Civil Engineering Construction – Part DM: Earthworks (roads, subgrade)
- u) SANS 1200, Civil Engineering Construction – Part DN: Earthworks (railway sidings)
- v) SANS 1200, Civil Engineering Construction – Part F: Piling
- w) SANS 1200, Civil Engineering Construction – Part G: Concrete (Structural). (Alt: SANS 2001CC1, Construction works – Part CC1: Concrete works (Structural).)
- x) SANS 1200, Civil Engineering Construction – Part GA: Concrete (small works)
- y) SANS 1200, Civil Engineering Construction – Part GB: Concrete (ordinary buildings)
- z) SANS 1200, Civil Engineering Construction – Part GE: Precast concrete (structural)
- aa) SANS 1200, Civil Engineering Construction – Part GF: Prestressed concrete
- bb) SANS 1200, Civil Engineering Construction – Part H: Structural steelwork
- cc) SANS 1200, Civil Engineering Construction – Part HA: Structural steelwork (sundry items)
- dd) SANS 1200, Civil Engineering Construction – Part Section HB: Cladding and sheeting
- ee) SANS 1200, Civil Engineering Construction – Part HC: Corrosion protection of structural steelwork
- ff) SANS 1200, Civil Engineering Construction – Part HE: Structural aluminium work

- gg) SANS 1200, Civil Engineering Construction – Part L: Medium - pressure pipelines. (Alt: SANS 2001DP2, Construction works – Part DP2: Medium pressure pipelines)
- hh) SANS 1200, Civil Engineering Construction – Part LB: Bedding (pipes)
- ii) SANS 1200, Civil Engineering Construction – Part LC: Cable ducts. (Alt: SANS 2001DP3, Construction works – Part DP3: Cable ducts.)
- jj) SANS 1200, Civil Engineering Construction – Part LD: Sewers. (Alt: SANS 2001DP4, Construction works – Part DP4: Sewers.)
- kk) SANS 1200, Civil Engineering Construction – Part LE: Stormwater drainage. (Alt: SANS 2001DP5, Construction works – Part DP5: Stormwater drainage.)
- ll) SANS 1200, Civil Engineering Construction – Part LF: Erf connections (water)
- mm) SANS 1200, Civil Engineering Construction – Part LG: Pipe jacking
- nn) SANS 1200, Civil Engineering Construction – Part M: Roads (general)
- oo) SANS 1200, Civil Engineering Construction – Part ME: Subbase
- pp) SANS 1200, Civil Engineering Construction – Part MF: Base
- qq) SANS 1200, Civil Engineering Construction – Part MFL: Base (light pavement structures)
- rr) SANS 1200, Civil Engineering Construction – Part MG: Bituminous surface treatment
- ss) SANS 1200, Civil Engineering Construction – Part MH: Asphalt base and surfacing
- tt) SANS 1200, Civil Engineering Construction – Part MJ: Segmented paving
- uu) SANS 1200, Civil Engineering Construction – Part MK: Kerbing and channelling
- vv) SANS 1200, Civil Engineering Construction – Part MM: Ancillary roadworks
- ww) SANS 1200, Civil Engineering Construction – Part NB: Railway sidings (trackwork)
- xx) SANS 62-1, Steel pipes: Part 1: Pipes suitable for threading and of nominal size not exceeding 150mm
- yy) SANS 677, Concrete nonpressure pipes
- zz) SANS 674, Steel-reinforced spirally wound PE drainage and sewer pipes
- aaa) SANS 719, Electric welded low carbon steel pipes for aqueous fluids (large bore)
- bbb) SANS 791, Unplasticized poly (vinyl chloride) (uPVC) sewer and drain pipes and pipe fittings
- ccc) SANS 966, Components of pressure pipe systems - uPVCC and mPVC
- ddd) SANS 1315, Polypropylene pressure pipes
- eee) SANS 1601, Structured wall pipes and fittings of unplasticized poly (vinyl) chloride (PVCU) for buried drainage and sewerage systems
- fff) SANS 1835, Ductile iron pipes, fittings, accessories and their joints for use in high and low pressure systems for potable and foul water
- ggg) SANS 4427, Polyethylene (PE) pipes for water supply – specifications
- hhh) SANS 6269, Welding of thermoplastics - Test methods for welded joints
- iii) SANS 966, Components of pressure pipe systems – Part 1: Unplasticized poly (vinyl chloride) (PVCU) pressure pipe systems
SANS 966, Components of pressure pipe systems Part 2: Modified poly (vinyl chloride) (PVCM) pressure pipe systems
- jjj) SANS 8773/ISO 8773, Plastics piping systems for nonpressure underground drainage and sewerage – Polypropylene (PP)
- kkk) SANS 21138, Plastics piping systems for non-pressure underground drainage and sewerage - structured wall piping systems
- lll) ISO 9969: 1995, Thermoplastics pipes. Determination of ring stiffness

- mmm) SANS 1671, Welding of thermoplastics - Machines and equipment
- nnn) SANS 10268, Welding of thermoplastics - Welding processes
- ooo) SANS 10269, Welding of thermoplastics - Testing and approval of welders
- ppp) SANS 10270, Welding of thermoplastics - Approval of welding procedures and welds
- qqq) SANS 1655, Welding of thermoplastics - Welding rods, fillers and solvents

Bibliography

AS/NZS 4360, Risk Management

Buttrick, D., and Van Schalkwyk, A. (1998). Hazard and risk assessment for sinkhole formation on dolomite land in South Africa. *Environmental Geology*. Volume 36 (12), November, 170178.

Buttrick, D. B. (1992). *Characterisation and appropriate development of sites on dolomite*. PhD thesis, University of Pretoria.

Buttrick, D. B., Van Schalkwyk, A., Kleywegt, R. J., and Watermeyer, R. B. (2001). Proposed method for dolomite land hazard and risk assessment in South Africa. *Journal of the South African Institution of Civil Engineering*, Volume 43 (2), 2736.

Kleywegt, R. (1987). Keynote address. *Seminar on the engineering geological evaluation of sites on dolomite*. S. A. Geological Survey, Pretoria, 7 September.

Schoning, W. L. (1990). *Verspreiding van sinkgate en versakkings in die dolomiet gebiede suid van Pretoria*. MSc Thesis, University of Pretoria.

South African Institute of Steel Construction (2013). *Southern African Steel Construction Handbook*, 8th edition, 2013 (reprinted in 2017).

Watermeyer, R. B., Buttrick D. B., Trollip, N.Y.G., Gerber, A.A., Pieterse, N. (2008). A performance based approach to the development of dolomite land. *Proceedings of the Geotechnical Division of SAICE's Conference on Problem Soils in South Africa*, 34 November, Midrand. 167 174.

Wagener F von M (1985). Dolomites: Dolomites: problem soils in South Africa State of the Art. Vol 7 Issue 7, *Civil Engineer in South Africa*. 1985.

Chapter 1: Introduction

1.1 Background

1.1.1. Risk management is commonly understood to be the culture, processes and structures that are directed towards the effective management of potential opportunities and adverse effects. In the context of dolomite land, the:

- a) opportunities are the development potential of such land;
- b) the adverse effects related to the hazards (i.e. the source of potential harm or a situation with a potential to cause loss), in the form of sinkholes (i.e. subsidence that occur suddenly, having very steep sides and being of limited lateral extent) and subsidences (i.e. shallow, enclosed depressions in the ground surface).

Sinkholes and subsidences are found in areas underlain by dolomite and limestone (refer to SANS 1936-1, Annex B and C for descriptions and definitions of dolomite, sinkholes and subsidences).

1.1.2. The geotechnical factors that influence the susceptibility of an area to sinkhole and subsidence formation include:

- a) ground surface topography;
- b) drainage,
- c) the nature, thickness and origin of the transported soils and residuum;
- d) the nature and topography of the underlying strata;
- e) the depth and expected fluctuations of the groundwater level;
- f) presence of underlying structural features such as faults, fracture zones and dykes.

1.1.3. Sinkholes and subsidences are usually induced by human activity in areas that are susceptible to such ground movement events. Primary trigger mechanisms include:

- a) ingress of water from leaking water bearing infrastructure and structures;
- b) poorly managed surface water drainage and;
- c) dewatering or re-charging of the natural groundwater level.

1.1.4. The hazard of sinkhole formation, in the absence of risk mitigation measures and depending upon their location, can result in loss of life, severe damage or total loss of buildings and severe damage to infrastructure. The hazard of subsidence formation is generally confined to differential movements that might cause extensive damage to unprotected buildings and infrastructure.

1.1.5. Risk avoidance measures such as prohibiting development of any kind on areas underlain by dolomite land is not always practically feasible as between 4 and 5 million South Africans currently reside or work on such land. Twenty-five per cent of Gauteng, the commercial, mining and manufacturing centre of South Africa is located on dolomite. At the other end of the spectrum, risk acceptance is not socially acceptable, given the nature of the hazard, the number of people currently residing on such land and the Government's obligations in terms of the Bill of Rights. Risk mitigation measures are therefore required.

1.1.6. Risk management is recognised as an integral part of good management practice and is to be applied across all disciplines involved in a project from the inception through to its decommissioning or alienation by the Department. Broadly, risk may be managed on dolomite land by:

- a) placing restrictions on land use;
- b) ensuring appropriate development in relation to the Inherent Hazard;
- c) establishing requirements for the management and monitoring of surface drainage and dewatering;
- d) establishing requirements for the installation of below ground infrastructure, particularly water bearing services and structures;
- e) establishing requirements for the construction of above ground infrastructure, particularly water- bearing services and structures;

- f) establishing requirements for the construction and maintenance of above ground and below ground water bearing structures and services;
- g) establishing design requirements and procedures for buildings, structures and infrastructure to allow, as a minimum, the safe evacuation of occupants and users in the event of a hazard occurring;
- h) implementation of the above listed requirements during planning and development;
- i) undertaking ongoing risk management functions for the lifespan of the development or facility.

Dolomite Risk Management of a property commences with the purchase and development of a site and should continue through to its eventual decommissioning or sale. The Department of Public Works and the Client Departments have a perpetual co-responsibility for actively implementing risk management for the lifespan of a facility or development.

All actions focused on achieving the above objectives, require multidisciplinary input from a range of professionals and officials in the Department and Client Departments, driven by the need to comply with the requirements established by the dolomite risk assessment of the site. PW344/2017 establishes requirements for the development of an appropriate Dolomite Risk Management system to manage the risks associated with developments or the provision of infrastructure (or both) on dolomite land to within acceptable limits in accordance with SANS 1936.

1.1.7. Dolomite Risk Management is an iterative process, consisting of steps, which, when undertaken in sequence, enable continual improvement in decision-making and risk management processes. The Department of Public Works Dolomite Risk Management strategy (DRMS) in general involves the following steps:

- a) Desk Study of all available information;
- b) Detailed dolomite stability investigation and assessment;
- c) Appropriate planning and design in accordance with the dolomite stability assessment recommendations;
- d) Construction monitoring and reporting;
- e) Dolomite Risk Management of a particular site or property during its in-service period, executed in accordance with the contents of a Dolomite Risk Management Plan;
- f) Close-out report on alienation of the property.

1.1.8. The objective of applying a risk management strategy to buildings, structures and infrastructure is to ensure the safety of occupants, protection of property and to avoid fruitless expenditure. Avoiding sinkholes is not only important from a safety point of view, but rehabilitating sinkholes and repairing buildings/ infrastructure are also costly.

1.1.9. Infrastructure must be appropriately designed, constructed, and serviced to facilitate management of the dolomite hazard. To this end, the Department of Public Works has adopted a centralised Dolomite Risk Management Strategy (DRMS) for infrastructure located on all dolomitic land. Primarily the policy, procedures and requirements for Dolomite Risk Management are incorporated in Manual PW344/2017 which:

- a) serves as a guideline on appropriate development and risk management of infrastructure located on dolomite in South Africa. These guidelines are aimed at informing Departmental staff, principal agents and appointed/ contracted service providers/consultants and other consultants of the minimum requirements of the Department of Public Works concerning the upgrading, extension and development of existing and new infrastructure on dolomite, thereby promoting safe, sustainable development. 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, principal agents and appointed /contracted service providers involved, to recourse through a number of avenues, including the Occupational Health and Safety Act of 1993. It should be clearly understood that officials, principal agents and appointed/contracted service providers are not absolved of their responsibilities and cannot claim ignorance in the event of damage to infrastructure or loss of life when a dolomite-related incident occurs.

- b) establishes requirements aimed at reducing risk to levels acceptable to society and to minimize loss of life should the hazard occur and to ensure sustainable safe Land Usage. It establishes qualitative, quantitative and specific performance requirements adopted by the Department of Public Works for the continual safe use of dolomite land. It also provides the means by which compliance with such requirements may be determined in terms of;
 - i. Geotechnical investigations
 - ii. Land Usage
 - iii. Design and construction of buildings, structures and infrastructure
 - iv. Dolomite Risk Management

Note: The principal agent and other service providers play a crucial role in ensuring that the Dolomite Risk Management Strategy is successfully implemented by applying appropriate planning, water precautionary and remedial measures as outlined in PW344/2017.

1.2 Approach to managing risk on dolomite land

1.2.1 Dolomite hazard assessment is an empirical science that relies heavily on past experience and the review of historical records. The method of hazard classification predominantly applied in South Africa today is set out in a paper by Buttrick et al (2001). This method requires hypothesising the impact of man's future activities on the hazard of sinkhole formation within a dolomite karst environment in the context of the dewatering or non-dewatering scenarios in the dolomite aquifer. Based on the geotechnical information gathered, a site is zoned in the context of eight defined Inherent Hazard Classes. Risk mitigation strategies are commonly developed around these Inherent Hazard Classes.

1.2.2 The occurrence of 650 events, which developed over a twenty year period from 1984 to 2004, in an urbanised environment of 3 697 ha located south of Pretoria in the Gauteng Province of South Africa has been comprehensively documented by the Department of Public Works prior to the development and implementation of a risk management strategy. Records of events after the implementation of a comprehensive risk mitigation strategy are also available. This data set permitted an analysis and a review of the methodology most commonly used in stability analysis in Southern Africa.

1.2.3 An analysis of this data set and a review thereof has confirmed the validity of the Buttrick et al (2001) classification system and the risk mitigation measures put in place by the Department of Public Works. PW344/2017 is accordingly based on this methodology and risk management strategies implemented by the Department.

1.3 Distribution of dolomite in South Africa

Refer to Annex B in Volume 2 for the location of Dolomite in South Africa. The tables provided in Annex B provide a detailed list of Provinces, Magisterial Districts, Municipalities and Towns located on dolomite. The maps at the end of Annex B provide the extent and location of Dolomite within the areas of responsibility for the various Regional Offices of the Department.

1.4 Risks associated with dolomitic land

Dolomite rock is slowly soluble, in acidic water. The slightly acidic rainwater and percolating groundwater gradually dissolve the rock over very long 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 subsidences (refer to SANS 196-1, Annex C: Mechanisms associated with sinkholes and subsidence formation). It should be noted that in South Africa the terms sinkhole and subsidence are currently used to refer to geomorphologic features and are no longer distinguished by the mechanism of formation.

1.4.1 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 1m to 100m in diameter and 1m to 150m deep. Sinkholes are catastrophic and can cause property damage and/or loss of life. Refer to Annex A: Plates 1 to 7 for typical sinkhole incidences.

Sinkholes:

- a) may be catastrophic, as they occur unexpectedly with little or no warning;
- b) may cause property damage and/or loss of life, if they are sufficiently large;
- c) are usually precipitated by human activity such as;
 - i. dewatering and rewatering of groundwater compartments, due to mining activity,
 - ii. water extraction from aquifers,
 - iii. leakage of wet services such as water and sewer services, reticulation and connections,
 - iv. interference with natural drainage patterns by development and disturbance of superficial soil materials leading to concentrated water ingress.

1.4.2 Subsidence

Subsidence are less sharply defined than sinkholes, occur slowly and are generally not catastrophic (refer to Annex A: Plates 8 and 9).

Subsidence:

- a) may be large ranging from tens of metres to kilometres in diameter or length;
- b) typical visual observations at small subsidence are shallow earth depressions and surface cracks in a circular or semi-circular pattern.

1.4.3 Triggering mechanisms for sinkhole and subsidence formation

Sinkholes and subsidence are mostly caused by water ingress/seepage or a lowering of the ground water table.

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 raveling and the void moving upward towards ground surface. The void will eventually daylight and manifests as a sinkhole. Often paleo sinkholes are reactivated by groundwater level draw down. Paleo sinkholes are ancient features infilled over time by transported soil material, e.g. wind-blown, aeolian sands. These materials may extend below the original groundwater level. In such instances, lowering of the groundwater level leads to a change in the moisture regime of the soils that re-activates the sinkhole.

Seepage of water most commonly occurs from leaking water bearing services such as sewers, water pipes, stormwater systems etc. The leaking water erodes the soil covering the dolomite rock and carries the material down into the underlying cave systems resulting in the formation of a cavity below ground surface. A sinkhole results when this cavity daylights. Sinkholes and subsidence may occur soon after installation of services because of poor workmanship or use of inferior materials or after a period of time due to continual consolidation of poorly compacted materials. Obviously, as the condition of water bearing services deteriorate with time, the frequency of leaks increases and so does the likelihood of a sinkhole occurring.

The groundwater level drops when boreholes are used to pump water from underground aquifers. The groundwater level can also be lowered when mines pump water out of groundwater compartments to keep their underground workings dry. Groundwater level lowering leads to lowering of porewater pressure, which lowers, ground bearing capacity or draining of subsurface cavities, which may result in sinkhole or subsidence formation.

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 are located on the Far West Rand in the Gauteng Province. In many of these areas, the groundwater level is located above the bedrock, in residual soils. These residual materials are essentially composed of wad and ferroan soil. The artificial lowering of the groundwater level may produce significant ground movement at the surface. This process manifests as a subsidence at ground surface.

1.5 Dolomite Risk Management concept with respect to a Departmental project

Dolomite Risk Management as previously described is an iterative process, consisting of steps, which, when undertaken in sequence, enable continual improvement in decision-making of risk management processes. The Dolomite Risk Management concept with respect to a Departmental project involves the following decisive steps:

1.5.1 Desk Study

Once a Client Department identifies a particular need for a new facility or development or an addition to an existing development or maintenance works, a preliminary assessment of all geological available data is undertaken. This preliminary assessment needs to indicate that the site is potentially located:

- a) directly on dolomite (necessitating a detailed Dolomite Stability Investigation);
- b) within the buffer zone i.e. close to the dolomite and possibly on dolomite (necessitating confirmation of the presence of dolomite through limited geotechnical drilling of site/facility);
- c) not on dolomite.

1.5.2 Detailed dolomite stability assessment

The detailed assessment of dolomite stability conditions on a site is undertaken in accordance with SANS 1936 (Parts 1 and 2) and PW334/2017 (Chapters 2 and 3).

Recommendations are made with respect to land use planning in relation to the risk, appropriate water precautionary measures, appropriate foundation solutions and Dolomite Risk Management in accordance with PW334/2017 (Chapters 2 and 4).

Provisional Monitoring Designations are determined at this stage as required by PW344/2017, (Chapter 5).

1.5.3 Planning and Design Stage

The project may proceed only when the **Dolomite Status Certificate (PRM011A)** (refer to generic example in Annex G) is completed and signed by the Departmental Dolomite Risk Manager and the Director Civil and Structural Engineering. This certificate is only issued once for a development site. Interaction and conveying of the recommendations included in PRM011A to other professionals in the Department's development team occur through the National Dolomite Risk Manager resident at the DPW Head Office. This dissemination of information and awareness of dolomite matters is critical.

Once provisional planning is completed the Competent Person (geo-professional/engineer) needs to sign off the provisional development layout, confirming conformity of planning in relation to the dolomite hazard. Thereafter all planning, design and construction work is executed in accordance with Departmental standards contained in PW344/2017.

It is a compulsory requirement of the Department that documentation related to two critical project milestone stages, namely Preliminary Design Report (PDR) and Contract Tender Documentation shall be submitted in hard copy to the departmental project manager (PM) for review, who in turn shall submit such documentation for review and comments to the Dolomite Risk Manager, based in the DPW Head Office.

1.5.4 Construction Monitoring and Reporting

Monitoring (geotechnical) is undertaken during construction by a Competent Person (geo-professional) in accordance with the requirements of SANS 1936 and PW344/2017 (Chapters 2 and 5), involving:

- a) Inspection of open works;
- b) Participation in site meetings as required;
- c) Mapping, investigation of any problematic conditions identified;
- d) Adaptation of precautionary measures, layouts, etc. to take account of newly identified hazardous areas. (Process involves participation of other professionals such as project managers, architects, civil and structural engineers);
- e) Certification of final site classification at the end of the construction phase;
- f) Compilation of a Construction/Completion report constituting a record of final conditions and recommendations.

As and when required, the PM and/or the designated appointed professional service provider shall facilitate specialist inspections as noted above to be undertaken by the DPW Dolomite Risk Management Unit (DRMU) through formally acknowledged notification by the departmental project PM.

1.5.5 Dolomite Risk Management during the In-service Period

1.5.5.1 *Compilation of a Dolomite Risk Management Plan*

An appropriate Dolomite Risk Management Plan is to be compiled for each development in accordance with PW344/2017 (Chapter 5). The Dolomite Risk Management Plan is to be site specific and based on all data gathered until that time, taking cognisance of final precautionary measures, site layout and shall also contain the final Monitoring Designations.

The Dolomite Risk Management Plan shall outline the responsibilities and actions of the Department of Public Works and the Client Department.

It is a compulsory requirement for the appointed professional service provider to prepare a site specific Dolomite Risk Management Plan (DRMP) for the development in accordance with the requirements of SANS 1936-4 and PW344/2017 (Chapter 5). This aspect is regarded as an additional service (to the appointment of the professional service provider), which must be:

- a) Priced for consideration/approval by the PM in collaboration with the Departmental Dolomite Risk Manager (DDRM);
- b) Reviewed, corrected and signed off by the DDRM;
- c) Submitted (once signed off) in five (5) fold for distribution to the PM, client representative (during site handover), the DRMM, the D/KAM and the D/PPM.

1.5.5.2 *Briefing of User/Client Department regarding Dolomite Risk Management Plan (DRMP)*

It is essential that the Department of Public Works (in the broadest possible context) and the Client Department clearly understand that they are jointly accountable for the implementation of the risk management strategy and that external review will take place (as noted above). PW344/2017 (Chapter 5) requires that the Department shall ensure that a review of the Dolomite Risk Management programme is carried out:

- a) *internally at specified intervals not exceeding one year, sufficient to ensure its continuing suitability and effectiveness in satisfying the requirements of PW344/2017 (Chapter 5) and the organisation's stated risk management policy and objectives;*
- b) *by an independent Competent Person every five years.*

The User Department/Client Department is to be fully briefed by the DRMU manager at Head Office on all the above requirements and be provided with relevant documentation e.g. Dolomite Stability Reports and Risk Management Plans. The Client Department should fully understand its role, duties and functions in terms of the Dolomite Risk Management Plan.

During the in-service period, ongoing regular audits on the Risk Management Plan must ensure that all the monitoring activities are undertaken as specified and that those that show non-compliance are dealt with appropriately. Refer to SANS 1936-4 (Item 4.2.1.8) for details.

The Departmental PM shall facilitate a formal appointment during which the Departmental staff should fully brief the User Department/Client Department regarding the decommissioning requirements when assets, including infrastructure, developments, complexes, individual structures etc., in the Department's Portfolio are sold or handed over to a third party or removed from operation or use.

1.5.5.3 Proactive and Reactive Measures

During the lifespan of a project, multidisciplinary teams participate in the planning, construction, in-service management and decommissioning of a Departmental asset. The various role players should be striving to comply with the requirements and recommendations set by the Competent Person (geo-professional/engineer) responsible for the development.

There rests an onus on all professional, technical and administrative officials of the Department involved in the development and management of a facility to act pro-actively and responsibly. The Department's and the Client Department's roles and scope of responsibilities must be clearly defined and understood (i.e. who does what and when to comply with the approved DRMP and general norms).

When incidents of instability arise at a facility the Client Department must report the incidents to the Department at the office of the Departmental Dolomite Risk Manager (DRM) using the Ground Hazard Incidence Report (GHIR) as included in Annex I. The Department then needs to immediately dispatch appropriately experienced officials or competent persons to inspect the identified problem area and appropriate action needs to be taken based on the conclusions from the inspection.

1.5.6 Decommissioning or Alienation of a Facility

On the decommissioning, sale or alienation of a property a number of actions are required by the Department.

The new owners should be provided with:

- a) information concerning the site, including that it is located on dolomite and the hazard characterisation, previous problems, sinkholes, etc.
- b) the site specific Dolomite Risk Management Plan;
- c) information concerning any special precautionary or remedial measures implemented on the site;
- d) Monitoring Designations and especially, records of previous inspections and monitoring.

By following these processes, the Department limits its liability from a latent or patent defect perspective. The information concerning the site must form part of the deed of sale and/or alienation agreement.

1.5.7 Project Types

The Department has the following development project types to which the above philosophy should be applied.

1.5.7.1 New Projects

New projects are full lifespan projects where new tracts of land are to be purchased, projects undertaken, managed in-service and eventually decommissioned or alienated.

1.5.7.2 **Existing Projects**

Existing projects are **partial lifespan projects**, in that the ongoing risk management is introduced after a Dolomite Stability Investigation and status quo assessment of all elements of the development are undertaken. Fundamental elements of risk management, as applied to **full lifespan projects** are not necessarily available (e.g. appropriate land use planning in relation to the risk - the structure/s, infrastructure, etc. has already been constructed and may be located on land with a hazard zonation not appropriate for the current development). These projects include:

- a) Existing developments and the extension or upgrading thereof;
- b) Purchase of existing developments or infrastructure;
- c) Existing assets to be decommissioned;
- d) Existing assets to be alienated.

1.5.7.3 **Maintenance Projects**

Maintenance projects are **partial lifespan projects**, in that the ongoing risk management is introduced with or without a Dolomite Stability Investigation and status quo assessment of all elements of the development. Fundamental elements of risk management, as applied to **full lifespan projects** are not necessarily available. These projects include:

- a) Existing projects that fall under specific identified Repair and Maintenance Projects (RAMP);
- b) General day-to-day maintenance processes.

1.5.7.4 **Projects located on Dolomite, where the Department is the Owner but not responsible for Maintenance**

Projects where the Department is the owner but where maintenance, in-service management and upgrading is decentralised to the Client will need special attention due to the legal obligations from an ownership perspective.

Such projects are subject to comments by the Departmental Dolomite Risk Manager with respect to maintenance requirements. No additions to buildings, structures and infrastructure and/or changes to Land Usage may be made without the consent of the Department.

1.6 **Departmental Administrative Arrangements**

1.6.1 **Dolomite Risk Management - Departmental Dolomite Risk Manager**

The Department has appointed a Dolomite Risk Manager (DRM) at the Head Office:

**Directorate: Civil & Structural Engineering,
Dolomite Risk Management Unit (DRMU)**
Central Government Offices
6th Floor
cnr. Church and Bosman Streets
Pretoria
Tel. No.: 012 406 1425
Email: dpwdolomite@dpw.gov.za

The appointed official can be consulted to ascertain whether sites are underlain by dolomite.

The Dolomite Risk Manager shall (for all projects on dolomite) be involved in an advisory capacity in the following:

- a) briefing of appointed/contracted service providers/consultants,
- b) vetting/approval of Preliminary Design Reports (PDR);
- c) final tender documentation;
- d) construction oversight.

The Departmental Dolomite Risk Manager reserves the right to request the implementation of changes to a design or development as deemed necessary, to ensure that the best practice requirements are met.

Any comments or instructions by the Dolomite Risk Manager do not relieve the Departmental Project Manager and/or appointed/contracted service providers/consultants and other Competent Persons from their respective legal obligation to ensure compliance with compulsory regulations required by SANS 1936 and/or PW344/2017.

The Directorate: Civil & Structural Engineering at the Head Office of the Department is the only division that will issue the required certificates (Dolomite Status Certificate PRM011A – refer to Annex G) for the procurement, development planning or maintenance projects to proceed on dolomite land.

1.6.2 Departmental Project management (PRM) Forms

1.6.2.1 Dolomite Status Certificate (PRM011A)

A Dolomite Status Certificate (PRM011A) confirms:

- a) Ownership of the land;
- b) The existence of Previous Dolomite Stability Investigation Reports (if available);
- c) The hazard zonation of the land;
- d) The references to the mandatory development, design criteria and risk management to be implemented for all developments (upgrading, extending or maintenance of existing development or planning of new development).

A Dolomite Status Certificate (PRM011A) is required for:

- a) Procurement of land;
- b) Sale of land;
- c) Alienation of land;
- d) Acceptance of donated land;
- e) Donation of land to other parties;
- f) Development planning of new properties;
- g) Extension/additions to existing development;
- h) Upgrading and/or replacement of infrastructure and the maintenance thereof;
- i) Obtaining of servitudes or right-of-way;
- j) Provision of servitudes or right-of-way;
- k) Maintenance projects involving underground wet and dry services.

Note: A Dolomite Status Certificate is issued only once for a particular parcel of land after a Dolomite Stability Investigation was conducted in terms of the provisions of PW344/2017.

1.6.2.2 Standard PRM Forms Related to Development on Dolomite

The following are Departmental Project Management (PRM) forms that specifically reference competency, procedures and planning processes related to development on dolomite. Particular attention is to be given to Inception Check List (PRM007) to ensure that the consultant/service provider is properly briefed.

Table 1.1 — Standard Departmental Project Management Forms related to development on dolomite

| PRM FORM | DESCRIPTION |
|----------|--|
| PRM 003 | The appointment of consultants from a roster |
| PRM 004 | Field of competence |
| PRM 006 | Consultants team |
| PRM 007 | Inception check list |
| PRM 011 | Policy and procurement for the demolition of state buildings |

| PRM FORM | DESCRIPTION |
|----------|---|
| PRM 011A | Dolomite status certificate |
| PRM 012 | Report on property |
| PRM 016 | Environmental and social aspects to be considered |
| PRM 017 | Submission of drawings to local authorities |

The latest version of the above PRM forms have to be obtained from the Departmental Project Manager or downloaded from the official Departmental website at <http://www.publicworks.gov.za>

1.6.3 Dolomite Risk Management – Regional Office Advisors

The Department has regional offices in the areas affected by dolomite, namely Johannesburg, Kimberley, Mmabatho, Nelspruit, Polokwane and Pretoria, where regional representatives are available to assist with local projects on dolomite. These officials will assist the Departmental Project Manager and/or consultant/service provider as required.

Where the assistance of the regional representatives is required, the Dolomite Risk Manager (DRM) at the Head Office in Pretoria shall be contacted (refer to the contact details presented in 1.6.1) to obtain the contact details of the applicable regional representative.

These officials must ensure that the Departmental Dolomite Risk Management Strategy (DRMS) is implemented at all levels of facility planning, maintenance and management. It is imperative that the person appointed as the regional representative liaise with the Departmental Project Managers and other officials directly involved in any works/development located on dolomite.

1.6.4 Dolomite Risk Management - Training of Departmental Staff

In order to ensure that Dolomite Risk Management Principles and the DRMS are disseminated to all levels in the Department, training should be provided to all departmental staff and will be provided by the Departmental Risk Manager working in the Directorate Civil and Structural Engineering. Such training must include:

- a) Definition of dolomitic land (refer to SANS 1936-1, Annex B);
- b) The spatial distribution of dolomitic land;
- c) Distribution of state land on dolomite;
- d) Problems associated with dolomitic land;
- e) Description of sinkholes and subsidences;
- f) Primary causes of sinkholes and subsidences;
- g) Problems associated with de-watering, non-dewatered and re-watering areas;
- h) Inherent Hazard versus development risk;
- i) Risk associated with the development of dolomitic land;
- j) Negative consequences of inappropriate development on dolomitic land;
- k) Irreversible risk deterioration as result of development neglect;
- l) Standards for investigation of dolomitic land in general (SANS 1936 and PW344/2017).
 - i. Hazard classification of dolomitic land in general;
 - ii. Dolomite Area Designations and Land Usage principles;
 - iii. Appropriate development;
 - iv. Risk management and risk management plans.
- m) Appropriate development planning;
- n) Geological investigations required prior to procuring or developing of dolomitic sites;

- o) Scope of required geotechnical investigations and minimum reporting content;
- p) Typical site selection or rejection criteria;
- q) Procurement and leasing of property – contractual requirements if property is on dolomite;
- r) Property allocated to the Department in Township planning (required reporting prior to acceptance);
- s) Planning Instructions (PI) prerequisite to determine if site is on dolomite (new, upgrading or maintenance projects);
- t) Applicable PRM forms;
- u) Briefing of appointed/contracted service providers/consultants;
- v) Execution of dolomite investigation report conclusions;
- w) General legal requirements and dereliction of duty (officials and appointed/contracted service providers/consultants);
- x) Special conditions of contract (with reference to GCC and JBCC) and contractual/ insurance requirements;
- y) General construction activities and site hand over prescriptions;
- z) Typical site visit observations during construction;
- aa) Hazard (sinkhole, subsidence, cracked building) reporting requirements and forms;
- bb) Typical signs of imminent danger;
- cc) Investigation of geological incidents;
- dd) Incident information logging and Departmental requirement to report;
- ee) Departmental Dolomite Risk Management Strategy database;
- ff) Level of data to be available in future from Risk Management Strategy database;
- gg) Current listing of large, medium and small sites under investigation;
- hh) Information at Regional Offices that should be forwarded to Head Office (location of sinkholes, subsidences, cracked or damaged structures and any historical geological reports);
- ii) Information regarding current projects or planned future projects;
- jj) Lists of contact persons (tel, fax, e-mail);
- kk) Departmental administrative arrangements.

1.6.5 Project Managers' Briefing of Principal Agent and appointed Service Providers/Contractors

Departmental Project Managers appointed to execute a project located on dolomite, must ensure that the design and construction of new buildings, structures and infrastructure or upgrading and maintenance of existing buildings, structures and infrastructure are according to the requirements of PW344/2017. If in doubt, the Departmental Project Manager can consult the Departmental Dolomite Risk Manager to ascertain whether the site is located on dolomite.

1.6.5.1 Any property located close to or within the Magisterial Districts, Municipalities and Towns as per the tables provided in Annex B requires referencing by the Departmental Dolomite Risk Manager.

1.6.5.2 For each project, a Dolomite Status Certificate (DSC) (Departmental form PRM011A) is to be obtained from the Departmental Dolomite Risk Manager. The Departmental Project Managers may not proceed with planning unless a DSC has been issued for the particular location of the proposed project. The Departmental National Dolomite Risk Manager may issue:

- a) No Dolomite Status Certificate (NDSC) that states that the Project is not located on dolomite. In such cases the standard design and development criteria of the Department applies, including geological review of in situ materials.

- b.) Dolomite Status Certificate (DSC) indicating the Inherent Dolomite Hazard Classification, as well as prescriptive development criteria. In such cases the Project Manager may proceed with the Project Planning provided that the Dolomite Status Certificate is issued to all internal and external appointed/contracted service providers/consultants involved in the planning and design of the project. The Departmental Project Managers must ensure that the project specific appointed principal agent/project manager (engineer, architect or quantity surveyor) and other appointed/contracted service providers/consultants, including other Departmental Officials and/or Officials from the Client Department ensure that all planning and development are in accordance with the:
 - i. Dolomite Stability Investigation recommendations and conclusions;
 - ii. Dolomite Status Certificate prescriptions;
 - iii. PW344/2017 and SANS 1936.
- c.) **Notification that the project is located on dolomite, but no Dolomite Stability Investigation has been executed in the past** and that planning may only proceed once a Dolomite Stability Investigation has been completed. Such Dolomite Stability Investigation/assessment shall be undertaken in accordance with the requirements of SANS 1936-2 and PW344/2017 by an appointed Competent Person (geo-professional) who conforms to the requirements of SANS 1936-1, Annex A.

1.6.5.3 The DSC will include the perpetually imposed maintenance and monitoring requirements of that parcel of land approved for development. The Project Manager in collaboration with the appointed/contracted service providers/consultants that are responsible for the development must ensure that the requirements of the issued DSC as well as the general requirements of PW344/2017 (Chapter 5) are applied indefinitely to the development. These requirements shall be reported on as the Dolomite Risk Management Plan (refer to Annex J for generic format of plan). This plan shall be included provisionally in the Preliminary Design Report and be finalized upon completion of the project taking into consideration all elements of the development. The final Dolomite Risk Management Plan (DRMP) shall form part of the Project Final Delivery Documentation to be submitted to the Departmental Dolomite Risk Manager as part of the Development close out documentation.

1.6.5.4 Departmental staff shall, by means of specific clauses in the deed that will result in the transfer of ownership, ensure that the successors in title of the particular portion of land are informed of the Dolomite Status Certificate (DSC) and once development is completed the Dolomite Risk Management Plan (DRMP).

1.6.6 Appointed/Contracted Service Provider/Consultant Team - Primary Responsibilities

1.6.6.1 Development on dolomite land requires that all professionals are appropriately briefed regarding the current dolomite hazard zonation associated with the site. The Departmental Project Manager must ensure that all appointed/contracted service providers/consultants are appropriately briefed on and supplied with a:

- a) Dolomite Status Certificate PRM 011A;
- b) Relevant Dolomite Stability Investigations;
- c) Copy of this manual PW344/2017.

Note: The dissemination of this information must ensure that all development is according to the recommendations of the Dolomite Stability Investigations reports and that Departmental precautionary measures as outlined in PW344/2017 are applied.

1.6.6.2 The Project Principal Agent must ensure that:

- a) All members of the appointed/contracted service providers/consultants team receive a copy of the issued PRM 011A;
- b) The Competent Person (engineer) certify in writing that the Development Planning, Designs and Tender Documentation comply with all requirements as prescribed in PW344/2017 and related documents.

1.6.6.3 Dolomite stability investigations (Chapter 2 and 3) do not cover preliminary geotechnical investigations (surficial soil geotechnical investigation) aimed at making initial determinations regarding the suitability of land for development.

Near surface soil horizon investigations on dolomite land for township developments should be undertaken in accordance with the requirements of SANS 1936: Development of Dolomite Land, SANS 634: *Geotechnical investigations for township development* and SANS 633: *Soil profiling and rock logging in Southern Africa*.

Near surface soil horizon investigations for the design of roads, foundations, structures and related works are to be undertaken under control of the appointed Competent Person (geo-professional/engineer). The Competent Person (engineer) will determine the exact requirements and scope of such investigations required by the Principal agent and appointed/contracted service providers/consultant team suitable for all the requirements of the proposed development plan.

Note: Refer also to Department of Public Works, PW2006/1: Identification of Problematic Soils in Southern Africa, Technical Notes for Civil and Structural Engineers,

1.6.7 Appointed/Contracted Service Provider/Consultants - Co-ordination

Developments involving multi-disciplinary professional appointed/contracted service providers/consultants require that cognizance be taken of the fact that the design of buildings, structures and infrastructure on dolomitic land may be substantially different from the norm.

It is essential that the Preliminary Site Investigation of the principal agent and the proposed development site plan (sketch plan: see PRM 017/1) be compared with the Dolomite Stability Investigation and the issued PRM 011A. Matters such as topographical constraints, position of service connections, location of services routes, placement of buildings and structures, building restrictions, etc. must be compared with:

- a) the Inherent Hazard Zones;
- b) Permissible Land Usage;
- c) Dolomite Area Designations of the site.

The inherent dolomite hazard zones must be indicated on the site plan for provisional planning (sketch plan) and the principal agent shall call for written comments from all members of the team to indicate the influence thereof on the design, construction and cost of buildings, structures and infrastructure. The combination of these various factors will determine the suitability/viability of a site for development.

Refer to Annex F for rudimentary information related to concept and preliminary designs, all of which are to be indicated on the Principal Agent's development site plan.

The following items (but not limited to) need to be co-ordinated and resolved between the professional appointed/contracted service providers/consultants.

- a) Development planning and land usage in terms of the Dolomite Area Designations;
- b) Type of earthworks prescribed below foundations and services (normal / soil / mattress / dynamic compaction etc.);
- c) General site earthworks to divert or relocate natural stormwater as well as general works to allow free drainage of the entire site;
- d) The foundation design (reinforced footings/raft foundations piles, etc.);
- e) The influence of services installations in raft foundation if applicable (provision of sleeve pipes and ducts/positioning of wet cells, etc.);
- f) Brickwork on rafts foundations (raft exposed or clad with brick tiles or brickwork on an exterior nib, etc.);
- g) The top structure design (column and beam/reinforced brickwork/load bearing brickwork, etc.);
- h) Surface mounting of wet services;
- i) Site drainage in general and the usage of roads or paved areas for stormwater purposes;

- j) Liquid retaining structures (including limitations regarding hazard zonation class);
- k) Areas with excessive water spillage such as washbays, kitchens, bathrooms, swimming pools, etc.);
- l) The draining of internal courtyards;
- m) Gardening, water features, atriums etc.;
- n) Chillers, coldrooms, freezers, icemakers, airconditioners and display coolers or any other equipment that produces condensate;
- o) The washing, cleaning and floor draining systems in kitchens, lockerrooms, changerooms and areas where floors are normally washed by means of hosing down. Refer to special requirements regarding floor slabs on grade inside the building footprint;
- p) The pipes installed in subfloor sleeves (inspection and working manholes that allow for the removal and replacement of such services in future);
- q) Water supply to buildings. Buildings shall generally be supplied with only one water supply point. The architect needs to liaise with the civil engineer regarding the supply of fire and domestic water in one or separate supply lines. The pressure reducing facilities to protect the internal installation and the distribution of the internal water pipe distribution network is the sole responsibility of the architect;
- r) Termite and ant proofing as well as vegetation control around buildings and structures prior to completion of paving and landscaping.

1.7 Land Procurement, Servitudes and Development Planning

1.7.1 General

- 1.7.1.1** In order to prevent costly development of inappropriate High Hazard Dolomite sites the Department requires that land acquisition be subjected to a Dolomite Stability Investigation (refer to Chapter 3) that proves that land can be economically developed for the intended land usage purpose as provided for in PW344/2017 (Chapter 2).
- 1.7.1.2** Written recommendations on the feasibility to develop the site for the intended land usage must be reported to the Departmental Dolomite Risk Manager prior to proceeding with development of:
 - a) land owned by the state;
 - b) procurement of new land;
 - c) acceptance of land donated.
- 1.7.1.3** All new sites should have sufficient land available for the development of a particular land usage based on the dolomite stability investigation as allowed for in PW344/2017 (Chapters 2 and 3). If this is not feasible, due to the Inherent Hazard classification of the land, then from the outset it should be noted that extraordinary remedial and precautionary measures may be required, as well as rationally designed sub- and superstructures. The financial implications of such measures may impact on the financial feasibility/viability of the project and will result in it exceeding the cost norms and standards of the Department. Revision of the standard cost units (SCU) should be based on this additional information, if applicable.
- 1.7.1.4** As a result of providing services to client departments in particular areas as dictated by the Client's function and locality, the Department is in some cases forced to develop property normally not allowed for by the provisions of PW344/2017. In such cases, the Departmental Dolomite Risk Manager will issue extraordinary project notifications, requirements and precautionary measures in addition to the requirements of PW344/2017. Typically, this will relate to land having a Dolomite Area Designation of D4 for the particular land usage as described in SANS 1936-1 Table 2.

1.7.2 Proclamation Stage Circulation or Procurement of New Property

1.7.2.1 At the township proclamation stage circulation of a new development to the Department or in the event of purchasing new properties in a dolomitic region, the following information should be obtained and submitted to the Departmental Dolomite Risk Manager:

- a) Obtain from the South African Surveyor General and the South African Registrar of Deeds the submitted general plan for township establishment as well as the applicable Deed. Consult the Departmental Dolomite Risk Manager to establish whether the property is located on dolomite or within the 4km dolomite buffer zone;
- b) Obtain the proclamation stage Dolomite Stability Investigation report for the township on which the property is located;

Note: The Departmental Dolomite Risk Manager may require that these reports be subject to a peer review by a Competent Person (geo-professional).

- c) Obtain written certification from the township applicant/seller that a Competent Person (geo-professional) has certified that the layout and land allocation complies with the recommendations set out in the applicable Dolomite Stability Investigation report. Drawings for the parcel of land in question shall be provided, indicating the Inherent Hazard Classification, boreholes drilled and test pits dug for geo-technical investigations;
- d) A development plan stating the intended (or potential) future Land Usage by the Department according to the definitions contained in SANS 1936-1 Table 2. This plan must at least indicate the footprint area of the intended development as a percentage of the land.

1.7.2.2 The Departmental Dolomite Risk Manager will in terms of procurement (or obtained free of charge) of existing registered property, issue:

- a) An instruction that additional geo-technical investigation be conducted prior to a decision on the development potential of the property; or issue
- b) A Dolomite Status Certificate (DSC) if the land can be developed for the intended purpose; or issue a
Note: The DSC may contain provisions to which the Deed of Sale may be subject to.
- c) A DSC stating that the land cannot be developed for the intended purpose and a Departmental memorandum with reasons why the potential procurement should be rejected.

1.7.2.3 The Departmental Dolomite Risk Manager will in terms of Proclamation Stage Circulation of a new township issue:

- a) A DSC if the land can be developed for the intended purpose and that the Department can thus proceed to accept or procure the property;

Note: The DSC may contain specific conditions that need to be included in the offer of acceptance. These conditions, that will place a legal responsibility on the developer, may include:

- i. Assurance that no borrow pit; fill or surficial soil disturbances occur during the township construction/development phase.
 - ii. Assurance that stormwater alterations due to development shall not negatively impact on current natural drainage of the proposed property.
 - iii. Assurance that no site camp for construction purposes shall be allowed on the property.
 - iv. Assurance that no activities on adjacent land will impact on the property in question;
- b) A DSC stating that the land cannot be developed for the intended purpose and a Departmental memorandum with reasons why the potential property cannot be purchased or accepted.

1.7.3 Servitudes and Right-of-Way

1.7.3.1 The conditions for registration of a servitude or right-of-way in the dolomitic environment shall specifically include the appropriate determinations and prescriptive precautionary measures for the intended development in accordance with PW344/201.65. These conditions may include geo-

technical investigation procedures, Land Usage determinations, Dolomite Area Designations as well as general and specific design, construction, maintenance and perpetual risk management of the land. The conditions for registration shall specifically state the performance requirements of services and related activities within the servitude and, if called by the Competent Person (geo-professional), any requirements related to activities on adjacent land. The conditions need to be extended to provide also for the conditions related to other servitudes that are currently, or may potentially in future, traverse the servitude for which registration is required.

1.7.3.2 The registration of servitudes or right of ways on dolomite land owned by the Department must be subject to the inclusion of:

- a) Dolomite stability investigation report (DSI);
- b) Dolomite Status Certificate (DSC);
- c) Appropriate dolomite design, construction, maintenance and risk management requirements as proposed by the Department. The determinations and requirements of PW344/2017 in general shall prevail and may be extended with specific other requirements as deemed necessary by the Competent Persons (geo-professional/engineering) and/or the Departmental Dolomite Risk Manager.

The above must be approved and be issued by the Departmental Dolomite Risk Manager and form part or be referred to in the legal documentation for registration and /or agreement.

1.7.3.3 *Legal documentation pertaining to servitudes on dolomite land may require the inclusion of minimum technical requirements/pre-conditions and prescriptions and/or references to:*

- a) Dolomite Hazard Zonation (alternatively: the investigation methodology to be applied to ensure uniformity with current Departmental practice);
- b) Type of proposed servitude used;
- c) Standard information to be sought from servitude holder (e.g. full construction drawings and technical specification of services to be installed) for comment and inclusion in deeds;
- d) Measures that ensure appropriate use in relation to the hazard;
- e) National regulations and standards that may apply;
- f) Waiver of risk /acknowledgement of risk by servitude holder;
- g) Acknowledgement of liability for damage and repairs within and outside the servitude in the event of sinkhole or subsidence generation due to negligence by the servitude holder;
- h) Obligations to report any instability events or major failures to the Department;
- i) Right of access for general and construction inspections by the Department e.g. trench works to gather additional data;
- j) Right to act in the event of non-compliance or negligence;
- k) Technical specifications (i.e. extracts from PWD PW344/2017 and/or specific requirements);
- l) Right to intervene and request higher standards or precautionary construction and maintenance measures in areas of latent instability (e.g. paleofeatures);
- m) Requirement to notify and obtain the approval for change of use within the servitude (e.g. size or type of pipe);
- n) Requirements with respect to general and specific maintenance within the servitude (e.g. stormwater etc.);
- o) Serviceable life spans for proposed services;
- p) Impact of instability events on adjacent land and potential means of mitigating this risk;

- q) Right to rescind the servitude in the event of continuous failure to manage risk within the servitude in accordance with the deed;
- r) Special conditions where different servitudes intercept;
- s) Submission of 'as built' drawings for record purposes;
- t) Submission of operational and maintenance procedures for installed services;
- u) Submission of the servitude holder's risk management plan (including emergency reaction planning) for the servitude and services;
- v) Integration of Risk Management Plans with those of adjacent land;
- w) Provisions that limit the liability in the event of a damage or loss of life due (conditions pertaining to the land owner, servitude holder and third party);
- x) Method of resolving disputes (e.g. court or arbitration).

1.7.3.4 The generic format of a servitude agreement is included in Annex K.

1.7.4 Development Planning

1.7.4.1 *Planning of new Development*

No site may be developed if land parcels as geo-technically investigated in terms of PW344/2017 (Chapter 2) is not large enough in extent to accommodate the planned land usage as defined in SANS 1936-1 Table 2.

If the planned land usage can be accommodated on the land then the development planning, design and construction as well as perpetual management of the development may continue based on the requirements of PW344/2017 as well as the recommendations and conclusions of the Dolomite Stability Investigation.

Wherever feasible plan for the erection of buildings and related structures as well as potential future similar development on land that has the lowest Dolomite Area Designation. Particular attention is to be given (during the initial development process) to land allocation strategies for developments that have the potential of expanding in future.

Land parcels having a D4 Dolomite Area Designation may be developed but the entire development process shall be subject to the requirements of PW344/2017 and allowances and approvals made by the Departmental Dolomite Risk Manager.

1.7.4.2 *Additions or Upgrading of Existing Infrastructure*

Infrastructure and engineering services on land classified in terms of SANS 1936-1 Table 3 having a Dolomite Area Designation of D1, D2 and D3 may be upgraded, replaced or extended in terms of the provisions of PW344/2017.

Additions to existing buildings, structures and infrastructure require the same level of investigation as for new development.

Many properties of the Department were developed in the past on land having a D4 Dolomite Area Designation. Similarly, as for new developments, the entire development process shall be subject to the requirements of PW344/2017 and allowances and approvals made by the Departmental Dolomite Risk Manager.

1.8 Building and Facilities hired/leased

All facilities on dolomite that is occupied by the Department and its Client Departments should be subject to conditions regarding dolomite risk management as allowed for in PW344/2017 (Chapter 5). The lease agreement must stipulate:

- a) The responsible party (to the Agreement) that will be legally required for appropriate maintenance, monitoring and management in relation to the dolomite hazard of the area;
- b) What specific requirements of general maintenance and or facility use may influence the dolomite hazard and what standard procedures are to be implemented by the Department to ensure compliance with the risk management plan of the owner;
- c) What operational procedure is to be followed in the event of sinkhole or ground subsidence and what reporting protocols are required;
- d) The special conditions that may apply in the event of structural damage that results from evacuation of the building(s) temporarily/permanently;
- e) What method of compensation and or insurance will be available to the Department in the event of loss of life or property as result of a sinkhole or subsidence.

All agreements must include a clause that stipulates that disputes related to losses of both parties as result of sinkholes and subsidences related to dolomitic environment must be referred to and settled in a court of law.

Note: It is advised that a Competent Person (geo-professional) provide advice via the office of the DRMU, in the compilation of the agreements regarding hiring and leasing property.

1.9 Dolomite Stability Peer Review Function

The Department of Public Works may appoint Competent Persons (geo-professional/engineer) to peer review all reports related to dolomitic land for and on behalf of the Department. Such reports include, but are not limited to:

- a) Dolomite stability investigations and related surficial soil reports;
- b) Risk management plans.

The selection and design of appropriate precautionary measures in relation to the dolomite hazard is as important as determining the hazard. A peer review process multidisciplinary in nature, by a Competent Person (geo-professional) and Competent Person (engineer - civil and structural engineer) is therefore required.

The impartial peer review is critical for:

- a) Consistency in application of the science;
- b) Verification of the validity of recommendations that an area may be developed;
- c) Review of development densities;
- d) Review of development layout in relation to the Dolomite Area Designations;
- e) Review of the precautionary measures to be applied;
- f) Review of the risk management system to be applied;
- g) Review of foundation design recommendations;
- h) Multidisciplinary evaluation of all development proposals;
- i) Sustainable development.

Chapter 2: General Principles and Requirements

2.1 Introduction

The general principles and requirements for the development of dolomite land are contained in SANS 1936-1. The objective of these principles is to provide a framework for developing dolomite land in a manner that will ensure that:

- a) people live and work in a safe environment;
- b) damage to and loss of assets are within limits acceptable to society; and
- c) the future use of such land is not compromised by current usage.

2.2 Quantitative Requirements for Land Safety and Usage

2.2.1 Parcels of dolomite Land shall be developed in accordance with the relevant provisions of SANS 1936-1, Table 2, with the Dolomite Area Designations and Inherent Hazard Classes defined in SANS 1936-1, Tables 1 and 3 respectively.

Also refer to Table 2.1, which is similar to SANS 1936-1, Table 1, but with explanatory notes added.

Table 2.1 — Dolomite Area Designations

| Dolomite Area Designation | Description |
|---|--|
| D1 | No additional precautionary measures, other than the application of Nationally published/excepted best practice engineering codes of design and standards for construction are required to permit development planning and construction. |
| D2 | General precautionary measures in accordance with the requirements of SANS 1936-3 that are intended to prevent the concentrated ingress of water into the ground are required. |
| D3 | Precautionary measures in addition to those pertaining to the prevention of concentrated ingress of water into the ground, in accordance with the relevant requirements of SANS 1936-3, are required. |
| D4 | Land designated as having a dolomite designation D4 may be developed in accordance with the precautionary measures specified by a <u>Competent Person (geo-professional)</u> ¹⁾ provided that such measures are independently reviewed and accepted by the Department's accepted/appointed/nominated <u>External Senior Competent Person (geo-professional)</u> who is not a business associate of such <u>Competent Person (geo-professional)</u> ¹⁾ and who does not have a vested interest in the development of such land. |
| Note: Dolomite Area Designations indicate the levels of precautionary measures required to support development. These designations relate to the precautionary measures required to establish a tolerable hazard rating associated with a parcel of land that has a particular Inherent Hazard Class. Refer to SANS 1936-1, Annex A for requirements. | |

The inherent hazard class (IHC) of parcels of dolomite land shall be determined by means of a geotechnical site investigation conducted in accordance with the requirements of Chapter 3.

The owners of infrastructure and developments on parcels of dolomite land (except land categorized as D1) shall establish and implement appropriate dolomite risk management strategies in accordance with the principles and requirements of Chapter 5 to mitigate the risks associated with the provision of infrastructure and developments on such land.

2.2.2 Parcels of land underlain by Black Reef Formation shall satisfy the requirements 2.2.1 above, unless such information has been assessed as presenting no hazard of sinkholes and subsidence formation and are designated as being D1.

2.3 Repair of Sinkholes

Repair of sinkholes shall be undertaken according to the requirements of SANS 1936-1.

2.4 Compliance with Requirements

The Competent Person (geo-professional/engineer) responsible for applying any aspect of Chapters 3, 4 or 5, as relevant, shall certify compliance with the relevant parts of PW344/2017 on all site/development/township and construction drawings and reports, and provide his or her name and registration particulars below such certification.

Chapter 3: Geotechnical Investigations and Determinations

3.1 Introduction

SANS 1936-2 establishes requirements for:

- a) feasibility-level geotechnical investigations to determine the general suitability of dolomite land for development;
- b) design-level investigations, including footprint investigations, where necessary;
- c) the determination of the inherent hazard class of dolomite land, to be used in conjunction with SANS 1936-1 to ascertain the dolomite area designation and requirements for the development of such land;
- d) inspection and verification during the implementation phase of a project on dolomite land.

Note 1: This chapter does not cover preliminary geotechnical investigations aimed at making initial determinations regarding the suitability of land for development. The Department of Housing Generic Specification GFSH-2: Geotechnical site investigations for housing developments covers such investigations.

Note 2: Near surface soil horizon investigations for developments should be undertaken in accordance with the requirements of the Department of Housing Generic Specification GFSH-2.

Note 3: The first phase of the detailed investigations requires fieldwork to enable the land to be characterized in terms of its stability. The second phase is undertaken during the installation of services and entails observations and further investigations as are necessary to confirm the Inherent Hazard characterization of dolomite land or Dolomite Area Designations (or both) determined during the first phase of the investigations. The detailed footprint investigations, where necessary, entails further investigations to provide specific design information for structures, facilities, infrastructure or bulk services for design purposes.

3.2 Requirements

3.2.1 General

The general requirements for geotechnical investigations are described in SANS 1936-2 (4.1).

All percussion borehole sample logging and rotary core logging shall be undertaken in accordance with the requirements of Geotechnical Logging of Soil Profiles and Rotary Percussion Boreholes for Engineering Purposes in Southern Africa (SANS 633).

3.2.2 Feasibility-level Dolomite Stability Investigation

3.2.2.1 General

The Competent Person (geo-professional) shall perform the feasibility level geotechnical investigation according to SANS 1936-2 (4.2.1) and formulate and document an opinion as to Inherent Hazard characterization using geophysics, the assessment of the bedrock morphology, subsurface profile from ground surface to dolomite bedrock, and the geohydrological regime conditions and groundwater compartmentalization in accordance with the methodology contained in Annex C of PWW344/2017 and SANS 1936-2, Annexes B and C.

3.2.2.2 Geophysical Survey

- 3.2.2.2.1 The geophysical survey shall include a gravity survey according to SANS 1936-2 (4.2.2). In addition, the grid spacing for gravity surveys shall in general not exceed 30m or the anticipated thickness of the overburden. In certain instances of thick (greater than 60m) overburden a grid of 42,5m may be considered. Instances of outcropping and sub outcropping dolomite might merit the undertaking of microgravity (at a spacing of 10m or less). Refer to Annex C.

- 3.2.2.2.2 Remote sensing techniques and other non-destructive geophysical methods in addition to the mandatory gravity survey, might be required, depending on the geology for example, electro magnetics may be used to establish the contact between dolomite and conductive material such as Karoo shale.
- 3.2.2.2.3 The location of the rotary percussion boreholes should be based on data obtained from the gravity survey, geological and geomorphological data.
- 3.2.2.2.4 A geophysical report shall be produced describing the work procedures, interpretation and conclusions of the survey.

3.2.2.3 Borehole Drilling

Boreholes shall be drilled as specified in SANS 1936-2 (4.2.3).

Representative samples shall be retrieved for every 1m drilled and the borehole shall be logged in accordance with the requirements for Geotechnical Logging of Soil Profiles and Rotary Percussion Boreholes for engineering purposes in Southern Africa (SANS 633).

3.2.2.4 Gathering of Geohydrological Data

The available geohydrological data shall be gathered in accordance with SANS 1936-2 (4.25).

3.2.2.5 Report

3.2.2.5.1 The investigator/Competent Person (geo-professional) shall document and report all findings and opinions in a written report to the requirements of SANS 1936-2 (4.2.6) and use the standard headings, subheadings and requirements contained in Table 3.2 below.

3.2.2.5.2 All reports shall be specific in title as follows:

- a) First line in Title: Report number assigned by Competent Person (geo-professional) as well as the Departmental Dolomite Risk Manager: Client Department abbreviation: Province: Town: Site name: Type of investigation
- b) Second line in Title: Departmental Project Name: WCS Number

Example:

First line in Title : 1234: DEPARTMENT OF (Name): GAUTENG: PRETORIA: SITE NAME: NEW BUILDING: DOLOMITE STABILITY INVESTIGATION
 Second line in Title : PROJECT NAME: WCS NUMBER

or

First line in Title : DEPARTMENT OF (Name): GAUTENG: PRETORIA: SITE NAME: NEW BUILDING: SOILS INVESTIGATION
 Second line in Title : PROJECT NAME: WCS NUMBER

3.2.2.5.3 Drawings shall be to a common and appropriate scale, legible and easily reviewable. All drawings shall be correctly referenced with a clear indication of coordinates. (Preferably the Site layout drawing shall be at 1:500 scale).

3.2.2.5.4 The report and all drawings shall be presented to the Department in the format according to Table 3.2.

Table 3.2 Headings, subheadings and instructions for reports

| Number | Headings and subheadings | Specific instructions relating to content |
|------------|--|---|
| | Executive summary | |
| 1 | Introduction | State the purpose of the investigation as well as its context. |
| 2 | Terms of Reference | Indicate the client/Department and state the nature of the appointment. |
| 3 | Site description | Provide particulars of site boundaries and a full description of the property. |
| 4 | Information used in the study | Document existing information assimilated and used in the study. |
| 5 | Investigation procedures | State the procedures in the investigation |
| 6 | Geology and geohydrology | Discuss the geology and geohydrology in both the regional and site specific context |
| 6.1 | Regional | |
| 6.2 | Site specific | |
| 6.3 | Geohydrology | |
| 7 | Dolomite stability characterization | Explain and motivate the hazard characterisation of the site in terms of ingress of water and groundwater level changes. |
| 7.1 | Characterisation procedure | |
| 7.2 | Stability characterisation of the site | |
| 8 | Conclusions | Summary of risk zoning |
| 9 | Recommendations | Modify headings to accommodate the proposed nature of the development depending upon the Land Usage sectors that are involved. Specify, for the nature of the development, as relevant, water precautionary and special founding measures for each Inherent Hazard zone which are additional to the standard precautionary measures provided in , and Chapter 4 of PW344/2017: APPROPRIATE DEVELOPMENT OF INFRASTRUCTURE ON DOLOMITE: MANUAL FOR CONSULTANTS. |
| 9.1 | Appropriate land use recommendations | |
| 9.2 | Water and foundation precautionary measures | |
| 9.3 | Development densities and types | |
| 9.4 | Dolomite Area Designations for each Inherent Hazard zone | |
| 9.5 | Outline of the preliminary dolomite risk management plan | |
| Appendices | | Provide copies of: a) gravity survey report, b) borehole profiles c) any pertinent results of laboratory and in situ field tests |
| Figures | | Provide the following: a) locality plan of site; b) site layout plan; c) regional geology. |
| Drawings | | Provide the following: a) site plan showing positions of boreholes and gravity contours; b) dolomite stability map showing the distribution of the Inherent Hazard Classes. c) map of dolomite area zone designations relative to the intended Land Usage |

3.2.3 Design Level Dolomite Stability Investigation

3.2.3.1 General

3.2.3.1.1 Design level investigations shall conform to the requirements of SANS 1936-2 (4.3.2 and 4.3.3).

The investigator/Competent Person (geo-professional) shall, during the design-level investigation confirm and refine the Inherent Hazard Zone and the associated Dolomite Area Designations, and

confirm that the mandatory precautions associated with a designation have been observed.

3.2.3.1.2 The investigator/Competent Person (geo-professional) shall, as a minimum to comply with the requirements of 3.2.3.1.1: interact with suitably qualified professionals and the person responsible for the development of the parcel of land or the relevant portions thereof concerning appropriate planning, design of infrastructure, buildings, structures, and residential units.

3.2.3.1.3 The investigator/Competent Person (geo-professional) shall develop a risk management plan strategy specific to the development in accordance with the requirements of Chapter 5.

3.2.3.2 Report

The investigator/Competent Person (geo-professional) shall prepare a design-level report generally in accordance with 3.2.2.5 and also including the following:

- a) a method description of the work undertaken;
- b) a drawing indicating the location of the points profiled in the service trenches;
- c) records of all profiles, boreholes and tests;
- d) records of any geotechnically problematic conditions intercepted, such as paleokarts structures, sinkholes etc.;
- e) a description of any additional geotechnical investigations undertaken;
- f) a description of any precautionary or remedial measures applied to problematic conditions identified during the design-level inspections;
- g) a site/development/township layout drawing which confirms the Inherent Hazard Classes and Dolomite Area Designations of each individual stand, in accordance with the requirements of SANS 1936;
- h) an indication where the dolomite designations of stands have been changed and provide a motivation for such changes;
- i) a comprehensive list and description of any ongoing monitoring required;
- j) an identification of monitoring area designations in accordance with the requirements of Chapter 5, where the Department requires that a risk management plan be developed;
- k) an indication that amended water precautionary measures shall apply.
- l) the report and all drawings shall also be presented to the Department in an electronic format.

3.2.4 Additional Requirements for Specific Types of Development

3.2.4.1 General

These additional requirements apply in addition to the requirements of 3.2.1, 3.2.2 and 3.2.3. Also refer to the requirements of SANS 1936-2, Annex A.

Detailed footprint stability investigations form part of the design-level investigations and shall, where appropriate, be undertaken for specific structures, facilities, infrastructure or bulk services for design purposes.

3.2.4.2 Additional Requirements for Township Development

Feasibility-level, design-level investigations and inspections during implementation for township development shall be performed in accordance with the requirements of SANS 1936-2, Annex A (A.2).

3.2.4.3 Additional Requirements for Infill Development on Residential Stands

Note: Infill development comprises a stand or part thereof in an established site/development/township.

The requirements for infill development on residential stands shall be in addition to the requirements of 3.2.1, 3.2.2 and 3.2.3 and according to SANS 1936-2, Annex A (A.3).

3.2.4.4 Additional Requirements for Rezoning and Multiple Dwelling Rights on Residential Stands

The requirements for rezoning and multiple dwelling rights on residential stands shall be in addition to the requirements of 3.2.1, 3.2.2 and 3.2.3 and according to SANS 1936-2, Annex A (A.4).

3.2.4.5 Additional Requirements for Roads, Railway Lines and Runways

The requirements for roads, railway lines and runways shall comply with the requirements of 3.2.1, 3.2.2 and 3.2.3 as a minimum and also with SANS 1936-2, Annex A (A.5). The gravity survey over the proposed alignment and verges shall be performed at 30 m grid spacing with a minimum of three lines.

3.2.4.6 Additional Requirements for Bulk Pipelines

The requirements for bulk pipelines shall comply with the requirements of 3.2.1, 3.2.2 and 3.2.3 as a minimum and also with SANS 1936-2, Annex A (A.6). The investigation shall also include the following:

- a) a gravity survey over the proposed pipe alignment at 30 m grid spacing with a minimum of three lines;
- b) additional investigations for line deviations in the event that Inherent Hazard Class 6, 7 and 8 conditions (refer to SANS 1936) are encountered along the proposed alignment;
- c) investigation of potential paleosinkhole structures wherever they are exposed;
- d) where necessary, supplementary geotechnical site investigations.

NOTE: Wherever feasible, the proposed pipeline should be at least 100 m from the nearest housing or commercial development.

3.2.4.7 Additional Requirements for Pump Stations and Water Works

The requirements for pump stations and water works shall comply with the requirements 3.2.1, 3.2.2 and 3.2.3 as a minimum and also with SANS 1936-2, Annex A (A.7). The investigation shall also include the following:

- a) additional investigations for alternative sites in the event that Inherent Hazard Class 6, 7 and 8 conditions (refer to SANS 1936) are encountered;
- b) inspection of the open works to verify the hazard zone and to check for palaeokarst structures;
- c) investigation of potential paleosinkhole structures wherever they are exposed.

3.2.4.8 Additional Requirements for Cemeteries

The requirements for cemeteries shall comply with the requirements of 3.2.1, 3.2.2 and 3.2.3 as a minimum.

The investigation shall also include the following:

- a) a gravity survey over the site at 30 m grid spacing;
- b) rotary percussion drilling based on gravity anomalies and below the footprints of proposed associated structures, for example chapels;
- c) a dolomite stability report which discusses the risk characterization of the site as well as monitoring area designations and maintenance zones;
- d) additional investigations for alternative sites in the event that Inherent Hazard Class 3, 5, 6, 7 and 8 conditions (refer to SANS 1936) are encountered;
- e) development of a dolomite risk management strategy specific to the infrastructure in accordance with the requirements of Chapter 5;
- f) inspection of the open works to verify the stability zone and to check for palaeokarst structures.

3.2.4.9 Additional Requirements for Attenuation Dams, Retention Dams, Reservoirs and Public Swimming Pools

The requirements for dams, reservoirs and public swimming pools shall comply with the requirements of 3.2.1, 3.2.2 and 3.2.3 and also with SANS 1936-2, Annex A (A.8). The investigation shall also include the following:

- a) a gravity survey over the site at 30 m grid spacing with a minimum of three lines;
- b) additional investigations for alternative sites in the event that Inherent Hazard Class 3, 5, 6, 7 and 8 conditions (refer to SANS 1936) are encountered;
- c) inspection of the excavation to verify the stability zonation and to check for paleokarst structures;
- d) investigation of potential paleosinkhole structures wherever they are exposed;
- e) where justified, supplementary geotechnical site investigations.

Note 1: The proposed site for dams and reservoirs should be at least 100 m from the nearest housing or commercial development.

Chapter 4: Design and Construction of Buildings, Structures and Infrastructure

4.1 Introduction

This Chapter establishes requirements for the design and construction of permanent or temporary buildings, structures and infrastructure including wet and dry engineering services on dolomitic land, comprising one or more farm portions, small holdings, erven or servitudes (own title or across registered property) registered in a deeds registry, identified for the purpose of development requiring precautionary measures to support sustainable development.

Extensions, additions and upgrading or maintenance works to existing buildings, structures and infrastructure on developed sites which have been designated as a D4 dolomite area, post their development, may be designed and constructed in accordance with the requirements of a Dolomite Area Designation D3 and D4 site in terms of this part of PW344/2017. However, a Competent Level 4 geo-professional (refer to SANS 1936-1, Annex A) must approve such additions, upgrading or maintenance works. The site specific precautionary measures for a D4 dolomite area designated site, must be specified by such independent Competent Level 4 geo-professional in addition to the general requirements allowed for in this Chapter in terms of development on a site having a D3 or D4 Dolomite Area Designation. It is also a specific requirement that the dolomite risk management strategy and plan developed in accordance with the requirements of Chapter 5 takes account of the increased risks associated with developments on sites so designated and provides more stringent monitoring and maintenance requirements.

New development of individual sites which have been designated as a D4 dolomite area may be considered under the conditions as prescribed in Chapter 2, Table 2.1. The dolomite Inherent Hazard class, foundation design performance requirements, precautionary measures and dolomite risk management requirements shall be reviewed and approved by an independent Competent Level 4 Geo-professional. It is a specific requirement that the dolomite risk management strategy and plan developed in accordance with the requirements of Chapter 5 take account of the increased risks associated with developments on sites designated as a D4 dolomite area and provide more stringent monitoring and maintenance requirements.

The Permissible Land Usage and Infrastructure type based on Inherent Hazard Class and Dolomite Area Designations are defined in SANS 1936-1, Tables 1, 2 and 3 (also refer to Chapter 2, Table 2.1).

Chapter 2 contains provisions for the following Dolomite Area Designations (D1 to D4) to ensure sustainable Land Usage and development:

- a) Dolomite Area Designation D1: No additional precautionary measures, other than the application of Nationally published/excepted best practice engineering codes of design and standards for construction are required to permit development planning and construction.
- b) Dolomite Area Designation D2: General precautionary measures intended to prevent the concentrated ingress of water into the ground are required;
- c) Dolomite Area Designation D3: Additional precautionary measures, over and above General precautionary measures (D2) are required. These additional measures may include special founding solutions, ground improvement, as well as special water precautionary measures. The applicable water precautionary measures are those described for the particular Inherent Hazard Class in this document (PW344/2017) - Chapter 4;

- d) Dolomite Area Designation D4: Normal precautionary measures cannot reduce the development risk to acceptable limits. Land that falls in this Dolomite Area Designation should normally not be considered for development. This document (PW344/2017) does not prohibit new development for Dolomite Area Designations D4, but in such cases project specific rational designs and multi-disciplinary specialist peer reviews inclusive of restrictions on land parcel subdivisions, deeds of sale, leasing, subletting and alienation shall apply.

Land designated as having a dolomite designation D4 may be developed, upgraded and maintained in accordance with the additional precautionary measures (D3 and D4) as prescribed in this Chapter 4, and in addition those specified by a Competent Person (geo-professional) provided that such measures are independently reviewed and accepted by the Department's accepted/ appointed/nominated External Competent Level 4 geo-professional (Dolomite land) who is not a business associate of such Competent Person (geo-professional) and who does not have a vested interest in the development of such land.

Note:

Maintenance and risk management requirements are established in Chapter 5. These design and construction requirements assume that:

- a) Liquid-retaining structures and wet engineering services are regularly inspected for leakages and any leakages that are detected are promptly repaired;
- b) The target response time for a repair team to reach the repair site and commence with the repair of any leak detected in wet engineering services, measured from the time that a leak is reported, is not more than 1 hour, except in the case of wet engineering services that have a diameter of less than 75mm where the response time should not exceed 1½ hours.

4.2 Precautionary Measures in Dolomite Areas designated as D1

- 4.2.1** No additional precautionary measures, other than the application of nationally published/ excepted best practice engineering codes of design and standards, statutes, by-laws and associated regulations for construction are required to permit development planning and construction.
- 4.2.2** Wet and dry engineering services shall be constructed strictly in accordance with the relevant requirements of SANS 1200 Civil Engineering Construction (alternative: SANS 2001 if so approved by the Department)
- 4.2.3** Annex N and Annex O of PW344/2017 provide the specifications for water and sewer services with regard to the minimum standards applicable for the installation of services on land with a D1 Dolomite Area Designation.
- 4.2.4** Annex N and Annex O provide the specifications for water and sewer services with regard to the minimum standards applicable for the maintenance/repair requirements of existing engineering services related to buildings on and land with any Dolomite Area Designation as an emergency/interim measure until appropriate upgrading or replacement to the requirements of PW344/2017 can be executed. Work of this nature will involve a limited replacement of a section

of an engineering service that became unserviceable as result of a minor default (i.e. cracked pipe, leaking fitting, etc.).

4.3 Precautionary Measures in Dolomite Areas Designated as D2 or D3

4.3.1 General

This section provides the general requirements for Competent Persons (engineer and geo-professional) and the general requirements for the precautionary measures applicable to various elements of the development and maintenance of buildings, structures and infrastructure and related wet and dry engineering services as required in terms of SANS 1936-1, Tables 1, 2 and 3.

4.3.1.1 Competent Persons

4.3.1.1.1 Design and Construction – deem to satisfy general requirement

The design and the associated inspection during construction and maintenance of temporary and permanent buildings, structures and infrastructure in parcels of D2 or D3 categorized land (in accordance with SANS 1936-2) shall

- a) be undertaken by one or more Competent Persons (engineer assisted by geo-professional for elements of the work related to geotechnical site conditions);
- b) take account of the content of and recommendations of the geotechnical site investigation/dolomite stability investigation report prepared in accordance with the requirements of Chapter 3 and adhere to the conditions as stated in the Dolomite Status Certificate (DSC);
- c) take account of the content and recommendations of the post development Dolomite Risk Management Plan (DRMP) aspects compiled in accordance with the requirements of Chapter 5.

4.3.1.1.2 Design and Construction – methodology

Competent Persons (engineer/geo-professional) shall, in the design and the associated inspection during construction of temporary and permanent buildings, structures and infrastructure, observe all relevant applicable National and/or International standards and codes of practice for design as well as industry acceptable rational designs, statutes, by-laws and associated regulations. In addition, all Competent Persons shall comply with the standards of professional conduct and best practice, as laid down or recommended by their respective voluntary/mandatory professional associations, if any.

The Competent Person's (engineer/geo-professional) attention is specifically drawn to the fact that his/her practice will accept *full responsibility* for the design, specifications and drawings. The Department's input regarding designs is merely 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 expertise.

4.3.1.1.3 Designs not compliant with PW344/2017

Competent Persons (engineers) shall specify on construction drawings all relevant design requirements/aspects or parameters that are required to be, but are not in accordance with PW344/2017. Such deviations from the PW344/2017 requirements are to be supported by signed notes from the Competent Persons (engineer) clearly indicating reasons for non-compliance. This requirement shall also apply to all rational designs.

These deviations must be specifically indicated in the Dolomite Risk Management Strategy and Dolomite Risk Management Plan for the development as compiled in terms of Chapter 5 of PW344/2017.

4.3.1.1.4 Competent Persons – professional conduct

Competent Persons shall affix their name, signature, professional registration number and contact particulars to all drawings (Planning, Design, Construction and Record drawings) and ensure that record information indicating deviations from construction drawings are prepared and completed within 60 days of the works being completed. Drawings shall be clearly marked as for planning, design, construction or record drawings.

All drawings shall be signed off by a Competent Person(s) (engineer/geo-professional) confirming the validity of the information and that the information has been checked and verified. These Competent Person(s) shall ensure that the information that is submitted is prepared in accordance with all Departmental standards and requirements, as amongst others, are contained in this Manual.

4.3.1.1.5 Planning, Design, Construction and Record Drawings

Drawings for buildings and structures and infrastructure and related wet and dry services shall clearly indicate all elements of the water, fire and drainage installations as well as all other liquid bearing infrastructure and dry engineering services. The drawings shall also indicate the construction and material specifications. Any changes to existing wet and dry services that may have been brought about by maintenance works or new works, shall be captured on the drawings.

The Department requires that record drawings and data be submitted as required in Annex L. The submission of drawings to the Department's Project Manager and Dolomite Risk Management Unit (DRMU) shall be in:

- a) Hard copy format;
- b) Electronic format;
- c) Electronic format compatible with the Departmental Geographical Information System (GIS)

Note: Current Departmental GIS system being ESRI – ArcSuite.

4.3.1.1.6 Installation control plan

The Competent Person (engineer) must submit (for all wet and dry engineering services) prior to construction an installation control plan detailing, amongst others, the following:

- a) Layout of all structures, building and infrastructure;
- b) Reference beacons to be installed and/or identified;
- c) Layout of the entire existing and new wet and dry engineering services network (separately layered and referenced);
- d) Points of connection into existing systems;
- e) Points of connection into infrastructure of bulk external suppliers;
- f) Each node of change in a system and/or connection points shall be described in terms of;
 - i. Pipe and/or structure type (material description)
 - ii. Pipe diameter, class and/or dimensions
 - iii. Pressure rating (bar)
 - iv. Working pressure (bar)
 - v. Flow average (ℓ/s)
 - vi. Flow velocity (ℓ/s)
 - vii. Peak flows (ℓ/s)
 - viii. Average flows (ℓ/s)
 - ix. Invert level (m)
 - x. X, Y and Z coordinates (Z value for surface and invert levels) (m)
- g) Detail description of all temporary connections;
- h) Expected date of connection (internal and external);

- i) Any preconditions for connections (internal and external);
- j) Expected area to be affected by the connection as well as duration thereof;
- k) Emergency and standby control measures in place for down time during tie-in periods;

4.3.1.1.7 Engineering services installation database.

On completion of each project the Competent Person (engineer) must supply the Department with a database of all the wet and dry engineering services elements as installed. Such a database must include the as-built information of the Installation Control Plan and be extended with:

- a) Description of element constructed – valve, pipe, manhole etc.;
- b) Numbering/markings as installed during construction;
- c) X-co-ordinate (m);
- d) Y-co-ordinate (m);
- e) Z-co-ordinate (m);
- f) Diameter (inside and outside) (mm);
- g) Type/mark installed;
- h) Design and operational flow/capacity (ℓ/s);
- i) Model or make;
- j) Slope/depth of installation (m).

All data submissions shall conform to the requirements according to Annex L (hard copy plus electronic format).

4.3.1.1.8 Service operation areas

4.3.1.1.8.1 The individual plans for wet and dry engineering services need to be extended with a specific service operation area plan. The operation areas shall be defined as the zones to which services are supplied or collected from. The zoning must be exact in terms of the supply and collection area. It must provide the Department with sufficient information to know exactly which area will be affected if a service to or from the zone is affected (i.e. valve is closed or a manhole is blocked).

4.3.1.1.8.2 For water installations each valve and meter configuration shall constitute a supply zone/district or subdistrict and downstream shutoff valves shall be classified as sub-supply zones. Valves and meters on supply lines to individual buildings shall be demarcated as point zones.

4.3.1.1.8.3 Underground dry engineering services shall demarcate the zones of distribution from each manhole or exit structure.

4.3.1.1.8.4 This aforementioned information regarding the various zones must be clearly marked on construction and as-built drawings.

4.3.1.1.9 Engineering services operation and maintenance report.

On completion of each project the Competent Person (engineer) must supply the Department with an operational and maintenance report that includes the following:

- a) Service level agreements with external utility providers for bulk connections;
- b) Servitudes and right of way registered for the installation of bulk or other services;
- c) The cyclic monitoring or testing of all parts of the development that requires ongoing maintenance;
- d) Demarcation of priority maintenance zones based on the soil conditions as described in the Construction Excavation Report (i.e. areas of poor soils/ areas of paleo structures/areas of rehabilitated sinkholes or subsidences/areas of poor drainage etc.) as well as the dolomite stability investigations that were executed during or as result of the construction;

- e) Elements of infrastructure not appropriately upgraded by the current project but where upgrading must be conducted in future;
- f) Proposed operational procedures;
- g) Proposed future emergency maintenance procedures;
- h) Operation and maintenance manuals;
- i) Auditing requirements and methodology;
- j) Services layout drawings for each type of subsoil piped system.

The above information is additional to the requirements as indicated in all other standard Departmental Consultant's manuals.

The operation and maintenance report shall ensure that all information required in terms of Chapter 5 to compile a Dolomite Risk Management Strategy and Dolomite Risk Management Plan for a development is provided.

Note: Maintenance of HDPE sewer/stormwater system: HDPE pipe systems are pressure tested closed systems. As such there are no root intrusions possible. The use of normal sewer/stormwater cleaning equipment such as root cutters, scrubbers or spearheaded rodding equipment or augers may not be allowed. Only rubber flange plungers or blunt and round bar twin spiral inward closing rodding equipment (double screw worm) may be used. The use of high-pressure jet cleaning equipment is the preferred cleaning method if financially viable.

4.3.2 Location of Infrastructure

4.3.2.1 *Bulk pipelines should be located as stipulated in SANS 1936-3, Section 4.3.1.*

Where this is not practically achievable, the bulk service shall be laid in a duct or culvert that will intercept any leakage in a manner that is readily observable. Alternatively, an appropriate rational solution shall be provided by a Competent Person (geo-professional /engineer). For such alternative the Inherent Hazard Class, foundation design performance requirements, precautionary measures and Dolomite Risk Management requirements shall be reviewed and approved by an independent Competent Level 4 Geo-professional. It is a specific requirement that the Dolomite Risk Management Strategy and Plan developed in accordance with the requirements of Chapter 5 takes account of the non-compliance and potential increased risks associated with the development and provides more stringent monitoring and maintenance requirements.

4.3.2.2 *Dams, reservoirs and stormwater retention or attenuation ponds should be located, as stipulated in SANS 1936-3, Section 4.3.2.*

Such structures shall be rendered impervious.

Where this is not practically achievable, an appropriate rational solution shall be provided by a Competent Person (geo-professional /engineer). For such alternative the Inherent Hazard Class, foundation design performance requirements, precautionary measures and Dolomite Risk Management requirements shall be reviewed and approved by an independent Competent Level 4 Geo-professional. It is a specific requirement that the Dolomite Risk Management Strategy and Plan developed in accordance with the requirements of Chapter 5 takes account of the non-compliance and potential increased risks associated with the development and provides more stringent monitoring and maintenance requirements.

2.NOTE: The location of waste and sewer disposal facilities is governed by prevailing legislation.

4.3.3 Stormwater Drainage

4.3.3.1 Concentrated stormwater shall not be disposed of other than in natural water courses unless the land upon which it is discharged is:

- a) not dolomite land; or
- b) dolomite land categorised as having a Dolomitic Area Designation D1 (refer to SANS 1936-1).

- 4.3.3.2** Stormwater drainage shall be such that no surface water ponds other than in natural watercourses save for that associated with the attenuation of stormwater for a period not exceeding 6 hours.
- 4.3.3.3** Stormwater retention and attenuation structures should preferably not be constructed on land of Dolomite Area Designation D4 in accordance with PW344/2017. Dolomite Area Designation D4 (Inherent Hazard Classes 5, 6, 7 and 8) may only be considered provided the conditions as prescribed in PW344/2017, Table 2 are met.
- 4.3.3.4** Appropriate precautionary measures should be specified for Dolomite Area Designation D3 (Inherent Hazard Classes 1, 2, 3 and 4).
- 4.3.3.5** The means for the control and disposal of stormwater around buildings shall be in accordance with the requirements of SANS 10400-R. It is a specific requirement that stormwater is controlled and will flow away from buildings:
- a) stormwater emanating from the roof, paving or area in the immediate vicinity of a building shall not cause damage to the building interior, structure, or structural elements or accumulate in a manner that unduly inconveniences the occupants;
 - b) stormwater disposal arrangements shall:
 - i. not result in the undercutting of foundations due to erosion or flooding;
 - ii. drain away from buildings, as far as possible, under gravity and not accumulate against or in close proximity to external walls;
 - iii. make provision for the drainage of sites that are waterlogged or seasonally waterlogged;
 - iv. be capable of being readily cleaned and maintained.

Note 1: Where streets are to be used as the primary stormwater drainage system, layout drawings shall indicate the level of the lowest drainage point on the site as well as the street level adjacent to such point.

3.Note 2: Stormwater disposal arrangements on a site include:

4. a) roof valleys and gutters and downpipes or, where gutters and downpipes have not been provided, other means of ensuring that stormwater from any roof is controlled and will flow away from such building;
- b) any surface stormwater drains, channels or below ground stormwater drains deemed necessary to convey stormwater away from such site or from one part to another of such site.

4.3.3.6 Valleys and gutters shall either have a cross sectional area of not less than that given in Table 4.1 for the rainfall region in question or be sized in terms of a rational design.

Table 4.1 — Roof valley and gutter sizes

| Region | Internal cross-sectional area of valley or gutter per m ² of roof plan area served |
|--|---|
| Summer rainfall | 140mm ² |
| Year round rainfall | 115mm ² |
| Winter rainfall | 80mm ² |
| Note: The internal cross sectional area of downpipes shall be not less than 100mm ² /m ² of roof plan area served by such downpipe or 4 400mm ² . | |

Note: The following documents provide guidance on the design of valleys and gutters:

- a) *The Southern African Steel Construction Handbook* (see bibliography);
- b) EN 120563.

4.3.4 Sanitation Systems

4.3.4.1 Sanitation systems shall not incorporate evapotranspirative beds, soak ways or french drains. Conservancy tanks linked to a low flush system complying with the requirements of SANS 10400-P may be used where municipal waterborne sewerage connections are not available.

Designs that incorporate conservancy tanks shall also establish the requirements, frequency and method of disposing of the contents of the tanks.

- 4.3.4.2** If no alternative is available, pit latrines designed and constructed in accordance with the requirements of SANS 10400-Q may be utilized on Dolomite Area Designation D1 and D2 sites, provided that the implementation is approved by the Competent Persons (engineer and geo-professional) as well as the local authority. Such latrines shall be constructed to preclude stormwater entering and shall be placed as far away as possible from any permanent structures.

Note 1: Examples of suitable means of preventing stormwater from entering the pit include the construction of a 0,5m high earth berm around the upslope section of the pit latrine to prevent stormwater from entering the pit or to ensure that the construction of the floor slab is 500mm proud of natural ground level.

Note 2: Annual reconstruction of such pit latrines on new locations is advisable.

Note 3: Redundant pits shall be allowed to dry and then be backfilled and compacted with suitable material to a higher density (except in rock) than the surrounding natural material.

Note 4: Matters such as pollution of water resources should be considered e.g. where infrastructure relies on a borehole or natural water course for its water supply. The utilization of suitable 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 local authority and the Department.

- 4.3.4.3** Pit latrines shall not be provided on Dolomite Area Designation D3 or D4 sites.

4.3.5 Dewatering and Boreholes for Water Abstraction

- 4.3.5.1** The historic lowest natural groundwater level before the development of dolomite land shall not be lowered by more than 6m.

- 4.3.5.2** Careful consideration, as a control on dewatering, is to be given before permission will be granted to allow boreholes for water abstraction. If the water table is above bedrock, a blanket ban on the exploitation of the groundwater shall apply.

- 4.3.5.3** Approval for a borehole for water abstraction should be subject to an evaluation by the Competent Person (geo-professional) and approval by the Departmental Dolomite Risk Manager. The continued use of previously installed boreholes shall also be subject to testing, an evaluation and approval by the Competent Person (geo-professional).

- 4.3.5.4** Any existing boreholes used for water abstraction shall be reported to the National Dolomite Risk Manager. If these boreholes are not compliant with PW344/2017, they must be terminated if so called for by the Competent Person (geo-professional). Similarly shall boreholes not compliant with PW344/2017, but located on land adjacent to the site of investigation, be reported to the Departmental Dolomite Risk Manager if and when such information becomes available.

4.3.6 Landscaping, Gardens and Areas Requiring Irrigation

- 4.3.6.1** All portions of reworked or landscaped areas shall have free draining surfaces.

- 4.3.6.2** All areas of the entire development must ensure free surface drainage. (Absolutely no ponding of water on site shall be allowed)

- 4.3.6.3** Gardens within 15m of buildings should not include:

- a) water features such as fish ponds; or
- b) water features with automatic replenishment systems. Such features shall not be allowed anywhere on the site.

- 4.3.6.4** No gardens shall be created on Dolomite Area Designation D3 sites within a 5m distance of any structure or building.

- 4.3.6.5** No trees and shrubs shall be planted within 5m of non-pressurised (gravity) pipelines.

4.3.6.6 Large grassed areas, such as sports fields, shall be detailed to have a fall to facilitate surface drainage.

Note: A fall/slope less than 1:80 results in poor drainage characteristics. Special attention is to be given to drainage of all areas with gradients less than 1:80.

4.3.6.7 Irrigation systems shall be designed as wet services by a Competent Person (engineer) taking due cognisance of specifying correct seasonal irrigation intensity and frequencies.

NOTE 1: For the development of the grassed areas a specific water management control plan must be prepared and submitted for approval by the Department Dolomite Risk Manager. This plan must include the required irrigation precipitation rates, irrigation system type, irrigation system control as well as the general layout and drainage design. Irrigation requirements shall be designed specifically for the type of vegetation, soil characteristics region and annual rainfall.

4.3.7 Construction

4.3.7.1 General

4.3.7.1.1 Measures shall be taken during construction to ensure that:

- a) land that is not part of the specific development is not disturbed by construction activities and construction equipment to the extent that it is compromised for future developments;
- b) water does not pond anywhere on the site during construction;
- c) existing wet engineering services are maintained and any damage to such services is promptly repaired;
- d) any services that are to be abandoned are dealt with in accordance with the requirements of PW344/2017;
- e) surface water does not interfere with or pose a flooding threat to adjacent properties;
- f) construction waste is disposed of in an appropriate manner as approved by the Competent Person (geo-professional/engineer);
- g) degradable waste is disposed of at an approved commercial dumpsite;
- h) the quality, quantity and flow direction of any surface water runoff shall be established prior to disturbing any area for construction purposes. Cognisance shall be taken of these aspects and incorporated into the planning of all construction activities. Before a site is developed or expanded, it shall be established how the development (or expansion thereof) will affect the drainage pattern. No water source shall be polluted in any way due to proposed changes;
- i) surficial soil disturbances are appropriately managed;
- j) reinstatement of vegetation is undertaken.

4.3.7.1.2 Construction equipment such as tower cranes, batch plants, storage facilities, and temporary accommodation buildings that are fixed in a location for a period of time, shall be designed and constructed in accordance with the requirements of this part of PW344/2017. Wet and dry services to such buildings and structures shall also satisfy the requirements of this part of PW344/2017.

4.3.7.1.3 The provision of construction related support functions, facilities and activities, including those provided to accommodate temporary habitation, shall not compromise the determined development risk.

4.3.7.1.4 Measures to mitigate dolomite-related risk shall include but not be limited to:

- a) The control of ingress of water and or other liquids (irrespective of source) into trenches and excavations:
 - i. construction excavations should be opened and closed as rapidly as possible. Avoid leaving trenches open over weekends or holidays;

- ii. berms should be constructed on either side of the trenches to prevent the inflow of water during rainstorms;
 - iii. all concentrated stormwater entering the site shall be diverted away from any structure, trench or developed area by means of (appropriately designed) temporary channels.
- b) Appropriate provisions shall be made for pumping equipment to keep excavations dry;
 - c) The site and surrounding area shall be shaped (if required) to permit the rapid drainage of surface water to prevent ponding on the site;
 - d) No consideration shall be given to the placement of retention and/or sediment ponds;
 - e) Where feasible, trenching operations and pipe laying shall be in the upslope direction. The down slope end of such trenches must allow for the removal of water entering the trench. If installed pipes are utilised to drain the upslope trenches, then appropriate cleaning and disinfecting procedures are to be introduced prior to commissioning of the pipe system;
 - f) Damage to existing wet and dry engineering services during construction shall be limited and repaired immediately if damaged.

4.3.7.1.5 Areas that require surface repair, such as road layer work or pavement shall be repaired in a single operation in order to minimize the ponding of water on partially repaired surfaces.

4.3.7.1.6 During the execution of projects the following are to form part of Risk Mitigating Measures related to emergency existing engineering services maintenance issues:

- a) the project design requirements shall include an assessment of potential emergency repairs to wet engineering services to be upgraded and /or replaced in the specific project description. Due allowances shall be made for potentially unknown wet engineering services that could be affected by the works.
- b) The bill of quantities must allow for emergency repairs during the contract period without the requirement of variation orders. Specifically measured repair, and if needed, maintenance items must be scheduled in the tender documents to cover such eventualities. The total allowance for items included in the bill for emergency repair work must not exceed 2,5% of the contract value. The Department Dolomite Risk Manager must approve the allowance for such maintenance and emergency repairs prior to tendering.
- c) typical emergency repair items which should be included in the scope of works as required, are as follows:
 - i. emergency water pipe bursts;
 - ii. replacement of defective valves;
 - iii. repacking of leaking valves;
 - iv. replacing of leaking valves;
 - v. cleaning of sewer pipes;
 - vi. replacing of sections of sewer pipe;
 - vii. replacement of damaged manholes;
 - viii. opening of blocked stormwater pipes;
 - ix. cleaning and sealing of stormwater canals;
 - x. replacement of damaged canal sections;
 - xi. repair of sinkholes and subsidences;
 - xii. emergency barricading of areas of ground settlement with steel fencing;
 - xiii. erection of notice boards (steel) that indicates sinkholes or area of danger;

4.3.7.1.7 It is a specific requirement of the Department that the Competent Person (engineering) shall supervise emergency maintenance of wet and dry engineering services, on any dolomite site for the duration of a contract that involves:

- a) the rehabilitation of sinkholes and subsidences;

- b) upgrading of existing buildings, structures and infrastructure;
- c) development of new buildings, structures and infrastructure.

4.3.7.2 Temporary Connections

All temporary connections to water, sewer and stormwater systems shall not be backfilled unless with the express instruction, in writing, of the Engineer's Representative. The installation shall, as a rule, be left open and be protected from stormwater drainage as well as barricaded as per the contractual standards until the permanent connections are made.

4.3.7.3 Quarries and Borrow Pits

- 4.3.7.3.1 Quarries and borrow pits shall be established under the direction of a Competent Person (geo-professional/engineer) only after written consent of the Department.
- 4.3.7.3.2 Departmental Projects may not establish any form of quarries or borrow pits on land not owned by the Department. Such activities shall only be allowed after a formal agreement has been reached between the Department and the landowner on whose property quarries or borrow pits are to be established. Such quarries and borrow pits shall be established under the direction of a Competent Person (geo-professional/engineer) and approved by the Dolomite Risk Manager.
- 4.3.7.3.3 Any quarry or borrow pit on dolomite land shall be free draining for the full period of operation and shall, on completion, be rehabilitated to standards specified by a Competent Person (engineer or geo-professional).
- 4.3.7.3.4 The record drawings shall indicate and describe the nature of any quarry or borrow pit, including the method used to rehabilitate such quarry or borrow pit.
- 4.3.7.3.5 Quarries and borrow pits as well as major surficial soil disturbances shall not be permitted on land already zoned (or provisionally allocated) for a specific land usage that does not specifically provide for the establishment of such quarries and borrow pits in the usage definition/description or conditions.
- 4.3.7.3.6 The establishment and operation of any quarry or borrow pit shall meet all environmental legislative requirements.

4.3.7.4 Rehabilitation of Small Areas of Borrow

The rehabilitation of small areas of borrow such as ashpits, abandoned pit latrines etc. requires particular attention. All organic and inorganic material irrespective of stage of decomposition/ weathering must be removed. The rehabilitation of the area of borrow shall be similar to the backfilling of trench excavations.

The uncovering of such areas during construction shall be inspected by a Competent Person (geo-professional/engineer) who will specify and oversee the appropriate rehabilitation method.

4.3.7.5 Stockpiles

- 4.3.7.5.1 Material stockpiling and stormwater management near such stockpiles requires particular attention during the design and construction phase.
- 4.3.7.5.2 Stockpiling of material on site requires due consideration of stormwater management in general as well as the prevention of physical blocking of existing inlet structures, culverts, stormwater canals, and general overland drainage and in particular drainage towards these inlet structures.
- 4.3.7.5.3 Design and construction drawings shall specifically allocate areas where stockpiling may/may not take place. Free draining of the site may not be inhibited by any form of stockpiling or construction debris.

4.3.7.6 Excavations for Buildings, Structures and Infrastructure

- 4.3.7.6.1 All trenches and open works as well as excavations for foundations are to be inspected by a Competent Person (geo-professional/engineer) to assess if adverse ground conditions are

present. This procedure allows for the adjustment of construction methods, i.e. improved foundation design, special bedding requirements, additional excavation and compaction, or pipe protection measurements.

Note: The adverse ground conditions may include surficial soil problems such as collapsible soil materials and geotechnical conditions such as shallow rock outcrops, sharp soil strata changes, paleo structures etc.

- 4.3.7.6.2 The findings of the excavation inspection by the Competent Person (geo-professional/ engineer) should be fully documented in a short excavation construction report that contains:
- a) details of the area of inspection;
 - b) identification of the inspected area in relation to the layout plans;
 - c) node description of inspection routes of pipelines;
 - d) description of inspection findings;
 - e) photographs to enhance report details (Photographs can be submitted in digital format provided that each photograph is appropriately numbered and dated in accordance with the report reference.);
 - f) description of soil profile (in general per chainage length);
 - g) descriptions of changes in soil colour, density or type; and
 - h) descriptions of the presence and location of any cavities and palaeo-structures.
- 4.3.7.6.3 The Competent Person (geo-professional/engineer) shall issue the person responsible for the construction with written instructions regarding the safety precautions to be followed in collaboration with the safety agent and the reports to be logged prior to the backfilling of excavations in the event of:
- a) sinkhole formation;
 - b) subsidence formation;
 - c) a sudden change in the colour of the soils;
 - d) exposing/over excavation of cavities;
 - e) excavation of palaeo-structures.
- 4.3.7.6.4 Any report that reflects the above must be forwarded to the Department Dolomite Risk Manager for review and comments prior to backfilling of trenches. This procedure must allow for, amongst others, the adjustment of construction methods, i.e. special bedding requirements, additional excavation and compaction, or pipe protection measurements.
- 4.3.7.6.5 In the event of a sinkhole or subsidence being reported then the procedures as provided for in Chapter 5 shall be followed.
- 4.3.7.6.6 Without limiting the responsibility for the safety of workers in any excavation, a contractor shall ensure the safety of the workers in trenches and excavations deeper than 1m in terms of the provisions of the Occupational Health and Safety Act. The Contractor may choose to batter excavations to a safe slope if sufficient space is available, or alternatively adequately shore the excavations. Before excavation work begins, an evaluation of the stability of the ground is to be conducted. No person shall be permitted or required to work in an excavation that has not been adequately shored, braced or the sides sloped to at least the maximum angle of repose. Should persons responsible for the excavations consider that an excavation is in stable material and consequently no shoring is required for that excavation, then the Engineer shall be provided with a written statement to that effect.
- 4.3.7.6.7 Where the stability of an adjoining building, structure or road is likely to be affected by an excavation, the contractor responsible for the excavation shall ensure that steps are taken to ensure the safety of the building, structure or road.
- 4.3.7.6.8 Every excavation, including all shoring and bracing, shall be inspected by the contractor's Competent Person (geo-professional/engineer):

- a) daily, prior to each shift;
- b) after every blasting operation;
- c) after an unexpected fall of ground;
- d) after substantial damage to supports;
- e) after rain.

The results of such inspections shall be recorded in a register.

4.3.7.7 Backfilled Areas

Backfilled areas shall be inspected at time intervals as specified by the Competent Person (geo-professional/engineer) for any form of subsidence. Any subsidence that is found shall be attended to as directed by the Competent Person (geo-professional/engineer).

5. Note: Typically, the backfilling inspections should on a minimum be prior to as well as in the middle and the end of a rainy season or as determined by the Competent Person (geo-professional/engineer).

4.3.7.8 Blasting Operations

Blasting operations shall be performed in accordance with the requirements of SANS 1936-3, Section 4.8.4.

4.3.7.9 Demolition of Buildings, Structures and Services

4.3.7.9.1 Buildings shall be demolished (or deconstructed) under the direction of the Competent Person (geo-professional/engineer), observing minimum site precautions to ensure that:

- a) water does not pond on the site;
- b) risk of wet services rupturing or leaking is minimized.

4.3.7.9.2 The general requirement for deconstruction of buildings is contained in Annex Q.

4.3.7.9.3 All subsurface pipework and associated structures (manholes, valve boxes, etc.) at sites earmarked for demolition shall be removed and the trenches suitably backfilled and compacted that the permeability of the trench is less than that of the in situ soil. Where old mains are under hard surfacing and where removal is uneconomical, pipes and ducts shall be fully grouted using a suitably designed pumpable or flowable soil: cement mixture with the addition of a suitable plasticiser agent (i.e. bentonite) if required. The same applies to all associated service structures such as valve boxes and manholes if they are not removed entirely.

4.3.7.9.4 The general requirement for grouting is contained in Annex M.

Note 1: The Department requires that particular attention be given to prevailing legislation regarding the removal of asbestos cement/fibre cement pipes.

4.3.7.10 Pipe Deconstruction and Replacement Techniques

Pipe replacement techniques that employ methods of destructing the in situ pipe or duct and replace it along the same route with the new pipe shall also implement measures/techniques to ensure that no voids are left around the new pipe or duct after completion of the replacement. Typically, a stabilized sand/cement grout shall be injected to fill all voids between the new pipeline and the surrounding material.

Note 1: Construction with pipe replacement techniques is not preferred in the dolomitic environment as result of the potential to create a mini "French drain" and thus concentrated drainage areas around the pipe. It shall only be allowed if all other conventional methods of construction were proven unsuccessful. Where a new pipe service utilizes the previously installed pipe, the void between the two pipes shall be grouted up such that the void is filled completely.

4.3.7.11 Pipe Jacking

4.3.7.11.1 Pipe jacking shall be in accordance with SANS 1200 / SANS 2001-DP8. The Competent Person (engineer) shall approve (specify) the proposed methodology and precautionary measures.

- 4.3.7.11.2 Water jetting techniques will not be allowed.
- 4.3.7.11.3 Pipe installation techniques which employ horizontal augering methods must ensure that no voids are left around the pipe or duct after completion. A designed stabilized sand/cement grout shall be injected to fill all voids between the new pipeline and the surrounding material.

4.3.7.12 Areas with Sinkholes or Subsidences

- 4.3.7.12.1 Fencing of high-risk areas where sinkholes or subsidences have already occurred or areas where subsurface cavities are known to exist, shall be mandatory until rehabilitation can be executed. No person, save for the Competent Person (geo-professional/engineer) investigating the area, shall be allowed to traverse such areas. Such areas shall be marked with adequate signage and the fence shall be at least 1,5m high.
- 4.3.7.12.2 The Competent Person (geo-professional/engineer) must specify, in detail, all precautionary and safety measures to be taken in the event of work related to sinkhole and subsidence repairs.
- 4.3.7.12.3 The general requirements for sinkhole, subsidence and grouting of cavities are contained in Annex M.

4.3.7.13 Incompetent Surface Material Horizons

- 4.3.7.13.1 Based on advice from the Competent Person (geo-professional/engineer) any areas with incompetent surface material horizons should be subject to detailed investigations to ascertain whether material is to be removed and replaced or alternatively reworked to attain the required competence.

4.3.8 Precise Levelling of Land, Buildings, Structures and Infrastructure

Precise levelling will only be required when instructed by the Department Dolomite Risk Manager and authorised by the Department Project Manager.

4.3.9 Design and Construction of Township Services and Services in Interconnected Complexes

4.3.9.1 General

Interconnected complexes on Departmental land are portions of land with development of multiple dwelling units, such as, terraced or multistorey complexes, or residential clusters type of developments (or both), where management of common property usually resides with, (but is not limited to) a specific management body at the client department. (i.e. residential development area in a military base that resembles a typical township development where a local authority may or may not have jurisdiction).

- 4.3.9.1.1 The design and construction of township engineering services in interconnected complexes shall comply with the requirements of SANS 1936-3, Section 5.1.

4.3.9.2 Performance Parameters

4.3.9.2.1 Stormwater drainage

Stormwater drainage shall comply with the requirements of SANS 1936-3, Section 5.2.1.

4.3.9.2.2 Sewer mains

Sewer mains shall comply with the requirements of SANS 1936-3, Section 5.2.2.

4.3.9.2.3 Water supply

- 4.3.9.2.3.1 Each stand shall be provided with a metered connection suitable to the local authority (if applicable) and the requirements of PW344/2017.

- 4.3.9.2.3.2 The number of high and low points shall be kept to a minimum. Pipes shall be laid to gradients greater than:

- a) 0,3% for pipes that have an internal diameter equal to or less than 200mm;
- b) 0,2% for pipes that have an internal diameter in excess of 200mm.

4.3.9.2.3.3 The materials for use in water systems shall comply with PW344/2017 Chapter 4.

4.4 Requirements for Wet and Dry Engineering Services

4.4.1 General

4.4.1.1 Wet and dry services shall comply with the requirements of SANS 1936-3, Section 6.

4.4.1.2 The backfilling to service trenches shall, except in rock, not be more permeable than the surrounding material:

- a) general minimum compaction standard to be 93% of Mod. AASHTO maximum dry density (MDD) at optimum moisture content (OMC), provided permeability requirements are met;
- b) where trench excavated material is utilized for bedding, surround and backfill materials, the materials shall be compacted to at least 93% of Mod. AASHTO MDD at OMC or the density of the in situ soil, whichever is higher;
- c) 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% of Mod. AASHTO MDD at OMC;
- d) bedding material shall conform to SANS1200 LB (Clause 3.1) subject to the maximum aggregate not exceeding 6mm and the permeability to be lower than the in situ soil ($PI < 12\%$);
- e) the use of non-cohesive single size graded sand or crusher sand for bedding, surround blankets and backfill shall not be allowed (bedding and fill blankets must not allow free draining).

4.4.1.3 Wherever feasible, provisions for future connections to all wet services shall be made in order to minimize cutting into pipes to provide such connections at a later stage.

4.4.1.4 Specification for Below Ground Surface Installations (Annex N) and Specification for Sewers in Buildings (Annex O) serve the purpose of minimum requirements regarding areas with a Dolomite Area Designation of D1 as well as the requirements to make emergency repairs and maintain existing infrastructure on Dolomite Area Designation of D2, D3 and D4 until such time that upgrading or replacements to the requirements of PW344/2017 can be executed.

4.4.2 Buried pipeline route markers

All wet and dry services and pipelines shall be clearly marked with appropriately designed concrete marker posts. Marking symbols and numbers are to be approved by the Department and be in accordance with the Civil Engineering Manual (PW347).

4.4.2.1 Installation of marker posts shall be as follows:

- a) Water:
 - i. On all points of change in direction;
 - ii. Every 60m on all straight pipe routes.
- b) Sewer/stormwater:
 - i. All joints and direction change where the manhole of such direction change is not clearly visible.
 - ii. Every 80m on straight pipes (including on sewer pump mains).

4.4.2.2 The marker post must display the following:

- a) pipe size;
- b) pipe type;
- c) installation date;
- d) direction(s) of pipe(s)

4.4.2.3 The installation of all route markers in areas with aircraft movement must be approved by the Departmental Engineer.

4.4.3 Valve Box and Manhole Markers

All valves, meters, fire hydrants, pressure reducing valves, manholes and junction boxes shall be clearly marked with numbers. Marking shall be by numbering cast into the concrete on top of structures. Marking symbols and numbers to be approved by the Department. (Brass Plate: 100mm X 50mm X 4mm with 2 X 10mm diameter bolts 100mm deep into concrete).

4.4.4 Watertightness of Structures Associated with Wet and Dry Engineering Services

All access chambers, inlet structure manholes, valve chambers, pump stations, and the like, shall be watertight and where necessary, shall be fitted with suitable backwater stops and internal water stops to all expansion and construction joints (applicable to joints below and above expected liquid levels).

4.4.5 Foundation Preparation of Watertight Structures Associated with Wet and Dry Engineering Services

Ensure sufficient compaction of foundation excavations to preclude any consolidation settlement. All water retaining structures are to have foundations appropriate to the conditions at the specific site.

4.4.6 Wet Engineering Services

- c) Wet engineering service systems shall comply with the requirements of SANS 1936-3, Section 6.2.

4.4.6.1 General

4.4.6.1.1 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).

4.4.6.1.2 All properties of pipe joints designed by the manufacturer must always exceed or be equivalent to the base parent pipe (i.e. joints shall not decrease the tensile strength properties of the overall pipeline).

4.4.6.1.3 Auditing of water, sewer and other liquid conveying systems that allow for the comparison of the statistical mean design demands/consumption with actual after installation recorded data from Departmental measuring installations as well as external appointed/contracted service providers/consultants are compulsory and shall be supported by the actual submitted design calculations.

4.4.6.2 Bulk Pipelines for Wet Services

4.4.6.2.1 Bulk pipelines for all wet engineering services shall be subject to a life cycle cost analysis between the various material types allowed for by the Competent Person (geo-professional) in terms of the Dolomite Area Designation and particular precautionary measures.

4.4.6.2.2 Pipe selection shall be based on:

- a) the ability of the pipe to stay serviceable under full operational conditions in the event of the occurrence of sinkhole or subsidence with a diameter nominated in the dolomite stability report;

- b) the potential to prevent harm or impact on public safety in the event of a sinkhole or subsidence occurring. The location, topographical features of the land and drainage patterns, the potential to impact on adjacent land as well as the proximity of other developments and the potential to impact thereon requires careful consideration.

4.4.6.2.3 Any pressurised bulk service pipeline shall be supplied with a shutdown system that will activate with any pressure variation similar to that of a pipe burst.

4.4.6.3 Water Supply

Water supply pipes shall be subjected to hydraulic pipeline testing after the installation in accordance with SANS 1200/SANS 2001-DP2 for the selected pipe class. Refer to Annex P in Volume 2 of PW344/2017 for details of the proposed test methodology.

4.4.6.3.1 It is a specific requirement that installation of new water networks in a dolomitic area are designed and constructed to a zero tolerance for leakages. Where existing water supply services are to be replaced/refurbished close to or below existing buildings, such services shall be sleeved according to the requirements for D4 sites (refer to Section 4.6).

4.4.6.3.2 Typical, minimum standard, details for engineering designs are included in PW344/2017, Volume 3. The engineer needs to extend and improve on these drawings to suit the site-specific conditions.

4.4.6.3.3 Water networks shall be fitted with:

- a) water meters at suitable locations measuring areas within a water distribution system that is supplied from a single pressure control device or reservoir, the boundaries of which are normally incorporated within the supply zones, districts and subdistricts or boundaries to allow for the auditing of water losses and the detection of leaks. Typically:
 - i. bulk meters are to be installed in the water distribution system to measure the volume of water that passes through that point and supplies a particular consumption area (zone) and could be used for bulk revenue purposes;
 - ii. a bulk district water meter installed in the water distribution system that measures the volume of water entering a district (area in a zone) to assist in water balance determinations, and that is also capable of registering the rate of flow into the district for minimum night flow purposes (MNF= the lowest consistently repeatable flow rate into an area or district, measured during the period of lowest consumption, leakage on premises and leakage from the distribution system)
- b) valves at suitable locations to ensure the rapid isolation of portions of the bulk and secondary water network, or links to individual buildings, in the event of sinkholes and subsidences;
- c) termination points in water networks that is supplied for future connections or other terminations of a permanent nature shall:
 - i. terminate in a watertight manhole and the pipe shall be provided with a flanged valve as well as a blank flange on the downstream side of the valve;
 - ii. design drawings shall specifically indicate the intended future use as well as the potential area (zone district or sub-district) to be serviced from this connection point;
 - iii. the manhole shall be sufficient in size to allow future connections.

4.4.6.3.4 Requirements regarding water networks:

- a) 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 SANS 10306;
- b) 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 development(s);
- c) primary and secondary water loops shall be closed as far as feasible except where otherwise approved by the Department;
- d) the position of flow control devices is to be rated for the required combined fire-fighting and other water demands;

- e) network pressure zones require identification according to network demands for fire, normal and zero demand consumption, operation of geysers and similar pressure rated devices as well as the presence of high rise buildings;
- f) domestic and fire water requirements shall be calculated in accordance with the DPW “Standard Specification for Domestic and Fire Water Storage and Fire Water Supply for Public Buildings” PW 345. Obtain latest version of these guidelines from the Departmental Engineer. (All facilities to be assumed fully occupied) In addition, Fire Fighting Design shall, if required by the Department, be in accordance with the National Building Regulations, SANS10400 and the requirements of the appropriate local Council and shall be officially approved by the local fire-fighting authority. The Department will call for a rational fire design if deemed necessary.

4.4.6.3.5 New installations must be fitted with water meters at the appropriate positions to allow for the auditing of water from the bulk supply system down to individual (point) end users. The designs of such networks shall specifically allow for the metering and auditing of the entire network with tolerances only as described for the specific meter units that are used. Water balancing that shows discrepancies beyond what is normally allowed for by the type of meters that is in the system should be investigated and repaired immediately.

4.4.6.3.6 Additions to an existing area that is already subject to auditing shall ensure that the design and consumption comparison data are duly updated to include the additional demands. The level of confidence and potential margin of error/accuracy in the design data and actual consumption measurements shall be reported for monitoring and Dolomite Risk Management purposes as called for in Chapter 5. Water balancing points and the expected balance over predetermined periods shall be clearly indicated on layout drawings (water balance = difference between the measured volume of potable water put into a water distribution system and the total volume of potable water measured at any intermediate point in the distribution system).

4.4.6.3.7 For the purpose of water auditing all water distribution networks shall be:

- a) Demarcated as an area (zone) that is serviced from a specific bulk distribution network;
- b) Areas with more than one bulk connection shall incorporate measures to prevent reverse flow through the various connection points;
- c) Each bulk connection shall be fitted with valves, meters and strainers and pressure management devices as required;
- d) Each zone shall be subdivided into water monitoring districts and subdistricts that are supplied with a single fed, monitored/metered lateral;
- e) Design drawings shall specifically demarcate the monitoring districts and the point of supply, metering and monitoring to such a district. If required, such districts shall be supplied with a ring feed for emergency purposes. An installation according to drawing DT11-4/W or DT11-5/W in PW344/2017, Volume 3 can typically be used;
- f) A water monitoring subdistrict shall be a facility, infrastructure, or group of buildings provided for a specific intended function, inter-related purpose and is administrated as a single area of accountability (i.e. police station, magistrate court, etc.) on an individual stand, and not exceed 1ha;
- g) Areas on which the various buildings do not serve an inter-related purpose, is not administrated as a single area of accountability or an area larger than 1ha in extent, shall be divided into districts of accountability, and then into subdistricts of similar function (i.e. police station and magistrate court on the same parcel of land shall be divided as two districts). The subdistricts shall preferably be defined by the land usage (residential, recreational and commercial etc.) as allowed for in SANS 1936-1, Table 2;
- h) Cross feeding between water monitoring districts may only be allowed in cases of emergency (typical detail for this service is as per detailed Drawing DT 11-4/W and DT 11-5W) in PW344/2017, Volume 3);
- i) Final designs shall specifically state the method of monitoring and procedures to be followed in water balancing calculations as well as operational procedures that needs to be implemented in the event of unbalanced evaluations;

- j) Within water monitoring subdistricts, water shall be measured to a level of individual building or facility.
- 4.4.6.3.8 The design engineer needs to ensure that the water supply to individual buildings and structures is in accordance with the Department's current civil engineering standards (PW 347) and the following:
- a) Taking into consideration the wall thickness of HDPE piping it is policy that water connections to an individual structure (residential, office etc.) are not smaller than a pipe of 32mm external diameter.
 - b) Shut-off valves and water meters to individual buildings (non-residential) shall be supplied at main supply with a permanently fixed pressure gauge and associated fittings for regular systems pressure testing on the building side of the main shut-off valve.
 - c) Water supply to fire hose reels shall not be fitted with shutoff valves. The installation must be approved by the local fire authority.
- 4.4.6.3.9 Valves and water meters for residential buildings shall be provided at all residential properties (erf connections) leading off from water mains. Such connections shall be provided, for testing purposes, with a connection point for a pressure gauge on the erf side of the valve. Such point shall be clearly marked and placed to ensure accessibility to maintenance crews without entering the premises.
- a) All individual residential buildings/units must be supplied with separate water meters;
 - b) The water meter shall preferably be surface mounted against the building;
 - c) For meters (15mm to 25mm) to be installed underground the typical detail is as per Drawing Type DT 24/W in PW344/2017, Volume 3.
- 4.4.6.3.10 Requirements regarding water meters:
- a) The installation of water meters on all bulk and secondary water supply systems are compulsory in terms of the Department's current policy of water management and auditing control in dolomite areas;
 - b) The main feed line to a property/complex or identified group of buildings (subdistrict) that is collectively responsible for the payment of a specific account is to be supplied with a water meter that has electronic logger capabilities. Such meters must also be fitted with a pressure gauge (supply also shutoff and bleed valve). All individual Client Department groups on the same site shall have separate meters;
 - c) All individual new structures must also be fitted with a water meter;
 - d) The type and position of water meters are to be approved by the Departmental Engineer;
 - e) Water meters shall comply to the generic performance standards as follows:
 - i. electronic/digital water meters – refer to Annex R.
 - ii. mechanical water meters –refer to Annex R.
- 4.4.6.3.11 Requirements for approval of water meters:
- The final design of water networks shall include the type, specifications, level of accuracy under all expected designs and usage conditions, operational functionality, management and maintenance requirements. The design engineer shall:
- a) specifically approve the proposed water meters and provide the Department with a certificate of compliance for each meter;
 - b) comment of the appropriateness of previously installed water meters on the bulk supply line or within the supply area to which the new or upgraded distribution system may link.
- 4.4.6.3.12 Underground valves, inline strainers, reflux valves, water meters or any other fitting other than pipe joints shall be placed in watertight chambers. All associated fittings such as flange adaptors, reducers etc. shall be within the watertight chamber.
- 4.4.6.3.13 Requirements regarding valves are:

- a) All valves on water mains to be clockwise closing;
- b) Valves shall be flanged resilient seal gate valves fitted with flange adaptors.

4.4.6.3.14 Requirements regarding valve chambers are:

- a) HDPE water manholes are to be manufactured to same standard as sewer manholes;
- b) Manholes and valve chambers to be watertight heavy duty welded HDPE (material type PE 100) with minimum ring stiffness 8kN/m² (refer to PW344, Volume 3, details TYPE DT 28/W, TYPE DT 28-1/W, TYPE DT 28-2/W, TYPE DT 29/W, TYPE DT 29-1W, TYPE DT 29-1W, TYPE DT 29-1W, TYPE DT 31W, TYPE DT 32/W, TYPE DT 04/D);
- c) Manholes that are supplied on a HDPE sleeve pipe system shall be supplied with HDPE stub pipe suitable to weld on the sleeve pipe system;
- d) Concrete manholes that are supplied on a HDPE sleeve pipe system are to be designed as water retaining structures. (i.e. cast in situ watertight reinforced concrete manholes if approved by Departmental Engineer);
- e) Concrete manholes require that HDPE stub pipes with puddle flanges are to be cast into the concrete. The stubs are to be suitable to weld on the sleeve pipe system. (PW344, Volume 3, details TYPE DT 12/W);

4.4.6.3.15 Requirements for concrete valve chambers/boxes:

The design of concrete valve boxes and manholes must conform to the relevant requirements contained in this document. The structure is to be designed as a water retaining structure. Of particular importance is the installation of the cover slab as an in situ installation that forms an integrated part of the structure. Reinforcing steel for walls must extend into the cover slab to form a watertight joint. If the cover slab is cast separately then it must be attached to the walls with an approved epoxy to form a watertight joint.

4.4.6.3.16 Requirements for valve box/ manhole lid:

All manhole lids shall be lockable and manufactured from a material that has no monetary value (i.e. steel and cast iron lids are not acceptable). Typical details are provided in PW344, Volume 3.

4.4.6.3.17 Requirements for fire hydrants:

Fire hydrants are to be above ground, tamper proof, right angled and in accordance with SANS 1128 and the local fire-fighting authority's requirements.

4.4.6.3.18 Requirements for buried piping:

- a) high-pressure compression connections are allowed below ground level only after approval by the Department's Dolomite Risk Manager and all such connections are to be placed in watertight manholes.
- b) buried piping from the water mains reticulation to a building shall, as far as possible, be free of joints between the water mains and the building, apart from any water meter or testing point or be installed in watertight chambers. All connections between flexible and rigid pipes shall be provided with flexible, self-anchoring joints. Such connections shall be either within watertight structures or above ground level and not be restrained from movement under conditions of subsidence.
- c) joints between below-ground and above-ground piping at buildings/structures shall be made not less than 100mm above ground or paving level. A 1000mm × 1000mm concrete slab, not less than 75mm thick, shall be cast around the exit point from the ground to protect the pipe where an apron is not provided.
- d) buried piping shall have a nominal working pressure rating, as stated in SANS 1936-3, Section 6.2.2.4.

- e) Buried water pipes shall have a minimum soil cover of:

| | | |
|---|-----------------------|-------------|
| a | Average | 0,75 m |
| b | Outside traffic areas | 0,60m (min) |
| c | Inside traffic areas | 1,0m (min) |

- f) Protect pipes with appropriately designed concrete slabs where minimum requirements cannot be met or if imposed loads necessitates protection.

4.4.6.3.19 Requirements for anchor blocks:

Taking into account that butt welding produces a joint with strength similar to the pipe itself the HDPE system is self-anchoring in general. However, it is a requirement that the design and tender documentation allows for the installation of anchor blocks for HDPE water supply system of all pipes larger than 100mm in diameter.

- a) Anchor blocks are required at:
- i. all changes of direction exceeding 11,5°;
 - ii. all T – junctions;
 - iii. all Y – junctions;
 - iv. all crosses;
 - v. all end caps.
- b) The pipes and fittings at such points must be fitted with suitable puddle flanges to ensure that no relative movement between the anchor block and the smooth HDPE pipe is allowed. Such puddle flanges shall be constructed of material not thinner than the wall thickness of the fitting it is welded to.
- c) Due to the nature of surficial soils in the dolomite area it is proposed that in the absence of detailed geotechnical information the following allowance shall be made in tender documents:
- i. 50% of anchor blocks in loose soil conditions;
 - ii. 50% of anchor blocks in medium dense soil conditions;

4.4.6.3.20 Requirements for above ground piping:

- a) water pipework above ground shall be fixed against the building or on steel pedestals. Manifolds shall be above ground with single HDPE feeds from below ground that terminates no less than 100mm above ground. (Refer to PW344, Volume 3 for typical details type number DT 03W, DT 05W, DT 07 W, DT 08W, DT 33W)
- b) the use of surface mounted steel 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.
- c) water pipe entries into all buildings shall be designed so that it can tolerate differential movements

4.4.6.3.21 Requirements for garden and external taps:

Refer to the requirements of SANS 1936-3: 6.2.2.8.

Note:

1. Preferably garden taps shall be placed as far as possible from buildings and structures provided that drainage from the taps is not impacting on adjacent property.
2. No garden taps shall be permitted on medium to high hazard rated dolomite land.

4.4.6.3.22 Materials for subsurface and above ground water pipes are as follows:

- a) pipes greater than or equal to 75mm in diameter:
- i. Below ground - HDPE

Application: Dolomite Area Designation (D1, D2, D3 and D4)

Pipe: HDPE: Type PE 100 or higher, PN 12,5 (or higher pressure class)

if required) to SANS 4427.

- Supply lengths: 12m (minimum) (except: 90mm diameter pipes should preferably be supplied in 100m rolls and 110mm diameter pipes in 50m rolls).
- Joints: Butt welded joints (SANS 10268 – Part 1) in general.
Electro-fusion welding (SANS 10268 – Part 2) must be requested from and approved by Departmental Engineer, where butt welding is impossible.
- Fittings: Manufactured from HDPE: Type PE 100, PN 12,5 (or higher, as may be required) to SANS 4427. Moulded and not machined fittings are preferred. No manufactured extrusion welded fittings will be allowed.
- Welding: All welding to relevant SANS 10268, SANS 10269, SANS 10270, SANS 1655 and SANS 1671 codes.

ii. Below ground - PVC (alternative - only if approved by the Department)

- Application: Dolomite Area Designation (D1 and D2)
- Pipe: High impact PVC pipes: modified poly (vinyl chloride) (PVC-M) pipes that comply with the requirements of SANS 966-2 or SANS 1283, with a pressure class of not less than 12,
- Supply lengths: 6m or 9m
- Joints: Pressed on Spheroidal Graphite Cast Iron (SG) iron or stainless steel Victaulic shoulders. Alternatively, pipes with spigot and socket ends provided with an additional metal locking ring (stainless steel).

iii. Above ground - Steel (exposed pipe installations)

- Application: Dolomite Area Designation (D1, D2, D3 and D4)
- Pipe >300mm: For bulk pipelines (diameter 300mm and larger) steel pipes shall comply with the applicable requirements of SANS 719 or SANS 1835.
Jointing shall be by means of continuous butt, sleeve or socket welds and or flanges. Such pipes shall be suitably protected by means of galvanising or coatings and where required cathodic protection.
- Pipe <300mm: For pipelines (diameter <300mm) steel pipes shall comply with the applicable requirements of SANS 719, SANS 1835 or SANS 62-1, with a pressure class to meet the design requirements and with suitable internal and external corrosion protection or galvanizing and, self-anchoring connections.
Jointing shall be by means of continuous butt, sleeve or socket welds, flanges or screwed fittings. Screw threads (<150mm) shall be cut as far as possible prior to 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.
- General: No welding will be permitted after galvanizing or application of protective coatings.
- Protection: Galvanizing shall be hot dipped heavy-duty to SANS 32 and SANS 121.
Protective coatings other than galvanizing shall be specified by the

engineer.

Cathodic and stray current protection, where determined to be required, shall be specified by the engineer.

iv. Below ground - Steel (bulk pipelines only)

| | |
|--------------|--|
| Application: | Dolomite Area Designation (D1, D2, D3 and D4) |
| Pipe >300mm: | Steel pipes shall comply with the applicable requirements of SANS 719 or SANS 1835. |
| Joints: | Jointing shall be by means of continuous butt, sleeve or socket welds. Mechanical joining device(s) consisting essentially of flanges are only allowable in manholes and valve boxes. |
| Protection: | Such pipes shall be suitably protected with internal and external corrosion protection and where required cathodic protection. Stray current protection, where required, shall be specified by the engineer. |

Note: All pipes shall have the attributes as specified by the Competent Person (engineer)

b) pipes of diameter less than 75mm:

i. Below ground - HDPE

| | |
|-----------------|--|
| Application: | Dolomite Area Designation (D1, D2, D3 and D4) |
| Pipe: | HDPE, Type PE 100 or higher, PN 16 (or higher pressure class if required) to SANS 4427. |
| Supply lengths: | 100m (minimum) |
| Joints: | Butt-welded joints (SANS 10268 - Part 1) in general or electro fusion welding (SANS 10268 – Part 2) where butt-welding is impossible. No compression fittings are allowed except if in watertight manholes. The use of underground joints is allowed only with approval of the Departmental Engineer. The use of unjointed pipes between inspection chambers is mandatory. |
| Welding: | All welding to relevant SANS 10268, SANS 10269, SANS 10270, SANS 1655 and SANS1671 codes. |

ii. Above ground (exposed pipe installations)

| | |
|--------------|---|
| Application: | Dolomite Area Designation (D1, D2, D3 and D4) |
| Pipe: | Steel pipes that comply with the requirements of SANS 62-1, with a pressure class to meet the design requirements and with suitable internal and external corrosion protection and self-anchoring connections. |
| Joints: | Jointing shall be by means of screwed fittings. Screw threads shall be cut as far as possible prior to 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. |
| Protection: | Galvanizing shall be hot dipped heavy-duty to SANS 32 and SANS 121. Protective coatings other than galvanizing shall be specified by the engineer. |

General: No welding will be permitted after galvanizing or application of protective coatings. Cathodic and stray current protection, where required, shall be specified by the engineer.

iii. Below ground - Steel (installations in HDPE sleeves or in watertight manholes)

The requirements shall be the same as for above ground (exposed pipes installations) if in valve boxes and the like. Installations in sleeves require approval from the Department.

4.4.6.4 Sewers and Gravity Drainage Systems

4.4.6.4.1 All manholes, pipes and associated fittings shall be watertight (zero leakage) and shall be tested for watertightness during construction.

4.4.6.4.2 Typical, minimum standard, details for engineering designs are included in PW344, Volume 3. The engineer needs to extend and improve on these drawings to suit the site-specific conditions.

4.4.6.4.3 Sewers and gravity drainage systems (medium pressure pipe types) shall be subjected to hydraulic pipeline testing, applicable to the type of pipe used, the after installation, in accordance with SANS 1200 / SANS 2001-DP2 for the selected pipe class. Refer to Annex P in Volume 2 of PW344/2017 for details of the proposed test methodology.

NOTE: The welding on of purpose made end-cap sections with feed and bleed valves as well as a pressure gauge can be used for this purpose to test welded pipe sections between manholes, prior to welding on of manholes.

4.4.6.4.4 The collection of sewer and waste pipes from multiple adjoining toilets or washbasins shall be surface mounted. These pipes shall feed into a single down pipe draining into the subsurface systems. (refer to Volume 3, drawing Detail TYPE No DT 07/D).

4.4.6.4.5 Depending on available space and height restrictions, the collection of sewer and waste pipes from multiple adjoining toilets or washbasins can also be collected in an appropriately designed watertight concrete manhole adjacent to the building footprint. These pipes shall feed into a single HDPE down pipe draining out of the manhole (refer to Volume 3, drawing Detail TYPE No DT 07-1/D).

4.4.6.4.6 Avoid using rodding and cleaning eyes and rather use small HDPE manholes (multi directional collecting pots) that are premanufactured small size (350mm, 500mm and 700mm diameter) manholes with factory fitted HDPE benching (refer to PW344, Volume 3, drawing Detail TYPE No DT 03/D and DT 05/D). Piping from the manhole to surface level shall consist of HDPE pipes and long radius bends with butt welded connections. All HDPE material to be Type PE 100 as per SANS 4427 and all welding to conform to SANS 10268, SANS 10269, SANS 1269, SANS 10270, SANS 1655 and SANS 1671. Manhole shafts to be structured wall (HDPE material: SANS 4427, Profile, pipe, fittings and pipe endings: SANS: 21138 or SANS 674) or solid wall HDPE pipes with 8,0kN/m² ring stiffness (ISO 9969) or alternatively manufactured to the same strength and material requirements.

4.4.6.4.7 The installation of small diameter manholes (350mm, 500mm and 700mm) close to building must be designed to allow access to the pipes for cleaning operations. The maximum depths of these small diameter manholes measured from the cover level to the crown of the in/outlet pipes are as follows:

| HDPE Manhole Diameter (mm) | Maximum Depth (mm) |
|---------------------------------------|-------------------------------|
| 350 | 450 |
| 500 | 500 |
| 700 | 750 |

- 4.4.6.4.8 Toilet pans shall be provided with an external flexible connection at the junction point to the subsurface sewer system.
- 4.4.6.4.9 Kitchens catering for hostels, military units or other facilities where large quantities of food are prepared, shall have grease traps fitted to the effluent disposal (sewer) pipes. Custom made units are available in the industry. Grease trap systems mainly consist of two types, namely mechanical and biological systems. The mechanical systems have different compartments, where the grease (fat, oils and grease) are separated from the effluent water draining into the sewer system. The accumulated grease has to be removed mechanically at regular intervals to prevent clogging and overflowing of the system. The biological systems also have different compartments, but use micro-organisms to break down the grease before entering the sewer system. It will be the responsibility of the project architect to specify the applicable type and size of grease trap system that will be applicable to the kitchen service. It will be responsibility of the Engineer (Competent Person) to confirm in consultation with the Departmental Dolomite Risk Manager that the grease trap system conforms to the requirements of SANS 1936-3. It will be the responsibility of the user department to enter into a contract with an approved service provider for the maintenance of the grease trap system to ensure that maintenance is performed regularly to ensure the long-term functionality of the system.
- 4.4.6.4.10 The planting of trees or formal gardening within 5m of sewer lines should be avoided where possible.
- 4.4.6.4.11 For auditing purposes, 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 10ℓ/s.)
- 4.4.6.4.12 The preferred materials for above and below ground sewer systems are as follows:
- a) Pipes below ground:
- i. Below ground - HDPE (minimum size 160mm)
- | | |
|-----------------|--|
| Application: | Dolomite Area Designation (D1, D2, D3 and D4) |
| Pipe: | HDPE: Type PE 100 or higher, PN10, SDR 17 to SANS 4427. |
| Supply lengths: | 12m (minimum) |
| Joints: | Butt welded joints (SANS 10268 – Part 1) in general. Electro-fusion welding (SANS 10268 – Part 2) must be approved by Departmental Engineer, where butt welding is impossible. Joints of solid wall pipes with a diameter of 400mm or larger could be improved by means of 300mm wide HDPE collar (to manufacturers specification) fitted over the joint and welded to both pipes. Alternatively, this collar can be factory fitted. |
| Fittings: | Manufactured from HDPE: Type PE 100, PN 10 (or higher, as may be required) to SANS 4427. |
| Welding: | All welding to be butt welding to SANS 10268, SANS 10269, SANS 10270, SANS 1655 and SANS 1671 codes. |
- ii. Below ground to above ground connections - HDPE (minimum size 110mm)
- | | |
|-----------------|--|
| Application: | Dolomite Area Designation (D1, D2, D3 and D4) |
| Pipe: | HDPE: Type PE 100 or higher, PN10, SDR 17 to SANS 4427. |
| Supply lengths: | 12m (minimum) |
| Joints: | Buttwelded joints (SANS 10268 – Part 1) in general. Electro-fusion welding (SANS 10268 – Part 2) must be approved by Departmental Engineer, where butt welding is impossible. |

| | |
|-----------|--|
| Fittings: | Manufactured from HDPE: Type PE 100, PN 10 (or higher, as may be required) to SANS 4427. |
| Welding: | All welding to relevant SANS 10268, SANS 10269, SANS 10270, SANS 1655 and SANS 1671 codes. |

iii. Below ground – Modified poly (vinyl chloride) (PVC-M) – waterpipe for sewer installation in exceptional cases

| | |
|-----------------|---|
| Application: | Dolomite Area Designation D2 and D3 (D4 only if in HDPE sleeves) |
| Pipe: | High impact PVC pipes: modified poly (vinyl chloride) (PVC-M) pipes that comply with the requirements of SANS 966-2 or SANS 1283, with a pressure class of not less than 12. |
| Supply lengths: | 6m or 9m |
| Joints: | Pressed on Spheroidal Graphite Cast Iron (SG) iron or stainless steel Victaulic shoulders. Alternatively, pipes with spigot and socket ends provided with an additional metal locking ring (stainless steel). |

iv. Below ground – Unplasticized poly (vinyl chloride) (PVC-U) (alternative - only if approved by the Department)

| | |
|-----------------|--|
| Application: | Dolomite Area Designation (D1 and D2) and (D3 and D4 only if in HDPE sleeves) |
| Pipe: | Unplasticised poly(vinyl chloride) (PVC-U) pipes that comply with the requirements of SANS 791, (Class 34) |
| Supply lengths: | 6m |
| Joints: | Mechanical devices consisting of sealing rings or grooves (or both) and clamps. Use stainless steel only for metal fittings. |

b) Pipes above ground:

i. Above ground – Unplasticized poly (vinyl chloride) (PVC-U)

| | |
|-----------------|---|
| Application: | Dolomite Area Designation (D1, D2, D3 and D4) |
| Pipe: | Unplasticised poly (vinyl chloride) (PVC-U) pipes that comply with the requirements of SANS 967. |
| Supply lengths: | 6m |
| Joints: | Welded or rubber ring sockets (use Kimberly Sockets above ground to connect to below ground HDPE pipes). |
| Support: | Fix pipes to walls or other designed supports at fixed distances to prevent sagging of pipes or alternatively use galvanised steel pipes for waste water. |

c) Manholes:

i. HDPE manholes:

| | |
|--------------|--|
| Application: | Dolomite Area Designation (D1, D2, D3 and D4) |
| Material: | All material for HDPE manholes to conform to HDPE: Type PE 100 or higher, SANS 4427 specifications and all welding to SANS 10268, SANS 10269, SANS10270, SANS1655 and SANS 1671. Manhole shafts to be structured or solid wall HDPE pipes. |

- Manufacturing: HDPE structured wall pipes used as manhole shafts shall be manufactured according to SANS 21138 or SANS 674 in terms of profile, pipe, fittings and pipe endings, but with stainless steel stiffeners and 5mm minimum wall thickness.
HDPE solid wall pipes used as manhole shafts shall be manufactured according to SANS 4427.
For typical detail refer to Appendix 18 drawing Detail TYPE No DT 04/D, DT 09/D, DT 10/D, DT 11/D, DT 12/D.
- Ring stiffness: Ring stiffness shall be tested according to ISO 9969
i. 8,0kN/m² ring stiffness for all depths,
ii. 4,0kN/m² ring stiffness for depths not exceeding 1,5m and approved by the Department.
- Joints to pipes: HDPE pipes to be extrusion welded to manhole.
- Benching: HDPE (PE100 to SANS 4427) flat sheet and pipe of minimum 12mm thickness.
- Cover slab: The installation of the cover slab must form an integral part of the structure by means of attaching it to the shoulder ring beam with an approved epoxy.

ii. Concrete manholes (if approved by Department):

- Application: Dolomite Area Designation (D1 and D2)
- Design: Design as water retaining structures. (i.e., cast in-situ watertight reinforced concrete manholes)
- Benching: Channels to be the same as the pipe type used. For HDPE pipes the channels shall be welded to the HDPE pipe.
- Joints: HDPE pipes shall be provided with puddle flanges to ensure watertight fixing into walls. For typical detail refer to Appendix 18 drawing Detail TYPE No DT 12/W).
- Cover slab: The installation of the cover slab must form an integrated part of the structure.

4.4.6.4.13 Requirements for HDPE sewer pipes internal burrs (welding bead):

All internal burrs (welding bead) shall be removed from solid wall HDPE pipes with an internal diameter up to 400mm.

- a) purpose made industrial equipment, as proposed and approved by the various pipe manufacturers are to be used for this purpose.
- b) de-burring is to be executed from an upstream direction.
- c) each removed bead must be numbered with the corresponding joint number and kept for the Engineer's inspection.
- d) camera inspection of de-burred joints shall be allowed for as an item in the BOQ.

4.4.6.4.14 Buried sewer pipes shall have a minimum soil cover of:

| | | |
|---|-----------------------|-------------|
| A | Average | 0.75 m |
| B | Outside traffic areas | 0,60m (min) |
| C | Inside traffic areas | 1,0 m (min) |

Protect pipes with appropriately designed concrete slabs where minimum requirements cannot be met or if imposed loads necessitates protection.

4.4.6.4.15 HDPE Pipes used as rising mains (pump installations) shall be similar to HDPE piping as specified above but to the pressure class as required by the specific design.

4.4.6.5 Stormwater Drainage

- 4.4.6.5.1 Stormwater drainage shall comply with the requirements of SANS 1936-3, Section 6.2.4.
- 4.4.6.5.2 Designs must ensure that open drains do not overtop at regular intervals. Overtopping has the same risk as that associated with wet engineering services such as leaking sewer and water pipes.
- 4.4.6.5.3 Typical, minimum standard, details for engineering designs are included in PW344, Volume 3. The engineer needs to extend and improve on these drawings to suit the site-specific conditions.
- 4.4.6.5.4 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.
- 4.4.6.5.5 The velocity of the 1 in 20 year stormwater, flowing along unsurfaced roadways shall not exceed 1,5m/s. Where unsurfaced roads are the sole stormwater system in an interconnected complex/ township, the roadways, which act as major stormwater collectors, shall be surfaced.
- 4.4.6.5.6 Stormwater drainage in general around buildings and up to 10m away shall preferably be kept on the surface. 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 allowed. Canals shall be at slopes of not less than 1:50 for surfaced areas and canals, and 1:20 minimum for unsurfaced areas. The placing of small diameter (300mm) pre-cast concrete stormwater canals next to and parallel to buildings is not recommended. Preferably use 1m or wider v-shaped concrete drains. Joints between structures and canals to be sealed similarly as for canal expansion joints. Steel reinforcement (if applicable) shall be continuous over joints to preclude horizontal displacement.
- 4.4.6.5.7 All stormwater from downpipes and gutters from buildings and structures shall discharge into concrete lined channels.
- 4.4.6.5.8 Paving that is 2m wide with a minimum slope of 1:20 shall be provided around all buildings and structures with no gutters. Joints between such paving and the building or structure, as well as any joints to control shrinkage/expansion shall be suitably sealed.
- 4.4.6.5.9 All brick paving and concrete paving shall incorporate a 250 micron HDPE lining with vulcanized joints.
- 4.4.6.5.10 Joints in box culverts etc. shall be watertight.
- 4.4.6.5.11 Inlet grids to subsurface systems shall preferably be locked and not allow the passing of any item larger than 40mm in diameter.
- 4.4.6.5.12 The preferred materials for stormwater systems are as follows:
- a) Pipes:
- i. Solid wall HDPE (minimum internal diameter 450mm)
- | | |
|-----------------|---|
| Application: | Dolomite Area Designation (D1, D2, D3 and D4) |
| Pipe: | HDPE: Type PE 100 or higher, PN10, SDR 17 to SANS 4427. |
| Supply lengths: | 12m (minimum) |
| Joints: | Buttwelded joints (SANS 10268 – Part 1) in general. Electro-fusion welding (SANS 10268 – Part 2) must be approved by Departmental Engineer, where butt welding is impossible. Joints of solid wall pipes with a diameter of 400mm or larger could be improved by means of 300mm wide HDPE collar (to manufacturers specification) fitted over the joint and welded to both pipes. Alternatively, this collar can be factory fitted. |

| | |
|-----------|---|
| Fittings: | Manufactured from HDPE: Type PE 100, PN 10 (or higher, as may be required) to SANS 4427. |
| Welding: | All welding to relevant SANS 10268, SANS 10269, SANS 10270, SANS 1655 and SANS 1671 codes. |
| Strength: | Joints shall have the same tensile strength in the longitudinal direction as the pipe section itself. |

ii. Structured wall HDPE (minimum internal diameter 450 mm)

| | |
|-----------------|--|
| Application: | Dolomite Area Designation (D1, D2, D3 and D4) |
| Material: | All material for HDPE manholes to conform to HDPE: Type PE 100 or higher, SANS 4427 specifications |
| Manufacturing: | HDPE structured wall pipes used as manhole shafts shall be manufactured according to SANS: 21138 or SANS 674 in terms of profile, pipe, fittings and pipe endings, but with stainless steel stiffeners and 5mm minimum wall thickness. |
| Ring stiffness: | Ring stiffness shall be tested according to ISO 9969 iii. 8,0kN/m ² ring stiffness for all depths, iv. 4,0kN/m ² ring stiffness for depths not exceeding 1,5m and approved by the Department. |
| Supply lengths: | 12m (minimum) |
| Joints: | Electro-fusion welding or hot gas extrusion welding (SANS 10268). Joints of pipes with a diameter of 400mm or larger could be improved by means of 300mm wide HDPE collar (to manufacturers specification) fitted over the joint and welded to both pipes. Alternatively, this collar can be factory fitted. The use of long-sleeve spigot and socket joints with rubber rings and welding are to be approved by Department. |
| Fittings: | Manufactured from HDPE: Type PE 100, PN 10 (or higher, as may be required) to SANS 4427. |
| Welding: | All welding to relevant SANS 10268, SANS 10269, SANS 10270, SANS 1655 and SANS 1671 codes. |
| Strength: | Joints shall have the same tensile strength in the longitudinal direction as the pipe section itself. |

iii. Unplasticized poly (vinyl chloride) (PVC-U) (alternative - only if approved by the Department)

| | |
|-----------------|--|
| Application: | Dolomite Area Designation (D1 and D2) and (D3 and D4 only if approved by the department) |
| Pipe: | Unplasticised poly (vinyl chloride) (PVC-U) pipes that comply with the requirements of SANS 791, (Class 34) |
| Supply lengths: | 6m |
| Joints: | Mechanical devices consisting of sealing rings or grooves (or both) and clamps. Use stainless steel only for metal fittings. |

iv. Concrete (alternative - only if approved by the Department)

| | |
|-----------------|--|
| Application: | Dolomite Area Designation (D1) |
| Pipe: | Non-pressure, Type SC, pipes that comply with the requirements SANS 677. |
| Supply lengths: | As available. |
| Joints: | Spigot and socket with sliding rubber joints. |

Bedding: Bedding conditions must ensure that the angular deflection tolerances are not exceeded as a result of consolidation settlement.

b) Manholes:

i. HDPE manholes:

Application: Dolomite Area Designation (D1, D2, D3 and D4)

Material: All material for HDPE manholes to conform to HDPE: Type PE 100, SANS 4427 specifications and all welding to SANS 10268, SANS 10269, SANS10270, SANS1655 and SANS 1671. Manhole shafts to be structured or solid wall HDPE pipes.

Manufacturing: HDPE structured wall pipes used as manhole shafts shall be manufactured according to SANS: 21138 or SANS 674 in terms of profile, pipe, fittings and pipe endings, but with stainless steel stiffeners and 5mm minimum wall thickness

HDPE solid wall pipes used as manhole shafts shall be manufactured according to SANS 4427.

For typical detail refer to Volume 3, drawing Detail TYPE No DT 04/D, DT 09/D, DT 10/D, DT 11/D, DT 12/D

Ring stiffness: Ring stiffness shall be tested according to ISO 9969
i. 8,0kN/m² ring stiffness for all depths,
ii. 4,0kN/m² ring stiffness for depths not exceeding 1,5m and approved by the Department.

Joints to pipes: HDPE pipes to be welded to manhole.

Benching: HDPE flat sheet and pipe of minimum 12mm thickness.

Cover slab: The installation of the cover slab must form an integrated part of the structure by means of attaching it to the shoulder ring beam with an approved epoxy or cement slurry.

ii. Concrete manholes (if approved by Department):

Application: Dolomite Area Designation (D1, D2, D3 and D4)

Design: Design as water retaining structures. (i.e., cast in-situ watertight reinforced concrete manholes).

Benching: If required Channels to be the same as the pipe type used. For HDPE pipes the channels shall be welded to the HDPE pipe.

Joints: HDPE pipes shall be provided with puddle flanges to ensure watertight fixing into walls. For typical detail refer to Volume 3, drawing Detail TYPE No DT 12/W

Cover slab: The installation of the cover slab must form an integrated part of the structure.

Note: As result of a lack of appropriate welders, ultra violet protection properties and or the physical properties of certain pipes the Department does not approve the use of;

- i. Polypropylene pipes (PP) which comply with the requirements of SANS 8773,
- ii. Unplasticised poly (vinyl chloride) (PVC-U) structured wall pipes which comply with the requirements of SANS 1601.

4.4.6.5.13 Always join different pipe types with a manhole.

4.4.6.5.14 Buried stormwater pipes (except concrete or steel) shall have a minimum soil cover of:

| | | |
|---|-----------------------|-------------|
| a | Average | 0,75m |
| b | Outside traffic areas | 0,60m (min) |
| c | Inside traffic areas | 1,0m (min) |

Protect pipes with appropriately designed concrete slabs where minimum requirements cannot be met or if imposed loads necessitates protection.

4.4.6.6 Dry Engineering Services

4.4.6.6.1 The placement and routing of dry engineering services that provide connectivity to substations or mini-substations must ensure that the placement of such substations can be allowed in terms of the provisions for structures and buildings as prescribed in SANS 1936-1 in terms of the Dolomite Area Designation.

4.4.6.6.2 Underground dry engineering service or dry engineering service sleeves shall in all respects comply with the requirements of the installation of a sewer system.

4.4.6.6.3 Sleeve and draw box systems for typical bundled electrical and communication cables shall be watertight, flexible and meet the requirements of a sewer system (as described in this document). No water shall enter or drain from the dry service system.

4.4.6.6.4 Dry engineering services pipes, sleeves or conduits (medium pressure pipe types) shall be subjected to hydraulic pipeline testing, after installation, as specified in SANS 1200 / SANS 2001-DP2 for the selected pipe type irrespective of application.

4.4.6.6.5 Dry engineering services should (where possible) not be placed parallel to buildings unless they are at least 5m away (if stand size allows) from the structure. Single direct connections to buildings are preferred.

4.4.6.6.6 The use of non-cohesive, single size, graded sand or crusher sand for bedding, surround blankets and backfilling of services not placed in sleeves are not permitted.

4.4.6.6.7 All sleeve systems must be constructed to designed slopes that permit drainage to predetermined inspection manholes that will:

- a) allow gravity based drainage into formal stormwater drainage systems.
- b) be fitted with automatic pumping systems (where required) that will discharge drainage into formal stormwater drainage systems.

4.5 Additional Precautionary Measures for Wet Engineering Services in Dolomite Area Designation D3 Sites

The wet engineering services in Dolomite Area Designation D3 shall comply with SANS 1936-3, Section 6.4, as well as the following requirements, in addition to those in 4.4:

4.5.1 Use only HDPE piping for water (Class PN 12,5 and higher), sewer (Class PN 10 minimum) and stormwater (solid wall: Class PN10 minimum or structured wall: 8kN/m² ring stiffness, stainless steel stiffeners and 5mm minimum wall thickness). The use of welded HDPE piping systems for water, sewer and stormwater is mandatory as the material is more tolerant of movement.

4.5.2 The above ground mounting of galvanised steel water reticulation pipes on pedestals is preferred. (Alternative materials only to be used if approved by the Department).

4.5.3 All material for HDPE pipes, structures and fittings must be in accordance with SANS 4427 for type PE 100, or higher, with butt-welded joints and manufactured in accordance with SANS 10268, SANS 10269, SANS 10270, SANS 1655 and SANS 1671 codes.

- 4.5.4** All HDPE pipe joints to be butt-welded, unless the joint is installed for future dismantling. Such joints are to be installed in water retaining structures that can be inspected.
- 4.6 Additional Precautionary Measures for Wet Engineering Services in Dolomite Area Designation D4 Sites**
- 4.6.1** Liquid bearing and dry engineering services must be placed above ground or where not feasible, and so allowed by the Competent Person (geo-professional), in ducts or sleeves. As a minimum sleeves shall be provided within 15m of a building or structure and the Competent Person (geo-professional) shall specify the minimum required distances of sleeved services in relation to other non-liquid bearing infrastructure.
- 4.6.2** Sleeves are to be provided with inspection chambers at both ends and must comply with the requirements of a sewer system for areas with a D3 Dolomite Area Designation. All sleeve systems must be constructed to designed slopes that permit drainage to predetermined appropriately designed drainage systems.
- 4.6.3** The specific requirements for sleeving of sewer systems shall be determined by the Competent Person (geo-professional) in collaboration with the Competent Person (engineer)
- 4.7 Design and Construction of Infrastructure**
- 4.7.1 General**
- The design and construction of infrastructure on dolomite designation D3 sites shall comply with the requirements of SANS 1936-3, Section 7.
- 4.7.2 Runways for Aircraft**
- Runways for aircraft shall comply with the requirements of SANS 1936-3, Section 7.2.
- 4.7.3 Swimming Pools and Liquid Retaining Structures**
- 4.7.3.1** Swimming pools and liquid retaining structures shall comply with the requirements of SANS 1936, Section 9.
- 4.7.3.2** Swimming pools and liquid-retaining structures shall be surrounded by a sloped, impervious paving of a width:
- domestic swimming pools (3m);
 - non-domestic swimming pools (5m);
 - liquid retaining structures (3m).
- All waste or drainpipes should release water in a suitably designed stormwater system or alternatively 30m from the structure on the topographical down slope. The releasing of water down slope shall not impact on the property or any adjacent property.
- 4.7.3.3** Earthworks around domestic swimming pools shall be sloped and compacted to a slope not flatter than 1:30 for a distance of not less than 5m away from the outer perimeter of such structures. The earthworks shall be sloped in such a manner that water does not drain directly towards the foundations of adjacent buildings. The area between the swimming pool and adjacent structures and buildings shall be shaped in such a manner that water drains away from both the swimming pool and the structure or building.
- 4.7.3.4** No swimming pool shall have an automatic water replenishment system.

4.7.3.5 The position for emergency potable water or fire water storage tanks less than 15 000 litres for small developments (i.e. Police Stations, Magistrate Court, etc.) may only be erected on a location specifically indicated by the Competent Person (geo-professional).

Free-standing reservoirs (on ground or elevated) shall be placed on foundations that meet the loss of support under foundation criteria as indicated by the Competent Person (geo-professional).

NOTE: Meeting the criteria for loss of support under foundations may in some cases lead to an extensive foundation footprint size to meet the design criteria. A footprint dolomite stability investigation shall be conducted on:

- a) the viability of a foundation with beams supported on rock outcrop and/or piling to solid rock;
- b) the viability that the reservoir forms part of the building structure provided foundation and structural designs are adapted to ensure stability in the event of ground movement.

4.7.3.6 Washbays

4.7.3.6.1 Washbays constructed for residential and commercial use must be constructed as water retaining structures and if possible not be incorporated within the structures and buildings of the main development of the property.

4.7.3.6.2 Only washbay effluent that complies with legal requirements may be discharged into the stormwater system. Any contaminated water must be disposed of in a legally acceptable manner.

4.7.3.6.3 The washbay must be provided with appropriately designed grease, debris and or mud traps.

4.7.3.6.4 Drainage systems associated with washbays shall be designed to the requirements of a sewer system as prescribed in PW344/2017.

4.7.3.6.5 NOTE: Preferably the washbay and collector system shall be a continuously cast water retaining concrete structure. Joints, if required, shall be provided with slip lined dowels that will ensure that no vertical displacement takes place. Alternatively, steel reinforcement will be continuous over the joint.

4.7.3.7 Attenuation and retention ponds

The placement/location of attenuation ponds shall be in accordance with the determinations of Chapter 2 and 3 of PW344/2017. The Competent Person (geo-professional) shall state specific design and precautionary requirements deemed necessary for the construction of attenuation ponds.

The design submitted to the Department by the Competent Person (engineer) shall be pre-approved by the Competent Person (geo-professional) in terms of:

- a) maximum level of water to be retained in terms of the design flood and the land that would be subject to flooding;
- b) earthworks preparations to create the basin and in particular the removal of in situ material blanketing the area;
- c) the permeability specification and thickness of any basin layer to be imported to reduce permeability;
- d) precautionary measures to be implemented to ensure that the basin layers that were constructed to reduce imperviousness is not damaged by future activities within or surrounding the attenuation area;
- e) the retaining walls required, method of construction and the specific Dolomite Stability Investigations that may be required prior to design;
- f) the demarcation of land to be registered as the servitude area for the attenuation pond and the allowance on the periphery as determined by the Competent Person (geo-professional);
- g) down slope impact in the event of overflowing and a catastrophic collapse of the attenuation pond wall;

- h) future Dolomite Risk Management plan.

Layout drawings of attenuation ponds shall specifically demarcate:

- a) cadastral information that shows the specific land portion on which the attenuation pond is to be constructed as well as those of the surrounding land and servitudes or rights of way that may traverse the property(s). The data shall include a verification of the ownership of all land portions, as well as any requirements as lodged within town planning schemes, Title Deeds or development planning allowed by the local authority (alternatively planning allowed by Department if not within jurisdiction of a local authority);
- b) building lines applicable to property as well as adjacent land;
- c) dolomite Hazard Zonation;
- d) topo cadastral data and the demarcation of all defined drainage patterns within the entire catchment area;
- e) maximum water level;
- f) impact on down slope properties in the event of a catastrophic collapse of the attenuation pond wall.

Note: Linings might be necessary to prevent leakage in attenuation and retention ponds for stormwater management, artificial lakes, slimes dams and waste disposal facilities.

4.7.3.8 Fuel Installations

The design of all fuel installations must comply with the general requirements for a wet service and shall be subject to close collaboration between the Department, Competent Person (geo-professional) and the Competent Person (engineering). The following basic design principals must be applied.

- a) the location of fuel tanks must be placed on the lowest hazard portion of the site. The location must be approved by the Competent Person (geo-professional) prior to any detailed development plan;
- b) the structural design of fuel tanks and bunkers shall be the same as for any other structure;
- c) the structure shall preferably be placed on rock (not floaters) or on piles imbedded in solid rock to ensure complete stability in the event of ground movement. The Competent Person (engineer) must liaise and obtain consensus with the Competent Person (geo-professional) regarding the structural foundation design;
- d) all fuel lines shall be designed to span, without compromising the structural or liquid conveying integrity, the largest potential ground movement event as reported in the Dolomite Stability Investigation;
- e) special care is to be taken of the design of backfilling material that covers underground pipes; designs must provide for the collapsing of overburdened soil without dragging the pipe down;
- f) antistatic design measures are to be incorporated to ensure no electrical friction sparks are generated in the event of structural or pipe movement as result of ground movement;
- g) the design shall in detail provide for the prevention of any environmental hazard in the event of ground movement events. Containment areas in the event of a fuel spill shall not compromise surrounding development;
- h) the maintenance procedure and Site Risk Management Plan (refer to Chapter 5) for the entire installation must provide detailed standard operational procedures to be implemented in the event of ground movement.

4.7.3.9 Additional precautionary measures in Dolomite Area Designation D3 sites

In Dolomite Area Designation D3 areas fuel installations shall comply with the requirements, in 4.7.3.8 and shall as far as is practicable, be above ground.

4.7.3.10 Sport fields, parade-grounds and large open grassed areas

4.7.3.10.1 Sport fields, and in particular, the long-term development thereof, needs to be described and commented on in the original Dolomite Stability Investigation. From the inception phase, all sport fields must be developed with a specific prescribed long term approved development plan as dictated by the Dolomite Stability Investigation.

4.7.3.10.2 The Dolomite Stability Investigation (DSI) must report on the availability of sufficient land for the development of all current and potential future facilities (engineering services, infrastructure, buildings, parking areas, etc.). DSI for sport fields shall demarcate specifically the geotechnical investigated and approved areas for potential future facilities and in particular, pavilions, clubhouses, ablutions, general facilities, change rooms, maintenance stores.

4.7.3.11 Additional precautionary measures on Dolomite Area Designation D3 sites

4.7.3.11.1 Grassed areas of sport fields shall not be supplied with subsurface irrigation or drainage systems.

4.7.3.12 Parking areas and stockyards

4.7.3.12.1 Parking areas and stockyards, and in particular, the long-term development thereof, needs to be described and commented on in the original Dolomite Stability Investigation (DSI). From the inception phase, all parking areas and stockyards must be developed with a specific prescribed long-term approved development plan as dictated by the DSI.

4.7.3.12.2 All parking areas and stockyards (paved/unpaved, formal/informal) that are to be used on a continuous or semi continuous basis shall be designed to ensure free drainage.

4.7.3.12.3 The DSI must report on the availability of sufficient land for the development of all current and potential future facilities (engineering services, infrastructure, buildings, etc.).

4.7.3.12.4 The DSI for parking areas and stockyards shall demarcate specifically the geotechnical investigated and approved areas for potential future facilities.

4.7.3.13 Additional precautionary measures in Dolomite Area Designation D3 sites

4.7.3.13.1 The subgrade (completed earthworks within a road prism before the construction of any subbase, base and surfacing) of parking areas and stockyards as well as associated access roads on Dolomite Area Designation D3 sites shall, if required by the Competent Person (geo-professional) be excavated and compacted to improve soil stability or to create structural arching by means of soil mattresses. Alternatively, subsurface conditions shall be improved by means of dynamic compaction or grouting, taking due cognizance of the presence of buildings, services, etc., as may be required.

4.7.3.14 Fences

4.7.3.14.1 A fence constructed of any material type shall permit free drainage of stormwater.

4.7.3.14.2 The earthworks on either side of a fence must allow for the regular clearing of vegetation to an acceptable level to prevent debris build-up as result of stormwater.

4.7.3.14.3 Appropriate earthworks on either side of the fence shall be designed to prevent erosion/undermining of the strip foundation and/or stub columns of all fence poles and other elements that require foundation works.

4.7.3.14.4 Concentrated stormwater outlets shall all be designed in accordance with the written agreements of adjacent landowners.

4.7.3.14.5 All outlet grids shall be designed to be self-cleaning (prevent build-up of debris).

4.7.3.14.6 The capacity of all stormwater outlets shall be designed to ensure that stormwater is removed from site as per the required runoff period prescribed by the engineer for the development.

4.7.3.14.7 The fence design shall incorporate design measures to prevent a catastrophic collapse in the event of minor settlements on the fence route (500mm settlement over 6m).

4.7.3.15 *Additional precautionary measures on Dolomite Area Designation D3 sites*

4.7.3.15.1 The design and construction of fences shall be such that, in the event of a sinkhole having the maximum diameter of surface manifestation indicated in the geotechnical report prepared in accordance with the requirements of Chapter 3 occurring within or adjacent to its footprint, shall not compromise other infrastructure, structures and buildings or cause leaking of the services it contains, nor shall it endanger public safety.

4.7.3.15.2 The designs of composite premanufactured palisade type fencing shall meet the requirements as stated above. The designs must incorporate measures that will prevent dislodging sections of the fence in the event of a sinkhole forming.

4.7.3.16 *Service ducts*

The construction of multi-purpose services ducts need to incorporate measures that:

- a) prevent the ingress of water and/or other liquids;
- b) include features that can contain any spillage from an environmental aspect;
- c) are equipped with a drainage system that will drain the entire duct in the event of an accidental spillage;
- d) the drainage system in the duct shall drain into an appropriately designed drainage system;
- e) the provision of drainage pumps (if required);
- f) preferably the installation of services is from top to bottom in the following order:
 - i. electricity (top);
 - ii. potable water;
 - iii. sewerage (bottom - provided that the required slopes are met).

4.7.4 Design and Construction of Buildings and Structures on D2 and D3 Sites

4.7.4.1 *General*

4.7.4.1.1 All buildings and structures shall be designed and constructed in accordance with the relevant requirements of

- a) SANS 10400-B and SANS 10400-H, in as much as these standards are applicable;
- b) international or national standards where such standards exist; or
- c) suitable codes of practice or other such technical documents.

4.7.4.1.2 The ground immediately against buildings shall be shaped to fall in excess of 3% over the first 3m beyond the perimeter of the buildings, from where it will drain freely away from the structures. Apron slabs, where provided, shall have the same fall.

4.7.4.1.3 Courtyards that necessitate subfloor level drainage systems should be avoided and all courtyards or spaces less than 4m between structures shall be paved and appropriately drained.

4.7.4.1.4 Ensure backfilling around foundations and foundation walls of buildings and structures are properly backfilled with suitable material that will, except in rock, not be more permeable than the surrounding material.

The backfilling to foundations and foundation walls shall:

- a) Not include building rubble or coarse aggregate exceeding 63mm in diameter;
- b) General minimum compaction standard to be 93% of Mod. AASHTO MDD at OMC, provided permeability requirements are met;
- c) Where foundation excavation material is utilized for backfill materials, the materials shall have PI<15% and be compacted to at least 93% of Mod. AASHTO MDD at OMC or the

density of the in situ soil, whichever is higher;

- d) Where imported materials are used backfill materials, laboratory permeability and density tests shall be conducted on both the in situ 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% of Mod. AASHTO MDD at OMC;
- e) The use of non-cohesive single size graded sand or crusher sand for backfill shall not be allowed.

4.7.4.1.5 Termite, ant and vegetation poisoning shall be introduced around all structures. Soil poisoning shall be in accordance with the recommendation of SANS 10124.

4.7.4.1.6 Floors within buildings that are frequently subjected to flooding and/or excessive water spillage (i.e. kitchens, showers and shower compartments, bathrooms, laundry rooms etc.) must be designed as a water retaining slab. The periphery of such a slab shall incorporate a sidewall of height that will ensure that all spillages are contained within the particular floor area (minimum height 100mm). The wall is to be cast monolithically with the floor. The floor shall be at a slope that will ensure free drainage of the entire floor into a collector system (channel, catch pit etc.) that discharges into the appropriate drainage system. Particular attention is to be given to this requirement if the floor of the building is designed as part of a raft foundation. No wet engineering services may be placed below the floor level and wet services penetrating the ground floor slab, shall be avoided at all cost. All such services shall be placed in watertight ducts that drain into an appropriate drainage system and the ducts shall allow inspections to detect leakages.

4.7.4.1.7 Urinals may not be constructed from brick, tile or prefabricated sections. The entire urinal must be a complete watertight stainless steel unit with welded joints forming the drainage trough.

4.7.4.1.8 It is a particular requirement that all airconditioning, or similar plants, that produce a continuous condensation, are fitted with watertight ducting that discharges into an appropriate stormwater system. This requirement is to be enforced even if the condensate is of limited quantities.

4.7.4.1.9 Overflow or pressure relief systems on the water supply network and on geysers and the like shall be fitted with overflow pipes and pressure relieve valves shall be fitted with watertight ducting that discharge into an appropriate stormwater system.

4.7.4.1.10 The upgrading of existing buildings shall meet dolomite compliant requirements (refer to DSC for generic specifications).

4.7.5 Special Design for Places of Detention

In addition to the normal requirements pertaining to buildings and structures, the following shall apply to places of mandatory and/or voluntary detention.

4.7.5.1 General

4.7.5.1.1 The placing of such facilities must be on the lowest Dolomite Hazard portion of the site.

4.7.5.1.2 Deformation of the foundation or any element of the structure may not lead to the collapse of any internal wall or roof element of the facility.

4.7.5.1.3 Any structure, building or infrastructure that may affect the detention facility in the event of a sinkhole or subsidence shall conform to the same standards as applicable to the detention facility.

4.7.5.1.4 The Departmental Dolomite Risk Manager must receive written approval from the Competent Person (geo-professional) and Competent Person (engineer) that the final placing and design of all elements of the structural design is compliant to PW344/2017.

4.7.6 Design of Buildings and Structures with Floors subject to vibrating loads

Buildings that contain equipment that may impose excessive vibrating loads must be subject to specific comment by the Competent Person (geo-professional) regarding the permissible ground vibrations.

4.7.7 Temporary buildings and structures (other than those required for construction purposes)

Temporary buildings and structures (inclusive of tented housing for residential purposes) shall be classified in terms of their function as allowed for in the National Building Regulations and be erected on land with a specific Permissible land usage provided for in terms of SANS 1936-1, Table 2.

The Departmental Dolomite Risk Manager shall determine whether a Dolomite Stability Investigation is required prior to the erection of temporary buildings. These procedures may include:

- a) a Dolomite Stability Investigation according to the provisions of SANS 1936-1,2;
- b) advice from a Competent Person (geo-professional) based on available technical information.

Temporary buildings shall only be allowed if the time of usage is pre-determined, communicated with and approved by the Departmental Dolomite Risk Manager. The Departmental Dolomite Risk Manager shall provide a report detailing the Permissible Land Usage and the Dolomite Area Designation applicable for such temporary development as well as the permissible occupation duration.

Earthworks and general site preparation as well as wet and dry engineering services shall be placed as far as possible above ground. Services that require subsurface installation as well as stormwater drainage shall comply with the requirements of PW344/2017. The provision of kitchen, laundry and ablution facilities shall only be allowed in an area specifically approved by the Competent Person (geo-professional) and sanctioned by the Departmental Dolomite Risk Manager (DRM).

Temporary buildings and structures shall not be used for purposes other than originally approved or periods longer than allowed for by the DRM.

4.7.8 Additional precautionary measures for design and construction of buildings and structures in Dolomite Area Designation D3 sites

The requirements as stated in SANS 1936-3, Section 8.2, shall be complied with.

4.7.9 Additional precautionary measures for design and construction of buildings and structures in Dolomite Area Designation D4 sites

4.7.9.1 *General*

Normal precautionary measures cannot reduce the development risk to acceptable limits. Land that falls in this Dolomite Area Designation should normally not be considered for development.

Development of individual sites only may be considered under the conditions as prescribed in SANS 1936-1. The same shall apply to upgrading projects of sites previously developed on sites classified as D4 in terms of Chapters 2 and 3.

4.7.9.2 *Water reticulation*

All water pipes, of 160mm diameter and smaller, traversing land having a Dolomite Area Designation D4, must be placed in welded HDPE sleeve pipes that terminate in HDPE manholes. Sleeve pipes shall be HDPE Type PE 100 Class PN 10. Alternatively, concrete manholes may be used, provided that sleeve pipes are appropriately tied into the walls and the structure is designed as a water retaining structure. The use of concrete manholes is to be approved by the Departmental Dolomite Risk Manager. The floor and roof construction joints must be appropriately sealed with a membrane and sealant as approved by the Department. All jointing details shall be specifically indicated on drawings.

Chapter 5: Risk Management

5.1 Introduction

SANS 1936-4 establishes requirements for the development of appropriate dolomite risk management systems to reduce the risks associated with developments and infrastructure on dolomite.

5.2 Requirements for Risk Management

5.2.1 Generic Requirements

The requirements as stipulated in SANS 1936-4, Section 5.2.1 shall be adhered to. Note that where reference is made in SANS 1936-4 to “the organization” read as “the Department of Public Works” and “accounting officer or accounting authority” shall refer to “Departmental Dolomite Risk Manager”. The following additional requirements shall be applicable.

5.2.1.1 *General*

5.2.1.1.1 Dolomite Risk Management can take place at three levels, namely:

- a) Departmental level;
- b) bulk service provider, utility organization and Government Department level; or
- c) individual development level.

The principles of dolomite risk management are essentially the same at all three levels, however specifics may differ. For example the Department is responsible for development planning and policies, whereas bulk service providers, such as waterboards, mainly consider the impact of their assets within their reserve on surrounding landowners and vice versa and homeowners are responsible for the maintenance and monitoring of their individual properties.

5.2.1.1.2 Risk Evaluation Criteria

The risk evaluation criteria shall include at least the following:

- a) the number of incidences of failure to comply with the requirements of the dolomite risk management strategy;
- b) the occurrence of sinkholes and subsidences on the dolomite land covered by the dolomite risk management strategy.

5.2.1.2 *Measures for mitigating risk – new development*

5.2.1.2.1 The requirements stipulated in SANS 1936-4, Section 4.2.2 shall apply.

5.2.1.3 *Measures for mitigating risk – existing development*

5.2.1.3.1 Risk management strategies shall incorporate steps to mitigate risk until upgrading compliant with SANS 1936 and PW344/2017 can be executed.

5.2.1.3.2 The requirements stated in 5.2.1.2 shall also apply to existing development.

- 5.2.1.3.3 All wet and dry engineering services not compliant with SANS 1936 and PW344/2017 must be subject to a detailed maintenance and monitoring program similar to that for new developments.
- 5.2.1.3.4 The responsibility for maintenance and monitoring is the sole responsibility of the Department as the registered landowner. The Department may delegate, but not cede any of these responsibilities to any person that occupies the land.
- 5.2.1.3.5 Maintenance planning and monitoring shall at all times be supported by:
- a) complete set of as-build drawings;
 - b) documentation of parts of the development that do not comply with SANS 1936 and PW344/2017;
 - c) special instructions to ensure that the maintenance report shall be effective until such date when the originally constructed infrastructure is altered to be compliant with SANS 1936 and PW344/2017;
 - d) the inclusion of previous maintenance reports;
 - e) specific instructions deemed to satisfy the scope of maintenance that will insure appropriate risk management is applied at all times;
 - f) all specific requirements regarding the appropriate materials and maintenance elements to form part of the maintenance plan;
 - g) all wet engineering services not compliant with SANS 1936 and PW344/2017 must be subject to an emergency reaction plan to ensure that serviceability of infrastructure will not compromise stability. Such reaction plan shall be based on specific response times for the type of service, and the potential volume of leakage as a result of failure of the service.

5.2.1.4 *Emergency Reaction*

The requirements of SANS 1936-4, Section 4.2.3 shall apply.

- 5.2.1.4.1 From a legal and safety perspective, the Department should develop and adopt a standardised, formalised Emergency Reaction Plan. This plan should be fully understood by emergency services active in the various regions, by Departmental and User Department officials involved in those areas and by base commanders, court officials, Police Station Commanders, Prison Officials, etc. This plan should briefly advise on:
- a) the identification of incipient sinkholes/subsidences;
 - b) how to detect whether a process of catastrophic ground movement is underway;
 - c) the potential extent of the problem;
 - d) area to evacuate/seal off;
 - e) emergency contact numbers;
 - f) designated officials, etc.

- 5.2.1.4.2 The development of this emergency reaction plan shall be formalised in collaboration with the Departmental Dolomite Risk Manager.

5.2.1.5 *Ground Hazard Incident Reporting (GHIR)*

- 5.2.1.5.1 Within a dolomitic area, the events as described below constitute a hazard and must be reported immediately to the Departmental Dolomite Risk Manager.

- 5.2.1.5.2 In an area where sinkholes and subsidences are triggered as result of ingress water, the following must be reported:

- a) any cracks in buildings (irrespective of size);
- b) any cracks in floor slabs;
- c) any cracks in paving or apron slabs;

- d) any cracks in the ground, especially those that are circular in nature;
 - e) any form of a hole in the ground;
 - f) any form of cracking, settlement or relative movement in canals paving slabs etc.;
 - g) any burst water pipes;
 - h) any overflowing or blocked sewer or stormwater systems;
 - i) any unnatural wet patches;
 - j) any ponding of stormwater;
 - k) any form of movement of any structure of facility;
 - l) sinkholes;
 - m) any form of ground settlement and or subsidence.
- 5.2.1.5.3 In areas of dewatering, the above shall apply as well as any form of lowering of the water table for the particular region.
- 5.2.1.5.4 The installation of boreholes for water abstraction in any of the two area types as described above constitutes a hazard unless approved by the Departmental Dolomite Risk Management.
- 5.2.1.5.5 The applicable Ground Hazard Incident Report according to Annex I should be used for reporting a Ground Hazard Incident to the Departmental Dolomite Risk Manager. Any accompanying photographic reference of ground hazards must show the date and time on photographs if in digital format. Printed photos shall be supplied with the same data. Ground Hazard Incident Reports and comments on the Emergency Events (EE) shall include but are not limited to:
- a) recording of the event (accurate position and dimensions);
 - b) general strike and or direction of sinkhole throat;
 - c) infrastructure damaged;
 - d) wet and dry services that traverses the location (damaged or still serviceable);
 - e) evidence of overflowing stormwater canals;
 - f) site features, such as stormwater drainage;
 - g) method of safeguarding applied or to be applied as well as applicable safety margins.
- 5.2.1.5.6 Any sudden structural movement, cracking, or ground movement must be treated as an Emergency Event (EE).
- 5.2.1.5.7 A building showing sudden cracks or movement must be evacuated temporarily until the Departmental Dolomite Risk Manager is informed and an inspection by a Competent Person (geo-professional/engineer) is conducted. Any such evacuation order (other than those issued by the Departmental Dolomite Risk Manager) must be communicated as a matter of urgency, with the Departmental Dolomite Risk Manager or the Regional person appointed as the single point of responsibility for dolomite related matters. Evacuation orders confirmed or approved by the Departmental Dolomite Risk Manager must be implemented by the official/responsible person receiving such orders. Any failure on the part of the Client Department/ official/responsible person to react must be reported to the Departmental Dolomite Risk Manager.
- 5.2.1.5.8 All areas of ground subsidence and sinkholes must be temporarily cordoned off as soon as it is noticed and preferably visible warning signs must also be posted until inspected by a Competent Person (geo-professional). The temporary demarcated area should be a distance away from the sinkhole perimeter which is not less than the depth of the sinkhole.
- 5.2.1.5.9 Any report that reflects the above must be forwarded to the Departmental Dolomite Risk Manager who will instruct the appropriate emergency reactions and required further investigations and procedures to be followed. Should the Dolomite Risk Manager declare the event an Emergency Event, then an emergency event incident report needs to be submitted within the time frames allowed (normally 1 hour). Emergency Events (EE) that could affect public safety must be inspected by a Competent Person (geo-professional/engineer) within the time as instructed by Departmental Dolomite Risk Manager. Officials and private individuals acting for or on behalf of the Department must

by means of contractual agreements be forced to respond to any report of a sinkhole or subsidence within the required timeframe.

5.2.1.5.10 Emergency reaction required in the event of a sinkhole or subsidence may include an assessment of potential emergency repairs to wet engineering services that were the primary cause of the event or was damaged as result of the event. Officials of the Department as well as other appointed/contracted service providers/consultants shall make due allowances in all upgrading, maintenance and Capital Works Documentation to deal with emergency repair work that may include but are not limited to:

- a) emergency water pipe bursts;
- b) replacement of defective valves;
- c) repacking leaking valves;
- d) replacing leaking valves;
- e) cleaning sewer pipes;
- f) replacing sections of sewer pipe;
- g) replacement of damaged manholes;
- h) replacement of defective toilets, washbasins and urinals;
- i) opening blocked stormwater pipes;
- j) cleaning and sealing stormwater canals;
- k) replacement of damaged canal sections;
- l) repair of sinkholes and subsidences;
- m) emergency barricading of areas of ground settlement with steel fencing;
- n) erection of notice boards (steel) that indicates sinkholes or area of danger.

5.2.1.5.11 Any Ground Hazard Incident and emergency repairs executed shall be monitored to ensure that the potential further instability does not compromise surrounding development and that emergency repairs were executed in an appropriate manner. Such monitoring reports must include a recommendation whether emergency repairs are to be replaced with permanent diversion or re-routing of services as may be required to ensure future long-term stability. The monitoring of buildings and infrastructure that sustained damage shall be recorded and submitted to the Departmental Dolomite Risk Manager within the time intervals as proposed by the Competent Person (geo-professional). A typical format of such monitoring submission is included in Annex I.

NOTE: Responsible persons should know, for example, where to cut off the water supply if piping is ruptured, as a result of the instability, and when to evacuate buildings.

5.2.1.6 *Dealing with the occurrence of a sinkhole or subsidence*

The requirements stipulated in SANS 1936-4 shall apply.

5.2.1.6.1 The Competent Person shall ensure that the sinkhole is repaired according to the requirements of PW344/2017.

5.2.2 Minimum requirements for the preparation of a dolomite risk management strategy (DRMS) and Dolomite Risk Management Plan

The requirements stipulated in SANS 1936-4, Section 4.3 shall apply.

5.2.2.1 Such a strategy and Dolomite Risk Management Plan shall at least contain the following, as relevant:

- a) site description and site layout drawing. (Surveyor General – Title deed diagram);
- b) record of reports pertaining to the site, including:
 - i. record the dolomite stability report and its findings, recommendations and conclusions;
 - ii. reports recording the land usage/utilisation and site development plans;
 - iii. other reports pertaining to status quo of buildings, structures and infrastructure, etc.;
 - iv. PRM11A (Dolomite Status Certificate), GHIR, forms, etc.

- c) Hazard risk zonation of the site in accordance with the requirements of SANS 1936-1 and permissible land usage;
- d) any restrictions that may be placed on developments for reasons of dolomite risk management, e.g. building line restrictions over rehabilitated sinkholes;
- e) site development plan with building numbers superimposed on the hazard risk zonation;
- f) infrastructure superimposed on the hazard risk zonation;
- g) topography/ground contours superimposed on the layout of the site;
- h) hazard zonation in relation to a site development plan;
- i) hazard zonation in relation to the provision of infrastructure.
- j) all precautionary measures required to support development for designated and potential future land uses;
- k) stormwater management requirements taking account of:
 - i. topography of site (ground elevations);
 - ii. location of stormwater pipes and canals;
 - iii. points of discharge onto adjoining properties;
 - iv. areas of anticipated poor drainage;
 - v. points of discharge into the local authority's stormwater system;
 - vi. design specifications;
 - vii. priority maintenance areas;
 - viii. linkages to and integration with regional stormwater management arrangements;
 - ix. sensitive areas from a ground stability perspective that should receive careful attention from a risk management perspective;
 - x. recommendations contained in dolomite stability reports.
- l) the delineation of areas of restricted movement, such as high Inherent Hazard areas or existing or latent sinkholes;
- m) the identification and demarcation of monitoring areas in accordance with the monitoring area designations derived from SANS 1936-4, Tables 1 and 2, based on the Inherent Hazard characterization and knowledge of problems or sensitive areas that might exist;
- n) groundwater and infrastructure monitoring requirements (refer to Annex H);

Note 1: The measurement of the groundwater levels should be recorded by a designated person at predetermined intervals. The actual measurements should ultimately be reported to the Department of Water and Sanitation.
- o) infrastructure and ground surface monitoring requirements (refer to Annex H);
- p) inspection schedule of water bearing services, stormwater drainage and structures, as relevant, indicating nature of inspection and monitoring activities;
- q) maintenance programme which takes account of short, medium and long-term maintenance requirements in relation to the nature, age and type of services and structures, prioritizes maintenance tasks according to monitoring area designations and establishes the work and procedures associated with the following:
 - i. routine service replacement;
 - ii. repair of service after damage;
 - iii. repair of service after instability;
 - iv. responsibilities for undertaking repairs and the like.

- r) emergency reaction programme which includes emergency procedures;
- s) recording of incidents, sinkhole or subsidence formation, damage and actions taken;
- t) dolomite risk awareness programme or communications with client/user departments. Records to be kept of such communications;
- u) audit of water, sewer and other liquid conveying systems that compares the statistical mean design demands/consumption with actual recorded data from Departmental as well as external appointed/contracted service providers/consultants;
- v) arrangements to capture records relating to routine service replacement and the repair of services after damage or instability, ground subsidence events and structural damage in an accessible databank and to report such events to the Council for Geoscience;
- w) the identification of all owners of registered servitudes that contain wet services that transverse the site, facility or development;
- x) direct references to PW344/2017 with every Dolomite Risk Management Plan to clearly outline the Department's policy and procedures on the enforcement of restrictions on developments in respect of complexes and individual erven including restrictions relating to water retaining amenities, etc.;

NOTE 1: The DRMS should be specific as by the time that a design-level investigation is undertaken, the development plan as well as the design of the services may have been completed. Only under exceptional circumstances may the DRMS be generic and present the principles only, for example commercial developments where individual properties are to be sold and developed at a later stage.

NOTE 2: Despite man's best effort to minimize the occurrence of instability, the occurrence of sinkholes, subsidences and severe cracking of structures or of the ground surface cannot be totally precluded. Treatment of dolomite related instability consists of five components:

- a) emergency reaction;
- b) timeous reporting;
- c) investigation of incident;
- d) rehabilitation;
- e) ongoing monitoring.

NOTE 3: A database, be it in electronic or hard copy form, is an important part of a DRMS as it allows for continuity of meaningful management. A database should contain the following:

- a) the dolomite stability and geotechnical report;
- b) old, yet relevant, reports and correspondence;
- c) a layout plan showing position of structures;
- d) a layout plan with location of services;
- e) the zonation map;
- f) stormwater plan;
- g) records of inspection and testing;
- h) records of maintenance (detailing when, how and what was undertaken);
- i) a register of damaged structures;
- j) a record of sinkhole and subsidence occurrences (with rehabilitation taken);
- k) monitoring areas;
- l) groundwater monitoring;
- m) "no go areas";
- n) photographic records.

5.2.3 Specific Requirements for Departmental Properties

5.2.3.1 Regional dolomite risk management strategy

The requirements stipulated in SANS 1936-4 shall apply.

5.2.3.2 Designation of a risk manager and officers

The requirements of SANS 1936-4, Section 4.4.2 shall apply.

5.2.3.3 Wet services in servitudes that are not maintained by the Department

The Department shall notify owners of registered servitudes traversed by wet services and which are not maintained by the Department, of the risk such services pose to developments. The Department shall issue such an owner with a specification which establishes monitoring and inspection requirements and shall take measures to ensure that the specification is complied with.

5.2.3.4 Minimum maintenance and repair requirements for water-borne services

The requirements of SANS 1936-4, Section 4.4.4 shall apply.

5.2.3.5 Requirements for building control officers/regional inspectors

The requirements of SANS 1936-4, Section 4.4.5 shall apply.

5.2.3.6 Notification of people living on dolomite land

The requirements of SANS 1936-4, Section 4.4.6 shall apply.

- 5.2.3.6.1 The Department shall fully brief the client departments whose developments/sites fall within dolomite land of the potential risks and maintenance requirements for services in these areas and the necessity to report any leakage, blockages or ponding of water in these areas to designated Departmental officials.

5.2.4 Specific Requirements for New Developments

The requirements of SANS 1936-4, Section 4.5 shall apply.

- 5.2.4.1 The DRMS shall be reviewed and, if necessary, modified during and after construction.

The developer shall remain responsible for the implementation of the management plan until such time as such responsibility can be transferred to and accepted in writing by the owner of the development or the accounting authority and, in the case of municipal services, to the Department (or both).

5.2.5 Specific Requirements for Interconnected Complexes

The requirements of SANS 1936-4 shall apply.

5.2.6 Lodging of Risk Management Plans

The completed DRMP for a particular development shall on completion of the development be lodged at:

- a) DRMS unit;
- b) KAM of each Client Department group;
- c) Client Department own Facility Management division;
- d) State Asset Register division of the Department.

5.2.7 Execution of DRMP - During the In-service Period

Dolomite Risk Management during the in-service period should be outlined in the Dolomite Risk Management Plan of the site, facility or specific development. Requirements are as follows:

- a) an appropriate Dolomite Risk Management Plan is to be compiled for each facility/base or development located on dolomite in the Department's asset register in accordance with PW344/2017;

- b) the Dolomite Risk Management Plan is to be site specific and based on all data gathered until that time, taking cognisance of final precautionary measures, layout, etc.;
- c) the Dolomite Risk Management Plan is to outline the responsibilities and actions of the Department of Public Works and of the client departments.

5.2.8 Execution of DRMP - Unambiguous Defining of Responsibilities

5.2.8.1 Where co-responsibility for a site exists between the Department of Public Works and a user department, responsibilities of each party should be clearly defined to avoid repetition or failure to undertake assigned responsibilities in terms of the Dolomite Risk Management Plan of a facility.

5.2.8.2 The DRMS Unit must compile a dedicated database for internal and external inspections per site/property for the development thereon as may be called for within the Dolomite Risk Management Plan.

5.2.8.3 Dolomite Risk Management plan monitoring

The DRMS Unit must compile a dedicated database that monitor the Dolomite Risk Management Plan feedback data process in a time sequential manner.

Chapter 6: Departmental Procedures, appropriate engineering design details and conditions of contract for work on dolomite land

6.1 Introduction

This Chapter provides background information regarding the Department's procedures, standardised documentation and requirements for Departmental Project Managers and other appointed/contracted professional service providers/consultants involved in the development and maintenance of properties that are located on dolomite.

Appointed/contracted service providers/consultants must keep in mind that the economy of designs is of prime importance.

When upgrade works are to be executed, the various elements of the project shall be prioritised based on the hazards associated with a particular service (e.g. leaking pressurised liquid conveying systems versus non pressurised liquid conveying systems of same diameter).

6.2 Concept and Preliminary Design Reports

6.2.1 Requirements

- 6.2.1.1. In the absence of express written approval for a deviation from departmental guidelines, the Department will assume that the requirements contained in the various design guidelines, manuals and design and development requirements for appointed/contracted service providers/consultants as published on the Department's official website www.publicworks.gov.za, have been fully addressed and incorporated in the proposed design solutions and specifications. Most important in terms of engineering services the Civil Engineering Manual (latest version of PW347/2012) and in particular Section C.1.3 (References), must be adhered to.
- 6.2.1.2. All requirements of the documents listed on the Department's official website for the various professions must be applied as well as any stipulation contained in PW344/2017.
- 6.2.1.3. Design and dolomite compliance requirements contained in PW344/2017 supersedes the stipulations of the other listed documents. Should there be any conflict between the requirements of the various documents, then PW344/2017 shall have preference.
- 6.2.1.4. The Departmental Project Manager/Engineer must ensure that any principle errors contained in the PDR are corrected by the appointed/contracted service providers/consultants in the PDR and not carried into the final design phase.
- 6.2.1.5. The premise for a Preliminary Design Report (PDR) is to:
- a) investigate current site conditions from a geotechnical/structural/architectural planning perspective;
 - b) investigate the status quo of current buildings, structures and infrastructure;
 - c) investigate status and development level of existing wet and dry civil engineering services;
 - d) Investigate status quo of bulk services;
 - e) determine site usage in general and identify level of development. (Obtain as-built drawings from the Department prior to site investigations of developed sites);

- f) determine site potential development and infrastructure requirements for a client's present and future needs;
- g) determine shortcomings of current wet and dry services installations (if any);
- h) report on the dolomitic hazard risk associated with the site (DSC - Dolomite Status Certificate- PRM11A) and any ground movement observations as well as determinations according to PW344/2017;
- i) inspect all current buildings, structures and infrastructure as well as open land for signs of structural distress (e.g. buildings cracks) and/or ground subsidence;
- j) establish the design criteria and principles for the type/scope of the envisaged project;
- k) verify the condition of wet and dry services as well as other infrastructure that require upgrade;
- l) identify aspects of bulk services that require upgrading and/or replacement;
- m) make recommendations on design alternatives as well as the supporting reasoning for such design decisions;
- n) make recommendations to make designs compliant with PW344/2017;
- o) provide a description of the scope of works based on the proposed design determinations;
- p) determine general construction constraints;
- q) provide budget cost estimate;
- r) highlight the scope of works with provisional sketch plan drawings;
- s) provide recommendations on safety regulation requirements.

6.2.1.6. The Preliminary Design Report (PDR) gives the designer the opportunity to:

- a) set out the design considerations;
- b) obtain approval for proposed deviations from Departmental standards (if required);
- c) provide recommendations on suitable design solutions where various options exist;
- d) obtain endorsement in principle from the Departmental Civil Engineer to proceed with final detail designs. (PDR sign-off is required before the process can move on to the sketch plan meeting.)

6.2.1.7. The generic requirements for Civil Engineering Preliminary Design Reports are given in Annex F, however supplemented with additional requirements as outlined in 6.2.1.5 and 6.2.1.6 above.

The Department requires that the general investigations, documentation, processes, procedures and format and content of reports as indicated in Annex F: Sketch plan and Preliminary Design stage Engineering must be followed to allow Departmental Officials the opportunity to evaluate reports in a structured manner.

6.2.1.8. For a dolomitic site all of the Department's requirements for civil engineering projects are to be evaluated in the context of the:

- a) Rated dolomite hazard zonation of the parcel of land to be developed or upgraded;
- b) precautionary measures described in dolomite stability reports as well as;
- c) the requirements of this (PW344/2017) document.

6.2.1.9. The Preliminary Design Report shall, in addition to the standard Departmental requirements, include an exposé on the conclusions and recommendations of all the applicable Dolomite Stability Reports. This exposé shall describe how the recommendations and conclusions of the stability report are to be translated into the required architectural and/or engineering design.

6.2.2 Interactions with the Competent Person (geo-professional)

6.2.2.1. The Design Report shall also include the interactions and final conclusions as may be applicable to the project after consultation with the specific Competent Person (geo-professional) responsible for the compilation of the Dolomite Stability Investigation Report.

6.2.2.2. All professional appointed/contracted service providers/consultants shall prior to development planning ensure that the limitations regarding the following are cleared with the appointed Competent Person (geo-professional);

- a) location of buildings, structures and infrastructure in general;
- b) identification of areas not to be developed and/or areas with critical limitations;
- c) foundation design requirements;
- d) limitation on building heights and dimensions;
- e) location of specific high risk elements of the development (i.e. water towers, fuel bunkers, washbays, fat traps, showers, bathrooms, etc.);
- f) appropriate positioning of wet engineering services, including irrigation/landscaping requirements.

6.2.3 Interaction between professional appointed/contracted service providers/consultants

6.2.3.1. The structural engineer shall proactively engage the project architect (if required) prior to finalising design proposals. This interaction must include:

- a) foundation design restrictions and particular requirements;
- b) feasible building footprint sizes taking into account the potential loss of support for which foundation designs are to cater for (information to be provided by the appointed Competent Person (geo-professional));

6.2.3.2. The following items (but not limited to) need to be co-ordinated between the professional appointed/contracted service providers/consultants:

- a) development Planning and Land Usage in terms of the Dolomite Area Designations;
- b) type of earthworks prescribed below foundations and services (normal/soilmatress/dynamic compaction etc.);
- c) general site earthworks to divert or relocate natural stormwater as well as general works to allow free drainage of the entire site;
- d) the foundation design (reinforced footings/raft foundations, etc.);
- e) the influence of services installations in raft foundation (provision of sleeve pipes and ducts/positioning of wet cells, etc.);
- f) the top structure design (column and beam/reinforced brickwork/load bearing brickwork, etc.);
- g) brickwork on rafts (raft exposed or clad with brick tiles or brickwork on an exterior nib);
- h) surface mounting of wet services;
- i) site drainage in general and the usage of roads or paved areas for stormwater purposes;
- j) areas with excessive water spillage such as washbays, kitchens, bathrooms, swimming pools, etc.
- k) the draining of internal courtyards (only if approved by Departmental engineer);
- l) landscaping, water features, atriums, retention ponds, etc.;
- m) chillers, cold rooms, freezers, icemakers, air conditioners and display coolers or any other equipment that produces condensate;

- n) the washing, cleaning and floor draining systems in kitchens, locker rooms, change rooms and areas where floors are normally washed by means of hosing down;
- o) the pipes installed in subfloor sleeves must have inspection and working manholes that allow for visual inspection to detect water leaks and the removal and replacement of such services in future;
- p) buildings shall generally be supplied with only one water supply point. The civil engineer needs to liaise with the architect regarding the supply of fire and domestic water in one or separate supply systems. The pressure reducing facilities to protect the internal installation is the responsibility of the architect. The distribution of the internal water pipe distribution network (fire and domestic) is the sole responsibility of the architect;
- q) termite and ant proofing as well as vegetation control around buildings and structures prior to completion of paving and landscaping;

The above items must be resolved between all professional appointed/contracted service providers/consultants prior to submitting Preliminary Design Reports.

6.2.4 Dolomite Status Certificate

The Dolomite Status Certificate (DSC)(PRM011A), signed by the DRMU manager and the Director: Civil and Structural Engineering, must be included in the Preliminary and Final Design Reports. No design report shall be accepted unless he signed DSC is included.

6.2.5 Existing engineering services, buildings, structures and infrastructure

An investigation report on the appropriateness of all buildings, structures and infrastructure as well as stormwater drainage elements on site in terms of the requirements as contained in PW344/2017 that needs to be satisfied for the Dolomite Area Designation of the site. Refer to Annex F for basic elements to be investigated for inclusion in the design report for both new developments and upgrading projects. The investigation shall compare the current status quo of any element of the development with the requirements of PW344/2017.

6.2.6 Status quo and master plan

The site investigations and findings of the appropriateness of all buildings, structures and infrastructure as well as stormwater drainage elements on site shall be presented to the Department as a comprehensive status quo report and master plan forming part of the preliminary design report (refer to Annex F for typical data sheets to assist in the investigation and Annex F for the typical information to be reported on in Preliminary Design Report (PDR)).

The status quo investigation shall report on the appropriateness of all elements of the development in terms of the current status and utilisation, expected lifespan, and appropriateness of design/materials/age as well as potential future use and compliance with PW344/2017.

The master plan shall comment on the future requirements and methodology, and if required the prioritised/phased manner in which the development is to be upgraded, extended or reduced to suit the long-term needs and to achieve compliance with PW344/2017. The master plan shall comment on the priority of maintenance, upgrading, demolishing or alternative use of all parts of the development. It shall also ascertain the current and future maintenance cost of all infrastructure in order to enhance strategic land utilisation decisions and the financial viability of upgrading service to these facilities in order to support cash flow programmes of future projects. The findings of the investigation must ensure that prioritised engineering upgrading programmes are targeting expenditure on facilities viable from a long-term maintenance and functional requirement perspective.

6.3 Design considerations

The investigation and design considerations in accordance with PW344/2017 Chapter 4 must in general include, but are not limited to, the following aspects:

6.3.1 Stormwater

6.3.1.1. When designing stormwater systems and/or features of a development, the following aspects are to be considered in conjunction with the prescriptive requirements specified in PW344/2017 Chapter 4:

- a) investigate the site in terms of general surface drainage and report on any areas that require attention to ensure drainage is appropriate for a dolomitic site;
- b) investigate the installed stormwater system (pipe, canals, paved areas etc.) and report the status of all elements in terms of hydraulic capacity, and current state of disrepair (water tightness);
- c) designs should be in accordance with specific stormwater return periods or whether deemed appropriate in terms of the site topographical constraints. The latter require specific motivation;
- d) the appointed/contracted service providers/consultants shall provide a preliminary designed layout regarding the routing (stormwater drainage patterns or directions) of stormwater even in the absence of detail survey drawings;
- e) special attention is to be given to obstructions of overland flow. (fences, berms, walls, etc.);
- f) report any substructure or under floor drainage as well as methodology to rectify;
- g) report the expected as well as any increase of stormwater runoff as result of the development and/or upgrading;
- h) report on the agreements, or the necessity to enter into new agreements with adjacent land owners or local municipality for the drainage of stormwater onto adjacent property or municipal waterway(s). This verification to be provided by the appointed/contracted service providers/consultants in writing.

6.3.1.2. Layout drawings must show for the major and minor systems the location of:

- a) piped systems;
- b) manholes;
- c) junction boxes;
- d) culverts;
- e) open/covered formal and informal(natural) canals;
- f) roads forming part of network (runoff on roads);
- g) retention ponds;
- h) stormwater outfalls (areas of acceptance and discharge of stormwater);
- i) dissipating structures;
- j) flood lines.

6.3.1.3. Designs must specifically define:

- a) area of catchment;
- b) drainage patterns and water courses;
- c) reserves for water courses;
- d) discharge onto and runoff on down-slope properties;
- e) geotechnical aspects of drainage areas (active and dispersive soils/infiltration/overland flow/slope stability etc.);
- f) storm determination formula used (stormwater management model);
- g) design storm frequencies (major and minor);
- h) rainfall and hydraulic formula used;
- i) runoff calculation methodology;
- j) attenuation/retarding/retention/storage requirements and design thereof;

- k) flood plains;
- l) flood lines;
- m) road gradients;
- n) encroachment on roads in terms of the major and minor storms;
- o) effects on road traffic-carrying capacity;
- p) stormwater management safety aspects;
- q) environmental impact.

6.3.2 Roads

6.3.2.1. When designing roads and paved areas of a development the aspects listed below shall be considered in conjunction with the prescriptive measures of PW344/2017 Chapter 4.

6.3.2.2. Any pavement construction and or repairs must be based on specific proposed design criteria in terms of:

- a) road categories;
- b) service level and standard;
- c) expected traffic loadings;
- d) analysis period;
- e) structural design period;
- f) design strategy;
- g) pavement type;
- h) geotechnical conditions;
- i) materials (in situ and available commercially);
- j) dolomite conditions/restraints.

6.3.2.3. The usage of roads as part of the stormwater reticulation must be discussed as part of the reporting of stormwater management. Information shall include:

- a) road levels;
- b) cross-section;
- c) gradients;
- d) kerbs and edging;
- e) stormwater inlet structures and drainage capacity;
- f) building elevation(s) relative to road surfaces.

6.3.2.4. The removal and replacement of existing roads, concrete slabs, paving and apron slabs must be motivated (condition assessment, drainage problems, etc.) and reported on, complete with photographs.

6.3.3 Water

6.3.3.1. The Design Considerations in accordance with PW344/2017 Chapter 4 must include but are not limited to the following:

- a) investigate the site network (external – not inside building) in terms of the current condition and appropriateness in terms of dolomitic design standards. Note that this includes all subsurface pipework up to above natural ground level to the entry point adjacent to the building footprint;
- b) make recommendations on sections of network that require replacement;
- c) provide proposed new service routes (co-ordinate with other services, old and new);

- d) make recommendations whether domestic and fire water are to be provided from the same or different supply systems;
- e) report any substructure or under floor reticulation as well as methodology to rectify;
- f) new systems are to be supported by complete hydraulic design calculations;
- g) report on reliability, maximum flow and pressure criteria as well as location (servitudes) etc. of municipal (or other) bulk water supply reticulation networks;
- h) provide service level agreements with the relevant municipal/bulk service providers or indicate whether such agreements are required. (include: photographic records, exact position/co-ordinates, diameter and type of connection, capacity , etc.);
- i) report all liaisons with relevant municipal service providers;
- j) indicate required future liaison with the local authority regarding current and additional water meters and or supply points;
- k) provide motivation as well as complete design report and all other information that may be required, by the bulk service provider, if an application for changes are required to the current bulk supply connection;
- l) provide requirements and full motivation regarding the need for on-site storage;
- m) provide details regarding the appropriate pressure rating of the municipal connection (maximum/minimum pressures) over a 48hr working day period;
- n) provide requirements for bulk supply and network pressure reducing systems, taking into account the current building installations in the network;
- o) provide specifications regarding the network elements (pipes, sleeves, valves, fittings manholes, pumps, etc.);
- p) proposals regarding future water consumption monitoring shall include the design calculations for the expected consumption in a particular water supply zone and water district (minimum, average and maximum demand) given the current level of development within a district. Such design calculations will be used by the Department as control data in the future consumption monitoring process.

6.3.3.2. Reticulation drawings must show the location of:

- a) all below and above ground pipe elements;
- b) isolating valves;
- c) air valves;
- d) scour valves;
- e) pressure reducing valves;
- f) fire hydrants;
- g) surge control systems;
- h) water meters;
- i) fire hose connection point(s).

6.3.3.3. Designs must specifically state:

- a) water demand;
- b) hydraulic formula used;
- c) peak factors;
- d) fire-fighting requirements;
- e) residual and static pressures;
- f) reservoir storage requirements;
- g) elevated storage and pump requirements.

6.3.4 Sewer

6.3.4.1. The Design Considerations in accordance with PW344/2017 Chapter 4 must include, but are not limited to, the following:

- a) investigate the site network (external – not inside building) in terms of the current condition and appropriateness in terms of dolomitic design standards. Note that this includes all pipework above natural ground level to the discharge point from the buildings;
- b) report in detail on any current on site storage (septic tanks, conservancy tanks etc.);
- c) make recommendations on sections of network that require replacement;
- d) report any substructure or under floor reticulation as well as methodology to rectify;
- e) provide proposed new service routes (co-ordinate with other services, old and new);
- f) new systems are to be support by complete hydraulic design calculations;
- g) report on the reliability of municipal (or other) bulk sewer drainage reticulation network;
- h) provide accurate details (ground and invert level) of the municipal sewer connection;
- i) provide details regarding the appropriate drainage capacity of the municipal connection;
- j) provide service level agreements with the relevant municipal service providers. (include: photographic records, exact position/co-ordinates, diameter and type of connection, capacity , etc.)
- k) report all liaisons with relevant municipal service providers;
- l) indicate required future liaison with the local authority regarding current and additional sewer connections;
- m) provide motivation as well as complete design report and all other information that may be required, by the bulk service provider, if an application for changes are required to the current bulk drainage connection;
- n) provide requirements regarding the need for on-site temporary/permanent storage facilities;
- o) provide specifications regarding the network elements (pipes, pumps, fittings manholes, etc.);
- p) proposals regarding future sewer flow monitoring should be addressed. If possible, sewer monitoring districts shall be the same as water monitoring districts;
- q) all points of discharge from a particular district shall incorporate flow measurement manholes on gravity systems and flow metering systems on rising mains;
- r) designs shall compare water and sewer demand calculations.

6.3.4.2. Reticulation drawings must show the location of:

- a) manholes (ground and invert levels);
- b) pipes (gradient, type, and design flow);
- c) sewer connections (ground and invert levels);
- d) cleaning and rodding eyes;
- e) pumping installations;
- f) pumping mains;
- g) temporary disposal and/or rerouting facilities.

6.3.4.3. Designs must specifically state:

- a) design flows;
- b) hydraulic flow formula;
- c) average daily flow;
- d) peak design flows;
- e) peak factors;
- f) minimum sewer pipe diameter;
- g) limiting gradients (desilting aspect);
- h) on site storage facilities and/or sewerage disposal systems;
- i) pump requirements (non-gravity systems) and associated electrical installations.

6.3.5 Dry Services

6.3.5.1. The design considerations in accordance with PW344/2017 Chapter 4 must include, but are not limited to, the following:

- a) investigate the dry engineering services for the site network (external – not inside building) in terms of the current condition and water tightness (areas where liquids might gain entry or drain from dry services) and appropriateness in terms of dolomitic design standards. Please note that this includes all pipework/sleeves or ducts above natural ground level to the entry point into the building;
- b) make recommendations on upgrading and/or replacement requirements;
- c) associated elements such as transformer rooms and foundations for overhead systems shall be investigated as per the requirements for buildings and structures;
- d) consult with user client on current/future requirements.

6.3.6 Design drawings – Bulk service providers (Service Level Agreements)

Design drawings shall specifically indicate the location of connections to external utilities/ service providers with the particulars (agreement number and date) of the service level agreement for such connection. Service level agreements may include, but are not limited to:

- a) water;
- b) sewer;
- c) stormwater;
- d) electricity;
- e) telecoms and data;
- f) gas.

The notation shall also include:

- a) size;
- b) type;
- c) capacity;
- d) pressure;
- e) other relevant details to ensure that connections made to this point are appropriate and in accordance with the design requirements;
- f) if and where necessary, servitude registration shall be included - refer to generic document contained in PW344/2017, Annex K.

6.4 Design standards

The designs shall be based on the latest revision of the documents listed in the table hereunder.

Table 6.1: List of documents for design of engineering services in dolomitic areas

| | |
|--|----------------------------|
| The Design Criteria for Dolomitic areas: Appropriate Development of Infrastructure on Dolomite: Manual for Consultants (THIS DOCUMENT) | PW344/2017 |
| Civil Engineering Manual | PW 347 |
| Standard specification for domestic and fire water storage and fire water supply for public buildings | PW 345 |
| Guidelines for the design of small sewerage treatment works for isolated DPW developments | Available on request |
| Guidelines for design of civil services for new generation prisons | PW342 |
| Human Settlement Planning and Design (Red Book) | CSIR |
| Water Supply and Drainage for Buildings (Part 1 and Part 2) | SANS 10252-1, SANS 10252-2 |
| Code of Practice for Community Protection against Fire | SANS 10090 |
| The Application of the National Building Regulations | SANS 10400 |
| Specifications of Materials and Methods to be used | PW 371 |
| Development of dolomite land (Parts 1 to 4) | SANS 1936 |

6.5 Project Standards

In addition to the general requirements of PW344/2017 Chapter 4 and the listed documents above the following requirements shall apply to all designs.

6.5.1 General

All existing buildings are assumed to be fully occupied for the hydraulic design of:

- a) water;
- b) sewer.

Where possible eliminate all pump stations, septic tanks and on site potable or fire water storage.

6.5.2 Presence of any ground movement events

An investigation report detailing the presence of current and all known past ground movement events (sinkholes and subsidences) within the investigation area or on adjacent land as well as the potential impact on the current development shall be compiled and made available.

6.5.3 Layout drawings

All the design elements (new or upgrading of existing) must be superimposed on drawings that show the dolomite hazard zonation.

All drawings must refer to the applicable Dolomite Status Certificate that was issued for the site(s). The drawing depicting the dolomite hazard zonation shall in addition to the Dolomite Status Certificate also refer (in the notes of the drawing) to the specific applicable dolomite stability reports.

In the case of upgrading of existing infrastructure it is also expected that the appointed/contracted service providers/consultants include some of the existing services layout drawings in the Preliminary Design Report in order to support the new designs and/or budgets.

6.5.4 Dolomite risk management plan

As per the requirement of the dolomite status certificate the appointed/contracted service providers/consultants should include in the preliminary design report a brief description of the future Dolomite Risk Management Plan (DRMP) according to requirements of PW344/2017 Chapter 5.

6.5.5 Design considerations

The design considerations shall refer to the appropriate clauses of PW344/2017.

6.5.6 Construction constraints

Normal engineering practice to provide services to buildings, structures etc. in dolomite areas are not always allowed in terms of PW344/2017 (i.e. example: under floor drains). The Competent Person (engineer) must evaluate all services to be included in the scope of work and provide directives to the other members of the professional team of particular design parameters that may influence the development planning.

6.5.7 Budgets (civil engineering upgrading and new infrastructure projects)

6.5.7.1. The budget requirements for all projects shall include a cost breakdown structure under the following headings:

- a) cost of buildings and structures and related works;
- b) cost of dry engineering services and related works;
- c) cost of water network and related works;
- d) cost of sewer network and related works;
- e) cost of stormwater system and related works;
- f) cost of construction and/or road repairs and related works;
- g) bulk earthworks;
- h) earthworks related to wet and dry engineering services;
- i) cost to external services/utilities providers;
- j) preliminary and general cost;
- k) additional disbursements such as surveys etc.;
- l) consultant fees and disbursements.

6.5.7.2. The above budget amount should be supported by a short or cryptic description of items such as:

- a) lengths and sizes of pipe to be laid for each service;
- b) number of manholes and type;
- c) quantum of stormwater canals and paving;
- d) extent and quantum of road works;
- e) budget allowance for specific structures or infrastructure elements;
- f) budget allowance for repair/rehabilitation of sinkholes and related bulk earthworks;
- g) budget allowance for authorised demolition activities;
- h) quantum of excavation and expected geotechnical conditions in terms of excavations (rock, etc.).

The reports need to be of a technical quality that will allow the Departmental engineer to validate the scope of work versus the proposed budget.

6.5.7.3. Contract administration

Reports need to include specific recommendations regarding:

- a) the proposed/expected construction period;
- b) the tendering entity CIDB grading;
- c) the General Conditions of Contract (GCC 2010 and additions or amendments thereto);
- d) the requirements for project specific technical and/or particular specifications for work not specified and measured in terms of standard SANS documentation.

6.6 Upgrading of existing engineering infrastructure

6.6.1 In order to allow for the prioritised upgrading of non-compliant engineering infrastructure services it is important that the entire existing system be identified/located and indicated on the design drawings. This is of particular importance for:

- a) upgrading projects intended for execution in part or as a whole;
- b) the truncating, removing or grouting of redundant systems.

6.6.2 During the site inspections of the existing engineering infrastructure routes, the following is to be examined and reported on:

- a) type, diameter, age, jointing methods and pressure rating if applicable;
- b) sinkholes and subsidences within the area of investigation;
- c) areas with extended periods of leaking services;
- d) areas where services were damaged as result of earthworks, vegetation growth, accidents, erosion, chemical or environmental oxidation, etc.

It is of particular importance that areas with extended periods of leaking are investigated from a stability perspective.

Drawings must indicate the required priorities for upgrading based on the level of deterioration of the existing services and the potential risk of continued use.

All design drawings shall clearly indicate the existing as well as proposed new services layouts.

6.7 Design standards for new developments and upgrading of Infrastructure on Dolomite Land

6.7.1 General

The requirements of the local fire-fighting authority shall prevail.

6.7.2 Water Supply

The general requirements of Chapter 4 shall be applied to all new developments as well as upgrading projects.

6.7.3 Sewer Design

The general requirements of Chapter 4 shall be applied to all new developments as well as upgrading projects.

Sewerage flows shall be calculated in accordance with the DPW "Guidelines for the Design of Small Sewerage Treatment Works for Isolated DPW Developments". Obtain the latest version of these guidelines from the Departmental Engineer. The following are applicable:

- a) pipelines are to be designed to ensure zero percent leakage and shall be tested according to the requirements of Annex P (Volume 3);
- b) minimum sewer diameter (nominal diameter)160mm;
- c) minimum diameter for sewer house connections (nominal diameter).....160mm;
- d) minimum diameter for pump station rising mains (nominal diameter)110mm;
- e) minimum pump flow velocity in rising mains0,7m/s;
- f) maximum pump flow velocity in rising mains2,5m/s;

- g) 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;
- h) stormwater infiltration into sewers0l/s;
- i) all services and pipelines shall be clearly marked. Marking symbols and numbers are to be approved by the Department and be in accordance with PW347.

6.7.4 Stormwater Design

The general requirements of PW344/2017 shall be applied to all new developments as well as upgrading projects on dolomitic land. Stormwater designs are to be calculated in accordance with the determinations of PW347.

6.8 Tender Documents and Conditions of Contract

6.8.1 Tender documents standardised format

- 6.8.1.1. Tender documents of contracts shall be strictly in accordance with the standardised format of the Department of Public Works requirements (in letter format and sequence). This also applies to the contract document cover and index. The requirements are specified in Manual, PW 347 (latest edition).
- 6.8.1.2. All appointed/contracted service providers/consultants must take note that The General Conditions of Contract for Construction Works (Referred to as GCC), published by the South African Institution of Civil Engineering, is applicable to all Civil Engineering Contracts.
- 6.8.1.3. The latest revision of the Contract Data (as issued by the Department of Public Works) forming the Annex to the General Conditions of Contract for use in connection with Works of Civil Engineering Construction – Latest edition (available from SAICE) shall apply.
- 6.8.1.4. The Tender documentation Schedule of Quantities shall be drawn up in accordance with provisions of:
 - a) SANS 1200; or
 - b) SANS 2001
- 6.8.1.5. The Departmental Project Manager needs to be consulted to advise on the latest applicable version to apply.

6.8.2 Features of the contract requiring special attention

- 6.8.2.1. Contracts must include a clause that states the following:

Features of the contract requiring special attention: Dolomitic Soil Conditions

Construction work is to be conducted in areas of highly unstable subsurface conditions and the Tenderer shall provide special risk insurance to cover the works, machinery and his and the Engineer’s and Employer’s personnel in the event of ground movement during execution of work.

The Engineer and/or Employer shall not be responsible or liable for any losses or damages incurred by the Contractor irrespective if it is due to the execution of work as per specifications or as directed in writing or verbally by the Employer or Engineer.

The Competent Person (geo-professional/engineer) must consider all elements of the development and specify, in detail, all precautionary and safety measures to be taken in general as well as additional measures for work related to:

- a) sinkhole and subsidence repairs;
- b) excavations;
- c) demolition/deconstruction;
- d) blasting.

6.8.2.2. The requirement of Special Risk Insurance must form part of all contracts that involve work in the dolomitic environment. The contents below provide an indication of the requirements of the Department and the latest edition must be obtained from the Departmental Project Manager for all new civil engineering contracts.

This clause requires revision for contracts other than those subject to The General Conditions of Contract for Construction Works and in such cases the Departmental Dolomite Risk Manager should approve any revision.

The Departmental Standard Contract Tender Form (current): DPW-05: (EC) CONTRACT DATA-(GCC (2010) must be amended with the following additions that are applicable to any Civil Engineering Contract on Dolomite Land (obtain latest revision from Departmental Project Manager):

| | |
|------------|--|
| Clause No. | <p>HIGH RISK INSURANCE</p> <p>In the event of the project being executed in a geological area classified as a “High Risk Area”, that is an area which is subject to highly unstable subsurface conditions that might result in catastrophic ground movement evident by sinkhole or subsidence formation the following will apply:</p> <p>(1) Damage to the Works</p> <p>The Contractor shall, from the Commencement Date of the Works until the date of the Certificate of Completion, bear the full risk of and hereby indemnifies and holds harmless the Employer against any damage to and/or destruction of the Works consequent upon a catastrophic ground movement as mentioned above. The Contractor shall take such precautions and security measures and other steps for the protection of the Works as he may deem necessary.</p> <p>When instructed to do so by the Engineer, the Contractor shall proceed immediately to remove and/or dispose of any debris arising from damage to or destruction of the Works and to rebuild, restore, replace and/or repair the Works, at the Contractor’s own costs.</p> <p>(2) Injury to Persons or Loss of or damage to Properties</p> <p>The Contractor shall be liable for and hereby indemnifies and holds harmless the Employer against any liability, loss, claim or proceeding arising at any time during the Contract Period whether arising in common law or by Statute, consequent upon personal injuries to or the death of any person whomsoever resulting from, arising out of or caused by a catastrophic ground movement as mentioned above.</p> <p>The Contractor shall be liable for and hereby indemnifies the Employer against any and all liability, loss, claim or proceeding consequent upon loss of or damage to any moveable, or immovable or personal property or property contiguous to the Site, whether belonging to or under the control of the Employer or any other body or person whomsoever arising out of or caused by a catastrophic ground movement, as mentioned above, which occurred during the Contract Period.</p> <p>(3) It is the responsibility of the Contractor to ensure that he has adequate insurance to cover his risk and liability as mentioned in Clauses and above. Without limiting the Contractor’s obligations in terms of the Contract, the Contractor shall, within 21 days of the Commencement Date but before commencement of the Works, submit to the Employer proof of such insurance policy, if requested to do so.</p> <p>(4) The Employer shall be entitled to recover any and all losses and/or damages of whatever nature suffered or incurred consequent upon the Contractor’s default of his obligations as set out in Clauses....., and..... Such losses or</p> |
|------------|--|

| | |
|--|--|
| | damages may be recovered from the Contractor or by deducting the same from any amounts still due under this Contract or under any other contract presently or hereafter existing between the Employer and the Contractor and for this purpose all these contracts shall be considered one indivisible whole. |
|--|--|

6.8.2.3. The bill of quantities related to such works shall state specifically a reference to the dolomitic hazard and special insurance required for the works.

6.8.3 Scope of works/contract data

The design and contract documentation must include in the scope of works/contract data the following data:

- a) reference to the availability of geotechnical reports (dolomite stability);
- b) states the hazard classification of the area where work is to be executed
- c) provide reference to the meaning of the hazard class;
- d) an abstract that explains the risk involved in executing work on the particular site;
- e) general site safety and appropriate precautionary measures to mitigate the dolomite risk;
- f) contractor's obligations to assist in risk management;
- g) actions that deem to satisfy risk management;
- h) specific obligations of the Department, engineer and contractor regarding Dolomite Risk Management for the entire project.

6.8.4 Sinkhole, subsidence and subsurface cavity repairs

6.8.4.1. Sinkhole and subsidence repair

Great care has to be taken when repairing sinkholes or subsidences or when working in and around an area of dolomite related ground movement.

In the event of a sinkhole it will be the responsibility of the Competent Person (geo-professional) to establish:

- a) the extent of instability;
- b) the area of safe movement of equipment and personnel;
- c) precautionary safety measures to be implemented prior to and during repair;
- d) repair methodology;
- e) construction precautionary measures;
- f) risk management during construction.

It is the responsibility of the Competent Person (engineer) to ensure that construction is executed in terms of the precautionary measures as stated by the Competent Person (geo-professional). This Competent Person (engineer) shall insure that:

- a) the repair of sinkholes, subsidences and other forms of dolomite related ground movement is described as a high risk construction activity in specifications required for the construction activities;
- b) construction work meets the safety and precautionary measures as determined by the Competent Person (geo-professional);
- c) contractual agreements for the repairwork include the required divulging of risk;
- d) special risk insurance for construction work covers the execution of the work;
- e) responsibility and indemnification of all parties are presented in writing. Sinkhole classes in relation to rehabilitation measures:

The following guidelines should not be considered as cast in stone. The Competent Person (geo-professional) should ensure that engineering judgement always prevail to ensure that where

specific conditions are encountered, which warrant the performance of a dolomite stability investigation, then such investigation must be performed.

- a) Active (Public) Areas where people work/move around as part of their daily routine
- (i) Sinkhole >2m deep

Rehabilitation Requirements:

Rehabilitate permanently by dynamic compaction (DC), implement efficient surface drainage and redesign all underground services.

Dolomite Investigation Requirements:

- Sinkhole exists for >1 year away from buildings: no investigation
- New sinkhole: perform gravity survey and percussion drilling
- Sinkhole close to building which may be affected: perform gravity survey and percussion drilling

- (ii) Sinkhole \leq 2m deep and doline

Rehabilitation Requirements:

Rehabilitate by excavation, backfill and compaction in thin layers, including efficient surface drainage away from sinkhole and termination of all underground services.

Dolomite Investigation Requirements:

No investigation, but use excavation and clearing of sinkhole as "investigation phase" and if no signs of bigger problem are observed, proceed with backfill, but if signs of a bigger problem is observed, perform dolomite stability investigation.

- (b) Open veld where vehicular access is possible

- (i) Sinkhole >2m deep

Rehabilitation Requirements:

Rehabilitate permanently by DC, implement efficient surface drainage and redesign all underground services.

Dolomite Investigation Requirements:

No investigation.

- (ii) Sinkhole \leq 2m deep and doline

Rehabilitation Requirements:

Rehabilitate by excavation, backfill and compaction in thin layers, including efficient surface drainage away from sinkhole and termination of all underground services.

Dolomite Investigation Requirements:

No investigation, but use excavation and clearing of sinkhole as "investigation phase" and if no signs of bigger problem are observed, proceed with backfill, but if signs of a bigger problem is observed, perform dolomite stability investigation.

- c) Open veld and remote areas of rock outcrop where vehicular access is not possible

Rehabilitation Requirements:

Implement efficient surface drainage to prevent inflow into sinkhole and put up proper fencing with notice boards - leave sinkhole open.

Dolomite Investigation Requirements:

No investigation, only perform thorough inspection and record conditions.

- d) Sterile areas inside active (public) areas
 - (i) Sinkhole >3m deep and diameter >5m

Rehabilitation Requirements:

Rehabilitate permanently by DC, implement efficient surface drainage and redesign all underground services.

Dolomite Investigation Requirements:

No investigation.

- (ii) Sinkhole ≤3m deep and diameter ≤5m

Rehabilitation Requirements:

Backfill sinkhole to 0,5m lower than ground surface, compact backfilled surface, then backfill and compact in thin layers to 0,5m above ground surface and 3m beyond sinkhole perimeter. Implement efficient surface drainage, put up proper fencing with notice boards and terminate all underground services.

Dolomite Investigation Requirements:

No investigation, but observe and record anything that is extraordinary during backfill operation.

6.8.4.2. Dynamic Compaction

The Competent Person (geo-professional) must approve the methodology and equipment to be used in the event of repair by means of dynamic compaction. It should be noted that the metastable subsurface conditions could be adversely affected by dynamic compaction and the safety precautions during construction must be enforced strictly. The typical requirements for dynamic compaction are attached as Annex M in PW344/2017, Volume 2.

6.8.4.3. Grouting

The typical requirements for grouting are attached in Annex M, PW344/2017.

In the event of subsurface cavities and or disseminated cavities the use of grouting might be prescribed by the Competent Person (geo-professional). Slimes from mining operations may not be used for grouting. Grouting stages and maximum grouting pressure to be used are to be approved by the Competent Person (geo-professional).

6.8.5 Specifications, construction requirements and schedule of quantities

6.8.5.1. General

The following typical general requirements to be included in the tender documentation for projects on dolomite. The design engineer needs to extend the list with the project specific requirements:

- a) no dumping is allowed on Site other than at the designated and approved fill areas. Dumping will only be allowed for filling sinkholes and subsidences and may not be detrimental to the natural stormwater drainage of the area. Only soil, rock and clean masonry and concrete rubble may be dumped in the designated dump areas;

- b) no borrow pits are allowed on site;
- c) 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;
- d) tender specifications in terms of HDPE pipes, fittings and structures shall include or refer to all relevant specifications according to this document. Specify the pipe materials, supply lengths, joining methods, removing of internal welding bead (de-burring), camera inspections of finished joints as well as the specific pressure testing requirements and methods. 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 the 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 SANS (or similar) specifications;
- e) the latest revision of the Occupational Health and Safety Act shall be applicable to all contracts. Appointed/contracted service providers/consultants to note the reference to this Act and the execution thereof according to the standard forms of appointment, related to professional appointed/contracted service providers/consultants, as issued by the Department. Particular requirements regarding the continuous hazard of working in the dolomitic environment shall be elaborated on within the particular specifications relating to the Occupational Health and Safety Act.

6.8.5.2. *Appropriate engineering design details*

Typical, minimum standard, details for engineering designs are included in PW344/2017, Volume 3. The engineer needs to extend and improve on these drawings to suit the site specific conditions. When using the design details included in PW344/2017 then only include the details applicable to the particular design in the contract drawings.

6.8.5.3. *Project specifications*

Typical, minimum standard and relevant specifications are given in the Annexes contained in Volume 2 of this document. 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 Competent Person (engineer).

6.8.5.4. *General Construction practices*

All contracts dealing with the provision of engineering and infrastructure construction in dolomite areas must specifically state:

- a) appropriate measures to deal with stormwater in general during construction;
- b) excavation procedures;
- c) measures and construction practice to prevent stormwater entering open trenches and or other excavations;
- d) methodology of excavations to ensure it can be kept dry;
- e) pumping equipment to be on site for the duration of the contract to keep excavations dry;
- f) dealing with existing wet engineering services;
- g) temporary site services for construction;
- h) abandoned services;
- i) dealing with overburden or the disturbance of topsoil;
- j) reinstating areas of disturbances.

6.8.5.5. HDPE product supply

The Department extensively specify and use HDPE products and as such it should be noted that quality control, especially installation in dolomitic areas, is the most important aspect of the process. Refer to Annex P for applicable requirements of:

- a) HDPE material;
- b) manufacturer approval;
- c) handling of products on site.

The principal agent shall supply the Department with all quality assurance documentation during and after the completion of a development. The documentation shall be adequately referenced with as-built drawings/data and the engineering services installation drawings database.

All properties of joints designed by the manufacturer must always exceed or be equivalent to the base parent pipe (joints shall not decrease the tensile strength properties of the overall pipeline)

HDPE pipes are to be joined by butt welding for solid wall pipes and hot-gas extrusion welding for structured wall pipes unless otherwise approved by the Department.

Electro-fusion welding will only be allowed in special circumstances and must be approved by the Department.

Electro-fusion welding versus butt welding shall be evaluated for each project based on the financial implication as well as meeting the technical requirements. Generally electro-fusion welding should be limited to areas where butt welding is impractical. It is a specific requirement that prior to implementation the following are to be approved:

- a) manufacturer of electro-fusion welding couplers;
- b) couplers that meet the technical requirements to ensure that a full penetration weld is achieved, and that the joints have the same tensile and pressure properties as an unjointed section of the pipe.

The Department reserves the right to specify minimum pipe wall thicknesses to ensure mechanical properties are met even if the pipe supplier meets the required specifications.

6.8.5.6. Bill of Quantities

Preliminary Bills of Quantities that include typical work related to the construction of wet and dry engineering services are attached as Annex U, Volume 2 of PW344/2017. These bills serve as a guideline and must be verified and checked by appointed/ contracted service providers/ consultants for correctness and appropriateness.

6.8.6 Construction and practical notes

6.8.6.1. Buoyancy of large diameter HDPE pipes

Construction control measures must take cognisance of the fact that large diameter HDPE products tend to be problematic in terms of buoyancy in the event of flooding of trenches prior to backfilling. Adequate construction preventative measures need to be included in the specification of the installation of these pipes.

6.8.6.2. Sliplining

The Department does not allow the lining of existing wet engineering services with thin flexible membranes.

Existing services may be used as a sleeve if approved by the Departmental Dolomite Risk Manager. In such cases the new service shall in all aspects comply with the requirements of PW344/2017 and if stipulated, the opening between the sleeve and the new service shall be grouted with a suitable flowing grout mix that will not damage the new service.

6.8.6.3. *In situ cracking and replacement techniques*

Pipe replacement techniques that employ methods of destructing the in situ pipe or duct and replace it along the same route with the new short section mechanically jointed pipes are not allowed. Pipes used in such cases shall comply in all aspects with PW344/2017.

6.8.6.4. *Surface mount installations of water network*

The installation of surface mounted wet engineering services requires close collaboration between the architect and the engineer to ensure that building aesthetics and traffic arrangements are not compromised. Surface mounted engineering services shall in so far as possible correspond with the formalised stormwater system.



TYPICAL SURFACE MOUNTED WATER INSTALLATION



TYPICAL SURFACE MOUNTED WATER INSTALLATION

6.8.6.5. Installations of large diameter HDPE manholes

The detail for HDPE manhole (Detail TYPE No DT 04/D contained in Volume 3 of PW344/2017) indicates that the area below the benching must be filled with concrete. This can also be achieved by means of turning the manhole upside-down and filling the space below the HDPE benching with concrete prior to installation. Refer to the Plates below and lugs, welded horizontally to the manhole shaft, are to be supplied to ensure that the concrete stays fixed to the manhole during all handling processes.



HDPE SEWER MANHOLE OF STRUCTURED WALL HDPE PIPE (BOTTOM)



HDPE SEWER MANHOLE OF STRUCTURED WALL HDPE PIPE (INSIDE)



HDPE STORMWATER MANHOLE OF STRUCTURED WALL HDPE PIPE (SIDE VIEW)