

# Assessing dolomite risk management plans' potential to guide town-planning decisions

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## **Abstract**

Areas underlain by dolomite pose a risk for sinkhole and doline development and subsequently have serious implications towards the safe planning of towns. Research also indicates that almost all sinkholes and dolines formed on dolomitic areas were man-induced and may be contributed to a lack of informed decision making by town planners.

Consequently, town-planning decisions must have a guiding plan to avoid unsuitable development on such areas. Such a guiding plan was identified as a Dolomite Risk Management Plan (DRMP). A DRMP has in recent years become a legal responsibility, to be implemented where development is taking place on areas underlain by dolomite according to SANS 1936 and the Geoscience Amendment Act, (16 of 2010). There however currently exists a need to determine to what extent a DRMP contributes to the town planning decisions making process.

The aim of this study is to determine to what extent currently existing Dolomite Risk Management Plans contribute to a town planning decision-making process by means of the analysis of four case studies.

Four case studies were assessed against a framework compiled through a literature study of all applicable legislation to determine to which extent each complies with the compulsory legislation in South Africa needed to guide safe and sustainable development.

The study indicated that a need existed for a DRMP to guide town-planning decisions because it is people's constitutional right to be protected and to live in a safe environment. It was also concluded, through the random sampling and assessment of available results from four case studies against criteria from applicable legislation, that currently only 50% are capable of informing and guiding town planning decisions adequately.

## **Key Words**

Dolomite, Dolomite Risk Management Plan, Town Planning

## List of acronyms

|        |  |
|--------|--|
| CGS    | Council for Geosciences                                  |
| DFA    | Development Facilitation Act (67 of 1995)                |
| DMA    | Disaster Management Act (57 of 2002)                     |
| DRMP   | Dolomite Risk Management Plan/Policy                     |
| DWA    | Department of Water Affairs                              |
| EIA    | Environmental Impact Assessment                          |
| IDP    | Integrated Development Plan                              |
| NEM:WA | National Environmental Management Waste Act (59 of 2008) |
| NEMA   | National Environmental Management Act (107 of 1998)      |
| NHBRC  | National Home Builders Registration Council              |
| NWA    | National Water Act (36 of 1998)                          |
| SANS   | South African National Standards                         |
| SDF    | Spatial Development Plan                                 |
| SPLUMA | Spatial Planning Land Use Management Act (16 of 2013)    |

## **Preface**

All the work presented henceforth in this study is based on experience as a town planner and therefore the development of Dolomite Risk Management Plans led to the purpose of this dissertation to demonstrate the guiding capability of these plans towards town planning. The Dolomite Risk Management Plan only came into being in the last 10 years and very little research has been done to determine the success of these plans on development.

This dissertation should be of interest to those whom are in the industry of the development of Dolomite Risk Management Strategies as well as town planning orientated fields, which are involved, with the development of Spatial Development Frameworks, Integrated Development Plans as well as rezoning and township establishment.

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## 1.1 Introduction and problem statement

Town planning and town planner's need to be guided and advised from a geotechnical point of view . The latter should aid in establishing where it is possible and safe to establish new townships as well as the type of development that is possible. This is especially essential when dolomite is present in the area, due to the inherent hazard that it poses to development and loss of life (Coetzee *et al.* 2012). Subsequently, it must be established to what extent does geotechnical studies through a Dolomite Risk Management Plan inform and guide town-planning decision when it comes to township establishment or rezoning applications

Buttrick (1986) notes that “dolomite is a carbonaceous rock beneath or in some cases above the surface of the earth, which dissolves when it comes in contact with any form of acid”. This could be with natural processes such as the very small quantities of acid found in natural rainfall as well as human induced actions such as acid water from mining and tailings dams (Trollip, 2007). When it dissolves it leaves a void or a cave beneath the surface of the earth. These voids, sometimes filled with water and sometimes empty will collapse over time but human action consequently speeds up the process considerably (Buttrick & Van Schalkwyk, 1995).

Development on dolomitic land therefore continues to present a challenge due to the risk of sinkhole and subsidence development, which can lead to large-scale disasters and to loss of life. According to Potgieter (2012) a total of 5 - 10% of South Africa and approximately 25% of Gauteng, as well as parts of Mpumalanga, Limpopo, Northern Cape and North West Province are underlain by dolomite. Although opportunities exist in the development of such land, the oppositional effects concerning the development of sinkholes and subsidence, whether naturally or as a result of development, cannot be ignored (Pretorius, 2012).

According to Buttrick and Van Schalkwyk (1995) there has been 39 known sinkhole related deaths in South Africa in the last 50 years. An estimated cost of damage to date is believed to be greater than R1.3 billion. The typical cost to repair a sinkhole is usually around R200 000 without the structural damage cost (Council for Geoscience, 2007a). The assessment of the stability of dolomitic land prior to development is therefore essential.

Buttrick & Roux (1993) indicated that almost all recent sinkholes and dolines formed in South Africa are man-induced. Whenever urban development occurs on dolomite, man is exposed to the potentially negative consequences of his activities, if precautionary measures are not implemented. According to La Moreux (La Moreux *et al*: 1995) the reason for increased interest in dolomitic land development can be contributed to the rapid urbanisation and population growth and possible application of new technologies. Rapid urbanisation and population growth brings about the need for increased water use, which is also a major factor to consider in a Dolomite Risk Management Plan.

Risks can be better managed with a primary source or a law that has numerous applications across the field. This source can function as a foundation for a system to legally develop on areas underlain by dolomite. Consequently, the Council for Geoscience has implemented a Dolomite Risk Management Plan or Strategy that must be compiled by all authorities that has some sort of dolomite occurrence.

The risk involved for legal non-compliance to a Dolomite Risk Management Plan when developing on dolomite, is ultimately development that has taken place on *nonecumene* land. To avoid legal risk, this land must remain unoccupied. Subsequently, the legal risk of developing on dolomitic areas can range from being accountable to justify actions or decisions wrongly and knowingly made, to accepting legal responsibility for loss of life.

The gap between the different legal foundations related to the support for development on areas underlain by dolomite can be seen between fields such as Town planning, Geology, Waste and Environmental studies that consequently does not convey in any holistic plan to guide development on dolomite. Although research has been done on the development on dolomite, existing frameworks such as a Dolomite Risk Management Plan or Strategy does not cover all the aspects needed.

From a town planning point of view, developing near or on dolomitic areas has been discouraged. Such discouragement can be seen in legislation since 1965, with the Transvaal Provincial Ordinance (25 of 1965 and 15 of 1986), the Less Formal Township Establishment Act no 113 of 1991 and the Development Facilitation Act (67 of 1995) (van Schalkwyk, 1998).

Other legislations that are indirectly used for application on dolomitic areas are: The National Environmental Management Act (107 of 1998) (NEMA), National Water Act (36

of 1998) (NWA) and Geosciences Amendment Act (16 of 2010). Conformity and accordance between the NWA towards the DFA, NEMA and the Geoscience Amendment Act would consequently be imperative so that appropriate measures are put in place. This will inform environmental impact assessments; town zoning and geotechnical studies to what possibilities are available when developing.

With reference to co-operative governance, there must be intergovernmental co-ordination and harmonisation of policies, legislation and action relating to the environment, according to Section 2(4)(l) of NEMA. This means that policy and planning documents such as SDFs, IDPs and housing sector plans must be aligned with related document of neighbouring municipalities and even to a national level.

Taking into consideration the various factors discussed above, it must therefore be established whether a Dolomite Risk Management Plan as proposed by the Council for Geoscience are indeed adequate to guide development on dolomite. The following research aim is consequently posed: Assessing a Dolomite Risk Management Plan's potential to guide town-planning decisions before developing on dolomite.

## **1.2 Research aim and objective**

The following research aim is consequently posed: Assessing a Dolomite Risk Management Plan's potential to guide town-planning decisions.

The following objectives are set to aid in addressing the research aim:

1. Establishing why there is a need for a Dolomite Risk Management Plan to inform town-planning decisions?
2. Establishing assessment criteria from applicable legislation
3. Evaluating four case studies against assessment criteria to determine the potential of Dolomite Risk Management Plan to inform Town Planning Decisions.

## **2.1 Research design and methodology**

Researchers have distinctive philosophies and methods of viewing and interacting within their environment (Wahyuni, 2012). As a consequence, the approaches in which research studies are conducted differ. Nonetheless, there are defined criteria and instructions that guide a researcher's philosophies and actions. These criteria and instructions or standards and principles can be referred to as a paradigm (Kraus, 2005)

To get an appropriate understanding of how and why the researcher selected the methodological approach in this study, a preliminary discussion will be done about the paradigm that best fits the emphasis of this study.

After the discussion concerning the research paradigm, the aim of this chapter is to confer the research design and methodology applied in this study. In order to define the research methods used in this study, the data collection methods and related analysis methods will be systematically discussed.

### **2.1.1 Research paradigm**

According to Fouché and Delport (De Vos *et al.*, 2005) a research approach refers to the methodological paradigm from which a study is conducted and according to Taylor *et al.* (2007), a paradigm is "a broad view or perspective of something". Furthermore, Weaver and Olson's (2006) description of paradigm shows how research might be impacted upon, as well as guided by a established paradigm by stating, "paradigms are patterns of beliefs and practices that regulate inquiry within a discipline *by* providing lenses, frames and processes through which investigation is accomplished".

This study utilised a constructivist paradigm as a approach to the research methods. Constructivist approach research has the intension of perceiving "the world of human experience" signifying that "reality is socially constructed" (Mertens, 2005). The constructivist researcher is inclined to trust the contributor's views of the situation being studied and identifies the influence on the research of their own context and familiarities. Constructivists do not normally start with a theory but they rather "generate or inductively develop a theory or pattern of meanings" (Creswell, 2003) through the research activity. The constructivist researcher is inclined to depend on qualitative data collection methods as well as analysis or a combination of both qualitative as well as quantitative methods (mixed methods). Quantitative data may be applied in a way,

which maintains or develops upon qualitative data and essentially deepens the description (Mackenzie & Knipe, 2006).

### **2.1.2 Research methodology**

Research methodology emphasises the process of research and the judgement that the researcher must make to execute the dissertation. According to Creswell and Clark (2011) the mixed method research design is implemented in two distinct phases. They state that the first phase can encompass the collection and analysing of qualitative data through different research methods and the second phase consists of an analysis part that may use quantitative analysis methods to help explain the qualitative results. Accordingly, for the purpose of this study, a mixed method research approach was used to get a holistic understanding of the effect of dolomite on town planning decisions.

According to Bernard and Ryan (2010), qualitative data can be the recording of text for the purpose of analysis. Consequently the researcher decided on a qualitative research method for the investigation of relevant literature for the potential of Dolomite Risk Management Plan's towards town planning decisions as qualitative research uses a realistic methodology that seeks to understand occurrences in "context-specific settings", such as "real world setting where the researcher does not endeavour to manipulate the phenomenon of interest" (Patton, 2001).

## **2.2 Methods of data collection and analysis**

To achieve objective 1 and 2, the study uses a literature review as a research method in Chapter 3. The review is done to obtain perspective on the most recent legislation and guidelines pertaining to relevant matters which can affect development as well as to identify all the disciplines which directly and indirectly affect development on dolomitic.

This will also assist in defining the broad risks involved and will function as the foundation and background to establish which legislation must be taken into consideration when developing a Dolomite Risk Management Plan to consider before town establishment can commence on dolomitic areas. From this legal review process an assessment framework will be derived, leading to the case study evaluation of four case studies of Dolomite Risk Management plans.

To achieve objective 3 a comparative analysis of case studies to determine to what extent they comply with the legal base established in the literature review.

The reason for the use of case study evaluation is that evaluation is a “well-established field of study” and is also regarded as “the process of making a judgement about the value or worth of an object under review” (Owen & Rogers, 1999). According to Owen and Rogers (1999) evaluation should essentially include: 1) establishing criteria of worth; 2) constructing standards; 3) measuring performance and comparing with standards; and 4) synthesizing and integrating evidence into a judgment of value. Chapter 3 was consequently developed from South African legislation and regulations to provide for the ingredients of evaluation followed by a judgment of value of the four DRMP case studies in Table 2. Considering the advice of Silverman (2006) and Yin (2003), the researcher purposively chose four case studies for analysis to achieve objective 3. Of particular importance was the case study research method’s ability to deal with a full variety of data collection techniques. The rationale for the choice of the case studies is provided in Chapter 4.

### **2.3 Case study selection and context**

As indicated in the methodology section 2.1 of this study, the case studies were chosen based on the characteristic of being able to deal with different data collection techniques. These four case studies were selected because of the geographical location that it covers. The areas that these studies cover are of critical concern with respect to dolomite and are within the municipalities, which have implemented a Dolomite Risk Management Plan.

The case studies will be presented in the following order, (Annexure A – B):

- (i) The Irene Farm Villages Dolomite Risk Management Plan (Annexure A),
- (ii) The Ekurhuleni Dolomite Risk Management Policy (Annexure B)
- (iii) The Tlokwe Dolomite Risk Management Strategy (Annexure C), and
- (iv) The Merafong City Local Municipality Dolomite Risk Management Plan (Annexure D)

The Irene Farm Villages Dolomite Risk Management Plan only covers a small geographical area in relation to the Ekurhuleni Metropolitan Area and the Tlokwe City Council and consequently the strategy is more focused and limited. In the Ekurhuleni Metropolitan Area more than 50% of the land area is located on dolomite land including areas of “intense” residential, commercial and industrial development and is therefore more elaborate than the Irene Farm Villages Dolomite Risk Management Plan. (Ekurhuleni, 2013)

The Tlokwe Dolomite Risk Management Strategy covers all the dolomite in the Potchefstroom District, which includes the area, governed by the Tlokwe City Council. Most of the dolomite occurs within the Ikageng and Lindequesdrift areas (Tlokwe City Council, 2013).

The Merafong City Local Municipality Dolomite Risk Management Plan covers areas in Gauteng such as Carletonville, Welverdiend and Khutsong. This area therefore forms part of the 25% of dolomite, which occurs in Gauteng and is itself underlain by 50% dolomite (Merafong, 2009)

## **2.4 Validity of data and results**

In qualitative research a reliable measure is one which produces the same response to a question and consequently allows for replication of previous studies (Flick 2014). In this study, the case study evaluation will need to give the same results if it is compared to the criteria set out in chapter 4 from an external individual, it should therefore have concurrent validity. (Shuttleworth, 2009)

According to Sitko (2013), qualitative methods are inherently iterative. Immediately analysing the data allowed for progressive focusing of the subsequent case studies. Through data reduction, the data was diagrammatically displayed for the purpose of analysis and the validity of the data could be enhanced so that the results could consequently be logically indicated.

According to Miles and Huberman (1994) “data reduction refers to the process of selecting, focusing, simplifying, abstracting, and transforming the data that appear in written up field notes or transcriptions” or in the case of this study, the literature study.

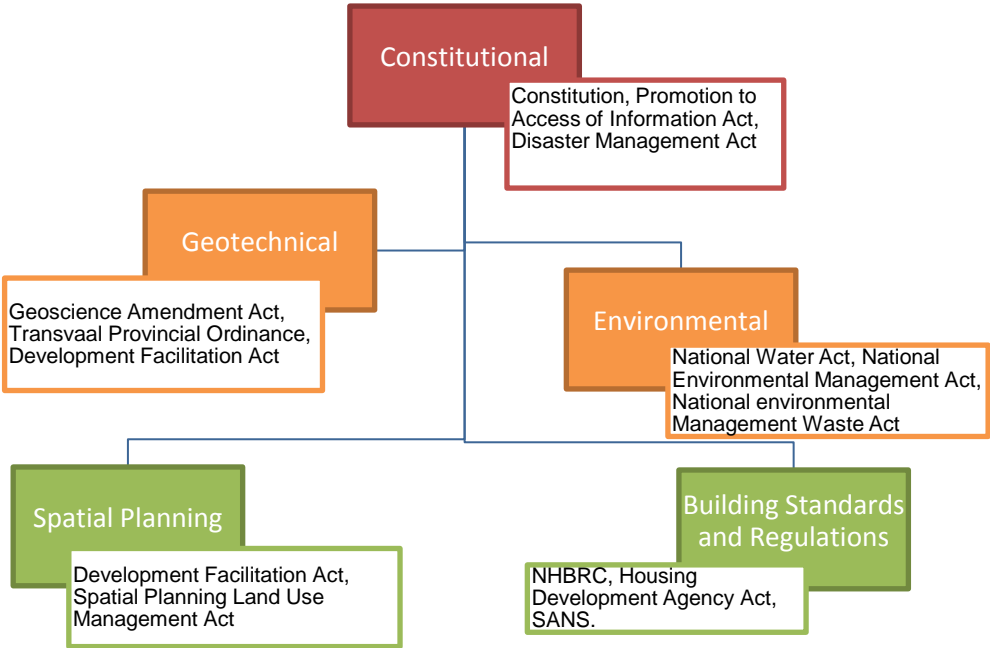
For the purpose of the validity of this study the method of triangulation has been implemented by means of collecting information from a diverse range of literature, investigator triangulation to minimize systematic bias arising from single source as well as using a mixed method research methodology for methodological triangulation (Guion *et al.* 2013).

**3.1 General aim of the literature review**

The aim of this chapter is to aid in achieving objectives one and two. The review will firstly aid in determining “why there is a need for a Dolomite Risk Management Plan to inform town-planning decisions” and will then aid in establishing assessment criteria to asses the case studies. The latter will be used in Chapter 4 as the framework for evaluating four case studies. An emphasis is put on all legislation and parts of legislation related to dolomite that are found in South African law, whether directly or indirectly.

**3.1.1 Theoretical perspective on the need for Dolomite Risk Management Plans**

The legal hierarchy (Figure 1) demonstrates the order by which legislation in this review will be approached. The Constitution of South Africa (1996) should be approached first as a priority, as it involves the rights of humans, which is the basic point of departure for a Dolomite Risk Management Plan.



**Figure 1 Legislative Hierarchy**

### **3.1.2 Literature sources for establishing assessment criteria for evaluating Dolomite Risk Management Plans**

The following legislation sources were chosen because they all pertain to dolomite and development directly as well as indirectly. Some of the legislation is more aimed at the development of Dolomite Risk Management Plans and other at a governmental context and their responsibilities towards elements such as co-operative governance and public administration and access to information. Together, they all form part of a basis that a DRMP should be accountable to.

#### **3.1.2.1 Constitutional and Inter Governmental Framework**

The constitution of South Africa was enacted in 1996 and forms part of the basis and law that governs the country and it enumerates a bill of rights for South African citizens. Section 24 of chapter 2 of the constitution directly states obligation towards the environment.

As stated by Section 24 of the Constitution (1996), the government has a duty regarding the health and safety of its inhabitants:

- i (a)“Everyone has the right to an environment that is not harmful to their health or well-being” while Section 152 (1)(d) states “the object of local government is to promote safe and healthy environments”

Because a Dolomite Risk Management Plan are not only focused on the present situation but must protect the environment for future generations, the following part of section 24 are therefore also imperative to indicate the need for a DRMP.

- ii (b)“to have the environment protected, for the benefit of future generations, through reasonable legislative and other measures that prevent:
  - ecological degradation
  - promote conservation, and
  - secure ecological sustainable development.”

Within local municipalities, this is substantiated with the Local Government Municipal Systems Act (32 of 2000), Section 11(3) where the Council of a municipality ... “has the duty to ... (l) promote a safe and healthy environment in the municipality”.

### **3.1.2.2 Environmental legislation**

#### **National Environmental Management Act, (107 of 1998)**

Within the principles of the first chapter of the National Environmental Management Act, (107 of 1998) (NEMA), Section 2 (2) it states that; environmental management must place people and their needs at the forefront.

In agreement with the Constitution, NEMA also affirms in its Section 2(1)(a) of the principles, “*that all actions by organs of state that may significantly affect the environment shall apply alongside all other appropriate and relevant considerations*” which include the states obligation to protect, respect, fulfil and promote the economic and social rights of all people.

The expression or term environment also pertains to humans and the surroundings within which we co-exist and live. The environment that is made up of amongst other the water, land, as well the atmosphere of the earth and the inter-relationship between them, all of these can affect dolomite (Coetzee *et al.* 2012)

When placing environmental management’s perspectives to dolomite, it can be said that you cannot manage dolomite but you can however manage the behaviour and activities of people that will impact dolomitic areas particularly when it comes to the above-mentioned environmental factors. Environmental management is therefore directed at regulating or directing the behaviour of people in a given society and location through a legal framework.

According to Potgieter (2012) the term sustainability is an indispensable term when it is linked to the management of dolomite; it turns into a governance matter and not just an environmental problem. This gives rise to a ‘precautionary’ approach being implemented where, as the authority in this instance must prevent harm as the leading method of environmental protection, and when knowledge is limited, applies a precautionary approach.

The government also has a duty of care as it is indicated in NEMA. With the use of natural resources in a given area, it is the government's responsibility to prevent environmental harm and to protect people. Environmental harm due to pollution can also have detrimental effects on dolomite and consequently, section 2(4)(a) of NEMA affirms that sustainable development necessitates the deliberation of all applicable factors including the following:

- ii That pollution and degradation of the environment are avoided, or, where they cannot be avoided, are minimised and remedied;
- iii That a risk-averse and caution approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions; and
- iv That negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where they cannot altogether be prevented, are minimised and remedied.

The consequences of pollution on dolomite will be discussed further in the section on the National Environmental Management Waste Act (59 of 2008) (NEM:WA). It is overall essential to take note that contamination and pollution must be avoided as it can potentially have a severe consequence on dolomite. NEM:WA highlights that it is essential that when knowledge of a situation is not complete such as the probable consequences of managing dolomite, a caution and risk-averse methodology must be taken.

With regards to public participation, NEMA states in Section 2(4)(f) that the involvement of all interested as well as affected persons in environmental governance must be encouraged, and all individuals must receive the opportunity to develop the skills, understanding and capacity required to achieve effective and equitable participation. Participation by disadvantaged and vulnerable individuals must also be ensured.

Since research indicates that almost all recent sinkholes and dolines formed in South Africa were man-induced (Buttrick & Roux 1993), public participation is an important tool to reduce the impacts of dolomite. Public participation will be further discussed under the Public Administration and Information Act.

According to Section 2(4)(l) of NEMA with regards to co-operative governance, there must be harmonisation of policies and legislation and intergovernmental co-ordination relating to the environment. This means that policy and planning documents such as IDPs, SDFs and housing sector plans should be aligned with other local and provincial document as well as to a national level. Therefore, all planning documents should contain all possible information concerning dolomite in its relevant and strategic area.

### **National Water Act, (36 of 1998)**

In Chapter 4 of the National Water Act (36 of 1998) (NWA), the usage of water based on extraction from resources is explained, whether from underground or aboveground. This is especially noteworthy when dolomite is present in the region and when water is being abstracted from ground water resources and not managed appropriately through infrastructure and legislation.

Every water usage, which does not fall within domestic water use or under schedule one of the NWA, needs to be licensed if it occurs on dolomite. Consequently, the Department of Water Affairs has the right to grant water usages and also prohibit water usages where it is safe or unsafe to do so and subject to any condition.

With the occurrence of dolomite it is particularly vital that the authority has every process in place to limit unnecessary water uses in these regions and that water usage is administered from a dolomite perspective as the uncontrolled usage of ground water can lead to sinkholes formation.

If these measures are absent, it can have disastrous consequences to a community and would not be in agreement with the Constitution of South Africa. When it comes to issuing of licenses the following regulations 29 (1)(a) and (b) of the NWA must be considered:

(1) A responsible authority may attach conditions to every license –

(a) Relating to the protection of -

(i) The water resource in question;

(b) Relating to water management by - Specifying management practices and general requirements for any water use, including water conservation measures.

## **National environmental Management waste Act, (59 of 2008)**

With reference to the National Environmental Management Waste Act (59 of 2008) (NEM:WA), licensing must be done with specific care due to the influence of polluted ground water on dolomite. A “waste treatment facility” according to NEM:WA is a site that is used for the purpose of accumulating waste for recovery and treatment, storage, recycling, reprocessing and sorting of waste.

When a license for a waste treatment facility is being considered, Section 48 (d) of the NEM:WA must be taken into consideration where it states that the licensing authority the Department of Environmental Affairs must consider all relevant matters such as a greater environmental and health risk that might appear as the consequence of the position where the waste management activity will be undertaken.

According to the National Water Act (36 of 1998) (NWA), waste includes any solid material or material that is dissolved or suspended in water for example those found in tailings dams and which is deposited or spilled on land as well as into a water course in such volume, composition or manner as to cause or to reasonably likely to cause, the water resource to be polluted. This matter is increased when waste like effluent or acid mine drainage from mines are pumped into tailings dams or lagoons.

### **3.1.2.3 Geotechnical Legislation**

Within the history of geotechnical legislation, it can be detected that there are tendencies or suggestions to develop laws that made developers and local authorities responsible for the investigation of geotechnical conditions.

In 1965 an ordinance was approved by the Transvaal Province Ordinance, (25 of 1965) in which certain regulations in connection with township proclamation were established. In terms of Clause 24(b) of the ordinance, it became compulsory for a town developer to report, amongst other, on “the suitability of the site with regard to soil and the presence of dolomite rock”.

According to van Schalkwyk (1998), the Transvaal Provincial Ordinance (15 of 1986) came into effect on 10 June 1987 and applied to township establishment applications submitted since that date. The ordinance did not make explicit reference to dolomitic land, but in terms of Regulation 18(1),

“an application for the establishment of a township in terms of Section 69 or 96 of the ordinance shall be accompanied by... (b) A detailed report with comprehensive motivation relating in the township with special reference to... (cc) how the township will be affected by...(bbb) geotechnical conditions...”

Provision was consequently made in the ordinance for the appointment of authorised municipalities with authorities to administer the ordinance and approve town-planning schemes in their area of jurisdiction.

The Geoscience Amendment Act, (16 of 2010) draft regulations, additionally addresses the accountability of the government with areas underlain by dolomite in three development situations. Depending on the condition, a documented investigation in the form of a dolomite risk management strategy must be submitted to the Council for Geoscience (CGS) for advice on how to minimize the hazard of dolomite instability events occurring.

The responsibility of the local authority is addressed in the Draft Regulations of the Geoscience Amendment Act where it states:

- a “All State authorities that are directly considering development or infrastructure of their own on dolomitic land, must prior to authorization for development, submit to the Council for Geoscience an appropriate Dolomite Risk Management Plan for advice to minimize the risk of dolomite instability events occurring;
- b “All state authorities that are approached for permission to develop on dolomitic land under their jurisdiction must, to minimize the risk of dolomitic instability events occurring, ensure that the relevant dolomite-related geotechnical reports are submitted to the Council for Geoscience for review and evaluation prior to authorization by the relevant state authority for development;
- c “All state authorities that have existing developments or infrastructure of their own on dolomitic land shall develop and submit to the Council for Geoscience an appropriate Dolomite Risk Management Plan for advice, to minimize the risk of dolomite instability events occurring”

The Development Facilitation Act (67 of 1995) (DFA) makes policy references to geotechnical research as stated in Section 3 that “the following general principles apply on the basis set out in Section 2, to all land development... “

(h) “Policy, administrative practice and laws should promote sustainable land development at the required scale in that they should-... “

(v) “Ensure the safe utilisation of land by taking into consideration factors such as geological formations and hazardous undermined areas...”

Regulations in terms of Section 46 of the DFA includes more specific instructions in connection with the required geotechnical assessment appearing in Government Gazette no. 17395 of 30 August.

#### **3.1.2.4 Co-operative Governance legislation**

Co-operative Governance amongst local and district authority as well as across provincial authorities are essential when it comes to dolomite. Dolomite is frequently not limited within a single region of jurisdiction and might range for several hundred kilometres. It is consequently essential that local authorities should support other authorities in their planning when dolomite is involved.

Within Chapter 5 of the Development Facilitation Act (32 of 2000) (DFA) Section 24, it provided the procedures for planning and the coalition between district as well as local municipalities. It indicated in Section 24 (1) that:

“The planning undertaken by a municipality must be aligned with, and complement, the development plans and strategies of other affected municipalities and other organs of state so as to give effect to the principles of co-operative governance contained in Section 41 of the Constitution.”

It is consequently essential that municipalities integrate any responsibility with regards to dolomitic matters in an Integrated Development Plan (IDP), Spatial Development Framework (SDF) and Housing sector plans. It ought to not only be incorporated in local municipal SDFs but also in the district, provincial as well as the national SDF.

The Disaster Management Act (57 of 2002) (DMA), provides clear priority to the function of the principle of co-operative governance for the determination of disaster risk

management and highlights the participation of all stakeholders in firming the competencies of municipal, provincial and national organs of state to decrease the probability and severity of disasters.

Disaster management in terms of the Disaster Management Act (57 of 2002) DMA, relates to a constant and integrated multi-disciplinary and multi-sectoral process of development and implementation of procedures intended for:

- Preventing or reducing the risk of disasters;
- Mitigating the severity or consequences of disasters;
- Emergency preparedness;
- A rapid and effective response to disasters; and
- Post-disaster recovery and rehabilitation.

Disaster management centres can apply these as well as disaster management plans as recommended by the DMA (2002) in Section 52. According to Chapter 5 Section 42 of the DMA, (1)

“Each district municipality must establish and implement a framework for disaster management in the municipality aimed at ensuring an integrated and uniform approach to disaster management in its area by (a) the municipality and statutory functionaries of the municipality, including, in the case of a district municipality, the local municipalities and statutory functionaries of the local municipalities in its area”.

There should accordingly be a concurrent methodology towards disaster management within local government. A disaster management framework must be established after consultation with the local municipalities in its area.

### **3.1.2.5 Public Participation**

The formation of public participation in government is recognised in the South African Constitution. Chapter 2 of the Constitution contains a ‘Bill of Rights’ which includes human dignity, equality, environment, freedoms, and also the rights to health care, housing, food, social security, water, education and access to information. In terms of

the responsibilities of local, provincial and national government the Constitution states the following:

“Section 151(1) (e) - obliges municipalities to encourage the involvement of communities and community organisations in local government.

Section 152 - the objects of local government (are) to encourage the involvement of communities and community organisations in the matters of local government.

Section 195 (e) – in terms of the basic values and principles governing public administration – people’s needs must be responded to, and the public must be encouraged to participate in policy-making”

When considering Section 151 (1) (e) of the constitution, persons affected by dolomite should be informed by means of a Dolomite Awareness Plan or similar plan.

According to Section 32 of the constitution, everyone has the “right of access to information held by the state or public body as well as any information held by another person, who is required for the exercise or protection of any rights”. As the matter is concerned with the environmental rights, individuals whether natural or juristic must be informed about the dolomitic hazards that occur in the applicable area. This is also emphasized in the Promotion of Access of Information Act (2 of 2000). A requester of information must be given access to information or a record of a public body, irrespective of the reason for the request. The requester must comply with procedural requirements to obtain any information when it is their right to know about the safety of his or her environment

The (DFA) in Section 21, states that when someone or a community needs to be informed by a municipality in terms of the DFA or any other applicable legislation, it must be done according to Section 21, (1 – 5). This section provides the types of media that can be implemented and the manner in which it should be used to convey to the public.

### **3.1.2.6 Spatial Planning Legislation**

The Spatial Planning Land Use Management Act, (16 of 2013) (SPLUMA) that was enacted in 2013 repealed the Removal of Restrictions Act (84 of 1967), Physical Planning Act (88 of 1967) and (125 of 1991) and the Development Facilitation Act (67 of 1995).

SPLUMA intends to provide a framework for spatial planning and land management in South Africa. In Chapter 2 of the SPLUMA, Section 6, it specifies that the subsequent principles will apply to spatial planning, land use management and land development,

“(b) The principle of spatial sustainability, whereby spatial planning and land use management systems must; (i) promote land development in locations that are sustainable... and (ii) result in communities that are viable.”

The sustainability of developing on areas underlain by dolomite must consequently be first established. In Section 20 of the SPLUMA, it refers to the properties of a Spatial Development Framework (SDF). According to Section 20(j) a regional SDF must incorporate a strategic assessment of the environmental opportunities and pressures in the municipal jurisdictional area. SPLUMA does not mention dolomite explicitly, but since dolomite contribute to an area being a sensitive environmental region for development, it must be taken into consideration.

### **3.1.2.7 Building Standards, Regulations and Guidelines**

According to the National Building Regulations and Building Standard Act (103 of 1977) and its amendments, an appropriate geotechnical investigation is one that was conducted in accordance with the requirements of the South African National Standards, SANS 10400-H and SANS 10400-B. The National Building Regulations refers to dolomite as:

‘

“Land underlain by dolomite or limestone residuum or bedrock (or both), within the Malmani Subgroup and Campbell Rand Subgroup, typically at depths of no more than

a) 60 m 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; 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”

The SANS 10400-H is written with specific references to building foundations. Therefore the application of the national building regulations require one to utilize the SANS 10400-H when constructing foundations on dolomite.

The National Home Builders Registration Council (NHBRC) is a statutory body established in terms of Section 2 of the Housing Consumers Protection Measures Act (95 of 1998), as amended, with the mandate, amongst others, to establish and promote ethical and technical standards in the home building industry. The NHBRC is also mandated to provide warranty protection to housing consumers against defined defects in new homes and to regulate the home building industry. In terms of Section 12(1) of the Act, the Council of the NHBRC publishes a Home Building Manual containing the NHBRC’s technical requirements and guidelines.

The Housing Development Agency Act, (23 of 2008) was established to give everybody access to sufficient and adequate housing in terms of Section 26 of the Constitution. As with the possibility with having to relocate due to the impacts of dolomitic land, this act is especially crucial with defining new areas for relocation and quality of new homes. It states in Section 7 (2) of the act, that in performing its function, the Agency must:

“Ensure that residential and community development are sustainable, viable and appropriately located”

Therefore, the local or district authority must confirm that new housing developments or those that needs to be relocated conform with the processes set out by the Housing Development Agency Act; these measures are stated by the National Home Builders Registration Council (NHBRC).

Consequently if the IDP or SDF have declared an area unsafe due to the occurrence of dolomite or that special care should be taken, the new housing development or

relocation must also conform to the measures that were set out by the IDP and SDF of that area.

The Department of Public Work has drafted the “appropriate development of infrastructure on dolomite” guideline, which is specifically aimed at consultants doing development on dolomite. This guideline must be used in accordance to the measures set out in by the NHBRC and Housing Development Agency.

According to the Department of Public Works (2010) the “document serves as a guideline on appropriate development and risk management of infrastructure located on dolomite in South Africa”. This guideline is intended to inform key agents and other consultants of the minimum requirements of the Department of Public Works regarding the upgrading, extension and development of new infrastructure on dolomite, to promote safe, sustainable development.

From the legal review in Chapter 3.1, it can be established with which broad legalities development on dolomite must comply. It can be seen as a concept of risk management and in this case the risks with the greatest impact and the greatest probability of occurring must get priority.

## **3.2 Review from relevant case studies**

Considering the legal review, Potgieter (2012) states “In practice, the process of assessing overall risks can be difficult, and balancing resources used to mitigate between risks with a high probability of occurring but lower loss versus a risk with high loss but lower probability of occurrence can often be misjudged.”

Consequently, an area underlain by dolomite must undergo a broad hazard identification not only limited to a geotechnical investigation but to all involved environmental questions to establish all the issues involved as well as the ranking of all hazards.

### **3.2.1 Dolomite Risk Management Plan**

According to the Council for Geoscience, a “Dolomite Risk Management Strategy refers to the process of using 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 sinkholes and subsidence occurring on dolomite land”. (Council for Geoscience, 2007a)

The South African National Standards (SANS) for development of dolomite land SANS 1936:2012 states in part 4, which is dedicated to risk management on dolomite, that a Dolomite Risk Management Plan must be established to reduce risk. This also appears in the Draft Regulations of the Geoscience Amendment Act.

Part 4 of the above mentioned SANS defines a Dolomite Risk Management Strategy as a document, which includes “pro-active policies and procedures which govern all facets of development on dolomite land, including planning, the design of structures, site development design, installation of water bearing infrastructure and maintenance and water abstraction enforcement”. Although SANS 1936-4 (2012) cover all developmental facets, it does not include more specific reference to environmental management. The legal review in Chapter 3.1, the Department of Public works guideline as well as SANS 1936-4 (2012) will be used to define physical factors as well as the anthropogenic factors pertaining to development on dolomite.

### **3.2.2 Physical factors**

For this study physical factors include the assessment of geological, geohydrological geotechnical as well as a physical assessment of factors that can have an impact on dolomite.

#### **3.2.2.1 Geological assessment**

The geology within the study area is the most important factor according to Potgieter (2012) within the land use and spatial development area. There can be distinguished between the regional geological condition and the local geological condition. When it comes to regional geology the stratigraphy, general characteristics, content and structure play an important role. With local geology or on a local scale, the type of geology must first be determined, including local geological structures and features including faults and fractures (Pretorius, 2012).

After the depiction of the regional and site specific geology in the study area, a methodology must be defined to develop a theoretical geological zone model and a risk

zoning for the area (Potgieter, 2012). To confirm the geological zone, field observations as well as drilling results must be incorporated.

### **3.2.2.2 Geohydrological assessment**

According to Potgieter (2012), the risk of instability in dolomitic terrains is directly affected by the Geohydrological conditions of the area. Changes in the groundwater quantity and quality within the dolomitic terrains can lead to ground instability and sinkhole formation. Both the natural character of the groundwater regime and human interaction needs to be defined. There are three apparent progressions that can cause sinkhole formation in relation with the dewatering of the underlying dolomite compartments:

- i As soon as the supporting hydrostatic pressure is removed by dewatering activities, the overburden on top of near surface cavities exceeds a critical point, sinkholes and dolines can develop.
- ii Many sinkholes form during rainy seasons, and especially after periods of heavy rainfall (Moen & Martini, 1996). As the soil becomes saturated, the critical weight is also exceeded whereby the supporting rock in the roof of a cavity fails to support the heavier overburden.
- iii Rainfall also causes erosion of unconsolidated surface material through pre-existing channels into underground cavities, leading to the upward migration of cavities.
- iv Again, one can distinguish between regional ground water conditions and local ground water conditions. The regional ground water tendencies may give a representation of the local geohydrological regime of the site. The local groundwater levels are necessary to evaluate the monitoring information and to develop trends with time.

From a dolomite perspective, it is therefore not only essential to determine the range and size of subsurface cavities, but also to monitor the ground water level. Sinkholes are to be expected to develop in areas with relatively shallow dolomite when the water table fluctuates with more than 5-6m in response to ground water abstraction. The dolomite guideline of the Department of Water Affairs was developed in 2009 as a tool

to effectively enable the assessment, planning and management of groundwater resources in dolomitic terrain and can be used for the purpose of development on dolomite.

### **3.2.2.3 Geotechnical assessment**

In order to understand the implications of land use and spatial development on dolomite land within a study area, it is important to conclude the geological description with reference to the character of dolomite and the occurrence of related dolomite structure like sinkholes and dolines.

Geotechnical stability of dolomite is based on hazard characterisation and evaluation procedures, which can be determined through a geotechnical assessment. These parameters are all based on and evaluated against data that are gathered by drilling of percussion boreholes. (Pretorius, 2012)

According to the Department of Public Works, (2004), the geotechnical engineer must indicate through the above mentioned geotechnical assessment the following:

- In which zones the erection of structures are permissible
- Where sports facilities/parking lots/parade grounds/radio masts, etc. (structures and wet services) may be developed
- Provide appropriate (site specific) comments of subsurface remedial work
- Anticipated foundation problems
- Water precautionary measures for each stability zone.
- Comment in general on earthworks to be conducted (borrow/fill/surficial soil disturbances, etc.)

The Department of Public Works' guideline indicate the following with regards to dolomite risk zoning by means of a geotechnical study. The study must demarcate low, medium and high-risk areas with specific development notes of each as well as other geotechnical problematic areas with specific descriptions thereof.

A geotechnical assessment is subsequently one of the most important parts to form a link between the geological reality and the making of town planning decisions. A physical assessment must also be done to determine situation of what currently exists in a specific study area.

### **3.2.2.4 Physical assessment**

The main finding of the physical environment, which can affect the dolomitic area, must be gathered. The combination of all the major contributing factors within the physical environment will largely result in an estimated average overall high risk factor. These physical conditions can include:

- i Drainage
- ii Topography
- iii Geophysical conditions
- iv Boreholes for water abstraction
- v Storm water management
- vi Waste water management (sewer)
- vii Water storage (dams and swimming pools)
- viii Electricity and communication
- ix Water infrastructure
- x Roads
- xi Foundations

### **3.2.3 Anthropogenic factors**

#### **3.2.3.1 Existing infrastructure and development**

The particular quality of infrastructure on dolomite is of great significance to the ground stability of urban areas underlain by dolomite. This is due to the enduring effect of fluids on weathered material spread over the surface of cavities. Water permeation from leaking sewerage or pipes has the likelihood to dissolve and erode the Calcium component of dolomite at a far greater rate than its natural dissolving rate (Blinkova & Eliseev, 2005).

### 3.2.3.2 Land use planning

Land use planning is defined in the Spatial Planning Land Use Management Act, 16 of 2013. It states that “*it is the planning of human activity to ensure that land is put to the optimal use, taking into account the different effects that land uses can have in relation to social, political, economic and environmental concerns*”. As land use planning leads to the establishment of population growth and encourages land development, more risk is created when communities are situated on dolomite.

According to Buttrick *et al.* (2011) “urban development commonly disturbs the meta-stable conditions in the dolomite environment which can lead to sinkhole formation”. He also goes further and indicates that from 1982 to 2004, 650 sinkholes manifested in an area of 3700 ha urbanised land near Pretoria, Gauteng. Of these sinkholes 643 (99%) were found to be directly attributed to leaking services or human negative influence. Of the 650 sinkholes, 246 were found to have caused damage to buildings. The damage was equal to a loss of 220 331m<sup>2</sup> of buildings and US \$ 250 million in damages. (Buttrick *et al.*, 2011)

When it comes to town zoning on dolomite it is important that the allowed densities must be directly taken from the dolomite risk zoning which was established through the geotechnical investigations. There are numerous possibilities of development on dolomite when the correct densities are being considered. These possibilities can be found in the Council for Geoscience’s approach to residential development on dolomite (2007b).

**4.1 Data analysys and results**

In this chapter the four chosen case studies will be measures against all the criteria indicated in Table 2 which was established from legislation in Chapter 3, it is therefore a comparative analysis of the case studies to determine to what extent they comply with the legal base established in the literature review. The outcome when the Risk Management Strategies are studied with regards to physical and anthropogenic factors will determine whether dolomite risk management is sufficient with regards to these case studies. This chapter firstly provides context to the case studies chosen (Table2), it then provides the analysis of the case studies before the results and the conclusion of the chapter.

**4.1.1 Framework for analysis**

The legal review was paramount in the compilation of Table 2, as well as to indicate the association between the different legislation, regulations and guidelines.

The following table will indicate through an analysis of the 4 case studies, which of them complies with all or certain part of the required legislation to determine, if indeed development on dolomite is managed sufficiently.

As a qualitative analysis method was used in this study, an evaluation matrix was developed to assist in the sorting of actions and to determine the extent of value added by verifiers. The assessment keys indicated below provide an indication of how the objective was achieved.

**Table 1. Description of Assessment keys**

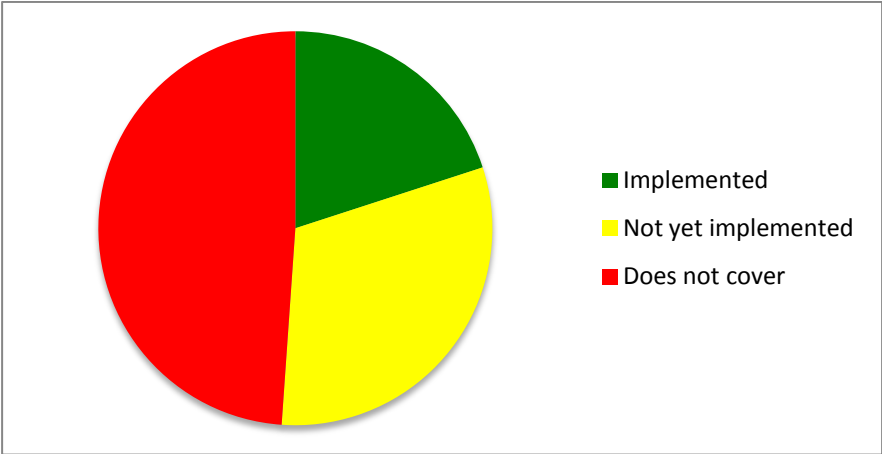
|                                     |   |
|-------------------------------------|---|
| <input checked="" type="checkbox"/> | Implemented: This means that DRMP discussed and implemented the certain criteria  |
| !                                   | Not yet implemented: This means that the DRMP discusses the certain criteria but it has not been implemented, by the plan or the responsible body (development of municipality) |
| <input checked="" type="checkbox"/> | Does not cover: This means that the DRMP does not cover the specific topic nor has the responsible body implemented it.   |

**Table 2. Assessment of Dolomite Risk Management Plans**

| Factors                            | Type of Assessment                           | Requirements  | Irene Farm Village DRMP                             | Ekurhuleni DRMP | Tlokwe DRMS | Merafong DRMP |   |
|------------------------------------|--|---|---|-----------------|-------------|---------------|---|
| 1. Physical Factors                | 1.1 Geological Assessment                    | Occurrence of sinkholes must be dealt with according to standards                                     | ↑   | ↑               | ✓           | ✗             |   |
|                                    |  | Hazard Zoning   | ✗   | ✓               | ✓           | ↑             |   |
|                                    |  | Risk Hazard Rating of areas   | ✗   | ✓               | ✓           | ↑             |   |
|                                    |  | Indication of Highly Susceptible Areas  | ✗   | ↑               | ✓           | ✓             |   |
|                                    | 1.2 Geohydrological Assessment               | Requirements for the control of de-watering and monitoring of groundwater levels                      | ✗   | ✓               | ✓           | ✓             |   |
|                                    | 1.3 Geotechnical Assessment                  | Development is appropriate in relation to the inherent hazard   | ✗   | ✓               | ✓           | ✗             |   |
|                                    | 1.4 Physical Assessment                      | Drainage  | Requirements for the management of surface drainage | ↑               | ↑           | ✓             | ↑ |
|                                    |  | Topography  | Taking ground elevation into account                | ✗               | ✗           | ✓             | ✗ |
|                                    |  | Geophysical Conditions  |   | ✗               | ↑           | ✓             | ✗ |
|                                    |  | Boreholes   | For water abstraction                               | ✗               | ✓           | ✓             | ✓ |
|                                    |  | Storm Water Management  | According to design standards                       | ↑               | ✓           | ✓             | ↑ |
|                                    |  | Waste Water Management  |   | ↑               | ✗           | ↑             | ↑ |
|                                    |  | Water Storage   |   | ↑               | ↑           | ↑             | ↑ |
|                                    |  | Electricity and Communication   |   | ✗               | ✗           | ↑             | ✗ |
| Water Infrastructure               |  | ✓   |   | ✓               | ✓           | ↑             |   |
| Roads and Trenching                | ✓  | ↑   |   | ↑               | ✗           |               |   |
| Foundations                        |  | ✗   | ✗   | ✓               | ✗           |               |   |
| 2. Anthropogenic Factors           | 2.1 Existing Infrastructures and Development | Requirements for the installation of below-ground infrastructure (e.g. water bearing infrastructure). | ✓   | ↑               | ✓           | ✗             |   |
|                                    |  | Hazard Zoning for the provision of infrastructure   | ✗   | ✓               | ✓           | ↑             |   |
|                                    |  | Design Requirements and procedures for building and infrastructure                                    | ↑   | ✓               | ✓           | ✗             |   |
|                                    |  | Maintenance programmes for infrastructure   | ↑   | ✓               | ✓           | ✓             |   |
|                                    |  | on-going precautionary measures and the monitoring and maintenance of buildings and infrastructure    | ↑   | ✓               | ✓           | ✓             |   |
|                                    |  | Reporting of damage to infrastructure and structures system   | ✓   | ↑               | ↑           | ✗             |   |
|                                    |  | Building Control to apply to Dolomite Management  | ✗   | ✓               | ✓           | ✓             |   |
|                                    | 2.2 Land Use Planning                        | Placing Restrictions on Land Use and densities  | ✓   | ↑               | ✓           | ✓             |   |
|                                    |  | Current land usage does not compromise the future use of such land                                    | ↑   | ↑               | ↑           | ↑             |   |
|                                    |  | Recommending correct development on suitable hazard rating including correct zonings                  | ✗   | ✓               | ✓           | ✗             |   |
|                                    |  | Dolomite Risk Management on Servitudes  | ✗   | ✓               | ✗           | ✗             |   |
|                                    | 2.3 Construction Design                      | Design of structures for short, medium and long term safety and stability                             | ✗   | ✓               | ✓           | ✗             |   |
|                                    | 2.4 Water Use Management                     | Abstraction, Storing, and Waste   | According to the NWA (36 of 1998)                   | ✗               | ✗           | ✓             | ✓ |
| 3. Social Factors                  | 3.1 Social Assessment                        | Dolomite Risk Awareness training programme  | ✗   | ↑               | ✓           | ↑             |   |
| 4. Management Factors              | 4.1 Monitoring Assessment                    | Reporting of Management Plan's performance to Authority   | ↑   | ✓               | ↑           | ✗             |   |
|                                    |  | Monitoring Guidelines during construction   | ✓   | ✓               | ↑           | ✗             |   |
|                                    |  | Reporting of all incidents system   | ✓   | ✓               | ✓           | ✗             |   |
|                                    |  | Recording of all incidents system   | ✓   | ✓               | ✓           | ✗             |   |
|                                    |  | Process of initiating actions to mitigate risks   | ↑   | ✓               | ✓           | ✗             |   |
|                                    | 4.2 Resource Assessment                      | Establishing resources (personnel) to manage risk and implement strategy                              | ↑   | ✓               | ✓           | ↑             |   |
|                                    |  | List of registered owners with wet and dry services not maintained by the local authority             | ↑   | ✗               | ↑           | ✗             |   |
|                                    | 4.3 Authority Assessment                     | Strategy incorporated at levels   | Local Authority                                     | ✗               | ✗           | ↑             | ✗ |
|                                    |  |   | Bulk Service provider/Government department         | ↑               | ✓           | ↑             | ✗ |
|                                    |  |   | Co-operative Governance                             | ✗               | ↑           | ✓             | ✗ |
|                                    |  |   | Corporate Ownership                                 | ✗               | ✗           | ↑             | ↑ |
| 4.4 Personnel Liability Assessment |  | Individual development  | ✗   | ✗               | ↑           | ✗             |   |
|                                    |  | Insurance Cover   | ✗   | ✓               | ✗           | ✗             |   |
|                                    |  | Emergency Reaction Plans  | ✓   | ↑               | ↑           | ✗             |   |

**4.2 Results for the evaluation of the Irene Farm Village Dolomite Risk Management Plan**

Through the comparative analysis in Table 2 it is indicated that from all criteria, the Irene Farm Village Dolomite Risk Management Plan has the second most aspects that were not covered. Most of the weaknesses of the plan can be seen in the lack of physical assessment of the conditions such as geological assessments, geohydrological assessments and geotechnical assessments. This however, is a crucial part that is missing from the plan, as it will mainly inform how the rest of the plan must be compiled.



**Figure 2 Irene Farm Village Dolomite Risk Management Plan**

According to the legislation and guidelines discussion in Chapter 3, it can be seen from the results that 49% of the plan does not cover the necessary requirements needed to manage dolomite properly (Figure 2). This case study has implemented 20% of therequirements and at least mention but has not implemented on site 31% of the requirements set out in Chapter 3. As mentioned in Chapter 4, the Irene Farm Village plan only covers a very small area in relation to the other three plans. It must be noted that the area is of low density with a high socio-economic status in relation to the other areas and therefore does not require the same detailed plan. The following criteria are not covered, but can be seen as critically important:

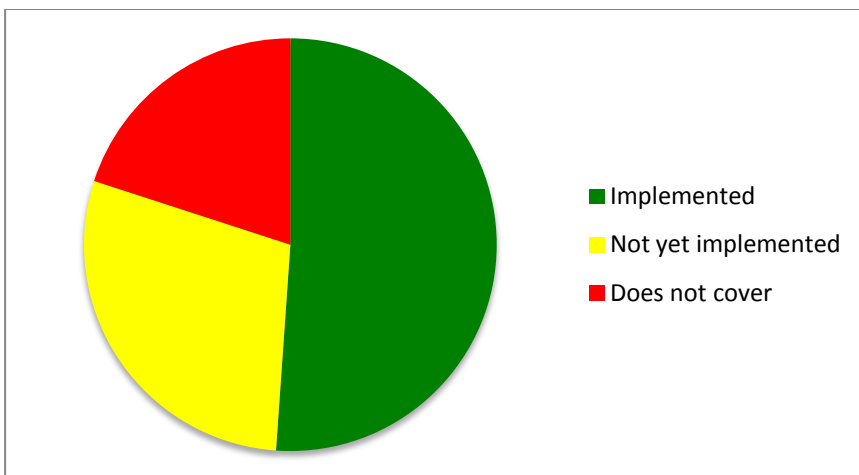
- Hazard zoning
- Geotechnical assessment
- Indication of highly susceptible areas
- Ground water monitoring and de-watering

- Development appropriate in relation to the inherent hazard
- Foundation requirements
- Building control related to dolomite
- Water storing
- Social awareness plan

The Irene Farm Village Dolomite Risk Management Plan will consequently need to perform the above-mentioned post development criteria as development has already taken place to establish a more detailed mitigation plan

### 4.3 Results of the evaluation of the Ekurhuleni Dolomite Risk Management Policy

Through the comparative analysis in Table 2, it is indicated that of all four the case studies, the Ekurhuleni Dolomite Risk Management Policy has the second most implemented criteria as established in Chapter 3. The Ekurhuleni plan is an elaborated plan with most of its strengths in the management factors. This can be seen as an improved method of assisting town planners in decision-making process.



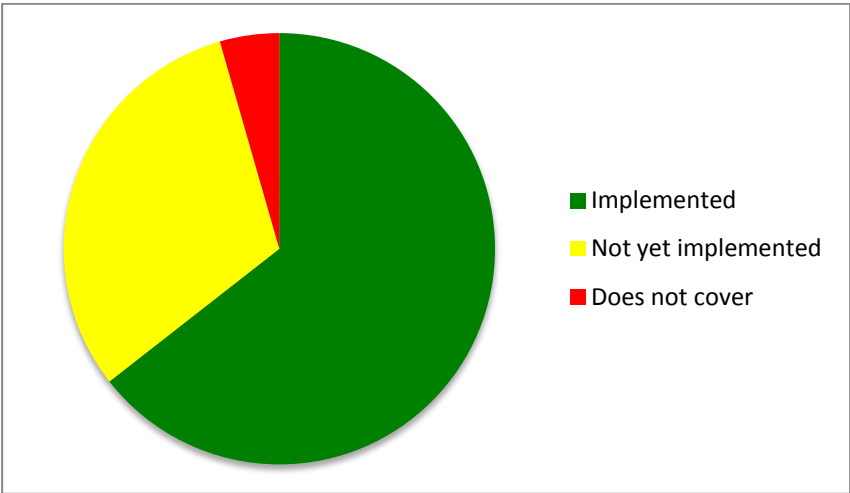
**Figure 3 Ekurhuleni Dolomite Risk Management Plan**

The Ekurhuleni Dolomite Risk Management Policy covers about 80% of all the requirements set out in Chapter 3 for developing on dolomite (Figure 3). It is therefore a much more comprehensive plan than the Irene Farm Village plan. It also covers a very large area with much more urban development than the other 3 plans. Some of the

positive points of this plan are that it has a dedicated dolomite section within the municipality to constantly monitor development on dolomite as well as any incidents that may take place to mitigate it according to the correct guidelines. The only real weakness to the plan is that it does not mention requirement for licensing of water abstraction and storing.

**4.4 Results of the evaluation of the Tlokwe Dolomite Risk Management Strategy**

Through the comparative analysis in Table 2, it is indicated that the Tlokwe Dolomite Risk Management Strategy has the most implemented criteria as established in Chapter 3. Most of its strength can be found in the physical factor assessment prior to developing the strategy. Assessment of the physical factors is imperative in guiding the developing of a DRMP and can be seen as a deficiency in the other plans.



**Figure 4 Tlokwe Dolomite Risk Management Plan**

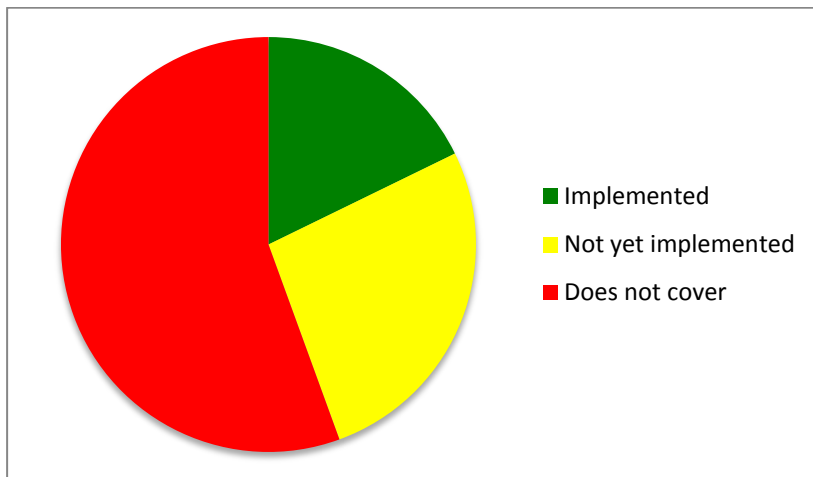
The Tlokwe Dolomite Risk Management Strategy is the most recent strategy of the four and was only completed at the end of 2013; it consequently had access to the most recent publications of guidelines and legislation of development on dolomite. This strategy cover 96% of the legal requirements needed for development on dolomite (Figure 4). One of the positive points of this strategy is the comprehensive risk class analysis, which the other three plans do not have. It also has a dolomite awareness plan, which have been implemented since 2012 and will be going on up until 2018.

The need for the comprehensive risk zoning and awareness plan was established due to the high-density urban areas in Ikageng that are situated on dolomite, which is

developing rapidly. The socio-economic construct of this area consequently desired a more elaborate plan for the mitigation process, which follows after the plan has been implemented.

#### 4.5 Results of the evaluation of the Merafong Dolomite Risk Management Plan

Through the comparative analysis in Table 2, it can be seen that the Merafong Dolomite Risk Management has the most aspects that were not covered, as established from Chapter 3. Most of the plan's weaknesses fall within its management factors and consequently has the greatest lack of guiding town planning decision-making. The Merafong Municipality has numerous mining activities, which makes it a high-risk area for development on dolomite.



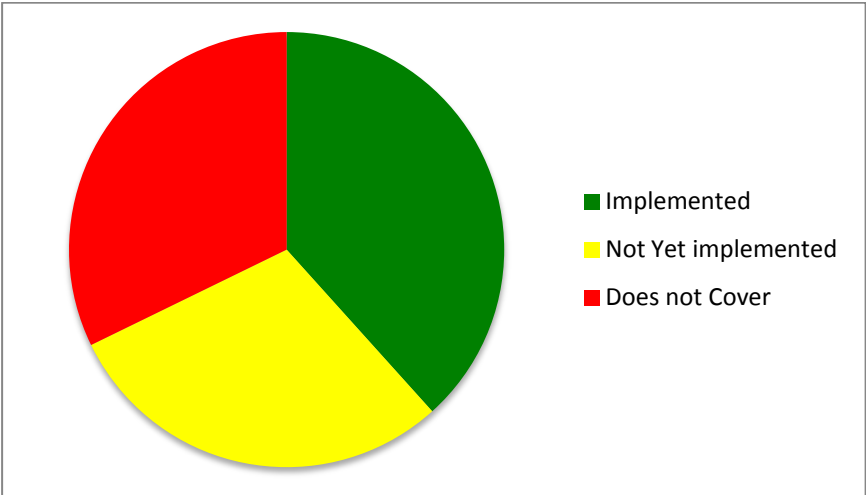
**Figure 5 Merafong Dolomite Risk Management Plan**

The Merafong City Local Municipality is one of the areas with the highest dolomite risk (Merafong DRMP). It is therefore interesting to see that their plan covers less than 50% of the required legislation for development on dolomite (Figure 5). This municipality's plan had its third review in 2009, which makes it the oldest of the four plans in this study. Some of the positive points of this plan are that it indicates that water uses such as abstraction of ground water must be licensed. It also indicates that there must be some sort of social awareness, but it is only limited to body corporates and inhabitants of complexes.

#### 4.6 Combined results for all four case studies

Of the four case studies, two of the studies, Ekurhuleni and Tlokwe, are satisfactory regarding the management of the development on dolomitic land. It takes enough requirements into consideration with regards to the pre-development as well as the post-development phases towards the mitigation development on dolomite land.

The Irene Farm Village Dolomite Risk Management Plan should be interpreted as different from the other three plans, due to the small and concentrated area that it covers. It must be asked whether there is a need for such a comprehensive study in a low-density high-income area with adequate infrastructure, which has been installed, prior to development. Since 96% of dolomite incidents are man induced, the biggest contributing factor to this type of areas can be a sufficient dolomite risk awareness plan, which can reduce the risk considerably.



**Figure 6 Combined Results**

From a basic dolomite risk management point of view, all the DMRPs must be compliant with the SANS 1936-4. The document stipulates general requirements for risk management, requirements for the preparation of a provisional DRMS and specific requirements for local authorities (Potgieter, 2013).

Only the Ekurhuleni and Tlokwe case studies complied with the SANS 1936-4 in principle. The SANS 1936-4 covers a very broad application of legislation of development on dolomite but a Dolomite Risk Management Plan or Strategy must not be limited to only complying with this legislation. With regards to the literature review in Chapter 3, it can be seen that there are numerous other legislation that are applicable with development on dolomite which a Dolomite Risk management Plan can include and comply with but which are not necessary included in the four case studies.

When viewing the combined results (Figure 6), it can be seen that the results are almost equally divided between the three assessment topics. 67% of all the necessary legal criteria has been dealt with (implemented and not yet implemented) and 32% has is

currently not being covered by Dolomite Risk Management Plans if the combined results are studied. This means that two-thirds of the required legal base set out in Chapter 3 is not being covered in the plans. Because the plans are geographically specific and in most cases must be done by the municipality, their results must be studied independently.

With regards to criteria being implemented by the four case studies, the Ekurhuleni and Tlokwe plans are above the average. The results of these two plans can be an area where planning decisions can be based on the guiding principles stated. The guiding potential of these plans are therefore high.

The Merafong and Irene farm village plans are below the average set out in this study. It can be concluded that the below average score of the latter two plan can result in a situation where there are not sufficient guiding principles standards to guide town planning decisions towards development. Consequently risk will not be reduced because a systematic approach of geological, hydrological, geohydrological, planning, engineering and social processes, procedures and methodologies cannot be followed. Without the required information, the risk related to dolomite cannot be managed. In the absence of detailed information from a DRMP of the relevant area, further research is required to sufficiently guide town-planning decisions. For municipalities with insufficient plans a precautionary approach is recommended. It is consequently imperative for these municipalities to update their DRMPs so that they are legally acceptable.

## **5.1 Conclusion and recommendation**

The aim of this research is to assess “Dolomite Risk Management Plans’ potential to guide Town-Planning decisions”. The following objectives of the study aided in achieving the aim:

1. Why is there a need for a Dolomite Risk Management Plan to inform town-planning decisions?
2. Establishing assessment criteria from applicable legislation
3. Evaluating four case studies against assessment criteria to determine the potential of Dolomite Risk Management Plan to inform Town Planning Decisions.

The above three objectives were met in the study and the main findings can be summarised as follows:

The results indicate that perhaps the most substantial factor to consider in the management of development on dolomite is the safety of people living on the dolomite. The need for the management of development on dolomite, is therefore, to enhance the safety of people, as it is their right to live in a safe environment according to the Constitution. Town-planning decisions with regards to elements such as township establishment, rezoning and relocations need to be informed by studies such as Dolomite Risk Management Plans to avoid detrimental consequences, damage to urban development and loss of life. It may therefore be concluded that for the purpose of informing town-planning decisions, a DRMP must, in great detail, determine what areas are suitable for which types of development or if any development can occur on dolomite.

In order to assess different Dolomite Risk Management Plans on an equal basis, assessment criteria was taken from relevant South African legislation and guidelines such as:

- The constitution (1996)
- National Environmental Management Act (107 of 1998)
- National Environmental Management Waste Act (36 of 2008)
- National Water Act (36 of 1998)
- Transvaal Provincial Ordinance (25 of 1965)
- Transvaal Provincial Ordinance (15 of 1986)
- Geoscience Amendment Act, (16 of 2010)
- Development Facilitation Act (67 of 1996)
- Disaster Management Act (57 of 2002)
- Promotion of Access to Information Act (2 of 2000)
- Spatial Planning Land Use Management Act (16 of 2013)
- National Building Regulations and Building Standards Act (103 of 1977)
- SANS 10400-H
- SANS 10400-B 1 – 4
- SANS 1936:2012
- Housing Consumers Protection Measures Act (95 of 1998)
- Housing Development Agency Act (23 of 2008)
- Appropriate development of Infrastructure on Dolomite Guideline

This legal assessment integrated and aligned significant and applicable parts of all the acts and guidelines, which a DRMP must comply with.

The results showed that a DRMP must indicate the exact extent and location of dolomite during its research. It is also important to consider in the plan, the regional setting. A DRMP must incorporate all the geological maps, drilling results, structural data and geohydrological assessments to construct simplified geological zones on a map to inform the town planner. This map must display the inherent character of the applicable dolomite, which plays a significant role in its instability. The absence of this detailed information enhances the risk for mitigation and future planning. It may therefore be concluded that a DRMP must not only be compliant with Geoscience legislation but also environmental, town planning and governmental legislation.

The above-mentioned assessment criteria was summarised in a table and the four case studies was evaluated to indicate their compliance. The strategy could have been implemented, not implemented, not mentioned, or covered certain parts of the required legislation. Through this assessment, the results indicate that it can be seen to what extent current DRMPs can inform, not only town planning decisions, but also IDPs' and Environmental Management Frameworks (EMFs'). The results indicated that the more recent plans, Ekurhuleni and Tlokwe, was much more suitable to inform the decision making process with regards to town planning. These plans had much higher score with assessment criteria being implemented as well as the least criteria not being covered. The results indicated that the two older plans, Irene Farm Village and the Merafong plan were insufficient to guide town planning decisions because it have only implemented a few of the legal criteria needed for a successful DRMP.

It can therefore be concluded that although there is a need for Dolomite Risk Management Plans to inform Town Planning decisions, the assessment results indicated that only half are capable of informing and guiding town planning decisions adequately.

## **5.2 Recommendation**

During this investigative study it could be seen that there are numerous legislation and guidelines for a DRMS to comply with to fully guide and inform the decision making process with regards to town planning. Although the handover process of a DRMS to a

town-planning department is easy, it is difficult for the town planner to identify whether the assessment for the plan was done adequately and according to standards to guide the town planner.

It is therefore recommended that town planners in South Africa should be more attentive and observant towards development on dolomite. Moreover a final DRMS must be compliant with the SANS 1936-4 as well as the regulations of the Geoscience amendment Act (16 of 2010). These documents specify the general requirements for risk management, requirements for the formulation of a DRMP and specific requirements for local authorities. It is also recommended that the entity formulating the DRMP should incorporate and comply with the additional legislation pertaining to development and development on dolomite in South Africa.

It is also recommended that local authorities capacitate themselves to manage risk through a risk manager, who is aware of what a DRMP must comply with, so that it can sufficiently guide town planning processes.

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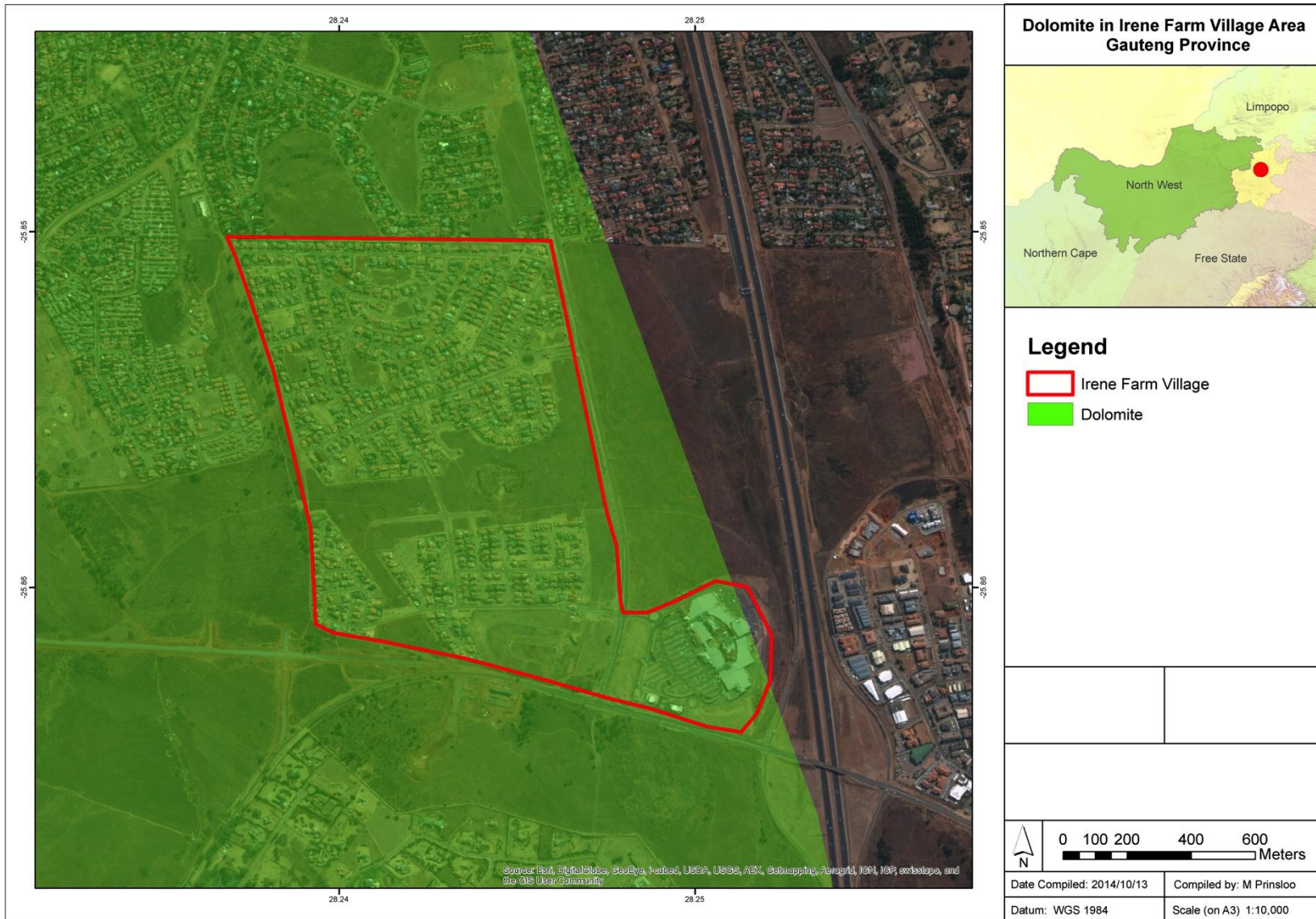
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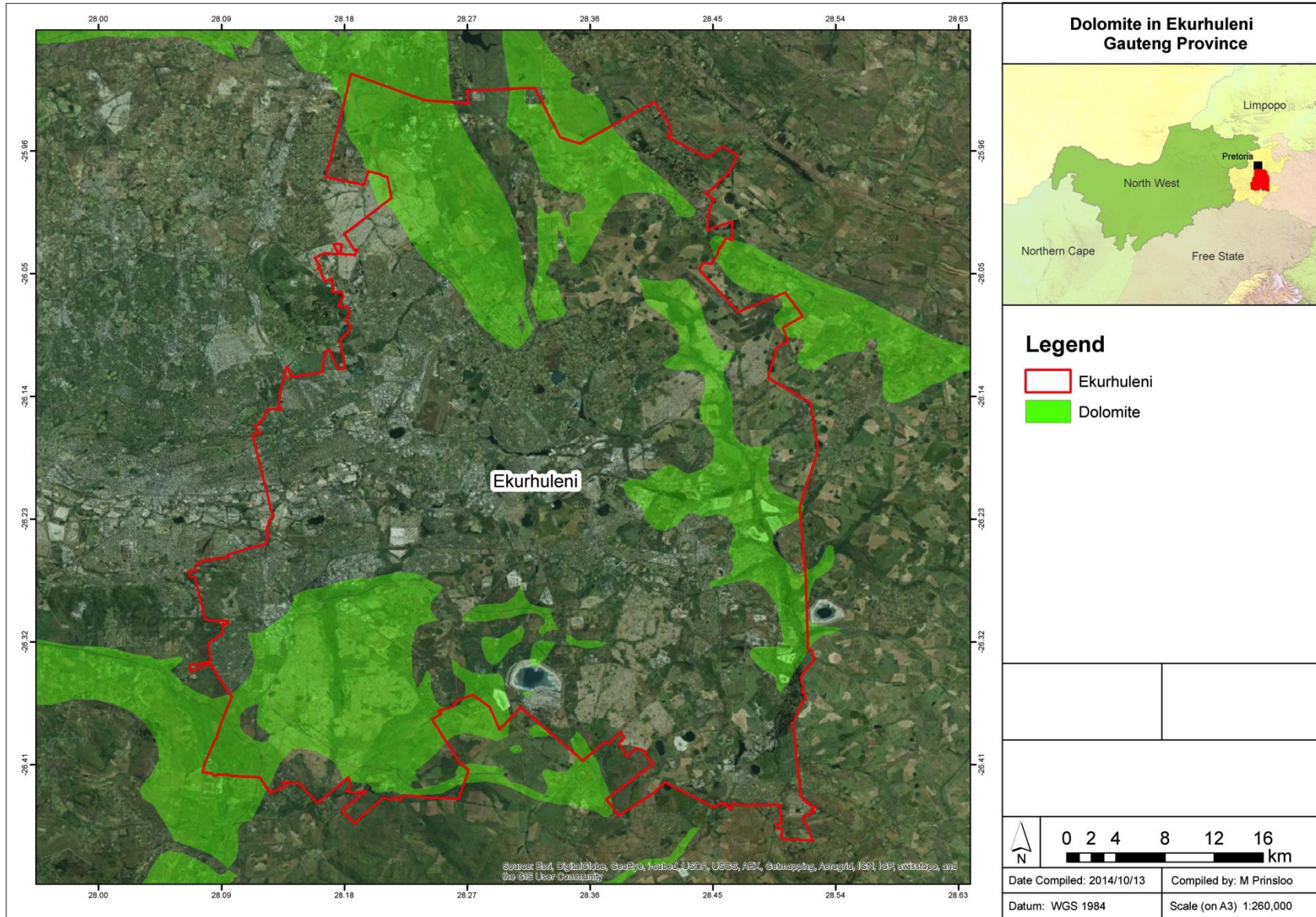
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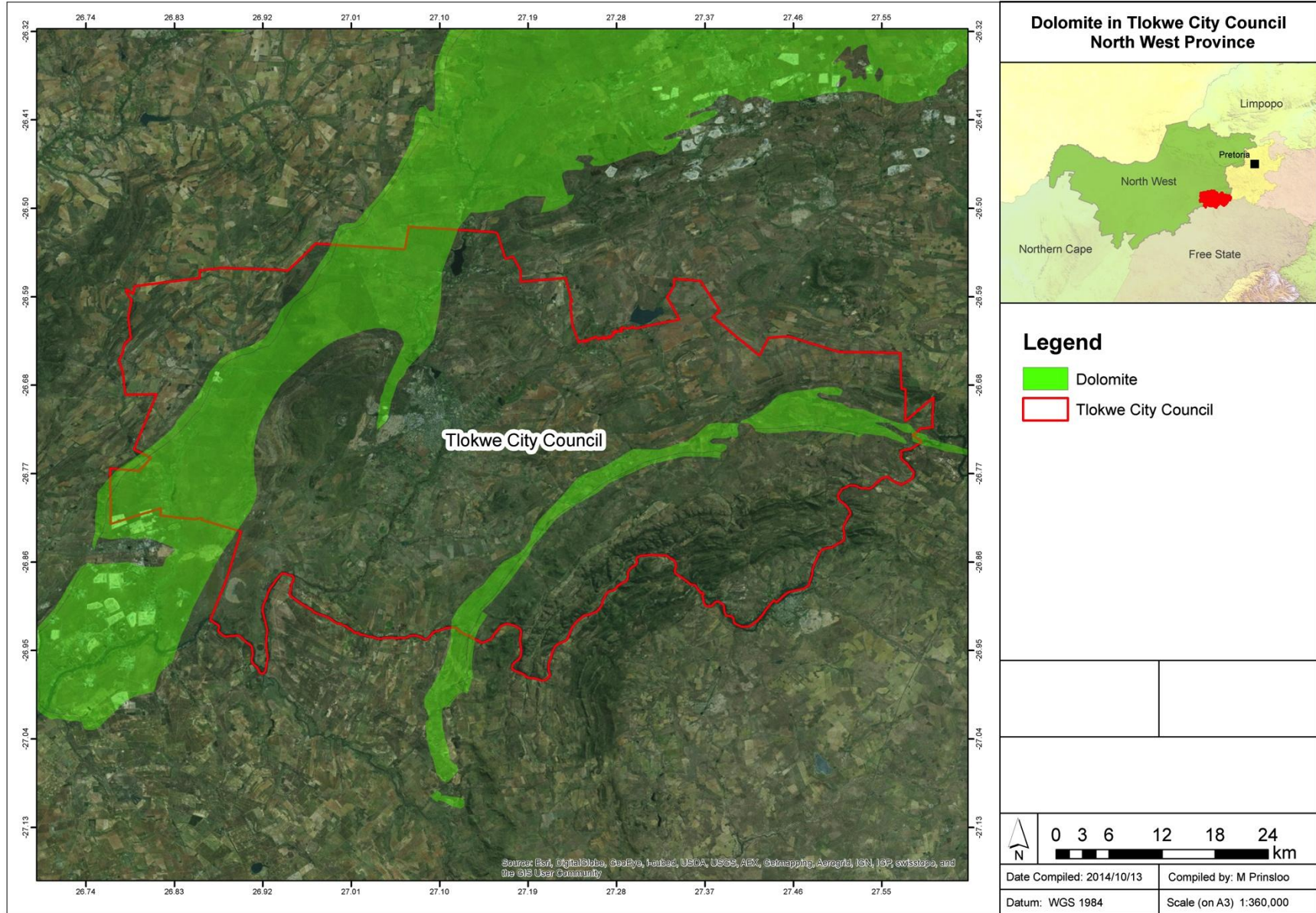
# Annexure A: Irene Farm Village Area



# Annexure B: Ekurhuleni Metropolitan Area



# Annexure C: Tlokwe City Council



# Annexure D: Merafong City Municipality

