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24 OCTOBER 2007

**GFSH-2, PHASE 2: INFILL GEOTECHNICAL INVESTIGATIONS: IRENE EXTENSION 70
INCLUDING THE ZONE 2 STANDS.**

SUMMARY

This report presents the results of GFSH-2, Phase 2 geotechnical investigations carried out in Irene Extension 70, particularly on stands located in the Dolomite Stability Zone 2 area. This stability zone is described in Intraconsult report IR523F, dated 23 July 2003. Additional investigations are required to establish the suitability of this zone for normal Residential 1 use.

The Stands within the Dolomite Stability Zone 1 area subjected to GFSH-2, Phase 2 infill investigations are as follows:

- ❑ Stands 3613 to 3618.
- ❑ Stands 3462 to 3470.

These investigations have been undertaken to comply with the requirements of:

- The NHBRC Home Building Manual, Parts 1, 2 and 3. Revision 1, February 2003.
- Generic Specification GFSH – 2 of the National Department of Housing, dated September 2002, entitled: Geotechnical site investigations for housing developments”.

These investigations involved field inspections, a review of available data, undertaking a gravity survey, a borehole drilling programme based on the gravity survey, excavation and profiling of test pits, sampling, analysis and reporting.

The Intraconsult report IR523F, dated July 2003 indicates that the stands investigated are located on a gravity gradient between a gravity high area of shallow dolomite characterised as Inherent Risk Class 5(6) and a gravity low area characterised as Inherent Risk Class 4. The infill investigations indicate that the transition zone within the Dolomite Stability Zone 2 area is underlain by dolomite bedrock at greater depth than earlier drilling results indicated. Irene Extension 70 including the

stands are underlain by dolomite and chert of the Chuniespoort Group. Weathered soil derivatives blanket the dolomite bedrock over the entire site. A thick sequence of Karoo materials, transported (reworked) Karoo materials or Post Eccles Formation (Leeuwenkloof Formation) deposits consisting of shale and chert overlie the dolomite bedrock and associated residual materials in sub-areas of the delineated study area.

The site is located in the Fountains East Dolomite Groundwater Compartment. Based on work by the Department of Water Affairs and Forestry, the OWL is anticipated at 1380m amsl in the general site area i.e. approximately 104m to 116m below ground surface. Although the ground water level occurs at great depth and most likely within dolomite bedrock, it is essential that ground water management should form an integral part of the Dolomite Risk Management Strategy of the Local Authority.

Based on the gathered geological, geophysical, geohydrological and historical data, the stability of the stands are characterised as reflecting a medium (with sub-areas of low) Inherent Risk of sinkhole and doline formation (all sizes) with respect to ingress of water and a low Inherent Risk with sub-areas of medium with respect to ground water level draw down i.e. **Inherent Risk Class 4/1//1(4) Area**. The stability conditions are therefore similar or better than those described for the remainder of Irene Extension 70 in Intraconsult report IR523F.

Based on this investigation and the findings of Intraconsult Report IR523F, all Residential 1 stands in Irene Extension 70 as shown on Drawing VGI 4063/1 are given a NHBRC D designation of D3.

This report documents recommendations on appropriate water and other precautionary measures in the context of the risk characterisation of the stands. The NHBRC Dolomite Area Designations are provided with respect to each of the Dolomite Stability Zones and their related Inherent Risk Classes.

Generic Specification GFSH-2, Phase 2 investigations will be required on the Residential 2 stands.

The Council for Geoscience and NHBRC require further detailed work on all Residential 2 and 3 sites. These additional investigations are required for design of precautionary measures and foundation specifications.

It is important to note that the Council for Geoscience must approve this report. It should be noted that these parties may arrive at different conclusions concerning aspects of this investigation. Consequently it is important that all further work and expenditure based on this report be undertaken in the knowledge that these parties must approve the final risk zonation of the site.

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GFSH-2, PHASE 2: INFILL GEOTECHNICAL INVESTIGATIONS: ZONE 2 STANDS: IRENE EXTENSION 70.

SUMMARY

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1. INTRODUCTION

This report presents and comments on the results and observations of GFSH-2 Phase 2 infill dolomite stability investigations undertaken on Residential 1 stands in the Dolomite Stability Zone 2 area identified in Intraconsult Report IR523F, dated 23 July 2003. This report documents the terms of reference, available data used in the study, investigation procedures, risk characterisation methodology, geology, geohydrology, dolomite risk zonation, profiling, analysis, conclusions and recommendations.

2. TERMS OF REFERENCE AND SCOPE OF WORK

At the request of M&T Developments, VGIconsult presented technical and budget cost proposals in letter reference VGI4063, dated 3 September 2007. The terms of reference and scope of the work to be undertaken were discussed with Mr P.W. Kruger of M&T Developments (Pty) Ltd. VGIconsult cc was appointed and instructed to proceed with the investigations on the 5 September 2007. Detailed infill drilling was required in the Dolomite Stability Zone 2 area delineated in Intraconsult Report IR523F, dated July 2003.

3. EXISTING INFORMATION

The following information has been used in the investigation and assessment of the site:

- Topographic map of the Director of Surveys at a scale of 1:50 000: Sheet 2528CC, Verwoerdburg, dated 1973.
- Intraconsult report, IR523F, dated July 2003, "Geotechnical investigations for proclamation: approximately 417ha east of Irene."
- Geological Map of the GSO: Scale 1: 50 000 Sheet 2528CC Lyttelton, dated 1969.
- "Proposed method for dolomite land hazard and risk assessment in South Africa." by Buttrick, Van Schalkwyk, Kleywegt and Watermeyer 2001, Journal of the South African Institution of Civil Engineering, Volume 43, Number 2.
- Department of Water Affairs and Forestry report GH3502, dated July 1988, entitled: "Hydrogeology of the Verwoerdburg dolomite aquifer."
- Generic Specification GFSH-2, National Department of Housing Specification, "Geotechnical site investigations for housing development".
- NHBRC Home Building Manual, Parts 1 and 2, Revision 1, dated February 1999.
- Trollip, Nicole, 2006. "The geology of an area south of Pretoria with specific reference to dolomite stability." MSC Thesis, University of Pretoria.

4. GENERAL LOCATION AND DESCRIPTION OF THE SITE

Irene Extension 70 is located immediately east of Pierre Van Ryneveld Extension 11, 13 and 14, south of the N1 Freeway and north of the proposed PWV6 road. The site incorporates approximately 21 ha of land. Stands 3462 to 3470 and 3613 to 3618 are located in the north western sector of Irene Extension 70, within the Dolomite Stability Zone 2 area defined in Intraconsult Report IR523F, dated July 2003.

The location of Irene Extension 70 is shown on Figure 1.

5. PROCEDURES USED IN THESE INVESTIGATIONS

These investigations have involved the following:

5.1 Gathering of existing data

During the early stages of these investigations, available information pertaining to the proposed site and immediate environs was gathered and studied to obtain a preliminary perspective of the geotechnical conditions of the delineated areas. This information includes existing geological, geotechnical, geohydrological, topographical, orthophotographic, geotechnical reports of surrounding developments, geophysical data (including aeromagnetics and gravity surveys) where available, sinkhole and stability data, etc.

5.2 Gravity survey

The gravity survey covering Stands 3462 to 3470 and 3613 to 3618 is derived from the gravity survey contained in Intraconsult Report IR523F undertaken for the larger site in which this development is located.

5.3 Rotary Percussion Boreholes

Boreholes were located using the gravity survey of the site. These infill boreholes were drilled to develop a perspective of the subsurface and geohydrological conditions in the Dolomite Stability Zone 2 area that is delineated in Intraconsult report IR523F, dated July 2003. The borehole profiles are presented in Appendix 1.

The drilling work was undertaken using a down-the-hole rotary percussion rig and a 950 c.f.m compressor delivering 308 psi to a 155mm diameter button bit or scraper. Chip samples were retrieved from the return air stream through each metre drilled, while the penetration times per metre were recorded (when using the button bit) with an electronic stopwatch. The retrieved samples are described according to current practice.

The positions of the boreholes are indicated on Drawing VGI4063/1. This borehole information is discussed in greater detail in sections below.

The X and Y co-ordinates for the boreholes, as reflected in Appendix 1, are given in metres latitude (7 digit value) and longitude (5 or 6 digit value). These co-ordinates are projected using the Gauss Conform Projection which is the Transverse aspect of the Mercator projection. The reference ellipsoid is the WGS84 (Hartebeeshoek 1994) ellipsoid. The Central Meridian (longitude of

origin or Lo) for this site is 29°E, with the site as a whole located east of the Central Meridian. In the South African coordinate system the X co-ordinates are measured southwards from the equator (where $x = 0$) towards the south pole which is positive. Y co-ordinates are measured from the Central Meridian (CM), increasing from the CM in a westerly direction so that Y is positive west of the CM and negative east of the CM.

6. GEOLOGY AND GEOHYDROLOGY

Irene Extension 70 is located on chert-rich dolomite of the Eccles Formation of the Chuniespoort Group, of the Transvaal Supergroup.

Karoo transported Karoo materials or Post Eccles Formation (Leeuwenkloof Formation) deposits consisting of shale and chert occur in the east and central areas of the site. The destructive nature of the pneumatic percussion drilling method often results in uncertainty as to the Origin of a material e.g. distinguishing between the transported materials and chert residuum.

The karst development has led to a highly variable dolomite and chert bedrock topography. Cavernous conditions can be expected both within the bedrock and the overburden. Hard, unweathered dolomite bedrock is overlain by slightly weathered jointed bedrock and thereafter, through a sudden, dramatic transition, to highly weathered and typically low strength, insoluble residual material consisting of mainly manganese oxides (dolomite residuum), chert and iron oxides.

The various lithological units and their weathered derivatives, recorded on the site are as follows:

LITHOSTRATIGRAPHIC UNIT	LITHOLOGY
Karoo Supergroup or Transported/Reworked Karoo materials or Post Eccles Formation (Leeuwenkloof Formation) deposits.	Shale and chert with soil derivatives.
Monte Christo Formation, Chuniespoort Group, Transvaal Supergroup.	Dolomite, chert and associated soil derivatives.

The study area is mantled in many places by unconsolidated material deemed to be Recent deposits (24 Ma and younger). The material varies in thickness, sedimentological- and geotechnical properties:

POST GONDWANA DEPOSITS	
Pedocretes (cemented soils)	Ferricrete (cemented or replaced by iron oxides)/ Ferruginised soil (less than 50% cement or replacement material)

POST GONDWANA DEPOSITS	
Colluvium: Talus (Course Colluvium) Hillwash Alluvium	Soils of clayey and silty composition

Boreholes drilled during the current investigation intercept the following subsurface conditions on Irene Extension 70:

- ❑ The boreholes drilled on site intercept variable, and in instances, substantial thicknesses of colluvium e.g. Boreholes 3463 (2m), 3464 (3m), 3465 (1m), 3466 (3m), 3467 (6m), 3469 (1m), 3470 (1m), 3614 (2m), 3616 (2m), 3617 (12m), etc Tables 1 and 2. This horizon is absent in sections of the site e.g. Boreholes 3461, 3462, 3613, 3615, 2115, 2530, 3026, etc, Tables 1 and 2, Drawing VGI4063/1, Appendix 1.
- ❑ Numerous boreholes intercept **thick horizons of residual Karoo Supergroup or transported/reworked Karoo material** or Post Eccles Formation (Leeuwenkloof Formation) deposits consisting of shale and chert, which varies in thickness e.g. Boreholes 3461 (0m to 60m), 3462 (0m to 25m), 3463 (2m to 60m), 3464 (3m to 6m), 3467 (6m to 40m), 3468 (1m to 19m), 3470 (1m to 25m), 3616 (8m to 22m), 3617 (12m to 60m), Tables 1 and 2, Drawing VGI4063/1, Appendix 1.
- ❑ **Thick horizons of chert residuum** is intercepted in various boreholes drilled on the stands e.g. Boreholes 3462 (25m to 60m), 3464 (6m to 60m), 3465 (1m to 60m), 3466 (29m to 60m), 3467 (40m to 60m), 3468 (19m to 60m), 3469 (0m to 60m), 3470 (25m to 60m), 3613 (0m to 60m), 3614 (2m to 60m), 3615 (0m to 60m), 3616 (22m to 60m), etc, Tables 1 and 2, Drawing VGI4063/1, Appendix 2. All these boreholes are terminated in the chert residuum at 60m below ground surface. It should be noted that uncertainty concerning the Origin often arises with respect to these materials due to the destructive nature of the drilling technique used and the similar nature of the materials.
- ❑ **Dolomite bedrock is not intercepted** in the boreholes drilled under these stands. Dolomite bedrock is intercepted in a borehole drilled on a gravity high field, located west of the stands and outside of the area of study.
- ❑ **No problematic conditions** (rapid penetration times, sample and/or air loss and in instances cavernous conditions) were encountered in the boreholes drilled on these stands.
- ❑ No groundwater was encountered in the boreholes drilled, although samples were, in instances, recorded as moist, particularly within layers of residual Karoo material, possibly suggesting the existence of perched ground water levels.

The Department of Water Affairs and Forestry has undertaken intensive work in the region which is documented in Report GH3502, entitled "Hydrogeology of the Verwoerdburg Dolomite Aquifer". According to the report the site is located in the in the Fountains East Dolomite Groundwater Compartment and the groundwater level is anticipated at a depth of 104m (ground elevation 1404m amsl) to 116m (ground elevation 1496m amsl) or 1380m amsl.

7. DOLOMITE STABILITY CHARACTERISATION (Refer to Tables 1 and 2)

7.1 Characterisation Procedure

The available information, geophysical data, borehole data and geohydrological information gathered during the GFSH-2, Phase 2 investigations, has been pooled and reviewed permitting the formulation of a perspective concerning the characterisation of the stability of Irene Extension 70 and the identified stands in the Dolomite Stability Zone 2 area.

The predominant mobilising agencies considered in this investigation are major groundwater level fluctuations (>6m), ingress water, ground vibrations and gravity.

Use is made of a generalised list of evaluation factors to evaluate the risk of sinkhole and doline formation. These factors are as follows:

- Receptacle development;
- Mobilising agencies, particularly ingress water from leaking services;
- Potential sinkhole development space;
- Nature of the blanketing layer;
- Mobilisation potential of the blanketing layer;
- Bedrock morphology.

Receptacles or disseminated receptacles refer to any voids or cavities in the dolomite bedrock or in the overburden capable of receiving mobilised materials. *Receptacles are assumed to be present as no reliable geophysical tool exists to determine the location of these features. Consequently the information gathered from boreholes, including penetration times, air loss, hammer action, etc, combined with geophysical and geological information are used to formulate an impression of the degree of cavitation.*

The potential sinkhole development space, where used, refers to the expected maximum size sinkhole that, conservatively, is anticipated to be generated if sustained ingress of water were to occur. This factor is related to the depth of the receptacles or disseminated receptacles. The gravity survey, combined with borehole information strongly guides the appraisal of this factor. The nature of the material covering the receptacles, be they above or in the bedrock, determines the susceptibility of the subsurface material to erosion by ingress water. The presence of materials such as shales or intrusives, which can act as aquitards, serve to reduce the mobilisation potential and enhance the stability. In the case of dramatic groundwater level fluctuations the susceptibility of the soil material to mobilisation (i.e. consolidation settlement - doline formation, or ravelling and arch failure - sinkhole formation, due to pore pressure changes in soils), is strongly influenced by the position of the original groundwater level in the subsurface profile.

In view of the factors discussed above the following characteristics have been extracted from the gathered information during the assessment process:

- borehole position relative to the gravity data (Drawing VGI4063/1).
- collar elevation.
- depth to present groundwater level and the OWL.

- depth to dolomite bedrock.
- depth to potential receptacles (Tables 1 and 2).
- nature and thickness of blanketing layer i.e. material type, penetration times, etc (Tables 1 and 2).
- position of the bedrock with respect to the groundwater level and the OWL.
- thickness and nature of the soil materials above the groundwater level (original) i.e. type soil and potential geotechnical characteristics.
- thickness and nature of the soil materials below the present groundwater level and the OWL.

The risk of sinkhole and doline formation is expressed in three broad categories, namely low, medium and high risk areas. The following reference to incidences, gives a perspective of the magnitude of problems encountered in each of the of risk zones in research areas. It is important to note that these figures were largely derived from developments not effectively and appropriately designed or maintained.

RISK CHARACTERISATION	GROUND-MOVEMENT EVENTS PER HECTARE IN A 20 YEAR PERIOD (STATISTICS BASED ON INAPPROPRIATE AND POOR SERVICE DESIGN AND MAINTENANCE)
LOW	0 up to and including 0.1 events per hectare anticipated but occurrence of events cannot be totally excluded.
MEDIUM	Greater than 0.1 and less than and equal to 1.0 events per hectare
HIGH	Greater than 1.0 events per hectare.

Sites are characterised primarily in terms of eight standard Inherent Risk Classes defined as follows:

- Class 1 Areas: Areas characterised as reflecting a low Inherent Risk of sinkhole and doline formation (all sizes) with respect to ingress of water.
- Class 2 Areas: Areas characterised as reflecting a medium Inherent Risk of small-size sinkhole and doline formation with respect to ingress of water.
- Class 3 Areas: Areas characterised as reflecting a medium Inherent Risk of medium-size sinkhole and doline formation with respect to ingress of water.

Class 4 Areas:	Areas characterised as reflecting a medium Inherent Risk of large-size sinkhole and doline formation with respect to ingress of water.
Class 5 Areas:	Areas characterised as reflecting a high Inherent Risk of small sinkhole and doline formation with respect to ingress of water.
Class 6 Areas:	Areas characterised as reflecting a high Inherent Risk of medium-size sinkhole and doline formation with respect to ingress of water.
Class 7 Areas:	Areas characterised as reflecting a high Inherent Risk of large-size sinkhole and doline formation with respect to ingress of water.
Class 8 Areas:	Areas characterised as reflecting a high Inherent Risk of very large-size sinkhole and doline formation with respect to ingress of water.

Zones delineated on the site may be combinations of the above. *In some instances, the Inherent Risk Classes are indicated with the primary zone description given first followed by a suffix in brackets. The primary Inherent Risk Class describes the predominant characterisation of the zone and the suffix describes the characterisation of anticipated pockets or small sub-areas within the zone. As an example a designation of 8(4) indicates that the zone predominantly displays a high Inherent Risk for very large-size sinkhole and doline formation with anticipated pockets or small areas of Class 4 i.e. displaying a medium risk for medium-size sinkhole and doline formation.*

Inherent Risk is defined in terms of ingress water and ground water level draw down reflected by two Inherent Risk Class designations separated by a double forward slash i.e. Inherent Risk Class (Ingress water)//Inherent Risk Class (ground water level draw down). As an example a designation of 1//8 indicated that the zone displays a low Inherent Risk with respect to water ingress of all size sinkhole and doline formation but a high Inherent Risk with respect to ground water level draw down

7.2 Stability Characterisation (See Tables 1 and 2, Drawings VGI4063/1 and 2).

The geotechnical information gathered during this investigation of the site is used to formulate a perspective on the subsurface conditions characterising the area. Summarised information concerning the risk characterisation of the boreholes drilled on the site is provided in Tables 1 and 2 of this report.

The site is located in the Fountains East Dolomite Groundwater Compartment. Based on work by the Department of Water Affairs and Forestry, the OWL is anticipated at 1380m amsl in the general site area i.e. approximately 104m to 116m below ground surface. Although the ground water level occurs at great depth and most likely within dolomite bedrock, it is essential that ground water management should form an integral part of the Dolomite Risk Management Strategy of the Local Authority.

Based on the gathered geological, geophysical, geohydrological and historical data, the stability of Irene Extension 70 and the identified stands are characterised as reflecting a medium (with sub-areas of low) Inherent Risk of sinkhole and doline formation (all sizes) with respect to ingress of water and a low with sub-areas of medium Inherent Risk with respect to ground water level draw down i.e. ***Inherent Risk Class 4/1//1(4) Area.***

The stands investigated are characterised by the following subsurface conditions:

- The delineated area largely occurs on a gravity gradient field (Drawing VGI4063/1), falling from a high to the north west of the site to a low in the east of the site.
- **The blanketing layer consists of the following horizons:**
 - **Colluvium:** The boreholes drilled in this zone intercept generally thin horizons of colluvium with localized exceptions e.g. Boreholes 3463 (2m), 3464 (3m), 3465 (1m), 3466 (3m), 3467 (6m), 3469 (1m), 3470 (1m), 3614 (2m), 3616 (2m) and 3617 (12m), This horizon is absent in sections of the zone e.g. Boreholes 3461, 3462, 3613, 3615, 2115, 2530, 3026, etc, Tables 1 and 2, Drawing VGI4063/1, Appendix 1.
 - **Karoo Supergroup deposits or reworked/transported Karoo materials:** Numerous boreholes intercept **thick** horizons of residual Karoo or transported Karoo material, that varies in thickness e.g. Boreholes 3461 (0m to 60m), 3462 (0m to 25m), 3463 (2m to 60m), 3464 (3m to 6m), 3467 (6m to 40m), 3468 (1m to 19m), 3470 (1m to 25m), 3616 (8m to 22m), 3617 (12m to 60m), Tables 1 and 2, Drawing VGI4063/1, Appendix 1.
 - **Chert Residuum:** Thick horizons of chert residuum are intercepted in various boreholes drilled on the stands e.g. Boreholes 3462 (25m to 60m), 3464 (6m to 60m), 3465 (1m to 60m), 3466 (29m to 60m), 3467 (40m to 60m), 3468 (19m to 60m), 3469 (0m to 60m), 3470 (25m to 60m), 3613 (0m to 60m), 3614 (2m to 60m), 3615 (0m to 60m), 3616 (22m to 60m), etc, Tables 1 and 2, Drawing VGI4063/1, Appendix 2.
 - **No problematic conditions** (rapid penetration times, sample and/or air loss and in instances cavernous conditions) were encountered in the blanketing layers in the boreholes drilled on these stands.
- **Dolomite bedrock is not intercepted** in the boreholes drilled under these stands. Dolomite bedrock is intercepted in a borehole drilled on a gravity high field , located west of the stands and outside of the area of study.
- **No groundwater was encountered** in the boreholes drilled, although samples were, in instances, recorded as moist, particularly within layers of residual Karoo material, possibly suggesting the existence of perched ground water levels. The Department of Water Affairs and Forestry has undertaken intensive work in the region which is documented in Report GH3502, entitled "Hydrogeology of the Verwoerdburg Dolomite Aquifer". According to the report the site is located in the in the Fountains East Dolomite Groundwater Compartment and the groundwater level is anticipated at a depth of 104m to 116m (1380m amsl).

It is anticipated that the Karoo/reworked or transported Karoo materials may act as aquitards or partial aquitards and are hence characterised by moderate to poor internal drainage characteristics. However, these materials are not present as uniformly thick layers across the entire zone and cannot be relied upon to present a continuous blanket of low mobilization potential. Sub-areas of this zone may be characterised by an absence of aquitards within the blanketing layer. The blanketing layer in these areas consists of chert residuum, characterised by good to very good internal drainage characteristics. Due to the depth to dolomite bedrock the potential development space is anticipated to be predominantly large. The area is thus characterised as reflecting a medium to low Inherent Risk of sinkhole and doline formation (all sizes) with respect to ingress of water. The OWL is anticipated at 1380m amsl in the general site area i.e. approximately 104m to 116m below ground surface. **The geological conditions in this zone are characterized as falling in Inherent Risk Class 4/1//1(4).** Although the ground water level occurs at great depth and it may occur within or above dolomite bedrock. Therefore it is essential that ground water management should form an integral part of the Dolomite Risk Management Strategy of the Local Authority.

8. CONCLUSIONS

8.1 Risk Characterisation (Drawings VGI4063/1 and 2 and Tables 1 and 2).

These investigations have been carried out in accordance with the standards and requirements set out in:

- ❑ Generic specification GFSH-2, National Department of Housing Specification, "Geotechnical site investigations for housing development."
- ❑ NHBRC Home Building Manual, Parts 1 to 3, Revision 1, February 2003.

Based on the criteria discussed in Section 7 of this report, the stability of the site is characterised in terms of the eight Inherent Risk Classes. The characterisation of the stability of the site provides valuable information for township and service design and maintenance. Urban development normally results in a disturbance of the metastable conditions in the dolomite environment. Consequently, factors such as the basic design of services, the final township layout, construction and service installation procedures, and ongoing infrastructure maintenance programmes are key elements in the overall strategy to reduce the probability of generating ground movement events. Based on the geological, geophysical, geohydrological and historical data gathered, the stability of the stands is characterised as reflecting a medium (with sub-areas of low) Inherent Risk of sinkhole and doline formation (all sizes) with respect to ingress of water and a low with sub-areas of medium Inherent Risk with respect to ground water level draw down i.e. **Inherent Risk Class 4/1//1(4) Area**. The stability conditions are therefore similar to those described for the remainder of Irene Extension 70 in Intraconsult report IR523F.

9. RECOMMENDATIONS

9.1 Appropriate development in relation to the risk characterisation.

Based on the stability zonation of the site, all **Residential 1 Stands** including Stands 3462 to 3470 and 3613 to 3618 as proposed on Drawing VGI4063/2 may be developed.

9.2 NHBRC Dolomite Area Designation for single storey masonry structures

STANDS	NHBRC DOLOMITE AREA DESIGNATION
3462 to 3470	D3
3613 to 3618	D3
Other Residential 1 stands in Irene Extension 70 as shown on Drawing VGI4063/1	Remain D3 as indicated in Intraconsult Report IR523F, dated July 2003.

9.3 Residential 2 and 3 stands

All Residential 2 stands i.e. Stands 3461, 3500, 3545, 3595 must specifically be investigated and reported on.

9.4 Water and other precautionary measures.

The various water precautionary and other precautionary measures outlined in Intraconsult report IR523F, dated July 2003 pertain to Irene Extension 70 and the stands investigated in this report (Appendix 3).

10. GENERAL RECOMMENDATION

These findings are based upon our interpretation of the data recovered during these investigations. While every effort has been made to determine overall ground conditions on this site, poorer sub areas may have been missed. For this reason, it is recommended that a Dolomite Risk Specialist undertakes inspections of open works during construction and reports thereon in a separate completion report.

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**GFSH-2, PHASE 2: INFILL GEOTECHNICAL
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FIGURES

LOCALITY PLAN: IRENE EXTENSION 70

FIGURE 1

REGIONAL GEOLOGY

FIGURE 2

SIMPLIFIED TOPOGRAPHY : IRENE EXTENSION 70

FIGURE 3

TABLES

RISK CHARACTERISATION OF BOREHOLE
DATA: IRENE EXTENSION 70.

TABLES 1 and 2

DRAWINGS

IRENE EXTENSION 70: RESIDUAL GRAVITY AND BOREHOLE POSITIONS

DRAWING
VGI4063/1

IRENE EXTENSION 70: DOLOMITE STABILITY RISK ZONATION

DRAWING
VGI4063/2

APPENDICES

BOREHOLE PROFILES

APPENDIX 1

INFRASTRUCTURE ON DOLOMITE: EXTRACT FROM PWD
MANUAL FOR CONSULTANTS

APPENDIX 2

INTRACONSULT REPORT IR523F, DATED JULY 2003

APPENDIX 3

APPENDIX 1

BOREHOLE PROFILES

Note: All borehole positions are based on co-ordinates derived from the Gauss Conform Projection, Reference Elipsoid: WGS84 (Hartebeeshoek 1994), Central Meridian/longitude of origin/Lo29°E

APPENDIX 2
INFRASTRUCTURE ON DOLOMITE:
MANUAL FOR CONSULTANTS
(EXTRACT)

APPENDIX 3
INTRACONSULT REPORT IR523F,
DATED JULY 2003