Scherzic

Ground Investigations

July 6, 2022

JMC Property Group c/- ERA Planning
Level 1, 125A Elizabeth St
Hobart, Tasmania 7000

Attention: Sarah Silva
Our Ref: 7390B

Dear Sarah

Re; 9 Rose Lane, Launceston South

Landslide Risk Assessment

We refer to our Geotechnical Site Review, report 7390A, dated November 2019 and Addendum, dated 3 June 2020 for a proposed residential development at 9 Rose Lane, Launceston South. (see Figure 1 below)

As per your request we have reassessed the Landslide Risk as per section 6 of our Addendum for the revised development of commercial buildings (Figure 2 below). The Risk to Life calculation is determined according to the following equation:

$$R_{(LOL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}$$

$R_{(LOL)}$ = the risk to life (annual probability)

$P_{(H)}$ = the annual probability of landslide

$P_{(S:H)}$ = the probability of spatial impact by a landslide on persons (inhabitants of buildings typically higher than visitors to site)

$P_{(T:S)}$ = the temporal spatial probability (the probability of site occupied)

$V_{(D:T)}$ = vulnerability of the individuals (probability of loss of life of the individual in buildings/site given the impact)

In our revised assessment, all the above terms except for $P_{(T:S)}$ remain unchanged. We recommend adopting a P(T:S) of 0.75 revised down for a commercial development. Hence our revised Risk to Life remains as 0.0 for all cross sections assessed in our 7390A-Addendum. Similarly, the risk to property remains at $0.00.

Sincerely,

Martin Schult, BEng., MEngSc., DipGeoSc., MIE(Aust). CPEng, NER(No 193316)
Building Practitioner CC6587
Geotechnical Engineer

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Figure 1 - Original Residential Layout

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Figure 2 - Revised Commercial Layout

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Scherzic

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JMC Property Group Pty Ltd

c/- RARE Innovation

Geotechnical Site Review

9 Rose Lane, Launceston South

November 2019

Report No: 7390A

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I. Limitations

This report has been prepared for JMC Property Group & RARE Innovation and is only for use by JMC Property Group & RARE Innovation for the purpose given below. No responsibility will be taken for use by other parties. Conclusions and recommendations are based on the investigation methods outlined and are considered to be a minimum requirement for the project. Further investigations and testing may be required where differing conditions or information are encountered. The recommendations contained in this report are based on the limited testing described within. The nature of foundation materials can vary over small areas and therefore conditions may exist which were not encountered or foreseen in this assessment. If conditions are found to differ from those described, then Scherzic should be contacted immediately to advise on the consequences. Conditions differing from those described may result in additional costs for footing and foundation works. Unless the site investigation points have been surveyed and clearly marked prior to the investigation, the location of the test sites should only be taken as approximate. This report does not assess contamination of soil or ground water.

Martin Schult, CPEng., NER

Geotechnical Engineer

Scherzic Pty Ltd

www.scherzic.com

Reports Issued			
Report No	Author	Review	Issue Date
DRAFT	DV	MBS	25/11/2019
7390A	DV	MBS	2/12/2019

II. Introduction

Rare Innovation Consulting Engineers, on behalf of JMC Property Group Pty Ltd (JMC) have appointed Scherzic to undertake a Geotechnical Review of stability of the surrounds to a proposed multi-unit site at

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9 Rose Lane, Launceston South (Glen Dhu). JMC are proposing to construct 30 residential units on the site which is located at the north west corner on a large tract of west sloping vacant land vacant land that has reported landside issues. The location of the lots of land (green dashed rectangle) and nearby slopes are shown below:

FIGURE 1 - PLAN VIEW OF DEVELOPMENT SITE

The purpose of this review is to determine the level of risk to future development (landslide and stability) at the toe of the slopes.

Two very recent site classification reports made by Rare and six recent reports/assessments made by Geoton Pty Ltd for the vacant area upslope of the site have been provided.

A GHD report/assessment from 2014 cited in the Geoton reports has not been provided and has not been sighted by Scherzic. (It is noted that this GHD report was authored by the reviewer of this Scherzic report). This report has not been provided to Scherzic for its view and therefore Scherzic analysis and assessment have been focused on the available documents. Scherzic keeps the right to modifying its analysis/assessment upon view of the unprovided GHD report.

III. Site description

The site area includes two lots of land on the southern and eastern uphill sides of the northern portion of Rose Lane, South Launceston. The site is characterised by low angle slopes and grass cover, while eastern and south-eastern uphill nearby area towards Westbury Road tend to steep slopes angles and is more characterised by trees and bushes in respect to grassland. Towards south and south-east uphill from the site, an approximately 4 to 5m high batter face associated with past quarry activities exists. Above this batter face of the old quarry, the slope continues up to Peel Street. Further upslope of this area is located Westbury Road. Refer to Appendix C for photographic description.

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IV. Geology

The area is included in the Tertiary Undifferentiated Paleogene-Neogene sequences Group, characterised by poorly consolidated clay, silt, and clayey labile sand with rare gravel and lignite and the presence of some iron oxide-cemented layers and concretions and some leaf fossils (see geological extract in Appendix A; source MRT Digital Geological Atlas 1:25000).

Previous excavations and drilling investigations in the interested area highlighted that the Rose Lane lots of land are mainly characterised by filling (at least 4-5m thick). While moving towards South the filling thickness diminished (about 2m) in proximity of the old quarry face. The first natural material encountered in the interested area during investigations is silty clay which can be interbedded by levels of clayey sand and fine gravel. Silty clay superimposing sandy clay and clayey sand levels alternance has been observed, until reaching sand at 20m depth. The quarry face, 4 to 5m height, is characterised by silty clay that could be interbedded. Above the quarry face, upslope towards Westbury Road, investigations reported a very thick silty clay layer (up to 18m), superimposed by moderate sandy clay/clayey sand and gravelly sand levels before to encountered again fill materials.

V. Previous reports

The area included between Rose Lane, Peel Street and Westbury Road has been investigated before, including landslide assessments, but was not conducted by Scherzic. In particular, the GHD report dated August 2014, reference number No 32/17320, focused on the immediate western side of Westbury Road and found that only localised downhill creep of the slope was related to the fill batter of Westbury Road, as it has been cited in other subsequent reports. The movement in the GHD report was estimated to be associated with two small-to-moderate landslides. This report has not been provided to Scherzic for view and therefore Scherzic analysis and assessment have been focused on the available documents only. Further reports by Geoton Pty Ltd dated between April and May 2015 (GL14281Ab and GL14281Bc), November 2017 (GL14281Df) and April 2018 (GL18044Ab) covered slope stability investigations and assessments, measuring land movements and groundwater levels variations. These reports mostly focused on the south-eastern uphill area below Westbury Road. These reports also mentioned that movements of Westbury Road surface were observed since the 1980's and continuous "levelling" of the road though application of asphalt was applied by Launceston City Council. The Geoton reports highlighted the presence of the groundwater level at a depth between 8 to 11 metres from surface level (around 50m altitude). Inclinometers data from boreholes located downhill in close proximity of the western side of Westbury Road, presented in the Geoton Pty Ltd reports, showed diverse sliding movements at different depths in about 2.5 years period (INC-1: about 10mm NW at 2 to 4m depth, about 15mm NW at a 13 to 15m depth; INC-2: between 10 to 17mm NW below 2m depth, less than 5mm N at 13m depth). Interestingly, both inclinometers data showed significant movement under 4m depth towards NW. One of the Geoton reports (GL14281Ab) showed that multiple asphalt layers have been found in different test pits excavated about 3m below Westbury Road, which the deepest was at 1.5m from surface (4.5m below the current Westbury Road level). Further Site Classification reports for the Rose Lane Units development area made by Rare Innovation Pty Ltd (April and August 2019) showed that groundwater level was encountered in test pits close to eastern slope between 1.9 and 3.75m depth and only in one test pit on the western side of the lots at 5m depth.

The Mineral Resources Tasmania (MRT) Tasmanian Landslide Inventory sheet, 1:25,000 scale, shows an active landslide (No. 1007) just below the western side of Westbury Road and including a significant area downhill (Figure 2). The same area is also shown as low to high slide susceptibility in the MRT Shallow Slide and/or Flow Susceptibility sheet. However, the same landslide is not present in the MRT Tasmanian Proclaimed Landslip Zones sheet, and it also has not been assessed as Zone A or Zone B. Two reports acquired from MRT database cited the landslip down to the western side of Westbury Road

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(I. Jennings 1962 report No. TR7_87_90 and W.L. Matthews May 1975 report No. UR1975-37). The first available report from 1962 showed two landslip zones under the western side of Westbury Road, in which the northernmost was also used as a tip (Figure 2). The 1962 report stated that Westbury Road was affected in the past by slips and remedial measures were taken solving the slip problem, although advising about possible future reactivation. This report did not explicitly define what has been done as remedial measure to stop slipping. The second available report of May 1975 cited the presence of a known slip down on the western side of Westbury Road, connecting the slip movement to the past clay quarrying activity at the base of the slope. This report did not show any evidence or supporting material to support this statement. The 1975 report also added that blocks and nearby land showed no signs of movement, and only “very minor slumping may have taken place in a 3 m cutting along the road-side, but this has no signs of recent movement” related to Westbury Road. No other historic report is available for the landslide No. 1007, as MRT confirmed directly to Scherzic inquiry.

As indicated above, a GHD report prepared for the City of Launceston circa 2014 was prepared by the Scherzic reviewer of this report. According to some incomplete data and recollection of the investigation, the most pertinent observation was the absence of any distress consistent with landslide movements to the east (Westbury Road) side of the structures.

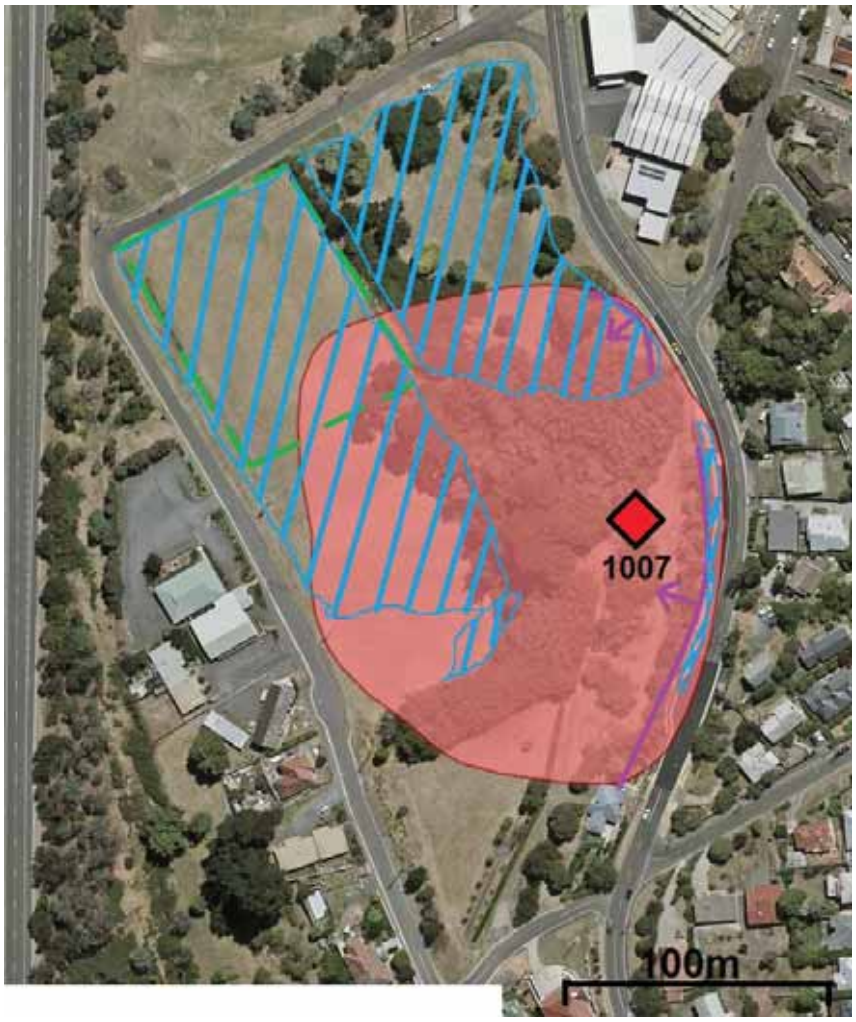

FIGURE 2 - MRT LANDSLIDE MAPPING

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Recent aerial image showing the MRT Landslide No. 1007 extend (in red), the Rose Lane Units development area (green dashed), the two landslips cited in the I. Jennings 1962 report (in purple), and the observed areas that were filled during the past over 70 years since 1946 (lined blue).

VI. Aerial images analysis

Historic aerial images have been acquired from the Department of Primary Industries, Parks, Water and Environment. Refer to Appendix C. Aerial images have been observed and analysed by Scherzic covering a time span of more than 70 years, starting from 1946 to present. In particular, historic aerial images dated 10th April 1946, 26th March 1966 and 24th April 1977 have been closely reviewed. The analysis was focused on the differences in morphology of the interested area and the possible visible movements of the slopes. The lots of land interested by the Rose Lane Units development are located were formerly the clay works buildings were placed. This area was subsequently covered by filling at the end of the clay works activity during the fifties (Figure 2). On the eastern side of the interested lots of land, a large area (included between northern Rose Lane and Norwich Street intersections on Westbury Road) was covered with filling with different nature as also used as a tip during the fifties and sixties (Figure 2). This area constitutes the current eastern upslope towards Westbury Road. Dwellings were already present on the eastern side and on the western side of Westbury Road since 1946. The analysis showed that the housing structures are unchanged, excluding additions during the years. The south-eastern slope just below Westbury Road did not show any visible difference in morphology from aerial images, excepting the emplacement of filling in proximity of the western side of Westbury Road visible on March 1966 aerial image (Figure 2). The southern slope just below Peel Street did not show any visible difference in morphology from aerial images. The Westbury Road has not been modified in size in more than 70 years. However, two road bays on its western side have been made in recent years on the south-eastern slope (Figure 2)

VII. Assessment

The assessment of the stability of the lots of land for Rose Lane Units development and the nearby slopes has been carried out by Scherzic Principal Geotechnical Engineer, together with an experienced Geologist. The stability assessment has including reviewing historic reports, collating recent geotechnical data, including historical aerial images analysis, and modelling with Limit Equilibrium software. Three cross sections through the slopes intersecting the proposed unit site were adopted to undertake the quantitative analysis (Figure 3).

As discussed above, the trigger for the assessment is MRT Landslide No.1007 which produce debris that can impact the Rose Lane Unit development.

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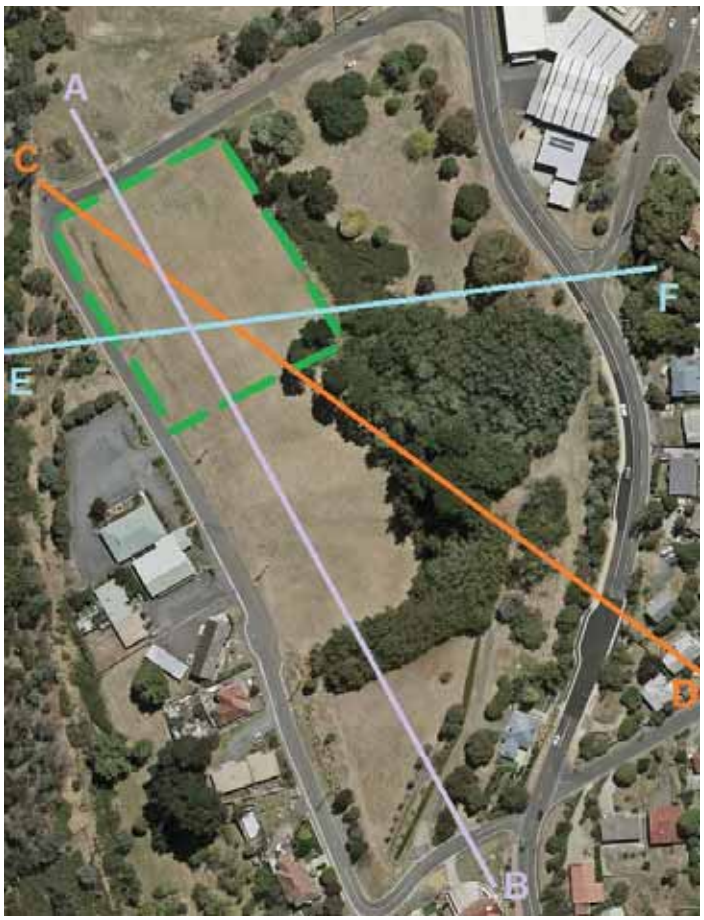

FIGURE 3 - SECTIONS OF SITE FOR ANALYSIS

1. Engineering Analysis

Three profile sections of the study area have been adopted for analysis as shown in Figure 2. All the significant data available in the cited reports have been adopted in the Limit Equilibrium Analysis using the Rocscience software SLIDE to provide both Factors of Safety (FOS) and Probability of Failure (Using Monte Carlo Method). All profile sections (A-B, C-D and E-F*) were assessed for both current conditions (quarry filled) and previous conditions at the tie of quarrying (ie deepest excavations). The SLIDE outputs are provided in Appendix D.

Sliding failure of slopes originate due to configuration, physical properties of the deposits, groundwater level and saturation, and external loads. Earthquakes can also trigger sliding due to external forces & effects on ground water pore pressures.

At this site, the configuration (previous quarry excavations) and soils/deposits which constitutes the slopes in the upslope areas may increase the risk of land sliding. Also, in the event of a landslide, the volume and travel distance of the landside debris are most important. The groundwater levels used in the sliding models produced and analysed by Scherzic have been collected from the available previous reports. Groundwater levels on the slopes of the three different profile sections analysed have been raised to ensure saturation. Loading upslope from Westbury Road has been added. No further loading has been considered as the slopes are mainly devoid of structures. The occurrence of an earthquake could affect the slopes modifying physical parameters of the deposits. Hence, the direct risk of sliding is commensurate with the risk of earthquakes.

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The probability & FOS due to rotational sliding failure using current conditions (ie quarry filled) at the slopes modelled using the software SLIDE from Rocscience is summarised:

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The probability at Section A-B is: 0.4%	The Factor of Safety is 2.5
The probability at Section C-D is: 0.0%	The Factor of Safety is 1.85
The probability at Section E-F is: 0.0%	The Factor of Safety is 2.1

For the conditions during operation of the brick works (quarry excavated) the probability & FOS due to rotational sliding failure is:

The probability at Section A-B is: 0.5%	The Factor of Safety is 2.1
The probability at Section C-D is: 0.0%	The Factor of Safety is 1.85
The probability at Section E-F is: 13.9%	The Factor of Safety is 1.3

The above results indicate that any land slide upslope of the proposed unit development would have been triggered by the quarry excavation and post filling, the probability of a land slide is very low. (*Note that the values indicated above are based on probabilistic analysis using estimated parameters. Although a quantitative analysis, variations on these results is likely with minor variations and assumptions; hence the numbers above should not be taken as absolute, but used for comparison between the differing scenarios*).

As indicated above, the existence of a landslide is secondary for development at the unit site compared to the mass/size of landslide debris and the travel distance of the debris. Hunter and Fell (2003) stated that possible landslides which have an unconfined travel path onto slopes with less than 15^o of slope angles will quickly come to rest close to their starting point. Qarinur (2015) defined landslides travel distances (L) using landslide height (H) (crown to toe) and slope angle (α) for different landslides types using a simple equation with coefficients obtained from statistical data. We applied the Qarinur (2015) equation using the slope data acquired from the two profile sections of the interested area related to the south-eastern slope. We considered the rotational landslide type as the most probable in relation to the deposits and slope settings. The results are as follows:

Slope angles for the different profile sections between slope toe and upslope road (Westbury Road, Peel Street):

Section A-B: 11^o

Section C-D: 13^o

Hypothetical landslide travel distance (L) in metres from toe:

Section A-B: L=1.346 + 1.788 H = 1.346 + 1.788 (23) = 42.4m

Section C-D: L=1.346 + 1.788 H = 1.346 + 1.788 (26) = 47.8m

The slope angles are all below 15^o and the hypothetical landslide travel distances obtained show limited cover at the toe area (i.e. below the old quarry face). This analysis indicates the occurrence of a landslide that quickly travels and covers the proposed unit site to be not credible for sections A-B and C-D. The volume of debris due to a landslide at section E-F is under current conditions is considered negligible.

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VIII. Discussion

The Rose Lane Unit site is partially included in the MRT Landslide No. 1007 area at the south-eastern edge and is marginally included as low slide susceptibility zone.

Historic reports from 1962 and 1975 do not show evidence of a major landslide below the western side of Westbury Road, but do highlight and mention past slip movements in proximity of the western side of Westbury Road embankment.

Historic image analysis of the study area shows that the Rose Lane Unit development site is in proximity of the old brick clay works buildings, and the site has been subsequently filled during the 1950s. The slope east of the development site has also been created by indiscriminate filling with diverse materials over some time which is confirmed in the historic aerial pictures. Furthermore, the historic aerial images show there are not significant morphological differences related to the eastern and south-eastern slope below Westbury Road over time, while repairs the Westbury Road pavement (asphalt patches in the images and filling on the western side of the road) has been consistently performed during past years and also cited in other reports (e.g. GHD???, Geoton). Dwellings on the same slope below and above Westbury Road were present since 1946 and no damage consistent with landsliding has been observed or reported occurred during the past 70 years. This background is consistent with movement only in the fill embankment of Westbury Road and not from a larger slope movement.

Geoton report (GL1428Df) inclinometers data can show the relationship between slope movements (under 4m depth) and the embankment of Westbury Road as also GHD found in the past (sourced from Geoton reports as GHD report has not been provided). Deep inclinometer INC-1 NW movements (without corresponding surface movements) presented in the Geoton GL1428Df report are inconsistent with the shallow recorded NW movements and maybe the result of casing failure. The inconsistency of the inclinometer data may also be attributed to poor inclinometer positioning during the tests – which is discussed by a professional external review (see Appendix C for the external opinion from Dr Pennington). Inclinometer data from INC-2 have consistent distribution and showed mainly shallow movements (above 6m depth) towards NW. The variation in movement direction observed between the second and third measurements in INC-2 towards east and then towards west at depth between 10 and 15m are probably the result of reactive clays activity (contraction and swelling) as the measurements were taken in diverse seasons of the year (winter and summer). The deep movements recorded by all the inclinometers are located all above the level of the old quarry batter and thus they do not affect the entire slope as suggested by MRT Landslide No.1007 drawings.

Landslide No. 1007 presents in MRT Tasmanian Landslide Inventory has not shown in the MRT Proclaimed Landslip Zones sheet. This fact indicates that this area could be susceptible to landslide movement due to the nature of the sediments present (as shown in the MRT Shallow Slide and/or Flow Susceptibility sheet) but not currently considered as a proclaimed active and dangerous zone. The presence of Landslide No. 1007 with its entity was not clearly presented in the available historic reports and no supporting evidence was provided either. However, as said above, two landslip zones just below Westbury Road were highlighted. In addition, the area highlighted as landslide No. 1007 includes a large portion of the eastern and south-eastern slopes and at the toe of the slopes which can be associated with a massive landslide of the entire slope. Despite so, data from the provided and acquired reports and from this analysis do not show this possibility. The head of the No. 1007 landslide is also coinciding with the western side of Westbury Road and following its contours. If a massive landslide was present would has likely affected the road and above the road land and dwellings, as all the area as the same deposits. This fact is in support of a sliding movement related to the Westbury Road embankment only. Hypothesising the presence of possible landslides departing from the western side below Westbury Road, data provided and acquired showed that their travel distance and entity could not affect the new Rose Lane Units development.

Focusing on the nature of the deposits, the area is mainly characterised by fine particles deposits. Soils rich in fine particles, such as silty and clayey soils are more prone to developed pore-water pressure on contraction (Hunter and Fell 2003). Clay soils, if undisturbed, retain a solid structure although high water content due to surface tension which holds clay particles (Hunter and Fell 2003). Thus, only an earthquake or sufficient shear (from load or slope angle) could disturb this process and ignite a fluid

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state. The probability of major earthquake affecting the interested area is very low with a hazard factor of 0.05 (from AS1170.4-2007 Earthquake Action in Australia and shown also in the Atlas of Seismic Hazard Maps of Australia). The eastern and south-eastern slopes did not present any excessive loading above slopes and have slope angles that are less than 13º. As Hunter and Fell (2003) stated that possible landslips which have an unconfined travel path onto slopes with less than 15º of slope angles will quickly come to rest close to their starting point. These factors defining the unlikeness of the possible occurrence of a major landslide that relatively quickly travels and covers the entire toe area, as shown by MRT Landslide No. 1007. On the contrary, the embankment below the western side of Westbury Road could be affected by excessive loading due to the multiple asphalt and filling emplacement made in road fixing during the years. The consequent possible localised sliding would not affect the Rose Lane Units development area due to their very modest travel path.

It is always possible that the quarrying activity could have triggered movement above the quarry before 1946 (no data or reports have been sighted by Scherzic before that time), however the significant amount of filling placed at the toe of the slope may have prevented any further movement. In addition the movement and evidence of movements below Westbury Road during the course of the years are most likely associated with the movement of the road embankment that underwent multiple and persistent loading through continuous superimposing of asphalt layers and filling (as previously highlighted in this report), which could be quantifiable at more than 4m thick as also evidenced by test pits performed downslope of Westbury Road and presented in the Geoton reports.

The probability of large and rapid landslip is extremely low or absent. Consequent to our research and analysis, we suggest that no major or active landslide on the eastern and south-eastern slope below Westbury Road is present and we support the development of Rose Lane Units.

1. Conclusions

Based on our assessment of the stability of Rose Lane lots of land and nearby slopes towards Westbury Road we conclude and recommend the following:

1. No major landslide movements have been observed and no supporting evidence has been found that define a major landslide on the south-eastern slope below Westbury Road (as shown by landslide No. 1007) which could potentially travel towards the proposed Rose Lane Units development.
2. The observed sliding movements affecting Westbury Road and its western side downslope can be associated with failure of the road embankment and thus do not affect the Rose Lane Unit development.
3. Possible significant sliding movement could have occurred from slope toe removal caused by the quarrying activity before 1946. Although no data or reports are available before 1946, two sliding analyses have been produced in sections A-B and C-D for this eventuality presenting the failure probability and the factor of safety of the slope in absence of the post-1946 slope toe backfilling (Rose Lane lots of land). The data showed that failure would not occur and a factor of safety always above 1.8. Subsequently to the end of the quarrying activity, massive filling of the toe of the slope has been observed which can prevent any possible massive slope movement, as also has been showed by Scherzic kinetic analysis which results in 0% probability of failure and a factor of safety above 2.6.
4. The slope east of the Rose Lane Units proposal has been assessed (Section E-F) and we believe its formation is associated with diverse filling events occurring in the past 70 years. The slope has been analysed by Scherzic for stability showing that major sliding is improbable towards the Rose Lane Units development.
5. Based on our assessment, we conclude the risk of impact from a landside/mass movement on the proposed development is <u>not credible</u> (travel distance & mass).

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6. Due to the nature of filling and natural soil type present in the unit site, we recommend further geotechnical investigation of Rose Lane Units development lots to provide footing/pile design parameters.

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