shaw:urquhart
consulting
geotechnical +
environmental
services

06282/1-C Rev.2 ku:
11 December 2006

Cardno (Qld) Pty Ltd

Commercial Centre

ISLE OF CAPRI QLD 4217

Attention: Mr Alaister MacRae

RE: PROPOSED RESIDENTIAL DEVELOPMENT, FRASER DRIVE, TWEED HEADS SOUTH

1. INTRODUCTION

At the request of Cardno (Qld) Pty Ltd (Cardno), Shaw:Urquhart has carried out a geotechnical review of the allotment layout master-plan for the above development. The geotechnical review was based on information provided to Shaw:Urquhart by Cardno. This information includes the following:

- Allotment layout plans and cross-sections for discussion.
- Copies of geotechnical reports prepared by Coffey Geosciences Pty Ltd (Coffey). These reports are ref. B17439/1-B dated 4 April 2002, B17439/1-F Revision 1 dated 30 September 2002, B17439/1-I dated 12 November 2002 and B17439/1-J dated 6 December 2002.

No geotechnical investigations have been carried out by Shaw:Urquhart.

2. SITE DESCRIPTION

The overall development consists of two distinct areas. On the eastern side of the site is an area of flat-lying alluvial flood plain which is currently under construction. This area was not included in the current allotment layout assessment.

On the western side of the site is an area of raised ground on the eastern side of a prominent ridge line. This area runs the full length of the site and is around 900m long (north-south) by 100m to 150m wide (east-west).

This area and the associated master-plan allotment layout was the subject of the geotechnical review. For the purposes of this report, this area is referred to as "the site".

Suite 6, 633 Logan Road
GREENSLOPES
QLD 4120 Australia

PO Box 19
GREENSLOPES
QLD 4120 Australia

T: +61 7 3847 8751
F: +61 7 3847 7863

3. GEOTECHNICAL REVIEW OF ALLOTMENT LAYOUT

Based of the geotechnical information provided in the Coffey reports, the main potential geotechnical issues relating to development of the site are considered to be as follows:

- Slope angles, which vary from around 10° to 25°, depending on location.
- Local geology, in particular the presence of an interface layer between the overlying basalt-derived materials and the underlying metamorphic-derived materials.
- Groundwater seepage and associated areas of existing slope instability, which are mainly located towards the northern end of the site.

In order to mitigate the potential risks associated with the above geotechnical issues, the following geotechnical constraints were applied to the allotment layout:

- Building areas within allotments should not lie on land with slopes steeper than 3H:1V (approx. 18°). No un-supported slopes should be steeper than 2H:1V (approx. 26°). The vertical heights of cuts and fills within proposed building areas should be no greater than 1.2m.
- Allotments should not include areas of existing slope instability unless in-filling of the allotments and removal of areas of disturbed ground results in a significant and appropriate improvement in the slope stability of such areas.
- Areas of existing slope instability located outside of allotments should be remediated.
- Measures to maintain the stability of the slopes within allotment areas are to include subsoil drainage around the basalt/metamorphic interface zone on each allotment and collection and containment of all stormwater discharge from gutters, downpipes driveways, paths and hardstandings.

The above constraints relate to the design of the allotments layouts. Other, more specific geotechnical constraints relating to development of individual allotment building areas and individual structures will be provided at the detailed design stage.

The application of the above constraints is recommended to reduce the likelihood of significant ground movement to "Unlikely' and the associated risk level to "Low to Medium" with reference to the methodology and terminology outlined in Appendix G (Landslide Risk Assessment - Example of Qualitative Terminology for Use in Assessing Risk to Property) of "Landslide Risk Management Guidelines" published by The Australian Geomechanics Society (March 2000). Based on the results of the geotechnical review combined with constraints applied by other considerations and disciplines, Cardno has prepared a master-plan allotment layout for the proposed development. A copy of the Cardno master-plan allotment layout is attached.

The proposed allotment layout is considered to be generally in accordance with the geotechnical constraints on the development of the site. It is expected that further geotechnical investigations will be carried out at the design stage to confirm the results of the review.

It is understood that areas of existing landslips will be remediated in accordance with the recommendations outlined in the Coffey reports. These recommendations should be reviewed if site observations indicate that surface conditions (for instance, local surface drainage or topography) have changed significantly since the Coffey report was completed.

The allotment layout includes the construction of a number of retaining structures to allow road formations to be constructed without over-steepening of the slopes above and below the road. In this geological environment, it is considered that construction of appropriate retaining structures in accordance with Council constraints is preferable to excavating and potentially over-steepening of the hill slopes.

The retaining structures have not yet been designed but the design process will include an assessment of the local and global slope stability of the retaining structures.

In general, it is recommended that the design and construction of excavations, earthworks and other structures on the site conform with the guidelines presented in Appendix J (Some Guidelines for Hillside Construction) from "Landslide Risk Management Guidelines" published by The Australian Geomechanics Society (March 2000).

If you have any questions or if you wish to discuss or clarify any of the issues raised in this report, please Keith Urquhart or Philip Shaw at our Brisbane office.

For and on behalf of

SHAW URQUHART PTY LTD

KEITH URQUHART

Principal Engineering Geologist

Att. Copy of Cardno Master-Plan Allotment Layout

Copy of Appendix G from "Landslide Risk Management Guidelines" published by The Australian Geomechanics Society (March 2000).

Copy of Appendix J from "Landslide Risk Management Guidelines" published by The Australian Geomechanics Society (March 2000).

APPENDIX G

LANDSLIDE RISK ASSESSMENT – EXAMPLE OF QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

Qualitative Measures of Likelihood

Level	Descriptor	Description	Indicative Annual Probability
A	ALMOST CERTAIN	The event is expected to occur	$>=10^{-1}$
B	LIKELY	The event will probably occur under adverse conditions	$=10^{-2}$
C	POSSIBLE	The event could occur under adverse conditions	$=10^{-3}$
D	UNLIKELY	The event might occur under very adverse circumstances	$=10^{-4}$
E	RARE	The event is conceivable but only under exceptional circumstances.	$=10^{-5}$
F	NOT CREDIBLE	The event is inconceivable or fanciful	$<10^{-6}$

Note: "=" means that the indicative value may vary by say ±1 order of magnitude, or more.

Qualitative Measures of Consequences to Property

Level	Descriptor	Description
1	CATASTROPHIC	Structure completely destroyed or large scale damage requiring major engineering works for stabilisation.
2	MAJOR	Extensive damage to most of structure, or extending beyond site boundaries requiring significant stabilisation works.
3	MEDIUM	Moderate damage to some of structure, or significant part of site requiring large stabilisation works.
4	MINOR	Limited damage to part of structure, or part of site requiring some reinstatement/stabilisation works.
5	INSIGNIFICANT	Little damage.

Note: The "Description" may be edited to suit a particular case.

Qualitative Risk Analysis Matrix – Level of Risk to Property

LIKELIHOOD	CONSEQUENCES to PROPERTY				
	1: CATASTROPHIC	2: MAJOR	3: MEDIUM	4: MINOR	5: INSIGNIFICANT
A – ALMOST CERTAIN	VH	VH	H	H	M
B – LIKELY	VH	H	H	M	L-M
C – POSSIBLE	H	H	M	L-M	VL-L
D – UNLIKELY	M-H	M	L-M	VL-L	VL
E – RARE	M-L	L-M	VL-L	VL	VL
F – NOT CREDIBLE	VL	VL	VL	VL	VL

Risk Level Implications

Risk Level		Example Implications(1)
VH	VERY HIGH RISK	Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to acceptable levels; may be too expensive and not practical
H	HIGH RISK	Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable levels
M	MODERATE RISK	Tolerable provided treatment plan is implemented to maintain or reduce risks. May be accepted. May require investigation and planning of treatment options.
L	LOW RISK	Usually accepted. Treatment requirements and responsibility to be defined to maintain or reduce risk.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (1) The implications for a particular situation are to be determined by all parties to the risk assessment; these are only given as a general guide.

(2) Judicious use of dual descriptors for Likelihood, Consequence and Risk to reflect the uncertainty of the estimate may be appropriate in some cases.

APPENDIX J

SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

ADVICE	*GOOD ENGINEERING PRACTICE*	*POOR ENGINEERING PRACTICE*
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical consultant at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminant bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements.
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant.	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	