coffey geotechnics
SPECIALISTS MANAGING THE EARTH

PRELIMINARY GEOTECHNICAL ASSESSMENT
PROPOSED 'LIFE CITY WOLLONGONG' HOSPITAL DEVELOPMENT
WARWICK ST, BERKELEY, NSW

TCG Planning

GEOTWOLL03229AC-AB
7 February 2013

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
118 Auburn Street Wollongong NSW 2500 Australia

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SPECIALISTS MANAGING THE EARTH

7 February 2013

TCG Planning
174/162 Gipps Road
Gwynneville NSW 2500

Attention: Elaine Treglown

Dear Anna,

RE: PRELIMINARY GEOTECHNICAL ASSESSMENT
PROPOSED 'LIFE CITY WOLLONGONG' HOSPITAL DEVELOPMENT
WARWICK ST, BERKELEY, NSW

Coffey Geotechnics Pty Ltd is pleased to present this report on a Preliminary Geotechnical Assessment of the above site.

We draw your attention to the attached sheets titled "Important Information about your Coffey Report". These sheets should be read in conjunction with this report.

Thank you for your commission for this work and we look forward to the opportunity of being of assistance on further stages of this project in the future. If you require further information or clarification regarding any aspect of this report, please do not hesitate to contact the undersigned.

For and on behalf of Coffey Geotechnics Pty Ltd

Scott Morrison

Associate Geotechnical Engineer

Distribution: Original unbound copy held by Coffey Geotechnics Pty Ltd
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1 INTRODUCTION

This revised report presents the results of a preliminary geotechnical assessment carried out by Coffey Geotechnics Pty Ltd (Coffey) at the proposed site for a Hi-Tech Holistic Cancer & Medical Hospital Facility, to be known as 'Life City Wollongong'.

The original report GEOTWOLL03229AB-AA dated 31 October 2012 has been revised following a site meeting carried out on 17 January 2013 by Scott Morrison (Coffey) in the presence of Elaine Treglown (TCG Planning), Dr. M.K. Rashid (Principal) and Edward Shin (C&M Consulting engineers). During this site meeting several options for efficient project management, planning and design were discussed and generally including the following:

- Preparation of indicative earthworks cut and fill concept plans;
- Preliminary geotechnical review of proposed earthworks plans and construction options as discussed during the meeting;
- Preparation of an updated geotechnical report which provides comment on the proposed earthworks plan; and
- Possible reduction of assessed slope risk from 'High Risk' to 'Moderate Risk' or even 'Low Risk' if good geotechnical engineering practice is employed at the site.

We understand TCG Planning have been engaged by Delbest Pty Ltd to coordinate the Part 3A development application process in relation to the proposed development. A geotechnical investigation was required as part of the Part 3A development application submission. This preliminary geotechnical assessment does not include any contamination assessment of the soils, rock or groundwater.

The proposed development is located off Warwick Street and is adjacent to the F6 Freeway in Berkeley, NSW. Figure 1 shows the location of the site and Figure 2 shows the overall Master Plan for the development provided to Coffey for this work. It is understood that the site will be developed in 8 overall stages with Stage 1 to commence during 2014.

The objectives of the preliminary geotechnical assessment were to assess the following:-

- General subsurface conditions over the site;
- Landslide Risk of the current site in accordance with the current Wollongong City Council Guidelines (from AGS (2007)); and
- The need for further investigation works in selected portions of the site.

2 SCOPE OF WORK AND METHODOLOGY

The scope of work and method of investigation are discussed in this section, and the results of the assessment works are presented in Section 3. The general location of the site is shown in Figure 1, and the Master Plan for the proposed development is shown in Figure 2.

2.1 Desk Study

A desk study was carried out prior to commencement of the assessment, which included reference to available geological information and aerial photos of the site.

Images of the site from 2005, 2008, 2009 and 2011 were also retrieved and viewed by Coffey from Google Earth (2012). The site appears relatively similar to current conditions in these previous aerial photos.

2.2 Mapping Works

Mapping works were carried out on 20 September 2012. A Project Engineering Geologist carried out the mapping works and walked over the site making visual observations relating to the landforms and geology at the site. A Principal Geotechnical Engineer visited the site during site investigation works on 25 September 2012 to view key geological features of the site identified by the Project Engineering Geologist and to observe exposed subsurface conditions within an open test pit.

2.3 Subsurface Investigation

Subsurface investigation works at the site were carried out on 25 September 2012. A total of 12 test pits were excavated by a 5 tonne mini-excavator at the approximate locations as shown in Figure 1. The test pits were excavated to depths of between 0.8m and 2.65m. Many of the test pits were terminated on 'very slow progress' (near refusal) on weathered rock. Some of the deeper test pits were terminated in soil strength materials or fill materials at the limit of practical reach of the excavator.

The test pits were excavated in the full time presence of a project geotechnical engineer who logged the subsurface conditions observed in the pits.

No laboratory testing was carried out as part of this preliminary assessment.

3 RESULTS OF INVESTIGATION

3.1 Desk Study and Geology

The 1:100000 Wollongong – Port Hacking soil landscape series sheet (1990) indicates the site is underlain by two different soil types:

- Gw – Gwynneville. The limitations of this soil type are 'extreme erosion hazard, steep slopes, mass movement hazard, local flooding, reactive subsoils and impermeable, low wet bearing strength clay subsoils; and
- Bk – Berkeley. The limitations of this soil type are 'mass movement hazard, extreme erosion hazard, reactive subsoils, locally impeded drainage.

The 1:50000 Wollongong Geology Sheet (1974) and the Berkeley Geology Sheet (1970) indicate that the site is underlain by three different geological units.

The majority of the central and northern portions of the site is mapped as being underlain by the 'Pheasants Nest Formation - interbedded lithic-sandstone, coal, carbonaceous claystone, siltstone, and claystone'. The Pheasants Nest Formation is a member of the Illawarra Coal Measures.

The areas in the south of the site (downhill and south of the ridgeline) are mapped as being underlain by rock mapped as 'Dapto Latite – melocratic, coarse grained and porphyritic Latite'. The Dapto Latite is a member of the Shoalhaven Group of Rocks and is of Early Late Permian Geological Age.

Both major rock types are of 'Early Late Permian' Age.

A third rock unit described as a 'Nolan Dolerite-mid-grey Dolerite' is mapped as lying near the eastern portions of the site closer to Nolan Street. This rock is not common within the Wollongong Map area and is restricted to a small portion of land with an area of about 3.0ha. The Nolan Dolerite is a much newer rock geologically (Post Late Triassic Age) and appears to be a volcanic intrusion into the much older surrounding geological environment.

In the Geological Cross Section that passes directly through this site, the map notes that the Dapto Latite rock type (Shoalhaven Group) underlies the Pheasants Nest Formation (Illawarra Coal Measures). The map indicates the contact between the two rock units is near horizontal.

The Berkeley Land Stability Sheet (Bowman, 1970) indicates the site is 'Zone 1 - Stable land – no landslip problems'.

Based on a review of Aerial Photos dating back to 2005 in Google Earth (Google, 2012), the site appears generally similar to present conditions. The site appears to comprise undeveloped grazing land. Several access tracks are noted across the site in all aerial photos viewed.

3.2 Surface Observations and Mapping Works

The following observations were made during mapping works and whilst moving about the site during the test pitting work:

- The site is an irregularly shaped portion of the land generally bounded by areas of residential housing to the north, east and south and the F6 Freeway to the west;
- High Voltage power lines lie within an easement that passes through the southern portions of the site; and
- The main topographical feature of the site is a ridgeline that wraps around a central valley. A vehicular track passes roughly along the top of this ridgeline.

In the portion of the site on the north-western side of the ridgeline (ie. on the 'F6 Freeway' side of the ridge):

- About 20m to 50m beyond the crest of the ridgeline within the site, the ground surface falls at between 3 and 20 degrees. The steeper sloping portions of the site are located over the sideslopes of the ridge and valley in the central portion of the overall site. These areas have slopes of between about 10 and 20 degrees and are generally located within about 100m of the top of the ridge. The lower sideslopes and floor of the valley have slopes generally between 3 and 8 degrees;
- The tree cover in this portion of the site was sparser compared to other parts of the site and with only small or scattered clumps of shrubs or trees, with the remainder of this portion covered in thick grass to a height of up to 1m; and
- An area of reed grass or marshy area was noted midway down the sideslopes of the central valley area which was possibly the location of an old farm dam. Apart from this area no significant soft or wet areas were noted over the site during our walkover, mapping and subsurface investigation.

It appears that a relatively large area (about 200m along the F6 boundary x about100m wide) of this portion of the site extending from Warwick Street along the boundary fronting the F6 may have been filled in the past. A least one old car body was noted in this portion of the site. In many areas the surface was irregular to walk over, however thick grass covered the surface and likely disguises mounds or layers of fill materials of variable quality and sources. The proximity of the site to the nearby residential areas was noted and it is possible that some illegal dumping of various materials may have occurred particularly in this portion of the site. To the east and south of the main ridge (ie. in areas sloping downwards towards areas of 'residential housing'):

- About 50m beyond the crest of the ridge the site falls at between about 10 and 20 degrees;
- This portion of the site is covered in dense vegetation and it was difficult to see the surface conditions in many areas. Access within these areas was difficult on foot and by excavator. In many areas access was restricted to small vehicle access or walking tracks; and
- No significant soft or wet areas were noted whilst walking over this part of site.

3.3 Subsurface Conditions

The general subsurface conditions for this preliminary assessment have been derived from the mapping works carried out by a Project Engineering Geologist, Principal Geotechnical Engineer and the results of the geotechnical test pits (TP01 to TP12) carried out by a project geotechnical engineer for this investigation. The test pits were widely spaced and are indicative of the subsurface condition in the vicinity of the test pit.

The general subsurface geology encountered in the test pits have been subdivided into a number of stratigraphic units and presented in a preliminary geotechnical model of the site, as presented below:

Table 1: General Site Stratigraphy

Unit	Depth to top of unit below existing ground level within test pits (m)	Thickness (m)	Description of Unit
1	**Surface** **(TP1, TP2 and TP3 only)**		**Fill**: **General Fill/Reworked Natural Material:** comprising clay / gravelly clay of medium to high plasticity, orange-brown with a trace of grey pockets. The material consistency ranged from firm to hard. This unit included some fine to medium grained sand, fine to coarse grained gravel, trace angular sandstone or latite cobbles/boulders. Occasional layers of organic materials were noted. Some gyprock, concrete, cobbles and car parts were noted within the fill materials in CTP2.
2	**Surface**		**Topsoil/Topsoil Fill:** comprising clay or sandy clay, medium or high plasticity, brown, with some fine to medium grained sand and roots. This unit was generally firm to very stiff.
3	**0.2** **(TP11 only)**	**>2.45m**	**Colluvial Soil:** Medium to high plasticity, orange/brown with some pockets of mottled black and grey, moisture content equal to or drier than the plastic limit, very stiff
4	**0.2 to >2.65m**	**0.45m to 0.90m**	**Residual Soil:** generally encountered as clay of medium to high plasticity and orange-brown colour. The consistency of this unit was generally very stiff to hard. This unit tends to grade from residual soil to extremely weathered rock with increasing depth.
5	**0.7m to >2.65m**	**Not proven**	**Rock**, consisting of highly to moderately weathered Sandstone, fine to medium grained, orange-brown with some occasional mottled black zones, low to medium strength. Latite rock was inferred as encountered in TP10. The latite was mottled orange/red/brown and medium to high strength.

The subsurface conditions encountered in the test pits are generally consistent with the published geological information with the exception of:

- The extent of the fill encountered over parts of the site. There appear to be extensive areas of filled land in the northern to north-western portions of the site; and
- In the nearby large road cutting to the west of this site for the F6 at Berkeley, mid-grey rock (possibly Nolan Dolerite or fine grained Dapto Latite) underlies sedimentary rock (Pheasants Nest Formation) and the contact between the two rock units appears near horizontal. This would infer that similar mid-grey rock may underlie the lower portions of this site. As yet this has not been encountered in the test pits and sedimentary rocks have been encountered in the test pits in the lower portions of this site. This could be due to the contact between the mid-grey Dolerite/Latite being non-horizontal further away from the F6 Freeway cutting and the edge of the unit or flow may be encountered inside this site.

4 DISCUSSION – GEOTECHNICAL ISSUES

4.1 Preliminary Landslide Risk Assessment to AGS 2007

The Berkeley Land Stability Sheet (Bowman, 1970) indicates the site is 'Zone 1 - Stable land – no landslip problems'.

The site has been qualitatively assessed in accordance with the methods of Australian Geomechanics Society as outlined in Appendix I. Appendix I also contains a number of guidelines from the AGS Geoguides with respect to good hillside construction practice, and these should be carried out in future development at this site. We note that even relatively small works such as trenches or retaining walls can pose risk to life and/or property if their construction does not conform with good geotechnical and civil engineering construction practice.

The filled areas appear to comprise largely uncontrolled fill and these areas will require remediation before development can occur over these areas. Remediation from the geotechnical perspective will likely involve progressive excavation of the filled areas, removal of unsuitable fill materials and reuse and re-compaction of reusable fill soils in a controlled manner to AS3798-2007. We note that environmental contamination has not been assessed in this report and a detailed contamination assessment of the fill materials will be required in order to assess the suitability of the fill materials for re-use. It is recommended that an integrated geotechnical/environmental fill reuse strategy is developed for this site so that a cost effective ground treatment solution can be developed.

As outlined in Figure 3, we have provided preliminary mapping of the site into various zones, with the risk to property due to landslide noted for each zone.

Tables 2,3 and 4 present an assessment of the 'level of risk to property' for multiple scenarios that have been developed based on geological features and potential slope hazards identified during our investigation. This has been carried out in accordance with Australian Geomechanics Society (2007) 'Practice Note Guidelines for Landslide Risk Management'.

The risk assessment is carried out based on good hillside construction practice techniques being adopted by the constructor of the development. Examples of good hillside construction practice are shown in LR8 in Appendix I. It is also carried out on the basis that:

- Cuts are limited to a maximum depth of 1.5m and fills are limited to a thickness of 1.5m;
- The areas of fill are remediated including progressive excavation of the filled areas, removal of unsuitable fill materials and reuse and re-compaction of reusable fill soils in a controlled manner to AS3798-2007; and
- Subsoil and surface drainage is installed at this site as necessary. Subsoil drainage will be important in areas where existing seepages have been noted (eg. in the mid-slopes where the marshy/wet area was noted).

Please note that as detailed architectural and structural drawings of the proposed for development are not available at this stage of planning, this Landslide Risk Assessment should be considered preliminary. This risk assessment should be revised once the design drawings are published.

Landslide Risk to Property

The landslide risk to property for this portion of the site is discussed below in Tables 2 to 4.

Table 2: Landslide Risk Assessment – Areas with ground slopes generally 3 to 10 degrees with thinner soil cover, soil cover less than 1m deep

Hazard	Likelihood	Consequence to Proposed Development	Risk to Proposed Development
Creep of surface soils	Unlikely	Minor	Low
Active/deep-seated slide	Rare	Medium	Low
Inundation of property from surface water and/or surface water with debris flow	Rare	Medium	Low
		Assessed Risk Level	**Low**

Table 3: Landslide Risk Assessment – Areas with ground slopes generally 10 to 20 degrees with thinner soil cover, (soil cover less than 1.0m deep)

Hazard	Likelihood	Consequence to Proposed Development	Risk to Proposed Development
Creep of surface soils	Likely	Minor	Moderate
Active/deep-seated slide	Rare	Medium	Low
Inundation of property from surface water and/or surface water with debris flow	Likely	Minor	Moderate
		Assessed Risk Level	**Moderate**

Table 4: Landslide Risk Assessment – Areas with ground slopes generally 10 degrees to 20 degrees and thicker soil cover, soil cover sometimes greater than 2.0m

Hazard	Likelihood	Consequence to Proposed Development	Risk to Proposed Development
Creep of surface soils	Likely	Medium	High
Active/deep-seated slide	Possible	Major	High
		Assessed Risk Level	**High**

For the area marked as 'high' risk of land instability, these portions of the site will require further engineering works and appropriately controlled construction works to reduce the future risk to property to not higher than 'Moderate'.

We note however that there may also be areas of 'High Risk' in areas of the site currently mapped as 'Moderate Risk'. This could be due to portions of this site being currently inaccessible for mapping purposes.

Landslide Risk to Life

In the areas marked as 'low' and 'moderate' risk of landslide to property as presented on Figure 3, we consider that the likely risk of loss of life for residential development in these areas is 'tolerable' as defined in AGS (2007).

In areas marked as 'high' risk of landslide to property as presented on Figure 3, we consider that the likely risk of loss of life for residential development in these areas may not be 'tolerable' as defined in AGS (2007). Ultimately the risk to life will be dependent on the findings of a detailed assessment of these areas and the specific development details proposed.

The portions of the site where risk to life is not 'tolerable' will require further engineering works and appropriately controlled construction works to reduce the future risk to life to at least 'tolerable' levels.

General Comments and Future Risk

Provided that further engineering works and appropriately controlled construction works are carried out over the course of this development that is targeted at reduce the currently assessed risk level, then it is feasible to progress development within these higher risk areas of the site. It is feasible to progress development provided that the risk level for property following engineering measures and construction activities is not higher 'Moderate' for property risk and the risk to life is at least 'tolerable',. Further work will be required to achieve this in accordance with the recommendations in Section 4.3.3 below.

In the absence of further geotechnical works, engineering design and/or good construction practice, for the areas of the site where the risk to property is considered 'high' and the risk to life is not 'tolerable', a 'geotechnical restriction zone' should apply to these areas.

It is possible that some smaller areas with only 'moderate' risk to property and 'tolerable' risk to life could be found within the higher risk zones at this site, however further work would be necessary to confirm the landslide risk in this area. In broad terms, we consider that whilst development within the 'geotechnical restriction zone' may be more costly for the developer compared to sites largely unaffected by landslide risk, it is still feasible to carry out development works in the form proposed at this site with appropriate engineering risk management measures.

This is a preliminary assessment and is based on the assumption that all proposed development is constructed in accordance with good geotechnical and civil engineering construction practices and that further assessment of landslide risk will be carried out once the development drawings are prepared. If poor engineering and construction practices are used at this site then the risk to property may increase and the risk to life may no longer be 'tolerable' in accordance with AGS (2007).

The assessed approximate extent of the areas of landslide risk are marked in Figure 3.

4.2 Site Classification to AS2870-2011

This area is generally underlain by residual clay soils weathered from the underlying Pheasant Nest sedimentary rock unit. Areas of thick Fill and Colluvium were also encountered at the site.

Based on the subsurface information, site classifications for the areas assessed as low risk to property due to landslide would be either 'M', 'H-1' or 'H-2' as defined in AS2870-2011.

Significant areas would also classify as 'P' lots due to either the presence of thick, uncontrolled fill or moderate to high risk of landslide (or potentially both fill and landslide risk).

4.3 Site Earthworks

4.3.1 Concept Design Stage - Cut and Fill Drawings

Concept stage cut and fill drawings have been prepared by C & M Consulting Engineers (Ref. 00864_SK07 Rev.P2 dated 24/08/2012) has and have been provided to Coffey. The drawings are presented as Figure 4 in this report.

We understand that cuts and fills in the order of +/- 4m are proposed at this site. It appears the majority of large cuts are proposed towards the elevated ridgelines in the northeast of the site and the majority of large fills extend west (downhill) from these ridgelines towards the lower lying portion of the site.

Some of the thickest fill is proposed in areas of geotechnical concern, in particular near the centre of the site where the land is assessed as having a 'high' landslide risk. This area is shown shaded orange in Figure 3. Further geotechnical investigation, structural design, earthworks design and good construction controls in accordance with good hillside construction practices will be required in this portion of the site. A copy of the Geoguide LR8 showing Good Hillside Construction Practice is included in Appendix B for your reference.

4.3.2 Potential Issues

The ground conditions at this site have been investigated at a preliminary level and further geotechnical investigation will be carried out to assess the soil and bedrock profile. Geotechnical Design Input will be necessary and must be carried out during all stages of construction.

Based on our review of the proposed cut and fill drawings provided we suggest the following geotechnical issues may be encountered during construction and will need to be catered for in structural design, design of earthworks and in construction practice:

- Groundwater seepages from the hillside ;
- Deep soil profiles comprising weathered colluvium soils derived from old landslide activity. These profiles may have low shear strengths along old landslide surfaces;
- Differing rock strengths may be encountered in cuts, ranging from more workable sedimentary rocks to igneous rocks requiring heavy machinery or vibration to remove or excavate. Vibration issues from excavation and the effect on nearby deep soil masses that may be prone to movement will need to be assessed;
- Waterlogged or loose soils requiring treatment or removal; and
- Fill soils requiring treatment or removal. These fill soils will also require input from both an experienced geotechnical engineer and from an environmental engineer or scientist experienced with the assessment of contamination prior to reuse.

We suggest that the above geotechnical issues are at this stage preliminary and could be added to or modified during the course of site investigations. Coffey has experience in dealing with these issues on sites in similar topography in the Illawarra area.

4.3.3 Rock Rippability

The site is underlain by three geological units being The Pheasants Nest Formation, Dapto Latite and Nolan Dolerite. As described in Section 3.1 above, the Pheasants Nest Formation comprises sedimentary rocks such as interbedded lithic-sandstone, coal, carbonaceous claystone, siltstone, and claystone'. This sedimentary rock unit is assumed to be underlain by Dapto Latite which is an igneous rock and is somewhat similar in strength to basalt.

Nolan Dolerite is also an igneous rock that is mapped as lying near the eastern portions of the site closer to Nolan Street. This rock is not common within the Wollongong Map area and is restricted to a small portion of land with an area of about 3.0ha. The Nolan Dolerite is a much newer rock geologically (Post Late Triassic Age) and appears to be a volcanic intrusion into the much older surrounding geological environment.

Based on our field observations and an isolated spread of test pits carried out towards the centre of this site, we anticipate that cuttings proposed in the lower portions of the site may contain a mix of latite and sedimentary rocks such as lithic sandstone. Although not observed, Nolan Dolerite may be encountered in the eastern portion of the site where access was hindered by dense vegetation growth during our preliminary investigation. General advice is provided below concerning excavation and rippability of the various geotechnical units mapped as being present at this site.

The majority of the soils and highly to moderately weathered rock should be readily excavated with conventional blade and ripping equipment on D7 to D9 bulldozers. In mixed faces however where lithic sandstones may be thin and Latite may have become weathered there is a potential for weathered Latite boulders (corestones) to be present within the soil profile, which could cause difficulties for excavation.

In the slightly weathered or fresh Sandstone, Latite or Nolan Dolerite, larger equipment may be required. As the site contains steep slopes of landslide concern, blasting techniques are not recommended. Blasting could cause excessive ground vibrations that may impact on unstable land or nearby residents or vibration sensitive infrastructure. Consideration could be given to the use of Penetrating Cone Fracture (PCF) type techniques or expansive grouts for rock breakage purposes if alternatives to dozers or rock sawing/hammering techniques are required.

4.3.4 Landslide Risk Post Construction

As discussed previously in Section 4.1, the landslide risk presented in Section 4.1 above in the higher risk areas of the site could be reduced such that development is feasible provided the following general recommendations are followed:

- Additional Geotechnical and Environmental investigations are carried out in accordance with Section 4.5 below;
- Coffey are involved in the review process for future geotechnical works onsite. This would include piling, design of retaining structures, design of earthworks, site regarding and proposed site cut and fill plans. Supervision of the contractor during earthworks should be carried out by the geotechnical engineer. A proactive approach to reducing the effect of future potential geotechnical issues will be necessary at this site prior to commencement of construction works onsite;
- All earthworks are carried out in strict accordance with AS3798-2007 'Guidelines on earthworks for commercial and residential developments;
- The earthworks design, drainage and specifications should be referenced to AGS (2007) Geoguides LR1 to LR10 presented in Appendix B;
- Residential footing and drainage design for residential type structures are carried out in accordance with AS2870-2011 'Residential Slabs and Footing'; and
- Pavements are designed in accordance with Austroad 2012 guidelines.

4.4 Site Maintenance and Drainage Issues

Development at the site should be carried out and maintained in accordance with examples of 'good hillside construction practice' and the CSIRO publication 'Foundation Maintenance and Footing Performance: A Homeowners Guide' (CSIRO, 1993), included in Appendix B. Whilst the CSIRO document refers to older terminology with respect to site classification and good construction practices, the document is still useful. Good hillside construction practice must be used at this site and these documents underpin many of the design assumptions in AS2870-2011 and our Preliminary Landslide Risk Assessment presented in above.

It should be noted that some cracking of residential structures is inevitable and is part of design to AS2870-2011.

Surface Drainage should be installed and maintained at the site. All collected stormwater, groundwater and roof runoff should be discharged into the stormwater disposal system. Similarly effluent flows should be directed into the sewerage system. Notes regarding effluent disposal and the possible detrimental effects to other factors onsite including landslide risk are included in Appendix B as part of LR9 'Effluent Disposal'.

4.5 Recommended Additional Work

The following additional work is recommended for the development at this site:

- Development staging for this site should be viewed in conjunction with our preliminary landslide risk assessment. The landslide risk assessment should be refined based on further mapping and site investigation works;
- Further subsurface geotechnical and environmental investigation is required comprising test pits, standpipe piezometers, dynamic cone penetrometer (DCP) testing and deeper cored boreholes to identify soil consistency and density, soil composition, soil thickness, depth to bedrock and bedrock consistency and insitu rock strength;
- Investigation assessing potential issues regarding earthworks and pavement design should be carried out. Laboratory testing of the site soils should comprise both undisturbed tube and bulk bag samples to assess such things as CBR, Shrink/Swell and other geotechnical parameters;
- An integrated geotechnical and environmental ground treatment strategy will be required for the site and should be prepared for the site. Coffey can assist with this; and
- If access to the site is to be gained from Nolan Street, further work should be carried out along accessways to assess ground conditions and in particular the extent of the Nolan Dolerite.

5 LIMITATIONS ON ASSESSMENT

The preliminary geotechnical assessment presented in this report is based on the site being developed for a future hospital development and that cuts and fills would be in the order of +/– 4m of current ground surface levels. Further work will be required before detailed design of the development is completed regarding landslide risk assessment, particularly if the Master Plan layout is amended.

This report covers geotechnical issues as outlined in the scope of work and methodology. The report does not provide an assessment of groundwater flow or direction or advice on other geo-environmental issues outside the scope of the report. Coffey can assist with further advice in relation to these aspects, if required.

The subsurface assessment work was carried out during September 2012. A period of very wet weather occurred in the area between about December 2011 and April 2012. It is possible that the moisture content of the clay soils at this site has changed somewhat when compared to long term average conditions. It should be noted that the future moisture content of the soils at this site could change based on climatic or seasonal weather patterns.

The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. Under no circumstances can it be considered that these findings represent the actual state of the site at all points. The subsurface conditions may vary significantly in other parts of the site, particularly where no nearby sampling and testing work has been carried out.

Should any site conditions be encountered during construction that vary significantly from those discussed in this report, Coffey should be advised and appropriate action taken.

6 REFERENCES

1. AGS Landslide Taskforce, Landslide Practice Note Working Group, 'Practice Note Guidelines for Landslide Risk Management 2007', *Australian Geomechanics* Vol 42, No. 1, March 2007, page 63-114.
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4. 'Austroads, Guide to Pavement Technology, Part 2: Pavement Structural Design' (2008), Sydney: Austroads Inc;
5. Bowman, H.N. 'Berkeley, Geology, City of Greater Wollongong, Sheet 12 of 21 sheets' (1970) Geological Survey of NSW, Department of Mines, Sydney;
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8. Soil Conservation Service of NSW (1990) 1:100,000 Wollongong Soil Landscape Series Sheet (9029-9129, First Edition);
9. Google Earth (accessed 2012), 'Aerial Photos from 2008, 2009 and 2011', Google Incorporated

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

coffey geotechnics
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Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.