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REPORT
ON
GEOTECHNICAL INVESTIGATION

CONCEPT PLAN APPLICATION
CALDERWOOD URBAN DEVELOPMENT PROJECT

Prepared for:
DELFIN LEND LEASE LTD

PROJECT 48742
MARCH 2010

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Executive Summary

A geotechnical investigation has been undertaken for the Concept Plan Application of the Calderwood Urban Development Project, a 720 ha site near Albion Park, NSW. The investigation comprised field mapping by a Principal Engineering Geologist, test pit excavations, borehole drilling and laboratory testing of soil samples.

The investigation was undertaken to assess geotechnical constraints (if any) that would need to be applied to development of the site and to address the Director General Requirements of:

- any likely geotechnical impacts and mitigation measures;
- groundwater details.

The subsurface conditions encountered ranged from typical alluvial deposits associated with Macquarie Rivulet (which traverses the site in the east-west direction), namely interbedded firm to stiff clays / sandy clays and loose to medium dense sands to residual clays overlying weathered rock belonging to either the Berry Formation or Budgong Sandstone. Groundwater was typically encountered at depths of 3 – 6 m below the existing surface in the lower elevations of the site. Site topography ranged from near-level adjacent to Macquarie Rivulet through gentle undulating terrain to steeper areas around the site perimeter.

Stability mapping and analysis indicates that instability risk classifications of very low to low are considered appropriate for most of the site. Engineering works and the adoption of conventional hillside design & construction techniques will be required in some areas (refer Drawing 9) to achieve a low risk classification following completion of construction.

Development of the site (as proposed) is considered to be geotechnically feasible and suitable for typical residential and commercial structures. Comments are given in the report on groundwater, slope stability, acid sulphate soils, hydrogeology, erosion, development potential and geotechnical site constraints.

This report addresses the Director General Requirements for geotechnical impacts and mitigation measures and groundwater.

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REPORT ON GEOTECHNICAL INVESTIGATION
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1. INTRODUCTION

1.1 General

This report presents the results of a Geotechnical Assessment undertaken on a 720 ha parcel of land known as the Calderwood Urban Development Project, near Albion Park, henceforth "the site" (refer Drawing 1 and 2). The work was commissioned by Cardno Forbes Rigby Pty Ltd (Cardno) on behalf of the potential developer of the site, Delfin Lend Lease Ltd (DLL).

As part of the Part 3A application, Douglas Partners have also prepared the following studies:

- Report on Groundwater Investigation, Project Number 48742.02, dated 22 January 2010; and
- Report on Acid Sulphate Soils Investigation, Project Number 48742.03, dated 22 January 2010
- Report on Stage One Contamination Assessment, Project Number 48742.04, dated 22 January 2010;

It is noted that each of these assessments is a preliminary assessment for Concept Plan Application purposes. A preliminary master plan schematic as well as various GIS layers (including, contours, cadastre and aerial photography) were provided by the client for the purposes of the investigation.

The geotechnical investigation comprised test pit excavation and borehole drilling followed by laboratory testing of selected samples, groundwater monitoring, engineering analysis and reporting. Details of the work undertaken and the results obtained are given below together with comments relating to design and construction practice.

1.2 Background

This investigation has been prepared to accompany a Concept Plan Application under Part 3A of the Environmental Planning & Assessment Act, 1979 (EP&A Act) in relation to the Calderwood Urban Development Project. A Concept Plan Application under Part 3A of the Environmental Planning & Assessment Act 1979 and a State significant site listing proposal under Schedule 3 of the State Environmental Planning Policy Major Development 2005 have been submitted to the Department of Planning.

The Calderwood Urban Development Project proposes a mix of residential, employment, retail, education, conservation and open space uses. The development proposes 4,800 dwellings and approximately 50 hectares of retail, education, community and mixed use / employment land. The overall development will accommodate about 12,400 people and will deliver $3 billion in development expenditure and create 7,600 full time equivalent jobs by 2026.

The Calderwood Urban Development Project site is located within the Calderwood Valley in the Illawarra Region. It is approximately 700 hectares in area with approximately 600 hectares of land in the Shellharbour LGA and the balance located within the Wollongong LGA.

The Calderwood Valley has long been recognised as a location for future urban development, firstly in the Illawarra Urban and Metropolitan Development Programmes and more recently in the Illawarra Regional Strategy (IRS).

The IRS nominates Calderwood as an alternate release area if demand for additional housing supply arises because of growth beyond projections of the Strategy, or if regional lot supply is lower than expected.

In 2008, the former Growth Centres Commission reviewed the proposed West Dapto Release Area (WDRA) draft planning documents . The GCC concluded that forecast housing land supply in the IRS cannot be delivered as expected due to implementation difficulties with the WDRA,

and the significantly lower than anticipated supply of housing land to market in the Illawarra Region is now been recognised as a reality.

The GCC Review of the WDRA also recognised that there is merit in the early release of Calderwood in terms of creating a higher dwelling production rate and meeting State government policy to release as much land to the market as quickly as possible. Given the demonstrated shortfall in land supply in the Illawarra Region and the WDRA implementation difficulties highlighted in the GCC Report, the release of Calderwood for urban development now conforms to its strategic role under the IRS as a source of supply triggered by on-going delays in regional lot supply. The Calderwood Urban Development Project can deliver about 12% of the IRS' new dwelling target.

Changes in outlook arising from global, national and regional factors influencing investment and delivery certainty, housing supply and affordability and employment and economic development also add to the case for immediate commencement of the Calderwood Project.

In April 2008 the Minister for Planning issued terms of reference for the preparation of a Justification Report to address the implications of initiating the rezoning of Calderwood for urban development including associated staging, timing and infrastructure considerations.

In February 2009 the Minister for Planning considered a Preliminary Assessment Report for the Calderwood Urban Development Project that provided justification for the planning, assessment and delivery of the project to occur under Part 3A of the EP&A Act, having regard to the demonstrated contribution that the project will have to achieving State and regional planning objectives.

Subsequently, on the 16 April 2009, pursuant to Clause 6 of SEPP Major Development, the Minister for Planning formed the opinion that the Calderwood Urban Development Project constitutes a Major Project to be assessed and determined under Part 3A of the EP&A Act, and also authorised the submission of a Concept Plan for the site. In doing so, the Minister also formed the opinion that a State significant site (SSS) study be undertaken to determine whether to list the site as a State Significant site in Schedule 3 of SEPP Major Development.

The Part 3A process under the EP&A Act allows for the Calderwood Urban Development Project to be planned, assessed and delivered in an holistic manner, with a uniform set of planning

provisions and determination by a single consent authority. Given the scale of the proposal, the Concept Plan and SSS listing provide the opportunity to identify and resolve key issues such as land use and urban form, development staging, infrastructure delivery and environmental management in an integrated and timely manner.

This report has been prepared to fulfil the Environmental Assessment Requirements issued by the Director General for the inclusion of the Calderwood site as a State Significant Site under SEPP Major Development, and for a Concept Plan approval for the development. Specifically, this investigation has been prepared to satisfy the following bullet points in the DGRs under the heading 'Stage 1 Project Application':

- 'Any likely geotechnical impacts and mitigation measures.
- Groundwater Details.'

2. SITE DESCRIPTION

The site is located in the Calderwood Valley, northwest of the township of Albion Park. The site is bounded by the Illawarra Highway to the south and Marshall Mount Road in the north. North Macquarie Road bisects the site in an approximate northeast – southwest direction. The site itself comprises an irregular shaped area of 718.6 ha with maximum north-south and east-west dimensions of 3.70 km and 3.22 km respectively (refer Drawing 2, in Appendix A).

Macquarie Rivulet and Marshall Mount Creek run west to east across the site in the south and north respectively. Overhead high voltage electricity lines also cross the northern part of the site.

Topography across the site is varied and ranges from essentially flat flood plains bordering the creeks, gently undulating terrain across most of the site to extremely steep ground on the flanks of Johnstons Spur. Topographic relief is from RL 165 m, relative to Australian Height Datum (AHD) at the top of Johnstons Spur to less than RL 10 m in the Marshall Mount Creek drainage channel.

The site consists of 21 distinct land packages in the local government areas of Wollongong and Shellharbour. Each of these properties has been designated a letter from A – U for the purposes of this report (refer Drawing 2 for property names). The land is principally used as farm land, incorporating hobby farms, dairy farming, horse agistment and horse breeding. The site has been largely cleared though pockets of remnant vegetation remain, especially on the elevated portions of the site.

3. REGIONAL GEOLOGY AND SOIL LANDSCAPES

The Kiama and Robertson 1:50 000 Geological Series Sheets (References 1 and 2) indicate that the study area is underlain by a gently dipping (about 5° to the north - northwest), highly varied section of the stratigraphic sequence of the Permo - Triassic Sydney Basin. This sequence is locally to extensively overlain by alluvium, and locally by talus (slopewash and rockfall debris), of recent (Quaternary) age.

The distribution of the principal units of the bedrock stratigraphy is shown in Drawing 3. Typical lithologies of these units are summarised below in oldest to youngest order:

Berry Formation - comprising mid grey to dark grey siltstone and fine-grained sandstone. This formation is found at the foot of hill slopes in the subject area, adjoining the Budgong Sandstone up-slope and the alluvial deposits down-slope.

Budgong Sandstone - comprising red brown to grey volcanic sandstone. This formation underlies foot to upper valley slopes in most of the study area.

Bumbo Latite Member - a grey to blue grey aphanitic to porphyritic latite. This member within the Budgong Sandstone appears on the lower midslope of Johnstons Spur.

Cambewarra Latite Member – similar to the Bumbo Latite Member, this unit is present at higher elevations, specifically at the highest point of Johnstons Spur.

The Soils Landscapes of the Kiama 1:100 000 Sheet (Reference 3) indicates that the properties included within the study area are located within six soil landscapes representing swamp, erosional and depositional geomorphological processes. The distribution of the soil landscapes are given on Drawing 4 and are summarised below:

Albion Park Soil Landscape (ap)- an erosional soil group developed on short, steep (15% - 50%) upper slopes and long gentle (5% - 15%) footslopes generally underlain by rocks of the Berry Formation, but also including localised sections of the Budgong Sandstone and Bumbo Latite. The group comprises moderately deep (0.5 m - 1 m), Brown and Yellow Podzolic Soils, respectively on crests and upper slopes, and Soloths on footslopes and drainage lines. These soils include sandy clay loam or sandy loam topsoil to 0.4 m in depth underlain by light clay, sandy loam or heavy clay subsoils. Limitations of the soils include waterlogging, seasonally high watertable and hard setting topsoil.

Bombo Soil Landscape (bo) - an erosional soil group developed on low rolling hills (slope gradients 15% - 25%) with benched slopes underlain by the Bumbo Latite. The group comprises shallow (<0.5 m) Structured Loams on crests, moderately deep (0.5 m - 1 m) Krasnozems on upper slopes and benches, and Brown and Red Podzolic Soils on mid and lower slopes. These soils include sandy clay loam or sandy loam topsoil to 0.15 m in depth underlain by light medium clay, sandy clay or medium clay subsoils. Limitations of the soils include rock outcrop and hard setting character.

Cambewarra Soil Landscape (ca) - an erosional soil group developed on steep to very steep (>30%) hills with broad colluvial benches underlain by latite. The group comprises deep (>1.5 m) Red Solonetic Soils or Krasnozems on upper slopes or benches. These soils include sandy clay loam or silty clay loam topsoil to 0.5 m in depth underlain by light clay or medium clay subsoils. Limitations of the soils include mass movement hazard, extreme water erosion hazard, shallow soil, rock outcrop and stoniness.

Fairy Meadow Soil Landscape (fa) – a swamp landscape including floodplains, valley flats and minor terraces and scattered swamps with slopes generally <5%. The group includes moderately deep Alluvial Loams and Siliceous Sands on terraces and Prairie Soils and Yellow Podzolic Soils on the drainage plains. Limitations of the soils include flood hazard, low wet bearing strength, highly permeable topsoils and high watertable.

Wattamolla Road Soil Landscape (wt) - a depositional soil group developed on long, gently to moderately inclined (5% to 15%) sideslopes, undulating to rolling hills with broad benches underlain by the Budgong Sandstone (and to a lesser extent by latite). The group comprises moderately deep (0.5 - 1 m) Red Podzolic Soils on upper slopes and benches, and Yellow Podzolic Soils on the mid and lower slopes. These soils include sandy loam or silty loam topsoil to 0.1 m in depth underlain by light clay or medium clay subsoils. Limitations of the soils include rock outcrop, localised mass movement and hard setting character.

The Wollongong Acid Sulphate Soil Risk Map (Reference 4), published by NSW Department of land and Water Conservation (1997), maps the eastern extents of Properties C and I as having a low probability of finding ASS below a depth of 3 m (Refer to Drawing 5). Further it states that this mapping level '*Generally* [is] *not expected to contain ASS materials, although highly localised occurrences may occur especially near boundaries with environments with a high probability of ASS occurrence*.' The nearest boundary with high probability is 230 m further east down Marshall Mount Creek. Based on this level of mapping the probability of finding ASS soils was deemed to be low.

4. FIELD WORK METHODS

The field work comprised 89 test pits (TP1 – TP89) excavated to depths of 1.5 - 3 m and twelve boreholes (BH 101 – BH112) drilled to depths of 4 – 8.5 m.

The test pits were excavated by two teams both working with New Holland LB110B backhoes fitted with 450 mm wide buckets. The bores were drilled with a Gemco 210B trailer mounted drill rig using 140 mm solid flight augers. Boreholes 101 and 102 were drilled to refusal of the v-bit then continued to near refusal using a TC – bit. The remaining bores were terminated prior to refusal. The pits and bores were logged on-site by either experienced geotechnical engineers or engineering geologists who collected both disturbed and undisturbed samples to assist in strata identification and for geotechnical laboratory testing.

Dynamic Cone Penetration tests (AS1289 6.3.2) were undertaken from the surface level to depths of 1.2 m adjacent to each test pit to enable assessment to be made of the strength of the near surface soils. Standard penetration tests were undertaken in two of the boreholes (101 and 102) for in situ strength assessment and sample collection. A description of the test method is given in the general notes included in Appendix B with the penetration 'N' values shown on the borehole logs.

At the completion of drilling, standpipe piezometers were installed in BH102 – BH112 (excluding BH104, and BH111) to facilitate long term monitoring of groundwater levels and hydraulic conductivity determination (the results of which are reported in the Groundwater Investigation Report).

Samples were collected for initial testing from the test pits in areas known to have acid sulphate potential based on the ASS maps (refer Drawing 5). The results of which are reported in the Acid Sulphate Soil Investigation Report, Project 48742-4, dated 22 January 2010 and summarised within Section 8.4 of this report.

A site walkover was also undertaken by an experienced geotechnical engineer to assess, stability and general geotechnical constraint.

The locations of the field tests are shown on Drawing 6 in Appendix A. The levels shown on the pit logs and borehole log sheets were determined by interpolation from the 2 m contour levels supplied by Cardno.

5. FIELD WORK RESULTS

5.1 Test pits and boreholes

The test pit and borehole logs are included in Appendix B, together with notes defining classification methods and descriptive terms.

The field tests encountered relatively uniform subsurface conditions with the principal variation being between two distinct terrain units namely, alluvial and residual soil landscapes. The site is essentially a residual environment split by two valleys in-filled with alluvium. The two alluvial deposits meet as Johnstons Spur descends to the alluvial plain around Property I. The valleys contain Marshall Mount Creek in the north and Macquarie Rivulet in the south.

For each of the terrain units the succession of strata is broadly summarised as follows:

ALLUVIAL

TOPSOIL:	generally silty sand with clay, gravel and rootlets to depths of 0.1 – 0.4 m;
CLAY:	ranging from firm to very stiff clays or sandy clays, gravelly in parts, damp to saturated in most locations;

SAND: loose to dense sand, silty sand or clayey sand encountered at depths of 0.5 – 3.0 m, typically wet to saturated. (This strata was only present in approximately 15% of test pits)

RESIDUAL

TOPSOIL: generally silty clay or clayey silt, with gravel and rootlets to depths of 0.1 – 0.3 m;

RESIDUAL CLAY: ranging from firm to very stiff residual clays or sandy clays, gravelly in parts, humid to moist, (but saturated in parts);

SANDSTONE or LATITE: extremely low to low strength, extremely to moderately weathered sandstone or latite (two locations encountered siltstone) intercepted below depths of 0.7 – 3.0 m.

5.2 Groundwater

Groundwater monitoring wells were installed at 10 locations across the site. Wells were generally located in the alluvial deposits between RL10 and RL20 m AHD. Depths to the water table were measured from the surface and not converted to relative levels due to the low level of accuracy of survey available (from the 2 m contour plan). The results are provided in Table 1, below. Water Levels will be able to be calculated once accurate survey of the monitoring wells has been undertaken.

Table 1 – Groundwater Depths

Borehole ID	Depth below ground level (m) 11 December 09	Depth below ground level (m) 7 January 10
BH102	4.5	5.8
BH103	3.3	3.6
BH105	3.4	3.5
BH106	2.8	3.0
BH107	3.1	3.3
BH108	2.6	2.5
BH109	2.7	2.5
BH110	3.0	2.8
BH112	4.5	4.4

Testing was undertaken to determine the hydraulic conductivity of the shallow aquifers found on the site. The results of the hydraulic conductivity results are summarised in Table 2.

Table 2 – Hydraulic Conductivity Results

Borehole ID	Hydraulic Conductivity (m/sec)
BH102	4×10^{-8}
BH105	5×10^{-7}
BH106	9×10^{-8}
BH107	3×10^{-6}
BH110	High
BH112	4×10^{-7}

A detailed description of the test methods, results and discussion are given in our report dated 22 January, Project 48742.02, Report on Groundwater Investigation. The results indicate typical values for clayey sands and sand aquifers. The results also show the variability of the alluvial deposit across the site.

5.3 Geological Mapping

The main items noted during geological mapping on 11 and 12 November 2009 are summarised below and are additionally shown on Drawing 7 (Sheets 1 and 2) and Drawing 8 (Sheets 1 and 2). Drawing 7 shows the location of the Mapping reference Points, referred to below, as well as the approximate boundaries of geological units as determined from a combination of published mapping (References 1, 2 and 5) and the results of the test pitting and drilling of the current investigation.

- The alluvial sequence (mapping unit Qa) included at least two terrace levels within and extending some 2 km to the west of the Albion Park township. These comprised a lower terrace level associated with the current courses of the Macquarie Rivulet and Mount Marshall Creek, and a high level terrace system (approximately 5 m above the current terrace levels) representing an earlier deposition phase into which the current terrace and stream bed system are entrenched. The boundary between alluvium and colluvial/residual soils was commonly poorly defined due to the deposition of colluvial soils at the base of the steeper hillsides.
- The banks of the Macquarie Rivulet and Marshall Mount Creek are typically grass and shrub covered with only very minor areas of erosion being observed.
- The alluvial sequence exposed in gully walls of Hazelton Creek upstream of the Illawarra Highway included at least two distinct depositional regimes. These comprised a surface silty

clay layer to approximately 1 m to 2 m deep, overlying a gravel to boulder-rich (boulders to greater than 1.5 m) extending to greater than 3 m at some locations.

- Erosion channels locally expose alluvium (clays and gravelly clays) to the order of 1 m deep infilling the bases of gullies crossing mid and foot slope locations (e.g. near Mapping Reference Point 1).
- There are localised and discontinuous areas of erosion of gully beds and banks. The erosion is generally as a result of concentration of flow in farm dam spillways or under-road pipes and disturbance of the vegetation cover along animal pathways. Repairs to or filling of erosion gullies are noted in several locations (e.g. Mapping Reference Points 2 and 16) and, as such, some areas of uncontrolled filling may now be hidden by re-profiled pasture land.
- There are only isolated, distinct outcrops of micaceous siltstone and sandstone the Berry Formation (mapping unit Psb) and Budgong Sandstone (mapping unit Psg), these being mostly within the bases of entrenched gullies, where high strength material is present at depths of less than 1 m.
- Zones of sandstone joint blocks (some to boulder size) derived from the Budgong Sandstone mantle several of the highest (elevation) ridge crests or upper hill slopes lying to the north of North Macquarie Road and in isolated locations (e.g. Mapping Reference Points 14 and 15) may be associated with small landslides.
- A linear gully, with entrenchment depths of 0.5 m to 1 m and extending directly downslope from Mapping Reference Point 12, may represent a degraded erosion or landslide scarp.
- Rocks of the Berry Formation and Budgong Sandstone are additionally exposed in road cut batters of Illawarra Highway, Mount Marshall Road and North Macquarie Road, where the bedrock typically underlies 0.5 m to 1 m deep soil profiles.
- Small outcrops of latite (Bumbo Latite member; mapping unit Psgb) and associated dense joint block cover are present within a densely vegetated zone (between Mapping Reference Points 5 and 10) lying to the north of North Macquarie Road.
- A small zone of cemented latite blocks and fragments of colluvial origin is exposed in a track base (at Mapping Reference Point 7) downslope of the mapped location of the Bumbo Latite member.

6. LABORATORY TESTING

Selected samples from the test pits were tested in the laboratory for measurement of field moisture content, plasticity, particle size distribution, dispersivity and California bearing ratio. The detailed test report sheets are given in Appendix C, with the results summarised in Table 3.

Table 3 – Results of Laboratory Testing

Pit No.	Depth (m)	FMC (%)	LL (%)	PL (%)	PI (%)	LS (%)	ECN	Material
TP3	1.0-1.2	31.8						Brown orange silty clay
TP4	0.5-0.7	17.3						Brown orange grey sandy clay
TP6	1.0-1.1	11.5						Brown clayey silty sand
TP14	2.4-2.5	11.9						Brown clayey silty sand
TP18	1.0-1.2	17.1						Light brown gravelly silty clay
TP19	0.5-0.7	17.7						Brown clayey silt
TP22	0.5-0.6	37.8					4	Brown silty clay
TP23	0.9-1.0	37.1	90	35	55	21.5		Brown clay
TP24	1.0-1.2	18.1						Brown silty clay
TP25	1.0-1.1	21.6						Orange brown silty clay
TP27	0.5-0.6	12.9						Brown sandy clay
TP28	1.0-1.2	25.4						Brown sandy silty clay
TP29	0.5-0.7	22.6						Brown silty clay
TP30	1.0-1.2	26.3	67	23	44	15.0		Light brown silty clay
TP31	0.5-0.7						4	Brown sandy silty clay
TP32	0.5-0.6	27.0	62	25	37	16.5		Brown silty clay
TP33	1.0-1.1	39.4	97	35	62	22.0		Brown clay
TP39	0.9-1.0	24.0					4	Brown silty clay
TP40	0.5-0.6	28.0					4	Brown silty clay
TP41	1.0-1.1	27.8						Brown red grey silty clay
TP43	1.0-1.2	22.4					4	Brown silty clay
TP44	1.0-1.2	28.3	96	30	66	16.5		Brown clay
TP46	0.5-0.7	24.9					4	Brown clay
TP47	0.4-0.6	26.3					4	Brown clay
TP48	1.0-1.1	22.1						Brown red clay

Pit No.	Depth (m)	FMC (%)	LL (%)	PL (%)	PI (%)	LS (%)	ECN	Material
TP51	1.0-1.2	37.3	102	33	69	20		Brown clay
TP52	0.3-0.5	19.6					4	Brown gravelly silty clay
TP53	0.5-0.7	21.5						Brown gravelly silty clay
TP55	2.0-2.2	29.3						Brown silty clay
TP58	1.0-1.2	20.9						Light brown silty clay
TP58	1.0-1.2	30.5					4	Brown clay
TP62	1.5-1.7	22.5					4	Brown gravelly silty clay
TP64	0.5-0.7	11.7						Light brown gravelly sandy clay
TP65	0.5-0.7						4	Dark brown gravelly silty sandy clay
TP71	1.0-1.2	16.9					4	Brown silty clay
TP74	0.5-0.7	22.7						Brown gravelly silty clay
TP84	1.5-1.7	20.4						Brown gravelly silty clay
TP85	0.5-0.7	16.4						Brown clayey silt
TP87	0.5-0.7	26.1						Orange brown silty clay
TP88	0.5-0.7						4	Brown sandy clayey silt
TP89	0.5-0.7	34.6						Brown silty clay

Where FMC = Field moisture content; PL = Plastic limit
LL = Liquid limit; PI = Plasticity Index
LS = Linear shrinkage; ECN = Emerson Class Number

Six samples of the clays were tested for measurement of Atterberg limits and linear shrinkage. The results indicated liquid limits in the range 62 – 102%, plastic limits in the range 23 – 35% and linear shrinkage from the liquid limit condition in the range 15 – 22%. Field moisture contents were 11 – 39%, with most results indicating moisture contents significantly dry of the plastic limit. These results indicate the soils are of intermediate to high plasticity and would be moderately reactive to changes in volume with seasonal fluctuations in soil moisture content.

Particle size distribution (grading) tests were carried out on fifteen samples and generally indicated three principal soils types:

- 29% of the samples tested were fine grained materials; clayey silts, slightly sandy in parts (refer TP 7, 31, 56, 88),

- 43% of the samples tested were coarser grained materials; typically sands with some silt (refer TP8, 15, 42, 65, 78, 81), and
- 29% of the samples tested were a mixture of these two groups (refer TP59, 69, 76, 82).

All of the particle size distribution results confirmed the field logging.

California bearing ratio tests were carried out on three samples of the silty clays recovered from various depths within the range 0.4 – 1.0 m and two samples of clayey silts to assess the suitability of the soils for both road subgrade and as general fill. The samples were compacted to 100% of standard maximum dry density at standard optimum moisture content and soaked for 4 days under surcharge loadings of 4.5 kg (refer Test Method AS1289 2.1.1). There was up to 3.3% swell recorded during soaking of the silty clays and 0.5% of swell for the clayey silts. The measured CBR values were within the range 2.5 – 8% for the silty clays and 9 – 12% for the clayey silts.

Emerson crumb dispersion testing was carried out on 13 samples of the upper soils to assess the dispersion characteristics. The results were all Emerson Class No 4 which is indicative of slightly to non-dispersive soils.

7. PROPOSED DEVELOPMENT

The Calderwood Urban Development Project is a master planned community development by Delfin Lend Lease. A concept plan for the site has been prepared (refer Drawing 1). The project proposes a mix of residential, commercial, conservation and open space uses. The site will also include the construction of water detention ponds, largely confined to the existing creek lines, sports fields as well as internal and connecting roads.

8. COMMENTS

8.1 Slope Stability

The following assessment is based on the results of the geological mapping, the subsurface investigation undertaken and DP's involvement in similar projects in the local area. Aspects included in the slope stability assessment are the bedrock geology, observed or anticipated soil depth, steepness of slope relative to historical or ancient slope failures in similar materials, the disturbance of soil and vegetation cover during development, the influence of groundwater or surface saturation, and the effects of earthquake forces.

The geological mapping has indicated only isolated, minor or possible (where surface conditions are degraded making visual confirmation uncertain) occurrences of slope instability within moderately steep (10° – 18° range), steep (18° – 27° range) or very steep (27° – 45° range) and locally extremely steep (>45°) slopes on the flanks of Johnstons Spur lying north of North Macquarie Road (refer Drawing 8, Sheet 2). These occurrences comprise joint block runout below outcrops (near Mapping Reference Point 15) and narrow linear or localised shallow slump scarps associated with erosion and over-steepening of gully heads.

Bowman (Reference 5) developed maps of the Greater Wollongong area, including the study area north of the Illawarra Highway, on which zones of instability were outlined and the remaining areas classified in terms of the suitability for development. Similar classification methods were employed by Neville (Reference 6) for the area lying to the south of Macquarie Rivulet. The mapping indicates that the study area includes several zones (refer Drawing 8, Sheets 1 and 2):

- *Stable land* with *no landslide problems*. Land within this zone encompasses most of the study area.
- *Stable land – minor area of slope instability* (most likely where thick accumulations of soil occur at the heads of gullies and at the toes of slopes). Land within this zone is restricted to an approximately 400 m by 200 m area, lying between the Illawarra Highway and the Macquarie Rivulet, within the south-western corner of the study area.
- *Less stable land that may mostly be safely utilised although some areas are unsuitable.* Land within this zone includes elevated ridge crest areas and mostly moderately sloping valley floors about two gully lines in Properties J, K and L that front North Macquarie Road

within the south-western section of the study area. At least one possible erosion of shallow soil slump scarp has been identified (at Mapping Reference Point 14) within the zone. Only one test pit (Pit 62) lies within the zone. It intersected a 1.3 m deep soil profile overlying sandstone bedrock.

- *Moderately unstable land* where *thorough investigation is required before development* and *generally topographically high relief land underlain by potentially unstable material*. Land within this zone occupies moderate to steep, mid and upper slope locations along the east-west oriented ridge within the southern section of the study area. It also includes locally over-steepened gully heads and rapid topographic steps down developed over weathering resistant sandstone and latite bands. Test pits within the zone (TP 52, 53, 59, 61 and 64) indicate potential for moderately deep (1.3 m to 1.5m) to deep (2.6 m to 3.1 m) soil profiles. Steep areas will, in particular, require additional detailed investigation to confirm the distribution of soil depths and any groundwater seepage. It is noted that the source points of gullies within the zone frequently correspond to the subcrop of the Bumbo Latite which may act as an aquifer.
- *Essentially unstable land*, that is *best left undeveloped* but *some areas may be developed after detailed evaluation*. Land within this zone comprises two ridge crest and steep to very steep, upper slope areas along the east-west oriented ridge within the southern section of the study area. Scattered joint blocks on the slopes may potential for downslope movement of material fallen or eroded from weathering resistance outcrops.

The capability for urban development may be related to the degree of surface disturbance involved in the following categories of site development:

Extensive building complexes - the development of commercial complexes such as offices or shopping centres, which require large scale clearing and levelling of broad areas of floor space and parking bays.

Residential development - infers a level of construction which provides for roads, drainage, and services to cater for current residential development lot sizes.

Strategic residential - refers to areas unsuitable for widespread development, but where closer investigation may permit isolation of pockets of land for individual house sites, or definition of engineering measures required to maintain stability of what would otherwise be unsuitable land for development.

Reserves - which may require shaping and modification of the ground surface and vegetation improvement, but no building and minimal roadway construction is envisaged.
In general, it is considered that, after development using good engineering practice for hillside slopes (refer Appendix D for general development guidelines), sites within the *Stable land* and *Stable land with minor areas of instability* zones will be expected to achieve very low or low risk of slope instability in accordance with the methods of the Australian Geomechanics Society (Reference 7). Such areas would be suitable for residential development. Extensive building complexes would preferably be sited within flat or more gently sloping sites to minimise the requirement for cutting and retaining of deeper soil profiles as intersected in many of the test pits of this investigation. Comparison of the development layout (refer Drawing 1) and the distribution of zones of instability indicates that sites of commercial and infrastructure development are included within areas of assessed very low risk of slope instability.

Comparison of the development layout (refer Drawing 1) and the distribution of zones of instability indicates that the majority of the proposed development areas are located on stable land. There are sections of the proposed residential areas that extend into zones of *Less stable land* or *Moderately unstable land*. Instability in the zone can be expected if development does not have regard to site conditions, with the most likely areas of instability being in gully heads and in areas of thick soil accumulation affected by seepage, especially if excavations for deeper road cuttings are required in areas of deep clay soils. Consequently, it is recommended that all proposed developments in these zones are subject to detailed investigation by appropriately qualified geotechnical practitioners.

It is considered that urban (residential) and/or strategic development is generally feasible within these zones subject to appropriate investigation and construction methodology to result in a low risk of slope instability after development. Site specific items indicated below should be included in investigation and design programs:

- Orientation of access roads, residential structures and services to minimise requirements for excavation and possible retaining structures. In general, unsupported cuts should be restricted to a maximum 1 m depth.
- Maximisation and/or replacement of tree cover.
- The creation of larger lots to permit more sensitive development of the individual site.
- Programming of development, particularly road works, which would be the main activity to expose potentially erodible or landslip susceptible colluvial and residual soils, to minimise

time of exposure and also the inclusion of techniques (e.g. spray coating) to minimise erosion which may trigger shallow slumping.

- Installation of site specific surface and subsurface drainage.
- Founding of residential and retaining structures in intact bedrock.
- Selection of residential designs to minimise the requirement for excavation.

Areas earmarked for development have been tentatively assigned AGS risk classifications based on the proposed development to be undertaken on the site on Drawing 9. The extent of the site that will require engineering works (described in the bullet points above) to achieve a low risk classification after development are shown in red. Areas with no shading are classified as low risk or very low risk. Areas on the current Concept Plan shown as non-development areas (ie green space reserves) have not been mapped. If it is proposed to revise the extent of development shown on the plans and discussed in the report, advice must be sought from DP in relation to the potential development outside the boundaries shown.

Areas of *Essentially unstable land* are included within proposed reserve areas and this is consistent with general requirements to maintain the risk of instability within no greater than tolerable levels.

8.2 Erosion

The study area is characterised by only isolated occurrences of stream and gully bank or bed erosion (refer Drawing 8; Sheets 1 and 2), mostly resulting from stock movements or concentrated flow from spillways of farm dams or pipe culverts in gently sloping lands and previous clearing and stock movements in moderately steep to steep lands. Control (and in some cases repair) of erosion as part of the agricultural and pastoral uses of the land has included the construction of farm dams, filling and revegetation of gullies.

The generally well vegetated alluvial flats, stream banks and hill slopes mostly restrict the potential for erosion within the study area. Future erosion and bank instability potential is assessed as mostly being restricted to localised sections of the banks of streams and tributary gullies during flood events. Volumes of eroded or slumped materials are anticipated to be of a few cubic metres or less per location under the existing vegetation conditions and flow regime.

The proposed development layout (refer Drawing 1) includes Macquarie Rivulet and the streams of the Hazelton Creek and Marshall Mount Creek systems and their associated tributary gullies within extensive drainage corridors. It is anticipated that the proposed development (including good engineering practice for disposal of stormwater drainage) will have minimal effect on erosion potential of the current stream courses. Site specific items indicated below should be included in investigation and design programs for the development to minimise the risk of erosion:

- Orientation of access roads, residential structures and services to minimise requirements for excavation and retaining structures.
- Maximisation and/or replacement of tree cover.
- Programming of development, particularly road works, which would be the main activity to expose potentially erodible colluvial and residual soils, to minimise time of exposure and also the inclusion of techniques (e.g. spray coating) to minimise erosion.

8.3 Acid Sulphate Soils

An acid sulphate soil investigation report (refer Section 1 of this report) was prepared for the site and should be read in conjunction with this report. The findings from the ASS report are summarised below.

The results of the limited testing undertaken to date indicate the presence of acid sulphate soils of heterogeneous lateral distribution within parts of the proposed development area, and generally below depths of 2 – 3 m. The extent of ASS at the site was beyond the published mapping. The act of disturbing or exposing these soils through construction activity shall necessitate the production of an acid sulphate soil management plan (ASSMP). The extent of ASS will require further investigation once final cut and fill levels have been determined for the areas of ASS risk prior to the creation of an ASSMP. Specifically the following will be required:

- Maximum excavation depths at Property A, B, C, G, I, N, O, P, and Q.
- Further ASS investigation in these properties where excavation is proposed.
- Preparation of an ASSMP based on the findings of this report supplemented by the findings of the additional investigations.

8.4 Hydrogeology

Based on the results of the groundwater investigation, which was reported under a separate cover (refer Section 1 of this report), the following comments are offered:

- Groundwater bores were generally drilled within the 10 m – 20 m AHD band of the site. Rock was intercepted during drilling at varying depths between 4 m and 8.5 m below ground surface level (refer to Borehole logs 101 – 112). Two bores (BH 106 & BH107) did not encounter rock and BH104 encountered rock at 0.7 m.

- Groundwater levels during the investigation were found to be in the range of 2.5 – 4.5 m below ground surface level (refer to the blue text on Drawing 1). Due to the proximity of the water table to the ground surface, further investigation is required to ascertain the seasonal high groundwater level in future stages of the development;

- The shallow aquifers generally were contained in the alluvial deposits of Marshall Mount Creek and Macquarie Rivulet and were limited by the underlying bed rock (the shallow groundwater was essentially perched on this impermeable unit). The aquifers comprised clays and sandy clays with some gravel.

- Hydraulic conductivities (K) varied across the site and were in general lower than expected considering the sand content of the aquifers, however they were in the expected range for clayey sands. The values ranged across 2 orders of magnitude from 10^{-6} m/s – 10^{-8} m/s (refer to the red text on Drawing 1). BH110 in the southeastern corner of the site, recorded high values of K (flow rates of 20 L per min were obtained with only minimal drawdown noted over a 15 min period.) The variability in K across the site could not be linked specifically to observed surface landforms but is more likely the result of heterogeneous alluvial deposits.

- In general groundwater will not be a significant constraint to development across the majority of the site above RL20. Below this RL groundwater may present itself as a moderate constraint due to its proximity to the ground surface. Planning for deep (>2 m) cuts in these areas will require careful consideration and planning to mitigate the effects of groundwater. In addition, the location of detention basins may also require further investigation to assess the local conditions at the proposed sites.

8.5 Drainage

Surface drainage should be installed and maintained at the site. In undertaking earthworks operations at the site, it should be recognised that the drainage characteristics of the site will be significantly altered and that temporary measures therefore, will be required during construction to divert stormwater flows from the work areas. Both the alluvial and residual soils would be highly susceptible to inundation and consequently, temporary drainage measures (with drains say 300 – 500 mm deep) should be designed where possible to avoid inundation during wet weather periods.

8.6 Site Constraints and Development Potential

Based on the results of the geotechnical investigations completed to date, development of the site as proposed on Drawing 1 is considered feasible.

Most of the site proposed for development will be classified as either very low or low risk with respect to instability with construction considered to be relatively straightforward. Some of the steeper areas of the site have been classified as less stable land or moderately unstable land (refer Drawing 8), parts of which encroach into the proposed development area (refer Drawing 9). Detailed design and the undertaking of engineering works described in Section 8.5 will be required to achieve a low risk classification of instability after completion of construction, commensurable with the majority of the development area.

The main geotechnical constraints to development with the nominated areas therefore are limited to the following:

- adoption of hillside design and construction techniques for the steeper portions shown on Drawing 9;
- awareness of groundwater profiles in designing basins and earthworks;
- site traffic ability in areas where sandy soils are exposed and susceptibility of the soils to rapidly loose strength on exposure.

In summary therefore, development of the site as proposed is considered feasible provided all work is undertaken in accordance with good engineering practice.

9. LIMITATIONS

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Calderwood in accordance with DP's proposal WOL090407 dated 17 September 2009 and acceptance received from Mr Anthony Barthelmess of Cardno Forbes Rigby Pty Ltd dated 2 October 2009 on behalf of Delfin Lend Lease Limited. The work was carried out under DP Conditions of Engagement. This report is provided for the exclusive use of Cardno Forbes Rigby Pty Ltd and Delfin Lend Lease Limited for the specific project and purpose as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party.

The results provided in the report are considered to be indicative of the subsurface conditions on the site only to the depths investigated at the specific sampling and/or testing locations, and only at the time the work was carried out. DP's advice is based on observations, measurements, tests or derived interpretations. The accuracy of the advice provided by DP in this report is limited by unobserved features and variations in ground conditions across the site in areas between test locations and beyond the site boundaries or by variations with time. The advice may be limited by restrictions in the sampling and testing which was able to be carried out, as well as by the amount of data that could be collected given the project and site constraints. Actual ground conditions and materials behaviour observed or inferred at the test locations may differ from those which may be encountered elsewhere on the site. Should variations in subsurface conditions be encountered, then additional advice should be sought from DP and, if required, amendments made.

This report must be read in conjunction with the attached "Notes Relating to This Report" and any other attached explanatory notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions from review by others of this report or test data, which are not otherwise supported by an expressed statement, interpretation, outcome or conclusion stated in this report. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

DOUGLAS PARTNERS PTY LTD

Christopher C Kline
Associate

Reviewed by:

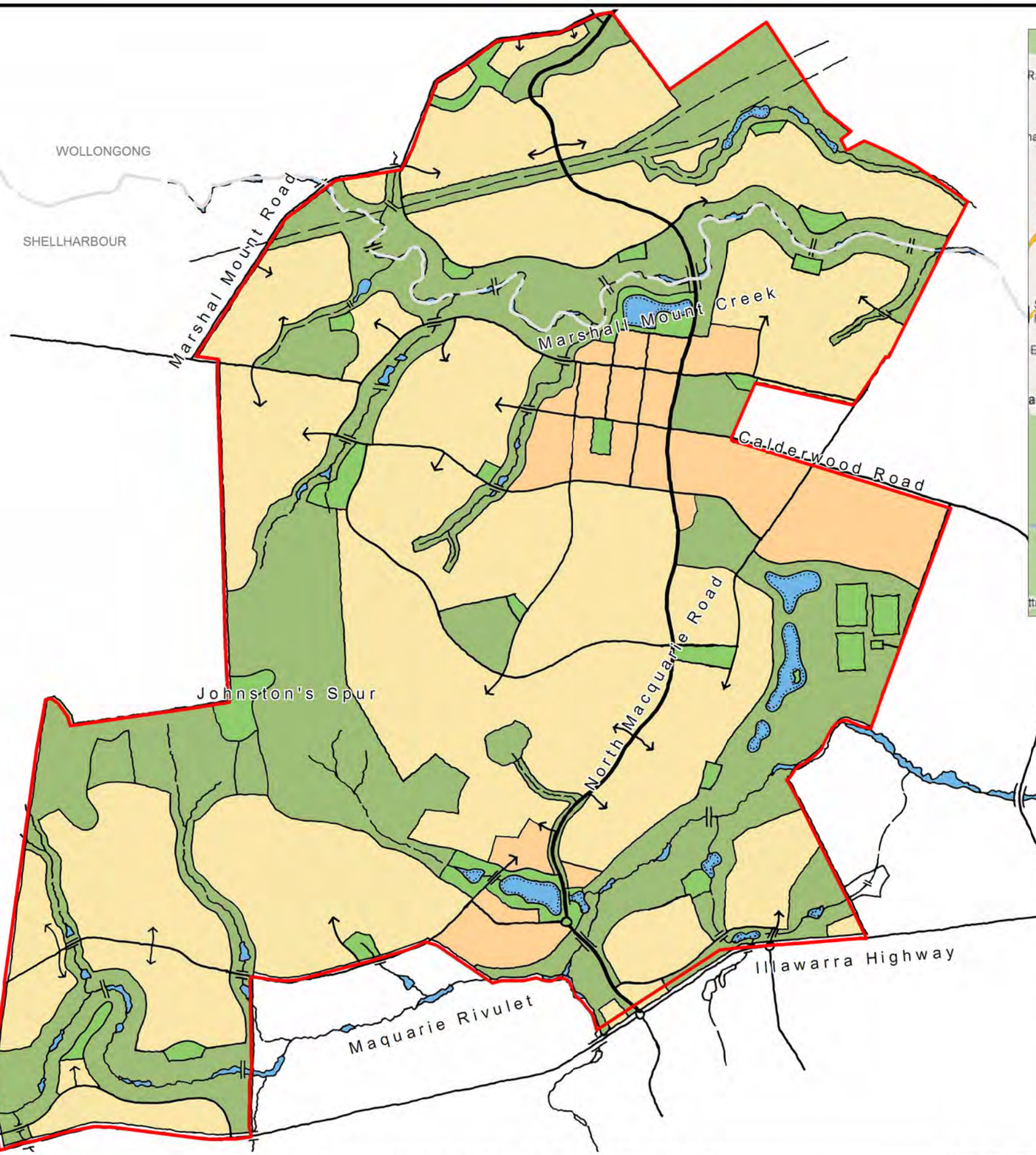
G W McIntosh
Principal

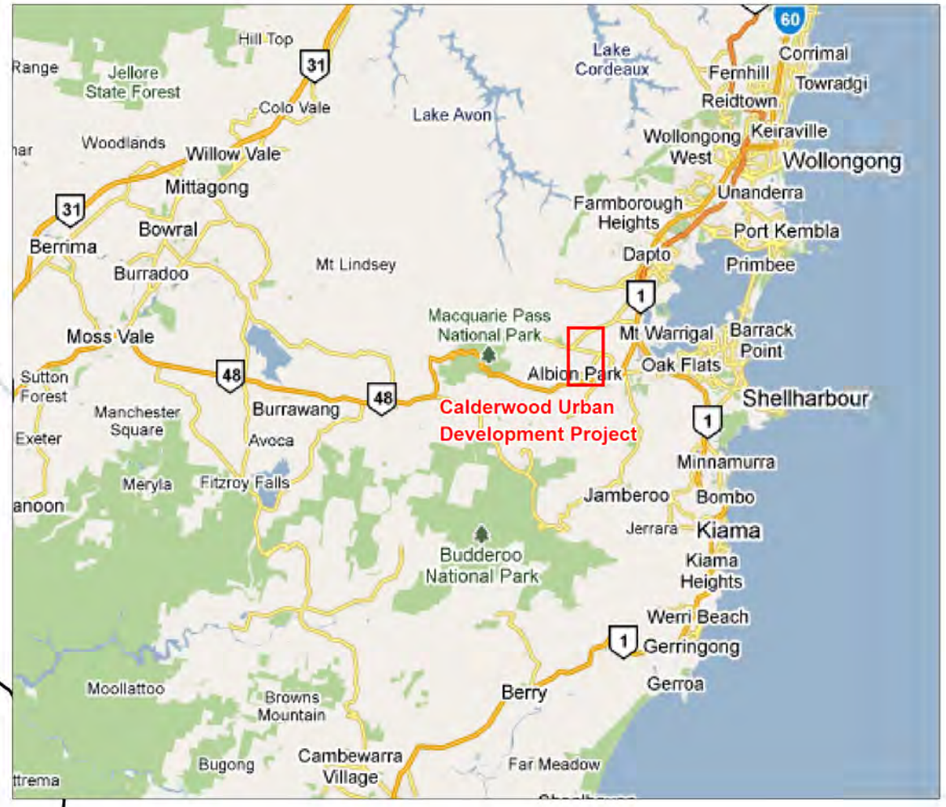
References:

1. Department of Mines, "Geology of the Kiama 1:50 000 Series Sheet No. 9028-1", 1977.
2. Department of Mines, "Geology of the Robertson 1:50 000 Series Sheet No. 9028-4", 1977.
3. Department of Conservation and Soil Management, “Soil Landscapes of Kiama 1:100 000 Series Sheet 09028” 1993
4. Wollongong 1:25 000 Acid Sulphate Risk Map. NSW Department of Land and Water Conservation (1997).
5. Bowman, H N. “Natural Slope Stability in the City of Greater Wollongong”. Records of the Geological Survey of NSW Vol. 14(2), pp.159-222 (1972).
6. Neville, M J. “Land Stability Assessment of the Kiama Area”. Geological Survey of NSW Report No. GS 1977, 067 (May 1977).
7. Australian Geomechanics Society. “Practice Note Guidelines for Landslide Risk Management”, Australian Geomechanics, Vol. 42 No. 1 (2007c).

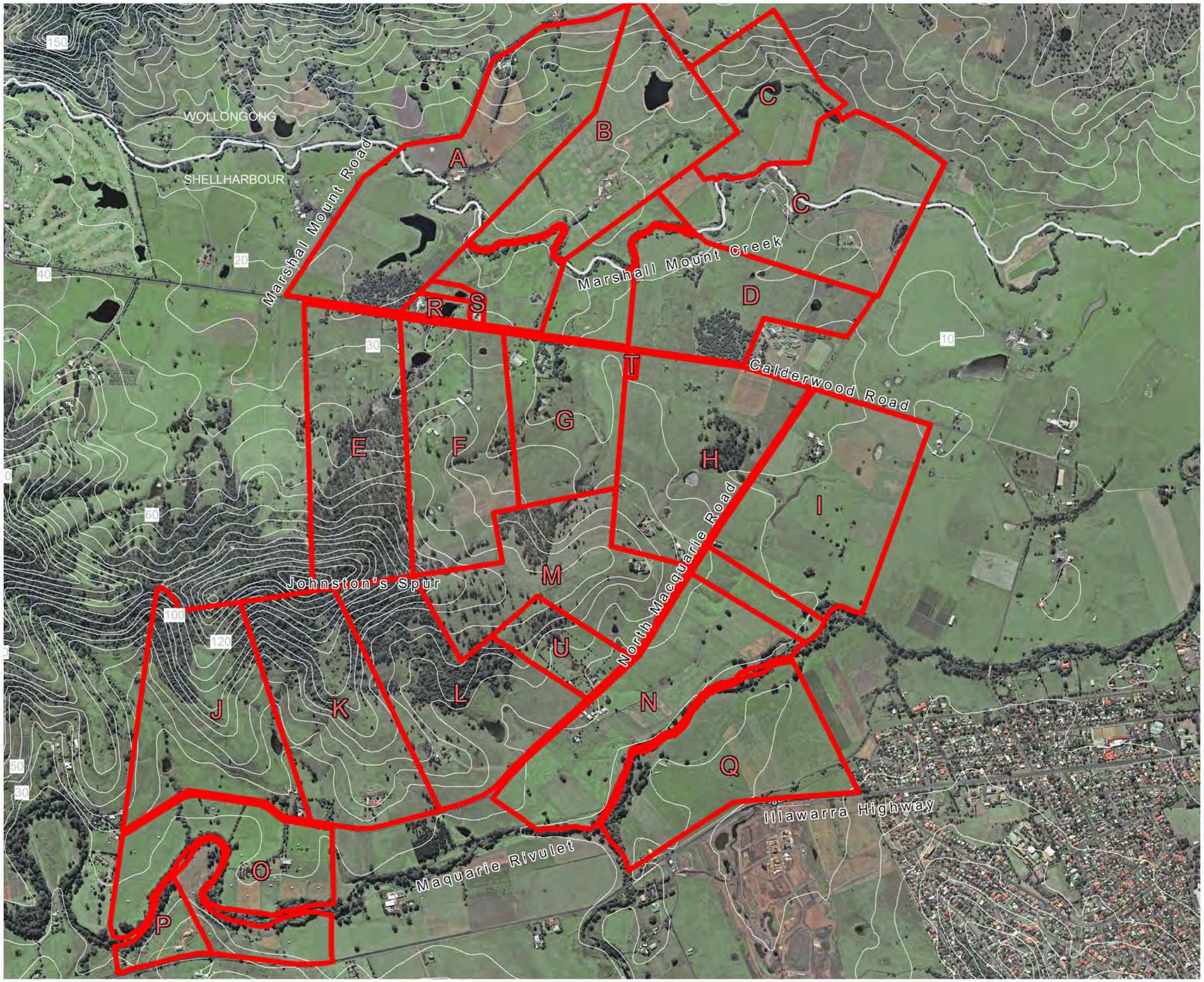
APPENDIX A

Drawing 1 – 9





Douglas Partners Geotechnics · Environment · Groundwater	CLIENT: DELFIN LEND LEASE LTD		TITLE: CONCEPT PLAN AND LOCALITY PLAN CONCEPT PLAN APPLICATION: GEOTECHNICAL STUDY CALDERWOOD URBAN DEVELOPMENT PROJECT	PROJECT: 48742.00
	DRAWN BY: CCK	SCALE: 1:15000 @A3 OFFICE: W'GONG		DRAWING: 1
	APPROVED BY: CCK	DATE: 18 FEB10		REVISION: 1



Legend

- LGA Boundary
- 10 m Contour
- Region
- A — Property Name

Douglas Partners
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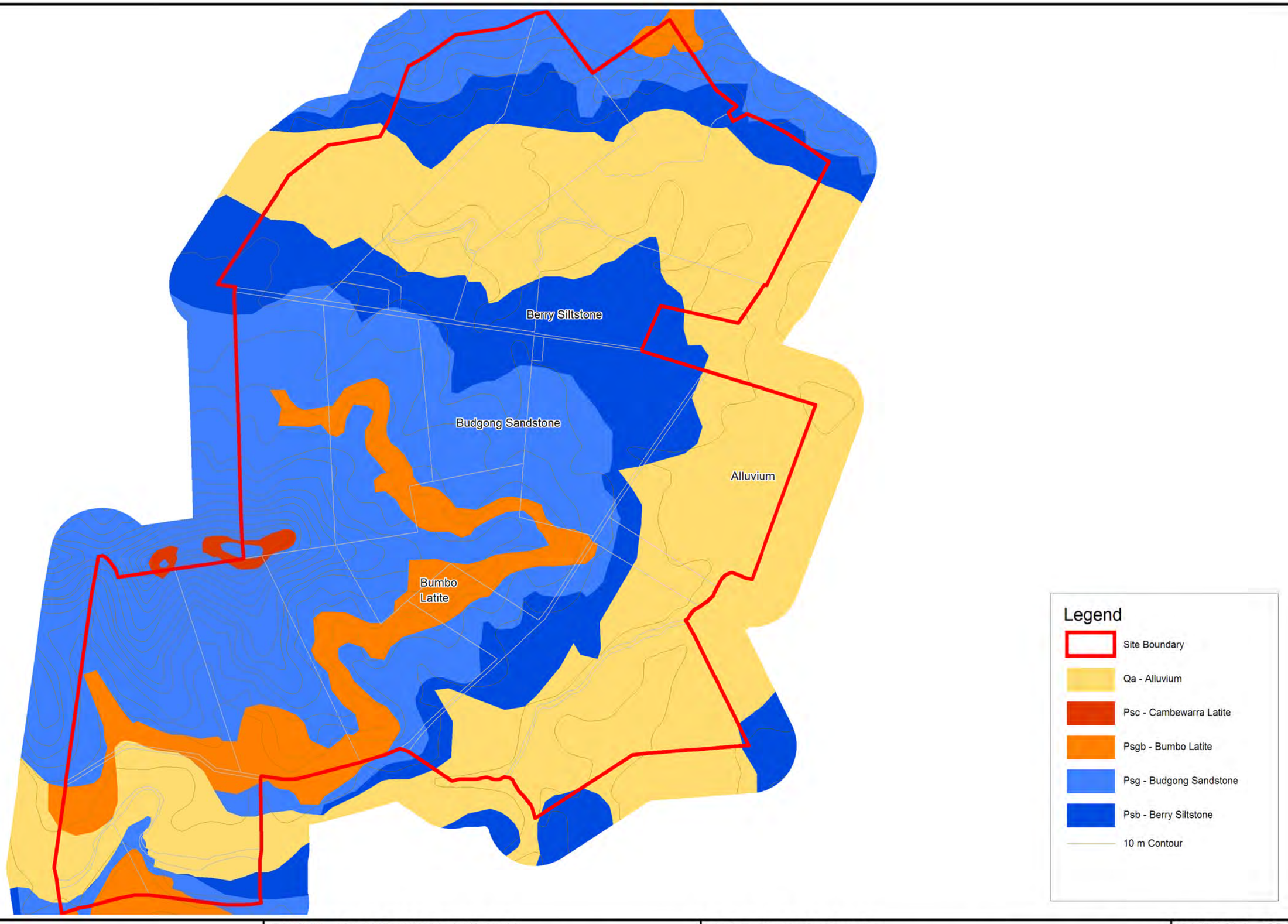
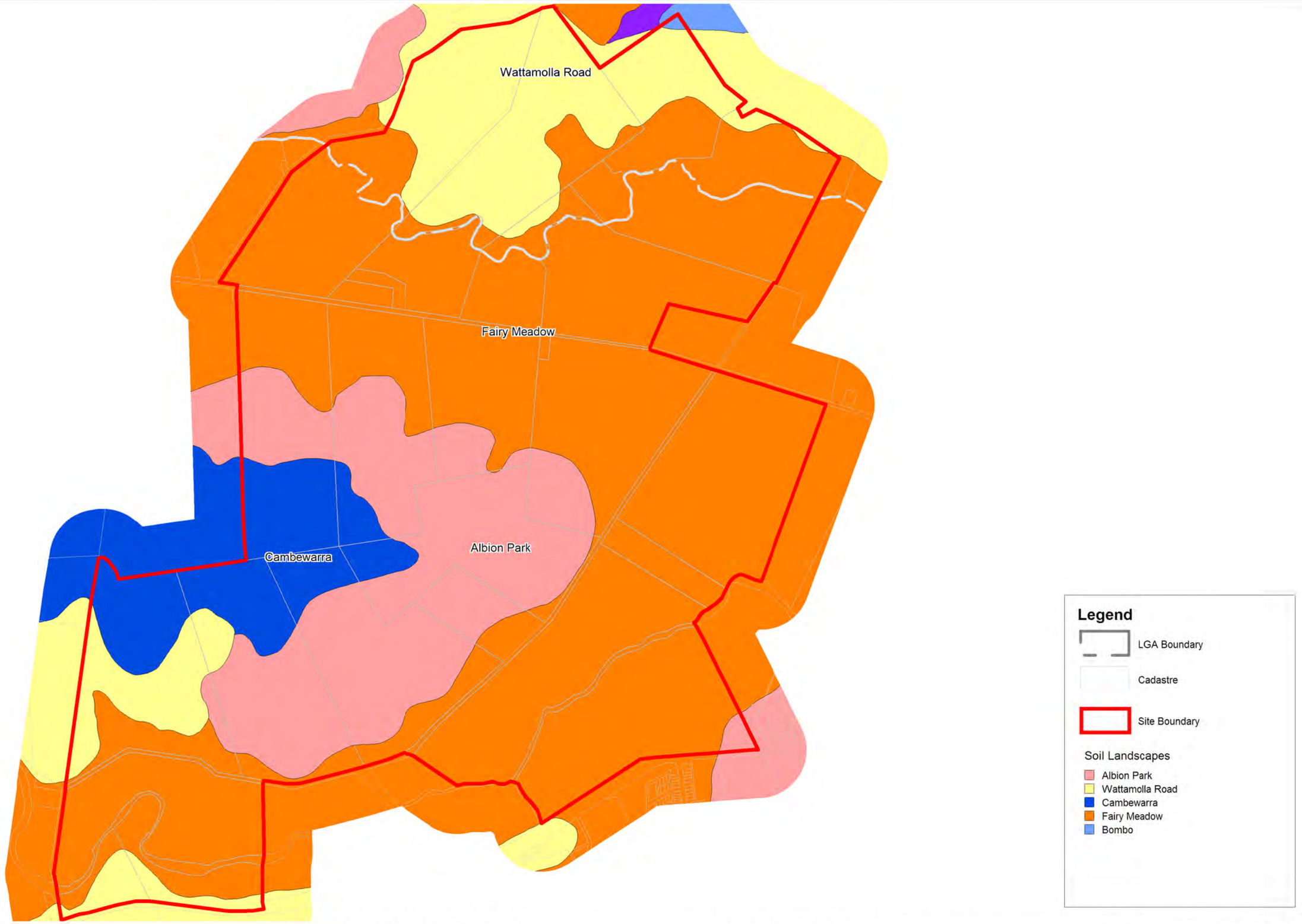
CLIENT: DELFIN LEND LEASE LTD			TITLE: SITE FEATURES AND PROPERTY NAMES CONCEPT PLAN APPLICATION: GEOTECHNICAL STUDY CALDERWOOD URBAN DEVELOPMENT PROJECT	PROJECT: 48742
DRAWN BY: CCK	SCALE: 1:15000 @A3	OFFICE: W'GONG		DRAWING: 2
APPROVED BY: CCK		DATE: 18 FEB10		REVISION: 1

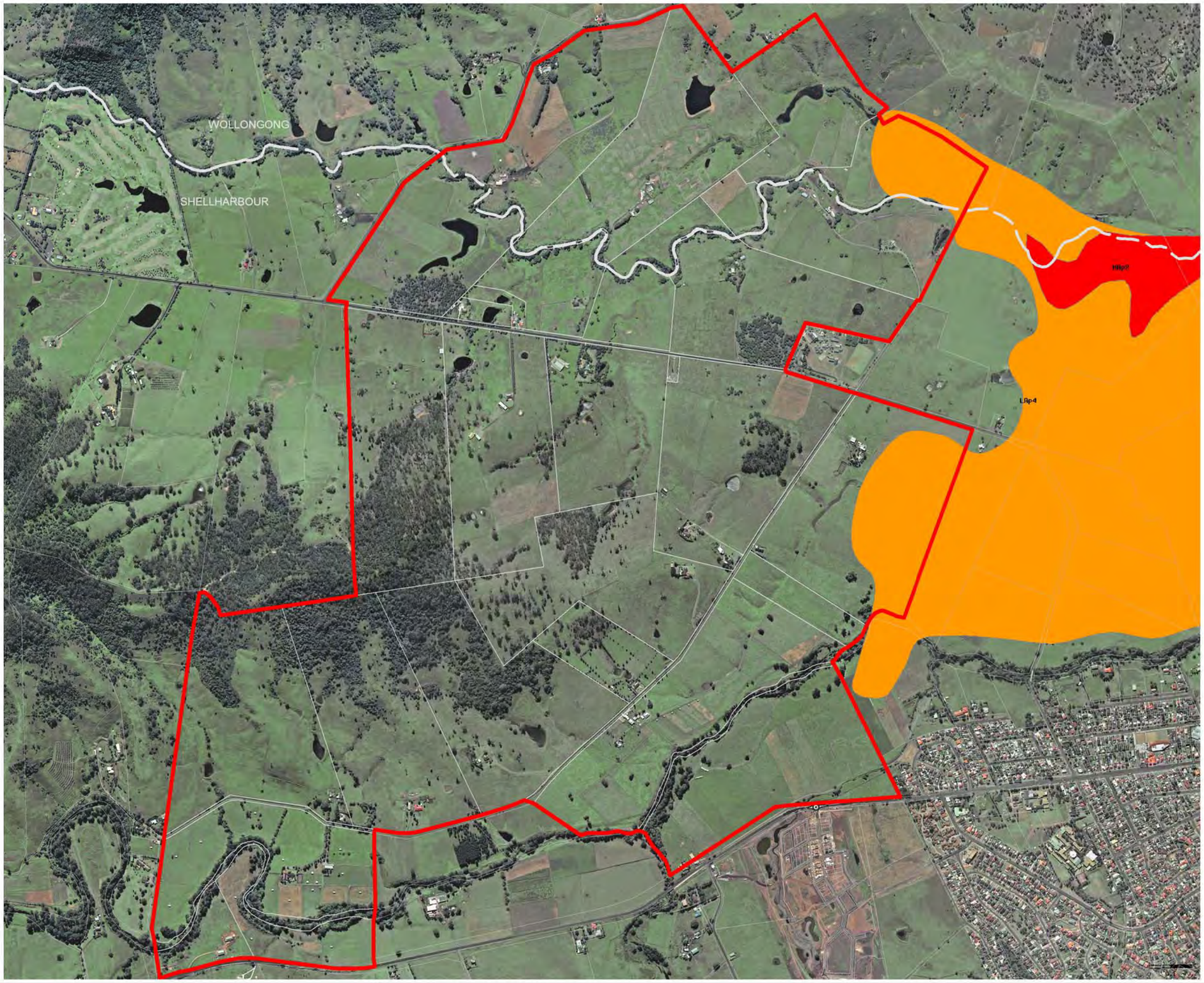


Douglas Partners Geotechnics · Environment · Groundwater	CLIENT: DELFIN LEND LEASE LTD		TITLE: SITE GEOLOGY CONCEPT PLAN APPLICATION: GEOTECHNICAL STUDY CALDERWOOD URBAN DEVELOPMENT PROJECT
	DRAWN BY: CCK / SCALE: 1:15000 @A3	OFFICE: W'GONG	
	APPROVED BY: CCK	DATE: 18 FEB10	
			PROJECT: 48742
			DRAWING: 3
			REVISION: 1



Douglas Partners Geotechnics · Environment · Groundwater	CLIENT: DELFIN LEND LEASE LTD			PROJECT: 48742
	DRAWN BY: CCK	SCALE: 1:15000 @A3	OFFICE: W'GONG	DRAWING: 4
	APPROVED BY: CCK		DATE: 18 FEB10	REVISION: 1

TITLE: SOIL LANDSCAPES
CONCEPT PLAN APPLICATION: GEOTECHNICAL STUDY
CALDERWOOD URBAN DEVELOPMENT PROJECT



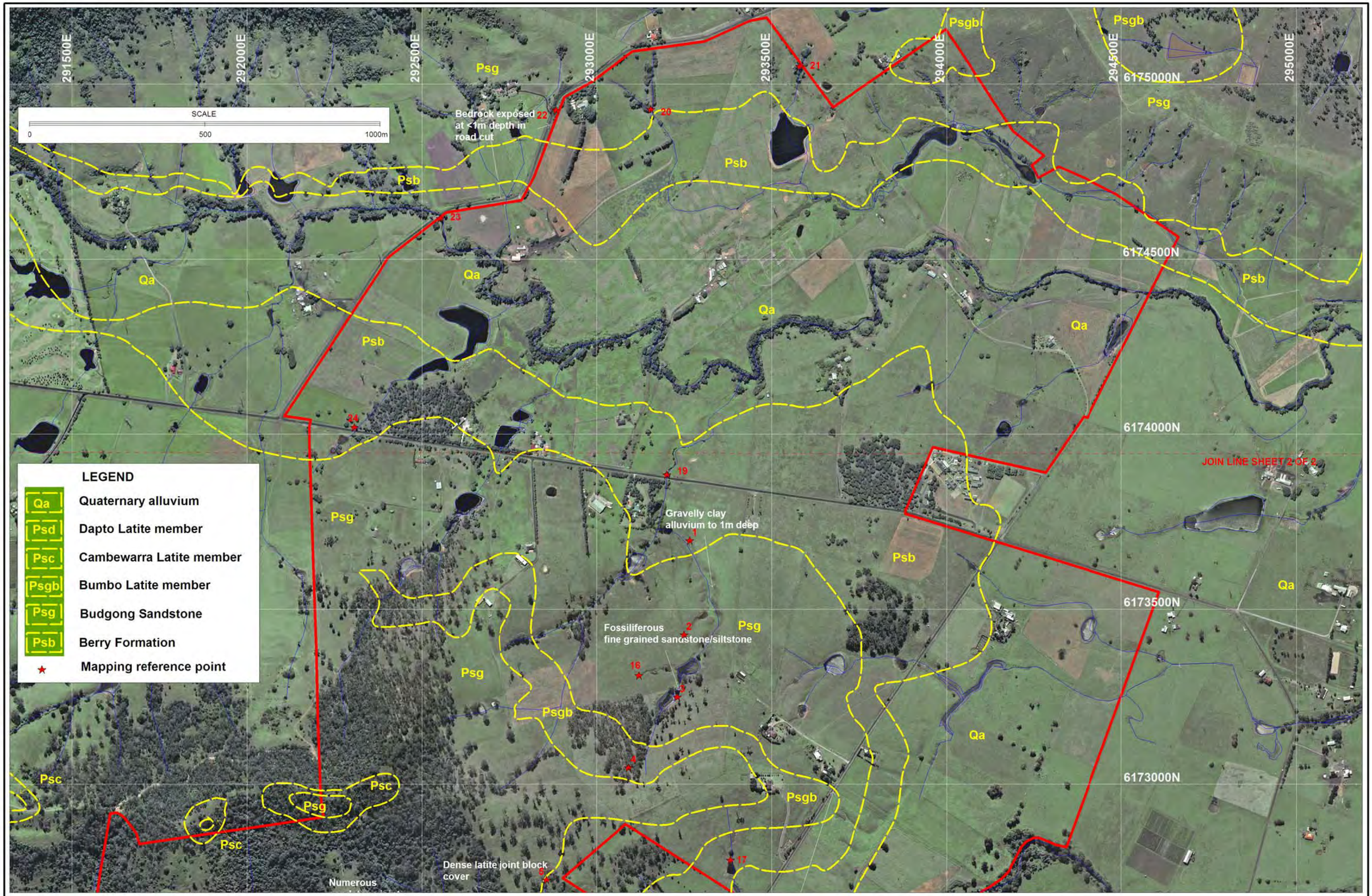
Douglas Partners Geotechnics · Environment · Groundwater	CLIENT: DELFIN LEND LEASE LTD			PROJECT: 48742
	DRAWN BY: CCK	SCALE: 1:15000 @A3	OFFICE: W'GONG	DRAWING: 5
	APPROVED BY: CCK		DATE: 18 FEB10	REVISION: 1

TITLE: ACID SULPHATE SOIL RISK MAP
CONCEPT PLAN APPLICATION: GEOTECHNICAL STUDY
CALDERWOOD URBAN DEVELOPMENT PROJECT

Douglas Partners Geotechnics · Environment · Groundwater	CLIENT: DELFIN LEND LEASE LTD		
	DRAWN BY: CCK	SCALE: 1:15000 @A3	OFFICE: W'GONG
	APPROVED BY: CCK		DATE: 18 FEB10

TITLE: TEST LOCATIONS
CONCEPT PLAN APPLICATION: GEOTECHNICAL STUDY
CALDERWOOD URBAN DEVELOPMENT PROJECT

PROJECT: 48742
DRAWING: 6
REVISION: 1



Douglas Partners *Geotechnics · Environment · Groundwater*	CLIENT: Delfin Lend Lease	TITLE: **SITE GEOLOGY** **CONCEPT PLAN APPLICATION: GEOTECHNICAL STUDY** **CALDERWOOD URBAN DEVELOPMENT PROJECT**	PROJECT No: 48742
	DRAWN BY: GRW / SCALE: As shown / OFFICE: Sydney		DRAWING No: 7 Sheet 1
	APPROVED BY: GRW / DATE: 18 FEB 10		REVISION: 1

SCALE

0 500 1000m

LEGEND

- Qa — Quaternary alluvium
- Psd — Dapto Latite member
- Psc — Cambewarra Latite member
- Psgb — Bumbo Latite member
- Psg — Budgong Sandstone
- Psb — Berry Formation
- ★ — Mapping reference point

Gravelly clay alluvium to 1m deep

Fossiliferous fine grained sandstone/siltstone

Dense latite joint block cover

Numerous sandstone joint blocks along ridge

Bedrock at <1m depth over much of road cuts

Cemented colluvium

Sandstone joint blocks

High strength sandstone in gully base

Micaceous siltstone/ fine grained sandstone

Bedrock at shallow depth

Gravel and cobble bedload

JOIN LINE SHEET 1 OF 2

6173500N
6173000N
6172500N
6172000N
6171500N

291500E
292000E
292500E
293000E
293500E
294000E
294500E

Douglas Partners *Geotechnics · Environment · Groundwater*	CLIENT: Delfin Lend Lease		
	DRAWN BY: GRW	SCALE: As shown	OFFICE: Sydney
	APPROVED BY: GRW		DATE: 18 FEB 10

TITLE: **SITE GEOLOGY**
CONCEPT PLAN APPLICATION: GEOTECHNICAL STUDY
CALDERWOODURBAN DEVELOPMENT PROJECT

PROJECT No: 48742
DRAWING No: 7 Sheet 2
REVISION: 1

SCALE

0 500 1000m

LEGEND

- Stable Land
- Stable Land - minor area of slope instability
- Less Stable Land
- Moderately Unstable Land
- Topographically Unstable for Development
- Essentially Unstable Land
- Mapping reference point
- Areas of discontinuous erosion

Discontinuous erosion in gully floor and walls

Partially filled erosion gullies

Boulders and cobble spill down slope

Latite cobbles and gravel bed load

Possible erosion or shallow soil slump scarp

Minor, discontinuous erosion in gully bases

Minor erosion below dam exposes bedrock

Mostly well vegetated creek banks

Well vegetated river banks

JOIN LINE SHEET 1 OF 2

6173500N

6173000N

6172500N

6172000N

6171500N

291500E

292000E

292500E

293000E

293500E

294000E

294500E

Douglas Partners *Geotechnics · Environment · Groundwater*	CLIENT: Delfin Lend Lease Ltd		
	DRAWN BY: GRW	SCALE: As shown	OFFICE: Sydney
	APPROVED BY: GRW		DATE: 18 FEB 10

TITLE: **SLOPE INSTABILITY HAZARD ZONING**
CONCEPT PLAN APPLICATION: GEOTECHNICAL STUDY
CALDERWOODURBAN DEVELOPMENT PROJECT

PROJECT No: 48742

DRAWING No: 8 Sheet 2

REVISION: 1

SCALE

0 500 1000m

LEGEND

- Stable Land
- Stable Land - minor area of slope instability
- Less Stable Land
- Moderately Unstable Land
- Topographically Unstable for Development
- Essentially Unstable Land
- Mapping reference point
- Areas of discontinuous erosion

292500E
293000E
293500E
294000E
294500E
295000E
6175000N
6174500N
6174000N
6173500N
6173000N

Creek banks well vegetated

Incised vegetated gullies

Localised exposure of soils

Revegetated erosion channels

<0.5m deep, discontinuous gully erosion

Discontinuous erosion in gully floor and walls

Partially filled erosion gullies

JOIN LINE SHEET 2 OF 2

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CLIENT: Delfin Lend Lease Ltd		
DRAWN BY: GRW	SCALE: As shown	OFFICE: Sydney
APPROVED BY: GRW		DATE: 18 FEB 10

TITLE: **SLOPE INSTABILITY HAZARD ZONING**
CONCEPT PLAN APPLICATION: GEOTECHNICAL STUDY
CALDERWOOD URBAN DEVELOPMENT PROJECT

PROJECT No:	48742
DRAWING No:	8 Sheet 1
REVISION:	1

Legend

- LGA Boundary
- Site Boundary
- Engineering works required to achieve low risk classification
- Very Low or Low Risk All development areas excluding the hatched area)
- Not Classified (Non development areas)

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CLIENT: DELFIN LEND LEASE LTD		
DRAWN BY: CCK	SCALE: 1:15000 @A3	OFFICE: W'GONG
APPROVED BY: CCK		DATE: 18 FEB10

TITLE: AGS CLASSIFICATIONS (POST DEVELOPMENT)
CONCEPT PLAN APPLICATION: GEOTECHNICAL STUDY
CALDERWOOD URBAN DEVELOPMENT PROJECT

PROJECT: 48742
DRAWING: 9
REVISION: 1